Cariboo Regional District
Regional Broadband Strategy

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1 EXECUTIVE SUMMARY

The Cariboo Regional District (the "CRD" or the "Regional District") has a large connectivity problem. While the Highway 97 corridor has decent broadband and cellular coverage, there are large tracts of highways that are without any cellular service and only 34% of its rural residents have broadband connectivity at the CRTC universal service objective of 50 million bits per second download speed and 10 million bits per second upload speed ("50/10" or the "USO").

With two of every three CRD residents living outside of the four member municipalities, the importance of reliable, connectivity to the rural and remote areas of the region is critical for the CRD as highlighted by the COVID-19 global pandemic that accelerated the shift of education, healthcare and employment on-line. Our goal as Canadians should be to advance our ability to provide online access to these essential services. As highlighted by recent global events, connectivity is the foundation for providing these services in an ever-increasing online world.

This project has identified and documented the state of connectivity throughout the region, with a focus on the rural electoral areas' broadband connectivity. In the CRD, 30% of households and businesses in the rural areas of the CRD are considered served at the USO level while over 50% of the 23,000 homes and businesses in the CRD having connectivity that would be considered poor making access to essential services online difficult. As part of the project, 68 project areas were identified representing over 16,000 homes and businesses in the area identified for these projects.

There are some initiatives underway in the CRD that may address some of the areas of concern, but there is still a substantial problem that will require a focused effort by the CRD. While infrastructure exists that can be leveraged, effort will be required by the CRD to work with existing providers to make the most effective use of that infrastructure with the goal of solving a bigger problem for more people. On the positive side, the connectivity challenge for the CRD may be easier to solve when compared with other regions of BC due to the relative number of larger clusters of home in closer proximity making the possibility of a suitable, subsidized business case more compelling for third parties. However, it still represents a highly significant financial challenge as detailed in the ancillary document so substantial efforts will be required to obtain suitable funding.

Steps that the CRD should take now include:

- Establishing a dedicated resource that can focus on leveraging all the assets available and finding creative ways to finance and move the process forward in an effective way.
- Develop criteria for prioritizing project areas and apply them to create a prioritized list.
- Determine the role CRD will play in advancing those priority areas.
- Seek opportunities wherever possible for a focused effort for third party providers and potential industry partners.
- Communicate to Telus the importance of developing timely cellular coverage along highway 20 leveraging the Pathways to Technology fibre to the home project from 2020.
- Collaborate with area First Nations in applying pressure to expand cellular coverage.

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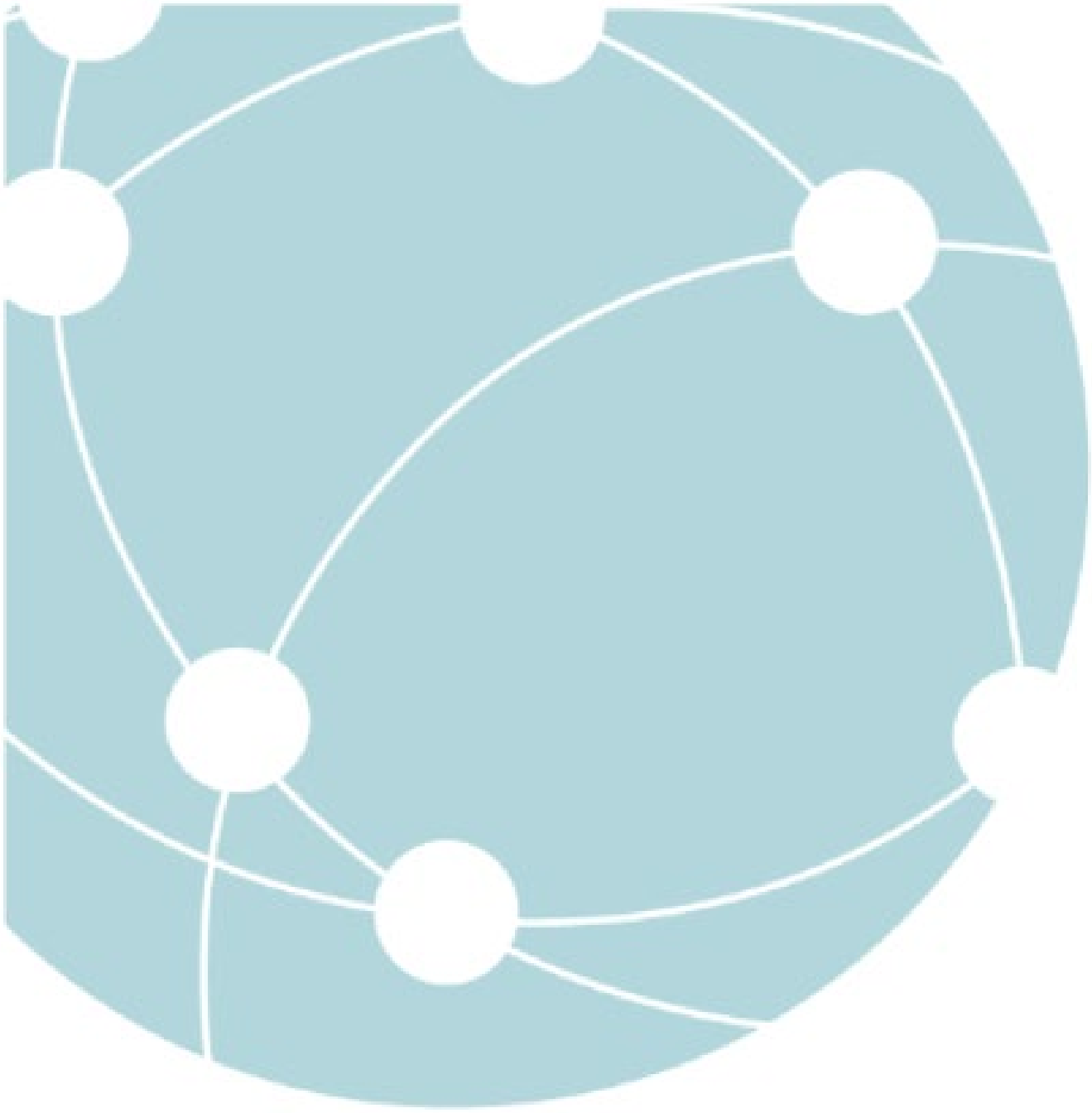

2 INTRODUCTION

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2.1 Purpose and Organization of Report

This report provides a strategy for the CRD to connect residents and businesses that do not have broadband service at the USO as well as to develop broad cellular coverage throughout the region. The project:

- assessed the existing state of connectivity and cellular coverage within the Regional District;
- identified:
  - entities providing internet or cellular service in the region;
  - the service areas for such identified entities;
  - the technology type that such entity provided service through;
  - areas that are not served or are underserved at the USO;
- provided a path forward to improve connectivity and cellular coverage in the region; and,
- developed high-level budgetary costing.

The report is organized to step the reader through relevant background information about the CRD, identifies what the CRD wants its future state to look like and why, provides a summary of where CRD is today and then discusses what can be done to improve connectivity in CRD.

2.2 Intended Audience

This report is intended to be utilized internally by CRD staff and Board of Directors for education, guidance, and planning purposes to support decision making and advocacy efforts to improve access to, and availability of, cellular service and high-speed connectivity throughout the CRD. This regional connectivity strategy has been provided along with ancillary supporting information and documentation to the CRD for its sole benefit and reference.

2.3 Project Scope & Assumptions

The project focused on the rural electoral areas of the Regional District and included an assessment of its existing broadband connectivity and cellular coverage and then developed a strategy for improvement. The scope of the project did not include an assessment of any member municipalities. Additionally, while the information gathering on this project included efforts to reach out to rural First Nations in the area to obtain information about connectivity and cellular coverage on populated reserve lands, assessment and creation of a strategy for improved connectivity on First Nations lands was not within the scope of this project.

2.4 General Approach

Resources from TANEx and the CRD worked collaboratively to complete the strategy through various phases of the project. Regular bi-weekly calls were scheduled to keep the project moving and share information through the project. At a high level, developing this strategy included a series of activities including project kickoff, information gathering, public and stakeholder outreach, CRD Board of Directors' vision development, presentation of draft strategy to the CRD, receiving feedback, and report preparation and finalization.

The current state of broadband connectivity and cellular coverage in the CRD was assessed by:

- undertaking public domain research including data from Innovation, Science and Economic Development Canada ("ISED");

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- survey of area residents and businesses;
- direct outreach to service providers and stakeholders; and,
- direct outreach to rural area First Nations where possible.

An analysis of the difference between the current state of connectivity in the CRD and the CRD Board of Directors' vision was completed. Alternatives to fill the gaps in broadband connectivity and cellular coverage were developed and a draft strategy to do so was prepared and reviewed with the CRD staff team. The draft strategy incorporated feedback from the CRD project team and was then presented to the Board of Directors.

2.5 Impact of COVID-19 on the Project

COVID-19 demonstrated the critical importance of connectivity for everyone as the flood of BC residents tried to work from home, see their doctors remotely, and get an online education. The restart and success of the economy is highly driven by the ability to work remotely and be productive. The right to do so and engage in the economy belongs to every Canadian and connecting rural Canadians to broadband service must be of the highest importance. With 2 of every 3 residents in the Regional District living outside of member municipalities, high-speed broadband connectivity and cellular coverage to the rural and remote areas is absolutely vital to allow CRD residents to maintain health and education as well as run their businesses and work from home in this new world public health environment.

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3 CRD SUMMARY

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This section provides a background understanding of the Regional District as a whole and a lens through which to view this report, the strategy, and the recommendations.

3.1 Geographic Location

The CRD is one of the 5 largest regions in British Columbia at over 80,000 km^2. It is centrally located, and its neighbours are the seven regional districts of Bulkley Nechako, Fraser Fort George, Thompson Nicola, Squamish Lillooet, Strathcona, Mount Waddington and Central Coast.

3.2 Population and Communities

Cariboo is somewhat unique in the sense that most of its population resides within its electoral areas rather than in the municipalities. The 2016 census puts the population at 61,988 but is now quite out of date, so the BC estimated population of 66,872 may be more accurate[1][2]. Population numbers noted below are from the 2016 census data. Electoral Area population numbers do not include population from within member municipalities nor from First Nations' reserve lands geographically located in that Electoral Area.

Cariboo has only 4 incorporated municipalities while it has numerous First Nations' and rural communities. As noted above, Cariboo's population is very much located in its rural communities. The total incorporated municipality population is only 22,584 out of total population of 61,988. Stated another way, 64% of the population resides in the Electoral Areas.

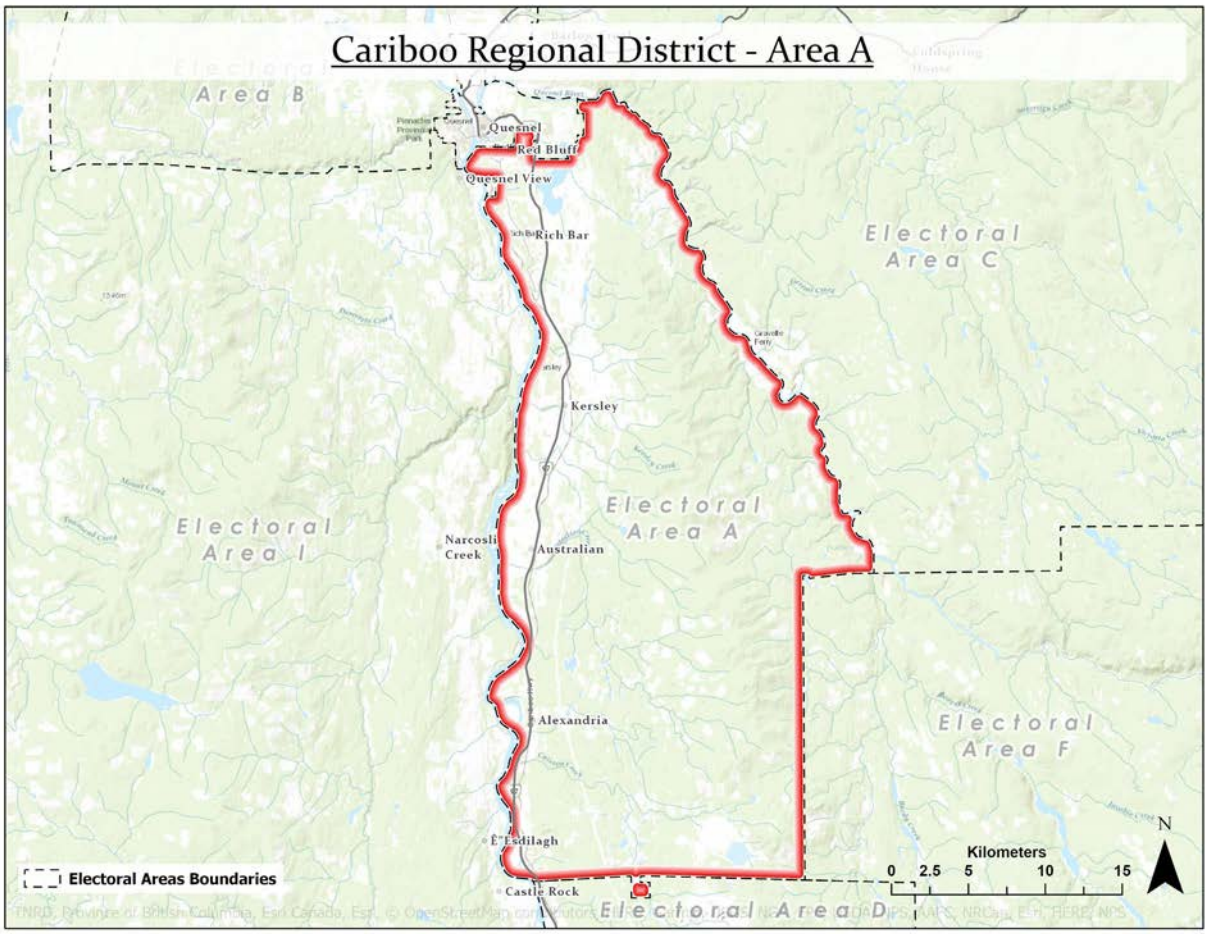
3.2.1 Electoral Areas

As outlined in the map below, the CRD is made up of 12 electoral areas which are identified by letters A – L. This strategy focused on those electoral areas and the rural communities within them that lack broadband connectivity at the USO as well as cellular coverage at appropriate levels. The total population for the electoral areas is 39,404.

[1] 2016 Statistics Canada Census Profile
[2] BC Population Estimate

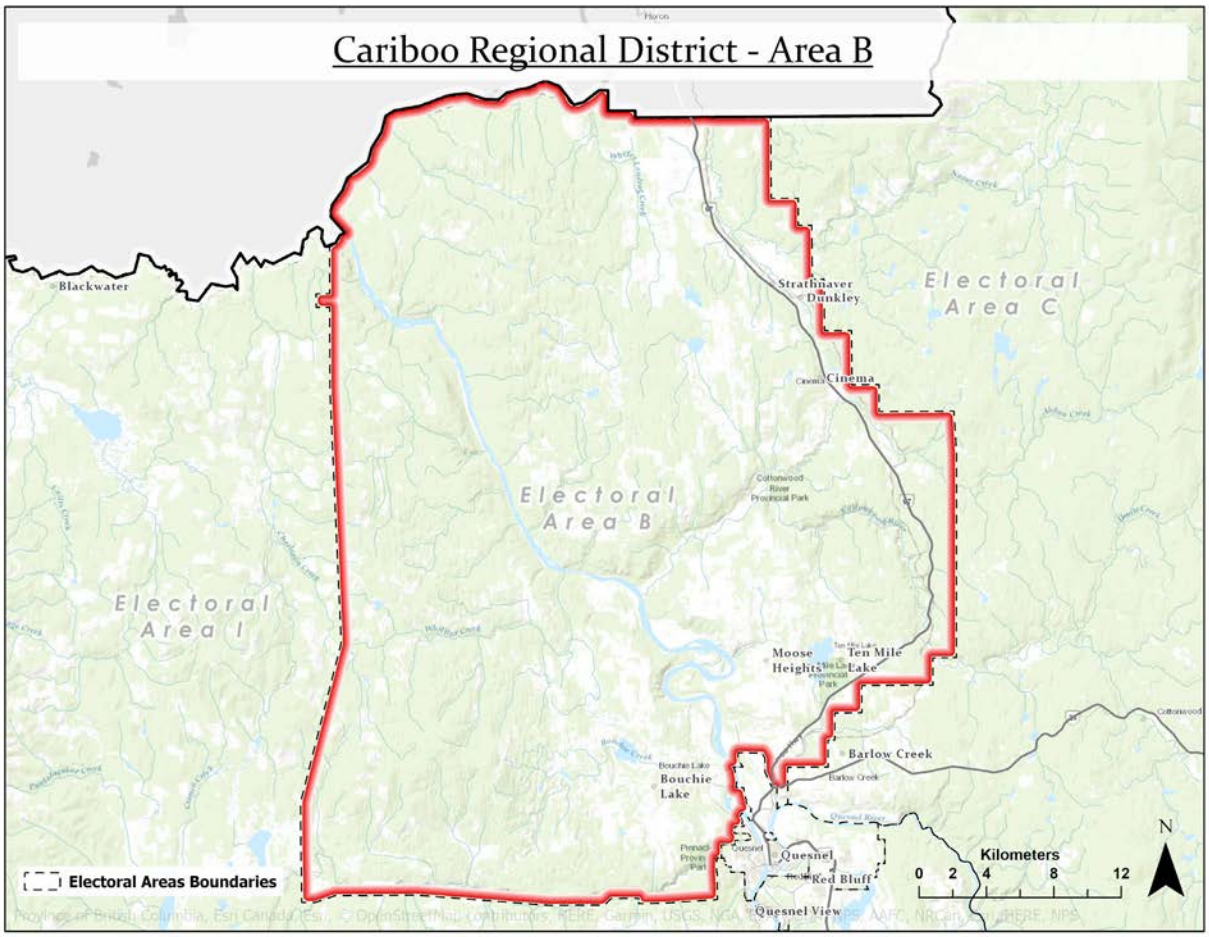
3.2.1.1 Area A – Red Bluff/Quesnel South

Area A is centrally located within the Regional District and is the smallest electoral area with 780km^2. It is just south of the City of Quesnel and has a significant population of 6,265 residents despite its small area. Rural communities in the Area include Red Bluff/Rich Bar which has about half of the area's population along with Kersley, Alexandria, and Dragon Lake.



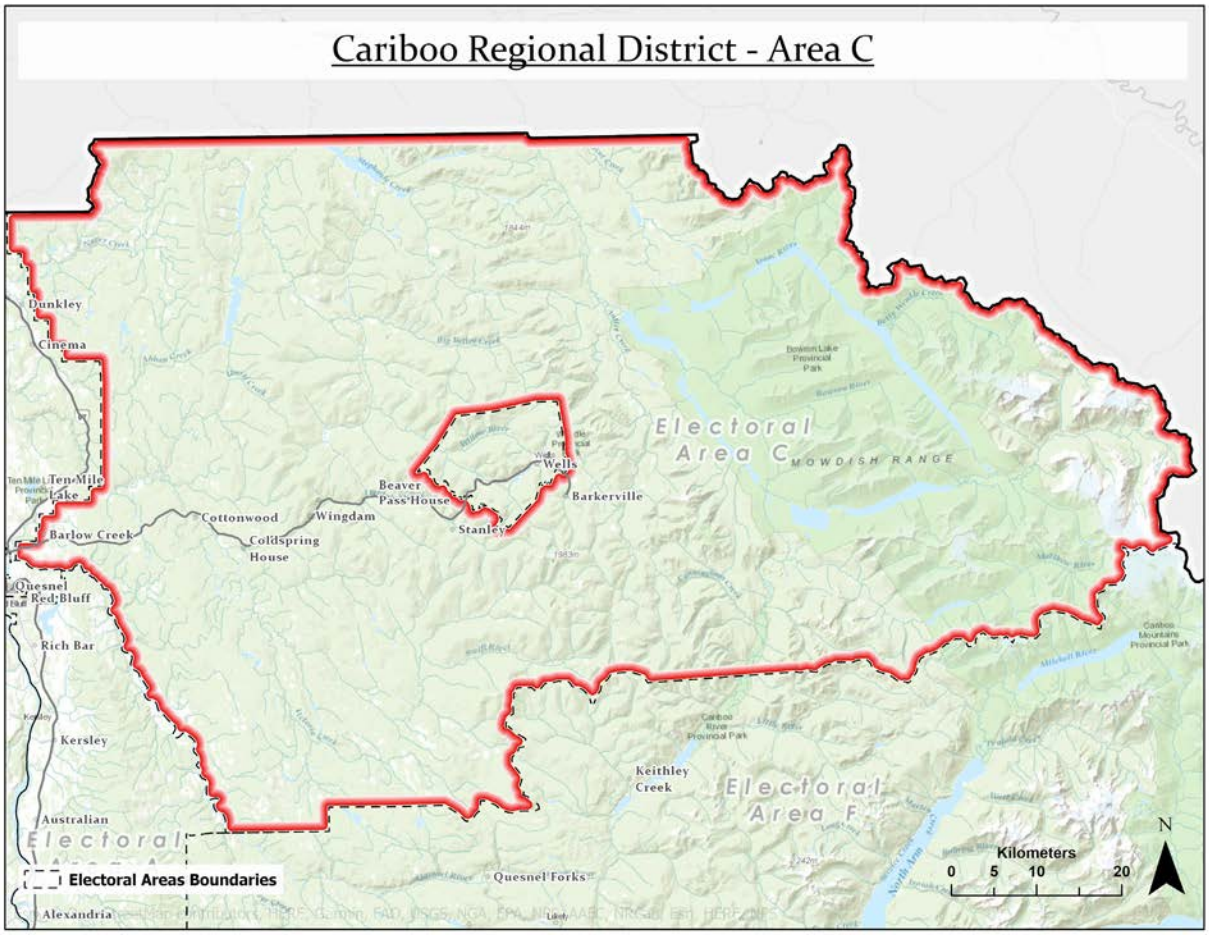
3.2.1.2 Area B – Quesnel West / Bouchie Lake

Area B, with a population of 3,842 residents, is one of the smaller geographical electoral areas in the CRD and is located north and west of the City of Quesnel. The largest community in Area B is Bouchie Lake with about 2,500 people. Other rural communities include Ten Mile Lake, Cinema, and Strathnaver. It covers about 1,415 km^2.



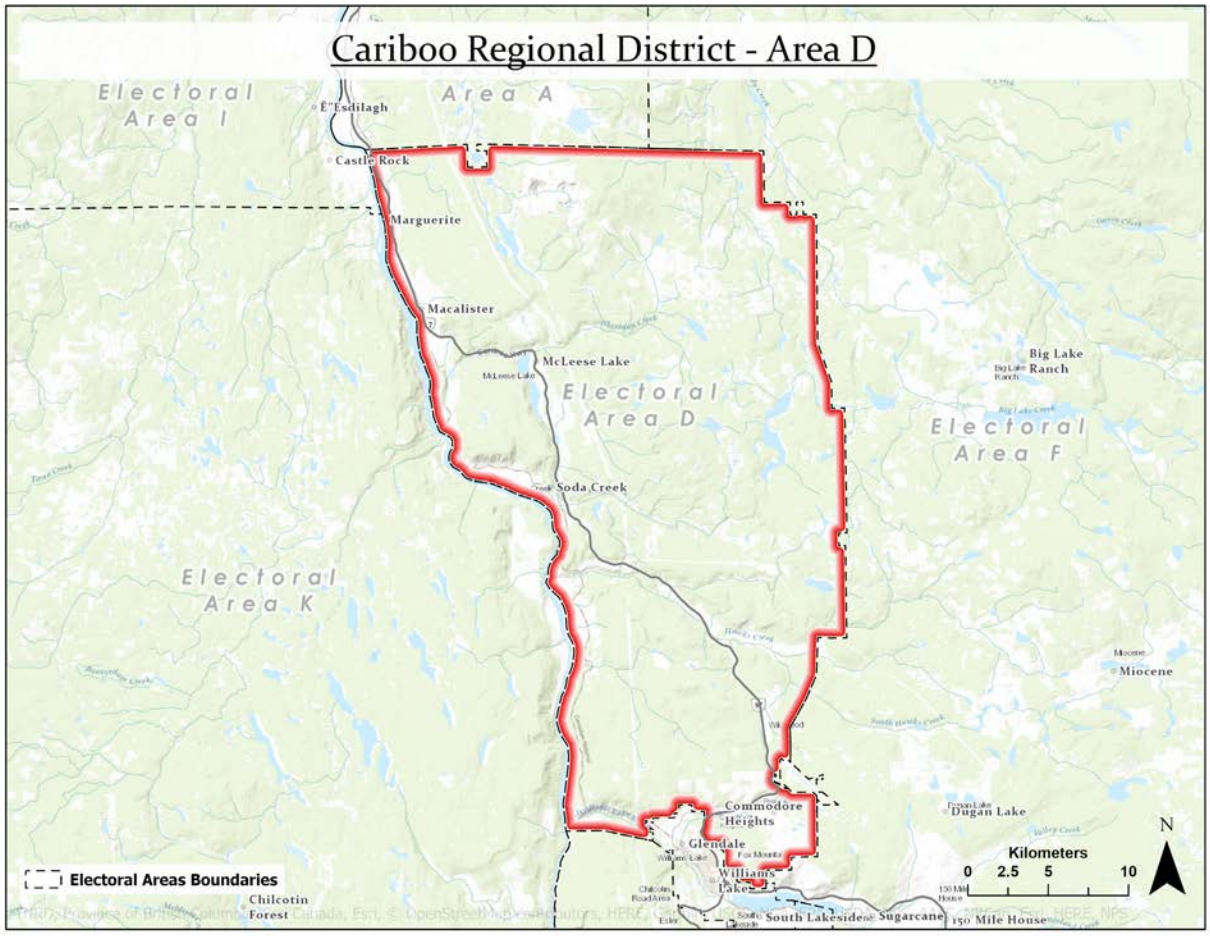
3.2.1.3 Area C – Barlow / Barkerville

In contrast to Area B, Area C is relatively large geographically with almost 7,500 km^2 of area. It is in the north-east corner of the CRD and home to far fewer residents. Its population is 1,225 who primarily live in Barlow Creek. The member municipality of the District of Wells is located within the geographic boundary of Area C. The Barkerville Heritage Trust historical settlement is also in Area C which has access to fibre service although no residents live there.



3.2.1.4 Area D – Commodore Heights / Fox Mountain / McLeese Lake / Pine Valley / Wildwood

Area D is central in the CRD and is directly south of Area A borders Williams Lake on its south boundary. It is the second smallest electoral area (853 km^2) and with a fairly significant population of 2,929. The largest community in Area D is Wildwood with other smaller communities including Pine Valley, Deep Creek, Soda Creek Valley, Mcleese Lake as well as a number of others.



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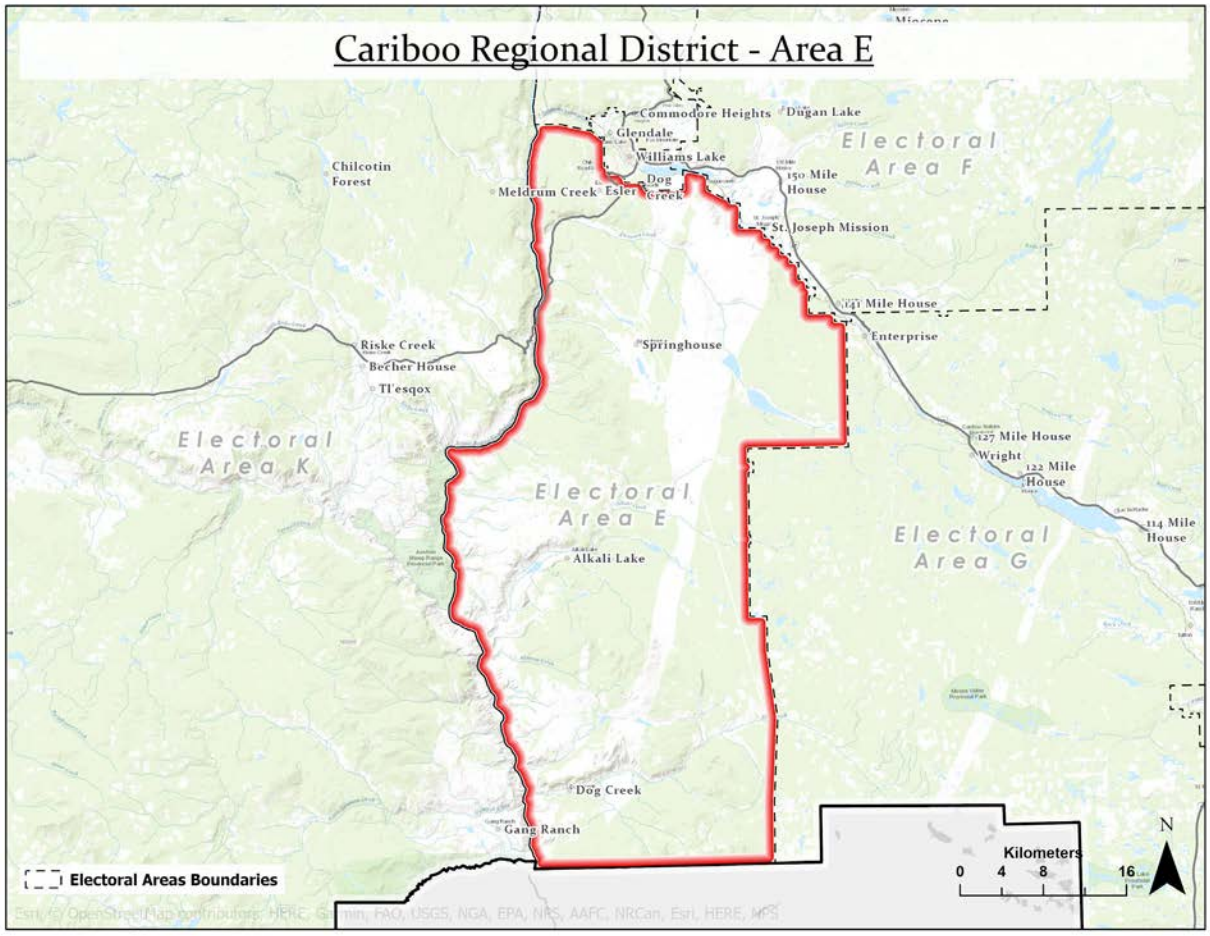
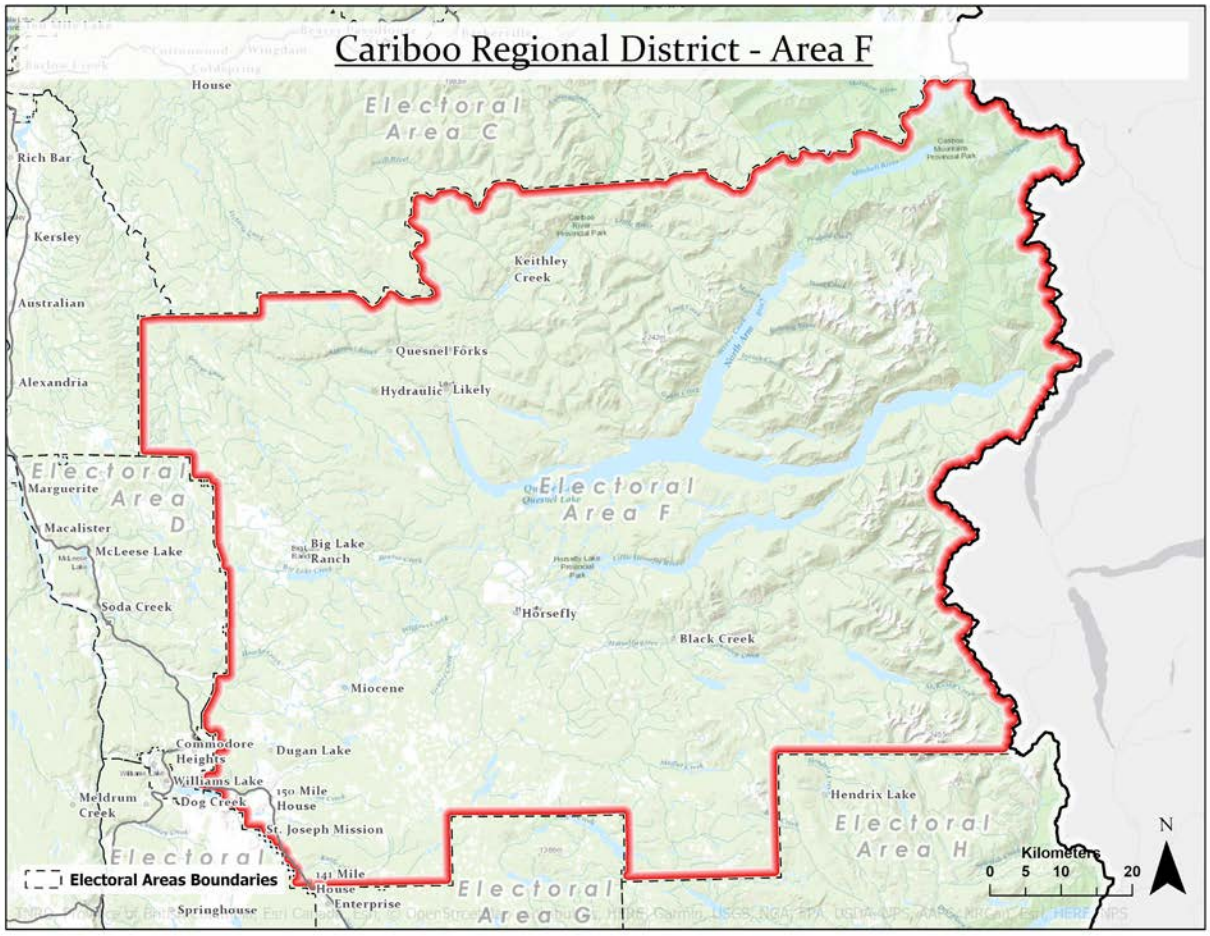
3.2.1.5 Area E – South Lakeside / Dog Creek

Directly south of Area D and Williams Lake is Area E. It is 1,749 km^2 and is home to 4,064 residents many of whom live in the fringe around Williams Lake. There are other small communities located south of the fringe such as Springhouse and Chimney Lake.



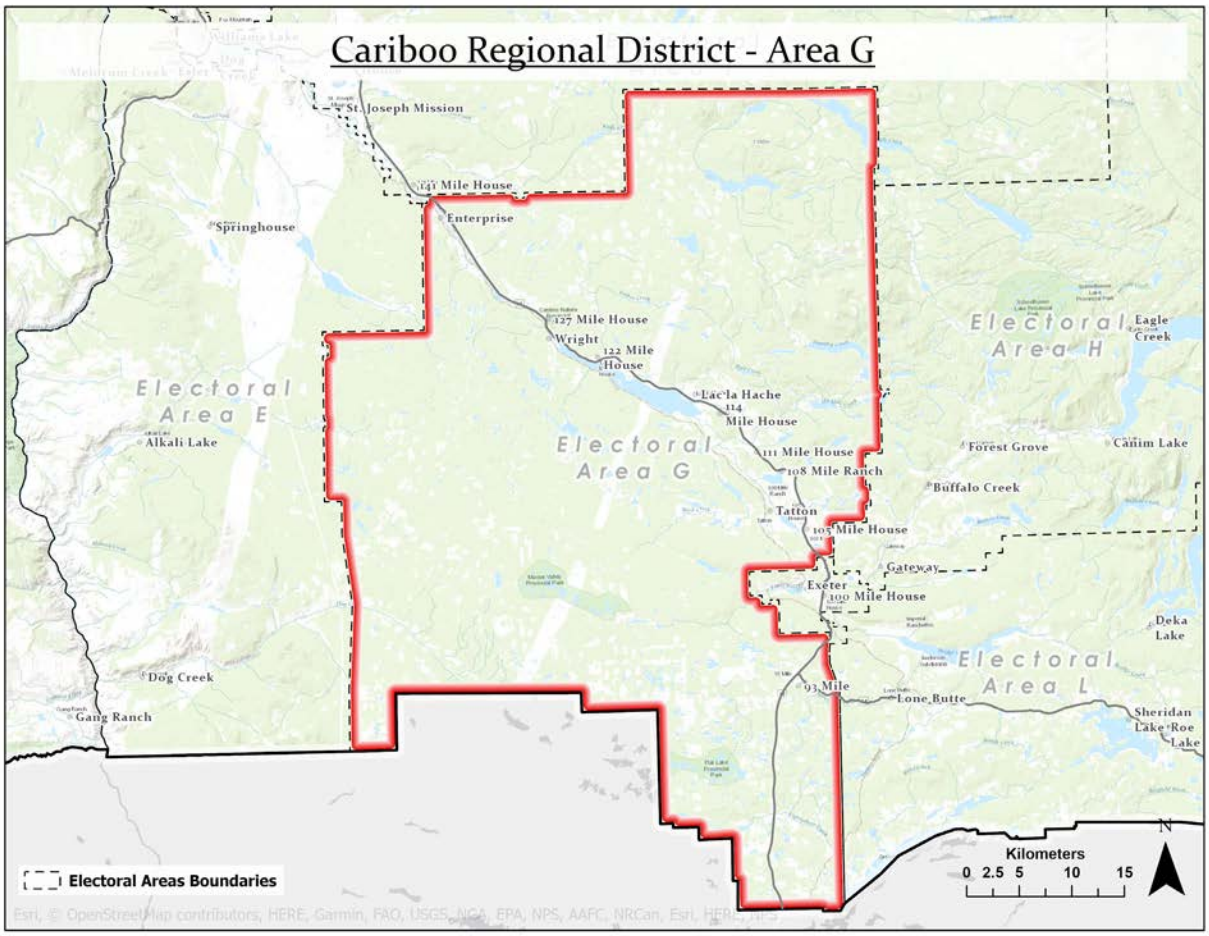
3.2.1.6 Area F – 150 Mile / Horsefly / Likely

Area F has a significant population of 4,554 in its expansive area of 9,761 km^2. The largest communities in Area F are Horsefly, Likely, Big Lake Ranch, and Miocene. Smaller communities include Hydraulic, Black Creek, Keithley Creek. Closer to the highway, the communities of 150 Mile House, 141 Mile House, and Dugan Lake are also in Area F.



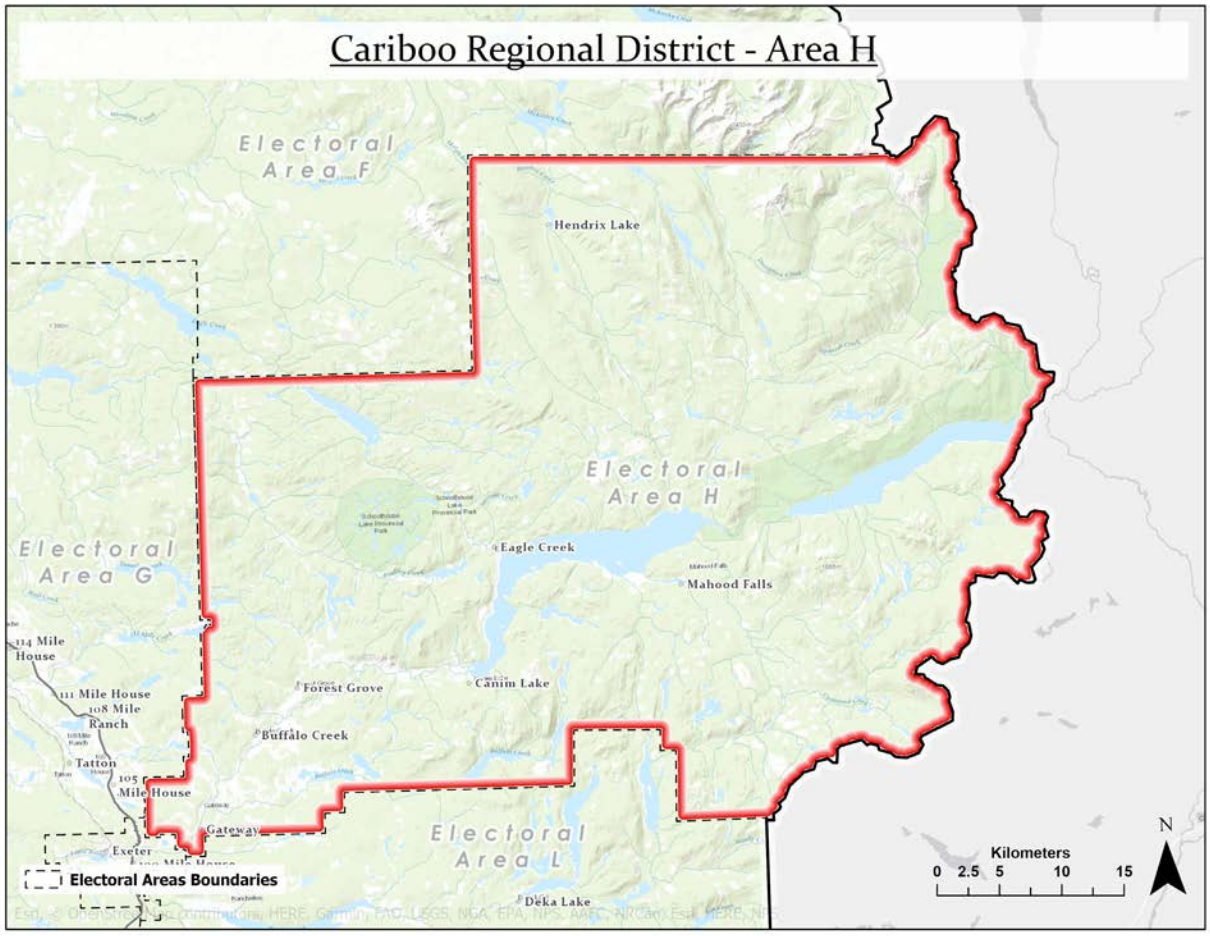
3.2.1.7 Area G – Lac La Hache / 108 Mile

South of Area F, sits the 2,681 km^2 Area G. Its population of 5,156 lives primarily in Lac La Hache and 108 Mile Ranch with smaller communities located in 93, 103 and 105 Mile House.



3.2.1.8 Area H – Canim Lake / Forest Grove

To the East of Area G, is Area H. Area H is 2,603 km^2 and has a population of 1,784 which are spread out among the communities of Canim Lake, Forest Grove, Ruth Lake, Hawkins Lake and Gateway. The Area Director reports a large seasonal population that swells the Area to around 5,000 people.



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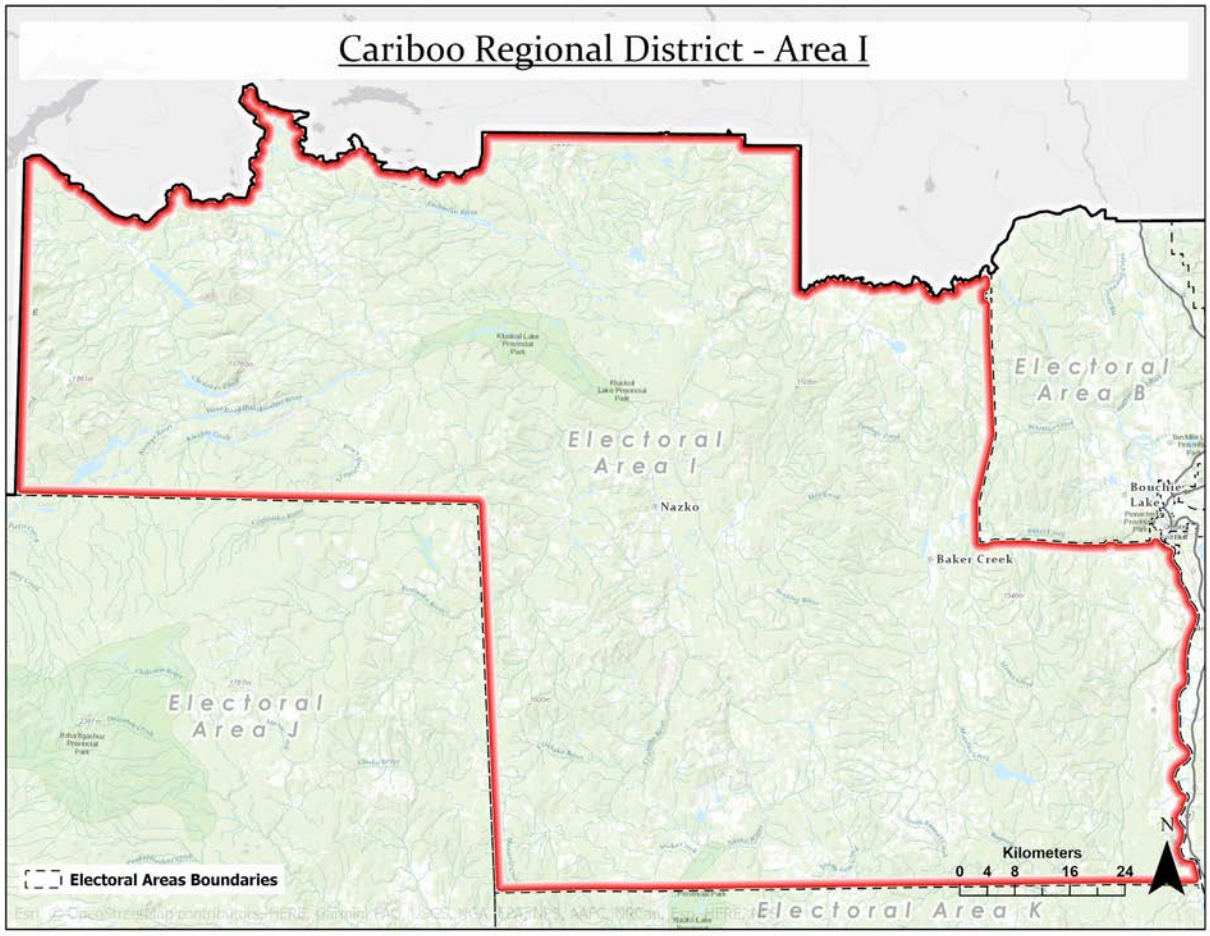
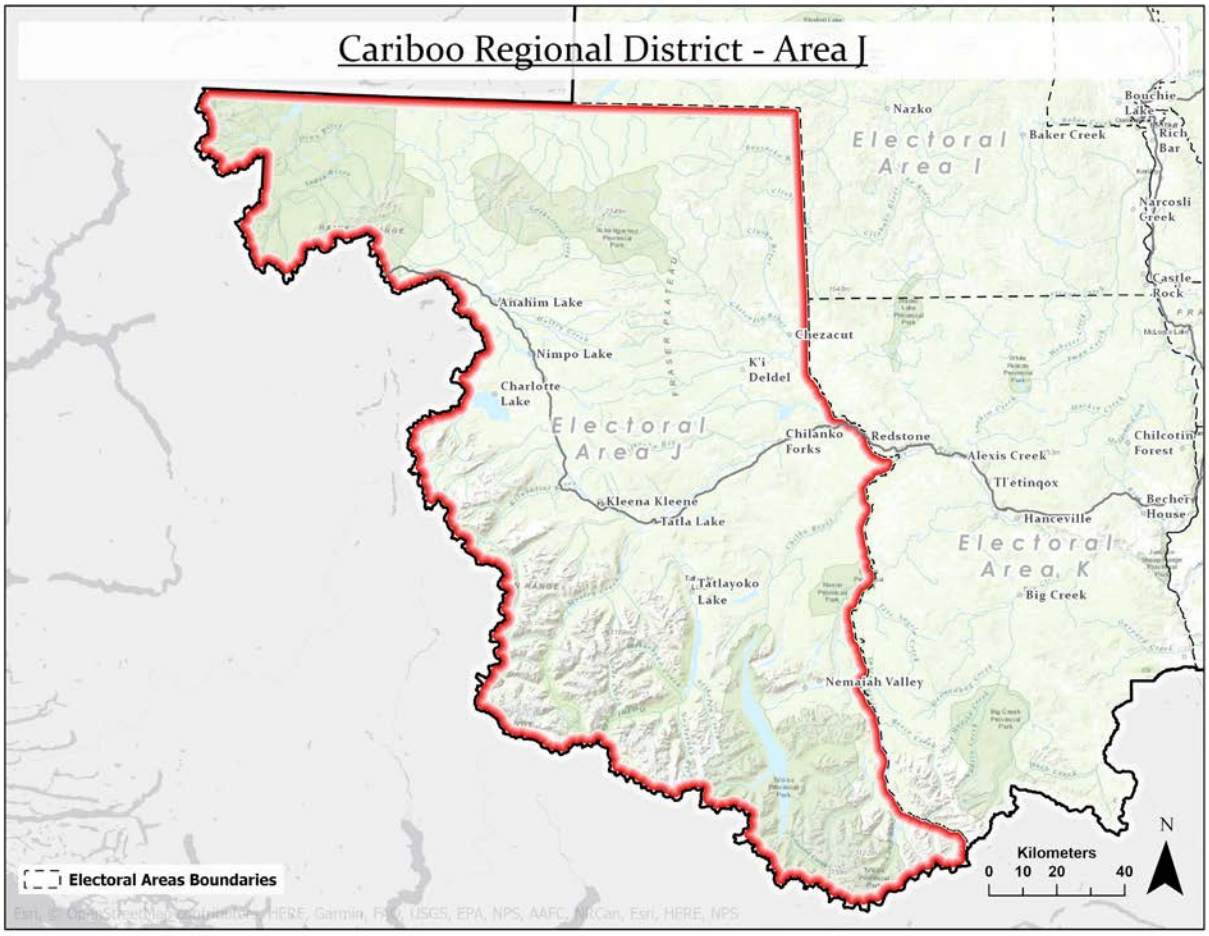
3.2.1.9 Area I – West Fraser / Nazko

In the North-West corner of the CRD is Area I which is very large at 11,947 km^2. Its population of 1,440 is one of the smaller populations by Electoral Area. The largest remote communities in the area are Nazko and Baker Creek. In Nazko, people reside both on and off First Nation reserve lands. There are also numerous people living closer to the Fraser River in the eastern portion of the area.



