Cargo Airship Strategy For Northern Canada

Canadian Arctic Innovation Association

May 31, 2023

British R100 - Airship

St. Hubert, Quebec

August 1930

Top Speed 130 kph

Practical Lifting Capacity 55 metric tonnes

Acknowledgements

This document focuses on the application of airship technology to address various infrastructure challenges encountered in Northern Canada. Its purpose is to offer readers an informative overview of airships, highlighting their rich history and operations aspects, white also considering the modern advancements in terms of materials, computers, avionics and design. . By considering disparate information, this document serves as a foundational resource for the airship industry in Canada, paving the way for its eventual resurgence. It is important to note that no other public document of this type has been attempted or exists for Canada.

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- Town of Moose Factory
- Airport of Moosonee
- City of Yellowknife
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NORTHERN CANADIAN CARGO AIRSHIP CORRIDORS

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1 CONTEXT OF THE STUDY

1.1 Introduction

This study examines the potential for a new generation of cargo airships to provide year-round transportation services to Northern Canada. It seeks to answer three fundamental questions. First, does enough market demand in the North exist for an airship industry to serve it profitably? Second, are the costs and service that could be provided by cargo airships sufficiently attractive to be embraced by shippers and receivers in the North, or does it require a government subsidy? Finally, how would the airship corridors be organized to provide timely, efficient transportation services to the remote communities, mining operations and other users in the North?

Freight rates to the remote communities in northern Canada are high because the population is sparse, the distances are long, and there is neither road, nor railway infrastructure. Residents in these "thin" markets are often faced with monopoly services. In most cases they have no southbound freight and must pay the full roundtrip costs.

The high cost of transportation has direct impacts on the prices and quality of everything consumed in the North. Food prices are two and half to three times higher than in the southern cities. Housing is over-crowded, and many houses are in need of significant structural repair. Employment opportunities are scarce, malnutrition is widespread, and health problems with molds and diabetes are chronic. Although the lack of affordable freight rates is seldom the direct cause of these social and economic challenges, improved transportation is the solution.

Infrastructure gaps in the North persist because it is uneconomic to construct enough roads, ports, or paved runways in the rugged terrain and islands that span seven (7) million km2. With rock outcrops, permafrost, swamps, muskeg and water crossings, the cost of constructing a gravel road in northern Canada averages $3 million per kilometer. Air transport is the only way to serve such vast distances and sparse populations year-round, but gravel runways limit airplane size, and bigger items must come in on an annual sealift or over a winter road.

Existing technology cannot alter the pattern of economic disparity between the highly developed southern Canada and the developing world conditions of the sparsely populated North. A transformative change in transportation costs and service is required. This is why cargo airships are being considered.

Cargo airship service would benefit more than just the remote communities. The mining industry, northern research industry and the Department of National Defense (DND) also bear high transportation costs to operate in northern Canada. Cargo airships could expand the mining industry, especially for higher value critical minerals, allow DND to stretch their budgets and improve their effectiveness in the Arctic and provide arctic researchers greater logistic support. It is also worth noting that synergies could be found in the operations of DND, miners and remote communities. The weight of mineral concentrates coming south, could far exceed the volume of goods going north. This could lead to backhaul freight rates for the remote communities.

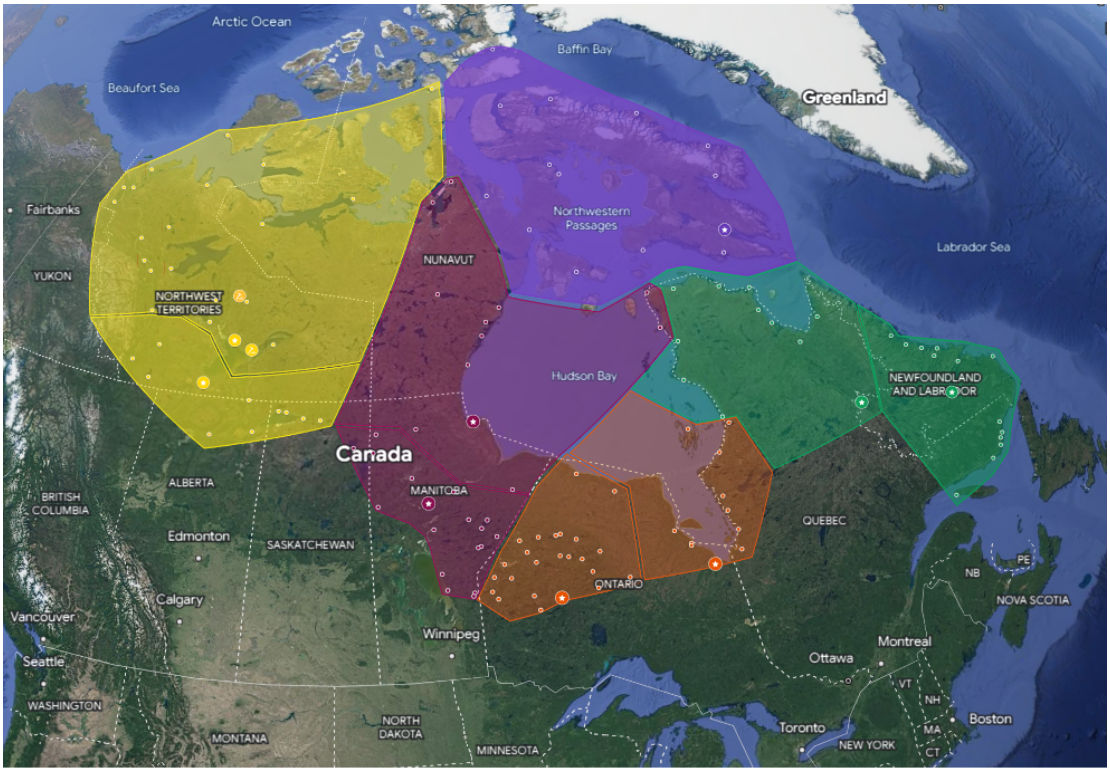
Cargo airships are a sixth mode of transport, as distinct from airplanes as trucks are from railways. Each mode of transport has its advantages and limitations. Like other modes of transport, airships need to have their own ground infrastructure for transshipment and facilities to maintain/inspect the aircraft. These infrastructure requirements are needed at key locations on the trade corridors, not every location.

Least cost supply chains are typically multimodal. Goods move by the lowest cost mode of transport for as far as possible. Airships will link up with truck, rail or marine transport along existing trade corridors to serve the wide expanse of the Canadian North. Airship corridors begin where the existing transportation infrastructure ends.

1.2 Scope and Objectives

The purpose of this study is to assess the development of cargo airship trade corridors to serve the remote communities across northern Canada. This area, which encompasses 70% of Canada's land mass, is only economic to serve through regional corridors and established gateways. All freight would be transported as far as possible by land or sea, then transshipped to cargo airships for delivery to the remote communities. Figure 1-1 illustrates the shape of the market areas that would minimize the distance from the gateways to all the identified communities.

Figure 1-1 Primary and Secondary Gateway Locations for each corridor



North West Corridor (Yellow) Primary: Yellowknife, NWT Supporting: Enterprise, NWT

Central West Corridor (Burgundy) Primary: Churchill, MB Supporting: Thompson, MB

Central East Corridor (Orange) Primary: Moosonee, ON Supporting: Pickle Lake, ON

North East Corridor (Green) Primary: Schefferville, PQ Supporting: Happy Valley, NL

Arctic North Corridor (Purple) Primary: Iqaluit, NU Supporting: N/A

The scope of this report is broad and comprehensive. It seeks to inform on the following topics and analysis.

1. The study describes the uniqueness of the Canadian Northern, with specific emphasis on the unique demographics, geography, environment, climate, remoteness and logistic challenges.
2. The study provides a briefing on airship technology and advances that make the current generation robust and sustainable.
3. The study catalogs airship concepts, designs, and prototypes and discusses potential uses for different airships.

4. The study identifies the leading airships developers, their TR state of readiness and examines the progress made on the regulatory framework.
5. The study assesses airship infrastructure requirements for transshipment and maintenance.
6. The study considers the private and public demand for airship services in the North.
7. The study estimates the freight costs for movements through the selected corridors for inbound and outbound shipments.
8. The study reviews the logistics and environmental benefits of airship supply chains.
9. Engagement with the primary gateways and how their communities will benefit from better freight rates and year-round service.

1.3 Method of Analysis

An economic model is used to estimate the costs of cargo airships to deliver goods to the remote communities and to bring concentrates from critical mineral mines. As previously stated, these shipments are complementary. The communities have mainly northbound loads, while the mines have more loads coming south. It may be possible to identify routes that can serve both needs simultaneously, but for this analysis only one-way trips are considered.

With so many communities, and such a diversity of goods moved to the remote communities, the ability to account for the breadth of possibilities is beyond the scope of this research. Instead freight rates are estimated for representative cargo from the corridor transshipment gateways. Freight going to the villages is represented by building materials. The study assumes that building materials represent about 20% of the total amount of goods being transported into the communities.

The freight rates for transporting the materials into the remote communities are calculated for three different sizes of airships: 30t, 60t and 100t lifts. For the purpose of estimating these costs, cargo airships are assumed to make direct trips in and out, rather than a multi-stop route system that might ultimately emerge. Also, all trips are costed as if they have no return loads, and the receivers are paying round-trip costs.

In the case of the mining industry, a mine that is not connected by current infrastructure is modeled as a representative case study. The comparison is between the net present values of building a gravel road and using trucks versus the operations of cargo airships.

1.4 Organization of the Study

The first section of the report considers the conditions for operations and the state of the airship industry worldwide. The survey of the airship industry includes the various types of airships and their applications. Background is also provided on the state of airship companies and readiness for certification.

The next section examines the demand for airship services. The three markets are the remote communities, DND and the mining industry.

This is followed by a section that estimates the demand for airship freight services to the remote communities via each of the airship gateways and trade corridors.

The fourth section considers the economics and costs for the airship service to the remote communities and as an alternative to gravel road access for the mining industry. This also involves some sensitivity analysis.

The fifth section examines infrastructure needs and environmental considerations. Land use and carbon emissions are key elements of this discussion

The report concludes with commentary on the risks and threats involved with the airship transportation system, and recommendations for next steps.