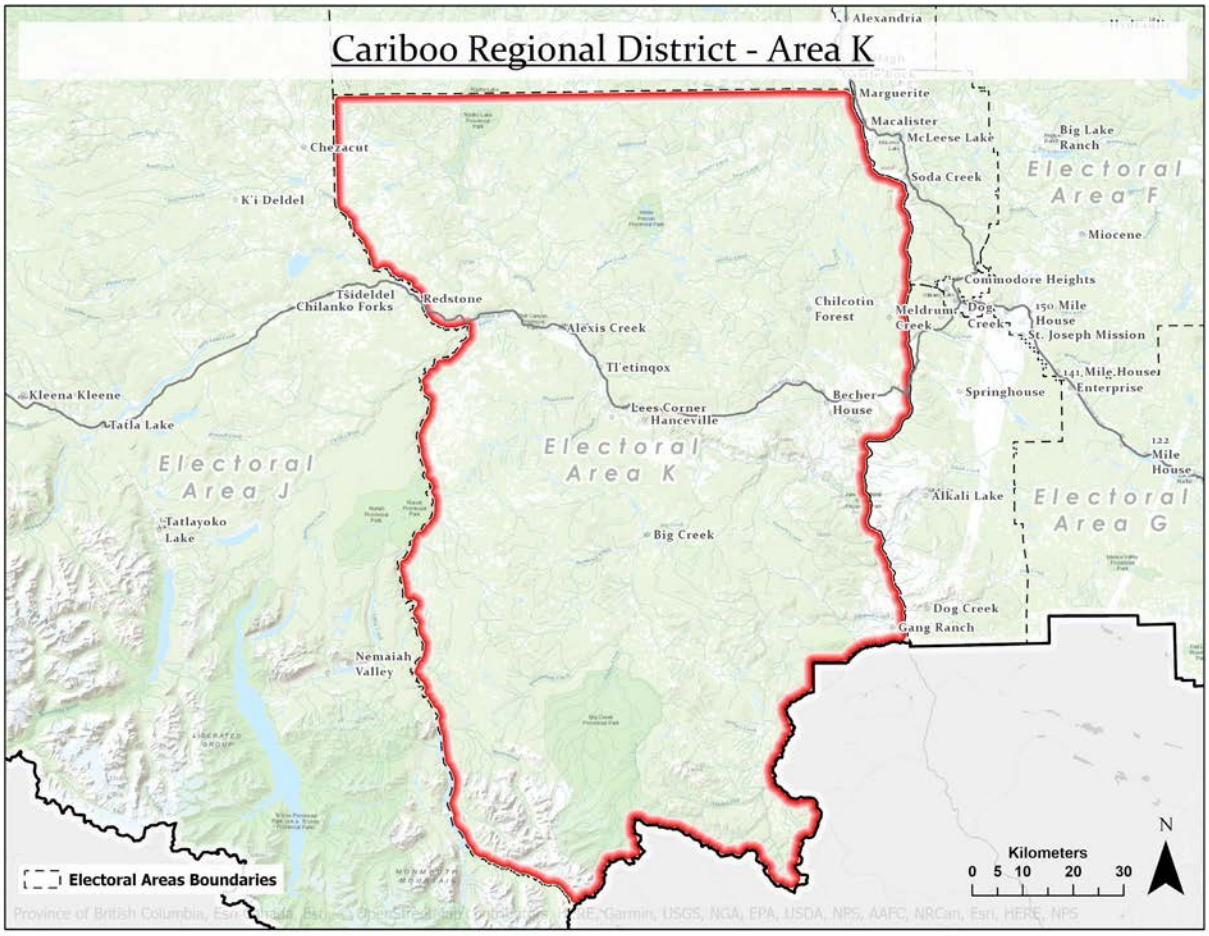
3.2.1.10 Area J – West Chilcotin

Area J is the largest Electoral Area in the CRD with a population of just 642 spread across the vast 25,932 km^2. Sizable communities include Tatlayoko Lake, Tatla Lake, Charlotte Lake, and Nimpo Lake. Anahim Lake is a community which has people living both on and off First Nation reserve lands.



3.2.1.11 Area K – East Chilcotin

Area K is also extremely large with a very small population. It is 13,679 km^2 with just 398 rural residents. Most of these reside in the communities of Alexis Creek, Hanceville, and Riske Creek all of which are located along the Chilcotin Highway.



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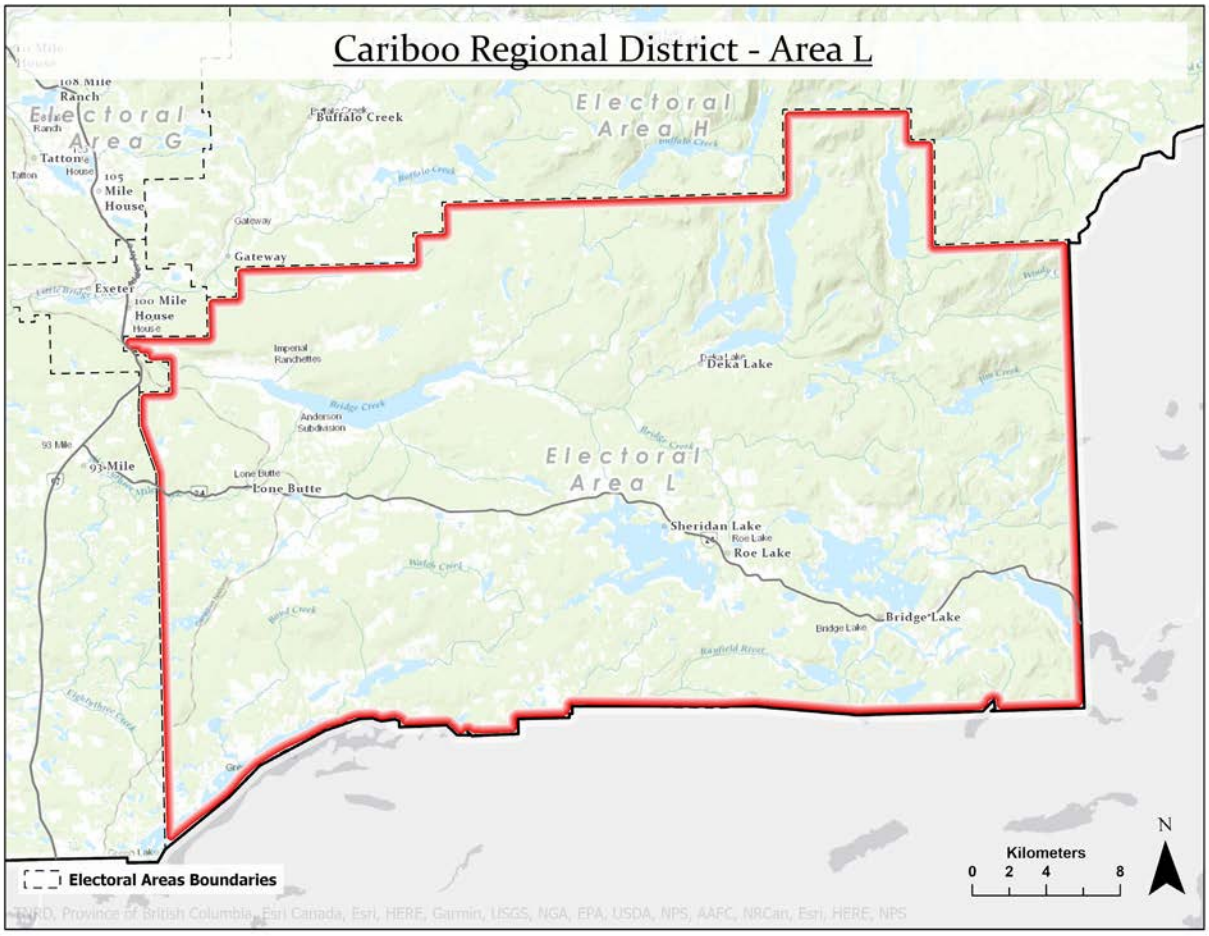
3.2.1.12 Area L – Lone Butte / Interlakes

Area L is in the South-East corner of the Regional District. It is 1,749 km^2 with a population of 4,064. The major communities in this area include Deka Lake, Sheridan Lake, Roe Lake, Bridge Lake, Lone Butte, Horse Lake, Watch Lake and the northern part of Green Lake.



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3.2.2 Member Municipalities

Along with the electoral areas noted above, there are four member municipalities within the CRD:

Member Municipality	Municipal Population 2016 Census[3]	Bordering Electoral Areas
Williams Lake	10,508	D, F and E
Quesnel	9,879	A, B, C and I
100 Mile House	1,980	G, H and L
Wells	217	C

3.2.3 First Nations Reserve Lands

The CRD has a large number of First Nations neighbours with reserve lands in the rural areas of the CRD which include[4]:

Band/First Nation	Members On/Off Reserve	Land Base (ha)	Electoral Area of Interest
Esdilagh First Nation	58/198	1348.20	A and I
Alexis Creek First Nation	342/364	4362.50	J
Canim Lake First Nation	430/176	2064.90	H
Esk'etemc First Nation	444/585	3960.10	E
Lhoosk'uz Dene Nation	58/184	1647.50	I
Lhtako Dene Nation	89/94	682.70	A
Nazko First Nation	130/277	1973.10	I
Xat'sull First Nation	170/271	2092.70	D
Stswecem'c Xgat'tem First Nation	296/477	Not available	E
Tl'etinqox-t'in Government	586/1053	5655.90	K
Tl'esqox First Nation	173/205	2582.50	K
Ulkatcho First Nation	651/414	Not available	J
Williams Lake Indian Band	278/567	1983.40	F
Xeni Gwet'in First Nations Government	243/211	1260.50	J
Yunesit'in Government	264/227	2146.40	K

[3] Statistics Canada, 2016 Census Profiles
[4] British Columbia Assembly of First Nations – Cariboo Region

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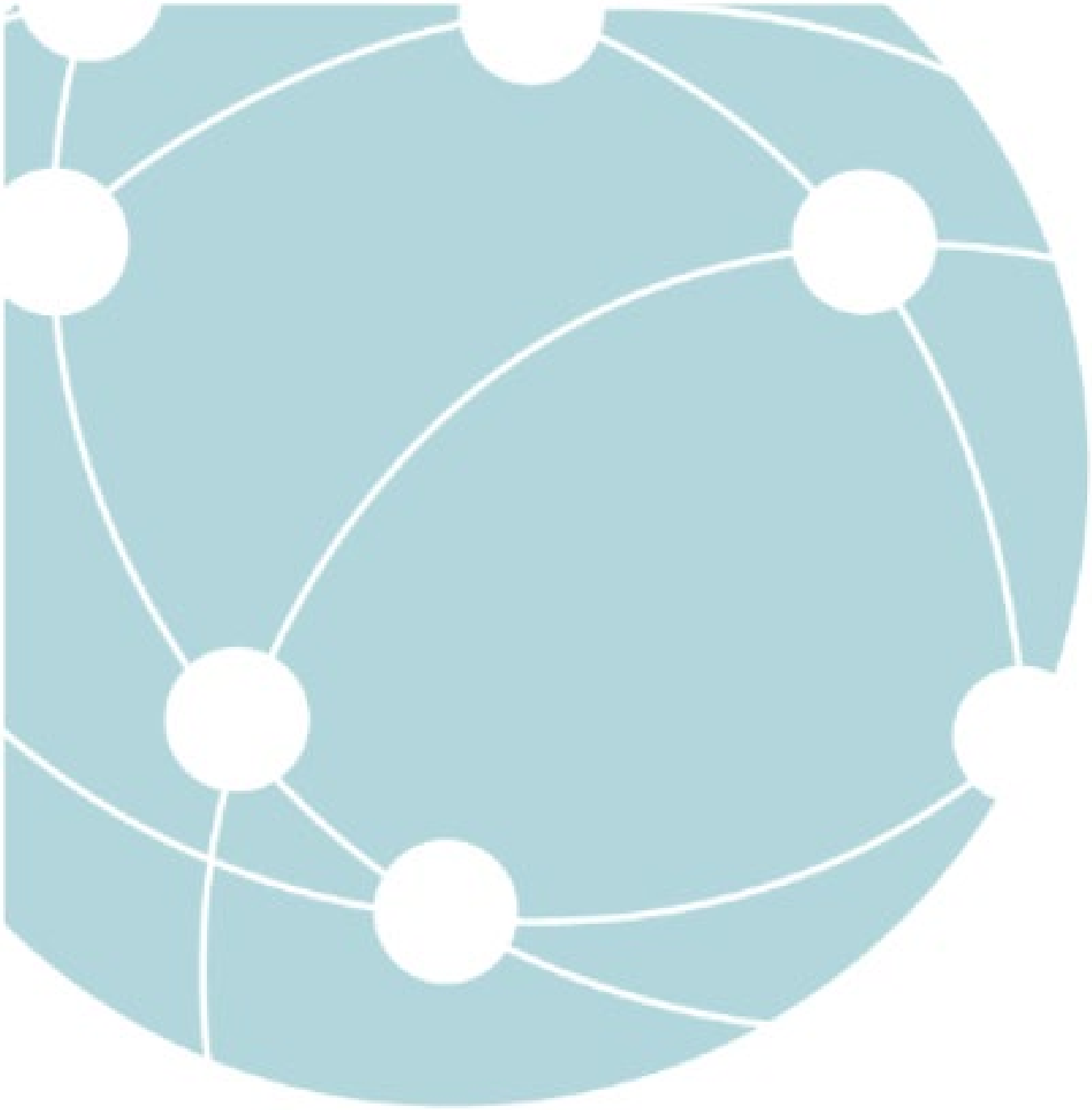

4 VISION AND GOALS

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4.1 Vision

TANEx remotely facilitated a vision development session with the CRD electoral area directors which resulted in the following draft vision statement:

"The widespread high-speed connectivity network in the Cariboo Regional District is well developed and extends throughout the region. It generates opportunities for residents to access services and information, work remotely or have a home-based business, and for all businesses to access the global marketplace and conduct business at the speed of today."

4.2 Goals & Benefits

4.2.1 Benefits

The benefits of high-speed broadband connectivity are well established including physical and mental wellness, better access to education, economic diversification, a leveled playing field for business and better public safety[5]. Benefits that are more specific to the CRD include providing critical support to important area industries such as tourism and agriculture and promoting the rural lifestyle that CRD represents. Better cellular coverage will also support those industries as well as providing the added benefit of increased public safety by eliminating extended highway sections with no access to cellular service to access 911 services such as highway 20.

4.3 Connectivity Goals

In conjunction with identifying what the future state of the CRD looks like once connectivity is achieved, the connectivity project team also prepared some connectivity goals that could be used to identify progress of the strategy as follows:

CRD Connectivity Goals

1. Increase cellular coverage along Highways 20, 24, 26 and 97 to 90% by 2026.
2. Increase cellular coverage along Nazko Road and Likely and Canim to 50% by 2026.
3. Enable broadband connectivity to 90 % of residences and businesses within 250m of an NBD[6] road with broadband connectivity at the USO by 2026.
4. Enable cellular coverage to 90 % of residences and businesses in the CRD.
5. Enable broadband connectivity at the USO and cellular coverage for all institutions such as airports, first responders, hospitals, walk-in clinics, government offices, courts, K-12 and post-secondary schools, libraries, civic facilities by 2026.

[5] Brookings Institute – Tomer *et al – Digital prosperity: How broadband can deliver health and equity to all communities*
[6] National Broadband Road – Road segments delineated by ISED Canada which are 250m in length and have an available speed in Mbps associated with them.

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5 METHODOLOGY

5.1 Methodology

This section described the methodology used in gathering information used in the report for mapping and outreach. The information obtained will be summarized later in the document.

5.1.1 Mapping Methodology

Part of the information gathering process involved obtaining available GIS data from the CRD along with other sources and using it to create maps. The methodology and discussion of elements used for creating the important layers in these maps is generally laid out below.

Sources – The sources used in the analysis include the CRD, various stakeholders corresponding to the affected areas, the Canadian Radio-television and Telecommunications Commission (CRTC), Innovation Science and Economic Development Canada (ISED), Statistics Canada, and BC Open Data. The main dataset of analysis was sourced from the CRD and included the Points which are discussed in more detail below. The material sourced from the CRTC included the 25km^2 hexagons that indicate which type of service is available in a location[7]. Examples of the types of service include cable, fibre, DSL, wireless among others. Data from Statistics Canada included census data that determined the number of people and the number of dwellings in certain communities within the CRD. Another important layer sourced from the CRTC/ISED is the National Broadband Road Segments layer which is discussed in more detail below[8]. The existing infrastructure dataset that came from the public sources showed where existing cell towers and fibre lines were located[9]. Contextual information sourced from BC Open Data included anchor institutions such as schools, hospitals, government buildings, etc[10]. Road networks, administrative boundaries, and other layers were also sourced from BC Open Data and the CRD.

Potential Subscriber Points – Potential subscriber points ("Points"), are one of the most important datasets in the analysis. TANEx used CRD's GIS dataset of Address Points which is used to approximate a potential subscriber location which may be a single dwelling or multiple dwellings within one geographic location. The Points were then assigned both density and available internet speed characteristics which are discussed in more detail below. The combination of Point characteristics created the foundation for delineating proposed project areas and the overall characteristics of those project areas as discussed in the project areas section below.

CIRA Points – Similar to the Potential Subscriber Points outlined above, the CIRA point data showed the results of a speed test at a given location by an internet subscriber. This data is derived from a map and underlying database collected and hosted by Canadian Internet Registration Authority (CIRA). This data was collected, imported, and then compared to the Potential Subscriber Points in order to show possible locations of discrepancy between the ISED data and the speeds people were actually experiencing. Note that ISED speeds show potential speeds available across all technology types and all service packages whereas CIRA speeds show the speed experienced for a certain technology type, at a certain time, while subscribed to a certain service package which may not be the highest available.

Density & Density Buffer Areas – In order to gauge the density of certain areas, six buffer zones around the Points were created. The six buffer distances used were 25m, 50m, 100m, 200m, 1km, and 2km. Individual buffer zones emanating from the Points were then dissolved into contiguous areas. If

[7] Government of Canada, *National Broadband Data Information*, Hexagonal Grid of Canada
[8] Government of Canada, *National Broadband Data Information*, National Broadband Data Road Segments
[9] Steven Nikkel, 2020, *Canadian Cell Towers Map*
[10] Government of British Columbia, BC Data Catalogue

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any of the buffer zones contained only one Point, they were erased. The results are contiguous areas that contain two or more Points. If a Point falls within a buffer zone, it is designated as Type 1 (25m), Type 2 (50m), Type 3 (100m), Type 4 (200m), Type 5 (1km), or Type 6 (2km) density, defaulting to the higher designation if it falls within two or more of the buffer zones. If a Point does not fall within the lowest density buffer zone designation (Type 6), it is designated as Type 7 which means it is outside the 2km buffer area. Such Points are very remote and very rare.

Speeds & Speed Buffer Areas – ISED maintains a dataset of national broadband road ("NBD") segments which designate the internet speed a person could expect if they lived in the area of that road. ISED notes that the data collected and used internally by ISED is, in most cases, accurate to within 250 metres[11]. This data is based on information provided annually by service providers[12].

Based on the accuracy ISED denotes, as referenced above, a Point was assumed to have a speed equal to the closest road within 250m of it. The range of speed combinations (download speed/upload speed) in Mbps are as follows: 50/10, 25/5, 10/2, 5/1, Less than 5/1, or No Service. If a Point did not fall within 250m of a NBD road segment, its speed was undeterminable and was designated "Unknown".

Project Areas – Project areas were created from the Points and the density buffers. Minor project areas were delineated 1km around the densest clusters of Points with a number of things in mind: Point characteristics for density, speed, topography, and distance between clusters. Lower density Points such as those 2km or further away from another Point were omitted from project areas. Large, consistent clusters of Points with speeds of 50/10 Mbps were also omitted since they already have service at the USO. Points and clusters of Points separated by natural boundaries (e.g. cliffs, water bodies, etc.) were either omitted or split into different areas where necessary. Clusters of Points far away from others were not determined to be logical groupings unless absolutely necessary such as when they fall along corridors where existing or future fibre lines may run. Minor project areas were then grouped together into major project areas based on proximity to one another and connecting features such as fibre lines/highways.

Fibre Lines – The routes of fibre lines were sourced from public domain. Fibre lines and an understanding of where they are situated are important since they form a key element of the network infrastructure needed to serve potential customers.

Cell Towers – Cell tower locations and data were also sourced from public domain. Cell towers are another important element in providing existing and potential future internet service to underserved areas and their constituents.

Service Provider Coverage – Service provider coverage was sourced from ISED databases and where possible, verified with the service provider. The databases derive their information directly from individual service providers. Some of the information is older and may be out of date but nonetheless gives a sense of which service providers operate in which area and what types of technology they utilize in those areas. Examples of such technology include coaxial cable, DSL, fixed wireless, or Fiber-to-the-Premises/Home.

Limitations of Data – The data used for the analysis has a number of drawbacks. ISED has created coverage maps using 25km^2 hexagons upon which they base certain assumptions about connectivity within that hexagon. This creates a geographically large area which may well have varying degrees of connectivity but the ISED assumptions are such that service within that hexagon is uniformly at the highest level achieved in the hexagon. ISED has also developed 250m NBD road segments that depict

[11] Innovation, Science, & Economic Development Canada
[12] Government of Canada, *National Broadband Data Information*, National Broadband Data Road Segments

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Mbps speeds in that area. These are more accurate geographically speaking but lack specificity in terms of which ISPs operate in the area or what the technology type is available there.

5.1.2 Outreach Methodology

5.1.2.1 Public

A publicly available survey was developed to get information from residents and businesses about their access to, use of, and satisfaction with, broadband and cellular connectivity in the Regional District. Surveys were available online and in paper form to residents, businesses, organizations, First Nations, and institutions and provided feedback from the public about different aspects of internet and cellular service. The survey asked the respondents if they were interested in further communication on the topic. Respondents who responded in the affirmative were sent an email providing a link to a few more questions to get more granular information about their connectivity experience and impacts.

A summary of the results of the surveys are available later in this report. Reported results are simply as reported by the participants with it being beyond the scope of this report to undertake any form of validation including with respect to cost and speed of service.

5.1.2.2 Key Stakeholders

Key stakeholders were identified by the CRD and telephone or email contact was made (or attempted to be made) with those stakeholders to schedule a one-on-one call to obtain information and views on the state of connectivity and cellular service and challenges from their perspective. Stakeholders included electoral area directors, community leaders, community champions, business and industry representatives, emergency services representatives and other parties holding valuable insight into the connectivity challenge. A summary of the feedback obtained from those key stakeholders is contained later in this report.

5.1.2.3 First Nations

Email and telephone outreach was made to area First Nations and where possible, a one-on-one telephone interview was conducted between TANEx and the First Nation representative to obtain information about access to broadband connectivity and cellular service on the populated reserve lands.

5.1.2.4 Internet Service Providers

A list of service providers was created from information provided by the CRD, stakeholders and research of publicly available sources identifying providers in the area. TANEx conducted at least one one-on-one telephone interview with each known area service providers and in some cases, more than one.

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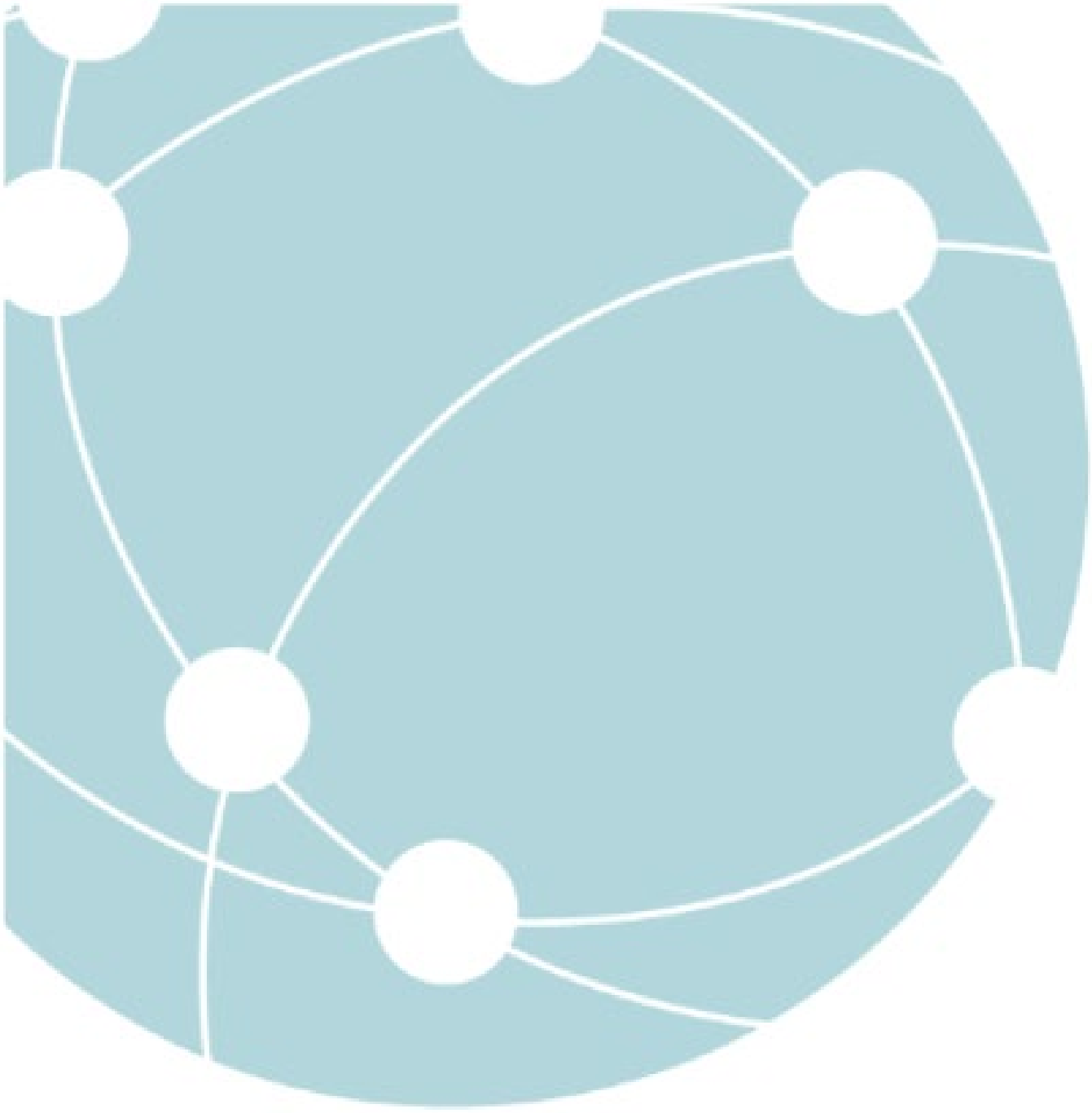
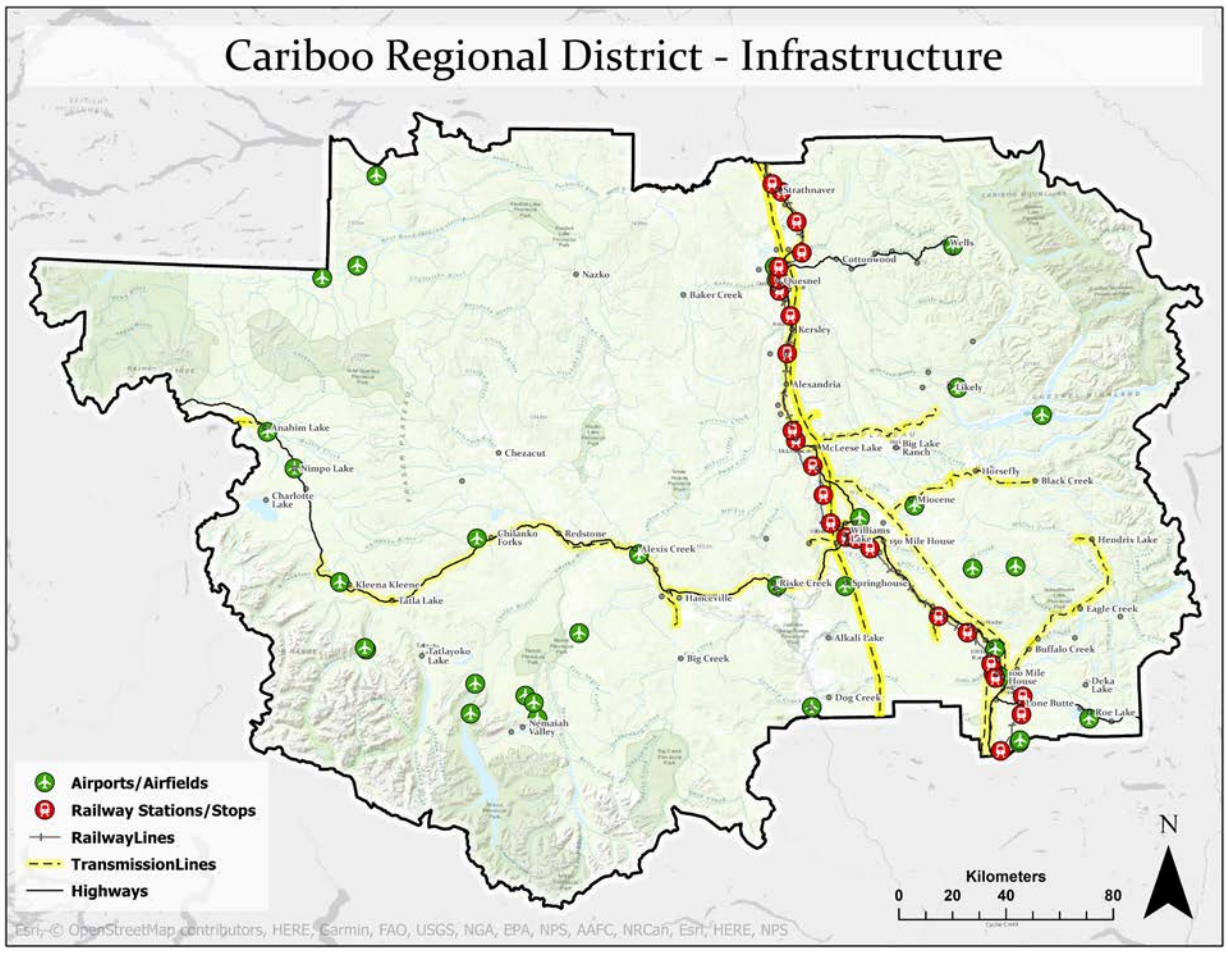


6 CRD CURRENT STATE

Formulating a strategy that applies to the CRD requires a clear understanding of the region from the perspective of what currently exists in terms of infrastructure and industry but also the kinds and levels of telecommunications service that exist and where in the region they are not available currently.

6.1 Infrastructure and Institutions



The CRD is part of British Columbia's central interior plateau between the Cariboo Mountains in the east and the Coast Mountains in the west. This creates a diverse and varied geography with vegetation ranging from dry grasslands to spruce, pine, and fir forests at low to mid elevations. Inland temperate rain forests and alpine forests are also found in the region. The Fraser River cuts north to south through the region, becoming a rugged canyon near the south boundary. In addition to the Fraser, the Chilcotin, Chilko, Quesnel, Cariboo and Horsefly Rivers are major tributaries which are, in turn, fed by numerous lakes and creeks.

Administratively, the region consists of two cities, Quesnel and Williams Lake and two district municipalities, 100 Mile House and Wells. Wells is the only one of these communities that is not on the Highway 97 corridor. The rest of the region is divided into twelve electoral areas and the Secwepemc, Tsilhqot'in, and Dakelh First Nations[13].

[13] British Columbia Assembly of First Nations

6.1.1 Transportation

6.1.1.1 Road & Rail Transport

Highway 97 and the CN Rail line run north south through the region, connecting Quesnel and Williams Lake to major centers including Prince George in the North, and the lower mainland in the south. The rail line and highway parallel one another through most of the region[14]. This transportation corridor enables same day delivery to major international shipping points including Vancouver, Calgary, Edmonton, and Prince Rupert. This corridor is the main route for the movement of goods and people between the north and south of the province.

Highway 20, also called the Chilcotin Highway, runs west from the junction on Highway 97 at Williams Lake, leaves the Cariboo region, crosses the Coast Mountains and terminates in Bella Coola on salt water. The highway is a connector for the remote communities scattered across this sparsely settled part of the region. Portions of this 450 km highway are narrow and not yet paved.

Highway 26, also called the Barkerville Highway, runs east from the junction on Highway 97 near Quesnel to the foot of the Cariboo Mountains. This 81 km highway is a connector for several communities, including the District of Wells and, at the highway's terminus, Barkerville. This highway provides access for tourism, which is a significant economic base for the area since mining operations closed.

Highway 24, also known as the Little Fort Highway or the Interlakes Highway, is a 97-kilometre-long east-west connection between the Cariboo Highway, just south of 100 Mile House, and the Southern Yellowhead Highway at Little Fort.

6.1.1.2 Air Transport

There are regional airports at Quesnel, Williams Lake and 108 Mile Ranch (South Cariboo Regional Airport). These airports feature paved single runways and have facilities to support commercial air movements. There are also more than two dozen air strips scattered across the region. Many support access to remote lodges and are mostly unpaved turf or gravel strips, with paved runways at Barkerville and Alexis Creek being exceptions. There are a few float plane facilities, such as, at Green Lake[15].

6.1.2 Economic Activity & Industry

Forestry and mining were early economic drivers and formed the basis of the early settlements. Today, primary economic activities in the region include forestry, agriculture, and ranching. Mineral exploration, mining, transportation, energy, outdoor recreational and tourism are also significant.

Economic activities in support of the natural-resources sector include professional services, administration, and manufacturing[16]. Outreach resulted in reports of a trend toward a new demographic of self-employed professionals moving or wanting to move into the area that may be prompted by the Covid-19 pandemic.

Pine beetle infestations, wildfires and flooding incidents in recent years, and their predicted increase arising from climate change, is leading to research and planning for improved forest biodiversity and

[14] Railway Association of Canada - Canadian Rail Atlas
[15] OurAirports.com - BC
[16] Guide to the BC Economy – Cariboo Region

hydrological stability[17]. Economic diversification is increasing in importance to reduce the impact of the boom-and-bust cycles that characterize commodity-based resource industries, and lead to economic instability.

6.1.2.1 Energy

Electric power distribution: BC Hydro provides power to most of the population in the region from their integrated electric grid. However, grid power availability away from the Highway 97 corridor is limited. BC Hydro provides non-integrated (off grid) power to Anahim Lake using a 3.65 MW diesel plant (52.464929, -125.316059). Many of the sparsely settled areas of the region do not have access to BC Hydro power and rely on locally generated power.

Electric power generation: There is a small amount of electric generation produced by independent power producers (IPP). The following table identifies the IPPs that have electricity purchase agreements with BC Hydro (as of 2020-10-01)[18]. In addition, there is a small hydroelectric generating plant on Morehead Creek (52.60233, -121.779485) with 0.11 MW capacity. This plant, located about 18 km west of Likely, was operated by Morehead Valley Hydro Inc.; however, their electricity purchase agreement was canceled in 2019.

Electric power generation by independent power producers in the region[19].

Independent Power Producer (IPP)	Location	Type	Capacity (MW)	Energy (GWh/yr)
Atlantic Power Ltd.	Williams Lake	Biomass	66	388.4
EnPower Green Energy Generation Limited Partnership	150 Mile House (52.128686, -121.943859)	Energy recovery	6	34
Tsilhqot'in Solar Farm	Hanceville	Solar	<1	1.8
Cariboo Pulp and Paper	Quesnel	Biomass	61.3	172.3

Electric power transmission: The region hosts a major electric power corridor as high voltage transmission lines cut north south through the region bringing electric power from generating stations on the Peace River to load centers in the lower mainland. These lines generally follow or parallel the Highway 97 corridor[20].

In addition to the BC Hydro transmission lines, the following are BC Hydro rural distribution lines:

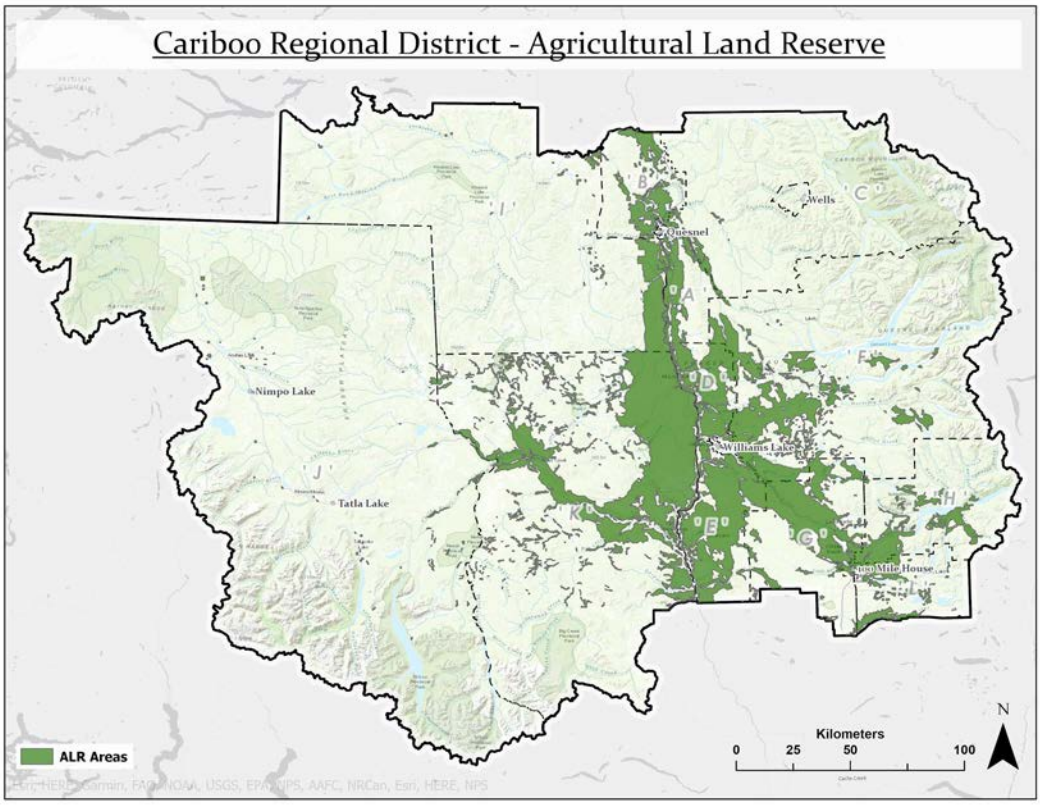
- A feeder extending west from Williams Lake along Highway 20 to Kleena Kleene and extending about another 20 km further west along the highway.
- A feeder extending east from Williams Lake along Horsefly Road to Horsefly and extending another 25 km further along Black Creek Road.
- A feeder line extending east from 100 Mile House to a closed mine site west of Hendrix Lake; the line is operational at least as far as Canim Lake.
- A feeder line extending west from Quesnel to Nazko; right of way generally follows Nazko Road (approximately 110 km route length).

[17] Province of BC – Environmental Protection & Sustainability – Cumulative Effects – Cariboo Region
[18] BC Hydro – Independent Projects History & Maps
[19] BC Hydro – Independent Projects History & Maps
[20] BC Hydro – Transmission System Map

Liquid petroleum and natural gas pipelines: The Pembina Oil Pipeline brings liquid petroleum products from Alberta to the BC interior and lower mainland for local use and for export. This pipeline generally follows Highway 97 down from Prince George, cutting through the Region and connecting to the Trans Mountain Pipeline in Kamloops[21]. The Enbridge Westcoast line is the primary natural gas pipeline moving product from the gas fields in the north east corner of the province to the lower mainland. This pipeline generally parallels Highway 97 with a spur to Kamloops and points east[22].

6.1.2.2 Agriculture

Agriculture is a significant economic activity in the region producing a wide variety of products. There are over a thousand farms in the region totaling over a million acres. About 15% of BC's Agricultural Land Reserve (ALR) is in the Cariboo, some 936,367 ha (9,364 km^2)[23]. Although less than half of Cariboo's ALR area is being farmed and the number of farms has been in slow decline, the total gross farm receipts grew at a compound annual rate of about 1.6% from 2006 to 2016. The rolling plains of the region are ideal for cattle and other livestock production. Nearly 40% of the province's pastureland is in the Cariboo. It is no surprise that cattle ranching, and hay farming make up the majority of the region's gross farm receipts. Beef is the primary industry in Cariboo making up 20% of the provincial cattle population and the BC Livestock Co-op in Williams Lake is one of the largest cattle auction markets in the province[24].



[21] Energy BC – BC Oil Infrastructure Map
[22] Energy BC – BC Natural Gas Infrastructure Map
[23] Williams Lake – Creating Our Future – Local Food & Agriculture
[24] BC Ministry of Agriculture – Agriculture in brief – Cariboo Regional District

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Current challenges for the agriculture sector in the region include difficulty attracting and retaining labor and lack of economies of scale. Future challenges include adapting to climate change, unharmonized agricultural regulations, increased pressure on margins from competition and changing consumer preferences. Potential ways of addressing some of these challenges include increased use of technology and innovation, increased local processing prior to shipping and collaboration with First Nations.

6.1.2.3 Mining

There are two open pit mines in the area which include Taseko Mines Ltd.'s copper and molybdenum Gibraltar Mine which is north of Williams Lake and Imperial Metals Corporation's copper and gold Mount Polley Mine which is east of Williams Lake near Likely. Mount Polley operation were suspended in May of 2019 however and the mine is on care and maintenance status. Mount Polley reports having acquired an option to earn a 100% interest in seven mineral claims adjacent to Mount Polley Mine in 2020[25]. The Spanish Mountain gold project which is about 6 kilometres from Likely is a potential new mine[26].

6.1.2.4 Tourism

Much of the CRD is included in the Cariboo Chilcotin Coast Regional Tourism area. Tourism is an established and growing industry in the Regional District with incredible natural beauty and outdoor activities. Highway 20 is the gateway to the Cariboo Chilcotin Coast. Historic points of interest abound with the Barkerville Historic Town and Park being a significant area attraction.

6.1.3 Health

Cariboo Regional District has both the Northern Health Authority and the Interior Health Authority areas within it. The health authorities govern, plan and deliver health-care services within their geographic areas and have responsibility for identifying health needs, planning programs and services, and overseeing program and service funding, management and performance[27].

There are hospitals in Quesnel (G.R. Baker Memorial Hospital, Williams Lake (Cariboo Memorial Hospital), and 100 Mile House (District General Hospital). In addition, there is a walk-in clinic in each of these centers plus an additional clinic in 100 Mile House. These clinics provide non-emergency health care services on a walk-in basis during clinic hours which vary by facility.

6.1.4 Educational Institutions

The region encompasses School District 27 Cariboo-Chilcotin and 28 Quesnel[28]. Most of the population resides in the larger centers located along the Highway 97 corridor; therefore, most of the schools are in these centers. The following table identifies the rural and remote schools that serve students outside the larger centers.

[25] Imperial Metals – Mount Polley
[26] Williams Lake & District – Chamber of Commerce – Industry
[27] BC Provincial Health Authority
[28] BC Education – BC Map of Schools

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Rural and Remote Community Schools in the CRD			
SD	**School name**	**Address**	**Type**
27	Anahim Lake	2484 Chilcotin Hwy 20, Anahim Lake, BC	Elementary, Junior Secondary
27	Tatla Lake	Hwy 20, Tatla Lake, BC	Elementary, Junior Secondary
27	Alexis Creek	7651 Yells St, Alexis Creek, BC	Elementary, Junior Secondary
27	Naghtaneqed	8350 Nemaiah Valley Rd, Nemaiah Valley, BC	Elementary, Junior Secondary
27	Dog Creek	General Delivery, Dog Creek, BC	Elementary, Junior Secondary
27	150 Mile Elementary	3081 Hwy 97, 150 Mile House, BC	Elementary
27	Lac La Hache Elementary	4787 Clarke Ave, Lac La Hache, BC	Elementary
27	Mile 108 Elementary	4958 Easzee Dr, 108 Mile Ranch, BC	Elementary
27	Forest Grove Elementary	4497 Eagle Creek Rd, Forest Grove, BC	Elementary
27	Horse Lake Elementary	6548 Ryall Rd, Lone Butte, BC	Elementary
27	Big Lake Elementary	4060 Lakeview Rd, Big Lake, BC	Elementary
27	Likely	6163 Keithley Creek Rd, Likely, BC	Elementary
27	Horsefly	3045 Boswell St, Horsefly, BC	Elementary, Junior Secondary
28	Nazko Valley Elementary	9560 Nazko Rd, Quesnel, BC	Elementary
SD is the School District number: 27 is Cariboo-Chilcotin; 28 is Quesnel.			

There are several post-secondary institutions located in the larger centers within the region. Thompson Rivers University has a campus in Hundred Mile House and in Williams Lake. Quesnel hosts two post-secondary institutions: University of Northern British Columbia South-Central Campus, and College of New Caledonia Quesnel Regional Campus. Outreach reports that students are negatively affected in COVID driven remote learning environment as not all students have access to the necessary connectivity to continue their education. Outreach suggested that First Nations are first and most deeply affected by those challenges which impacts access to education and economic opportunities.

6.2 Telecommunications

6.2.1 Service Provider Overview

Provider	Summary
ABC Communications	Primarily provides fixed wireless services in some regions of the CRD. ABC was recently acquired by Telus but at this time still operates as ABC Communications.
City West	While not actively providing services in the CRD, City West is completing the BC Connected Coast project that may provide a potential for City West to bring new services to the CRD through the neighbouring Central Coast Regional District via the Highway 20 corridor.

CP Electronics	Provides services using unlicensed wireless technology along the Highway 20 corridor of the CRD.
Rogers	Primary interest in cellular services along the main highway corridors. Rogers is involved in some fibre backbone projects in the CRD. Rogers recently announced the purchase of Shaw Communications although at this time, it is unknown how that may benefit / impact connectivity in the CRD.
Shaw	Provides wired connectivity using primarily coaxial cable infrastructure in Quesnel, Williams Lake and 100 Mile House regions of the CRD with backbone infrastructure along Highway 97 to support these services.
Starlink	Currently (2021 March) provides pre-commercial beta-test internet service from a constellation of low earth orbit satellites. Later this year, full commercial service should be available. Starlink (and potentially other LEO solutions) providing a promising alternative to remote residents in the CRD.
Tatlayoko Think Tank	Provides services using unlicensed wireless technology in the West Chilcotin area of the CRD.
Telus	Provides services in throughout the Regional District deployed using a mix of fixed wireless, fibre optics and DSL infrastructure and is considered the incumbent provider.
Xplornet	Provides direct to home internet service from a satellite in geostationary earth orbit. Prior to Starlink, Xplornet would be the only viable option for remote residents in the CRD.

6.2.2 Internet Connectivity

The following provides a summary map of the areas served by each provider the associated technology.

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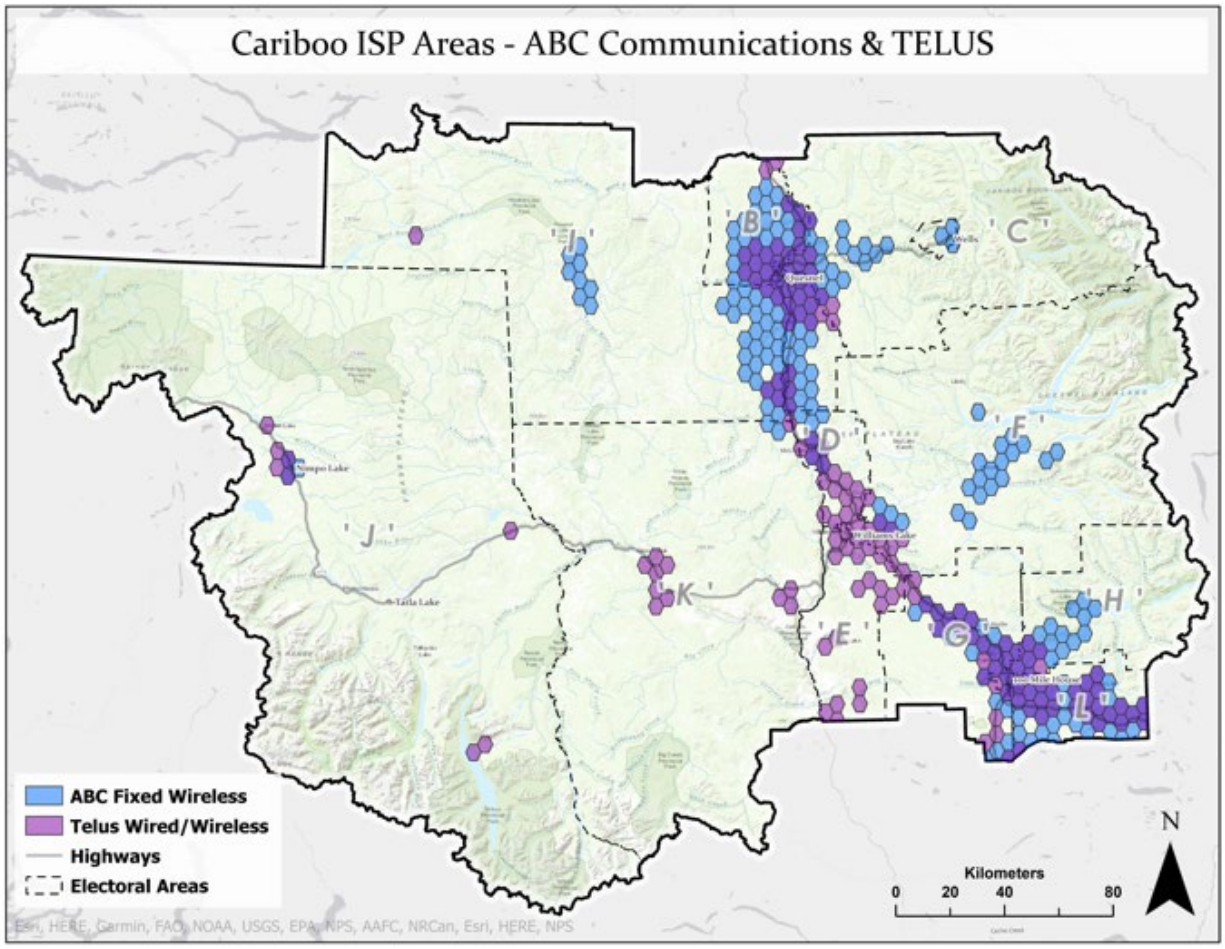
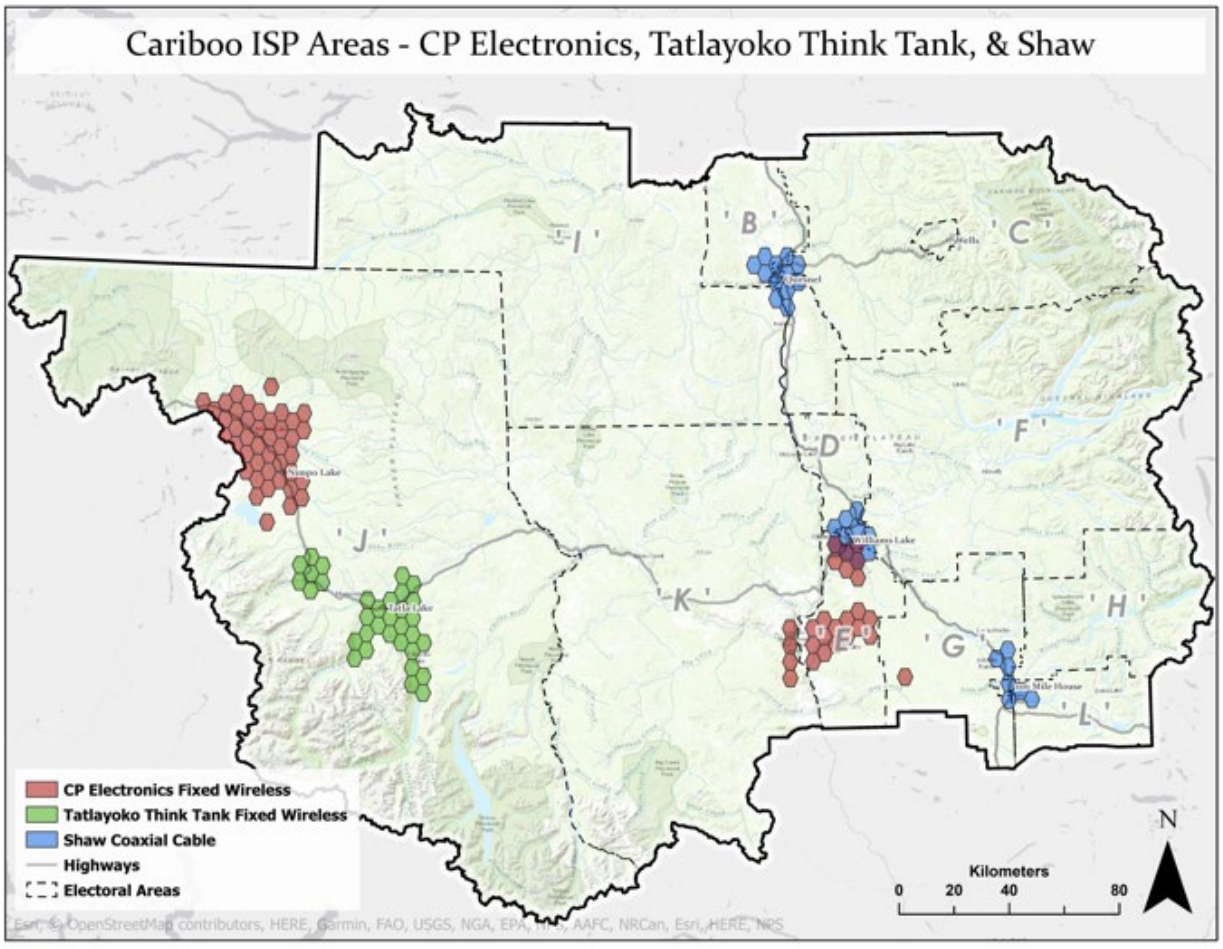




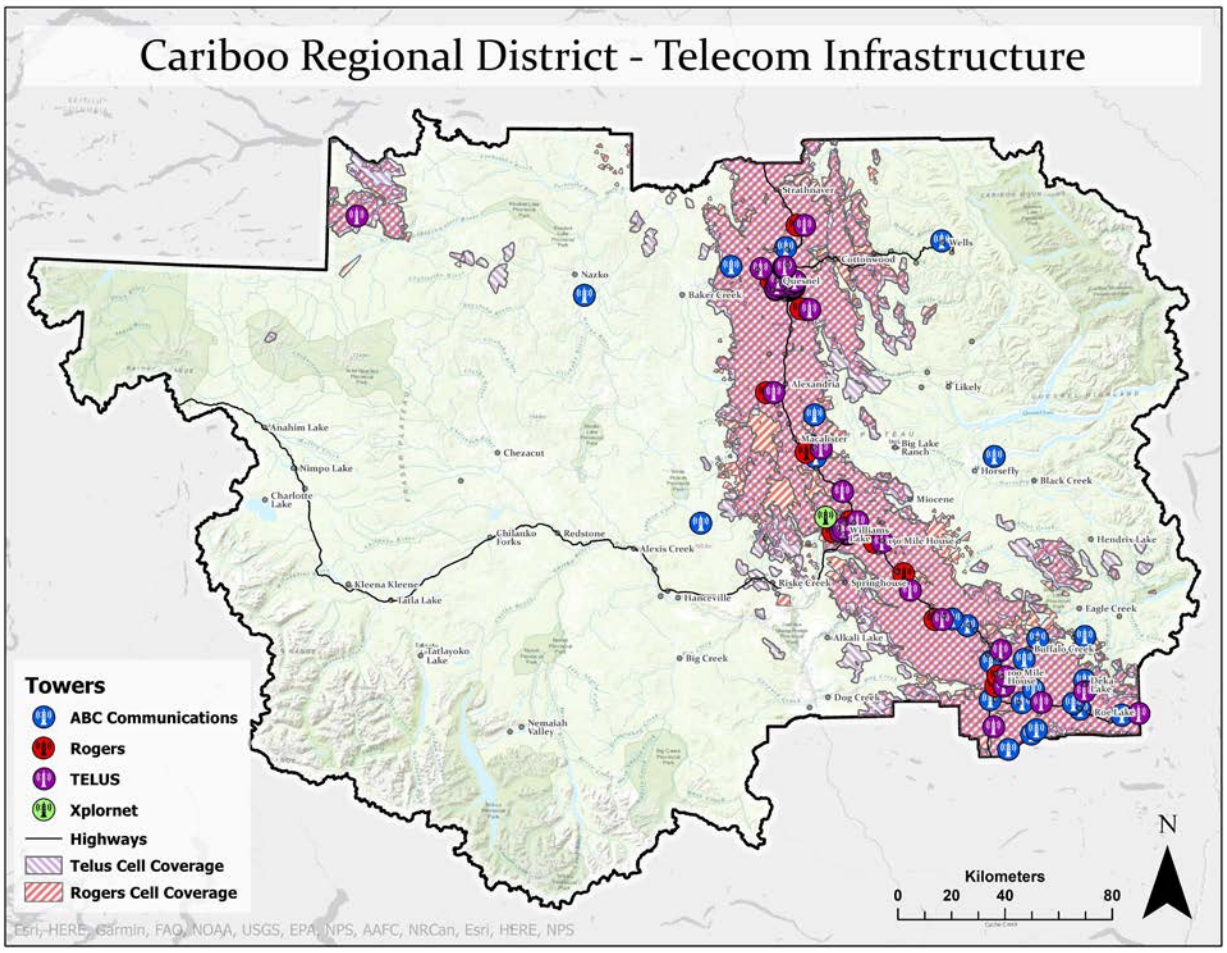
6.2.3 Cellular Services

6.2.3.1 Cellular Infrastructure

The following provides a summary of the cellular providers with cellular infrastructure in the CRD. Other providers may have service in the region using roaming agreements with these infrastructure owners.

Provider	Summary
Rogers Wireless	Provides extensive 3G (HSPA+) and 4G (LTE) cellular mobile coverage along the Highway 97 corridor through the Region with some 5G coverage being introduced at 100 Mile House and Williams Lake.
Telus Mobility	Provides extensive 3G (HSPA+) and 4G (LTE) cellular mobile coverage along the Highway 97 corridor through the Region.

6.2.3.2 Cellular Coverage Maps



6.2.4 Relevant Projects

While not necessarily a complete list, there are a number of announced initiatives related projects active in the CRD. Due to the confidential nature of these projects, detailed information may not be available or may not be public and as such, any information available is contained in the confidential addendum to this document.

As part of an initiative with Pathways to Technology and a number of CRD First Nations, Telus recently completed a significant infrastructure project to bring Telus Purefibre, fibre optic service to thirteen First Nations' reserves in the CRD. The following provides an overview map of this project. While providing immediate benefits to the First Nations that are within scope, this project places critical backbone infrastructure along several of the major highway corridors that may be leveraged by future projects.

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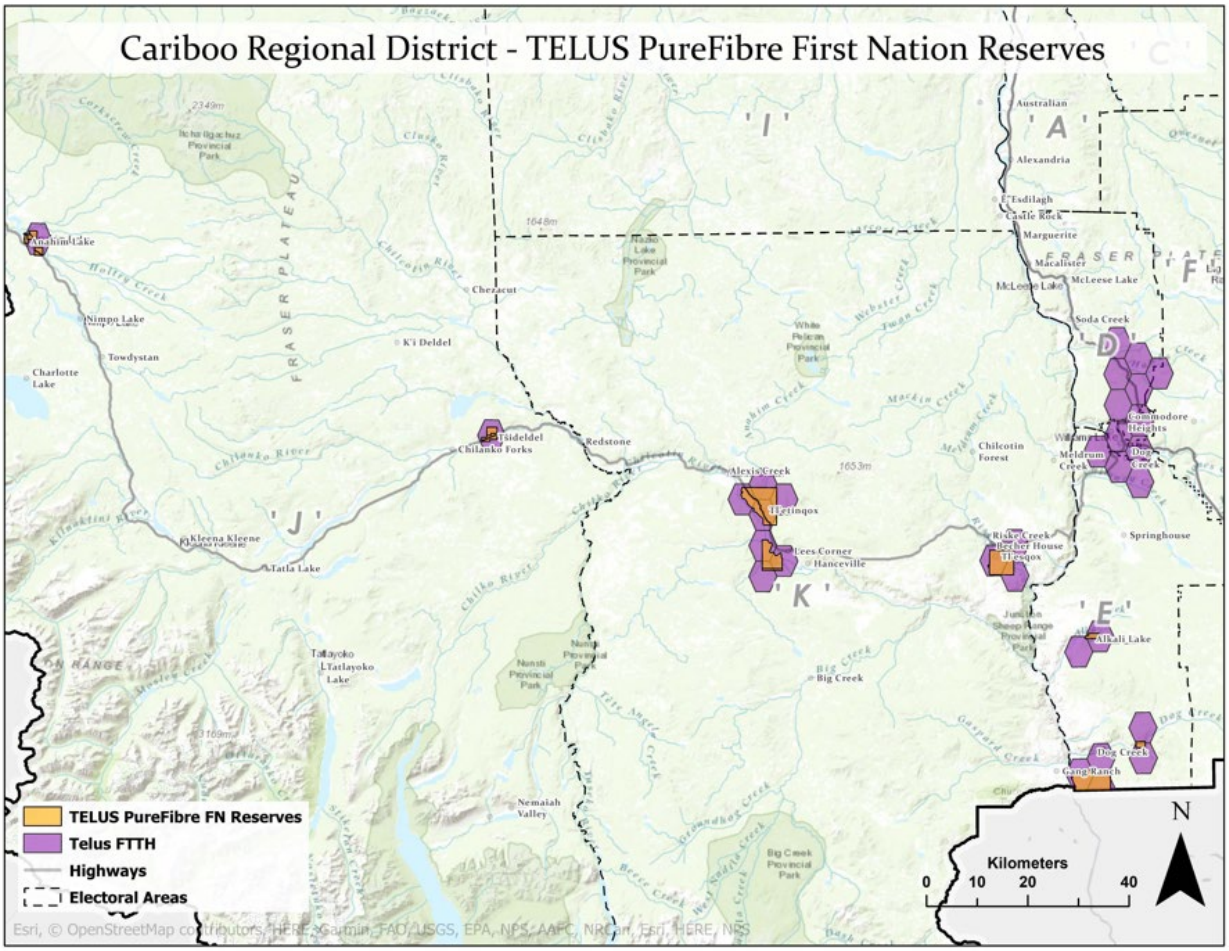

In addition to the above Telus fibre project, and while not currently active, City West is completing a major initiative in BC called the Connected Coast project. This project promises to deliver services to over 100 communities along the west coast of BC, with a Connected Coast landing area in Bella Coola. The Bella Coola landing area has the potential of bringing additional providers and services to the CRD providing a strategic 135km fibre from Bella Coola to Anahim Lake was constructed and/or available.

While the following map does not provide all the fibre infrastructure available throughout the province of BC, it does provide a high-level overview of some major fibre corridors that need to be considered when evaluating the critical fibre backbone infrastructure required to deliver all services. Of particular importance is the creation of redundant paths or fibre rings. Diversity is critical to providing reliable connectivity especially when considering events such as forest fires that can severely damage this critical infrastructure.

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6.3 Public Feedback on State of Connectivity

As part of the information gathering, a survey of the residents and businesses located in the CRD was completed. The survey was intended to gather information from Electoral Area residents and businesses including about available service, costs, satisfaction, and service providers. Municipal residents and businesses were not prevented from completing the survey but analysis focused on the responses from

the Electoral Areas, so the analysis below is filtered for responses from the Electoral Areas. A paper copy of the survey was available from the CRD as well as being online through the CRD website. It remained open for 67 days. The survey was promoted to electoral area residents and businesses by:

- CRD staff and Electoral Area directors;
- CRD publication on its website;
- CRD social media promotions;
- Making paper copes of the surveys available;

The following provides a brief summary of the survey results and a complete detailed summary of the survey results are contained in ancillary documents.

6.3.1 Summary of Residential Survey Results

Overview

With nearly 2,000 responses from communities across the CRD, there was a clear desire from respondents to make a statement about the state of internet connectivity in the region. As the focus of this project was the rural areas, much of the analysis in this section is focused on the rural regions but virtually every respondent (95%) said that internet was either very important or critical to them.

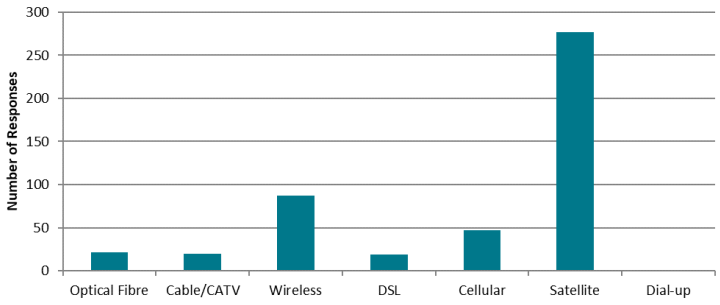
Quality and Cost

Over 75% of people reported having download speeds of less than 50 Mbps and more than 50% of people reported paying $100 dollar or more per month. On top of this, nearly half of respondents stated paying overage charges for at least one month of the year with some paying such charges every month. Such charges were stated to be as much as over $100 dollars per month. Nearly 75% of respondents rated their quality of service as less than good.

Choice and Need for Improvement

Incredibly, over half of respondents stated they are currently using some form of satellite service for internet connectivity. Well over half of respondents stated they were dissatisfied to some degree with their choice of providers. Even more stated they were also dissatisfied with the internet service speed they experience day-to-day. More still – 79% – stated dissatisfaction at the overall cost for value they were paying for. Reliability was also flagged as an issue with over half of respondents expressing dissatisfaction. 95% of respondents agreed that there is a need to improve internet service in the CRD and that internet is an essential service.

Type of home internet service respondents have.



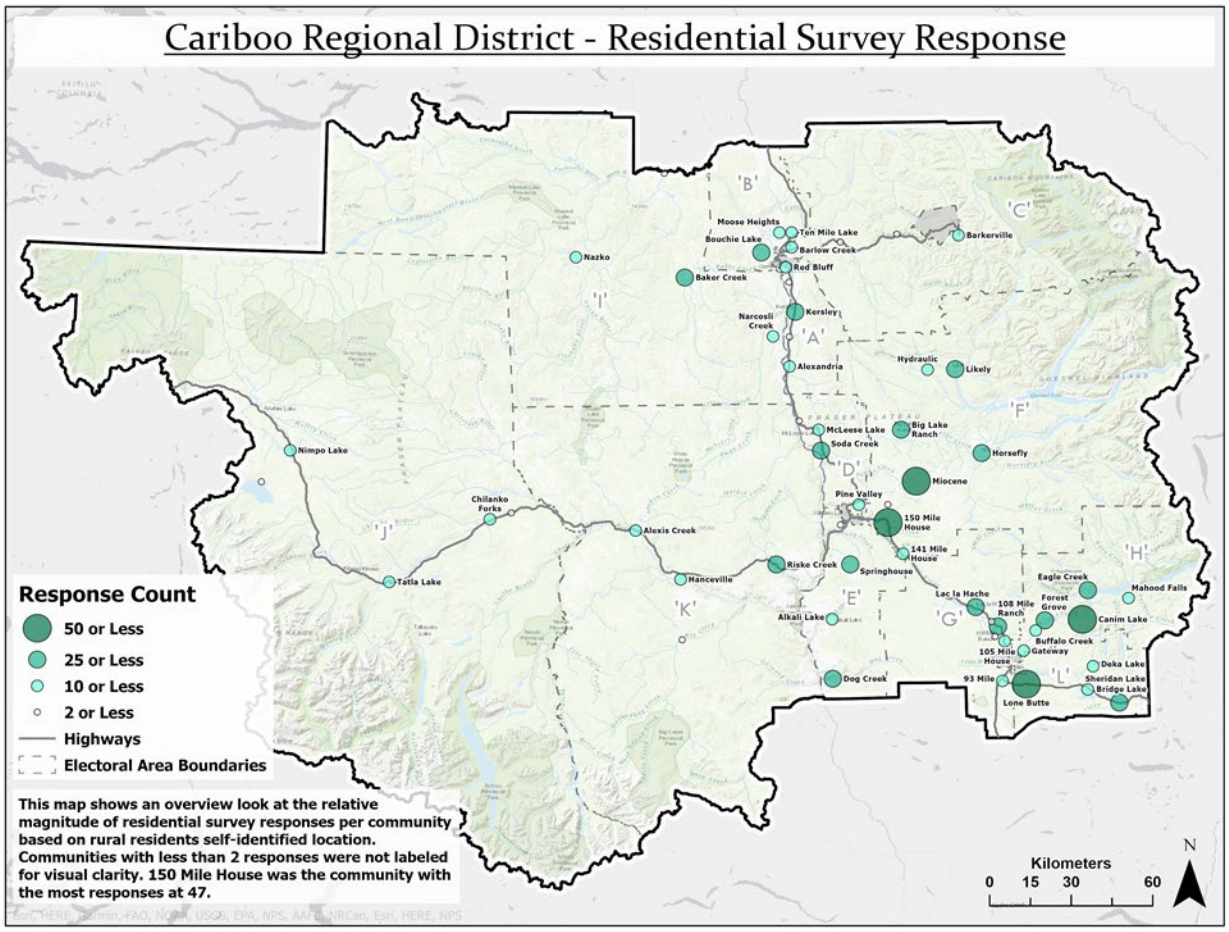
Cellular Service

Half of respondents stated they do not currently have cellular service and 90% of those indicated this was due to service being unavailable to them. 80% of respondents stated they are concerned about safety due to lack or quality of cellular service in the CRD. Approximately 65% of respondents are dissatisfied with cellular service in the region, have found themselves in an emergency situation without the ability to call for help because of a lack of cellular service phone coverage and are either somewhat or very dissatisfied with the reliability and costs of cellular service in the region. 93% of respondents said they would support additional cellular sites in their community in order to improve cellular service.

Summary

Among respondents there was clear agreement with the notion that improved internet is needed in the CRD and that such improvements would have positive effects for the region such as attracting potential residents and businesses, improving economic activity, and other such benefits. Most respondents stated they would support the CRD providing support to service providers and subsidizing the cost. Most respondents – 60% – do not think the CRD should fully build, own, and operate an internet utility themselves. Other options included:

- Internet Service Provider builds and operates the infrastructure without financial assistance from the CRD – 41% support this option even though it may mean no improvement in service. While 60% support the idea of the CRD providing assistance to the service provider which might include financial support.
- The CRD wholly owns, funds, and operates the infrastructure itself – 40% support this option.
- The CRD partners with private industry partners to share costs, control, and responsibility of the infrastructure – 56% support this option.



6.3.2 Summary of Business/Organization Survey Results

General Overview

Over 50 responses were received from business owners from across the CRD including such places as Anahim Lake, Miocene, Horsefly, Bouchie Lake, Riske Creek, and many more. There was feedback from

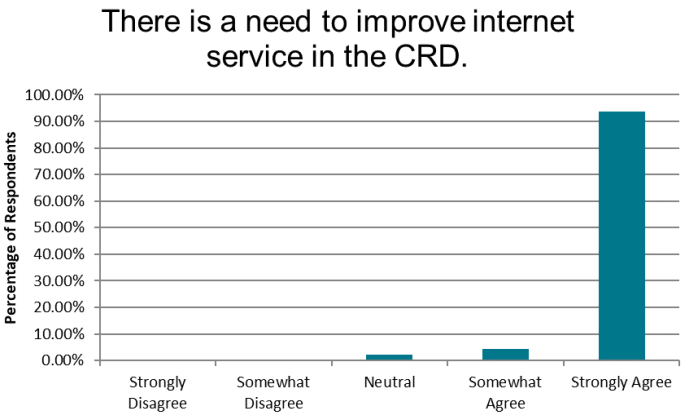
all corners of the rural area. Most were small businesses employing 5 people or less although some were larger. Most respondents categorized the nature of their business as either agriculture, tourism, or professional service types. Nearly 94% have some form of internet access currently at their place of business.

Service Overview

Almost two-thirds of business owners are using some form of satellite internet provider for their internet connectivity an many stated there are often more than one person at a time using the internet at their place of business. Over 80% said they pay $100 or more per month for internet connectivity with nearly as many stating they pay overage charges at least one month of the year. 90% reported having download speed of less than 50 Mbps with nearly that many being dissatisfied with their internet speed.

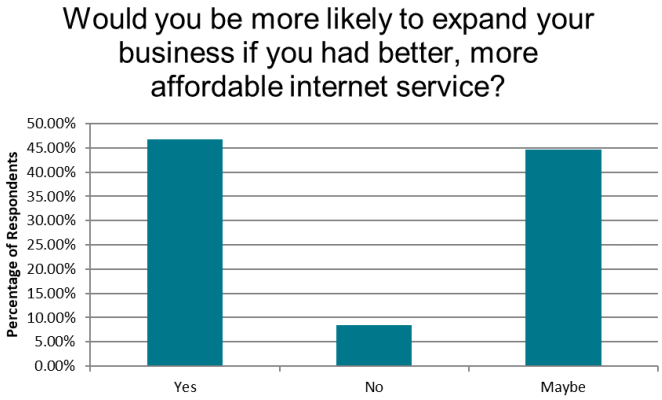
Need for Connectivity

Nearly 90% rated their internet service as less than "good" yet well over 90% stated internet service is very important or even critical to their business. 68% indicated some level of dissatisfaction with the choice of internet service providers available to them. Only 10% of respondents stated their internet usage would not change if their internet was more reliable, faster, or less expensive.



Summary

Among business respondents, well over 90% agreed that internet service is an essential service and that there is a need to improve internet in the CRD. All respondents agreed that improved internet would attract potential residents and businesses, improving economic activity, and have other significant benefits for the region. Over 70% said their current internet service or lack thereof negatively impacts their business. Less than 10% of business respondents indicated that improved internet service would not make them more likely to expand their business. Many businesses also stated they do not have cellular service and that this is problematic for them. Similar to residential respondents, most business respondents stated they would support the CRD providing support to service providers and subsidizing the cost. Overall, there was a clear desire and sentiment among respondents for improved connectivity in the CRD.



6.3.3 Stakeholder Response

Key stakeholders were identified by the CRD and augmented by TANEx. An attempt was made by TANEx to contact the stakeholders by direct telephone contact to have a one-on-one interview to gather insight and additional detail about the challenges or successes of connectivity and cellular service in the area. The following provides a summary of the themes identified in these discussions where contact was made.

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Stakeholder Summary: Elected Officials

Summary of Information Reported:

- Significant concerns over public safety where gaps in cellular coverage exist.
- Access to 911 service patchy in CRD. First responders and search and rescue need better communications in emergency situations.
- Physician shortage means access to high-speed broadband is even more important to access telehealth.
- Concerns about Cariboo being left behind as a less desirable place to re-locate because of the widespread lack of high-speed broadband connectivity and access to cellular service.
- Residents not being able to work from home because of lack of connectivity.
- Some support noted for the idea of a backbone controlled in the public interest.

Stakeholder Summary: First Nations

Summary of Information Reported:

- Concerns raised over sufficient communication to members. Lack of cellular coverage negatively impacts communication ability.
- Concerns over inconsistency in services available to members depending on what reserve they reside on.
- General satisfaction in communities that have fibre to the home.
- Reserves closer to more urban centres report greater satisfaction with cellular and broadband services.
- Many First Nations communities have no cellular service and, in some cases, don't even have power.

Stakeholder Summary: Agriculture and Business

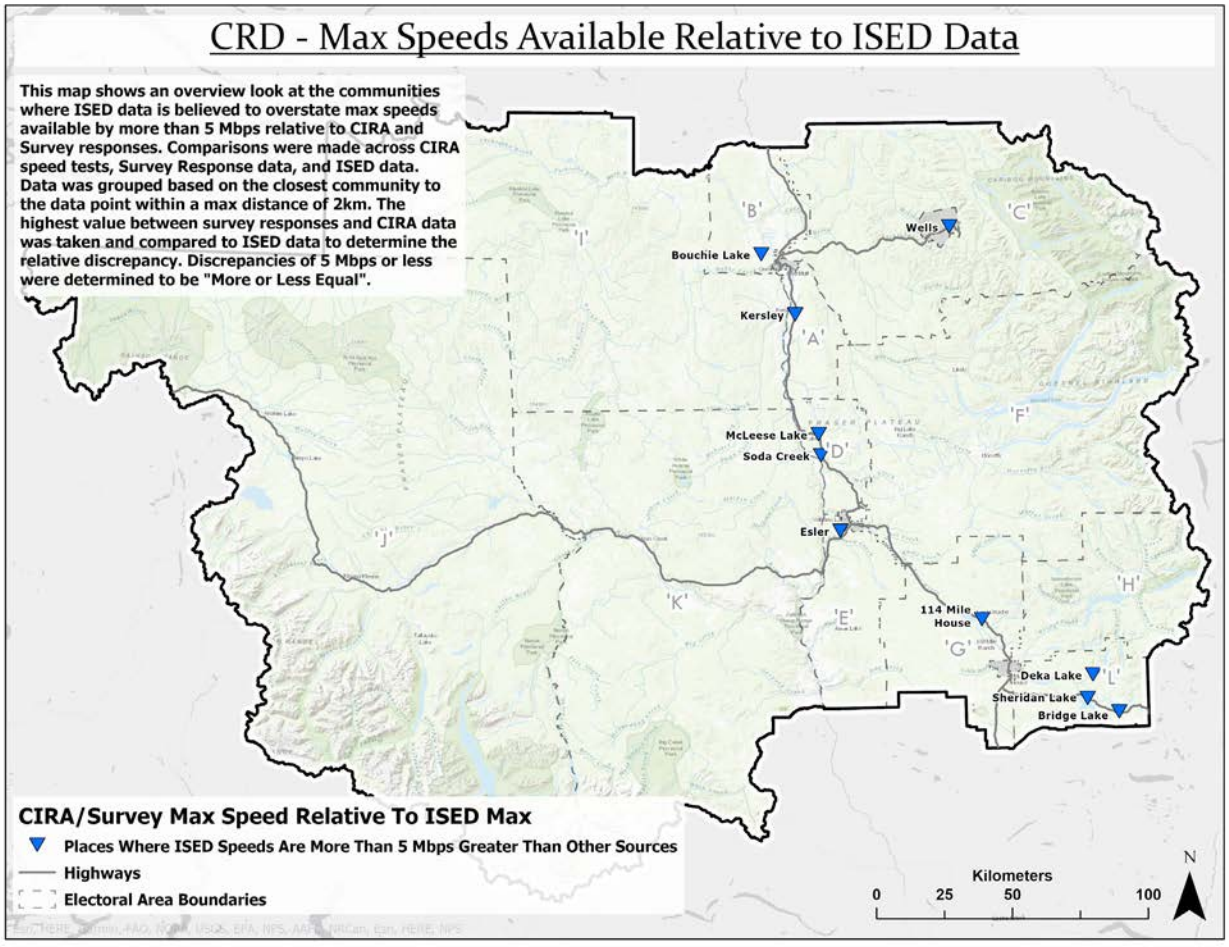
Summary of Information Reported:

- High levels of frustration that agricultural operations were not connected at the same time as the Telus/Pathways to Technology project.
- Inability to access business critical websites because of poor connectivity.
- Numerous agricultural tools (Smart Farming) are available but cannot be accessed because of poor connectivity.
- Require better support for connectivity for agricultural sector because of importance of food security.
- Business express concern about the unlevel playing field created by lack of access to broadband connectivity at the USO.
- Interest expressed in helping to be part of the solution.
- Belief in aggregating for a solution.
- Concerns about impacts to tourism industry arising about of lack of broadband connectivity and cellular coverage. Need access to connectivity or people are reluctant to come.
- Restricted in services businesses can offer because of lack of broadband connectivity to provide services online.

Stakeholder Summary: Community Representatives
Summary of Information Reported: • High sense of frustration over different treatment vis a vis connectivity options. • Reported difficulties in working from home and accessing online services such as education and healthcare. • Concerns about being left behind.

6.3.4 Reported Performance Summary

This map is a high-level illustration of areas within CRD where the ISED map that is used for much of the grant funding reflects a higher level of service than the highest speed reported through survey responses and speed tests conducted at http://performance.cira.ca/cariboord . It is acknowledged that there may be contributing factors for that discrepancy.



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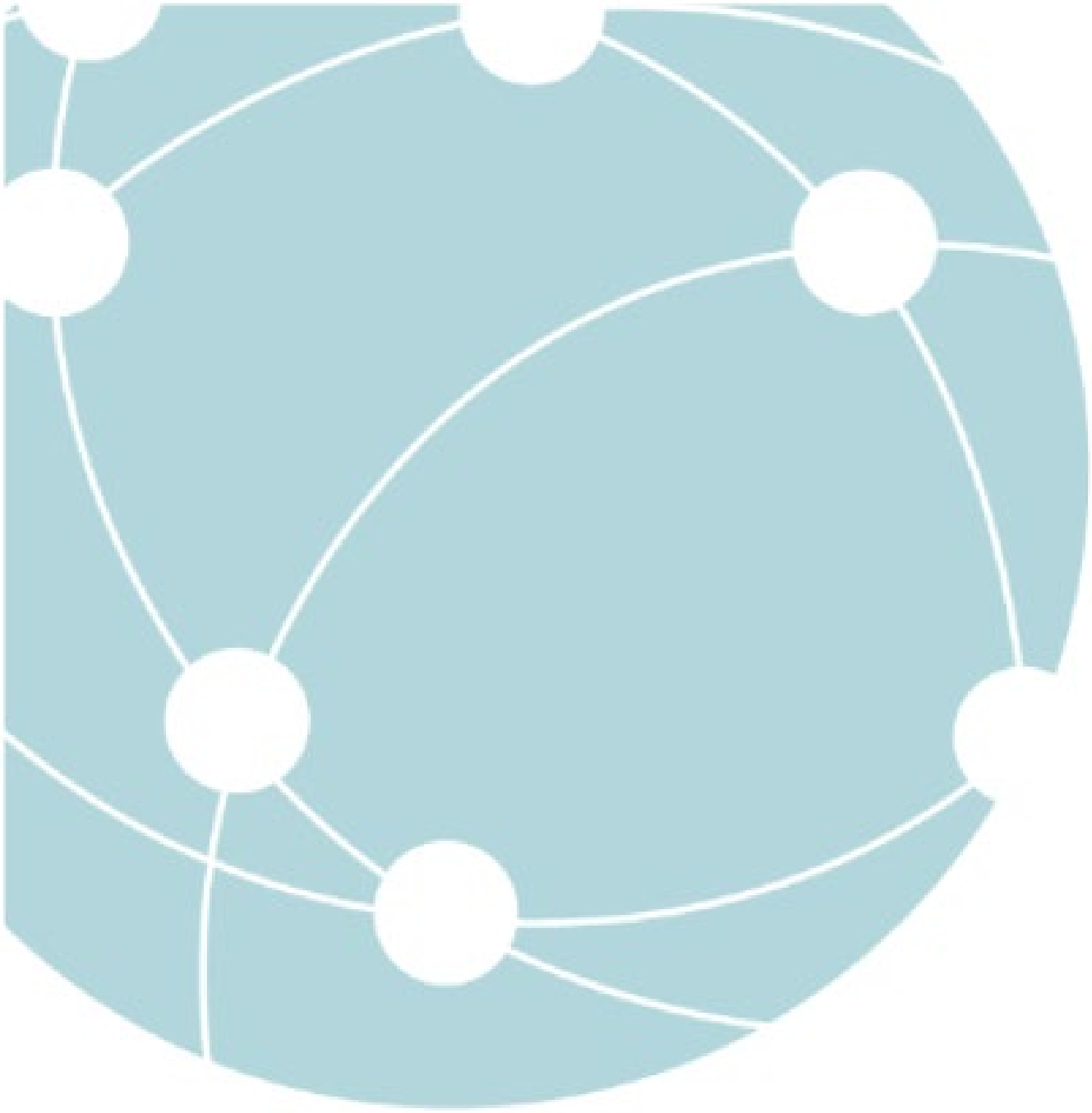

7 SITUATIONAL ANALYSIS

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7.1 Moving from Current State to Vision

In order to achieve the CRD vision, a number of steps must be completed from understanding and documenting the current state through to achieving the vision as shown below.

Previous sections of this report provide information on the first two items of this sequence and the remainder of this document will focus on subsequent steps required.

7.2 Identify the Gap

7.2.1 CRD Connectivity Factors

Understanding the CRD connectivity situation and creating a strategy to address to gap requires the identification of the strengths and weaknesses of the region from a connectivity perspective. The CRD strengths, weakness, opportunities, and threats have been summarized below:

STRENGTHS
• A major north south provincial transportation corridors run through the RD, the John Hart Highway (97). This corridor also has a rail line and energy transport facilities including electrical power and pipelines for liquid petroleum products and natural gas. This corridor attracts and supports development. • There is existing presence by large providers in the major corridor of the region. • Existing initiatives by major providers that can be leveraged. Telus fibre infrastructure has already been deployed for First Nations projects. Eg. Telus Pathways to Technology for area First Nations. • There is a passion within the Regional District organization and residents to solve the connectivity challenge as evidenced by the number of survey responses. • Diversity of industries that can benefit from improved connectivity such as forestry, agriculture, mining, tourism, natural resources, transportation. • A fiber optic communication cable route follows the Highway 97 corridor providing high-capacity transport connectivity to the communities along the highway: Quesnel, Williams Lake and 100 Mile House. This corridor can provide redundant ring connectivity to internet exchange points in Vancouver and in Alberta, enabling reliable broadband transport within the region and to the global internet. • Strong organized tourism and agricultural sector. • Large number of unserved subscribers outside the major corridor. • Fairly high density of rural clusters with 42% of points in the Electoral Areas located within 25m from another point. • Clusters are located along highway corridors. • 1/3 of points are within 1km of a highway and 2/3 are within 10km. • Majority of rural residents are non-seasonal (85% regular residents). • Highly organized industry groups with connectivity initiatives. • Competitive cellular coverage along Hwy 97 – 100% of rural points within 5km of Hwy 97 have cell coverage. • Of all points in rural area, just over 50% are within 25m of each other.

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WEAKNESSES
• Large geographic area which has very remote areas and is expensive to build infrastructure. • Outside the larger communities on the Highway 97 corridor, the population density is very low and scattered across a large geographic area. This means a challenging business case for rural broadband. • No current regional growth strategy or economic development plan calling out connectivity as a strategic priority. • CRD has a large connectivity problem. Identified number of project areas is large. • Unemployment consistently higher than the provincial average. • Vast numbers of unserved subscribers outside the municipalities (Only 1/3 of points outside municipalities are served with 50/10 Mbps). • Terrain challenges – variations make cellular coverage challenging in some areas. • Population is decreasing according to recent labour market survey. • Identified worker shortage. • Shortage of large industry to assist in supporting high-capacity connectivity. • Lower average income than provincial average. • Only 15% of anchor institutions outside municipalities have access to 50/10. • Limited number of providers outside the Highway 97 corridor.
OPPORTUNITIES
• ISPs generally express willingness to cooperate and partner to improve service in under-served areas. Greater success can be achieved by leveraging resources and government subsidies to solve a bigger problem for more people. • The Connected Coast project in concert with recent Telus fiber extensions along Highway 20, would enable additional ring diversity for region and also has the potential of providing ring diversity for the communities on Highway 20. • A variety of subsidy funding sources are available. • The COVID-19 pandemic reinforces the important need for improved connectivity to rural and remote communities for services like education and medical care. The COVID-19 pandemic is reinforcing the need for improved connectivity to under-served areas. • Over the next few years, the emerging availability of low earth orbit (LEO) satellite service should improve the quality of broadband service available to isolated farms, businesses and scattered residences in the Regional District. Starlink is currently in beta testing south with good coverage over the southern part of the Regional District and may extend service north over the entire CRD within the next year or two. Other LEO initiatives are also in various stages of planning and development. • CRD's central location allows it to facilitate greater cooperation among area stakeholders both within CRD and outside. • Leverage improved connectivity to diversify the economy and support traditional industries such as forestry, mining, agriculture and manufacturing. • Increased food security awareness as a result of COVID-19 may strengthen CRD position. • Consistency of political will for improved connectivity. • Many communities are along existing and fibre optic backbone facilities which may reduce the need for new construction. • Major ISPs have a presence and some smaller regional and community ISPs.

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- Telus infrastructure already placed along some major areas of concern (Highway 20). Existing initiatives by major providers. Eg. Telus Pathways to Technology for 10 First Nations.
- Expression of interest by external providers to deliver services in a partnership model.
- Vast numbers of unserved subscribers outside the corridor potentially improving the business case for providers.
- Most population (2/3) outside the municipalities – rural centric – business case for larger regional solution may lower the cost / sub.
- Large number of rural residents that need better service. (10s of thousands)
- Recent labour market study shows need for more workers (nearly 2000 jobs over next 5 years). Connectivity will likely be a major consideration. One of the biggest gaps in work force is health care.
- People wanting to relocate to smaller centers (at least in the short term).
- Surrounded by other Regional Districts with similar connectivity concerns that are actively pursuing connectivity strategies.

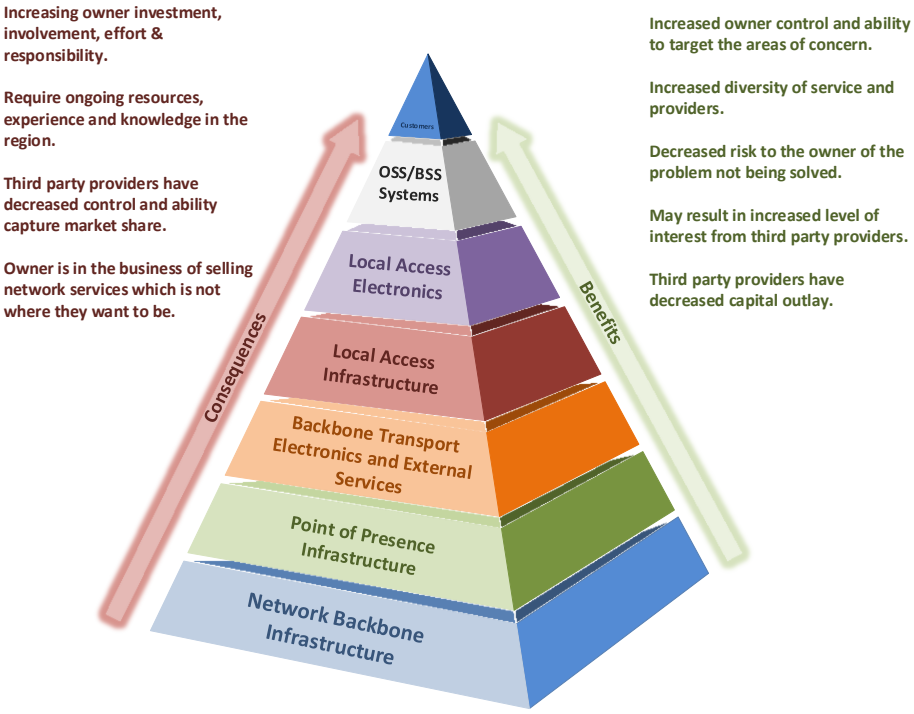
THREATS

- Economic impact of commodity market weakness in general, closure of major industry and COVID-19 related concerns impacting the business market.
- Continuing economic stress from the collapse of forestry related markets.
- Continuing economic stress from contraction of mining and mineral extraction related markets.
- Although network operators have expressed a willingness to cooperate and complete transport fiber network rings and facilitate access networks, the difficulty of achieving cooperation should not be under-estimated when it involves other parties that usually do not cooperate or that are fundamentally competitors.
- The incumbent may leverage its dominant position in the market to sabotage competition.
- The COVID-19 pandemic may have significant near-term impact on tourism revenues.
- Applications for subsidy funding are complex and involve significant effort. Further, applications to different funding sources often need to be combined in order to create a viable business case; increasing the complexity and effort required.
- Competition for government subsidy funds and competition for network build resources may create a difficult construction market in the near term.
- Regional District on its own does not qualify for existing funding opportunities.
- A minimum level of local operations and maintenance capability and commitment is necessary for community networks to be long-term sustainable. This can be difficult in smaller communities; particularly if the economic base is small, eroding, or has limited growth potential.
- Split of views on Regional District's role in solving connectivity challenge.
- Continued negative pressure on forest industry. Threats from climate change and natural disasters (mountain pine beetle, wild-fires, flooding).

7.2.2 Technology

7.2.2.1 Broadband Service Delivery Pyramid

From a technical aspect, solving the connectivity challenge for rural and remote areas is the same as an urban environment and requires a service delivery model that encompasses a number of layers that all need to be provided. The following Service Delivery Pyramid ("SDP") provides a visual depiction of the layers of infrastructure that must be present to solve the connectivity issue:



The diagram above outlines the SDP and delineates the individual layers that must be provided and the relative levels of responsibility the network owner must address to satisfy the goal of improved services to the residents and businesses. Solving the connectivity problem requires that all layers of the SDP be provided, either by one entity or by the collaborative efforts of numerous parties.

As the network owner commits to, and moves up the layers of the pyramid, increasing levels of complexity and involvement are required. Although this may seem intimidating, the benefit of increased control and influence on improvement of services may outweigh the hurdles.

The layers of the SDP are as follows:

Backbone Infrastructure: This is the physical infrastructure required to bring long distance connectivity to a community. For high-capacity modern networks, this would typically be fibre optic cable but in some cases, high-capacity microwave may also be suitable. The term backbone is also synonymous with “transport infrastructure”.

Points of Presence: POPs are the infrastructure required in each community (or along the backbone route) used to locate the electronic components required to enable connectivity as well as act as a termination point for the backbone infrastructure. For example, in the case of a fibre optic backbone, the physical cable would be installed inside the POP and the cable connected to the electronic components within the POP. A POP houses sensitive electronic components so suitable environmental controls are including, but not limited to, air conditioning, battery, backup power, and security.

Backbone Transport Electronics and External Services: This layer represents the electronic components and services required for the POP to enable connectivity outside of the local area to other POPs and ultimately, the global internet.

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Local Access Infrastructure: This includes the physical assets required to connect the local POP to the subscriber's home or business. There are numerous choices for technology, but for modern, high capacity, scalable networks, fibre optic connectivity is the preferred option. Different options for local access technology are more detailed in supplementary documentation.

Local Access Electronics: This layer of the SDP represents the electronic components required in the POP and in the subscriber's home or business that enable connectivity to underlying layers of the SDP. This is the final physical component required to enable connectivity.

OSS/BSS Systems: All the lower levels of the SDP, require management to ensure they are operating correctly and to provide the business operations of the network. These operations include, but are not limited to, network monitoring and management systems, billing, provisioning, technical support, customer service support, maintenance, among others.

Customers: The final layer to a successful broadband network is the existence of customers subscribing and paying for services on the network. In the case of rural and remote networks, anchor tenants or institutional customers can be particularly beneficial in supporting the sustainability of the network.

Greater detail on the technical aspects of the Service Delivery Pyramid and a comparison of technology can be found in Appendix.

7.2.2.2 Technology Overview

Broadband connectivity can be provided using a number of different technologies each having various advantages and disadvantages. While a more thorough comparison of different technologies in contained in the Appendix of this document, it is important to understand a few key technologies for delivering high quality connectivity in rural areas.

7.2.2.2.1 Fibre Optic Technology

For delivering high capacity, scalable and very reliable connectivity over long distances, fibre optic technology is the only viable technology available. Long distance fibre optic backbone networks are critical to enabling almost all other technologies to deliver services in a manner that provides the high capacity needed to deliver the USO now and in the future. Fibre-optic backbones combined with local access delivery using Fibre to the Premise ("FTTP") provides the best possible fixed service currently available with virtually unlimited ability to offer a variety of services in the most reliable fashion and lowest ongoing operational costs. While fibre has the disadvantages of high up front capital cost and lack of mobility, it is still the preferred alternative for all broadband connectivity. However, when considering the lifetime of fibre optic infrastructure is 25+ years, the capital cost over the lifetime of the asset makes the cost fibre comparable to other technologies.

7.2.2.2.2 Cellular Technology

Cell networks began as a means of delivering mobile telephone service but have evolved to include text messaging and access to most of the communications, information, and other services available over the Internet. Cell phones have displaced fixed line telephone service as the preferred way to communicate with individuals. The smart phone has become an essential personal appliance, providing communication, access to information and many other services and applications for personal

convenience, productivity, safety, and entertainment. Safety and security are often cited as a primary use for cell phones. In many areas, over 80% of emergency calls to 911 are from cell phones[29].

The cellular mobile system is a separate network with cell sites that connect forward with radio to user terminals, typically smartphones. The cell sites are backhauled to a core network, typically over fiber. The core network has gateways into other networks including the public switched telephone network and the public internet as well as, in many instances, secure gateways to specific enterprise and private networks. The technology is governed by open global standards, enabling cell phones to generally "roam" world-wide. Access to spectrum (radio frequencies) is an essential ingredient which is regulated by national governments and cell spectrum is usually auctioned to mobile network operators who have the financial backing to afford the spectrum.

The current generation of cellular network in Canada is the fourth generation or 4G - commonly referred to as Long-Term Evolution (LTE). The LTE network was designed from the ground up to support the Internet Protocol suite with high data rates. Although not designed to compete with FTTP data speeds and monthly usage levels, where several user devices, including big screen TVs are accessing the internet, the cell network provides good internet access given the small form factor of most mobile devices. In the home, Wi-Fi is used to connect mobile devices to the internet, offloading usage from the cellular system.

Next generation cell, 5G, has rolled out to urban centers across Canada and is generally expected to gradually extend to smaller centers and rural areas over the next few years. The 5G network features improved efficiency, capacity and capabilities that are intended to support additional use cases, including fixed wireless broadband access. The new frequency bands to support fixed broadband will only be released in Canada through government auction processes over the next few years.

For further information on cellular mobile technology, refer to the appendixes.

7.2.2.2.3 Low Earth Satellite Technology

While the appendix of this document provides additional detail on different technologies, LEO technology has been specifically addressed because of its emergence in the market and it provides a viable alternative to remote connectivity.

Satellite based communications have been characterized as "distance-insensitive" because there is no linear chain of terrestrial cables or radio links between the end points, only the radio link through the satellite network. Satellite networks designed to serve directly to the customer's premises combine the transport and access (last mile) network functions into a single network. Xplornet is an example of such a network based on geostationary earth orbit satellites. Unfortunately, transmission delay and the relatively high cost for normal consumer broadband usage levels are significant limitations for these satellite networks.

A new generation satellite networks are being planned and deployed into low earth orbit (LEO) that vastly improve the delay performance and may address the data usage affordability issue. The Starlink system being launched by Spacex is the first-to-market. As of the writing of this report (March 2021), beta test service is available from Starlink in northern US and southern Canada. Over the next few months, coverage should improve and extend all the way through the region. The beta service is proving popular for isolated customers and is available for approximately $800 for the terminal (self-installed) after shipping and taxes and then $130 per month. So far, the beta test results support Starlink claims of 50 - 150 Mbps downlink speeds and 10 - 30 Mbps uplink speeds with round trip delay in the 20 - 40 msec range. Whether the system will retain these performance figures as the system and

[29] Local21News – *"How accurate is your cell phone location data in an emergency?"*

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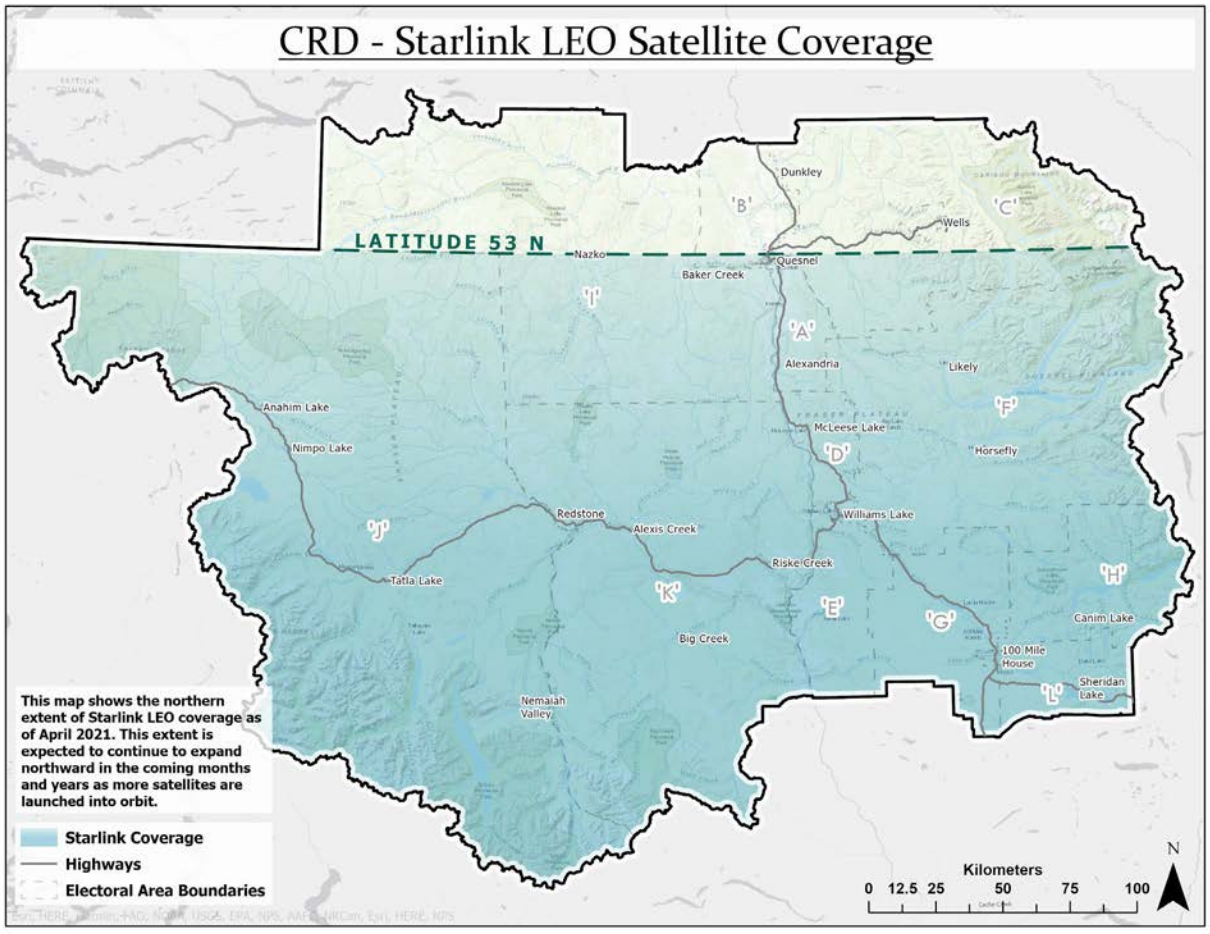
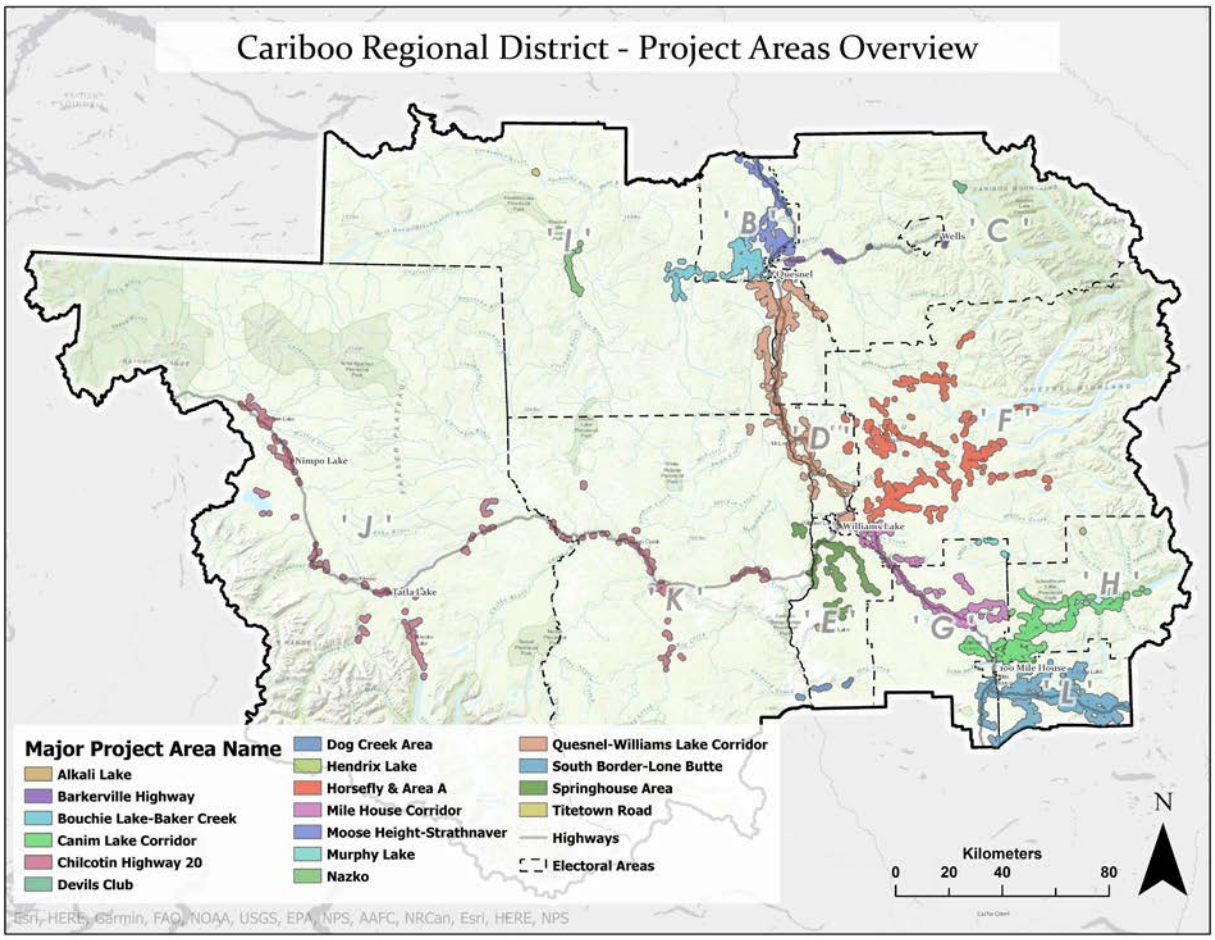
subscriber base scales up is unknown at this time. Other broadband LEO systems are also planned, but service is at least one or two years out and these may not be consumer service plays (e.g. they may be used to backhaul access networks such as cell sites, remote camps and remote communities).