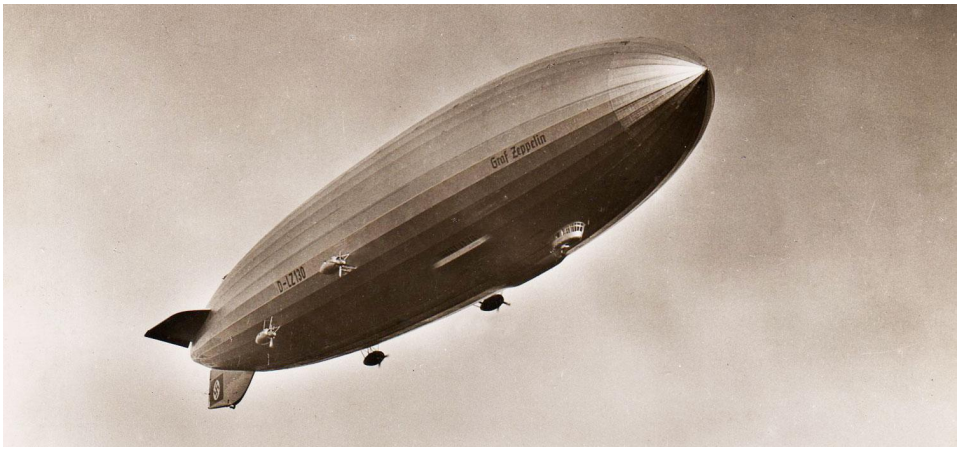
1.5 What is an Airship?

Airships are the oldest type of maneuverable aircraft. Prior to airships the only type of achievable flight was through passenger balloons that are dependent upon wind currents for movement. The first documented flight of an airship was in 1852 when Monsieur Henri Giffard, a French Engineer, traveled from Trappes to Paris a distance of 25 kilometers. The airship envelope was filled with hydrogen gas and the aircraft propelled by a three horsepower steam engine. This marked a significant milestone in aviation history as the first powered, controlled and sustained flight, but it was not until the development of internal combustion engines that commercial airship services became possible.

Airships remained the dominant form of long endurance passenger aircraft until the late 1930's, despite the successful flight of the Wright Brothers airplane in 1903. Efficient and reliable engines remained a problem up to WW2.

Figure 1-2 presents a photo of the Graf Zeppelin airship that operated successfully from its maiden flight in 1928 to its decommissioning in 1937. During this nine year period it showcased its endurance by completing the first transatlantic passenger flight in 1928 and the first global circumnavigation in 1929. The Graf Zeppelin still holds the record for duration and distance flown by an airship with a 71 consecutive hour flight covering a distance of 6,384 kilometers. The golden age of airships lasted 85 years from 1852 to approximately 1937 with the retirement of the Graf Zeppelin.

Figure 1-2 Photo of the Graf Zeppelin, passenger airship



Ultimately economics and the advances of jet engines during WW2 led to the demise of the large rigid airships. Fixed-wing, jet aircraft that emerged after WW2 were faster, appeared to be safer, oil was cheap, and no one cared about carbon emissions. Airships simply could not compete in the passenger market, and at that time, no one considered using large dedicated freight aircraft.

The military use of airships continued until 1962. Beginning in 1938, the United States Navy commissioned the non-rigid K-Class airships, as illustrated in Figure 1-3. They were used for a variety of purposes, including training, anti-submarine patrols, transportation, and search and rescue missions. A total of 135 blimps were built and the last N-model was retired in 1962.

Figure 1-3 Photo of a US Navy Blimp at its mooring mast

Since the retirement of the US Navy blimps, helium filled airships continued to be used in the private sector by niche operators focusing on advertising and sightseeing tours.

1.5.1 Airship Classification

Airships come in various designs and styles. The main airship taxonomy system categorizes them according to their envelope structure; rigid, semi-rigid and non-rigid

Figure 1-4 Photo of the USS Akron approaching mooring mast

A rigid airship is supported by an internal framework or rigid structure, which gives it a more fixed shape. This framework is covered with a lightweight aerodynamic skin. Internally within the framework are gas cells (balloons) that contain the lifting gas. The shape of a rigid airship is due to the framework.

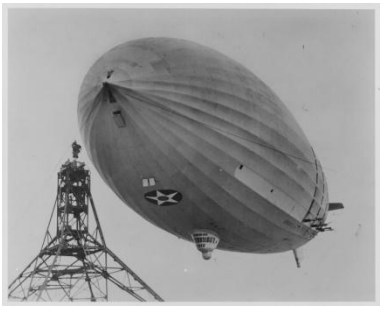


Figure 1-5 Photo Semi-Rigid airship Norge.

A semi rigid airship has a partial framework, traditionally a keel that runs along the length of the envelope from the nose to tail sections of the aircraft. The framework provides some structural support but the pressurized gas in the envelope plays a more significant role in maintaining the airship's shape.

Figure 1-6 Photo Non-Rigid airship US Navy K-Class.

A non-rigid airship, also known as a blimp, is a type of airship that is not supported by an internal framework or rigid structure. Instead, it relies on the pressure of the gas inside the envelope or balloon-like structure to maintain its shape.

It's important to note that airships can vary in shape, design and size and there may be different configurations and features depending on the specific model or purpose. Airships, however, no matter their particular style will fall within one of the three aforementioned categories. The six main styles are listed below.

Figure 1-7 Photo Graf Zeppelin

A classic airship is characterized by their cigar shaped streamlined elongated shape, a long cylinder that tapers at both ends.

Figure 1-8 Photo Airlander 10

A hybrid airship is a type of aircraft that combines the characteristics of both fixed-wing aircraft and airships. It is wider and broader than classic airships and its shape adds aerodynamic lift to the buoyant lift of the lifting gasses.

Figure 1-9 Photo Russian DP-27 Anyuta

A lenticular airship also known as discoid or saucer-shaped airships are characterized by their rounded or disc shaped envelope resembling a flying saucer. Practical and operational use of lenticular airships have been limited.

Figure 1-10 Photo 21st Century Airships Spherical Airship

A spherical airship is an aircraft that as its name describes has a spherical or near spherical design. Spherical airships and their designer (Canadian Hokan Colting) hold the airship altitude record at 6,234 meters.

Figure 1-11 Photo Canadian Solarship

A deltoid airship has a distinctive triangular ship in the shape of a triangle. A type of hybrid aircraft that depends upon buoyant gasses in addition to aerostatic lift.

Figure 1-12 Photo Cameron Balloons D-77 Thermal Airship

A thermal airship is a small type of airship that depends upon hot air for buoyancy. These are low endurance small vehicles that are typically used for recreation or advertising. As they rely on heated air they can be deflated and stored rapidly.

As of 2023 the airship industry has been around for 171 years, during which time a multitude of concepts, designs and manufacturers have emerged. Among the oldest of these companies is Luftschiffbau Zeppelin, a German company founded by Count Ferdinand von Zeppelin in 1908. While some companies like the GoodYear Tire & Rubber Co. no longer produce their own airships and instead focus on operating an airship fleet, others such as Zodiac have completely withdrawn from the airship industry to concentrate on other products. Additionally, numerous companies have appeared and disappeared over the years, including 21st Century Airship, a Canadian company that was the recipient of certification for its designs through Transport Canada.

The internet is brimming with airship concepts and designs, as well as the remnants of defunct companies. The objective here is not to enumerate all the companies but rather to highlight the currently active airship designers. In essence this is a small college comprising 14 distinct companies. These companies develop proprietary styles of aircraft for a variety of purposes ranging from passenger vehicles to heavy cargo transporters to sky cranes.

Airship Designers & Manufacturers (alphabetic order)

1. Aeros Airship Company - USA
2. Aerovehicles Airborne Solutions - USA
3. Airship do Brasil - Brazil
4. AT2 Aerospace - USA
5. Atlas LTA - Israel
6. Buoyant Aircraft Systems International - Canada
7. Cameron Balloons - United Kingdom
8. Flying Whales - France
9. Hybrid Air Vehicles - United Kingdom
10. LTA Research - USA
11. Millennium Airship - USA
12. Skyship Services Inc. - USA
13. Varialift - United Kingdom
14. Zeppelin GmbH - Germany

1.5.2 Leading Airship Developers

The present number of airship developers worldwide is approximately 14 active companies. These companies develop proprietary styles of aircraft for a variety of purposes ranging from passenger vehicles to heavy cargo transporters to sky cranes. Companies range from companies with advanced concepts to long pedigree companies like Zeppelin which have over a 100 years experience in the manufacturing and operation of airships. A catalog detailing these companies and their designs is included in Appendix 10.1.

The developers are mainly located in countries that have a significant history of airship operation, like the United States and Europe. Outside advertising, tourism and surveillance no commercial airship fleets are in operation. These airships have a maximum two metric tonne lift capacity. Although there are numerous airship designs and prototypes, most companies have struggled to obtain financing for civilian airships. Notable exceptions are Flying Whales in France and LTA Research in the United States. The Government of France invested €350 million in Flying Whales to develop a rigid airship for aerial logging that is designed to carry 60t. Other private investors have since joined the company and the Government of Quebec has invested $60 million to support a branch plant development in Montreal.

In the case of LTA Research, this is a private investment and they have not sought additional outside funding. They have acquired the giant Goodyear airdock in Akron, Ohio and the have a long-term lease on the former US Navy airship hangar at Mountain View, California. They expect to begin trial flights of the Pathfinder-1, in 2023. Their larger Pathfinder-3 airship is under construction at Akron.

Developers of cargo airships have designs that range from 10t to 100t and potentially beyond. Rigid airships of the early 20th century were able to carry cargoes up to 80t and cruise at 150 kmph. By the standards of the 21st century they had crude materials and only slide rules to estimate stresses and strengths for construction. Fabricators of modern airships can draw virtually everything that is needed from existing aviation supply chains and fly the airship in the computer before any material is cut.

Within Appendix 10.1 is a comprehensive directory of airship operators, complete with relevant contact information, a summary of their models and flights.