7.2.3 Potential Project Areas - Broadband

The CRD is a vast region with a large rural population that is challenging to connect. The connectivity challenge on a large region wide scale is overwhelming but on the positive side, the proximity and large clustering of the identified Points aid in the ability to solve the connectivity challenge by allowing the cost of infrastructure to be dispersed across many potential subscribers thus lowering the cost per subscriber for high quality services. To aid in solving the connectivity problem for the CRD, it is helpful to break down the rural CRD connectivity gap into smaller components so that projects can be understood, prioritized and solutioned in a focused manner.

The following provides a summary map showing all the major project areas identified according to the methodology described earlier in this document.



The map above provides a visual depiction of the project areas that are reported on the ISED map as served at less than the USO and identifies the gap that needs to be addressed. The map represents just under 20 major project areas that each contain a number of smaller sub-projects. There are approximately 75 sub-projects identified in the CRD. Sub-projects may have any number of potential subscribers from as low as a few dozen to several hundred. The CRD represents over 23,000 Points with nearly 70% of those located in areas shown on the ISED map as served at less than the USO.

Additional detail on the project areas and the characteristics of each is provided later in this document and in the confidential ancillary documents.

7.2.4 Potential Project Areas – Cellular

As can be seen from the previous cellular coverage maps, the Highway 97 corridor has generally good cellular coverage. However, the highways and rural roads to communities in the Regional District that extend out from the Highway 97 corridor are candidate project areas for cellular mobile coverage expansion. Highway 20, Highway 26 and Nazko Road at Nazko were selected as project area case study examples. A preliminary design was prepared to provisionally determine potential cell sites (near grid power and fiber backhaul) to provide reasonable community and roadway coverage. The map shows the predicted mobile coverage for each of the example areas. The following color code scheme applies to the predicted service availability:

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- Green: Reliable mobile and fixed wireless coverage.
- Blue: Unreliable mobile coverage, but reliable fixed wireless coverage to an outdoor antenna.
- Orange: No mobile coverage, but some fixed wireless coverage may be possible with an elevated outdoor antenna (e.g. high enough to clear local foliage and buildings in the direction of the cell site).

The three sample designs can be summarized as follows. Note that these samples are indicative only. They may be extrapolated to get a sense of what would be required to provide coverage of other rural highways and roads in the Regional District.

- The design for Highway 20, from Williams Lake to Anahim Lake, covers about 300 km of highway and is based on 10 cell sites that are generally located near communities.
- The design for Highway 26, from Quesnel to Wells and Barkerville covers about 100 km of highway and is based on four cell sites.
- The design for Nazko Road is intended to provide coverage at Nazko using a single cell site and along a stretch of Nazko Road some 10 to 15 km in each direction from Nazko.

Refer to the cellular appendix for additional background information on cellular technology and on the basis for these preliminary project area design examples.

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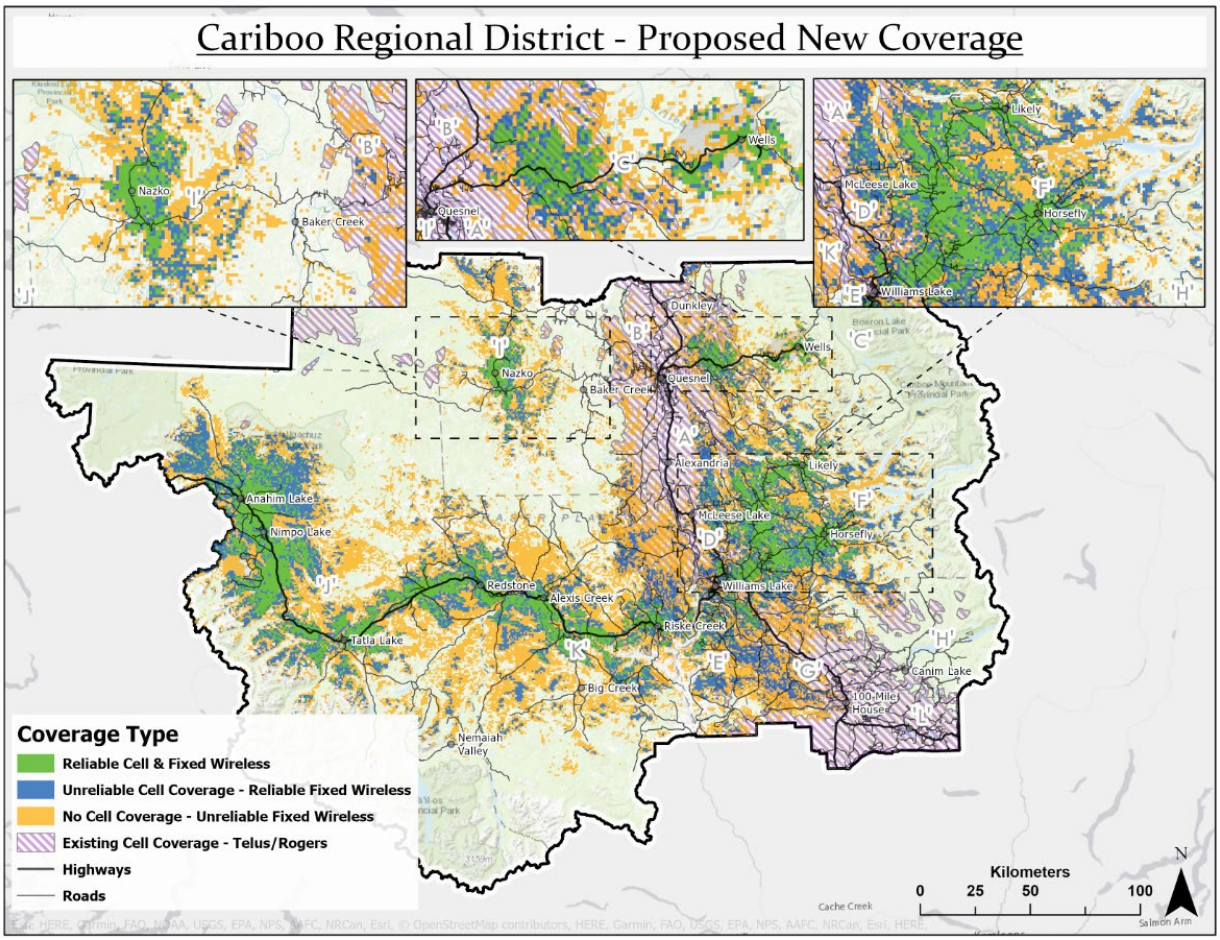

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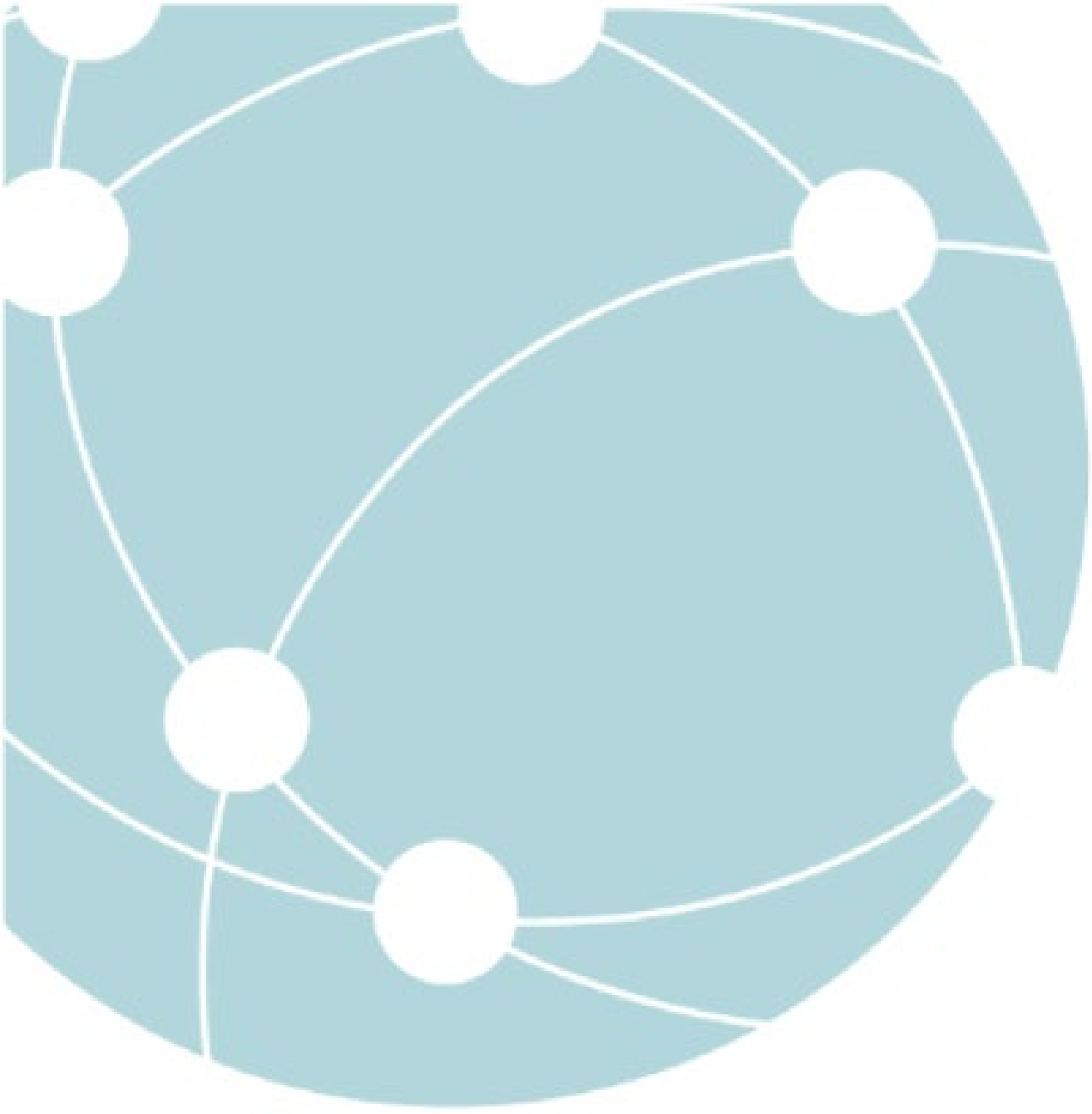

8 STRATEGY IMPLEMENTATION

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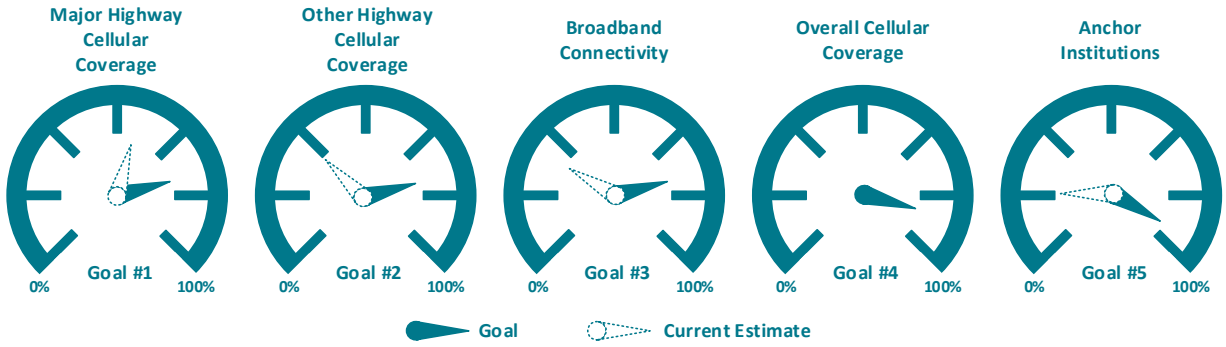
8.1 CRD Role and Areas of Focus

One of the key components to the strategy is to identify the role that the Regional District could play in advancing the connectivity initiative for different project areas. The CRD connectivity goals were highlighted earlier in this document and to understand the recommendations put forward, it is important to understand where the CRD currently is in relation to those goals. The following graphic provides a snapshot of the estimated progress towards these goals.



8.2 Bridging the Gap

The following table is a summary of the Points in the CRD in the project areas. The graphic following the table shows the total Point summary and then how it breaks down by electoral area and provides a starting point to prioritize potential project areas.

Detailed tables are contained in the appendix and provide a breakdown of Electoral Areas and identified projects with Points (potential subscriber location) shown at the USO. Points identified as “Remote Points” are points that are very sparse and not easily combined into a suitable project area or Points that may not be a potential subscriber location.

A summary of the entire Regional District is as follows:

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Project Area Summary

Mar 29, 2021

Major Project Name	Sub-Project Name	Area	BB	Project Definition: Local Access	Project Definition: Total Subs	Project Definition: % of Total	Project Definition: Primary Svc	Current Service Levels: 5/1	Current Service Levels: 10/2	Current Service Levels: 25/5	Current Service Levels: 50/10
			Totals	23,086		100%		9,851	3,120	2,792	7,323
								43%	14%	12%	32%

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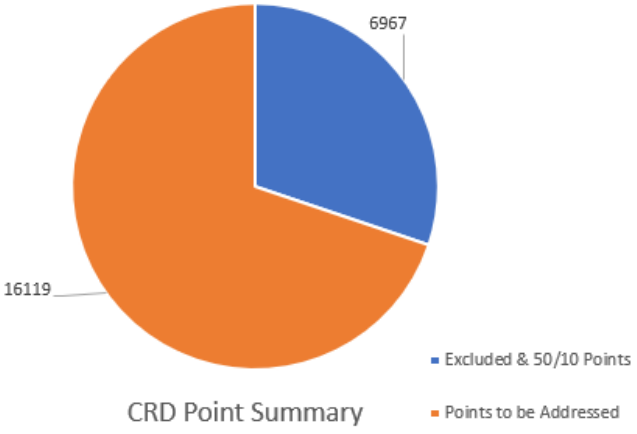
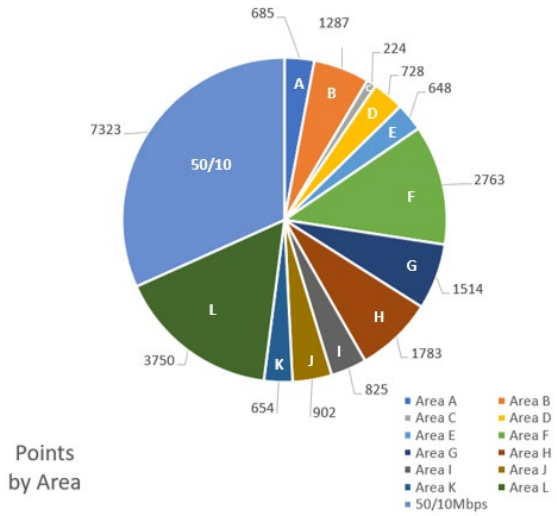
To provide further detail, the CRD has been broken down into project areas summarized by electoral area.





Project Area Summary Conclusions

The above table and charts provide the following conclusions:

- There are just over 23,000 Points not including municipalities and First Nations in the CRD.
- Of these points, about 32% (total of 7,323) have connectivity at the USO.
- Approximately 500 have been excluded due to their highly remote nature. These Points will be candidates for satellite service including the evolving LEO satellite service. This brings the total number of Points that are considered served at the USO or excluded to a total of 7,823.
- Approximately 15,263 Points would be considered as those that require improved service.

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- Nearly 60% or just about 13,000 Points are consider poorly served with connectivity of 10/2 Mbps or less.
- Approximately 2,800 Points are served with technology suitable for 25/5Mbps representing decent service but not at the USO. While these may not be the highest priority for solving the connectivity challenge, they should be considered when planning a solution.

8.3 Strategic Direction

The strategic direction the CRD should take in advancing the connectivity solution includes a number of actions. One of the first actions will be to develop criteria for prioritizing the proposed project areas and then to apply that criteria to prioritize them.

Next, the CRD will need to establish the role that it is prepared to play in advancing rural connectivity for each project area in the CRD. Connectivity is not already provided in project areas because those areas do not represent a viable business case for private providers. Accordingly, the Regional District may require more active involvement to address areas that may not be served by any other means. The CRD's role may vary project area by project area and may range from simple advocacy, to active financial supports for service providers through to establishing a service.

While the connectivity challenge in the CRD may seem overwhelming with many Points identified, it may not present the same challenges as other regions based on comparable processes for other regions. For private business to complete the necessary projects to bring improved connectivity, a suitable business case must be available and often funding subsidies are still required to attract the investment. In the case of CRD, with a total of 70 project areas defined, the majority of them have over 100 potential Points to be served with nearly 20 of them providing connectivity to over 400 potential subscribers. When considering rural connectivity, 400 subscribers would be considered a sizeable community.

8.3.1 Establishing Project Priorities

The CRD's project areas need to be prioritized to establish a logical sequence for implementation and realistic goals. Considerations for establishing priorities include:

- Logical sequencing of construction.
- Largest impact for the highest number of residents.
- Largest need for improvement. Areas that have the worst service may need it the most.
- Easiest to implement. Look for the quick wins.
- Lowest cost per subscriber.
- Areas that are eligible for federal and provincial funding.
- CRD focus on areas that are unlikely to be constructed by third parties.

To provide a starting point for this discussion, this study defined many project areas of varying numbers of Points. To establish priorities, consider the following:

Prioritize by Logical Construction Sequence

Networks need to be constructed in a logical sequence. This usually means that services are constructed in a fashion from the core of the network outward as there is little point in constructing a

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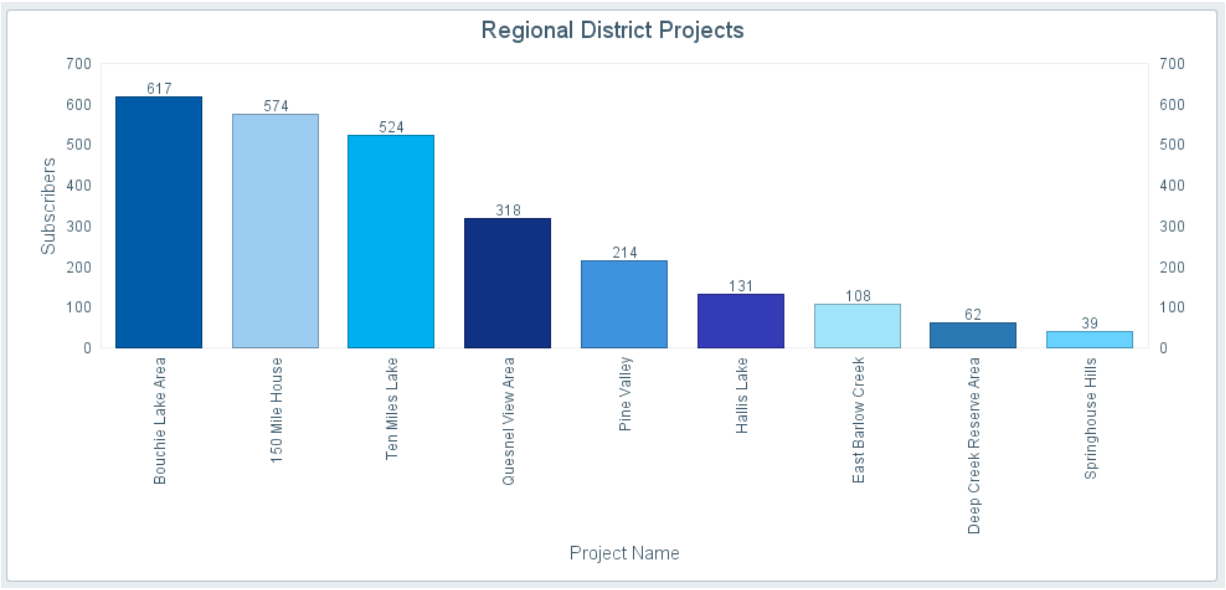
network that cannot connect to anything. The project areas defined in the CRD have been ranked by dependencies which assists in establishing a logical build sequence.

The following projects identify those that are likely to be constructed first as they allow future projects to leverage the infrastructure. In the case of the CRD, the number of projects with no dependencies is low as Williams Lake and Quesnel are natural aggregation locations for the rural projects. In order to obtain connectivity outside the region, it is very likely that connectivity must be aggregated back to one of these two locations, but this will be dependent on what the project owner may have available for existing infrastructure.



Prioritize by Largest Number of Points Served

The following projects represent the highest total number of Points at speeds less than 50/10Mbps filtered for projects over 100 Points. This represents the project areas that will present the CRD with the largest opportunity to solve the connectivity problem for the highest number of homes.

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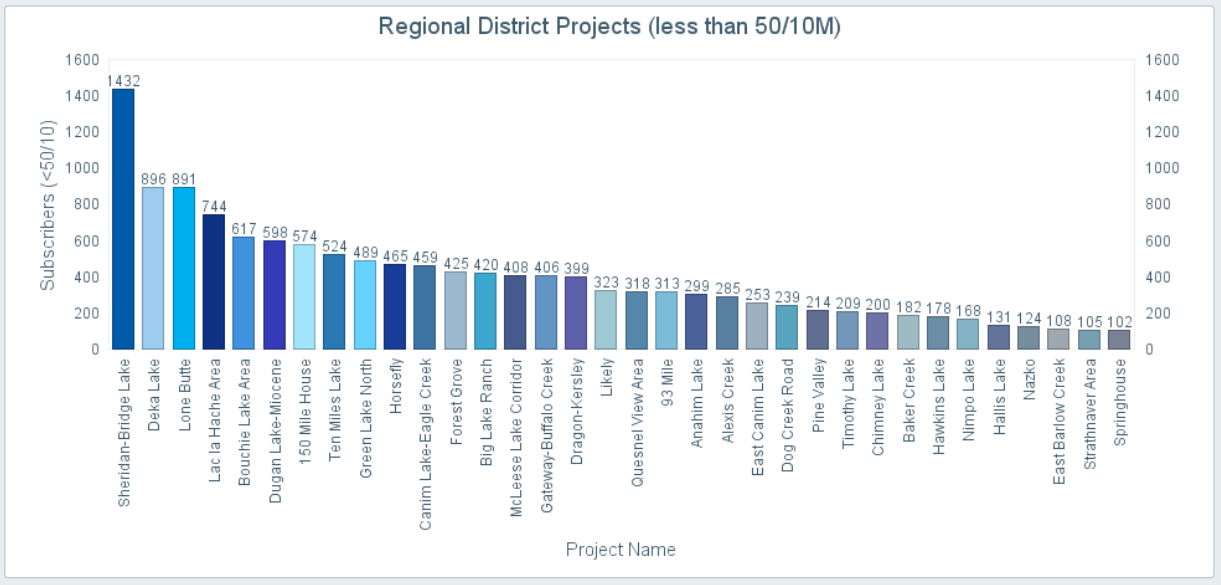
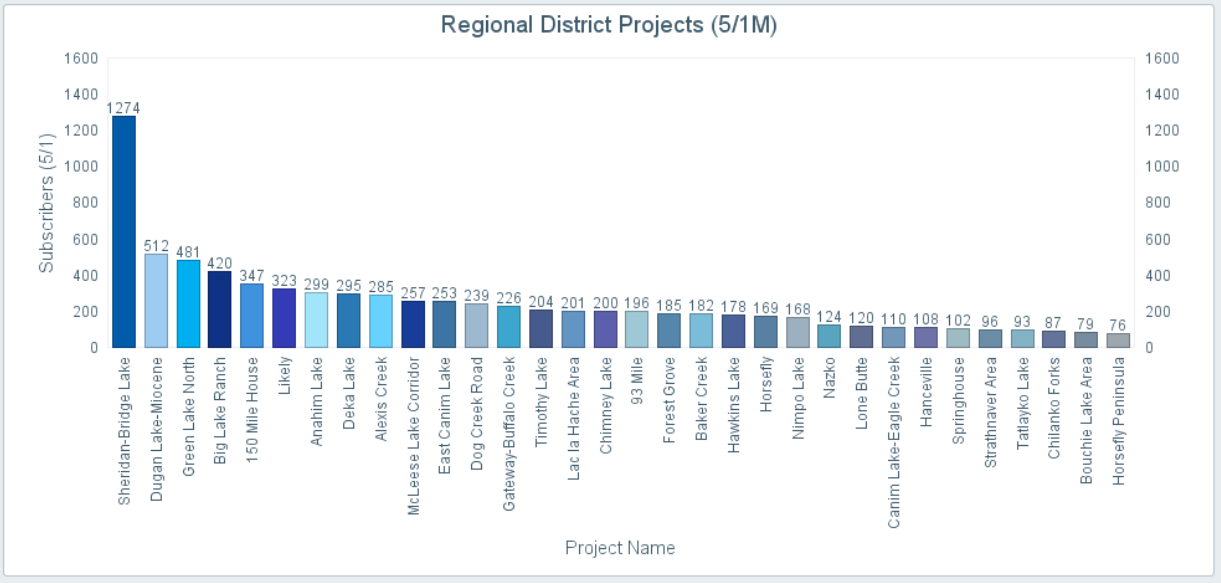


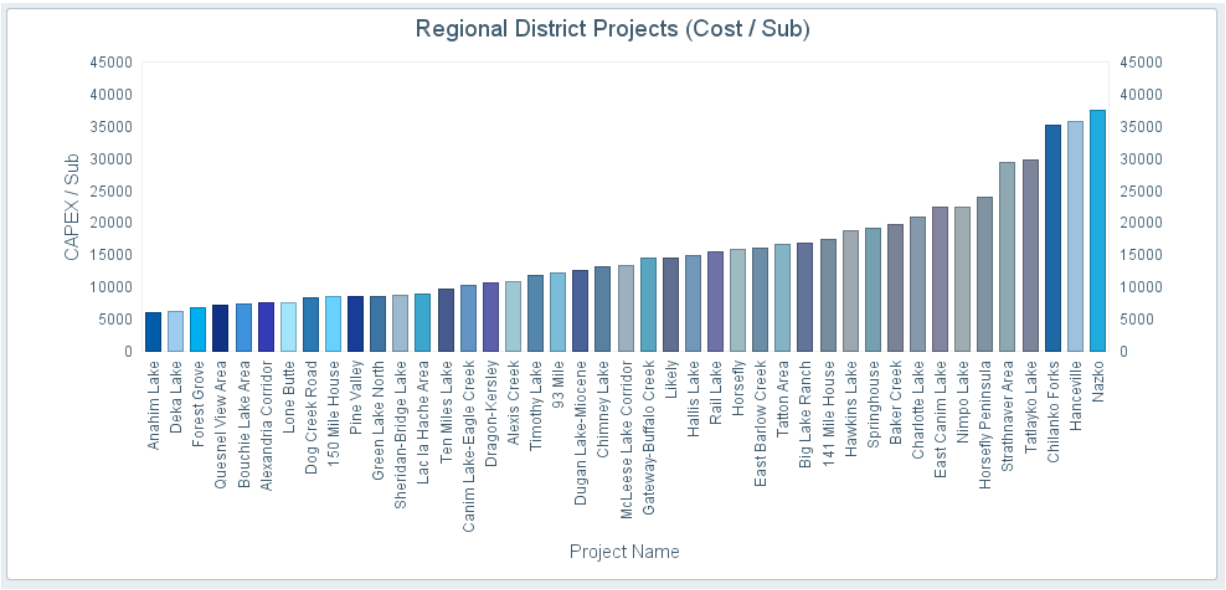
Prioritize by Poorest Existing Service

The following projects represent the highest total number of Points at the worst speeds of 5/1Mbps or less and that have over 75 Points.



Prioritize by Lowest Cost per Subscriber

The following provides the top projects based on lower cost per subscriber that serve more than 75 Points. This has been created using the cost assumptions outlined in the ancillary document.



8.3.2 Determine the Role of the RD

One of the major considerations that the Regional District must complete in addressing the connectivity challenge is to assess the role of the CRD. The established role may vary depending on the project area that is being considered. In some cases, the path forward will depend heavily on the CRD's appetite for increased involvement, and this may also have impacts on the Regional District's ability to access federal and provincial funding. One real possibility for Regional Districts is the establishment of a service area and providing the mechanism for residents and businesses to contribute to the capital funding through taxation. Completing this process will require a central authority such as the Regional District to implement this structure and coordinate the effort between the residents and providers.

The spectrum of roles is depicted in the following diagram in an escalating level of involvement.

8.3.3 Establish CRD Resourcing

Like most initiatives, making tangible progress towards the goal requires dedicated effort by the stakeholders. Like many organizations, Regional Districts suffer from a problem of many regional needs and lack of time and resources to complete these. In order to effectively move the connectivity challenge forward however, the CRD needs to seriously consider a dedicated resource that can

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manage the CRD priorities and ensure progress to the goal. Among others, some of the tasks for this resource may be as follows:

- Determining the role of the CRD and establish working parameters to guide the effort.
- Establishing CRD priorities.
- Communicating the priorities to external providers, partners and other stakeholders.
- Creating a method to measure and ensure progress.
- Create a connectivity working group with area First Nations and municipalities.
- Participate in existing connectivity working groups.
- Researching, gathering information and obtaining access to funding.
- Resolving discrepancies in the ISED map to maximize the number of eligible areas for funding.
- Working with other experts to create solutions.
- Gaining community support for initiatives.
- Focusing and responding to letters of support by providers to ensure the proposed solutions meets to the goals of the CRD.
- Potentially advancing the creation of service areas depending on the CRD direction.

8.3.4 Collaboration and Grass Roots Support

The federal, provincial and other local regional and municipal governments have initiatives underway to improve rural and remote connectivity. Of particular attention in the CRD are neighbouring Regional Districts who are actively addressing the same kinds of issues such as Thompson Nicola, Fraser Fort George and Fraser Valley Regional Districts who have all undertaken initiatives to improve connectivity. While there may be jurisdictional Regional District boundaries, connectivity is not contained within these boundaries and effective solutions will cross these jurisdictions. Collaboration across local, Regional and First Nations governments where possible may assist in speaking with a single voice, accessing multiple funding sources and aggregating the problem to a more significant size and solving a larger problem for more people. When considering the cost of implementing connectivity, the number of Points that can be included in the cost base is a critical component to spread the infrastructure costs across as many subscribers as possible.

Further, solving the connectivity challenges in remote and rural communities cannot be considered one community at a time as the business will likely never make financial sense for private industry. The CRD can play an important role in understanding and communicating the areas of concern to solution providers to make the most effective use of the effort and capital required to solve the problem.

Some project areas identified in the CRD, such as Green Lake may be better served in a coordinated effort with the neighbouring TNRD. Together with the TNRD, Green Lake represents nearly 1,000 underserved Points that all require capital infrastructure to be constructed. Where project areas are close to Regional District boundaries with neighbouring Regional Districts or First Nations, there is potential to advance the project by pushing the initiative together with those neighbouring governments.

Finally, it is very important that prioritized areas have a local community champion that is passionate about advancing a solution. Without such a person, initiatives often wither and lack community buy in whereas where there is a strong community champion that is able to provide leadership towards the solution, better traction is often seen and those community members will be vital to the CRD's success in solving this issue.

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8.3.5 Present Project Priorities to Providers

Regardless of the role of the CRD, the Regional District must establish those projects that it wishes to prioritize and communicate them to the providers that can participate in solving them. Providers such as Telus, are applying for funding subsidies based on their defined areas of interest and may not be considering all the priorities of the Regional District. Using the information outlined in this report, the CRD is better positioned to understand these areas and communicate its priorities to external third parties.

An advocacy role makes cooperative participation with providers a key action for the CRD. Providers engaged as part of this project expressed interest in working with the CRD to resolve its areas of focus through a variety of business models from supporting funding applications, to capital contribution through CRD raised funds where a viable business case simply cannot be made.

Letters of support are often requested by providers and these letters need to be considered carefully to ensure the proposed project aligns with the goals and priorities of the Regional District. Further, funding programs often have eligibility criteria and care needs to be taken to ensure that projects are positioned for future scalability and do not provide marginal improvement which has the result of disqualifying the area from future funding by establishing an improved service but not consistently throughout the community at the USO.

Investments in infrastructure, particularly if Regional District funding is required, should be scalable to meet the current USO and position appropriate technology for current and future requirements particularly if public funding is deployed.

Considerations for the letter of support should include:

- Definition on the specific projects area(s).
- Inclusion of other surrounding project areas and priorities that may not be the intended focus but could be addressed more efficiently by inclusion in the requested scope.
- Defined project timelines.
- Defined levels of service and technology. Ideally projects that are requesting funding should be completed with technology that meets or exceeds the current USO as while this may be considered sufficient for today's needs, technology continues to evolve and requirements for connectivity always increase.
- Definition of the services desired. This is discussed more in the next section.
- Support for infrastructure to be constructed in a manner that promotes competitive services and provides where the providers is seeking public funds.

In addition to communicating project priorities and support for third party initiatives, the CRD may be able to contribute Regional District owned assets that can be leveraged by providers to reduce the barrier to entry in the priority areas. The Regional District may have access to buildings, locations, rights of way, etc that may be available to contribute to a project. Firehalls provide a good example of a Regional District asset that could be used as a Point of Presence ("POP") required in delivery improved connectivity.

The Regional District should inventory its available assets in an effort to make them available where required to reduce the barrier to entry for a provider.

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8.3.6 Establish a Timeline for Improvement

The CRD should establish a timeline for noticeable action and improvement. Almost all problems can be solved in a timely manner with a large enough supply of money. Federal and provincial funding programs have an inherent problem of slow response. Often, funding programs are announced, time is given to obtain funding applications, time is allotted for evaluation, announcements are made, clarifications and questions are required, funding is deployed, detailed construction plans are drafted, approvals are required for access to existing infrastructure and finally construction begins. The problem is that the time to complete this is measured in years rather than months. Further contributing to this problem is that federal, provincial and local government changes in leadership may stop advancing the solution due to differing priorities.

The CRD must establish milestones which provide a checkpoint for completion with a predefined action and escalation plan if the milestone is not reached when expected. Once each project priority has been established, clear established milestones for engaging service providers, assessment of options, decision on the path forward, etc have been developed. For example, a timeline may be established that if provider engagement has not been achieved within 3 months of initial engagement, the CRD has a plan to escalate the initiative to what might eventually be a more active role for the CRD is obtaining the solution.

The CRD has numerous defined project areas and in defining a timeline for each priority, projects can be prioritized, and progress can be measured. A complete list of all defined projects in the CRD has been provided in the ancillary document.

8.3.7 Future Direction of Services

As the Regional District (or other parties) may be asked or required to provide a financial contribution to fulfill improved connectivity, when meeting this request local government must make efficient use of that contribution. As such, the following provides some considerations that should be addressed as part of a capital contribution program.

Services continue to evolve and connectivity to the internet should be considered as one of many services. As part of the defined vision and benefits, constituents of the CRD are demanding better access to services that are considered essential. While this is a desirable goal, the current models of funding and service deployment do not lend themselves effectively providing access to the essential services. As discussed in other material provided as part of this project, true access to essential services can be provided regardless of whether the other benefits of internet connectivity such as entertainment and social media are deployed or not. For example, access to online education may be considered essential and services need to be deployed in manner so that residents of the CRD can cost effectively obtain access to online education.

As a general rule, in today's deployment model networks are constructed in a manner that provides exclusive use of the infrastructure to a single provider. When infrastructure such as fibre is deployed it is more efficient and makes better use of the capital deployed if it is constructed in a manner to provide equal access to all providers and services that wish to utilize the infrastructure. The industry term for this model is Open Access and while there are variations on this general theme, the general premise is that all services can be deployed over the same infrastructure providing not only making the most effective use for capital funds but also providing consumer choice of providers and services.

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Finally, when significant capital is required to facilitate improvements in connectivity, these projects need to be constructed in a manner to ensure scalability and sufficient capacity to not only meet today's USO but future requirements. There are many services and considerations for future requirements and particularly if the local government is being asked to make a financial contribution, these items need to be considered so minimal future contributions are required. The 50/10Mbps USO may be suitable for today's needs but it is only going to increase, so a scalability plan needs to be created. For example, making a local government financial contribution to improve connectivity for a network that utilizes DSL technology may provide some immediate relief, but the long-term suitability is suspect and making a financial contribution for improved DSL may not be the most effective use of public funds.

Further, the technology used by the internet continues to evolve. Today's internet technology in Canada uses an underlying communications technology called Internet Protocol version 4 (IPv4). However, this technology is quickly becoming obsolete as more and more connections to the internet are realized and in fact, new deployments may already or soon will have difficulty in obtaining the necessary address space to continue with IPv4. A newer technology called IPv6 is already available and has been deployed in other countries of the world. Canada is behind in these deployments and at some point, will be forced to begin the transition. Investments in networks must consider these future requirements and ensure support for technologies such as IPv6, which is readily available today, so there is not another financial contribution required due to lack of planning now.

8.3.8 Seek P3 Partners

One of the options that is becoming more readily available for local governments to utilize in solving the connectivity challenge is the engagement of Public Private Partnerships ("P3'). While the CRD may not have considered these opportunities in solving the connectivity challenge, there are some very real possibilities that need to be explored with varying degrees. These can range from well established incumbent providers to more creative models involving private funding and in a variety of forms. This may also include a simple financial contribution with no established method for sharing of revenue, control or ownership, to a more active role of participating in the ownership and sharing of the revenue to make the investment sustainable.

8.3.9 Establish Critical Infrastructure

As discussed earlier, fibre optic backbone infrastructure is a critical component to all service delivery technology whether it be via cellular, wireless, DSL, coax or FTTP. Establishing fibre backbone, ideally with multiple providers and diverse paths is critical to reliable, high-capacity connectivity regardless of the technology. The CRD needs to ensure that infrastructure placed and perhaps financially supported by the Regional District is available to as many providers and services as possible. Having to duplicate this infrastructure is very costly and inefficient and rightly so, providers view this kind of infrastructure as strategic to their business. When being asked for letters of support or other items regarding backbone fibre, or any other infrastructure for that matter, the CRD should ensure that it is being constructed with a view to future providers and capability especially when it is being constructed using public funding or Regional District capital. All infrastructure paid for using public or Regional District provided funds should be available for any provider in a manner that provides a suitable business case for all parties. Think highways, not railways as the model where possible. Everyone with a car can drive on a highway but railways are only for the use of its owner.

For more information on the Open Access concept, refer to the appendix.

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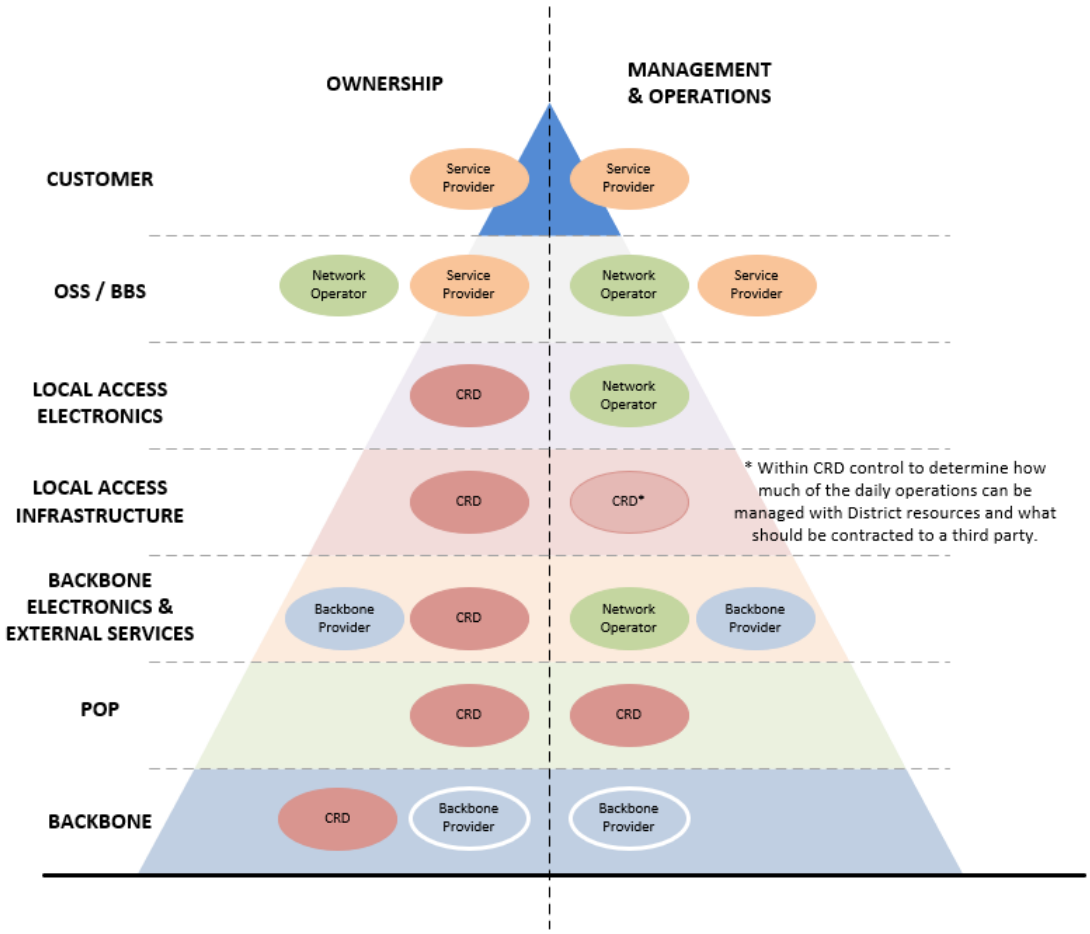
8.3.10 Active CRD Involvement

As discussed earlier, solving connectivity challenges requires that all layers of the SDP be solved. This does not mean that the CRD must own and manage every layer of the pyramid or have a detailed understanding of telecommunications and network troubleshooting, but rather that it actively participates in a model in which multiple parties collaborate to resolve the pyramid each bringing a set of skills and resources.

To solve the pyramid, there are four main parties involved each with a discrete role and responsibility. A single organization may fill multiple roles or, different aspects may be fulfilled by more than one party. The business model may vary but assuming the CRD decides to take a more active role in the solution, the main parties to consider are:

- The CRD – Owns (either by itself or together with others) the network and has ultimate control over it. To provide service, the CRD contracts with the parties below to provide the specified parts of the network.
- Backbone Provider – Third party that provides the backbone and global connectivity to the network.
- Network Operator – Third party that manages, operates, and maintains the network on behalf of the CRD and can provide technical escalation path to Service Provider.
- Service Provider(s) – Third party that provides the customer facing services, operations, billing, collections, and technical and customer support.

This structure is overlaid on top of the SDP that was introduced earlier in this report and provides a conceptual view of a business model, but there are several variations that can be considered depending on the role of the CRD.



8.4 Cost Estimate

The scope of this project is to provide the Regional District a strategy outlining the recommended actions to be completed by the Regional District and an order of magnitude cost to complete the strategy.

Cost estimates for identified projects are found in the project summary ancillary document and are intended for internal CRD staff and not intended for sharing with third parties including service providers.

8.4.1 Broadband Cost Estimate

Cost estimates have been provided using the underlying assumption of the preferred technology, that being a fibre-based solution. This report has assumed the necessary infrastructure would need to be constructed for all project areas but in reality, some of the required infrastructure may already be available. Use of available infrastructure is key to reducing the barriers to entry. While this may reduce

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the capital cost, it most certainly will increase the operational costs as infrastructure that is not constructed for the exclusive use of a provider will have to be leased from an existing provider.

8.5 Cellular Cost Estimate

Rough order of magnitude cost estimates can be made for each of the above case study examples by multiplying the number of cell sites by a typical cost per cell site. Cellular sites in rural areas typically vary widely depending on site location relative to grid power and fiber backbone, facility code compliance, carrier class and designed with capacity for future expansion using incremental investments.

Without the benefit of site specific information there will be uncertainty about key cost variables including: (i) distance to grid power; (ii) distance to fiber optic transport although the Broadband cost estimate provided ensures backbone fibre connectivity to all identified communities; (iii) civil works to provide physical site access and prepare the site for tower and equipment shelter foundations (clearing, leveling, filling, drainage); (iv) site acquisition related costs and permits; (v) environmental impact studies; (vi) cultural and heritage impact studies; (vii) tower type and height; (viii) local soil and required foundation type; and (ix) type of backup power and amount of reserve time.

8.6 Funding

Funding for rural broadband is a priority item for government, particularly considering the on-going COVID-19 pandemic. Remote and rural broadband projects are unlikely to be implemented by service providers without financial support as those service providers have business requirements that drive where and when they will invest their own funds to construct additional network capacity. Rural and remote capacity simply does not meet those requirements so there will be a financial gap between what a provider is willing to invest and what it costs to provide the service. This financial gap will need to be filled if service is to be provided in those areas.

Sources of funding in place at the time of writing for projects of this nature have been identified below. Funding programs have been included even if there is no currently open intake to identify places to look for funding options once a project is moving forward. **A detailed review of the application guide materials will be necessary to identify the specifics of the proposed project and the requirements for applying.** That detailed review should be a priority item so that appropriate work is commissioned in time to be “shovel ready,” if, and when, a decision is made to proceed with a project either through the Regional District itself or through a third-party provider or some combination of the two. It should be noted that as program intakes close, there are sometimes iterations of the funding requirements that apply in subsequent intakes so each phase or intake should be reviewed closely.

- Universal Broadband Fund (the “UBF”) is a $1.75 billion fund (believed to be updated to $2.75B as a component of the last federal budget) through ISED for the expansion of affordable, reliable, high-speed internet service in areas of Canada that have been identified by ISED as not having access to service at the USO or for mobile projects primarily benefitting Indigenous peoples. Funding is available until March 31, 2027. Applicants can request funding for up to 75% (or 90% in the case of highly remote areas or mobile projects primarily benefiting Indigenous peoples) of total eligible costs as defined in the program. The first intake just closed on March 15, 2021.

- Connecting British Columbia is a BC government funding program administered by the Northern Development Initiative Trust which is open to local, regional, or national service providers, local governments; First Nations or BC not-for-profits. The program has a number of focus points described below.
    - Last-Mile, Transport Infrastructure:
        - This program is in its third phase and has, as its objective, the acceleration of the delivery of internet connectivity at the USO to homes and businesses in rural and Indigenous BC communities. The program will accept applications through successive intakes until funds are exhausted. The fifth intake just closed on March 15, 2021. Projects that are already ready to go will rank more favourably than ones which rely on other steps to be taken first. A pre-screening process is required which ensures that an applicant either has the experience requirement (3 years' experience deploying and operating the proposed broadband infrastructure in Canada) for an application or will work with an ISP that does. In addition, the applicant must agree to own, operate, and maintain the resulting network for 3 years after the project is complete otherwise some repayment of the funds will be required.
            - Transport Infrastructure – 50% of eligible costs for transport infrastructure. Fibre project are highly preferred over other transport technologies such as microwave. In some cases, project will require a partnership with a facilities-based provider that provides confirmation that the proposed network design meets their standards for future expansion of cellular coverage along the route. Transport projects should achieve at least one of the following:
                - new or upgraded transport infrastructure that provides open-access for transport and internet gateways at affordable wholesale rates to last-mile service providers in those underserved regions;
                - improve network resiliency and provide redundancy;
                - provide future services such as cellular, public Wi-Fi or future technology;
                - increase competition in areas with high prices and low capacity;
                - enable government services in rural areas.
            - Last-Mile Project - 50% of eligible costs to improve last mile connectivity in underserved rural and Indigenous areas in BC but follows a baseline funding level of $250,000 per community. Last mile infrastructure is to provide potential for long-term usage and expansion through technologies such as fibre, coaxial cable and fixed-wireless LTE. The project is to align with the region's plans to show that the project is a priority for the communities it serves. It should be noted that the application documentation provides a list of BC rural and Indigenous communities along with whether that community does or does not have connectivity at the USO. The application guide states however, that if a project is also seeking funding from a federal connectivity fund, then the federal program will dictate whether the project is qualified. This is important to note as there are examples where the Connecting BC list includes a community, but the federal map shows it as served in some fashion.
    - Economic Recovery:

- A one-time $90 million infusion to encourage rapid expansion of connectivity to "drive regional economic development in rural areas, Indigenous communities and along BC highways." While there is no due date for applications, it is intended that the funds be allocated by March 31, 2021 for connectivity infrastructure projects that will be completed by October 31, 2021. This funding stream prefers projects that deliver 50/10 but considers projects that provide 25/5 as eligible. Compared to the regular Connecting BC program above, it has increased funding ratios (90% rather than the 50% through the regular Connecting BC program) and supports a wider range of technologies as well as highway connectivity projects.

o Core UBF:
- An intake intended to leverage the main federal Universal Broadband Fund. Now closed to intake.

o Rapid Response UBF:
- An intake intended to leverage the Rapid Response Universal Broadband Fund. Now closed to intake.

- The Broadband Fund (the "BBF"). – In connection with upgrading infrastructure to meet the USO, the BBF was established by the CRTC to provide funding of $750 Million over five years. The second call for applications closed on June 1, 2020 so this fund is not currently open for applications at the time of writing. This fund provides funding for backbone projects, local access projects and mobile wireless projects.

  CRD can apply to the BBF directly or as a member of a joint venture, partnership, or consortium with other eligible entities – eligible entities include other regional districts, first nations, municipal governments and private for-profit or not for profit service providers. BBF requires that "**the applicant, or at least one member of a partnership, joint venture, or consortium must have at least three years of experience in deploying and operating broadband infrastructure and must be eligible to operate as a Canadian carrier**." If this criterion is not met by the applicant or a member of the consortium, the applicant must enter contract with an entity that does.

- Gas Tax Fund – permanent funding normally provided twice a year by Infrastructure Canada. In BC, there is a tri-partite agreement between Canada, BC and the Union of British Columbia Municipalities ("UBCM"). Infrastructure Canada flows the funds to UBCM who then flows them to local governments for investment in local infrastructure priorities, specifically including use for broadband and connectivity.

- Trusts or non-profits that have support for CRD as part of their mandate.

- Private industry partners that may support a public/private partnership infrastructure project.

- Lenders such as the Canada Infrastructure Bank which has $2 billion in loans and equity for new broadband infrastructure projects.

- Local government taxation where possible.

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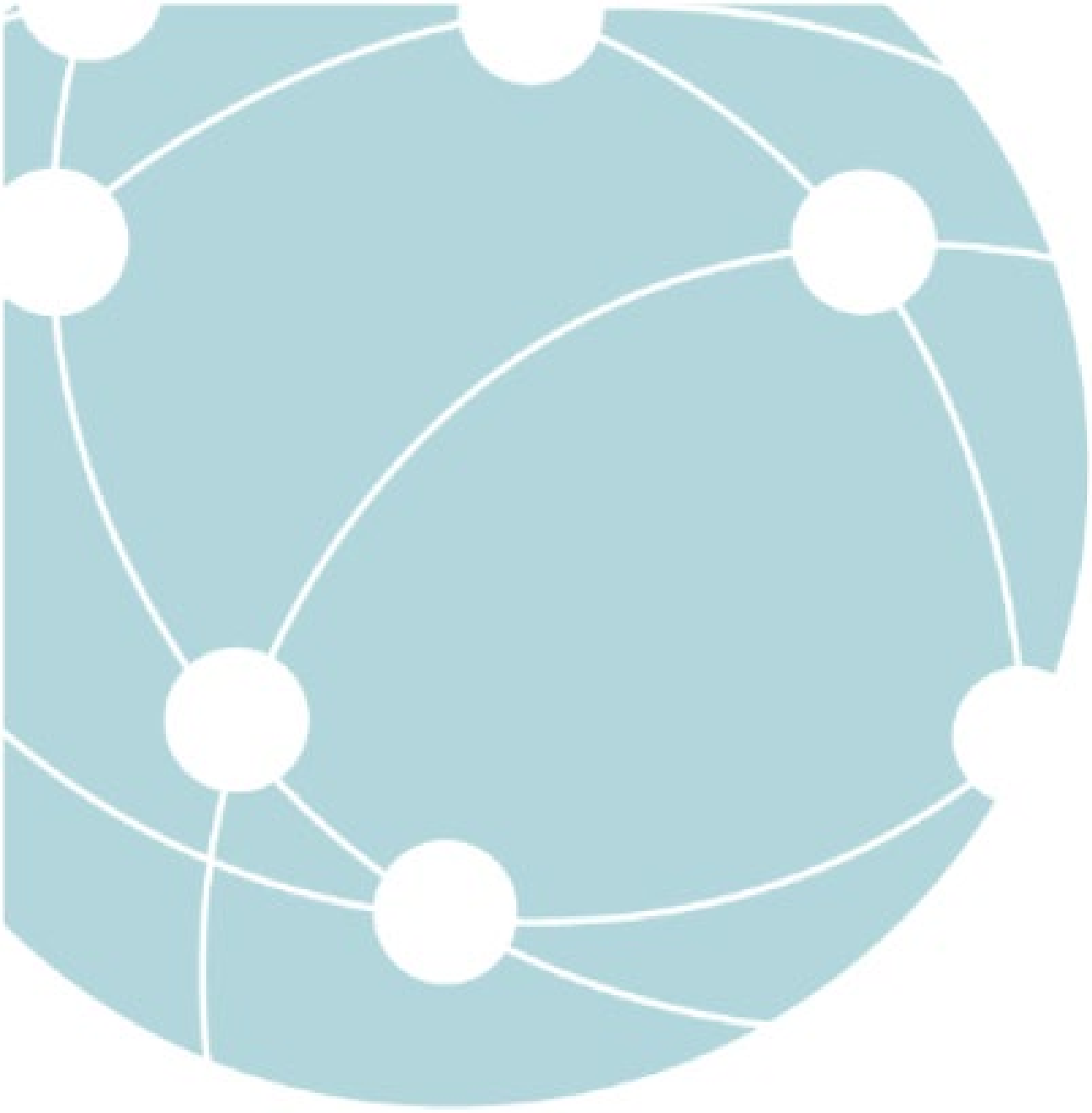

9 NEXT STEPS

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9.1 Next Steps

Based on the information gathered during the course of this project, the following provides a summary of the recommended next steps for the Regional District.

Fundamental Tasks

- Establish a CRD broadband working group focused on the connectivity challenge.
- Identify a lead internal staff resource to manage and advance connectivity initiatives.
- Establish Regional District's priority areas using the identified projects.
- Inventory CRD assets that may lower barriers to service delivery.
- Reach out and collaborate with other local governments, including municipalities, other Regional Districts and First Nations to identify and solve a larger problem for more people. Seek opportunities to partner or complete joint initiatives as often costly infrastructure can be leveraged if the costs are rolled into a single initiative.
- Align with other Regional District initiatives that may be ongoing.
- Actively provide intervenor feedback to the CRTC in collaboration with other local governments.
- If not already, become a member of the BC Broadband Association.
- Participate in broadband conferences, especially those focused on rural and remote communities.

Determine the Role of the Regional District

- Identify what contribution the Regional District will make to solving the connectivity challenge. These may include:
    - Advocate/facilitate/lobby
    - Contribute capital to third party. Establish a method and Regional District commitments and guidelines for facilitating this. While federal and provincial funding programs are available, they often have requirements, timelines, heavy participation and are often over-subscribed.
    - Partnership with a service provider.
    - Construct and own infrastructure.

- Determine specifics of how that role will be fulfilled:
    - If, for example, CRD decides that its role is to contribute capital, how will that be accomplished.

Prioritize the Project Areas

- Create criterion for prioritizing the potential projects identified in this report.
    - A list of criteria that identify how each potential project will be assessed which should include identification of projects where collaboration with First Nations or neighbouring Regional Districts is available.

- Complete the prioritization of the potential projects.

Create an Action Plan

- Identify project specific steps to address each priority area.
- Communicate priorities to service providers.
- Provide specific information about CRD's priority areas to providers for both internet and cellular.

- Develop a process and minimum service levels for responding to requests for letters of support to ensure that CRD's priorities are being addressed.
- Identify the specific barriers to service delivery in each priority area and determine whether the CRD can do anything to lower or remove them.
- Obtain proposals with pricing for priority project areas.

9.2 Implementation Recommendations - Cellular

If the Regional District wishes to drive cellular coverage improvements which are outside the carriers' normal business planning and implementation processes, it is recommended that the CRD undertake a coordinated facilitator's role and initiate the following discussions/activities.

Carriers

- Initiate detailed planning discussions with both Telus and Rogers to attempt to start the planning and costing elements for this expansion.
- Consider an RFP for carrier services to these areas if sufficient financial incentives can be obtained from various sources.

Federal Government

- Explore funding opportunities for grants or subsidies which are available to offset the capital costs. Particular emphasis should be placed on improving rural connectivity and safety along the highways.
- Explore interest from federal agencies requiring communication service (e.g. RCMP, etc.) that could be a tenant on the site infrastructure for their own private communications systems (cost offsets).
- Support for permits on Crown land.

Provincial Government

- Explore funding opportunities for grants or subsidies which are available to offset the capital costs. Particular emphasis should be placed on improving rural connectivity and safety along the highways.
- Explore interest from Provincial agencies requiring communication service (e.g. Highways, BC Sherriff, BC Hydro, BC Ambulance Service, etc.) that could be a tenant on the site infrastructure for their own private communications systems (cost offsets).
- Offset cost for rural power line extensions by BC Hydro (Crown corporation) to cell sites.
- Support for required land use permits.

First Nations Governments

- Explore funding opportunities for grants or subsidies which are available to offset the capital costs. First Nation groups have additional funding sources and may receive priority in provincial and federal funding programs. Particular emphasis should be placed on improving rural connectivity and safety along the highways.
- Obtain support to assist with lobbying Federal and Provincial governments.
- Support for land use permits.

Local Governments

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- Explore funding opportunities for potential improvement fees, grants or subsidies which are available to offset the capital costs. Particular emphasis should be placed on improving rural connectivity and public safety.
- Gain support from local communities and residents to assist with lobbying and to reduce likelihood of objections to the installation of cellular infrastructure.
- Support for land use permits.
- As a last resort, use a referendum to obtain authority to levy a local tax for service. The local government can they take out an infrastructure loan that is repaid over time from the tax revenue.

Public Private Partnerships

- If sufficient guarantees are in place for capital recovery, even if over a long period of time, there may be commercial entities willing to finance projects.

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9.3 About TANEx Engineering

TANEx is a professional engineering firm located in British Columbia, Canada focused on providing engineering consulting services specializing in telecommunications and networking. TANEx provides design, commissioning and operational services to its clients from varied industries and has a wide variety of expertise in connectivity technologies, infrastructure and services. For more information, please refer to our website at www.tanexengineering.com.

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10 Appendices

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Appendix A – Electoral Area Summary

Project Area Summary

Mar 31, 2021

			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Quesnel-Williams Lake	Alexandria Corridor	A	Yes	Yes	90	0.39%	5/1	57	24	9	0
Quesnel-Williams Lake	Dragon-Kersley	A	Yes	Yes	399	1.73%	25/5	7	165	227	0
Quesnel-Williams Lake	Hallis Lake	A	Yes	Yes	156	0.68%	10/2	33	50	48	25
Exclude (CRD)	Excluded (A)	A	No	No	1980	8.58%		0	39	10	1931
Remote (CRD)	Remote (A)	A	No	No	16	0.07%		14	2	0	0
		Area A SubTotal			**2641**	**11%**		**111**	**280**	**294**	**1,956**

Project Area Summary

Mar 31, 2021

			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Bouchie Lake-Baker	Bouchie Lake Area	B	Yes	Yes	1052	4.56%	10/2	79	502	36	435
Moose Height-	Strathnaver Area	B	Yes	Yes	105	0.45%	5/1	96	6	3	0
Moose Height-	Ten Miles Lake	B	Yes	Yes	524	2.27%	10/2	53	471	0	0
Exclude (CRD)	Excluded (B)	B	No	No	182	0.79%		1	17	0	164
Remote (CRD)	Remote (B)	B	No	No	23	0.10%		14	9	0	0
		Area B SubTotal			**1886**	**8%**		**243**	**1,005**	**39**	**599**

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Project Area Summary

Mar 31, 2021

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Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Barkerville Highway	Barkerville	C	Yes	Yes	18	0.08%	5_1	18	0	0	0
Barkerville Highway	Cottonwood	C	Yes	Yes	38	0.16%	5_1	38	0	0	0
Barkerville Highway	East Barlow Creek	C	Yes	Yes	108	0.47%	10_2	1	107	0	0
Barkerville Highway	Pine Grove	C	Yes	Yes	14	0.06%	5_1	14	0	0	0
Devils Club	Devils Club	C	Yes	Yes	24	0.10%	5/1	24	0	0	0
Exclude (CRD)	Excluded (C)	C	No	No	387	1.68%		0	6	0	381
Remote (CRD)	Remote (C)	C	No	No	16	0.07%		16	0	0	0
		Area C SubTotal			**605**	**3%**		**111**	**113**	**0**	**381**

Project Area Summary

Mar 31, 2021

		Project Definition						Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Quesnel-Williams Lake	Deep Creek	D	Yes	Yes	132	0.57%	5/1	57	0	5	70
Quesnel-Williams Lake	McLeese Lake	D	Yes	Yes	435	1.88%	5/1	257	34	117	27
Quesnel-Williams Lake	Pine Valley	D	Yes	Yes	250	1.08%	5/1	185	0	29	36
Exclude (CRD)	Excluded (D)	D	No	No	596	2.58%		6	0	10	580
Remote (CRD)	Remote (D)	D	No	No	28	0.12%		24	0	4	0
		Area D SubTotal			**1441**	**6%**		**529**	**34**	**165**	**713**

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Mar 31, 2021

		Project Definition						Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Alkali Lake	Alkali Lake	E	Yes	Yes	123	0.53%	50_10	1	0	0	122
Dog Creek Area	Dog Creek	E	Yes	Yes	79	0.34%	50/10	17	0	0	62
Springhouse Area	Chimney Lake	E	Yes	Yes	200	0.87%	5/1	200	0	0	0
Springhouse Area	Dog Creek Road	E	Yes	Yes	239	1.04%	5/1	239	0	0	0
Springhouse Area	Kirkpatrick Creek	E	Yes	Yes	31	0.13%	5/1	31	0	0	0
Springhouse Area	Springhouse	E	Yes	Yes	102	0.44%	5/1	102	0	0	0
Exclude (CRD)	Excluded (E)	E	No	No	1057	4.58%		44	0	2	1011
Remote (CRD)	Remote (E)	E	No	No	12	0.05%		12	0	0	0
		Area E SubTotal			**1843**	**8%**		**646**	**0**	**2**	**1,195**

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Project Area Summary

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Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Horsefly & Area A	Big Lake Ranch	F	Yes	Yes	420	1.82%	5/1	420	0	0	0
Horsefly & Area A	Black Creek	F	Yes	Yes	54	0.23%	5/1	54	0	0	0
Horsefly & Area A	Dugan Lake-Miocene	F	Yes	Yes	598	2.59%	5/1	512	85	1	0
Horsefly & Area A	Haggens Point	F	Yes	Yes	64	0.28%	5/1	64	0	0	0
Horsefly & Area A	Horsefly	F	Yes	Yes	465	2.01%	10/2	169	170	126	0
Horsefly & Area A	Horsefly Peninsula	F	Yes	Yes	76	0.33%	10/2	76	0	0	0
Horsefly & Area A	Keithley Creek	F	Yes	Yes	19	0.08%	5/1	19	0	0	0
Horsefly & Area A	Likely	F	Yes	Yes	323	1.40%	5/1	323	0	0	0
Mile House Corridor	141 Mile House	F	Yes	Yes	78	0.34%	5/1	76	0	2	0
Mile House Corridor	150 Mile House	F	Yes	Yes	665	2.88%	5/1	347	0	227	91
Exclude (CRD)	Excluded (F)	F	No	No	157	0.68%		1	0	17	139
Remote (CRD)	Remote (F)	F	No	No	74	0.32%		74	0	0	0
		Area F SubTotal			**2993**	**13%**		**2,135**	**255**	**373**	**230**

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Project Area Summary

Mar 31, 2021

		Project Definition						Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Canim Lake Corridor	Tatton Area	G	Yes	Yes	82	0.36%	5/1	60	1	21	0
Mile House Corridor	Lac la Hache Area	G	Yes	Yes	744	3.22%	25/5	201	83	460	0
Mile House Corridor	Rail Lake	G	Yes	Yes	83	0.36%	5/1	79	0	4	0
Mile House Corridor	Timothy Lake	G	Yes	Yes	209	0.91%	5/1	204	0	5	0
Murphy Lake	Murphy Lake	G	Yes	Yes	28	0.12%	5/1	28	0	0	0
South Border-Lone Butte	93 Mile	G	Yes	Yes	313	1.36%	5/1	196	58	59	0
Exclude (CRD)	Excluded (G)	G	No	No	1533	6.64%		4	0	6	1523
Remote (CRD)	Remote (G)	G	No	No	45	0.19%		41	0	4	0
		Area G SubTotal			**3037**	**13%**		**813**	**142**	**559**	**1,523**

Project Area Summary

Mar 31, 2021

		Project Definition						Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Canim Lake Corridor	Canim Lake-Eagle	H	Yes	Yes	459	1.99%	10/2	110	349	0	0
Canim Lake Corridor	East Canim Lake	H	Yes	Yes	253	1.10%	5/1	253	0	0	0
Canim Lake Corridor	Forest Grove	H	Yes	Yes	425	1.84%	10/2	185	237	3	0
Canim Lake Corridor	Gateway-Buffalo	H	Yes	Yes	406	1.76%	5/1	226	133	47	0
Canim Lake Corridor	Hawkins Lake	H	Yes	Yes	178	0.77%	5/1	178	0	0	0
Hendrix Lake	Hendrix Lake	H	Yes	Yes	37	0.16%	5/1	37	0	0	0
Remote (CRD)	Remote (H)	H	No	No	25	0.11%		25	0	0	0
		Area H SubTotal			**1783**	**8%**		**1,014**	**719**	**50**	**0**

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Project Area Summary

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			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Bouchie Lake-Baker	Baker Creek	I	Yes	Yes	182	0.79%	5_1	182	0	0	0
Nazko	Nazko	I	Yes	Yes	124	0.54%	5/1	124	0	0	0
Quesnel-Williams Lake	Narcosli Creek	I	Yes	Yes	69	0.30%	10/2	21	42	6	0
Quesnel-Williams Lake	Quesnel View Area	I	Yes	Yes	437	1.89%	25/5	29	128	161	119
Titetown Road	Titetown Road	I	Yes	Yes	30	0.13%	5/1	30	0	0	0
Remote (CRD)	Remote (I)	I	No	No	102	0.44%		98	4	0	0
		Area I SubTotal			**944**	**4%**		**484**	**174**	**167**	**119**

Project Area Summary

Mar 31, 2021

			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Chilcotin Highway 20	Anahim Lake	J	Yes	Yes	299	1.30%	5/1	299	0	0	0
Chilcotin Highway 20	Charlotte Lake	J	Yes	Yes	79	0.34%	5/1	79	0	0	0
Chilcotin Highway 20	Cherry Creek	J	Yes	Yes	24	0.10%	5/1	24	0	0	0
Chilcotin Highway 20	Chilanko Forks	J	Yes	Yes	87	0.38%	5/1	87	0	0	0
Chilcotin Highway 20	Kleena Kleene	J	Yes	Yes	34	0.15%	5/1	34	0	0	0
Chilcotin Highway 20	Nimpo Lake	J	Yes	Yes	168	0.73%	5/1	168	0	0	0
Chilcotin Highway 20	Tatla Lake	J	Yes	Yes	51	0.22%	5/1	51	0	0	0
Chilcotin Highway 20	Tatlayko Lake	J	Yes	Yes	93	0.40%	5/1	93	0	0	0
Remote (CRD)	Remote (J)	J	No	No	67	0.29%		67	0	0	0
		Area J SubTotal			**902**	**4%**		**902**	**0**	**0**	**0**

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Project Area Summary

Mar 31, 2021

			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
Chilcotin Highway 20	Alexis Creek	K	Yes	Yes	285	1.23%	5/1	285	0	0	0
Chilcotin Highway 20	Alexis Lake	K	Yes	Yes	27	0.12%	5/1	27	0	0	0
Chilcotin Highway 20	Big Creek	K	Yes	Yes	37	0.16%	5/1	37	0	0	0
Chilcotin Highway 20	Hanceville	K	Yes	Yes	108	0.47%	5/1	108	0	0	0
Chilcotin Highway 20	Redstone	K	Yes	Yes	24	0.10%	5/1	24	0	0	0
Chilcotin Highway 20	Riske Creek	K	Yes	Yes	49	0.21%	5/1	49	0	0	0
Dog Creek Area	Gang Ranch	K	Yes	Yes	8	0.03%	5/1	8	0	0	0
Springhouse Area	Meldrum Creek	K	Yes	Yes	20	0.09%	5/1	20	0	0	0
Springhouse Area	Springhouse Hills	K	Yes	Yes	39	0.17%	5/1	39	0	0	0
Remote (CRD)	Remote (K)	K	No	No	57	0.25%		57	0	0	0
		Area K SubTotal			**654**	**3%**		**654**	**0**	**0**	**0**

Project Area Summary

Mar 31, 2021

			Project Definition					Current Service Levels			
Major Project Name	Sub-Project Name	Area	BB	Local Access	Total Subs	% of Total	Primary Svc	5/1	10/2	25/5	50/10
South Border-Lone Butte	Deka Lake	L	Yes	Yes	896	3.88%	25/5	295	0	601	0
South Border-Lone Butte	Green Lake North	L	Yes	Yes	489	2.12%	5/1	481	8	0	0
South Border-Lone Butte	Lone Butte	L	Yes	Yes	892	3.86%	25/5	120	382	389	1
South Border-Lone Butte	Sheridan-Bridge Lake	L	Yes	Yes	1470	6.37%	5/1	1274	7	151	38
Exclude (CRD)	Excluded (L)	L	No	No	575	2.49%		6	1	1	567
Remote (CRD)	Remote (L)	L	No	No	35	0.15%		33	0	1	1
		Area L SubTotal			**4357**	**19%**		**2,209**	**398**	**1,143**	**607**

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Project Area Summary

Mar 31, 2021

Major Project Name	Sub-Project Name	Area	BB	Project Definition: Local Access	Project Definition: Total Subs	Project Definition: % of Total	Project Definition: Primary Svc	Current Service Levels: 5/1	Current Service Levels: 10/2	Current Service Levels: 25/5	Current Service Levels: 50/10
			Totals	23,086	100%		9,851	3,120	2,792	7,323	
							43%	14%	12%	32%	

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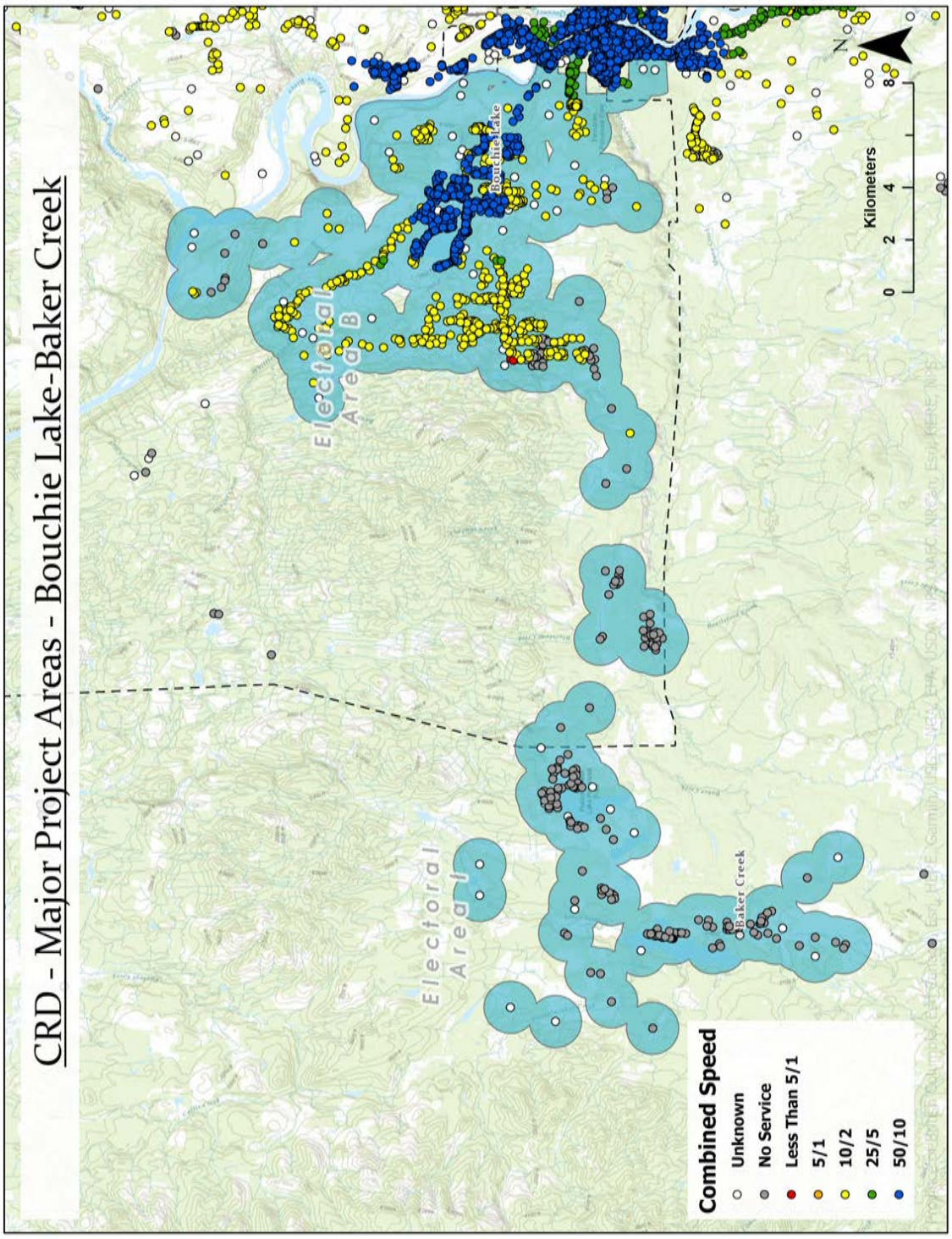
Appendix B – Project Area Maps



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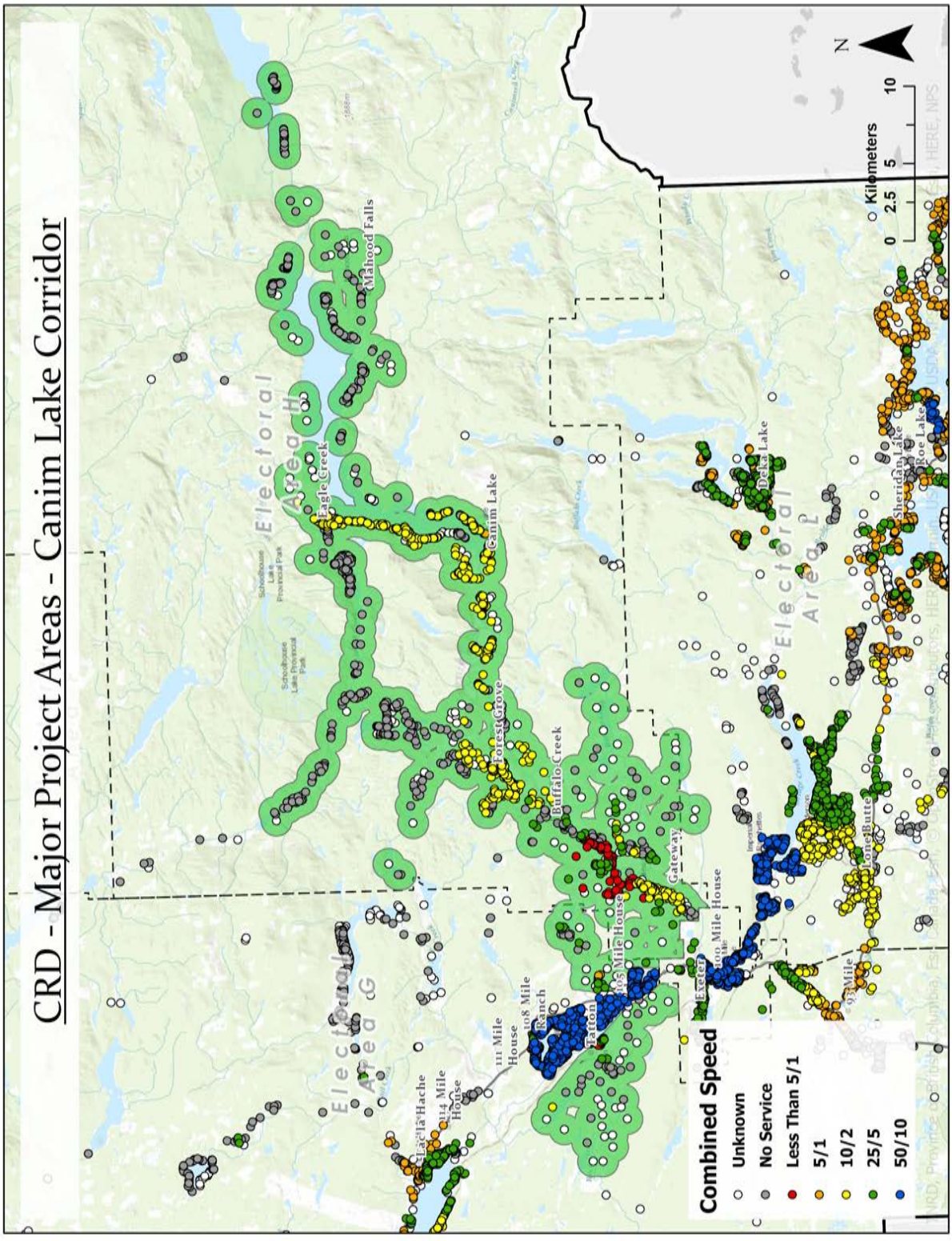

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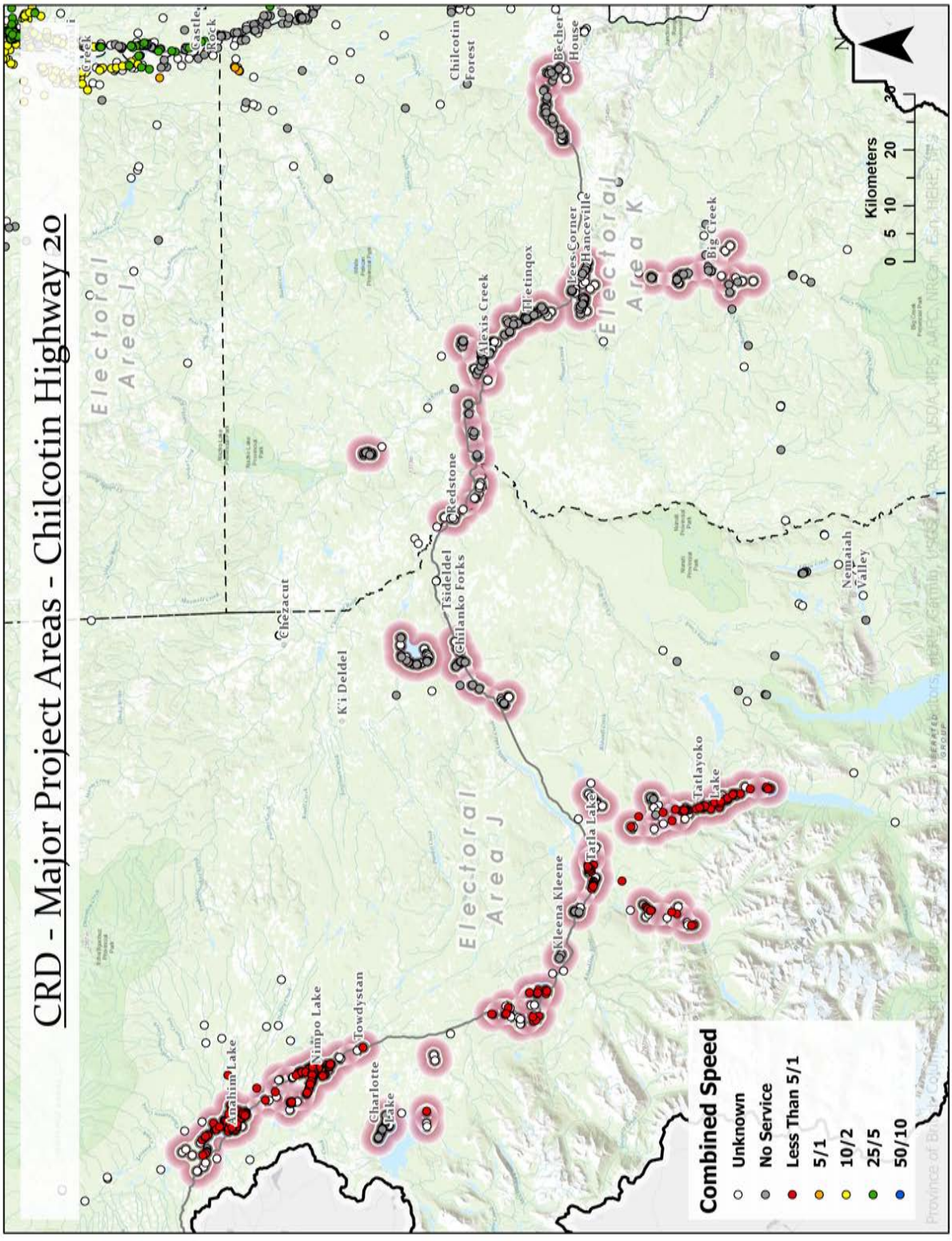

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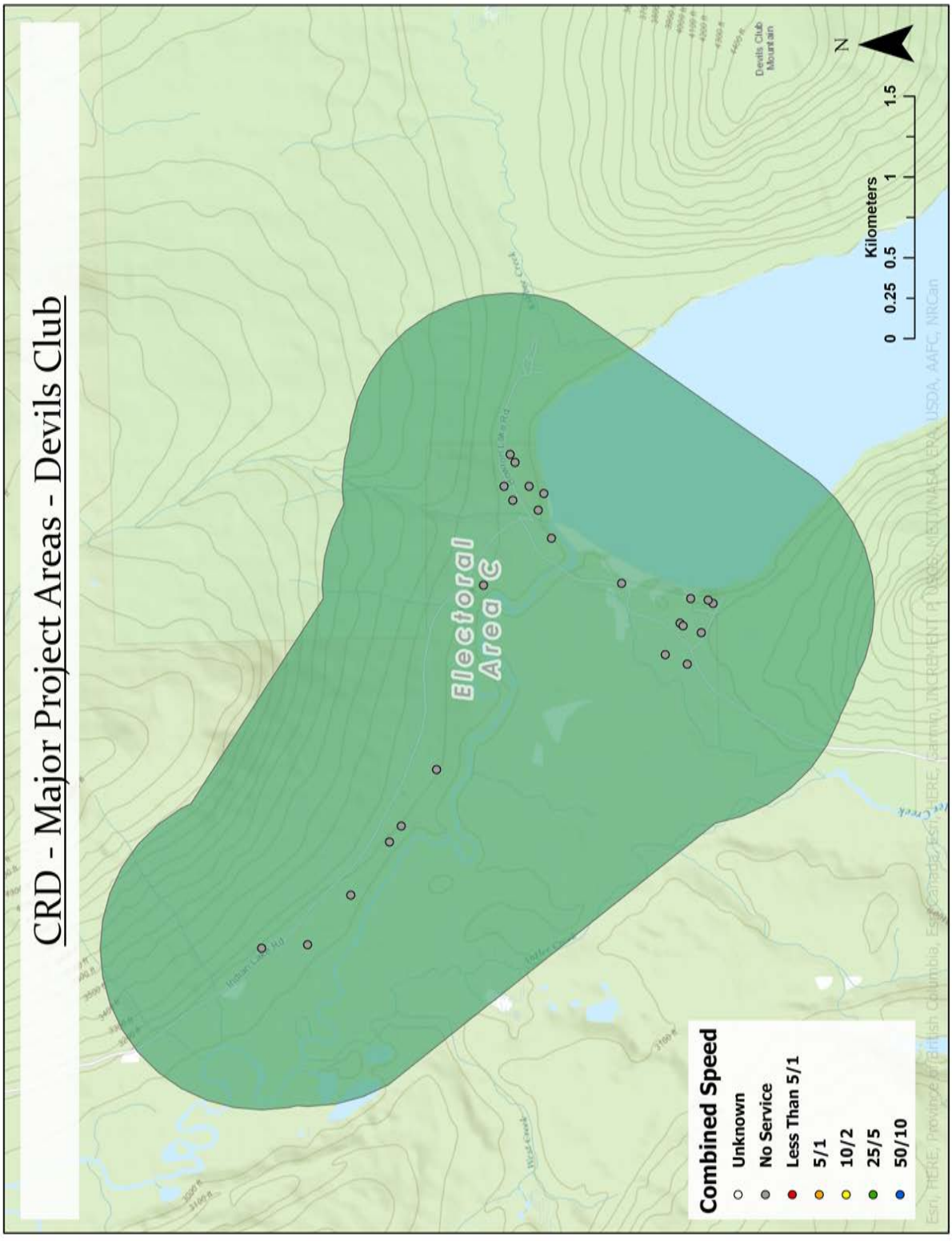

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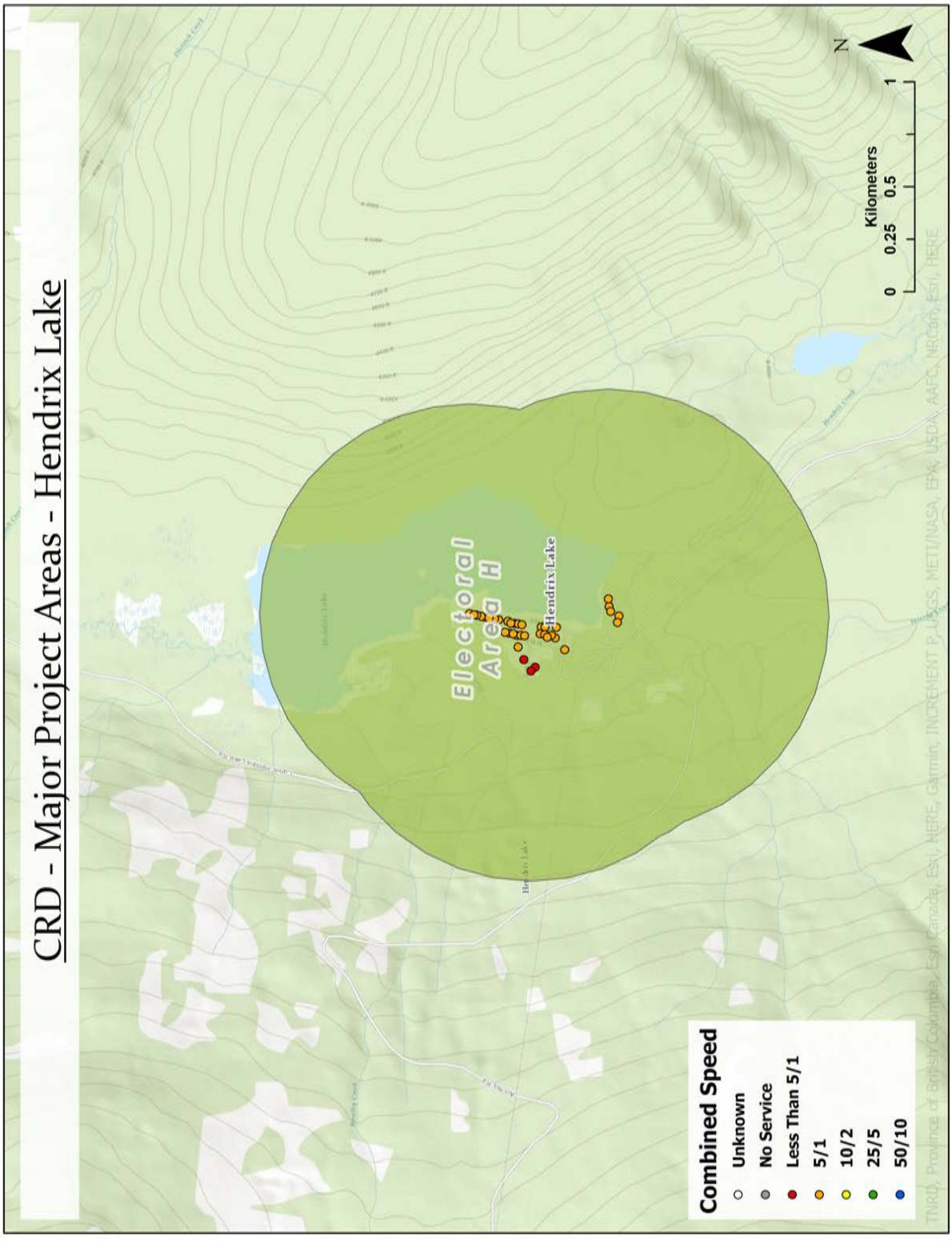

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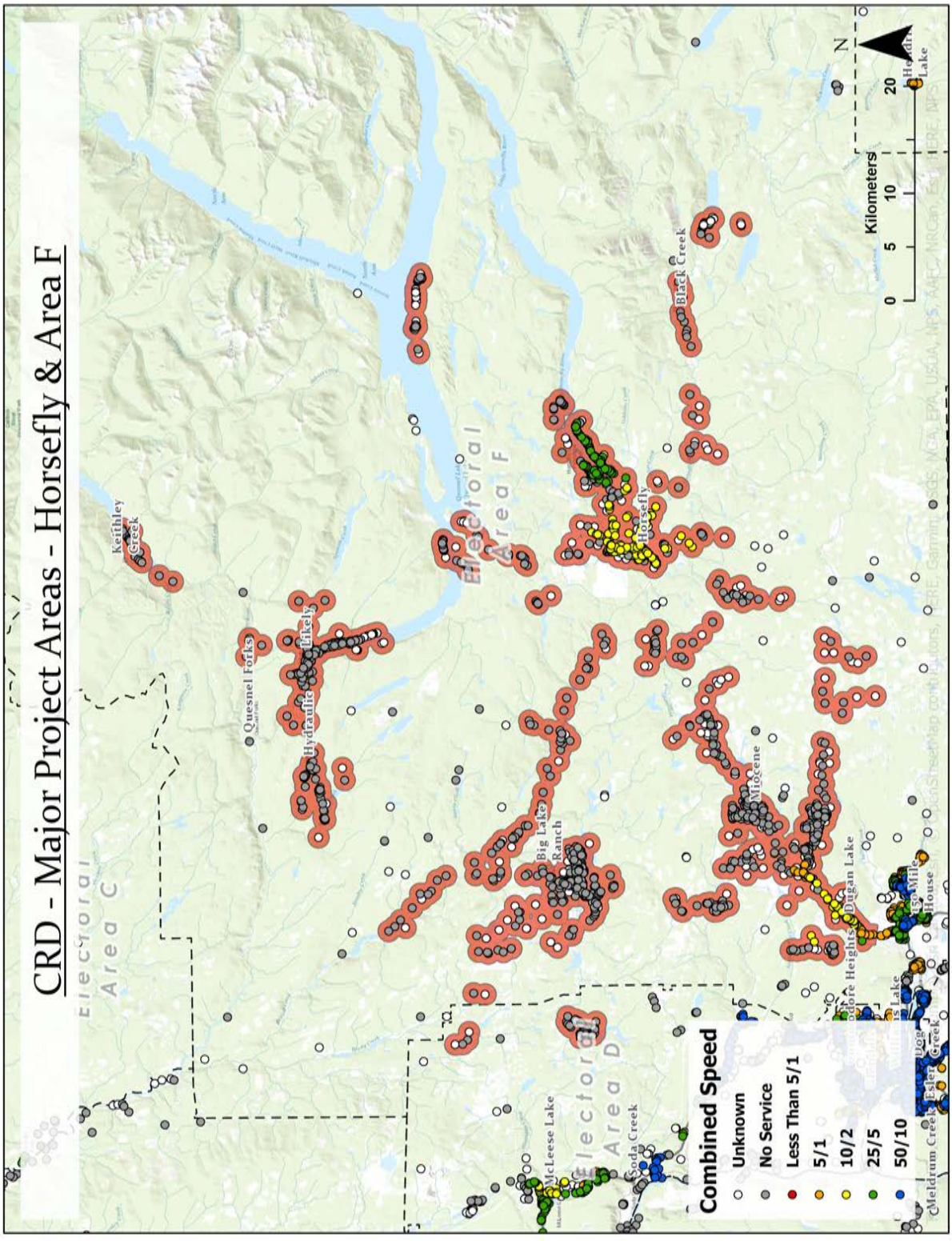

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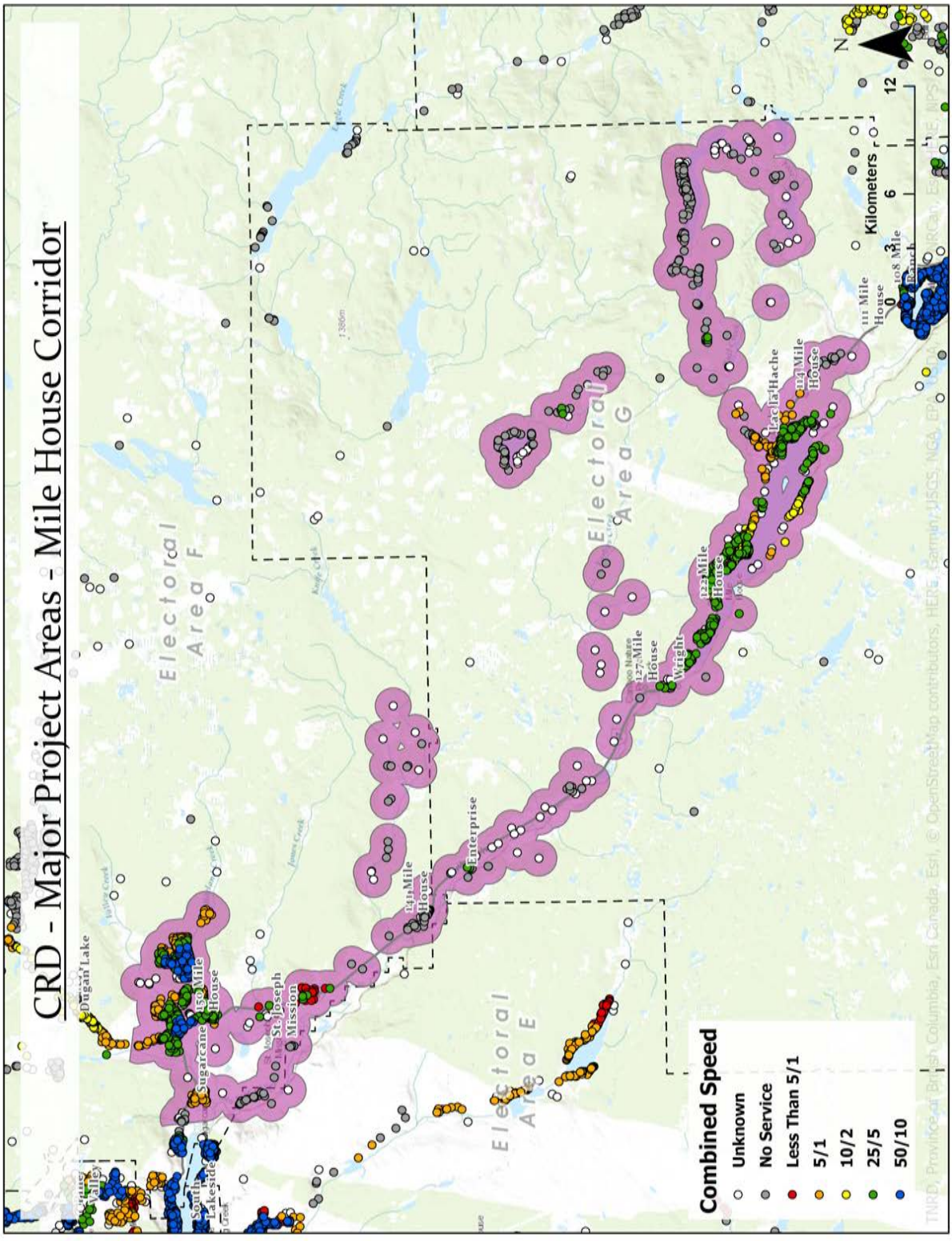

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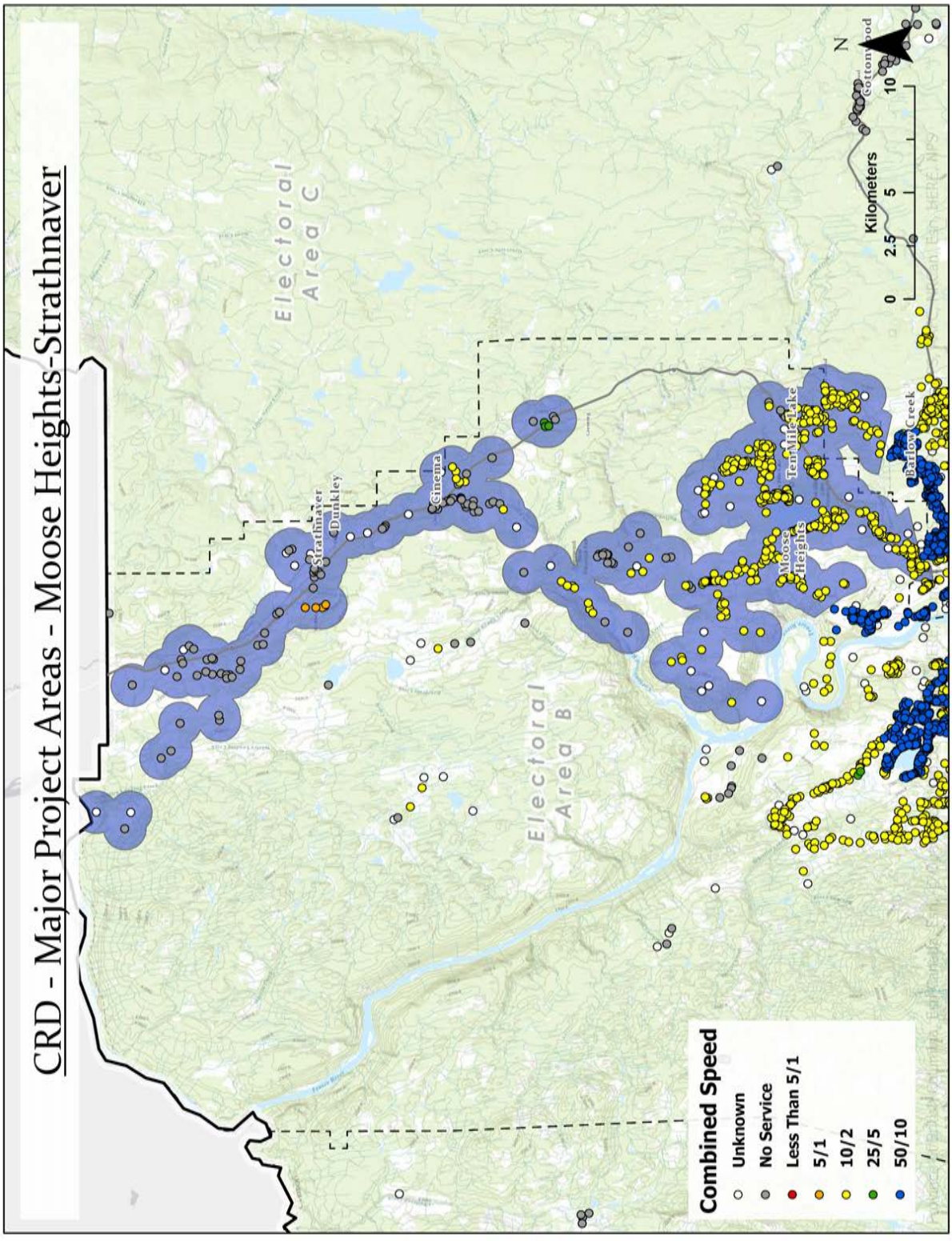