1.5.3 Leading Airship Operators

Airship developers and airship operators have distinctly different core competencies. Airship operators are organizations that maintain a fleet of airships to offer commercial freight or passenger services. They are the “airlines” that pilot the airships. Developers design, engineer and manufacture airships for the operators to fly.

Currently, only small blimps for tourism, advertising and surveillance operators (including geophysics) are in commercial use. In some cases, one operator does all three at once, like the Goodyear blimp at the Olympics that offers rides, carries cameras and communication relays, and advertises their tires. The largest number of aircraft belong to the Skyship Services Inc. (~10x), the Goodyear Tire and Rubber Company (5), Aerovehicles Airborne Solutions (~6), the Zeppelin Corporation (2) and Airship do Brasil (1). Not all of these airships are inflated and operational at the present time.

A number of potential operators stand ready to acquire and operate cargo airships, but they are not investing in their development. Several are awaiting the production of advanced blimp designs by Lockheed LMH-1 and the HAV Airlander to commence business operations. These airships are being designed to carry 10t to 20t. Market analysis by these companies indicates an economic case for cargo operations into remote and difficult to access regions of the world. The extensive geography and scant infrastructure in the Arctic Archipelago make it a compelling case for airships. These companies include;

1. Straightline Aviation - United Kingdom (https://www.straightlineaviation.com)
2. Hybrid Air Freighters (HAF) - France (www.hybridairfreighters.com)

3. Helion Aviation - Sweden (https://helionaerospace.com)
4. Flying Whales - France (www.flying-whales.com) (Manufacturer/Operator)
5. Aerovehicles - USA (www.aerovehicles.net) (Manufacturer/Operator)

2 CURRENT SITUATION

The economic disparity between northern Canada and southern Canada is longstanding. Despite efforts to improve the socio-economic conditions in the North, the gap remains wide, and some might say it is getting worse. For example, as new communications technologies have changed and advanced in the highly populated areas of Canada, the North has been left behind. Despite noble efforts to eliminate the need for boiling drinking water in the North, it remains prevalent in many communities. The population has the fastest growth rate in Canada but housing is overcrowded and inadequate to accommodate the existing population.

Adding to existing woes, climate change is occurring faster at the higher latitudes. Melting permafrost and warmer winter temperatures threaten to disrupt existing supply lines and damage infrastructure. This section considers the physical state of the North, and the impacts on transportation.

2.1 Arctic Archipelago Geography and Statistics

2.1.1 Demographics and remoteness

Northern Canada Is characterized by its harsh, remote environment, which can make it difficult for residents to access essential goods and services. This vast area is sparsely populated with most parts of this region lacking all-weather road or rail infrastructure. As a result, people in the North must rely upon seasonal winter roads, annual sealifts and air transport to receive the supplies they need throughout the year. Despite these challenges, Northern Canada has strong, vibrant communities with rich cultural heritage and close-knit community spirit.

According to the 2021 Canadian Census, the population of Northern Canada is approximately 123,000 people, with the majority of the population residing in the Yukon and the Northwest Territories. Nunavut is the least populated territory with a population of just over 38,000 people. The demographics of Northern Canada are diverse, with a mix of Indigenous and non-Indigenous populations living in both urban and rural areas. The Indigenous population includes Inuit, First Nations, and Métis peoples. Indigenous people make up a significant portion of the population in Northern Canada, with approximately 85% of the population in Nunavut being Indigenous.

The northern region faces many economic challenges including limited access to basic necessities such as food and medical services, high costs of living, and limited employment opportunities. The harsh climate also affects the delivery of essential goods. Winter roads and sea lifts are unreliable and uncertain in the wake of climate change. Efforts are being made to improve the quality of life for residents through initiatives such as the development of low carbon energy sources, the expansion of communication and transportation infrastructure, and the creation of new economic opportunities.

For the purposes of this study, only the more remote communities are being examined. The coastal communities can have sea lift or barge services in addition to small airplanes. Inland communities are dependent on winter roads for heavy freight and fuel supplies. The total population represented in this study is 123,054 (according to 2021 census data). This comprises a total of 129 communities across Northern Canada.

The Indigenous population is growing at twice the rate that is experienced in the rest of Canada. According to Statistics Canada, the Indigenous population in Canada increased by 42% between 2006 and 2016, compared to a growth rate of 5% for the non-Indigenous population during the same period. This significant increase is largely driven by a younger age structure, with a higher proportion of children and youth in the Indigenous population compared to the non-Indigenous population. Additionally, the Indigenous population is projected to continue growing at a faster rate than the non-Indigenous population in the coming years, making it a rapidly growing segment of the Canadian population.

The Government of Nunavut estimates that 10,000 young people will be coming of age in the territory during the next 10 years.[1] This represents almost a 25% increase in the territorial population which is currently 38,000. The additional amount of infrastructure required to support this growth means more housing, more schools, bigger health centres, more administrative offices and program spaces for more government staff to provide services.

No reliable estimates exist of the cargo tonnage each community receives per year. The City of Iqaluit alone receives approximately 150,000 lbs of cargo each week - mostly for their own requirements - but they also serve as a regional hub to smaller communities farther north. In conclusion, the rapid increase in population will require a significant amount of freight to provide housing and public buildings. The Government of Nunavut has announced its commitment to build 3,000 new houses. In addition, the increased population will require additional consumables from food to household goods and vehicles.

2.1.2 Temperature ranges and weather

The Canadian North encompasses most of the Boreal forest and land north of the tree line. This region is known for its harsh and unforgiving winter conditions. The extreme weather in northern remote Canada includes prolonged cold temperatures, heavy snowfall, and strong winds. The summer heat brings hoards of insects and an active layer of permafrost that makes overland travel impossible.

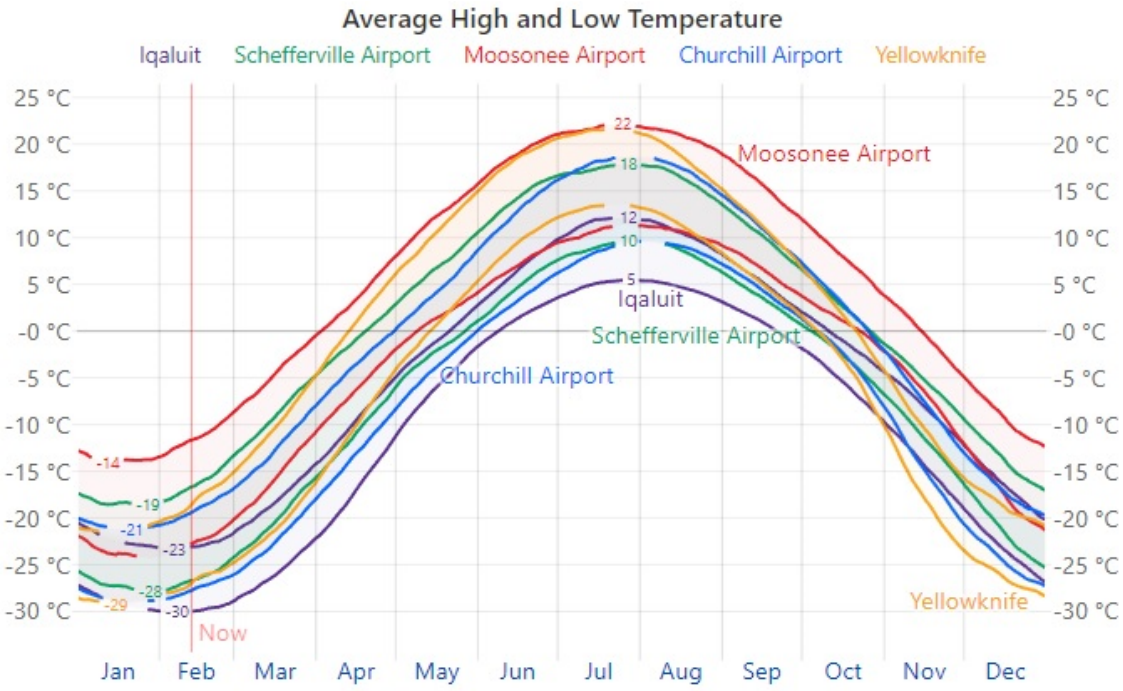
Extreme weather in northern remote Canada has an impact on infrastructure and transportation systems. Strong winds, snowdrifts, and ice can make it difficult to move goods and people from one place to another. This can be particularly problematic for remote communities that rely on air and ground transportation to access essential supplies and medical care. Additionally, cold temperatures can cause equipment to freeze and fail that result in costly repairs and prolonged downtime. The extreme weather conditions pose a significant challenge to the delivery of essential services, the economy, and the quality of life for those who live in the region.

Climate change is causing a significant warming trend in the North that is affecting the region's ecosystems and communities. The average temperature in the Canadian Arctic has increased by 2C to 1C over the past few decades, which is significantly higher than the global average (about 1.1C to 1.3C above pre-industrial levels). This warming trend is having a range of impacts, including:

- Melting of sea ice: The reduction in sea ice cover is causing significant changes to the Arctic marine environment and the species that depend on it, such as polar bears, seals, and walruses.
- Thawing of permafrost: The active layer of permafrost, which is the depth that melts each summer, is becoming deeper. This is causing the ground to become unstable, leading to increased erosion and slope failures. Melting permafrost is also releasing carbon dioxide and methane into the atmosphere. These are potent greenhouse gases that could potentially create a feedback loop accelerating climate change.
- Changes in vegetation: The warming trend is causing changes in the distribution and abundance of plant species that can have cascading effects on the entire ecosystem.
- Impacts on indigenous communities: Climate change is having a significant impact on indigenous communities in the Canadian North, who rely on hunting and fishing to sustain themselves. Changes to the Arctic environment can make it more difficult to access traditional food sources and threaten their cultural heritage.

[1] https://www.cbc.ca/documentaries/specials/10-000-young-people-in-nunavut-will-come-of-age-in-the-next-decade-what-does-their-future-look-like-1.6401095

Figure 2-1 Annual Temperature Ranges for Primary Airship Gateways



The daily average high and low air temperature at 2 metres above the ground.

The average extreme temperatures at the primary gateway locations are not quite as cold as would be encountered farther north, but the airships would have to be able to load and unload in such conditions.