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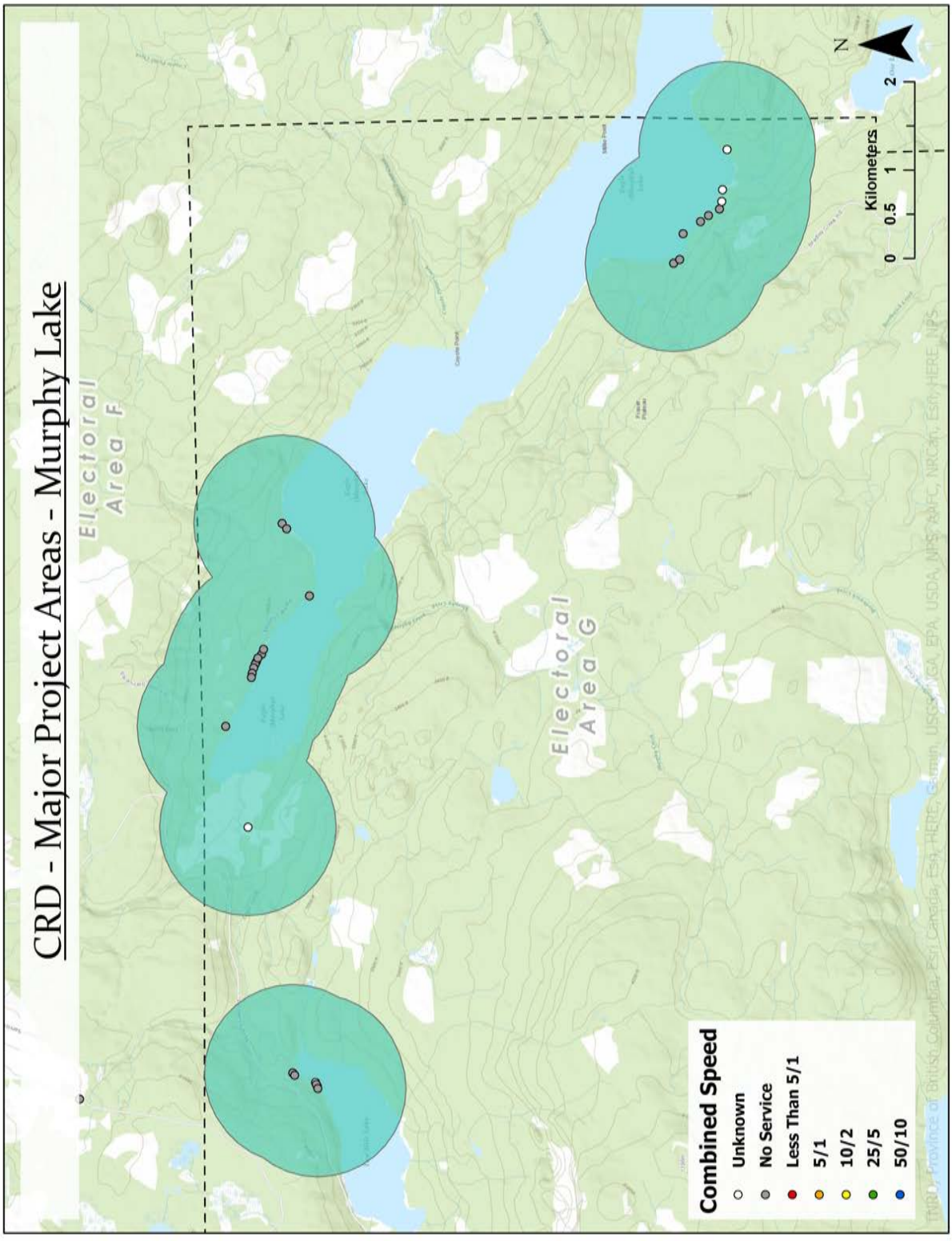

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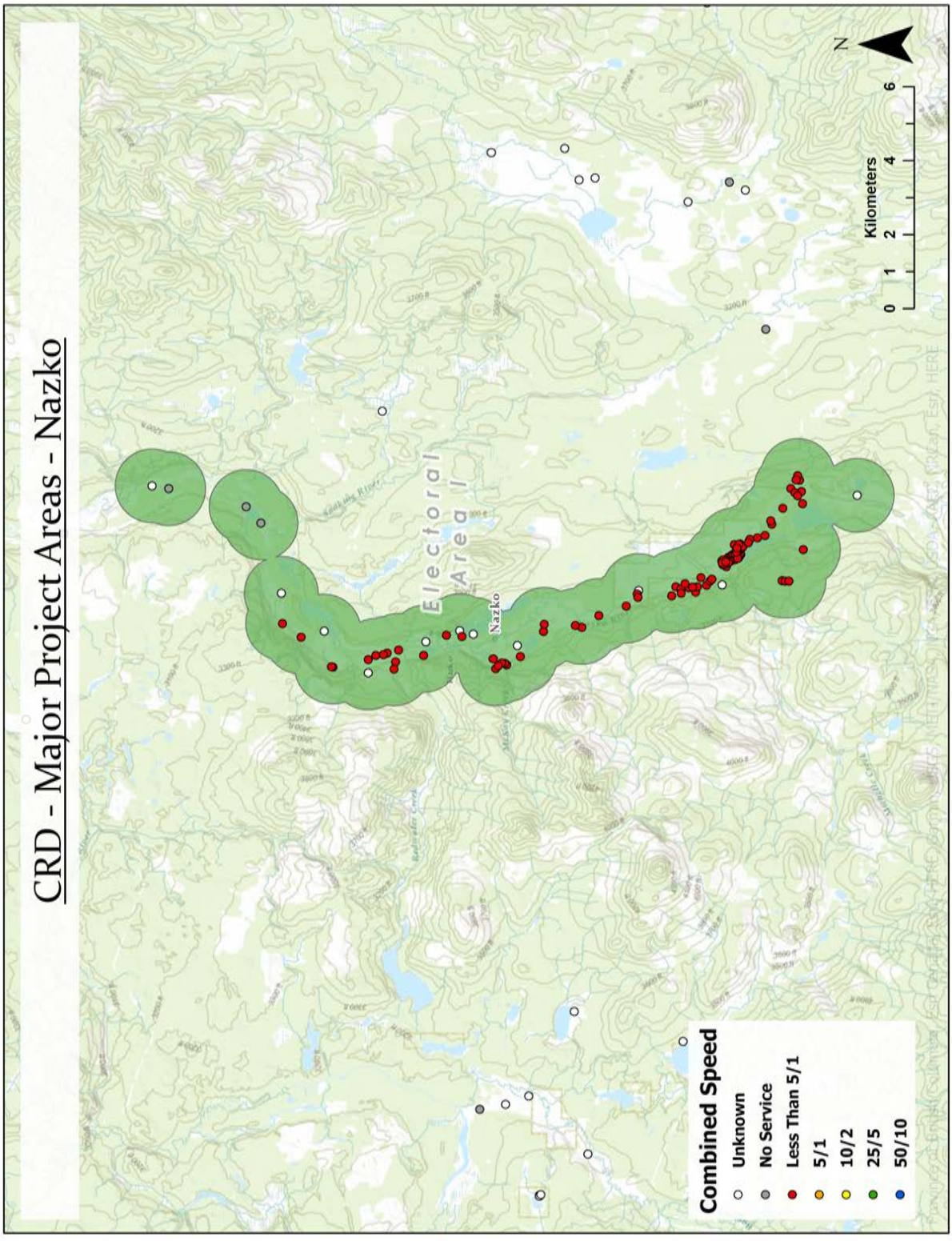

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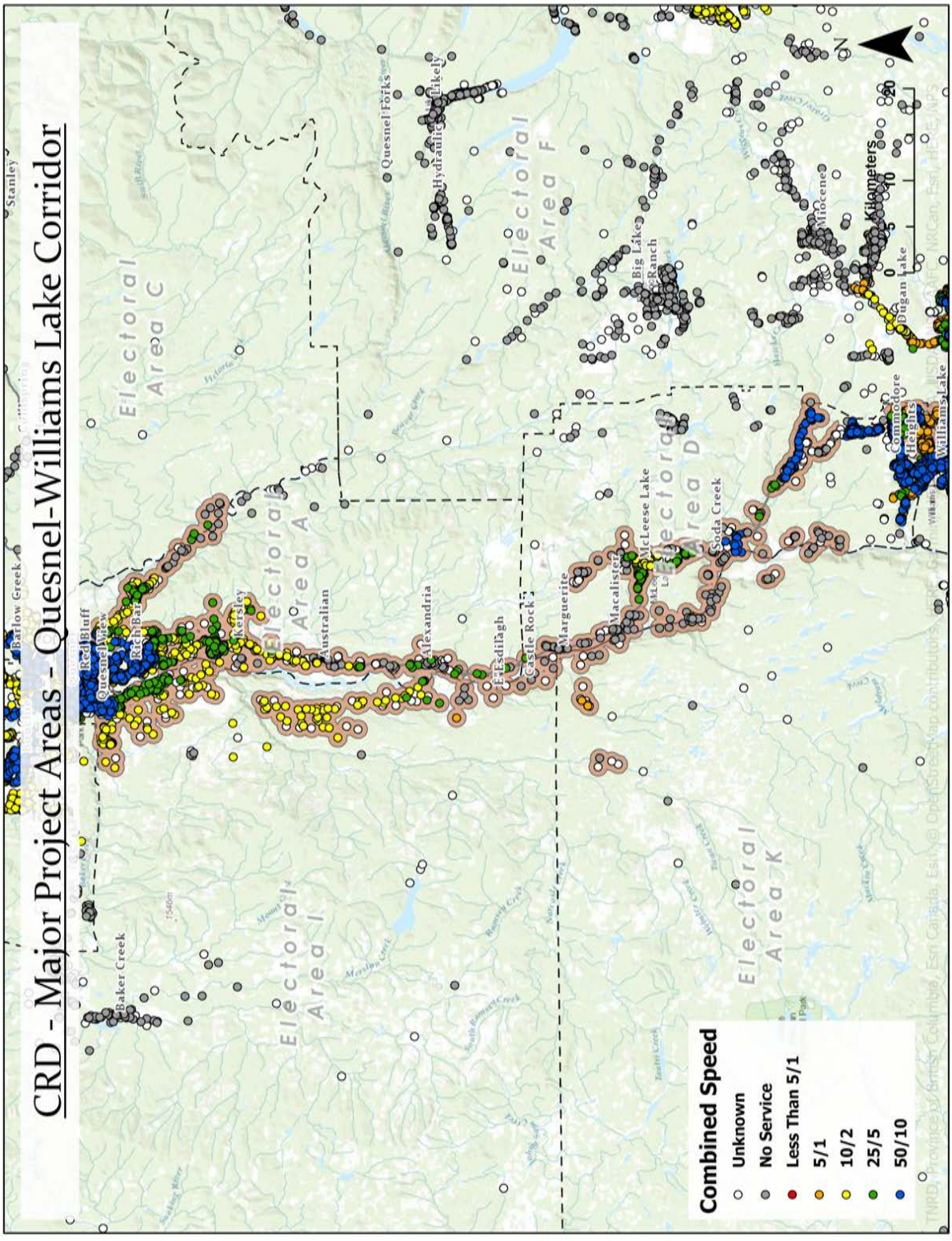

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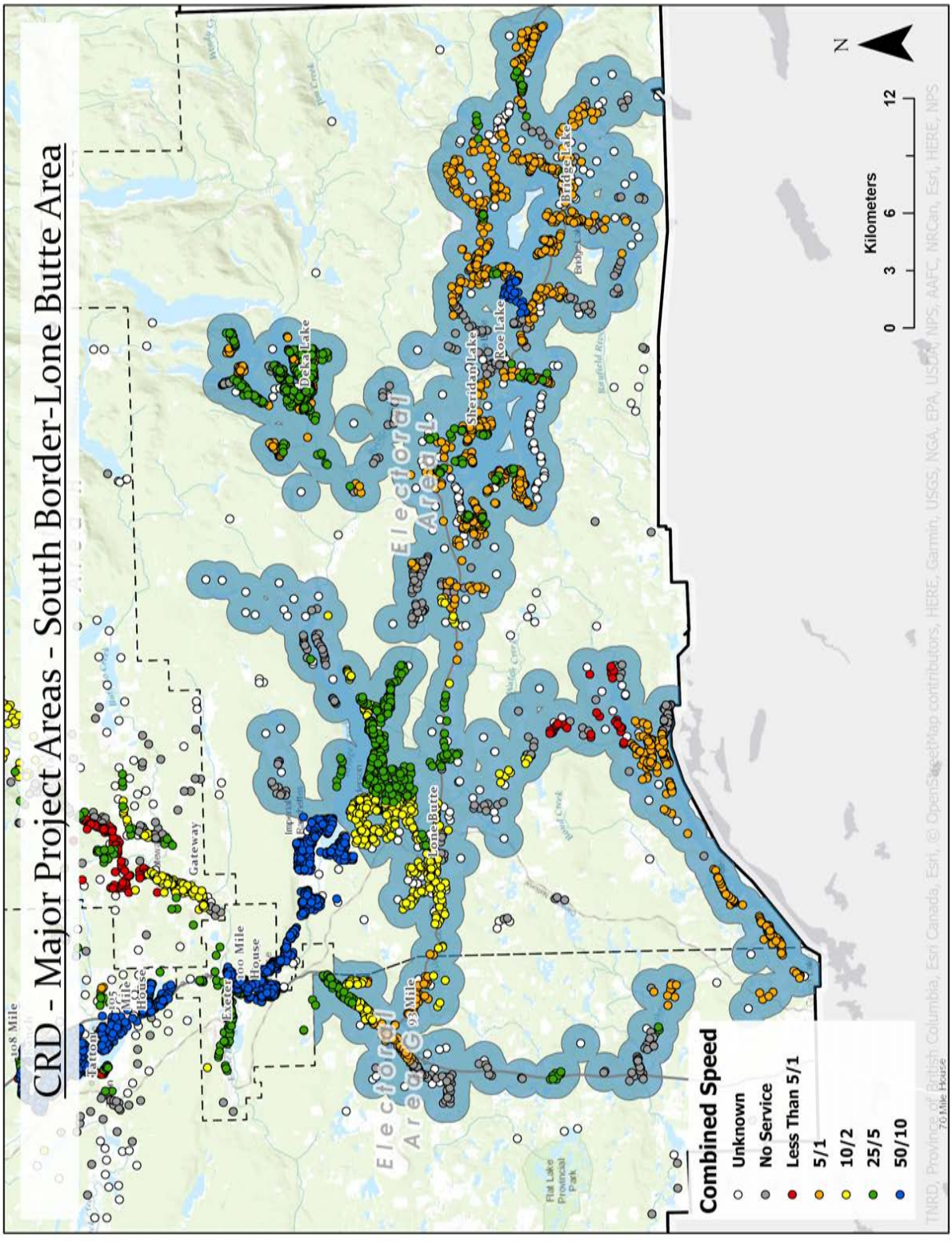

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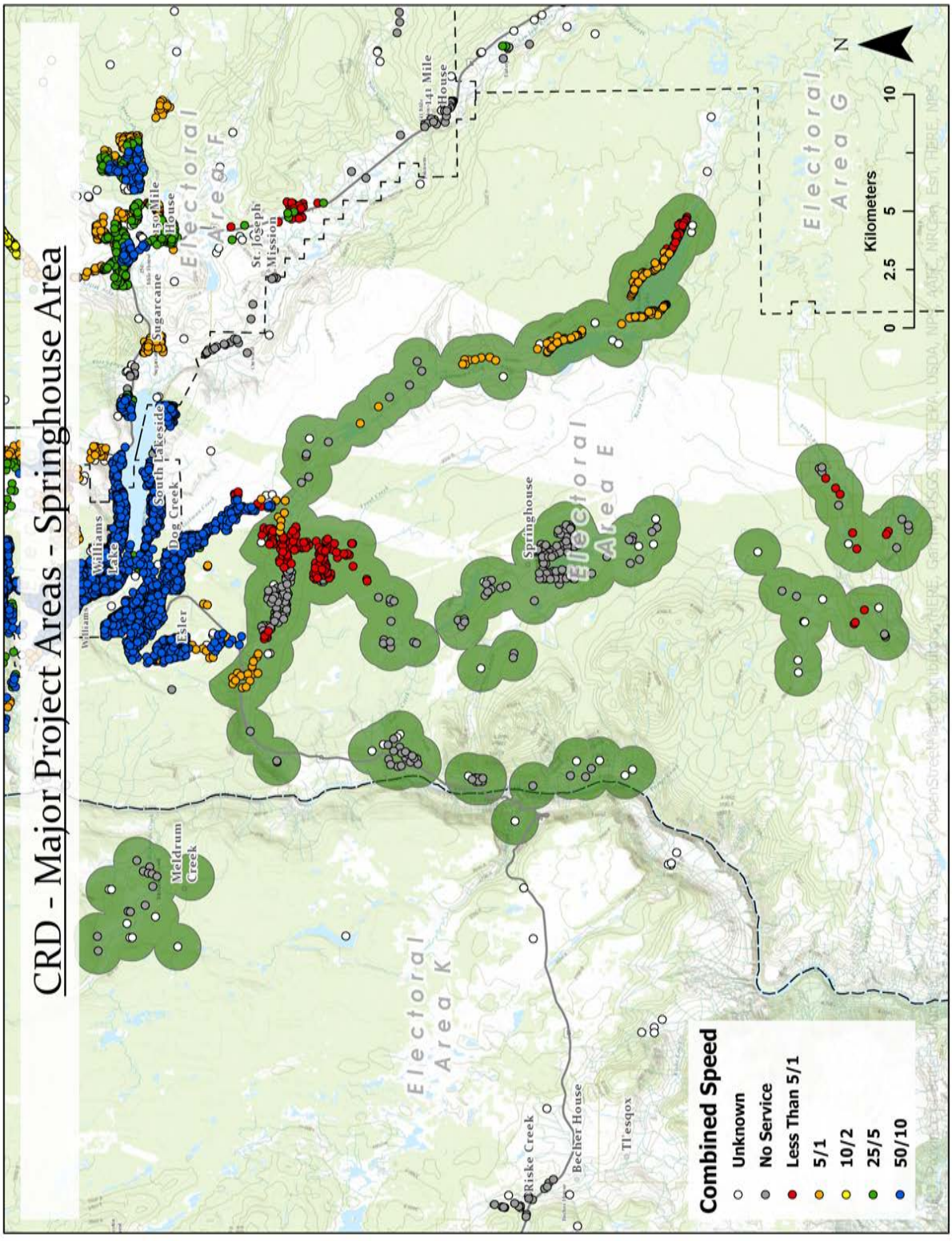

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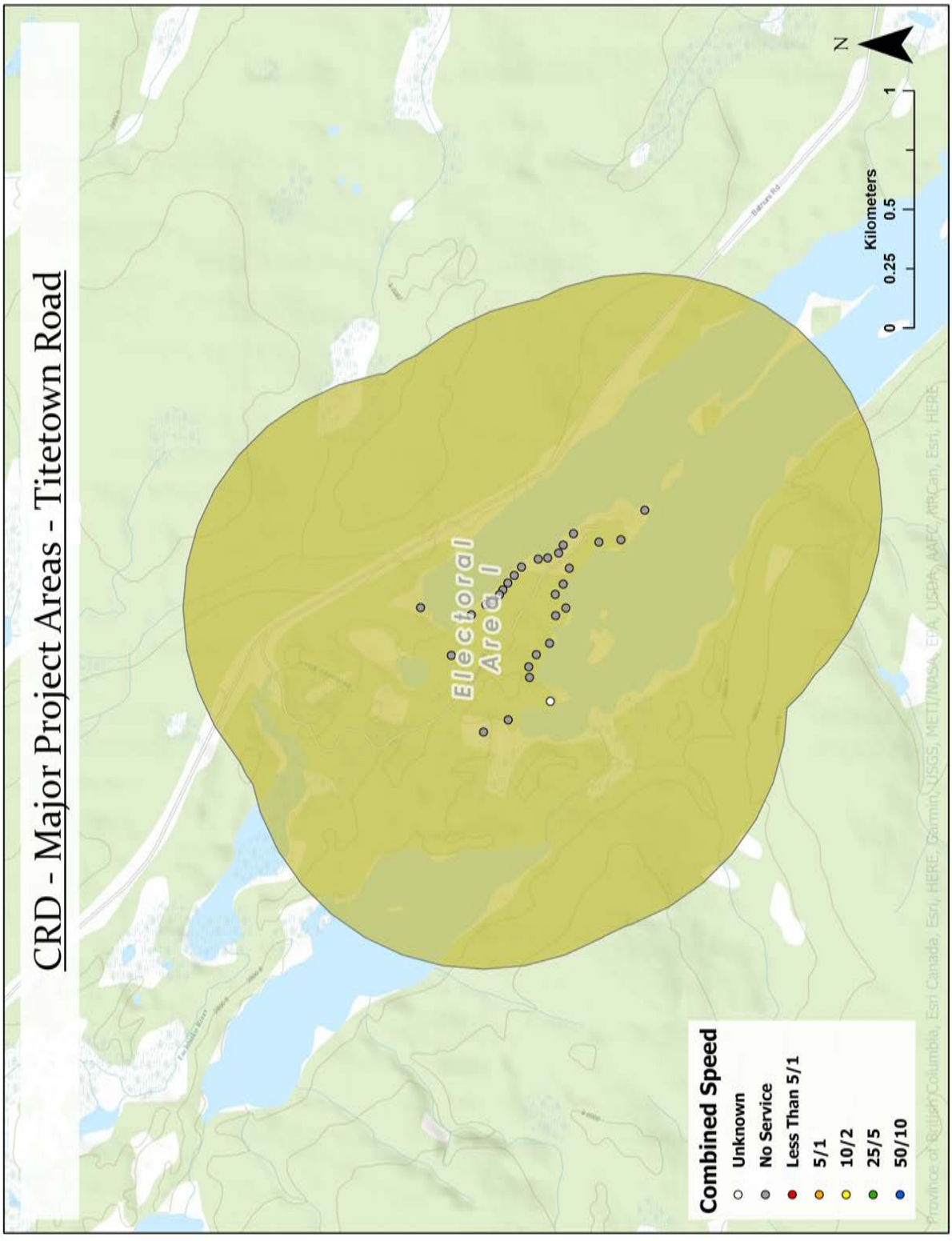

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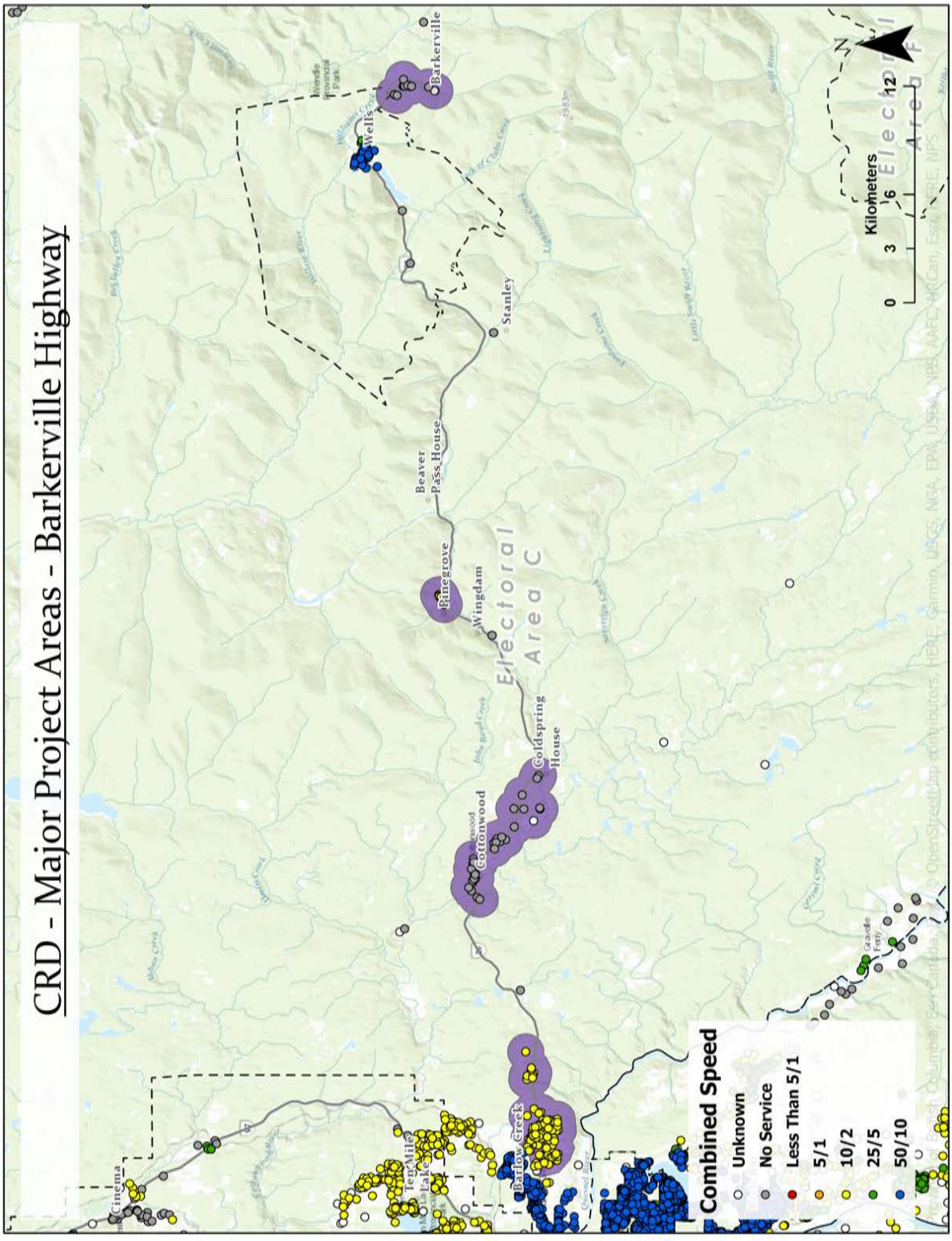

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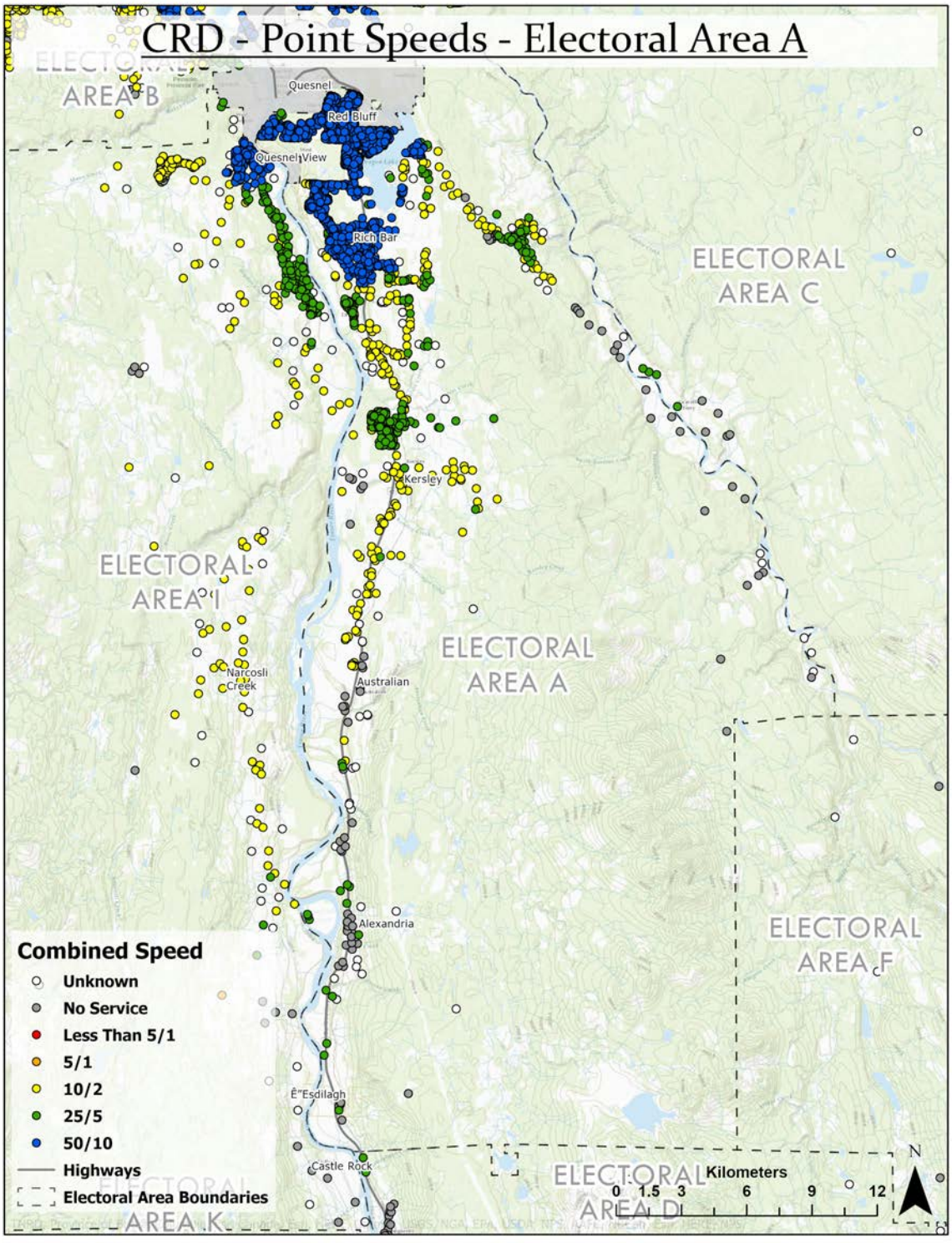
Electoral Area Points by Speed



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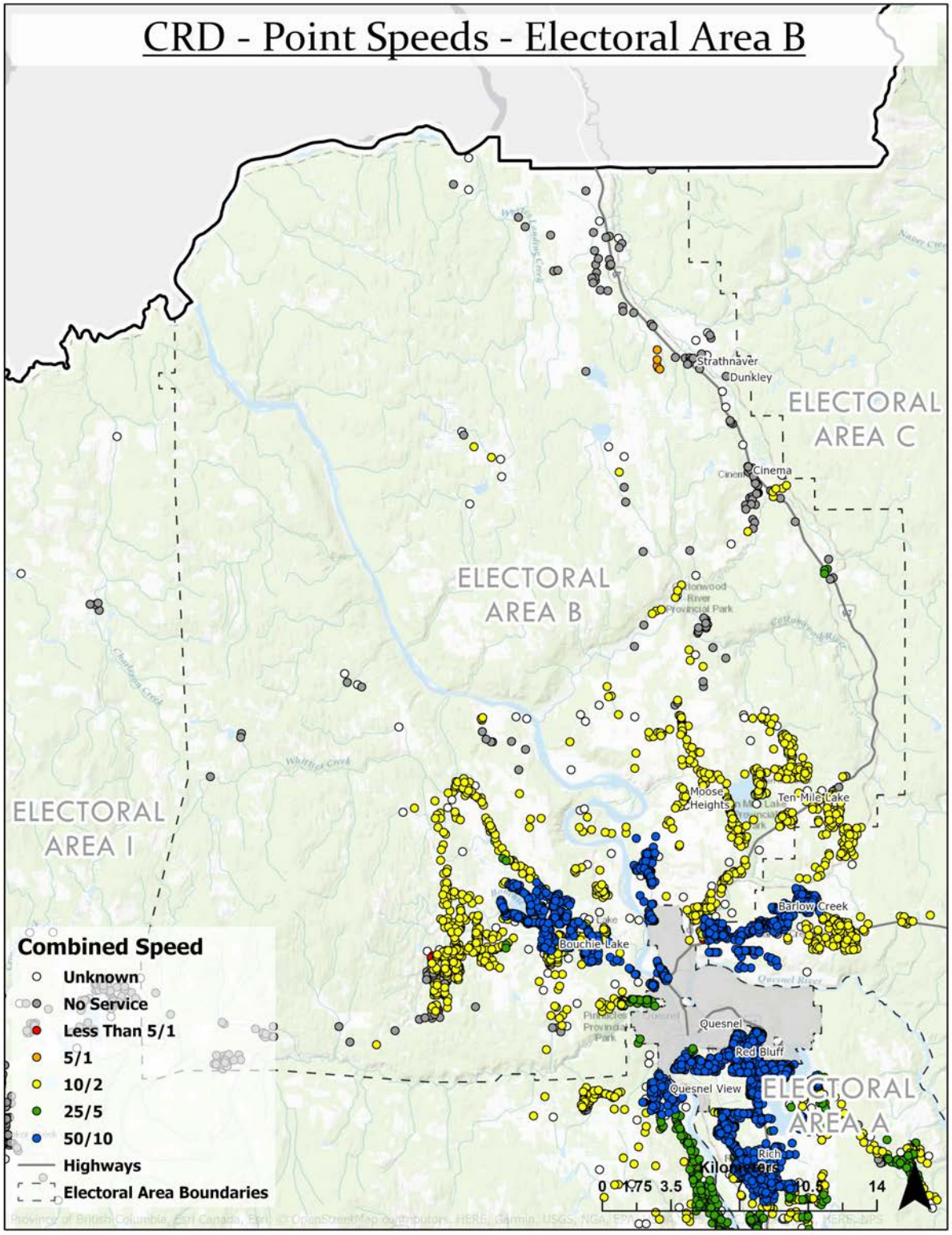

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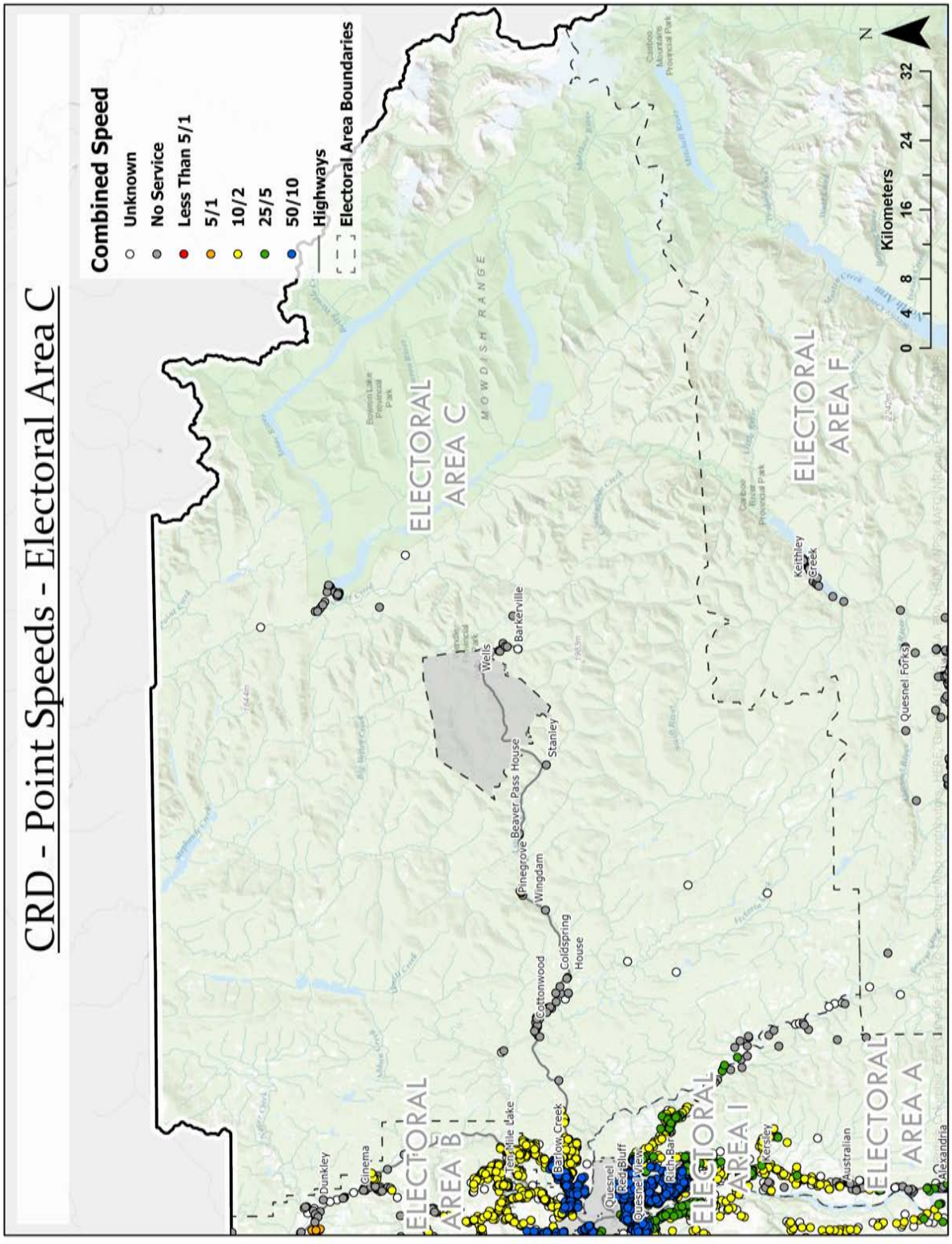

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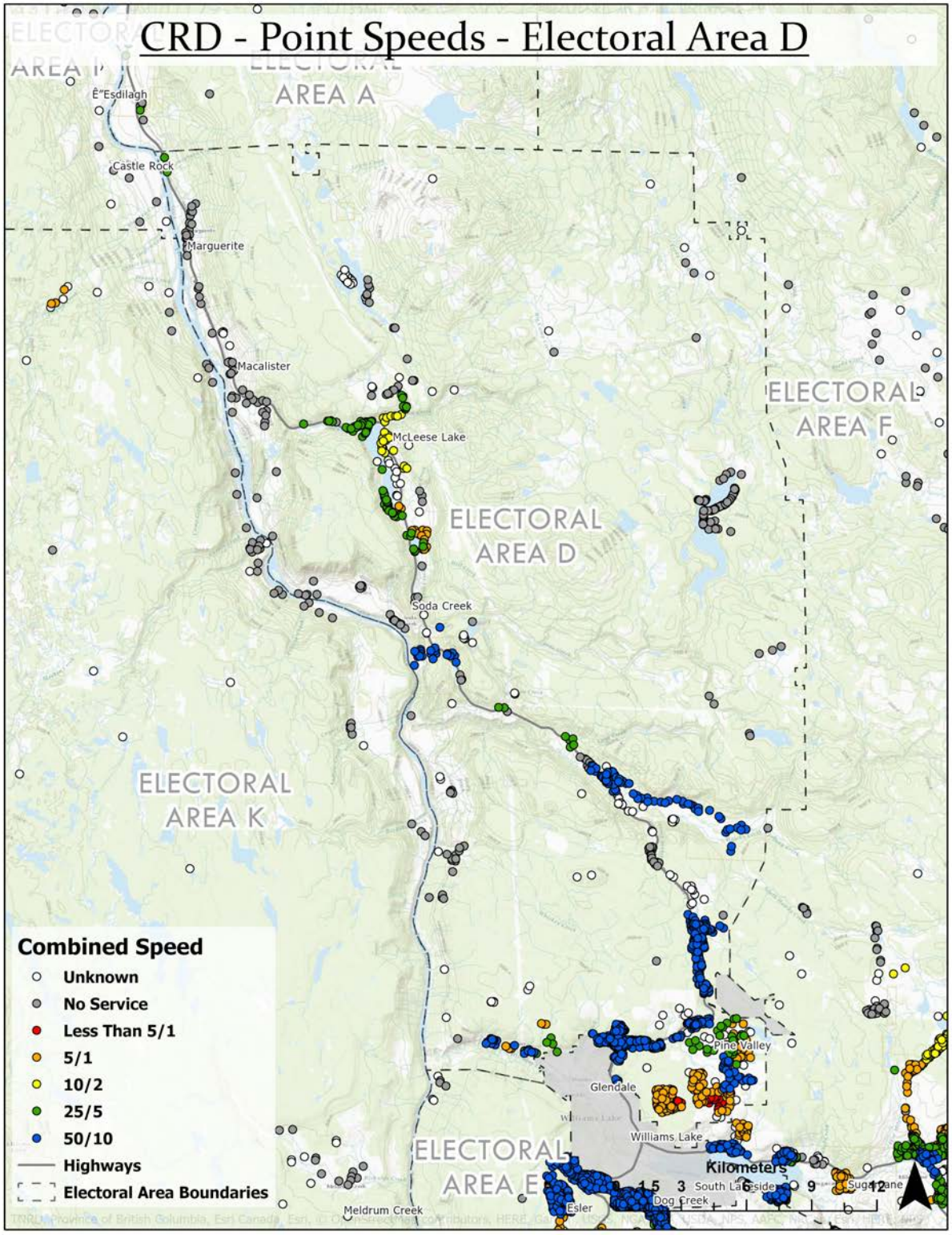

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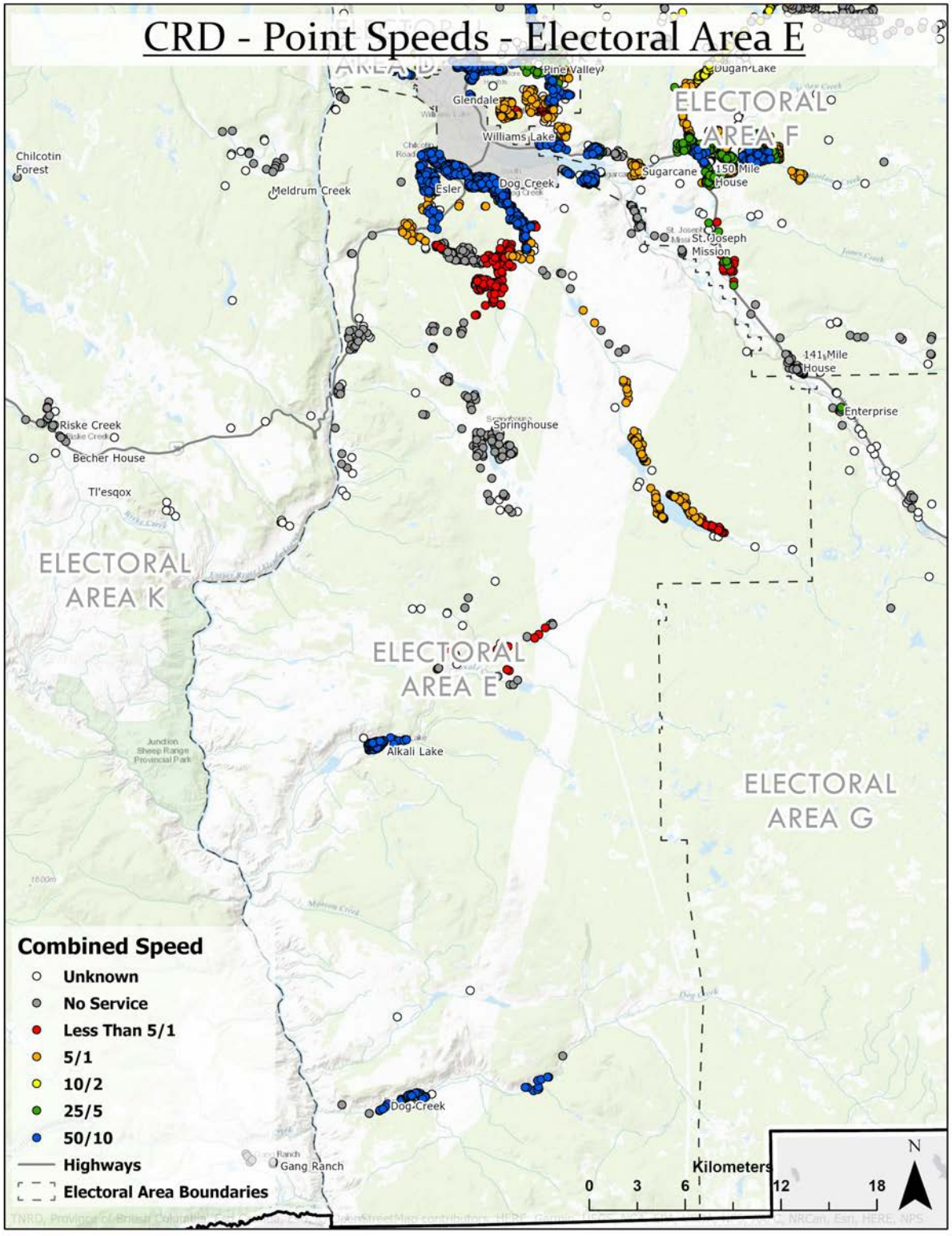

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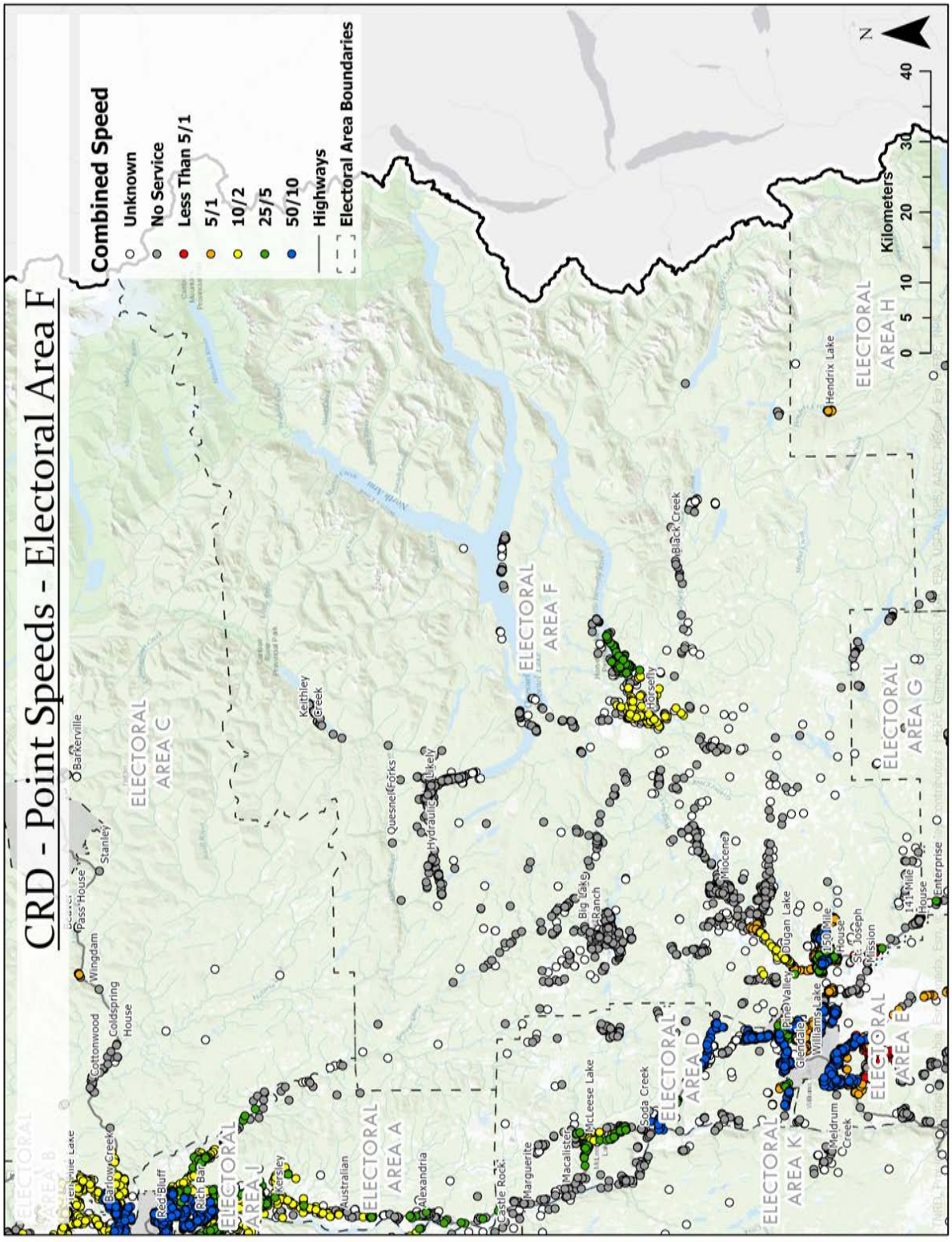

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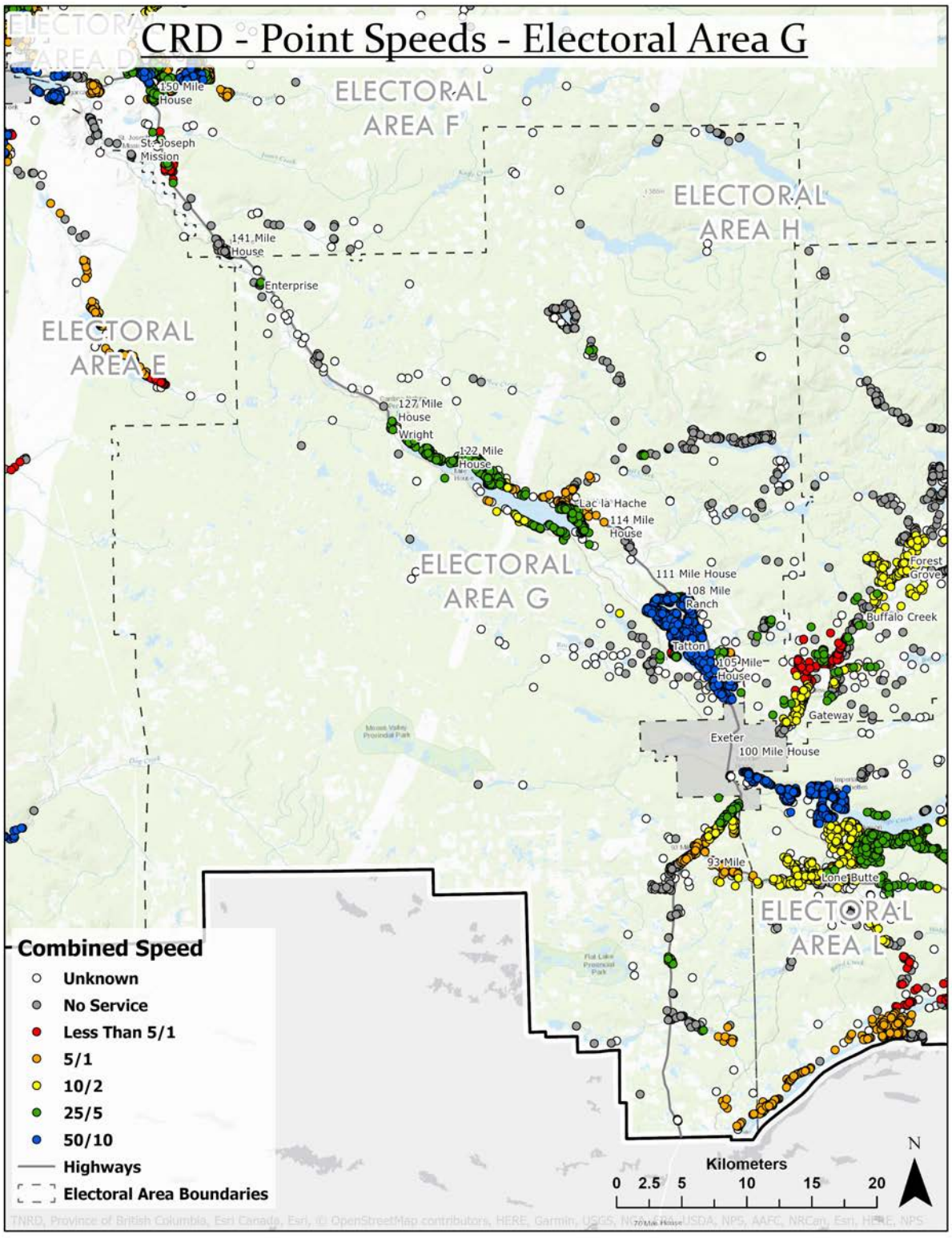

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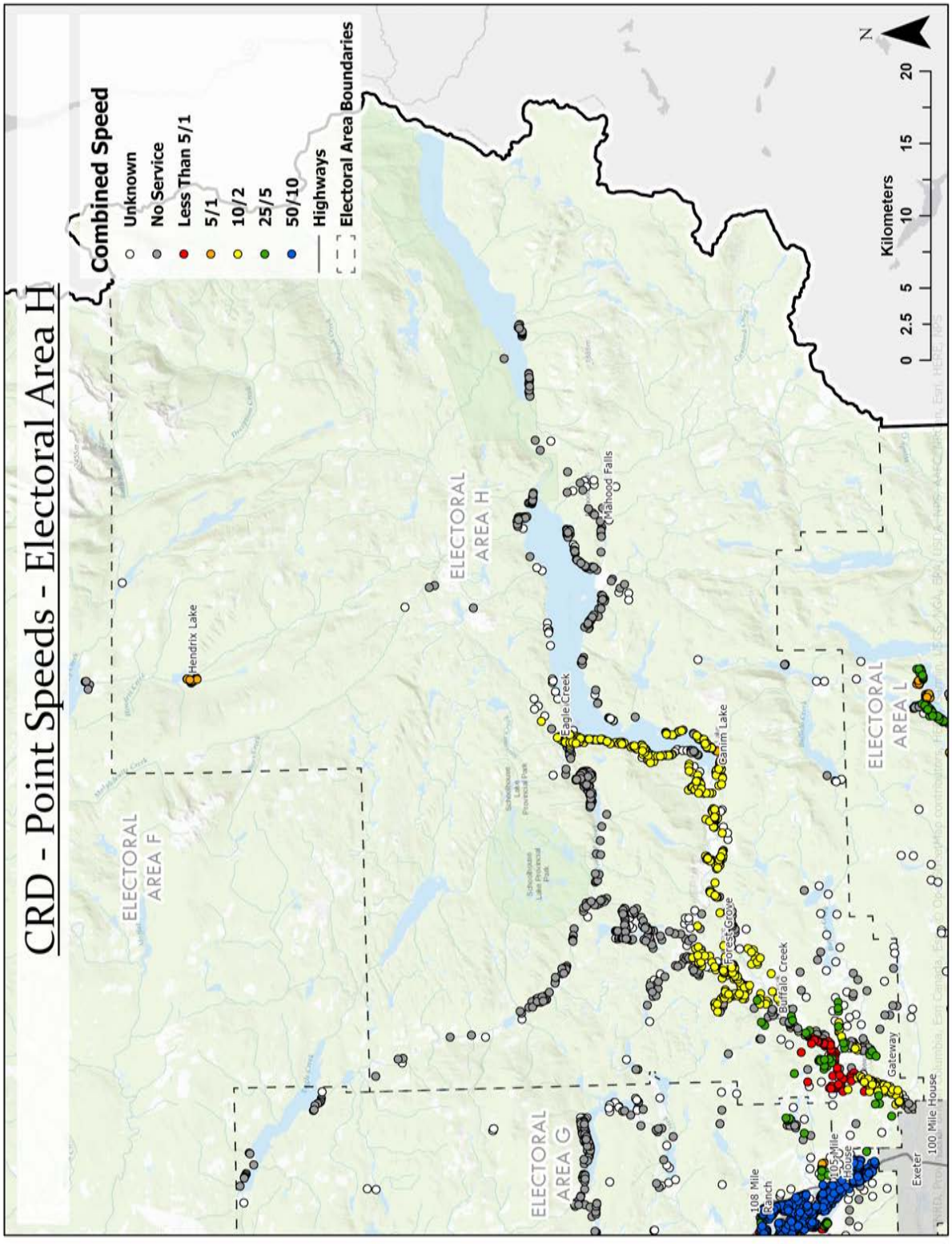

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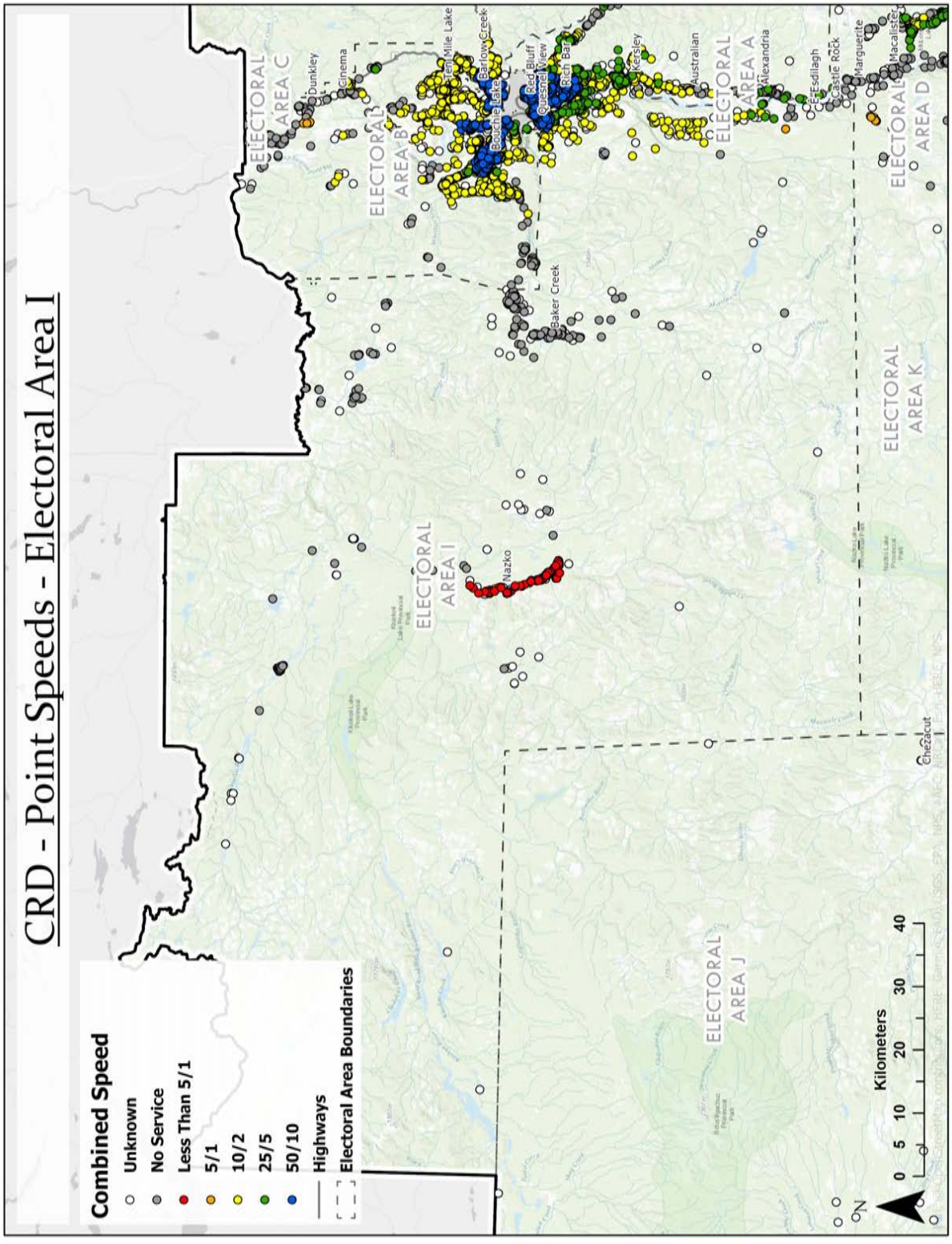

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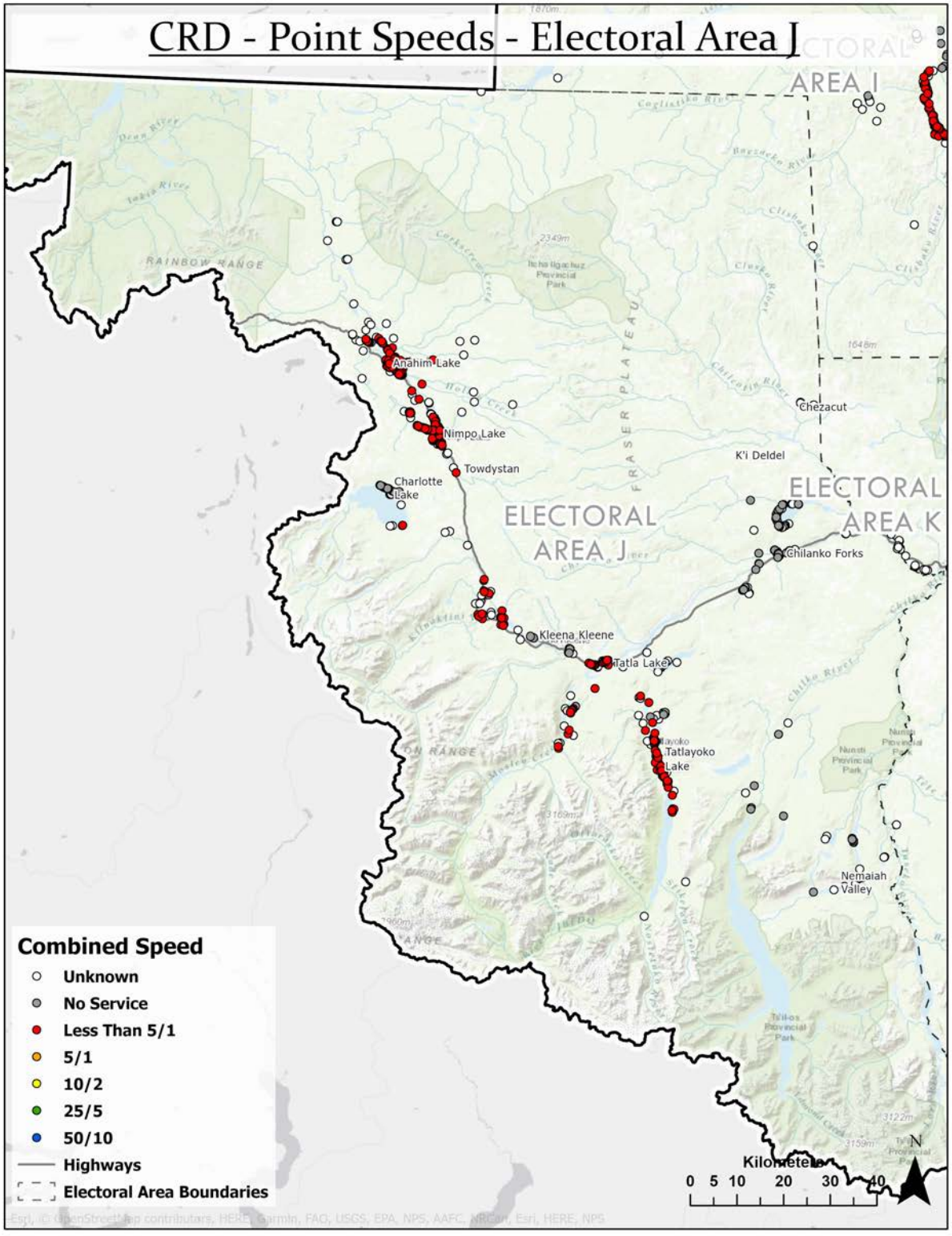

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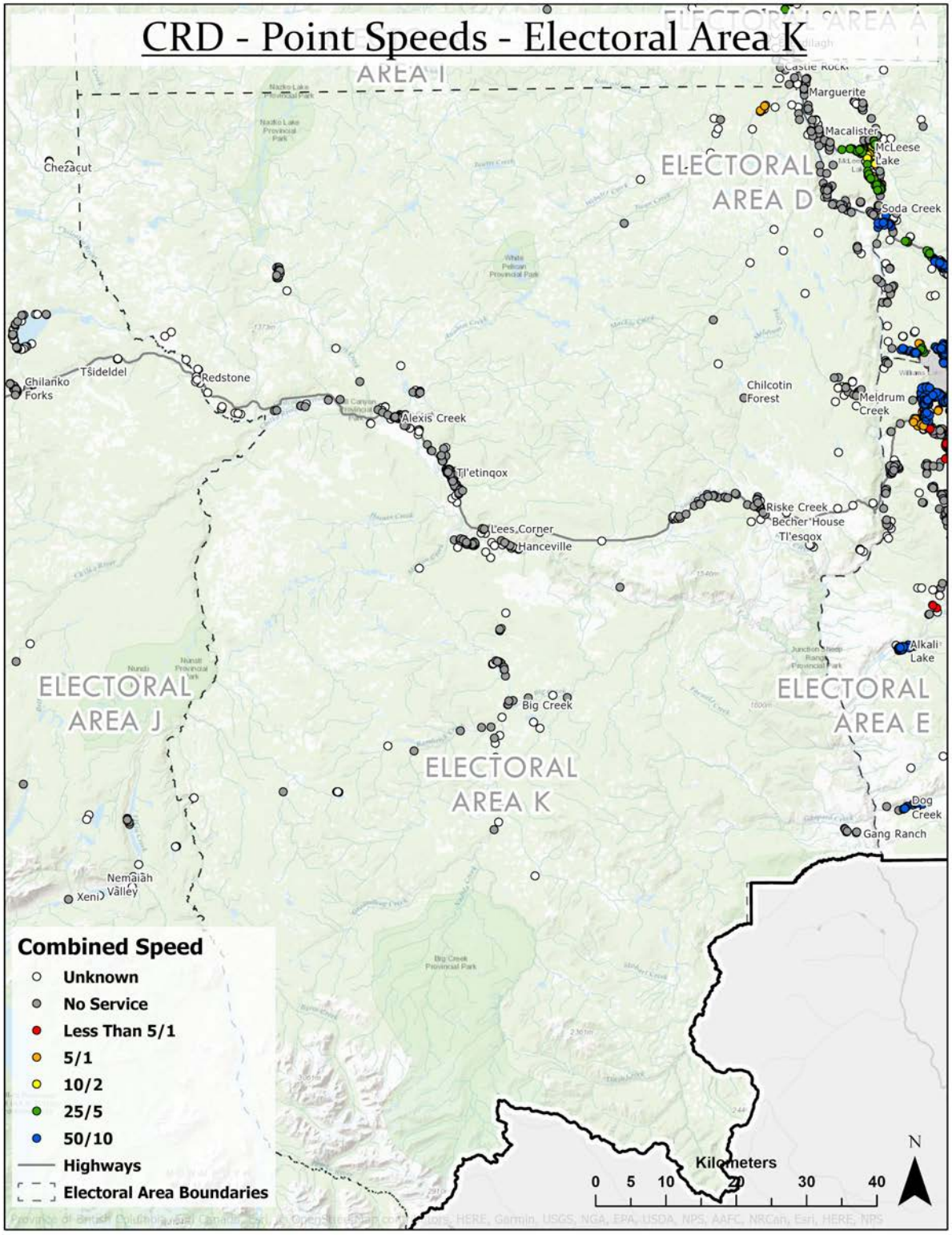

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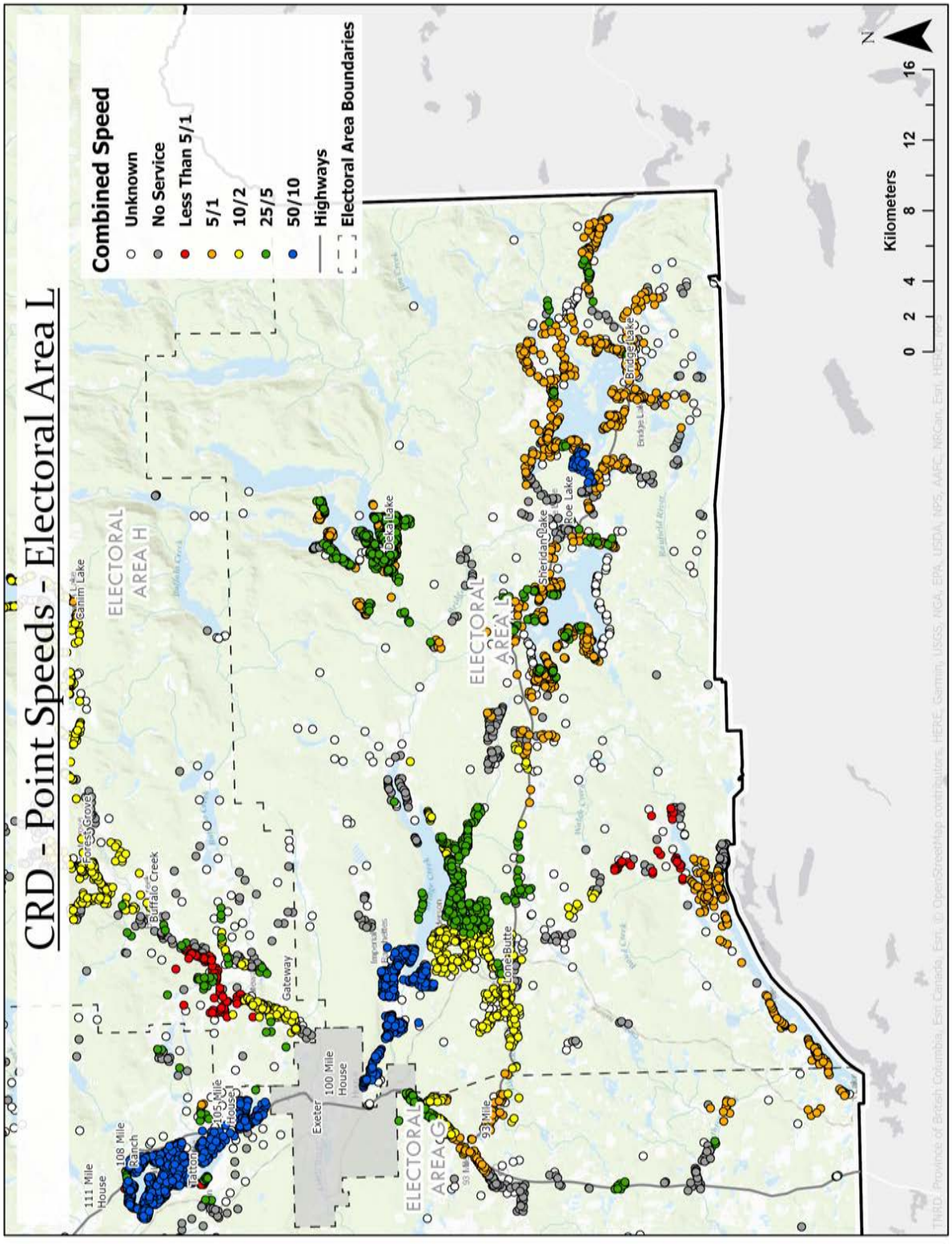

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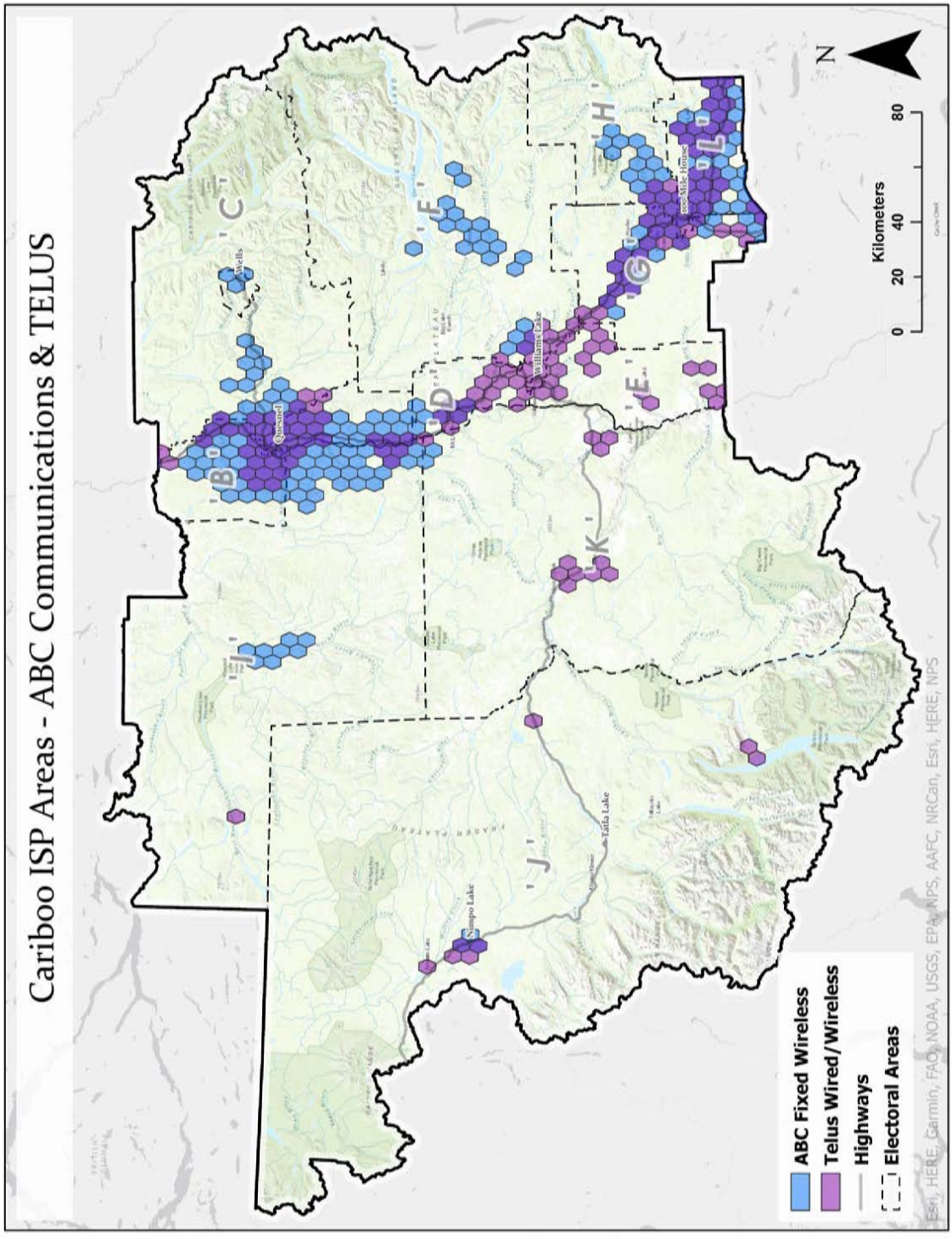
Appendix C – Service Provider Service Areas & Technology



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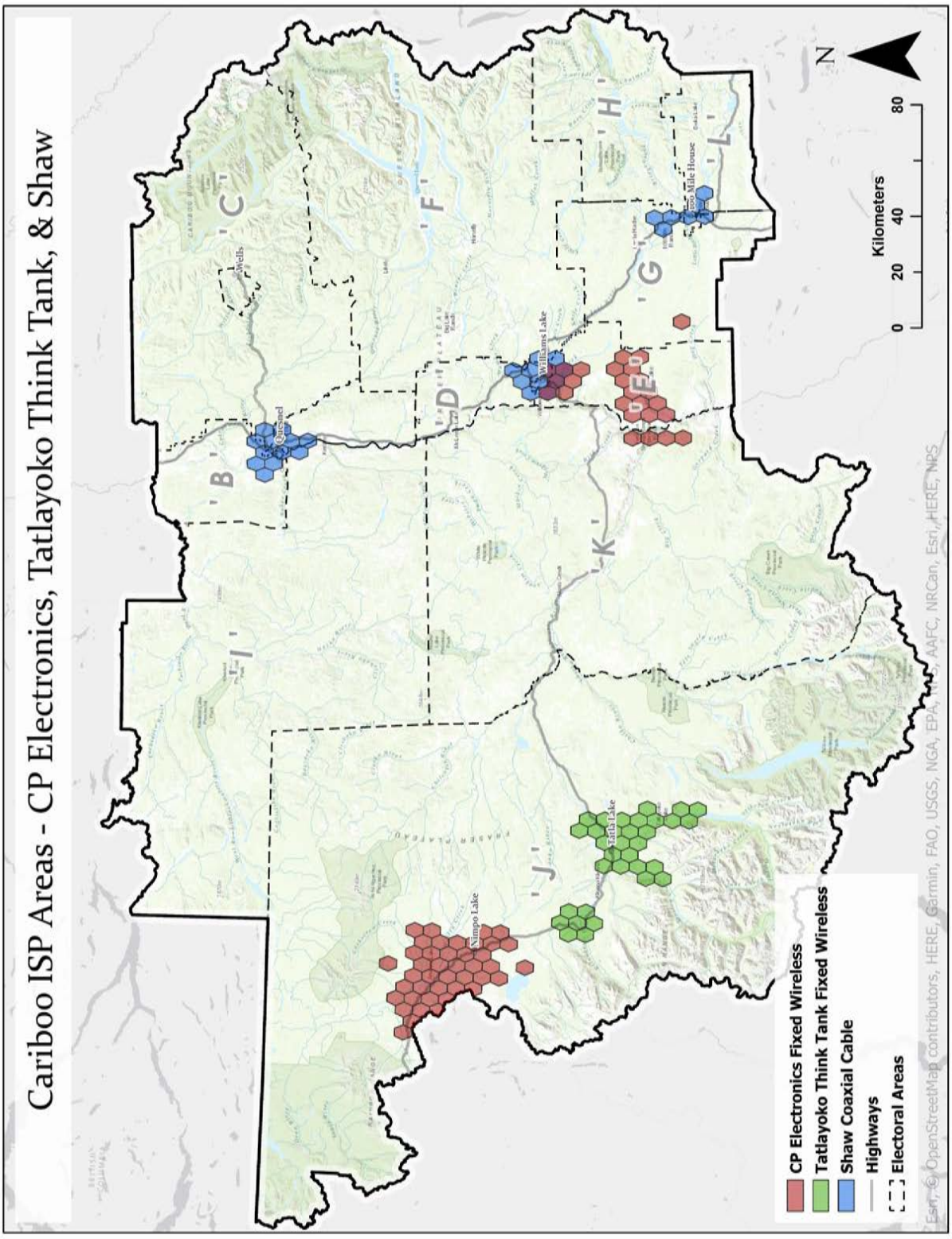

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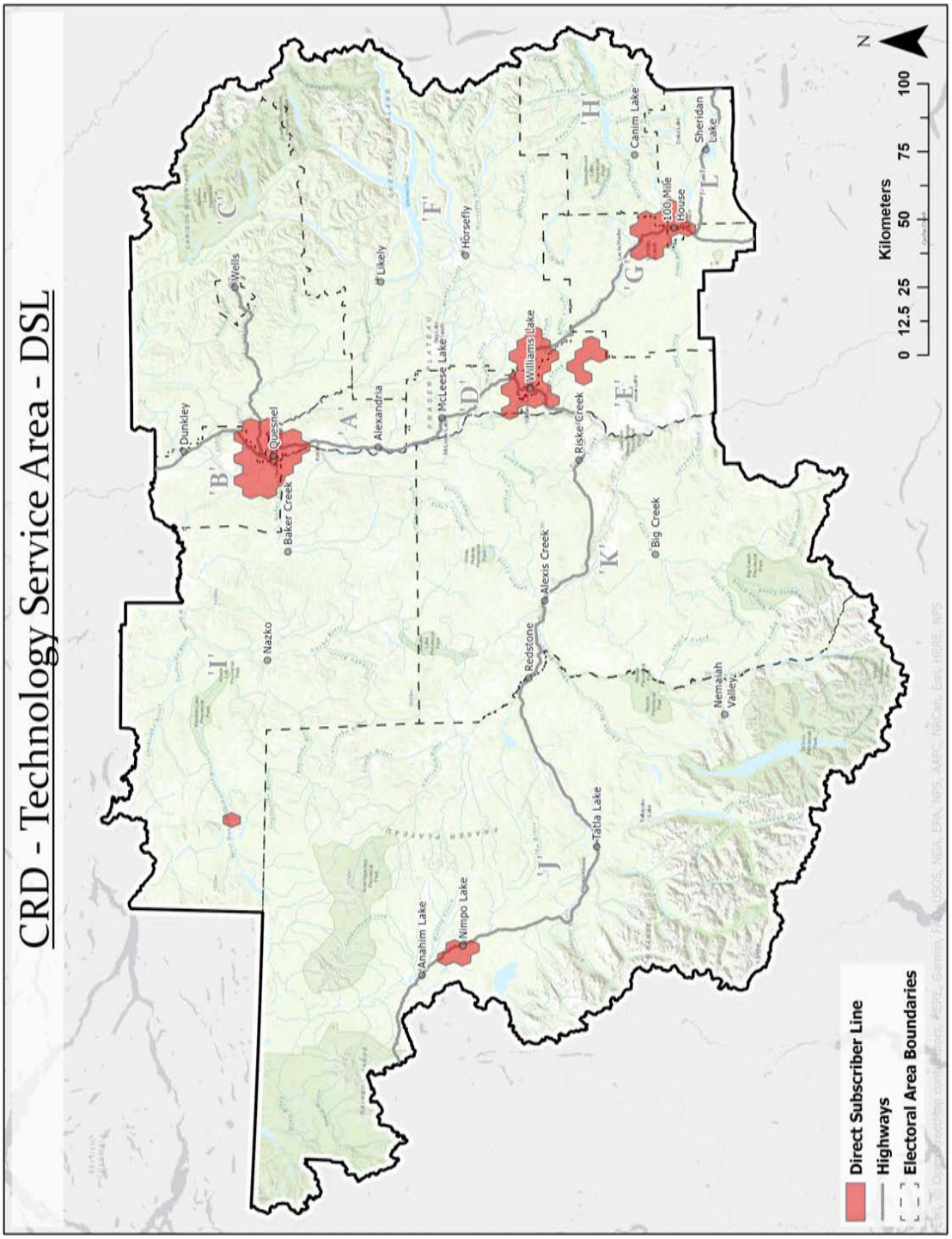
Existing Technology Service Type Maps



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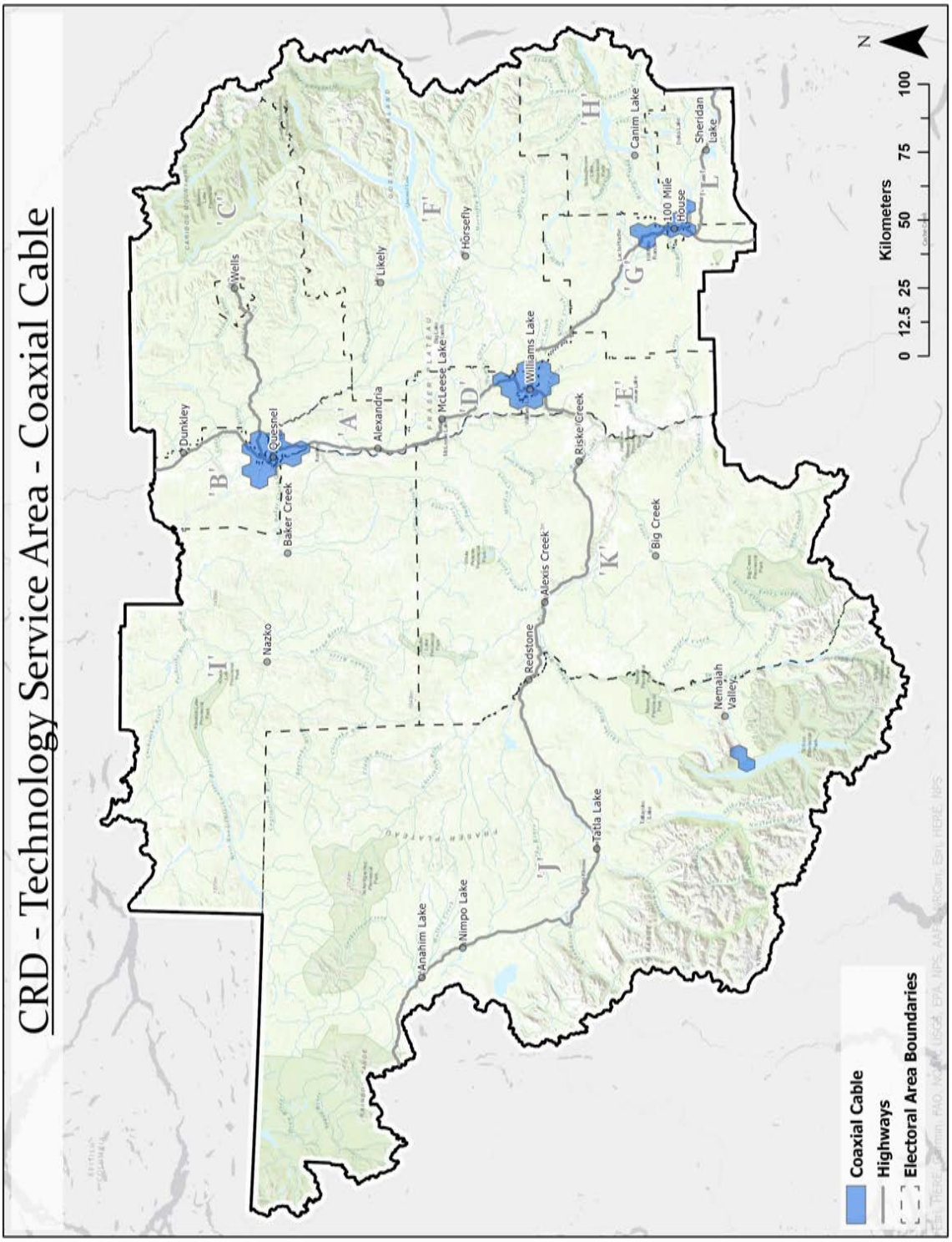

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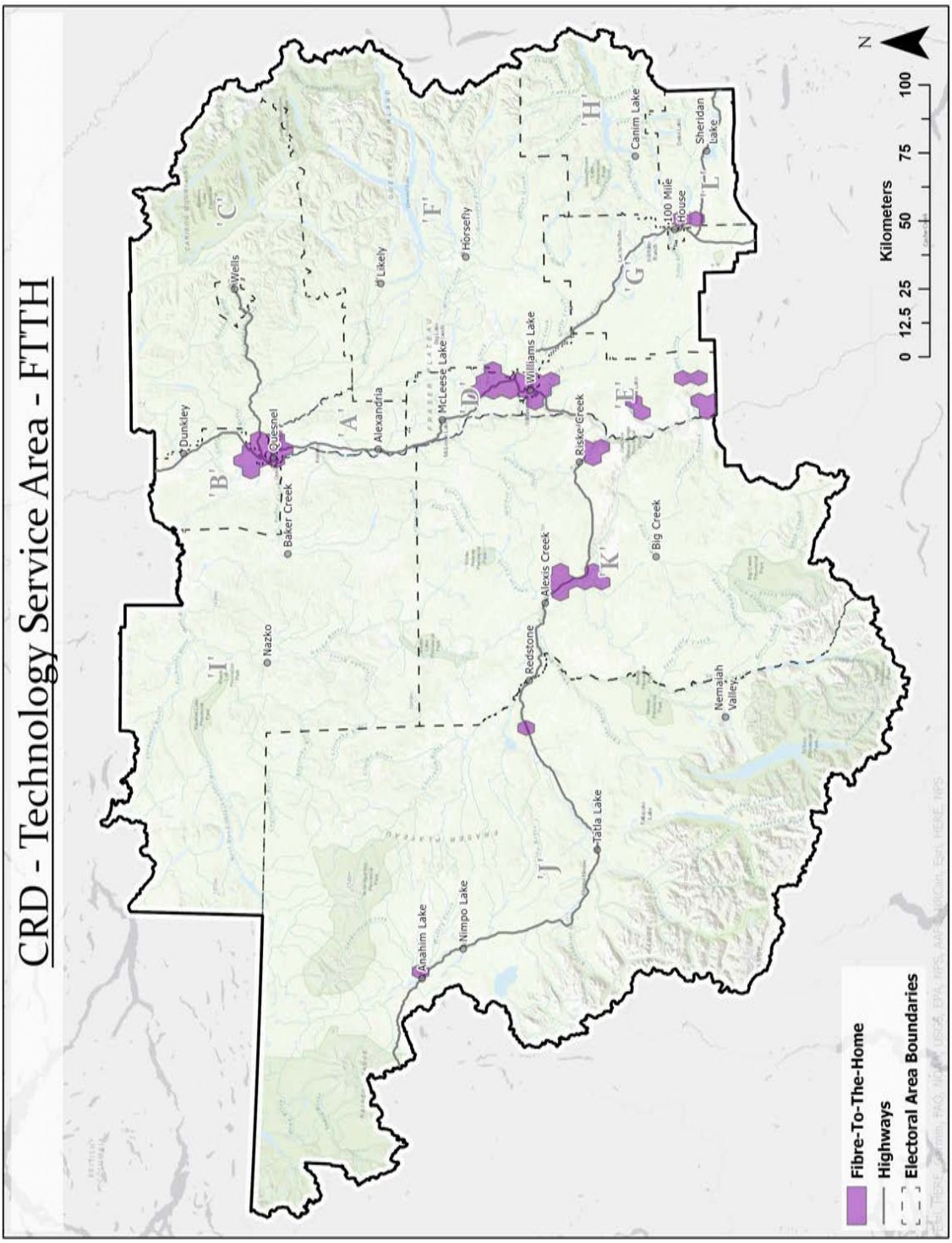

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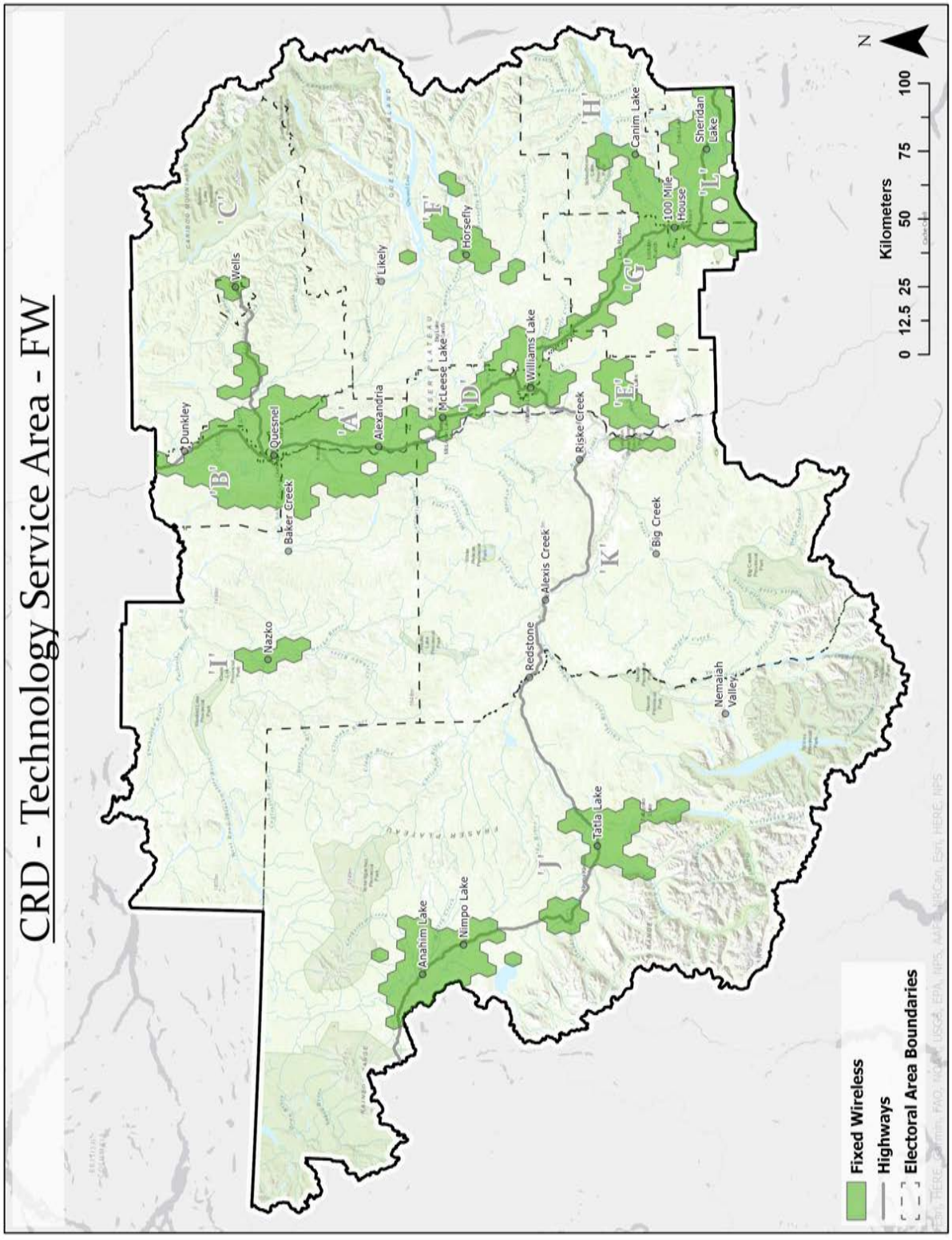

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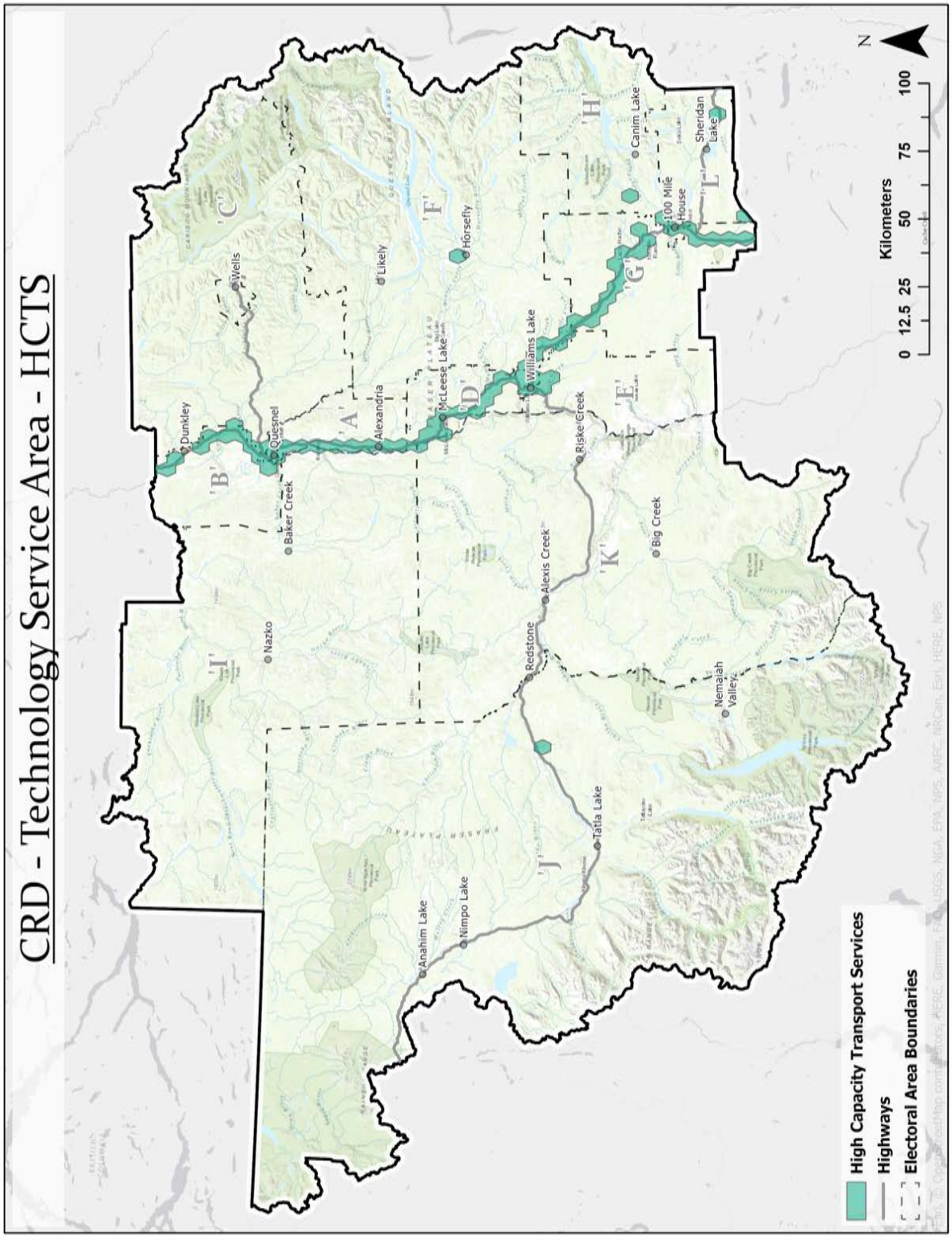

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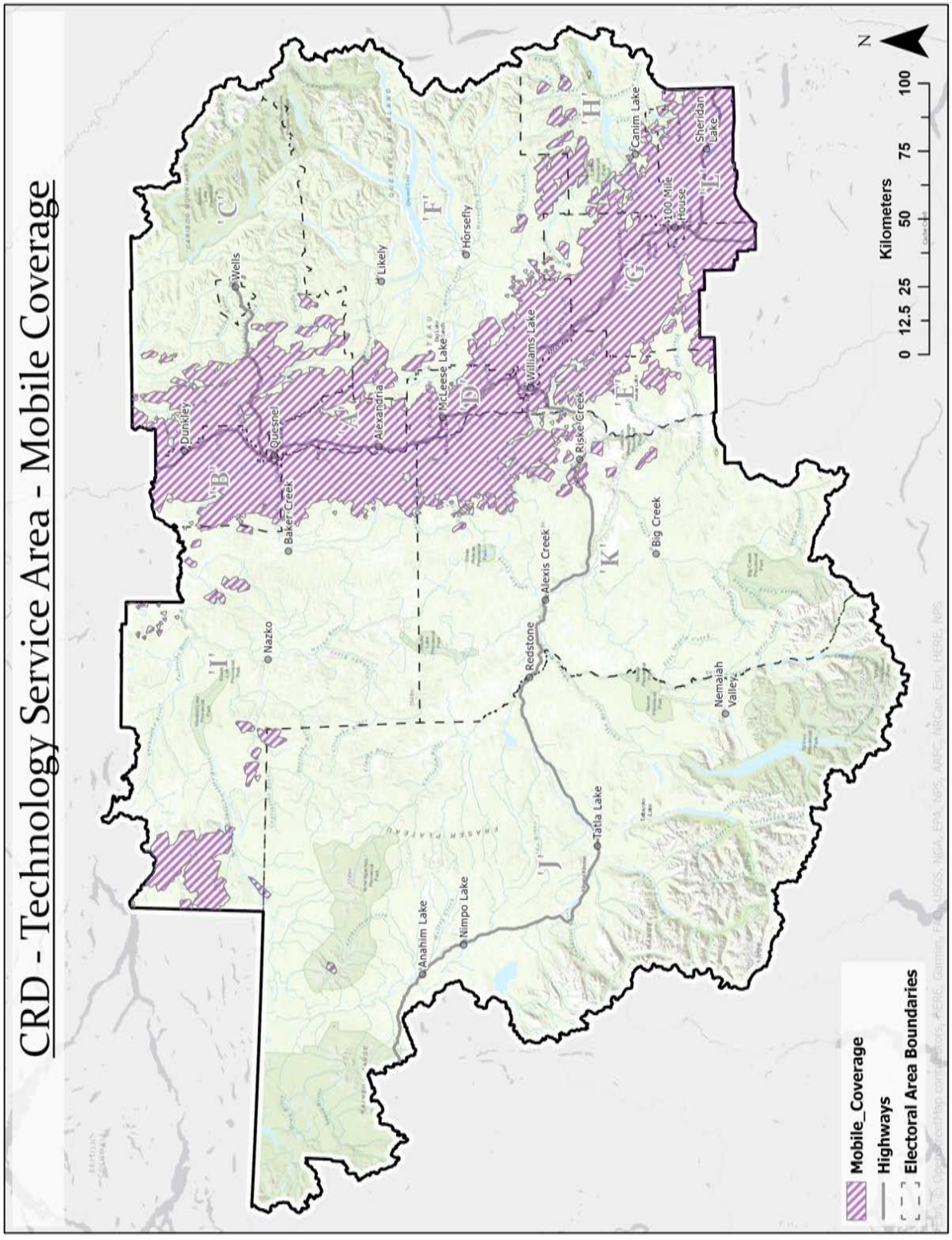

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Appendix D – Technology Overview

Technology Alternatives

In terms of technology, the primary obstacle for rural broadband is cost. Depending on the most suitable technology, the primary cost consideration may be associated with either the backbone or local access networks. A wide range of options are available and broadband services can be provided through a variety of technologies each with advantage and disadvantages. These technologies trade off high capital and operating costs with capacity, scalability and the ability to support the desired applications. The choice of technology needs to be assessed against the requirements for the particular situation and the cost of providing the services. While some technologies represent higher capital costs, the life expectancy may be factored over a long period of time (ie. 20 – 30 years) so capital costs need to be amortized over the lifetime of the asset when comparing technologies. This section of the document is a high-level introduction to these technologies.

Alternative technologies used to connect locations together are outlined below. Technology choice is dictated by the needs and circumstances of the service area. The challenge is to select technologies and configure them into systems that meet those requirements while minimizing life cycle cost.

As summarized above, **backbone or transport infrastructure** is the technology used to transmit and receive data over long distance to connect towns, cities, provinces and countries. Fibre optic cable (optical fibre), microwave radio, and satellite are the three principal transmission medias but fibre is, by far, the most desirable with very high scalable capacity, long life cycle and low operating cost. The challenge with fibre is the high initial cost and as such high capacity terrestrial microwave radio solutions, or even satellite, may be considered depending on the requirements.

Local access networks connect users to the backbone network in order to reach distant locations and applications. In broadband, the term applications, refers the services that people (subscribers) use including things such as the internet, video streaming or broadcast, voice communications, email, access to business services such as Microsoft Office 365, security services, business to business communications. These applications require high capacity, reliable connectivity.

Fibre to the Premise (FTTP, FTTH, FTTx) is the gold standard for broadband service to fixed locations such as homes, businesses and institutions, providing very high capacity, reliability and support for almost any application. As with backbone fibre, FTTP can be expensive to deploy as it requires a physical cable (or optical strand) to be connected from a local POP to every subscriber location.

Like fibre, **coaxial cable** service (typically used for Cable TV broadcast) and **Digital Subscriber Line (DSL)** service (over phone lines), share the requirement of installation of a physical cable from a local POP to the subscriber's premises. These technologies would typically be deployed in locations where this cable infrastructure already exists, thus avoiding the cost of construction. It would now be considered uncommon for a provider to construct new DSL or coaxial cable infrastructure rather than a fibre deployment. While coaxial cable can deliver capacity meeting, and exceeding, the CRTC Service Objective, DSL technology is limited in its ability to scale to these capacities. That said, neither technology can approach the capacity of fibre

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and as such, will likely not scale to meet the capacity requirements in the long term. Coaxial cable is also a shared technology as described below in Fixed Wireless.