Table 2-1 Numeric Temperature Averages for Primary Gateway Locations

High	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iqaluit	-22 °C	-23 °C	-18 °C	-9 °C	-1 °C	7 °C	12 °C	10 °C	5 °C	-1 °C	-8 °C	-17 °C
Schefferville Airport	-18 °C	-16 °C	-9 °C	-1 °C	7 °C	14 °C	17 °C	16 °C	10 °C	2 °C	-5 °C	-14 °C
Moosonee Airport	-14 °C	-11 °C	-4 °C	4 °C	12 °C	19 °C	22 °C	21 °C	15 °C	8 °C	-1 °C	-9 °C
Churchill Airport	-21 °C	-19 °C	-12 °C	-3 °C	5 °C	13 °C	18 °C	17 °C	11 °C	2 °C	-8 °C	-17 °C
Yellowknife	-21 °C	-18 °C	-10 °C	1 °C	11 °C	18 °C	21 °C	18 °C	11 °C	1 °C	-11 °C	-19 °C

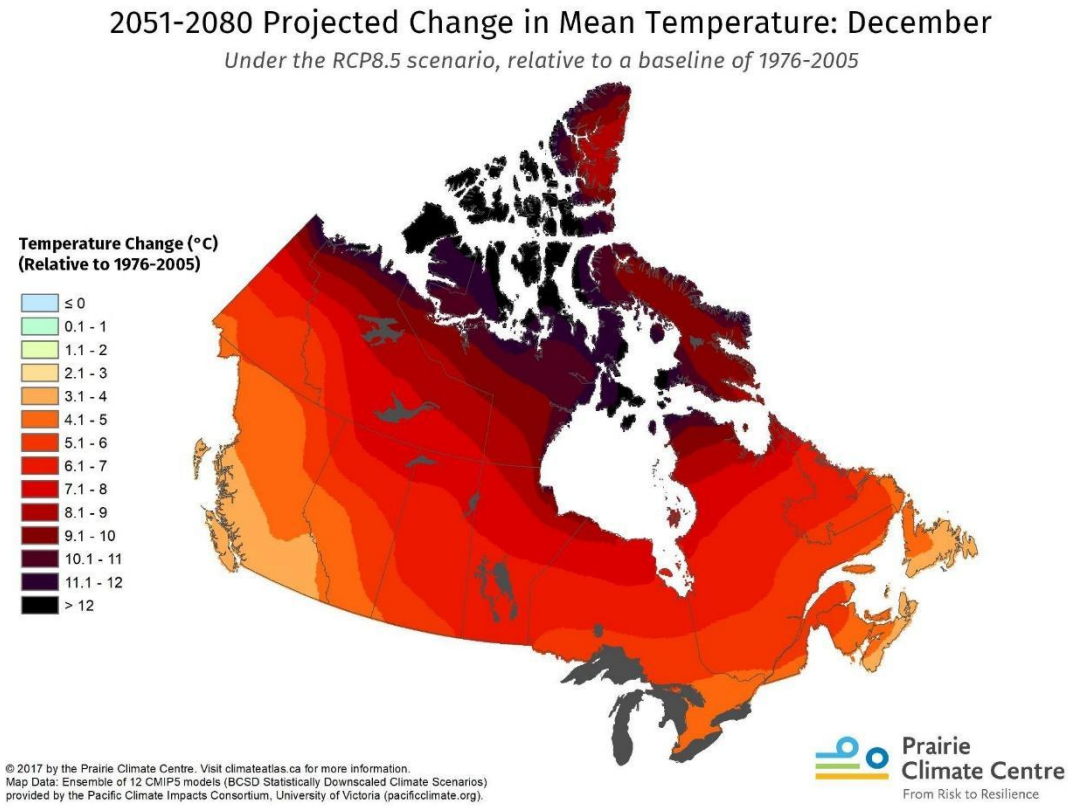
Low	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Iqaluit	-29 °C	-30 °C	-26 °C	-17 °C	-6 °C	1 °C	5 °C	4 °C	1 °C	-6 °C	-15 °C	-24 °C
Schefferville Airport	-27 °C	-26 °C	-20 °C	-11 °C	-2 °C	5 °C	9 °C	8 °C	3 °C	-3 °C	-12 °C	-22 °C
Moosonee Airport	-24 °C	-22 °C	-15 °C	-6 °C	1 °C	7 °C	11 °C	10 °C	6 °C	1 °C	-7 °C	-18 °C
Churchill Airport	-29 °C	-27 °C	-22 °C	-13 °C	-4 °C	3 °C	8 °C	9 °C	4 °C	-3 °C	-15 °C	-25 °C
Yellowknife	-29 °C	-27 °C	-21 °C	-10 °C	1 °C	9 °C	13 °C	11 °C	5 °C	-4 °C	-18 °C	-26 °C

Source: https://weatherspark.com/

Average weather and ranges for study zones listed in Figure 2-1 and Table 2-1. All locations follow a similar pattern, with the cold extremes greater at higher latitudes. The data are presented as averages. The airships would have to be able to function at temperatures that are at least -50C to +35C.

Changing weather conditions raise a plethora of concerns. As illustrated in Figure 2-2 the temperatures are expected to increase significantly more at the higher latitudes. The active layer of the permafrost is already increasing and the useful season of the winter roads is becoming shorter. The areas most impacted are also the places currently that have the least infrastructure to support the changing climate. Within the next 20 years mean temperatures in these Northern regions will rise to the point where supplying remote communities using winter roads may no longer be feasible. As the permafrost layer becomes more active existing roads are failing and even some runways are having problems.

Figure 2-2 Projected Temperature Changes in Canada, 2052-2080



Source: https://i0.wp.com/prairieclimatecentre.ca/wp-content/uploads/2017/10/2051-2080-RCP85-Mean-Temp-Delta-December.jpg?ssl=1

2.1.3 Logistical challenges and shipping season

Sealift and barges are used to supply remote northern communities on the coast, and along the Mackenzie River. Marine transport is used to carry heavy bulky objects, building materials, fuel, vehicles, machinery and non-perishable food to the coastal communities. The only year-round transport is by small airplanes using gravel runways. The exceptions are a handful of communities that have paved runways and can use larger jet planes. These are usually in passenger-freight combinations[2].

[2] Yellowknife, Iqaluit, Rankin Inlet, Whitehorse.

Remote communities that are inaccessible by sea, depend on winter roads to transport heavy bulky objects, building materials, fuel, vehicles, machinery and non-perishable food. These temporary roads offer an overland connection to the all-season road network, which links to their supply chains in the cities. During the winter months, these roads are crucial for transporting freight, but also passengers. The winter roads are used to travel between communities and to the cities to obtain services and goods that are unavailable.

2.1.3.1 Winter Road Trucking - Season: January - March

The trucks over winter roads are cost-effective to transport goods and services to the remote communities. Manitoba builds approximately 2,400 km of winter roads each year and in 2023 the estimated cost is $18 million. Winter roads also support the exploration, development and extraction of natural resources. The Tibbitt-Contwoyto Winter Road (TCWR) in the Northwest Territories is a private consortium-owned facility that is used to supply diamond mines. It connects to the all-season road and air networks. It is necessary for the winter road season to have enough capacity to meet the needs of the mines it serves. In years when there are shortfalls, airlift is used, but at a much higher cost.

The future viability of winter roads is a concern. Milder temperatures are a growing challenge for freight logistics, personal trip planning and the cost of constructing, monitoring, and maintaining the winter roads. Climate change is affecting the length of the season and the quality of the ice for transporting goods and ensuring travel safety. The speed restrictions, greater separation of trucks, and load limits increase freight transport costs.

Climate model research on the winter roads by Woolway, et al[3] has a cautionary message. As climate change continues, ice roads will not be safe for tractor-trailers. Trucks require at least a meter of ice. The Woolway study predicts that trucking across the lakes will be reduced by 90 percent when the warming reaches 1.5°C. Canada is currently between 1°C and 1.3°C of warming. The impacts will vary with latitude and other conditions. But Ice roads will likely be uneconomic to build long before global temperature increases by 2°C.

Another similar study by Barrette, Hori and Kim[4] examine the impact of climate change on season lengths and ice thickness. The literature shows that the winter roads have already lost half their season and the pace is accelerating. An excerpt from this analysis is presented in Appendix 9.1.

Uncertainty about the future of the winter roads is driving investment by territorial and federal governments in all-season gravel roads to replace winter roads, such as the 100-km long Inuvik-Tuktoyaktuk Highway. A similar road network was started on the East Side of Lake Winnipeg in Manitoba, but abandoned because of cost when the government changed. In both cases, the cost of these gravel roads averaged $3 million/km. Notwithstanding great care taken to avoid problems with permafrost, the Inuvik-Tuktoyaktuk Highway has required extensive annual maintenance

2.1.3.2 Sealift - Season: June - October

The shipment of goods via sea lift and barges occurs during the summer months, when the waters are navigable. The type of vessels used in sea lift transportation depends on the size of the cargo and the port facilities available. Oil is generally delivered in tankers, while general freight is moved in break-bulk ships. The break-bulk ships operate out of Montreal to the eastern Arctic and locations in Hudson Bay. Barges have also operated out of Churchill to Hudson Bay, but this service is now suspended. The Mackenzie barges operate out of Hay River, NWT, and serve some communities in the western Arctic.

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[3] Woolway,R. Iestyn, Lei Huang, Sapna Sharma, Sun-Seon Lee, Keith B. Rodgers, Axel Timmermann (2022). “Lake Ice Will Be Less Safe for Recreation and Transportation Under Future Warming.” Earth’s Future. Volume10, Issue10, October 2022 https://doi.org/10.1029/2022EF002907

[4] Barrette, P., Y. Hori, Amy M. Kim. (2022) “The Canadian winter road infrastructure in a warming climate: Toward resiliency assessment and resource prioritization.” Sustainable and Resilient Infrastructure. Vol.7: 842-860.

Some communities like Kuujjuaq and Iqaluit can receive three ships per season, but most are restricted to two voyages and a number of remote communities receive only one sealift per year.[5] In addition to supplying remote communities, sealift is also critical for supporting natural resource exploration and development in northern regions. The shipment of heavy equipment and supplies required for resource extraction is often performed via sealift.