The alternative to wired technology like optical fibre, coaxial cable or DSL is a radio-based "wireless" technology. **Fixed wireless** technology and unlicensed radio spectrum has been used as a low cost means of kick-starting internet service in low density rural markets. Fixed wireless is considered to be infrastructure that is fixed to a specific location, unlike technology used for mobile wireless described later. While no physical connection is required between the local POP and the subscriber's premises, high capacity wireless services typically requires "line of sight" to deliver reliable, high speed services. Any obstructions, including buildings, trees, or hills impair the signal resulting in no or poor service. Wireless technology, like coaxial cable, is a shared technology meaning that all subscribers using the wireless network are "sharing" the available capacity. The more subscribers using the service at one time, the less capacity each gets. The requirements to scale wireless service to high numbers of subscribers and capacities must be considered during the deployment of the network.

Cellular mobile technology, a variation of wireless, has become the de facto standard for voice and internet service direct to individual mobile devices. The data communication capability of current 4G (4th generation or LTE for Long-Term Evolution) cellular systems make this a viable broadband technology in appropriate circumstances. The emergence of 5G (5th generation) cellular over the next 5 to 10 years is expected to reinforce this trend (see emerging technologies below). While 5G technology is promising, it will require heavy investment in fibre to connect the local, high density of antennas to the backbone and ultimately globally provided services.

Finally, to reach isolated premises that are beyond terrestrial transport networks, fixed, or mobile wireless, direct to home **satellite** is the only viable choice. Xplornet's geostationary earth orbit satellite service is available across the region. Unfortunately, it suffers from high latency (the time it takes to send or receive information) resulting in some applications not functioning optimally and speeds can slow during periods of high usage. **Low earth orbit (LEO)** technology is emerging. The first to market with a direct to consumer play is Starlink. Starlink is currently (2021-02-19) in paid beta testing in northern US and southern Canada. As the satellite constellation fills in with more launches over the next few months to maintain continuous service, the service will become commercial. Beta test results support Starlink claims of 50 to 150 Mbps downlink speeds and 10 to 30 Mbps uplink speeds with round trip delay in the 20 to 40 ms range. Other broadband LEO systems are planned, but service is at least one or two years out and these may not be consumer service plays.

The following summarizes the key characteristics, advantages and disadvantages of the technologies used for broadband service delivery.

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Backbone and Local Access Technologies

Fibre optic cable - Backbone & Local Access

Extremely high capacity that is scalable for backbone / transport and local access. 10 Gbps already very common and 100 Gbps emerging.
[+] Long life cycle: 20 - 30+ years. Cost can be amortized over a long period of time.
[+] Low operating cost.
[+] High capacity, low latency, high subscriber counts.
[+] Very reliable.
[+] Very scalable. Upgrades to high capacity for relatively low cost.
[+] Supports a wide variety of applications.
[-] High initial (capital) cost.
[-] Acquiring right of way permits can be challenging
[-] Accessing existing underground and aerial infrastructure can be time consuming and expensive.
[-] Repair time can be long when cables break impacting network if redundant routes are not available.
[-] Not cost effective where low long-term capacity needs and long distances.
[-] Fixed to a specific location.

High capacity microwave - Backbone

High capacity microwave provides capacity up to approximately 1Gbps.
[+] Long hop distance is possible under optimal conditions (30 - 50 km). Higher distances may require multiple hops.
[+] Can be engineered for high reliability.
[+] Can be cost effective for one or two hops.
[+] Supports a wide variety of applications.
[-] Issues accessing or permitting to construct towers in some locations.
[-] High initial cost if tall tower required.
[-] High initial and recurring cost if remote tower sites are required.
[-] Can be support and power challenges for remote areas such as accessing mountain tops.
[-] Relatively low capacity: scales from under 100 Mbps to over 1 Gbps.
[-] Appropriate spectrum scarcity an increasing issue.
[-] Fixed to a specific location.

High-throughput satellite (Geostationary) - Backbone & Local Access

Well established technology with a competitive marketplace.
[+] Can be used direct to home (DTH).
[+] Cost does not vary with distance within the coverage footprint.
[+] Good capacity.
[+] Relatively low initial capital costs.
[-] High cost for usage (bytes per month).
[-] Can be susceptible to service impacts with severe weather.
[-] Larger antenna sizes needed at high latitude sites.
[-] Fixed to a specific location.
[-] May not be well suited to some applications.

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Cellular mobile – Local Access

Open standards allowing mobility and connectivity anywhere, anytime.
[+] Huge global market and competitive ecosystem with ongoing evolution.
[+] Low cost for user equipment (competitive market).
[+] Versatile user equipment.
[+] Mobile services.
[-] Relatively high usage costs compared to fixed services (bytes per month).
[-] High initial costs for network build (poor return in low density markets).
[-] Relatively high operating cost (management and evolution).
[-] Limited competition in lower density markets.
[-] Shared technology. Additional subscribers degrade overall performance.
[-] Performance can be inconsistent. Latency can be high.
[-] Higher capacity usually requires significant investment in network upgrades to new technology.
[-] May not be well suited to some applications.

Fixed wireless– Local Access

Different technology with different coverage and capacity characteristics. A range of proprietary and semi-proprietary products are available.
[+] Can be fast to deploy (if antenna tower permitting is not an issue).
[+] Can have high capacity if high frequency (trade-off with coverage).
[-] Limited spectrum and licensed spectrum can be expensive.
[-] Unlicensed spectrum: performance may degrade from interference.
[-] Susceptible to weather and local weather can cause service issues.
[-] Usually needs fibre for sufficiently high capacity backhaul.
[-] Requires line of sight for high capacity and reliability.
[-] Shared technology. Additional subscribers degrade overall performance.
[-] Fixed to a specific location.
[-] May not be well suited to some applications.

Emerging Technologies

Low earth orbit satellite (LEO)

Only Starlink service is available for beta testing in Canada as of 2021-02-21.
[+] User speeds 50-150 Mbps downlink and 10-30 Mbps uplink.
[+] Delay in the 20 to 40 msec range.
[+] Potential to lower the cost of usage to isolated customer locations (beta service in Canada is $130 per month for unlimited usage).
[-] A competitive market may not emerge if other initiatives fail (OneWeb, Telesat LEO, etc).
[-] High inclined and polar orbits required for high latitude coverage.
[-] Long-term costs and performance are still uncertain.
[-] Current costs are not competitive for communities that are large enough to economically support fiber transport and fiber access networks (FTTH).

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Cellular 5G – Local Access
Next generation 5G cellular
[+] Potential for low usage costs with 5G and mmWave frequencies.
[+] Mobile and fixed services.
[-] Requires a heavy investment in fibre to connect numerous 5G antennas..
[-] Emerging now in Canada but mmWave frequencies have yet to be auctioned.

Summary of Technology Alternatives

In summary, rural and remote areas are low density, meaning network links are required over long distance and all else being equal, rural telecom service costs per subscriber will always be higher than urban.

- Fibre optic infrastructure for both transport and access is the long-term end game for fixed broadband. No other currently available technology can match the speed and reliability of fibre connectivity or scalability for the future.
- Cellular mobile to open global standards is, and will remain, the delivery mechanism of choice for mobile voice and data communications direct to individuals.
- Proprietary radio access systems in license-exempt and licensed bands can have a role to play if they are sufficiently inexpensive that payback is within their expected service life.
- Satellite remains the service of last resort for isolated customer locations. Current services that are based on long-delay geostationary arc satellites can be expected to yield market share to low earth orbit broadband satellite service as or if cost-performance proves-in.

Business and Operational Considerations

Infrastructure enables services to subscribers, but it does not provide the resources required to effectively manage, monitor and obtain revenue from the network. When referring to the SDP introduced earlier in this report, the OSS/BSS layer provides all the infrastructure required to perform the operational and business functions required for the network to operate successfully.

The OSS/BSS layer of the SDP includes many components that enable and support service to the customer. In summary:

- Personnel with appropriate knowledge and experience with operating a network.
- Customer support to effectively support subscribers of the network such as technical support and customer service support.
- The infrastructure and software applications required to effectively monitor, manage and operate the network.
- Business operations for the business such as customer service and billing.
- Equipment, tools and assets required to complete onsite activities.

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The OSS/BSS layer must include, but is not necessarily limited to:

Resources:

- The personnel required to:
  - support and provision network services.
  - provide maintenance activities on the network electronics and other infrastructure.
  - manage subscriber requests for adding, removing and changing existing services.
  - Provide the expertise required to enhance services on the network.
- The support system, which includes the personnel, required to effectively support subscribers of the network such as technical support and customer service support.
- The processes and procedures related to the operation of the business.
- The equipment and tools required to complete onsite activities such as vehicles, tools, fibre splicing and testing equipment, network testing equipment, etc.

The personnel required to operate the network need the following skill sets:

- Overall management resources that are familiar with the operation of a network and can provide the overall guidance for the network operations.
- Technical resources that can effectively design, commission and support the electronic components of the network.
- Technical resources that can effectively design, commission and support the infrastructure components of the network such as POPs, power systems, environmental systems, outside plant, fibre, etc.
- Installation and maintenance skills that can provide the onsite support for the infrastructure, electronic components and subscribers.
- Customer service resources that can provide effective assistance to subscribers of the network.
- Sales resources that can manage new opportunities.

Business Systems:

- Customer database containing customer information.
- Billing systems to issue invoices and accept payments.
- Documentation storage.
- Reporting systems to gather, consolidate and report on customer usage that may be used for customer billing.
- Scheduling systems to book and schedule customer site visits and technician tracking that may be required.
- Remote access systems used to provide key support and business technicians access to the systems 7x24x365.

Operational Systems:

- Monitoring systems to monitor the network, locate problems, send alerts to support technicians, gather statistics, report on trends, etc.
- Trouble reporting systems to gather and maintain information on problems reported by customers for timely resolution.
- Provisioning systems to add, change and remove services to customers.

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- Logging systems to log network and customer events.
- Documentation storage.
- Manufacturer specific software required to operate and maintain network equipment.
- Backup and restore systems to maintain configuration backups and restore when required.
- Network maintenance software.
- Network operation systems that are required to make Internet services function. Eg. Domain Name Service (DNS)
- Network authentication and registration systems such as RADIUS and DHCP that are required to activate subscribers on the network.

The hardware and software systems are typically located in one or more datacenters (or POPs) on the network. The intent is to have a location suitable for the equipment required to run the software applications required to effectively operate the network. As these systems will contain sensitive operational and subscriber information, they would typically be implemented in a manner that provides security from external sources such as the internet. These systems contain the infrastructure that provide the daily operational functions for the network.

Along with appropriate resources and software applications the OSS/BSS systems include all the processes and procedures and physical equipment required to perform these functions. An example of a process would include the step-by-step procedure to install and activate a new subscriber on the network as a number of components need to be considered including the physical installation of the fibre drop, the equipment at the subscriber premises, connection of the subscriber in the POP, the activation of the service on the network, etc. Each of these functions needs to be completed in order for the service to be ready for the subscriber.

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Technology	FTTP/FTTH	Fixed Wireless	LTE 4/5G	DSL	Coaxial Cable	GEO Satellite	LEO Satellite
[+]	Unlimited capacity Easily scaled Very reliable Multiple services Low OPEX	Low capital cost Fast to deploy Big bang for your buck Common for regional ISPs	Good capacity Mobile services No wires Low cost for user Versatility in services	Cost effective if cable exists Supports multiple services Leverages existing phone lines	Cost effective if cable exists High capacity Supports multiple services	Available anywhere Can be moved easily	Available in remote locations Can be moved easily Good performance
[-]	High capital cost Requires permitting & approvals Fixed a specific location	Limited scalability Technology lifecycle Requires line of site Unreliable if designed wrong Interference concerns for unlicensed	Limited scalability Technology lifecycle Poorly suited to some services High usage costs to subscriber Limited ability for competition	Cable has high capital cost Scalability is limited Subject to reliability issues Subject to quality & distance Limited ability for competition	Cable has high capital cost Scalability is limited Unreliable if designed wrong Limited ability for competition	Lower capacity High latency Costly bandwidth Problems in extreme weather	New technology Not available eveywhere Will take time to build out Long term is unknown Only one provider at this time
Characteristics	Dedicated	Shared	Shared	Dedicated	Shared	Shared	Shared
	A/Symmetrical	Asymmetrical	A/Symmetrical	Asymmetrical	Asymmetrical	Asymmetrical	Asymmetrical
	Very Low Latency	Low latency	Medium Latency	Low latency	Low latency	High Latency	Low latency

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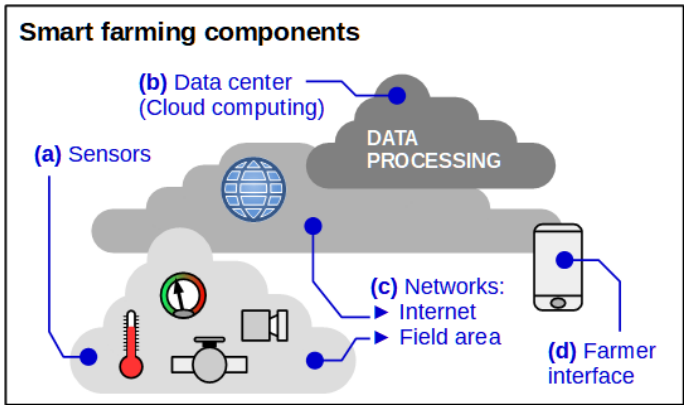
Smart Farming

CRD's agricultural sector is an important industry. It needs to be sustainable and competitive, and technology, including information and communications technology, will be involved in meeting these needs for the foreseeable future. Improved connectivity in the CRD will support access to farming and ranching technologies that are unavailable today.

"Smart farming" refers to the use of information technology to improve the efficiency and productivity of food production. Smart farming is also known as smart agriculture, precision agriculture, and the industrial internet of things (IoT) for agriculture. As shown in the diagram below, smart farming components include: (a) sensors that gather data; (b) data processing to analyze the data and recommend or initiate actions; (c) an interface for viewing findings and exercise control; and (d) communication networks that connects everything together.



Smart farming is important for food security and given the critical nature of agriculture, smart farming will continue to grow. Technologies and the way that they are deployed continues to expand, and significant successes are being reported. For example, smart farming with IoT sensors and satellite imagery has improved crop yields in Indonesia by 60 percent[30]. This highlights the need to use technology to remain globally competitive and to address the issue of local food security.

Communication networks are essential infrastructure to underpin smart farming. As with many industries, reliable communications are the building blocks for these initiatives and without this solid foundation, none of these technologies can improve the agricultural sector. Radio networks are used to communicate with sensors and controls that are scattered around the farm. Broadband networks are used by the farmer to access and use smart farming "applications" that are resident in the "cloud" (big data centers with low-cost computing and data storage capability). A range of radio networks have been deployed and continue to be deployed to gather data from sensors such as thermometers, soil moisture level detectors, imaging devices (including drones), livestock trackers and livestock health sensors to name a few. These same radio networks can be used to exercise controls such as starting and stopping pumps, moving irrigation pipes among other things. These controls can be under farm operator supervision or automatic or some combination.

Many farmers and ranchers currently lack access to the networks necessary to utilize existing technology (e.g., field sensors and cloud analytics). Although cellular mobile radio is one solution for

[30] General Electric, Dattabot and GE Work to Secure the Future of Agriculture in Indonesia

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field network coverage, the service becomes spotty as distance from the tower increases. Some farms still rely on dial-up internet access, which is slow to the point of being dysfunctional on today's internet and satellite, which is prohibitively expensive for real broadband usage.

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Appendix E – Cellular Service Delivery in CRD

Introduction

This appendix supports the report by providing additional background on cellular technology, by drawing out a more detailed analysis of the issues and costs to expand cellular coverage and strategy recommendations.

Purpose

The purpose of this appendix is to provide a deeper understanding of the current situation and technology factors that underpin the strategy implementation recommendations. Readers are expected to be Regional District staff involved in developing a long-term strategy to expand cellular coverage in the Regional District.

Scope

In reviewing the technologies, associated services and costs, the following two services are considered:

Mobile Service. Characterized by voice and data communications with a cellphone which is typically used in a portable or mobile mode. Use is typically 'bursty' in nature and lower data rates (speeds) and data volumes (monthly usage) are acceptable. Data rates of about one megabit per second (Mbps) and monthly volumes of 5 giga bytes (GB) are typically acceptable, but averages are much higher and growth is still trending upwards. In North America, the average smartphone user consumed an average of 12 GB of data per month in 2020[31].

Fixed Service. Characterized by a cellular access point mounted in a fixed location which is primarily used for data communications. Use more closely follows an internet service provider (ISP) model; requiring data rates over 25 Mbps and with monthly volumes of 500 GB, and growing. Note that home broadband average usage in the 4th quarter of 2020 was 482.6 GB per month, up 40% from monthly usage in the 4th quarter of the year before[32].

Current State

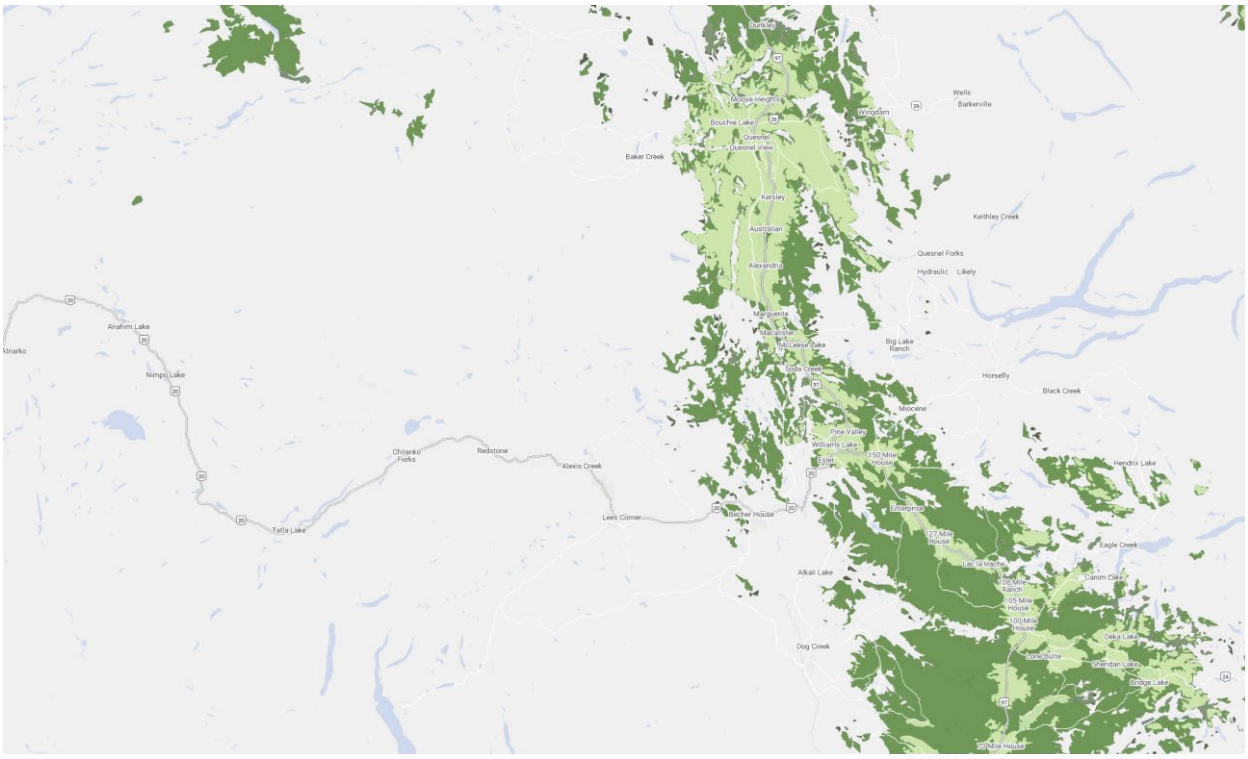
Cellular coverage within the CRD is currently provided primarily by Rogers and Telus. Through roaming agreements with these two providers, other cellular carriers, such as Bell, Shaw/Freedom and international carriers, are able to achieve mobile service within the Regional District.

Telus and Rogers also provide fixed service to rural customers as a subset of their mobile service through the use of fixed wireless terminals (Telus Smart Hub and Rogers Rocket Hub) and a rural home internet plan. Fixed service rates are typically in the order of $75 per month for data rates up to 25 Mbps with monthly data allocations of 500 GB. Fixed service requires the user to be within the LTE service area, albeit the range can be extended somewhat through the use of elevated, outdoor antennas.

[31] "A closer look at cable vs. 5G fixed wireless," Mike Dano, Light Reading, 2021-03-16.
[32] "A closer look at cable vs. 5G fixed wireless," Mike Dano, Light Reading, 2021-03-16.

Cellular Coverage Maps

The following maps show the approximate coverage areas for Telus and Rogers, and their roaming partners. Note that fixed service plans are not typically available with the roaming partners.



Telus LTE Coverage

Rogers Coverage Map

In both cases, the carriers have focused their cellular coverage along the Highway 97 corridor with very little coverage beyond this north-south corridor.

Coverage Gaps

Through stakeholder consultation and review of existing coverage, the following are the primary cellular coverage gaps that have been identified. Safety and security on roads between communities is typically cited as the reason for filling these coverage gaps.

- Highway 20 west from Williams Lake to Anahim Lake.
- Highway 26 east from Quesnel to Wells/Barkerville.
- Highway 24 south and east from 100 Mile House to Little Fort in TNRD.
- Nazko Road west from Quesnel to Nazko.
- Horsefly Road east of Williams Lake to Horsefly
- Likely Road east of Williams Lake to Likely.
- Canim-Hendrix Lake Road west of 100 Mile House.

Performance Gaps

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Assuming users have cellular coverage, the most important performance parameters for user satisfaction are voice quality for telephone calls and for internet sessions, the download and upload speeds (in Mbps) and delay time (in milliseconds). As expected, users in fringe coverage areas experience issues with inconsistent performance and intermittent outages.

Mobile Service: Provided that the area has adequate coverage, no significant performance gaps have been identified for mobile use.

Fixed Service: Within areas that have adequate cellular coverage, the following performance gaps have been identified for fixed data services:

- Peak user data rates of 25 Mbps and 5 Mbps, downlink and uplink respectively, limit bandwidth intensive applications such as video streaming and video conferencing.
- Data rate variability encountered during high traffic periods cause poor application performance for video streaming, video conferencing, remote desktop access, and other data intensive applications.
- Jitter (i.e. non-consistent delay variations between data packets) may cause poor performance in some real-time applications such as telephone calls and video conferencing.

Affordability Gaps

The cost of service, affordability, can become a significant barrier for consumer usage. This subsection addresses affordability for mobile and fixed service.

Mobile Service

Costs for mobile cellular services in Canada rank as the highest amongst the G8 countries and Australia[33]. While the geography and distribution of demand provides some rationale for the cost differentials, public perception would appear to indicate that pricing improvements would be well received.

Fixed Service

The cost for fixed service depends on whether the subscriber is on a mobile plan or a fixed use plan.

- Mobile Plan. With monthly data allocations of 10 GB or 25 GB then overage fees or speed throttling is not economical or practical for household use with entertainment, education, home/farm business and other typical use-cases.
- Fixed Use Plan. Pricing for 500 GB of monthly data is at the higher end of the cost scale when compared to wireline internet service, however the price-performance is competitive when compared to satellite and some wireless ISPs that use unlicensed spectrum.

Cellular Technology Trends

[33] '2017 Price Comparison Study of Telecommunications Services in Canada and Select Foreign Jurisdictions', Nordicity, Oct 5, 2017.

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Cellular mobile telecommunications began in the mid 1980s, gained market traction and overtook the number of fixed telephone lines in 2001 (taking only 15 years to surpass 125 years of telephone system growth). In the new millennium, as cell technology became more digital and internet friendly, it became a multipurpose tool with e-mail, camera, music player, games and other useful applications (apps). The iPhone launch in 2008 and fourth generation (4G) cell technology that went all-in embracing the internet was another turning point. At the end of 2020, there were 7.9 billion active mobile phones, over 75% are internet capable and most of these are so called smartphones with the power of a desktop computer from only a few years ago. Mobiles are an affordable way for most of the planet to communicate and to access the vast and expanding information space and service platform of the internet (as well as play games, take pictures, record audio, play audio, make videos, etc.). By fully embracing the internet in the fourth generation (4G), cellular service capabilities became limited only by what can be put over the internet and fit within the performance constraints of the cell network.

The advantage of cordless personal communications that works in many areas where people work and play was a key market force. Technology drivers included ever smaller and more efficient computers, mega scale data centers, fiber optics and more spectrum being made available. However, a key driver in the success was creating a virtuous circle that uses open global standards to form an open competitive ecosystem of equipment, networks and services that now spans the globe. Although several standards bodies are involved in the technology for cellular systems, since 1998 the 3rd Generation Partnership Project (3GPP) has coordinated the evolution of mobile technology specifications and fostered interoperability through the certification of equipment. The specifications advance the technology as a series of "releases." New "generations" are declared at major technology change points where full backwards compatibility is no longer possible. The following list summarizes the generations in broad terms.

- 1980s - 1G analog for voice only.
- 1990s - 2G digital voice and text.
- 2000s - 3G internet added.
- 2010s - 4G only internet protocol.
- 2020s - 5G new radio & new core.

It should be noted that 5G increases performance and flexibility for more use cases including fixed-mobile convergence as fixed becomes an early 5G use case. In fact, an objective of 5G is to reduce the cost per data byte moved. A recent survey[34] of what 5G capabilities would motivate customers to obtain a 5G device in the future found that ‘faster downloads‘ was the most desired (at 36%). One of the capabilities tied for second place (at 25%) was ‘using 5G as a replacement for home high-speed internet.‘ *"This continues to be an aspiration of smartphone users – the internet access equivalent of cutting the cord, while dangling the potential for reducing costs by not having to pay for both broadband and mobile internet access."* How effective 5G will be at displacing fixed internet service is unknown and will only be determined over the medium to long term (5 and possibly 10 years) as 5G expands and becomes the dominant mobile technology.

The personal mobile phone is the logical means of communication between people. Most 911 emergency calls are received from a mobile phone (over 80% in some jurisdictions). Mobile phones continue to displace land lines for basic telephone service as fixed telephone line service continues to decline globally.

[34] 451 Alliance Digest, Alliance News & Info, Vol #19, 2021-03-26.

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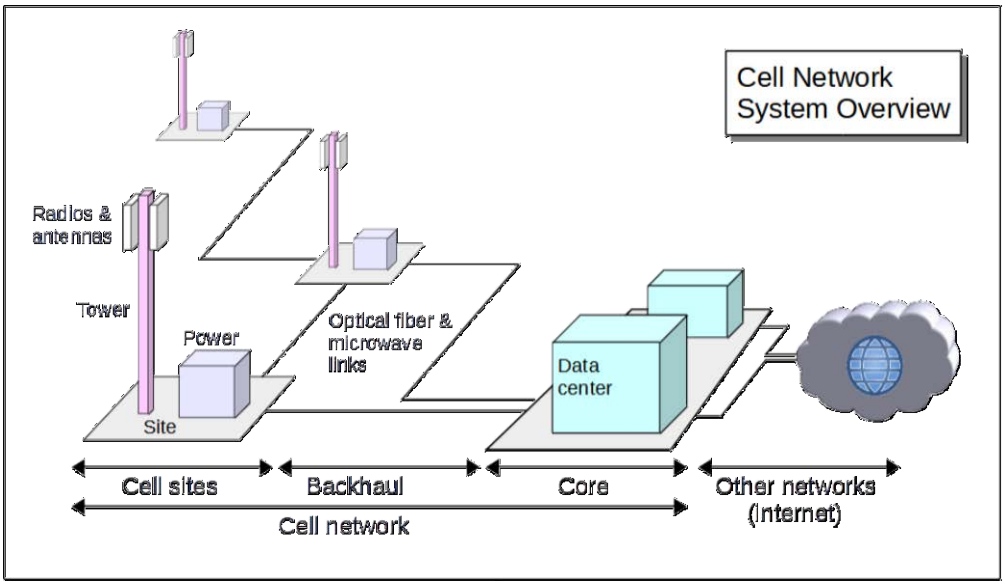
System overview

As shown on the overview diagram, cell networks comprise: (a) cell sites with towers, antennas, radios and power equipment; (b) a backhaul or transport network connecting the cell sites together and connecting to the network core; and (c) the network core is the brain for the network, providing network and business management functions (usually with a distributed data center architecture) and connecting to other networks including the internet. Like most large scale networks, some resources are shared for reasons of economy (taking advantage of the fact that individual subscriber usage varies at any given time). These resources include the radio channel(s) at the cell site, the backhaul network capacity, computing power in the core and the capacity of the connection to the internet. Good service depends on "provisioning" the amount of resources at each potential bottleneck ahead of traffic demand. Often it is the capacity of the radio resources at the cell site that causes user speeds to suffer during periods of high demand. Provisioning cell site capacity can take time as more or higher capacity radios are deployed or even more time if new cell site locations must be found, acquired, permitted and built.



Performance

As noted above, cellular mobile technology continues to evolve as a series of specification releases by the 3GPP. Performance depends on the "generation" of the cellular infrastructure and the "generation" of the user's equipment. Currently 3G (HSPA technology) is in decline and approaching sunset[35]. Today 4G or Long Term Evolution (LTE) is the dominant mobile network technology in Canada (as well as most parts of the globe). The next generation is emerging with 5G networks available now in major metropolitan areas across Canada. Over the next few years 5G will become available in smaller centers and in rural areas. Note that all new base station equipment being installed can be upgraded to 5G. Penetration of 5G is also dependent on the availability of user equipment. Pundits are citing the release of 5G capability with the iPhone 12 as a possible inflection point for user take-up in North

[35] The anticipated earliest sunset for 3G-HSPA networks by Bell, Rogers and Telus is 2025-12-31.

America. Another market driver for 5G is the ability of evolving 5G infrastructure to target new markets including business, industrial, utility, agricultural, transportation, etc.

The following table summarizes the performance for each of the cellular generations. Note that the peak channel rates are shared by all users that are active on a radio channel at any given moment. Therefore, the data speed seen by a typical user will be less, and may be much less if many users are accessing the network with high data speed applications (such as video streaming).

Summary of mobile cellular performance evolution.				
Parameter (units)	**3G HSPA**	**4G LTE**	**4G LTE-A**	**5G***
	Release 6	Release 8	Release 10	Release 15
Peak channel rate download / upload (Mbps)	14 / 5	300 / 75	3,000 / 1,500	20,000 / 10,000
Typical user rate, download / upload (Mbps)	4 / 1	8 / 2	25 / 8	100 / 50
Round trip time delay, target / typical (ms)	100 / 150	20 / 80	20 / 50	1- 5 / TBD
* Achieving the higher 5G user speeds will depend on the radio frequency band and, if not mmWave, then aggregating multiple lower frequency bands. 5G delay will depend on system design with low values requiring customization and/or a private 5G network.				

Usage is an important aspect of the service's cost-performance (potential affordability). Usage or the amount of data used per month over cellular networks has been relatively expensive. Over the past 5 years, cellular monthly usage has gone from a few giga bytes (GB) per month to a few tens of GB and continues to rise. However, it is a long way from typical residential line usage of a few hundred GB.

Design for broadband speeds and high monthly volume consumption is relatively new and constrained by the amount of spectrum and number of cell towers. Network operators have used data caps with overage fees and 'throttling' the speed available to a user when the monthly usage cap is exceeded. The additional spectrum becoming available for 5G (discussed below) will help. However, significant capacity gains to enable hundreds of GBs of affordable monthly usage will likely require more cell sites. This aspect is also discussed below.

From the network operator's perspective, range is also a performance parameter. Range is the distance or area that can be covered from a single tower site. The range depends mainly on tower height, frequency band, transmit power and type of antenna. Lower frequency bands have longer range and better foliage and building penetration than higher frequency bands. But the higher frequency bands have higher capacity and therefore can support higher user data speeds. The coverage versus capacity trade-off largely depends on the frequency band, which is further discussed below under Spectrum. In general, design for coverage is most important for rural service areas and highways, and design for capacity is most important for urban service areas.

Service Affordability

Canadian cellular carriers have maintained a generally constant cost for their core service packages in the $40 to $75 per month range. Based on history, this is expected to continue, albeit with improvements in data rates and monthly usage allocations. Unless there is a major shift in the Canadian regulatory environment, the cost of cellular services is not expected to change significantly.

Spectrum

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The part of the electromagnetic spectrum that is used for radio communications can be divided into government licensed and unlicensed. Licensed spectrum means that the government protects the license holder from interference through regulations and enforcement. Unlicensed frequency bands can be used by anyone using equipment that meets government regulations for unlicensed use. These regulations relate to the radiated power levels and, in some instances, to channel access protocols (e.g., listen for a clear channel before talking). Because anyone can use these bands, there is no protection from interference and therefore no guarantee of performance. Consequently, in order to control the quality of service, commercial communications service providers generally use licensed spectrum. An exception is in rural areas with fewer people, unlicensed spectrum is often used to provide adequate service for fixed wireless internet access.

In Canada today, the mobile bands listed below are in use. These are held as block license allocations to the various national and regional communication service providers.

Band (cellular generation)

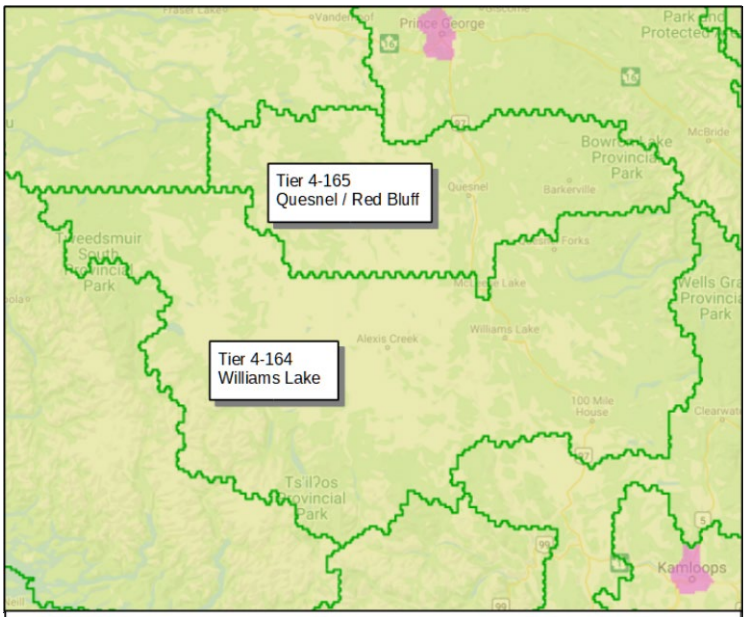
- 600 MHz (5G)
- 700 MHz (4G/LTE
- 850 MHz (3G, 4G/LTE)
- 1700 MHz (3G, 4G/LTE)
- 1900 MHz (3G, 4G/LTE)
- 2100 MHz (4G/LTE)
- 2300 MHz (4G/LTE)

Except for 850 MHz, these licenses were all auctioned to the highest bidder. The auction process is favored because it uses market forces to establish the so-called economic cost or value of the resource and it provides a significant source of government revenue. The auction process effectively excludes small providers. Low spectrum utilization in rural areas, where spectrum is needed, is a recognized problem. So far, remedies like "set asides" to address this have not been particularly successful. The following bands are also licensed in Canada and used for fixed access. Because these are also designated bands for 4G and 5G cellular, over time they will be used for mixed mobile and fixed service.

- 2500 MHz (4G/LTE)
- 2600 MHz (4G/LTE)
- 3500 MHz (4G/LTE, future 5G - see discussion below for action in this band)

As the licenses for the 3500 MHz band that were auctioned in 2004 have now expired, ISED held consultations and will be conducting a new auction in June 2021 for the 3450-3650 MHz band. This 200 MHz band has been divided into 20 blocks of 10 MHz for auction in ISED's 172 "Tier 4" service areas. Not all frequency blocks will be available in all 172 areas because existing users are retaining some spectrum. The amount available for auction in any given Tier 4 area varies between 30 MHz and 140 MHz. ISED will make provisions in the auction process for 50 MHz to be "set aside" for smaller carriers in 138 regions. Licenses will have a 20 year term and there are roll-out targets that dictate faster roll-out in higher population density areas. As shown on the map below, the Cariboo Regional District aligns with Tier 4-164 and 4-165[36].

[36] See this link for a map of the ISED's service area tiers, including Tier 4.
https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01627.html#tierMap



ISED Tier 4 service areas for the Cariboo Regional District.
Source: https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/h_sf01627.html#tierMap

There will be other spectrum auctions in Canada to facilitate the deployment of 5G in new frequency bands. Of immediate interest is the 3800 MHz band. This band extends from 3650 MHz to 4200 MHz (or possibly 3700-4200 MHz as the 3650-3700 MHz band is currently available as a shared or lightly licensed band where all applicants are licensed but required to coordinate to avoid interference[37]. This spectrum is part of a designated 5G band (n77). Consultations have been held on the band but the resulting decisions are not definitive and will be subject to further consultations in anticipation of an auction in 2022[4]. It is generally expected that the band plan and licensing framework will align with US decisions. This facilitates harmonization and exploits opportunities for US market economies of scale to benefit Canada. Additional 5G and unlicensed spectrum is being made available in the US and Europe by re-allocating the 6 GHz band. Canada is certain to follow these examples.

In Canada, the 5G "high band" or "millimeter wave" (mmWave) frequency bands are expected to be the subject of further auctions. Specifically, ISED will conduct consultations on the licensing framework for the 26 GHz, 28 GHz, and 37-40 GHz bands[38].

The cost of spectrum for broadband wireless access depends on auction variables. An indication of cost can be gleaned from the recent 600 MHz auction. Winners paid between $0.78 and $2.35 per MHz-Pop[39]. Of the 12 auction applicants, the 9 winners spent almost $3.5 billion for 104 licenses. In summary, the high cost of spectrum in bands where there is low-cost equipment and market demand has created a somewhat exclusive club of deep-pocket network operators.

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[37] Reference "Technical Requirements for Wireless Broadband Services (WBS) in the Band 3650-3700 MHz," Spectrum Management and Telecommunications, Standard Radio System Plan, Industry Canada, SRSP-303.65, Issue 2, June 2010.
[38] Reference "Decision on Releasing Millimetre Wave Spectrum to Support 5G," SLPB-003-19, June 2019. Link https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11510.html
[39] Reference: H. Sarkissian and B. Ayvazian, "The Canadian 600 MHz spectrum auction by the numbers," RCR Wireless News, article, 2020-04-15.

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Regulatory

Spectrum and radio frequency licensing regulations are not the only regulatory hurdle for public communications service providers. A license from the CRTC is required before an entity can offer service in Canada. As infrastructure is constructed permits will be required before construction can start. Permits are often contingent on the outcome of environmental, cultural and heritage studies. These studies and the construction permit process can significantly add time and cost to cellular build projects.

Cell Site Form Factor

As with other technologies, cellular equipment continues to become more compact and space efficient. Although cell sites come in a range of configurations and sizes, they can often be classified into 'macro' and 'micro' type sites.

Macro cell sites are designed for maximum wide area coverage. They need a high tower and high power base station equipment and antenna. These sites may have a 100 m to 120 m guyed tower with equipment in a small walk-in shelter or outdoor enclosure and consume on the order of a kilowatt or more of power to achieve 10 to 30 km of coverage. The range depends on terrain and whether the subscriber's antenna is blocked by trees or buildings.

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Micro cell sites are designed for more limited coverage and will typically 'underlay' a macro cell site, adding capacity to an area of concentrated demand. The smaller base station and antenna system for a micro cell also reduces the support facility requirements, which can significantly reduce total cell site costs. The radio and antenna can even be integrated into a single pole mounted unit. Micro cell technology may be suitable for rural community coverage where the community is only a kilometer or two across and coverage of the surrounding area and access roads has little benefit.

From a regional cellular strategy perspective, it is expected that cellular equipment will not be a dominant factor for coverage deployment. Rather, the supporting infrastructure (tower, power, and backhaul) required to economically provide wide area coverage will be the major consideration. Cell site infrastructure requirements are discussed in the next section.

Cell Site Infrastructure Requirements

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Cell sites are the dominant cost of a cellular mobile radio network. For each cell site, the cost for land use and support facilities at the site are dominant costs. Each cell site comprises cell base station equipment, antenna systems, and support facilities. The support facilities include the following items.

Cell Site Support Facilities	
Facility	**Comments**
Antenna mounting structure	The height of the tower depends on the desired coverage; higher tower for more coverage. The type of tower depends on the height and availability of land; tall towers are usually guyed and self support towers used where land is scarce or expensive. Towers up to ~45 m are usually self support lattice or monopole type. Over 106.7 m towers require additional air navigation obstruction marking, which raises cost. Antennas can also be on roof top masts and street level poles.
Land and civil works	The amount of land depends on tower type and height. Guyed towers usually have 80% guying (horizontal run is 80% of tower height) which requires just over 2 hectares for a 106.7 m tower. Depending on the site, civil works effort may include clearing, draining, leveling, filling, fencing, etc.
Physical access to the site	All weather road access is preferred to minimize construction and maintenance costs. Seasonal access only will raise the cost of any winter maintenance activities. Helicopter only access will significantly raise construction and maintenance costs.
Primary power	Utility grid power is always preferred where the power distribution system is reasonably close (under 1 or 2 km). Generating primary power at the site has high capital and recurring cost for diesel or fuel cell systems with high capacity tanks and refueling.
Backup power	Some battery backup is nearly always recommended to bridge primary power outages up to about 4 hours and 8 to 24 hours may be used depending on circumstances. If the service is critical (e.g., relied on by public safety), then utility grid power is often backed up by a standby generator with fuel for at least 3 days of run time.
Backhaul	Fiber optical cable connectivity is always first choice for capacity; however, if more than a few km are needed to reach the site, a microwave radio hop may be more cost effective than fiber. If more than one hop is needed and the capacity requirement is low (<100 Mbps), then a satellite may be considered. However, unless or until low earth orbit (LEO) satellite drive down the cost of satellite bandwidth for backhaul, geostationary arc satellites operating costs are generally prohibitive.
Equipment shelter	The equipment at the site needs environmental protection and physical security against vandalism. As a minimum, an outdoor locked equipment cabinet or enclosure with environmental controls is required. Depending on the site type and conditions, a walk-in closet or container may be required.

Although perhaps not obvious from the above table, an ideal cell site to keep capital and operating costs low will have: (i) commercial utility power nearby; (ii) all weather road access to the site; (iii) no expensive land use issues (i.e., low or no costs associated with land acquisition and permitting, low or no rent, etc.); and (iv) an affordable transport network nearby (such as a point of presence with optical fiber connectivity).

The support facilities dominate the cell site cost equation; typically accounting for about 80% of life cycle costs (capital and operating). The type, size and capacity of the site's support facilities, and therefore cost, will depend mainly on whether the site is a 'macro' or 'micro' cell site as defined above.

Situation Analysis

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As noted above, outside the Highway 97 corridor large areas exist with the RD without cellular coverage. The highways and roads without cell coverage were identified as gaps in the Current State section above. This section formulates design requirements, analyzes technical alternatives against the requirements, identifies practical business models and derives high level costs for a sample set of coverage extensions. Note that the design basis and rough costs for this sample set can be extrapolated to other highways and roads in the Regional District.

Requirements

The following cell service planning requirements were formulated considering the strategic goals articulated in the main report. These requirements and the regional context guide the selection of a cost effective technical solution and have some impact on business model decisions.

Capacity: The capacity provided to a community should only be limited by the available backhaul. Therefore, fiber transport is first choice for backhaul.

Community coverage: Community coverage should capture the main inhabited area, but recognize that it may not be economically feasible to reach some outliers (e.g., over 1 km from the main inhabited area). However, coverage should be generally maximized as a reasonable trade off with cost.

Highway coverage: As well as communities located along the highway or road, there may be other areas that should be covered; for example, development areas (e.g., parks, tourist attractions, existing industries, planned industries, etc.) or specific sections of the highway that are known trouble spots (floods, washouts, avalanches, holdups ... etc). Local stakeholder input will be needed to identify these areas.

Reliability: Communication service reliability to end users often targets 99.5% (i.e., the network should be available to a user that is within network coverage with a working terminal 99.5% of any month). This figure allows up to about 4 hours of outage per month. This requirement impacts the amount of equipment redundancy and backup power provisions to include, and therefore cost.

Technical Alternatives

Site architecture is the first consideration. A very limited number of technical alternatives exist to provide cellular coverage to the rural highways and roads in the Regional District. While also a business model consideration, the first technical alternative to consider and decide is whether a micro or macro site architecture should be utilized.

- **Micro-Site:** A micro-site architecture could be utilized to provide coverage to the communities along the route but little to no coverage would be afforded to areas outside the communities. Deployment of micro-sites to provide highway coverage is not considered to be economical due to the very large number of sites required.

- **Macro-Site:** A macro-site architecture, where sites located near communities could be utilized to provide coverage to both the communities and significant portions of the roadway along the route.

Therefore, considering the limited number of users present in this area, the macro-site approach is the most economical and feasible choice. In the future, micro sites may be added to supplement coverage or provide in-fill to smaller coverage gaps, if required.

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The following are secondary technical alternatives that need to be resolved, and that have a significant impact on total costs.

- **Frequency band**: For best range and penetration of foliage and buildings, the 600 MHz or 700 MHz band should be used. In addition, if the site is in a community that requires additional capacity, then the AWS band should also be used (Advanced Wireless Service band 1710-1755 MHz uplink, and 2110-2155 MHz downlink). In theory, the unlicensed 5 GHz band could be used to deploy MulteFire technology that is based on LTE specifications. However, this is not considered further because: (i) user equipment is limited; (ii) roaming onto licensed mobile networks outside the community may not be possible; (iii) there is no protection from interference; and (iv) the long term future of the technology is uncertain.

- **Backhaul**: The transport network will be selected for backhaul based on the following priority order: (i) fiber circuit with at least 1 Gbps capacity; (ii) one hop of microwave to a fiber circuit (line of sight and typically less than about 50 km); and (iii) satellite. To maximize the potential future viability, decisions on which routes to build should be guided by the availability of fiber transport.

- **Power**: Site reliability is usually constrained by the reliability of power. Battery backup is usually provided to bridge primary power outages. If enough statistical data is available, detailed calculation and design against the requirements can be performed. However, in practical terms, if the site has utility grid power then backup battery reserves for 4 to 24 hours is commonly provided (utility AC power availability objective for North America is typically about 99.975% and, although outage durations have wide variability, most power outages do not exceed about 2 hours). Remote sites that are off the grid and generate primary power locally often use redundant primary generators (e.g., diesel or fuel cell to meet the load requirements of a cell site) and also have some backup battery reserve to meet reliability objectives. Although hyrid solar generation can be used to reduce the carbon footprint, it will add capital and operating complexity and costs. If only summer operation is required and the cell site power needs are low enough (small cell with fiber backhaul), then stand-alone solar may be an option. As a reference design for estimating costs: (i) if grid power can be extended to the site, then 8 hours of backup battery has been applied; and (ii) if the site is off-grid, then redundant fuel cell and/or diesel generators will be necessary. If the site is remote with limited off season access, then the generator fuel tanks should have capacity for 15 months such that only one resupply trip per year is required. To maximize the potential future viability, decisions on which routes to build should be guided by the availability of grid power.

Business/Operating Models

As with the technology options, a limited number of business options also exist. One of the core requirements to any cellular deployment is the availability of spectrum. In BC, the prime wide-area spectrum suitable for cellular service (i.e. 700/800 MHZ bands) is licensed to either Telus or Rogers. Business cases either involve one of both of these companies extending service using their infrastructure, extending their service on 3rd party infrastructure, or by acquiring their spectrum and launching a new service provider. These three options are discussed below.

- **Telus/Rogers Service and Infrastructure**. Under this model, the cellular carrier would build infrastructure (e.g. towers, shelters, power, etc.) and deploy their service on that infrastructure. They may also lease space on their towers/sites to other cellular providers or other users to

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defray costs. This model has the highest upfront capital cost for the carrier with potentially large and uncertain risk of cost recovery.

- **Telus/Rogers Service on 3rd Party Infrastructure.** Under this model, the cellular carrier would deploy their service using 3rd party infrastructure (e.g. tower, power, etc.). They would typically pay lease costs associated with the tower, access to power and site maintenance. This model substantially reduces upfront capital cost and risk for the carrier; however, a 3rd party is introduced which must now bear the cost and risk.

- **3rd Party acquires spectrum and provides service and infrastructure.** Under this model a 3rd party acquires suitable spectrum (either under agreement with the carrier or by petitioning ISED to declare the carrier has lost its right to the spectrum for the region) and develops the infrastructure and service. This model has the same upfront risk and cost as the preceding models; and has the added complexity of licensing and managing the cellular service.

Given the carriers' experience in designing, deploying and managing cellular services and the associated infrastructure, the first business model is the recommended first path to pursue. Should an impasse be met, then the second or third model may be considered.

Costs assumptions and estimates for cellular improvements in the CRD have been included in the ancillary report accompanying this document.

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Appendix F – Open Access Overview

British Columbia and Canada face a problem with connectivity in remote and rural communities of Canada. Many of these communities are faced with absolutely no connectivity or connectivity that is poor or unreliable. The primary challenge is that rural connectivity lacks a business case to invest capital and operational funds. Private enterprises do not provide services in these areas because it simply does not make business sense to do so. As a result, providers position requests for funding to build transport where it creates opportunities for them and local access in areas that may already be served leaving rural areas untouched as a lower priority.

Government funding programs often require that infrastructure constructed using funds from these programs be available for other providers to use at pre-determined rates ("quasi open-access"). The challenge with this approach is that the lack of a business case makes it nearly impossible for one provider to provide services in these areas, let alone more than one. While it may be physically possible for more than one provider to service these areas, the business case dictates that it will likely be a single provider thus excluding any form of competitive services or pricing.

Government support to address the connectivity problem is appropriate but the distribution of funds is typically in the form of grants of funds to an existing (often for-profit incumbents) provider on the basis that it will provide new or enhanced services. Funds are granted to the provider on the basis that they use them to solve connectivity issues in these un/underserved regions. While quasi open-access is a step in the right direction, it doesn't go far enough.

The connectivity problem in rural BC is not going to fix itself and using public funds to benefit private enterprise that are not motivated to solve the rural challenge is not the right approach. We need to think bigger. We need to think differently. Rural funding programs should support government priorities not the priorities of the service providers. Rural funding should be done as part of much larger vision with affordable choice for consumers.

In the traditional model, for a service provider to service a customer, they must construct all levels of the Service Delivery Pyramid ("SDP"). While this model may be acceptable in larger centers where there are enough subscribers to make a suitable business case for providers to essentially overbuild each other with different types of technology, in remote and rural communities, there is not enough subscribers to justify one provider building this infrastructure let alone more than one. Once a provider has built the infrastructure, there is virtually no chance that a second provider will provide any competitive services. In the short term, the funding can be considered a success and area residents do get improved services. In the long term though, as service requirements change due to progression in technology and connectivity requirements, these areas will lag behind once again and the problem of second-class connectivity will again be reality. Then government must, again, incent the provider to upgrade the service.

True Open Access ("TOA") networks alleviate the above problem by architecting the solution in a way that addresses the problem at a broader regional level and encourages competition, provides support for government initiatives, choice of services and providers for the consumer. A TOA network leverages technology and a business model to allow multiple providers to share the network and deliver a variety of services to the consumer. In the end, the consumer is the winner with a choice of providers and services in a competitive market forcing providers to deliver innovative services at improved price points and high levels of customer service. In the case of rural connectivity, using this model over a larger number of communities, aggregating the costs under a single entity provides the opportunity to make more attractive business case with the benefit of choice to the consumer.

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