The sea lift is not without challenges. The coastal regions of northern Canada are prone to severe weather conditions, which can disrupt sealift operations. Additionally, the lack of port infrastructure makes sealift unloading a challenge. A port infrastructure is being built at Iqaluit and expected to open in 2023. This should reduce the time and cost of unloading freight.

2.1.3.3 Airplanes - Year-round

Air transportation is vital for serving the North and is generally available year-round. It is the only alternative to winter roads or sealift for remote communities in Canada. Airplanes are used for passenger travel, such as necessary medical and other travel, and limited freight transport of perishable goods. Examples of freight carried by airplanes are smaller items, groceries, perishable food, medical supplies, passengers, and when necessary some building materials and fuel. Information on the specifics of these deliveries is limited because they are private companies and often too few to ensure confidentiality.

Air transportation plays a crucial role in ensuring that essential goods and services are available to remote communities when winter roads are not operational, or when the winter roads' capacity is insufficient. In such cases, airlift is used to supply the remote communities, although at a high cost.

2.2 Dirigibles then, Electric Airships now

Steerable balloons, called dirigibles by the French and airships by the English, were a revolutionary form of transportation in the early 20th century. These large, hydrogen gas-filled balloons could achieve buoyancy and then be pushed through the air with the help of propellers. Dirigibles/airships were used for a variety of purposes, including commercial and military transport. They were made obsolete for passenger carriage by jet airliners and low oil prices.

In the 21st century, carbon emission targets will make some jet services obsolete. In particular, for the carriage of freight. Modern airships, electrically- powered by fuel cells with onboard batteries, have no carbon emissions. They also have less than half the cost and can travel much longer distances.

Airships achieve constant lift through gas filled balloons. They can be assisted in takeoff and landing through directionally adjustable electric fans, but the lift is basically free once the airship is inflated. Adjustable fans make modern airships more maneuverable and efficient than their predecessors. Only a few ground crew are needed to land, service and handle cargo transhipment.

The first generation of airships proved that the technology works. The difference for modern electric airships is 83 years of technological advances in aviation methods, fast computers, and materials for construction. Airship builders in the 1920s were using slide rulers to calculate stresses, and cow intestines to make gas cells. Modern airship builders have the benefit of advanced computer modeling and a host of strong lightweight synthetic materials to work with.

The costs of operating a modern airship will be much lower. The old airships had heavy, inefficient engines that made them slower and more expensive to operate. Airships will initially employ traditional APU technology using liquid jet fuel to provide power to the electric motors. As fuel cell technology reaches scalable levels, retrofitting to zero emissions is possible. Traditional airships also had 28 to 35 flight crew members to operate systems that would now be done by a computer and electric actuators.

[5] Desgagnés Transarctik inc., Nunavut Sealink and Supply Inc. and Taqramut Transport Inc.https://arcticsealift.com/en/schedule.php

Electric airships will be operated by two or three crew members, and eventually remotely-operated from ground stations making them lighter, and more cost-effective.

The ability to maneuver the airship at slow speeds is a major advance. Modern electric airships use vectoring fans to adjust their thrust and lift. Fans can also be placed in the nose and/or tail to turn and maneuver with greater agility.

Dirigible airships of the past made important technological advances and lighter-than-air technology can work much better now. The next sections delve deeper into the science and technology that is now available to build an efficient, cost-effective, and maneuverable cargo airship.

2.2.1 Carbon Fiber and new materials

Carbon fiber and other new materials have the potential to revolutionize the design and construction of modern cargo airships. Carbon fiber has a high strength-to-weight ratio that makes it an ideal for airship construction. This material is light and has excellent resistance to fatigue and corrosion. Carbon fiber and aluminum alloys are readily available for the construction of modern cargo airships. Designers can significantly reduce the weight of a rigid airship structure, thereby improving its fuel efficiency and cargo capacity by more than 30 percent.

Carbon fiber is highly flexible, making it ideal for use in airships that need to withstand changes in temperature and pressure. Carbon fiber airships can also be designed with more complex shapes, providing additional space for cargo and other essential equipment, and allowing for greater control over the airship's movement.

The integration of new materials into airship construction improves safety and reliability. Designers can create airships that are durable, and capable of handling the demands of modern cargo transportation. The use of these materials in airship construction is a key to the development of a more sustainable, efficient, and environmentally friendly air transportation system in the future.

In addition to carbon fiber, other new and advanced materials are also being researched and considered for use in modern cargo airships. One such material is aramid fibers, which are known for their high strength and durability. They have been used in military and aerospace applications for decades and have proven to be very effective in providing lightweight yet strong structural support. Aramid fibers are made from a group of synthetic polyamides that are thermally stable, flexible, and resistant to abrasion and cut. These characteristics make them ideal for use in airships, where weight is critical and the structures must be able to withstand harsh weather conditions.

Another material being considered for use in modern cargo airships is a family of high-performance thermoplastics known as thermoplastic composites. These materials offer a unique combination of high strength, low weight, and good resistance to impact, abrasion, and moisture. They are also easy to process, which makes them attractive for use in airship design and construction. Additionally, these materials can be easily molded and shaped into complex parts, which is essential for airships where aerodynamics and structure must be carefully considered. The use of thermoplastic composites has been increasing in the aerospace industry, and they are becoming an increasingly popular choice for the construction of modern cargo airships.

2.2.2 Vectoring Thrust

Vectoring thrust refers to the ability of an aircraft's propellers to be directed in different directions to provide additional control during flight, takeoff and landing. Computerized control (avionics) makes it easier for the pilot to maneuver the aircraft and control its movements, especially in situations of turbulence.

Advanced avionics is widely used in military aircraft, where precise control allows for high-speed and high-altitude aerial maneuvers. The technology has been integrated into some commercial aircraft as

well, which provides advantages in short takeoff and landing capabilities, improved fuel efficiency, and reduced noise levels. Precise control that directs the engine's thrust reduces the need for wing flaps, ailerons, and elevators, which results in lower weight, less drag, and improved fuel efficiency.

Vectoring thrust has the potential to revolutionize airships. These large aircraft have traditionally relied on directional control through the manipulation of ballast and/or rudders. Vectoring thrust allows airships to have a more precise and controlled movement, increasing their maneuverability and stability. This would make airships more suitable for a wider range of applications, such as aerial surveying, remote sensing, and cargo transportation. The use of vectoring thrust in airships could also include propellers in the nose and tail to increase responsiveness.

2.2.3 Hydrogen fuel Cells and electric drives

Hydrogen gas has the potential to be a clean, renewable, and efficient energy source for a variety of applications, including transportation. The electrolysis of water from renewable energy sources, such as wind and solar power, can be used to create hydrogen gas. Fuel cells work by passing hydrogen through a membrane, which separates the positive and negative charges in the hydrogen molecules. The positive hydrogen ions are drawn to the negative electrode, while electrons are forced to travel through an external circuit, generating an electrical current. The hydrogen ions then react with oxygen at the positive electrode to form water, completing the circuit. The reaction between hydrogen and oxygen is exothermic, releasing heat as a byproduct.

Unlike internal combustion engines, fuel cells do not burn carbon fuel, so they produce no air pollution and are more energy efficient. The use of hydrogen fuel cells is not without its challenges. Hydrogen must be stored and transported, which can be difficult. Large pressurized tanks require space that is not readily available on trucks or airplanes. This is not a problem for airships because they are so large that hydrogen fuel tanks can easily be stored without impinging on cargo or passenger space.

The use of hydrogen fuel cells in airships has the potential to greatly improve their sustainability and efficiency. Electric motors are being specified for modern cargo airships because they offer lower maintenance, are easier to rotate for vectored thrust and work well in extreme heat or cold. Many airship designs are also incorporating solar collectors on their large surface area that can be used to provide emergency power to the motors, if needed.

Cargo airships powered by electric motors offer several key benefits, including increased operational efficiency and lower operational costs. TElectric motors are lighter than their internal combustion counterparts, which is important for lighter than air vehicles that must account for every ounce.

A promising aspect of electric motors for use in cargo airships is their scalability. Unlike traditional engines, electric motors can be easily scaled to accommodate different airship designs, power requirements, and operating conditions. This means that cargo airships equipped with electric motors can be easily optimized for specific missions, and can be adapted to meet changing requirements over time.

2.2.4 Drone technology

Drone technology typically refers to unmanned aerial vehicles (UAVs) that are controlled remotely or autonomously. Drones come in a variety of shapes and sizes, ranging from small, consumer-grade models to large, industrial-grade systems. They can be powered by batteries, gasoline, or other energy sources. Most multirotor drones are equipped with only sensors, cameras, and other lightweight equipment because they have limited lift capabilities to move packages. Fixed-wing drones have been used by the military and can carry larger loads, but cannot deliver cargo to hard-to-reach locations.

The use of drones in the transportation industry has the potential to revolutionize the way goods are delivered and to increase efficiency and reduce costs. For example, in the case of cargo airships, drones

could be used to make the process of loading, unloading, and transporting goods more efficient and cost-effective.

Amazon has patented a design to use drones to deliver packages from a hovering cargo airship. Multirotor drones equipped would be used to transport goods to the ground then return to the cargo airship. This could reduce the need for labor, delivery trucks, and improve the speed and efficiency of delivery. This far no attempt has been made to demonstrate the utility of this patent.

Another potential use of drones in the cargo airship industry would be for inspection and maintenance. Drones equipped with cameras and other sensors could be used to inspect the exterior and interior of the cargo airship, helping to identify any issues or potential problems before they become serious. This could reduce downtime and increase the safety and reliability of the airship, leading to increased efficiency and reduced costs.

Drone technology could also be applied to the airship to fly autonomously, or be remotely controlled, making them ideal for a wide range of applications, including cargo transportation. For surveillance, a drone airship could stay aloft for extended periods of time without the need to rest crews or deal with human comforts. Drone airships for cargo transportation have the potential to revolutionize the industry. They would be especially valuable for long-distance flights where multiple crews might be needed. Also, drone airships could obtain significant weight reductions by replacing human pilots and their associated space. These weight-savings would go directly into greater cargo lift and profitability.

In terms of efficiency, drone airships can potentially operate around the clock, with minimal downtime for refueling or maintenance. This could greatly increase the speed and efficiency of cargo transportation, and reduce costs for both shippers and carriers.

Despite the potential benefits, drone airships would face some regulatory challenges, both nationally and internationally. Appropriate regulations and standards are necessary to develop and implement drone airships for cargo transportation. Undoubtedly, cargo airships will begin with human pilots, but the ability to develop reliable and safe drone technology is just a matter of investment in research and development. The building blocks of the technology already exist.

2.2.5 Advanced Satellite Weather Monitoring

Airships are weather-sensitive due to their large size, low weight, and reliance on buoyancy. Factors such as wind, thunderstorms, turbulence, temperature, pressure, precipitation, and limited maneuverability affect their operation. Strong winds cause drag, while thunderstorms and turbulence pose stability risks. Temperature and pressure changes impact buoyancy. Precipitation adds weight but does not affect the aerodynamics. Airships require careful weather monitoring and may need to adjust or postpone operations to ensure safety and performance. Advanced satellite weather monitoring Satellites can provide real-time and high-resolution weather data, enabling more accurate and timely weather forecasts. This enhanced monitoring will help airship operators make informed decisions about flight routes, timing, and potential weather hazards.

2.2.6 Lifting Gas

The buoyancy of an airship may seem almost magical, but is just ordinary physics. Everyone is familiar with boats that float (are buoyant) because their average density is less than the water they displace. It is more difficult to observe the buoyancy of airships because air is invisible, but the principle is identical. By filling the airship with a gas that is lighter than the air, the average density of the airship is less than the air it displaces, and consequently it floats. The weight that the airship and its cargo can lift is exactly equal to the weight of the air that it has displaced.

The lighter the gas used to fill the airship, the more that the airship can lift. Many gases can be used, including air, if it is heated to reduce its density. However, the two lightest gases, helium and hydrogen are the most efficient.

2.2.6.1 Helium

Helium (He) is a light, colorless, odorless, non-toxic, and inert gas, ranking as the second lightest element in the periodic table. While abundant in the universe, it is relatively scarce on Earth. Helium is present in small amounts in the Earth's atmosphere but extracting it is uneconomical. It is formed in the Earth through the radioactive decay of elements like uranium and thorium and is often found with natural gas or in non-petroleum underground gas deposits. Helium production, known as helium mining, is viable only when sufficient concentrations are present. Once purified, helium is stored in tanks or cylinders in gaseous or liquid form. Converting helium to a liquid state requires significant energy and refrigeration to maintain this state, but for long-distance transport it is generally necessary.

Helium has a wide range of uses in research, manufacturing and medical applications for which substitutes are inferior. High-value uses of helium include the manufacture of semiconductors, cryogenics, quantum computing, cooling for superconducting magnets in MRI machines, welding, leak detection in high pressure systems and for deep sea diving to prevent decompression sickness. Helium is commonly used as a lifting gas for consumer party balloons and is also the current lifting gas of the airship industry due to its inherent stability.

The first US airship to utilize helium as a lifting gas was the USS Shenandoah (ZR-1), a rigid airship that first flew in 1923. At the time, the US was the only country that could produce helium from its rich gas fields. Subsequently, rigid US airships like the USS Los Angeles (ZR-3), the USS Akron (ZRS-4), and the USS Macon (ZRS-5) were filled with helium as the lifting gas. At the time the element was considered highly strategic and the US Government established a National Helium Reserve in Amarillo Texas with a capacity of 35 billion cubic feet of Helium for the purpose of supplying airships. This reserve was phased out commencing 2005 and the final public sale was September 2022.

The “Canadian Critical Minerals Strategy”, which was released in 2022, lists helium as one of Canada’s 31 critical minerals. Statistics Canada however does not collect information on helium production in Canada. NRCAN however has recognized this gap and is planning to ensure the data is collected and published.

The sedimentary basin in southeast Saskatchewan is the centre of Canada’s helium Industry. Helium has been produced from this basin since the 1960’s and is the subject of significant investment by publicly traded helium exploration and production companies. In 2021 one such company North American Helium opened a $32 million dollar Helium Purification facility near Battle Creek, Saskatchewan. In November 2021, the Government of Saskatchean released the “Helium Action Plan: From Exploration to Export” with the explicit goal of securing 10% of the global Helium market by 2023. The government of Sasksatchewan maintains helium production statistics and has an established helium regulatory regime.

Bulk helium can be purchased from industrial gas companies Praxair, Air Liquide or directly from helium miner North American Helium. Helium prices are not disclosed outside of a sales contract and no commodity exchange exists for helium so daily spot prices cannot be obtained. Generally however the cost of helium in bulk quantities is significantly more expensive than similar volumes of hydrogen.

2.2.6.2 Hydrogen

Hydrogen (H2) is the lightest element (atomic number 1) and abundant in the universe. It exists in trace amounts in the Earth's atmosphere (<0.0001%). Hydrogen is found in compound molecules like water and methane. In its pure form, it is colorless, odorless, non-toxic, and burns without harmful byproducts, making it a promising fossil fuel alternative.

Hydrogen is extracted from water using a method called electrolysis and from methane using a process called steam methane reforming. Both methods require significant energy input to split the hydrogen from its respective molecular partner. The products of electrolysis are H2 and O2 whilst the products of steam methane reforming are H2 and CO2. The vast majority of the world's hydrogen is obtained through steam methane reforming. Other methods of hydrogen extraction have been designed, but are not producing hydrogen commercially. Once hydrogen is split from its compound molecule, it can be stored in tanks or cylinders as a liquid or a gas.

Hydrogen has a wide range of applications in metallurgy, fertilizer production, rocket fuel, food processing (hydrogenated oil) and as fuel for hydrogen fuel cell vehicles. As the need to reduce carbon emissions increases, hydrogen fuel cells are being used in cars, trucks, trains, and eventually in airplanes and airships.

The density of hydrogen gas is 0.089 kg/m3 which is much lighter than dry air which is about 1.2 kg/m3. Consequently, replacing a cubic meter of air with a cubic meter of H2 yields approximately 1kg of lift. A hydrogen filled airship would have 8% more gross lift than the same airship filled with helium which weighs 0.1785 kg/m3.

Hydrogen was the exclusive lifting gas utilized by airships for 71 years, from thes first airship flight in 1852 until the maiden voyage of the helium filled USS Shenandoah (ZR-1) in 1923. During WW1 the Zeppelin LZ class bombers, a type of rigid airship, were buoyed by hydrogen and sent on bombing raids across the English Channel. The rigid type Graf Zeppelin (LZ127), the most successful airship of all time, operated without incident from 1927 to its natural retirement in 1938.

The rigid airship Hindenburg was a rigid airship built by the Zeppelin Company and operated from 1936 to 1937. The airship was primarily used for intercontinental passenger transportation between Germany and the United states. As with other Zeppelins of the time H2 was utilized as a lifting gas. On May 6th, 1937 the Hindenberg arrived in Lakehurst New Jersey and attempted to dock to a mooring mast. The airship suddenly caught fire and was engulfed in flames. The cause of the fire is still debated, but it appears that the highly flammable paint used on the envelope exterior was the failure point, while static electricity created the ignition. The entire incident was spectacular and reached legendary proportions as the slow fiery descent was caught on film

Since the Hindenburg incident hydrogen was banned by the United States Federal Aviation Authority (FAA) and helium became the default gas for airships. The FAA regulations became copied around the world including in Canada where section 541.7 of the Canadian Aviation Regulations states "Hydrogen is not an acceptable lifting gas for use in airships". The ban on hydrogen in airships has been terminated in Europe where EASA (European Aviation Safety Agency) has new regulations that permit hydrogen-filled airships, providing the developer meets their safety requirements.[6]

H2 will only ignite, if the concentration in air is between 4% and 75%. An airship would never use less than 99% pure hydrogen, so the gas cells are not at risk, except from an external fire. Hydrogen leaks can be dangerous if the area is unventilated, but the flammability is often exaggerated. As a comparison, gasoline fumes will ignite with a 1% concentration in air, while hydrogen must reach a 4% concentration. This is more difficult than it appears. Gasoline fumes are heavier than air and sink to the ground when released, hydrogen goes straight up. Hydrogen is safe to handle when appropriate precautions are taken, and unlike the 1930s, inexpensive "hydrogen sniffers" are available that can detect parts per million. Any leaks can be quickly removed with ventilation. There is a need to re-explore the utility of hydrogen as a lifting gas in terms of the new hydrogen economy.

In December 2020, a "Hydrogen Strategy for Canada" was released. The strategy sets out a "framework for actions that will cement hydrogen as a tool to achieve net zero emissions by 2050". There is abundant

[6] The complete set of EASA regulatory requirements for large, gas-filled airships is available at: EASA, (2022) *CRI Consultation paper / Special Condition SC GAS*. https://www.easa.europa.eu/downloads/134946/en

hydrogen gas production in Canada to meet the needs of an airship industry. Other jurisdictions within Canada including British Columbia, Alberta, Ontario and Quebec have likewise released their own hydrogen strategies. As with Helium, bulk hydrogen can be purchased from industrial gas companies Praxair and Air Liquide. Hydrogen gas prices are not disclosed outside of a sales contract and no commodity exchange exists for hydrogen. Generally however the cost of bulk hydrogen is significantly less than Helium.

2.3 Airship Designs and Market Segments

Transportation has many sub-markets that depend on the requirements of the freight to be moved. Specialized vehicles are needed to move over-dimensional, and overweight, indivisible freight. For example, the length of a wind turbine blade means that customized trucks are needed to navigate the constraints of the highway system. Some goods are delicate or perishable and require higher speed, gentle handling and often temperature-controlled vehicles. Liquids, which are often dangerous goods, require tanks or bladders to be fitted to the vehicle. Finally, a miscellaneous category called “general freight” exists. Most of this freight is packaged goods or items that fit within a standard truck box. This is the largest category of freight, and also the segment with the most competition.

As a service, transportation sizes itself to accommodate market demand to obtain profitable utilization of its equipment. Different airship designs are better suited to some corridor markets than others. With this in mind, a brief survey of general airship proposals is considered with respect to the needs and issues of the markets they might serve. Some airships may be able to address more than one of the markets described.

2.3.1 Short-Haul and Long-Haul General Freight Markets

General freight markets are characterized by palletized loads, but do include some awkward freight pieces. The ability of an airship to handle slung-loads expands their market reach to include some oversized/overweight cargo. Similarly, a general freight airship would likely make provision for climate-controlled cargo space to be able to broaden its market.

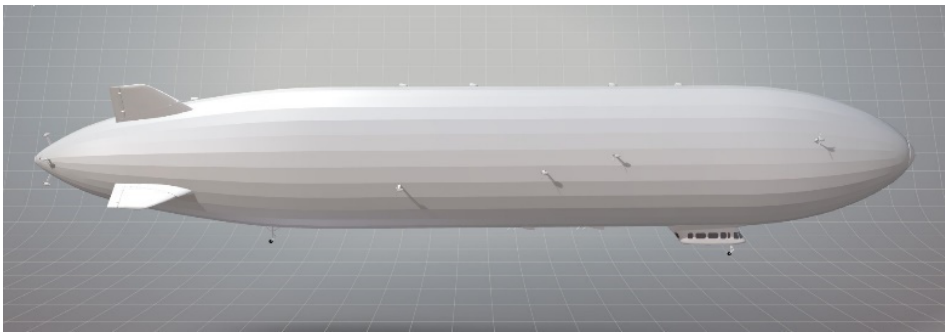
General freight shippers are more likely to try to minimize inventories, and obtain some level of Just-in-time supply chain service. Reliability is valued more by supply chains that operate on continuous re-supply (Neal and Koo)[7]. All-weather capability, especially operations with high winds and precipitation is important. Finally, competitive freight rates matter more in the general freight markets. High utilization rates and backhaul loads help keep costs in line.

Economies of distance and vehicle size are important in corridor markets. Airships need a streamlined design to minimize fuel use while maintaining a relatively high cruising speed. The longer the average trip distance, the more important vehicle size becomes. Size is critical because fewer cycles can be performed in a year. For example, a 30-ton lift cargo airship could easily cross the Pacific Ocean, but it would likely be as expensive as a cargo jet that can complete five cycles for every one that the airship completes. Smaller airships are constrained to short-haul markets. The longer the distance to be traveled, the larger the airship needs to be.

Figure 2-3 presents an example of a rigid, cigar-shaped airship, proposed by LTA Research, that would be well-suited to general freight markets. They are streamlined to minimize drag, and the rigid structure allows cargo weight to be distributed. These airships can be constructed to lift over 100 metric tons, based on the records set by the Zeppelins in the 1930s.

[7] Neal, Craig and Tay T.R.Koo. (2020) “Demand for cargo airships: An analysis of mode choice decision making in the freight transport industry.” Journal of Air Transport Management. Volume 83, March 2020. https://doi.org/10.1016/j.jairtraman.2019.101741

Figure 2-3 Rigid, Cigar-shaped Airship Design



Rapid and safe ground-handling systems are necessary in order to obtain high rates of utilization. The airship must be allowed to weathervane, while keeping the ground-handling personnel safe.

2.3.2 Project freight and Aerial-craning

Project freight markets are characterized by large, indivisible pieces that may be very heavy or awkward to transport overland. Often this freight is moved as far as possible by water, where the shipper can take advantage of the large size of ships and barges. Overland moves are generally done by rail, or by specialized trucks that may be articulated to navigate the road system. In many cases, bridges, tunnels and power lines create barriers. They may be surmounted by temporary strengthening or removal, but these are expensive actions.

The greatest difficulty often occurs during the “last mile” and craning the equipment into place. Getting a large, often delicate, piece of equipment from the factory to its installation is expensive and risks damage. Once it is close, the freight now needs to be put into position with a crane. Lifting large loads demands bigger cranes that cost more to rent and transport.

The ideal circumstance in project freight would be to have a heavy lift aircraft that could transport the over-sized freight, hover and place the equipment directly into position. Several airship companies share this vision. Figure 2-4 illustrates Aerovehicles design for project freight and craning.

Figure 2-4 Project Freight and Crane Delivery

In the past some companies have proposed lenticular disk-shaped airships. They would likely have good hovering capabilities for precision off-loading because they do not turn when the wind changes. The

range of these airships may be short because they are slow moving and lack streamlining for movement along a vector.

Whether or not these designs also intend to serve as aerial cranes is uncertain, but they would be able to carry project freight considerable distances.

For these missions, the airships would have to deal with the buoyancy change after dropping off their loads. Information on ballasting is unavailable, as are many details on landing, mooring and re-fueling.

2.3.3 Resource Extraction

As the world economy has grown, most of the easily accessible natural resources have already been explored, and many are economically exhausted at current prices. In the case of mining, the three remaining options are to dig deeper into the earth where existing minerals are known, open new deposits that are closer to the surface, but are located in harder-to-reach areas or to mine smaller traditionally uneconomic deposits with new modular mobile technologies.

Mountainous terrain, swamps, tundra or locations without nearby infrastructure often present barriers to access. Depending upon the location, mining roads are expensive to build, require long lead-times to obtain permits and environmental approvals. Roads are only economically viable, if the life of the mineral deposit is sufficient to offset their construction and maintenance costs. As suggested by Prentice, et al. (2013), cargo airships could likely compete against mining roads in Northern Canada over 100 km long, and especially if the mineral deposits were not expected to last more than 20 years[8]. The mining industry is showing increasing interest in the use of cargo airships, but have not yet invested in their development.

Forestry projects face similar issues. Although the resource is renewable, it does not pay to build quality access roads to extract the logs only once every 20 years, or more. Logging roads do not have to be built to the same standards as mining roads, but the authorities are more adamant that the footprint of these roads must revert back to their natural state after project completion. In many places, building any roads is prohibited. In areas with parks, First Nations reserves and wetlands, logging roads need to take circuitous routes that add to costs.[9] FLYING WHALES proposes a traditionally-shaped rigid airship, as illustrated in Figure 2-5, that is configured with many thrusters to hold the airship steady for unloading.

[8] Prentice, Barry E., Nirbir Grewal, Bryce Doell and Matt Adaman “Cargo Airships Versus All-Weather Roads - A Cost Comparison.” *Canadian Transportation Research Forum*. Proceedings Issue: 48th Annual Meeting (2013): 89-104. ISBN 978-0-9867070-4-9

[9] Prentice, Barry E. and Alena L. Wychreschuk. “Forestry Transport: Requirements, Current Practices and Opportunities for more Sustainable Harvesting.” The 58th CASI Aeronautics Conference -- AERO 2011, Montreal, Quebec, April 26, 2011: FTP://casi:ASTRO2010@astroconference.ca

Figure 2-5 Heavy-lift, Logging Resource Extraction

The use of airships for resource extraction is mainly for short-haul flights. Eventually the cargo must be transshipped to truck or rail, so it is best to do this as soon as possible. Consequently, the distances traveled to mine sights or forestry reserves is not likely to be far from a transshipment point. Short-hauls also allow the airship to complete several cycles per day that reduces average costs.

Minimizing cost is essential because the value of the resource is typically low. Certainly, airships that can operate as drones would be desirable. Some mining companies could make extensive investments in ground handling infrastructure, but in the case of forestry, the airships would have to have good hover control and the ability to vertically load/off-load cargo. On one leg of the mission, the airship could pick up a load and dump ballast water. Putting on ballast water, while dropping off the cargo is more challenging.

2.3.4 Military & Logistical Missions

The transportation needs of the military and remote logistics have similar characteristics. Emergencies come without much forewarning, so the location has minimal infrastructure, or what does exist is often damaged (Knott and Prentice)[10]. In many cases, the delivery point is not secure. A quick drop-off of cargo, without the need for ballast is desirable. A number of airship designs have been put forward to serve this market, and scaled prototypes have been flown.

The landing systems on the hybrid aircraft involve some form of modified hovercraft landing pads. The proposition is that once the aircraft has landed, the airflow through the hovercraft pads could be reversed to suck down the airship and hold it safely while the cargo is unloaded.

The airships by Lockheed-Martin (Now AT2 Aerospace), Airlander, Aeros and Atlas are generally referred to as hybrid aircraft because they depend on aerodynamic lift for about 30% of the weight. This allows these aircraft to drop off cargo and quickly leave the area without loading ballast. Figure 2-6 presents an illustration of a catamaran-shaped hybrid airship design by AT2 Aerospace.

[10] Knotts, Robert and Barry E. Prentice. “Climate-Related Humanitarian Relief: A Mission for Cargo Airships.” *Canadian Transportation Research Forum*. Proceedings Issue: 49th Annual Meeting (2014): 515-529. ISBN 978-0-9867070-5-6

Figure 2-6 Hybrid, Catamaran-shaped Airship Design

Such airships could serve many corridor roles, while also being available for emergency situations and to bring in supplies to serve remote northern bases and mining operations. Normand[11] sets out how such an airship service could resupply northern military bases from strategic corridors at a much lower cost than the use of airplanes. Prentice, et al.[12] present a case for using cargo airships to respond to emergency needs in the Canadian Arctic. The military or other institutions could have standby contracts with private carriers that would respond to their needs when emergencies arise. Clearly, such airships have to have fairly long-range capability because, generally, the location of need is unknown.

2.3.5 Tourism & Luxury Tourism

During the golden age of airship tourism, travelers were treated to an extraordinary and lavish experience aboard airships. These magnificent vessels, with their grand designs, captivated the public's imagination, evoking feelings of astonishment and marvel. Passengers had the opportunity to embark on leisurely voyages, relishing in awe-inspiring aerial vistas and savoring the exhilaration of soaring through the skies in a luxurious and opulent setting. The Graf Zeppelin was an intercontinental airship traveling the globe over a nine year lifespan.

In June 2022, Spanish regional airline Air Nostrum reserved ten Airlander-10 aircraft to commence operations in 2026. The interior of these vessels is much closer to a ship of the ocean in appearance than a typical aircraft. As shown in Figure 2-7 the luxury and space available for luxury tours and travel is top notch.

[11] Normand, Norm. (2021) *Airships In The Arctic: A Solution To "Too Much Geography"* Master Of Defence Studies, Canadian Forces College, 5 May 2021.
[12] Prentice, Barry E., Yui-Yip Lau, and Adolf K.Y. Ng (2021). "Transport Airships for Scheduled Supply and Emergency Response in the Arctic" Sustainability 13, no. 9: May 10, 2021.

Figure 2-7 Airlander 10 interior design image

Northern Canada encompasses a vast expanse of breathtaking landscapes, and airships have the potential to offer an unparalleled and adventurous tourism experience to those who are willing to invest in exploring rarely accessed regions of the country.

2.3.6 Ground-handling Systems (GHS)

The mooring and docking of an airship has a subtle difference. Docking involves landing and securing the airship on the ground in one spot regardless of the wind direction.[13] Mooring consists of anchoring the airship on the ground such that it weather-vanes. An airship is difficult to hold against the wind because it is like a giant sail. As the wind changes direction, the airship should be able to move rather than stay in a fixed position.

Before examining alternative Ground-handling System (GHS) solutions, it is useful to review some technical issues related to the physics and flight characteristics of airships. Airship landing operations are unfamiliar to most people, except perhaps for seeing a picture of large ground crews holding ropes. An airship's closest technical "relative" is a submarine, but these vehicles have the benefit of docking at the surface of the ocean. An airship literally docks at the bottom of an ocean of air, and must cope with changing wind conditions.

[13] Gibbens, R. P. (1975) "Airship Support Systems." Lighter Than Air Technology Conference.

The generic concerns encountered in airship landing operations are: (1) damage to the fragile shell, (2) controlling the variable buoyancy, and (3) dealing with wind and weather.[14] Maneuvering the airship to a docking position without damaging the hull is the first challenge. The tail must be kept from hitting the ground, and the nose must be kept from running into the docking mast. The second problem area is the control of the airship's buoyancy. A reliable and accurate means for monitoring the lift status and the physical adjustment of the ballast/cargo weight is required. The third issue is to protect the airship's structure from wind and variable weather conditions. The first two problems are related to the airship's structural design, avionics and mechanical systems. The third problem relates to the GHS design.

During the docking operation, the forces and moments experienced by an airship are usually caused by inertial effects, steady wind effects, and atmospheric turbulence. The inertial effect is a consequence of the airship's mass undergoing accelerations. Steady wind conditions can be accounted for in the design of the GHS. Turbulence, however, is random and includes discrete wind gusts, and is unpredictable both in frequency and magnitude.[15] The inertial effects can be controlled by selecting appropriate mooring points on the airship and the mooring system so as to restrict any translation or angular rotation of the airship. Steady wind effects can be countered by the engines of the airship that hold the vehicle steady. Turbulence effects may require advanced transient Computational Fluid Dynamic testing on the airship and use of advanced materials with high strength to weight ratios for the GHS's structure.

Various techniques and operational procedures have been devised, tried and tested in the field for large and small passenger airships, but no cargo airship GHS has ever been developed. The GHS for the US Navy Blimps and the giant Zeppelins employed between 20 and 100 men to hold docking ropes. Such labour-intensive landing systems are no longer considered practical or economic. Computer controlled systems of vectored thrust can eliminate the need for large ground crews. However, cargo operations were only a small by-product of these passenger or military airships activities. They only had to hold them steady while refueling and exchanging passengers.

In reviewing GHS systems, it is useful to note the design constraints and assumptions associated with an airship operation. These limitations and assumptions include:

- A simple GHS design that accommodates easy, quick, gentle and safe docking.
- High factors of safety to avoid any catastrophe due to ground turbulence.
- Mechanisms to drive this system that are easy to maintain (high wear and tear resistance).
- Overall dimensions that minimize the footprint of the airship.
- Materials that possess high strength-to-weight ratio i.e. lighter materials are more economic.
- Ability to operate in all-weather conditions and wind effects.
- Flexible, user-friendly technology.
- High operational efficiency and reliability with low maintenance costs.
- Ability of ground handling equipment, e.g. forklift trucks, to access the cargo bay of the airship without risk of pitch or yaw movements of the airship.

A successful GHS design must comply with all these requirements and constraints, while still being cost effective. There are several methods for handling airships on the ground, including mooring, anchoring, and ground-handling frames. It is also possible to operate autonomous landing systems that have specialized landing gear to hold the airship in place and fixed ground-handling infrastructure, like the Buoyant Aircraft Rotating Deck (BARD) system. The choice of method will depend on the specific requirements of each airship, including its size, weight, and the type of environment in which it will be operating. The BARD system and the autonomous landing systems are described here.

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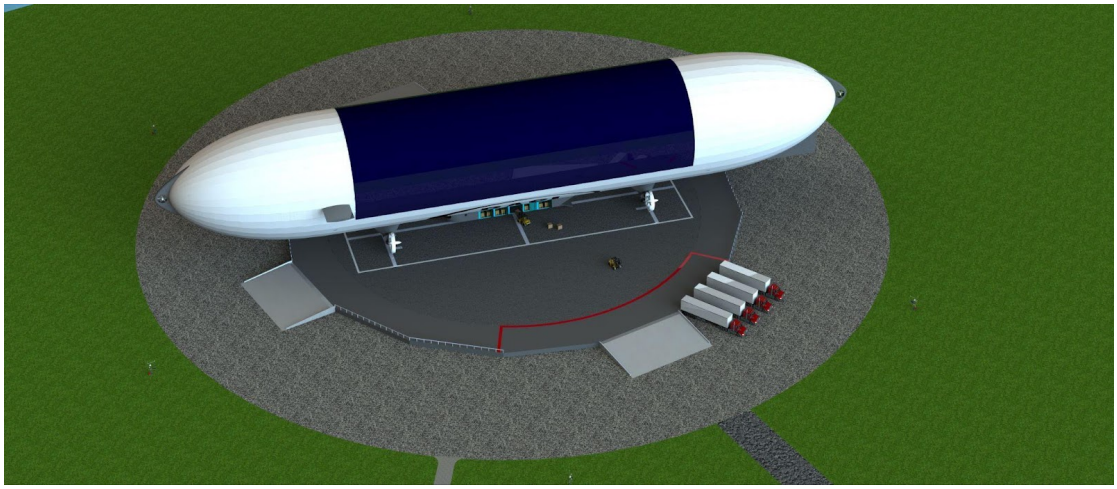
[14] Khoury, G. A. (2004) "Mooring" In Airship Technology, 258-322. Second ed. Vol. 1. Cambridge: Cambridge University Press, 2004.

[15] *ibid.*

The BARD is a specialized ground handling system designed specifically for airships As illustrated in Figure 2-8, the BARD is a large diameter turntable that allows a docked airship to rotate into the wind while it is being unloaded. This ensures the safety of ground handling personnel involved in loading and unloading cargo. If the wind changes, the airship and the turntable move together. The BARD turntable has tarmac material on its surface, providing a stable and secure platform for ground handling operations.

Figure 2-8 Buoyant Aircraft Rotating Deck



Rotating turntable landing pad points the airships into the wind

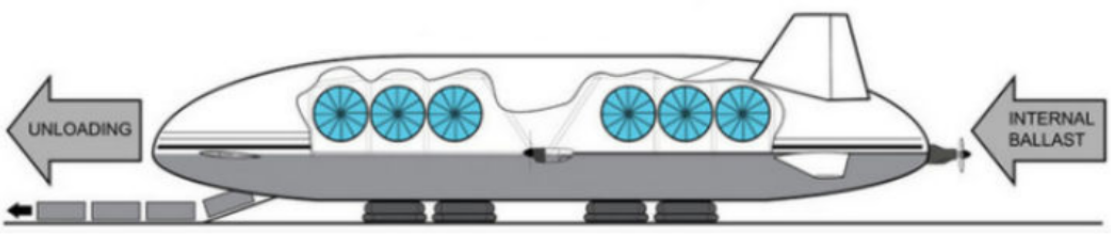
For landing, the airship approaches the BARD and orients itself into the wind. It holds this position directly above the turntable using laser guidance. A cable is dropped and secured in the middle of the turntable that is also oriented into the prevailing wind. Subsequently, the airship is winched down at a controlled speed to gently touchdown. Once the airship is securely attached to the turntable, ballast water is loaded to make the airship heavy. The airship can weathervane with changes in wind direction, while maintaining safety of the ground crew. Forklift trucks can proceed onto the turntable that is momentarily fixed as they cross over from the outside skirt.

The fixed landing base provides a secure supply of ballast water to make up for any difference in weight change as loads may not always be available. It can also provide ground power to the airship, lighting, ground-handling equipment (forklifts), fuel, and accommodations for staff.

An alternative approach to ground handling is to design the airship to operate autonomously. Like a helicopter, these airships are designed to land wherever a level, cleared area is available that is about three times the length of the airship. The key to this approach is the development of modified hovercraft pads. The companies that are using this technology include Lockheed Martin, HAV, Worldwide Aeros, and Aerocat. A schematic of the unloading system of the Worldwide Aeros airship is illustrated in Figure 2-9. These autonomously-operated airships have been designed with a military application in mind, in which landing at unprepared locations is necessary and the airship operator cannot be certain that ballast material will be available at the site.

The air cushion system is used for maneuvering on the ground and for docking and mooring. For docking and mooring, the air cushions landing pads are designed to operate with the fans reversed. Normally, the air cushion created by the fans lets the airship move freely, but when the fans are reversed the air cushions act like suction cups to adhere the airship to the ground while cargo rolls on and off a ramp.

Figure 2-9 Schematic of the landing and unloading system employed by Worldwide Aeros



Source: Worldwide Aeros

The air cushion landing system reduces the need for ground infrastructure. An advantage of this approach for transport in the North is the ability of these airships to land on open water, frozen lakes or virtually anywhere on the vast expanses north of the treeline. Floatplanes were essential to the opening of the North, and are still widely used. These “hybrid” airships could be the “floatplanes” of the 21st century.

2.3.7 TR State of Readiness

Cargo airships worldwide are in different states of readiness. Some countries and companies that are exploring the potential of this technology have advanced to scaled prototype testing. Others are taking a more cautious approach and still in early stages of airship development. There is still much work to be done in terms of developing and refining the technology, as well as gaining regulatory approval for their use.

That being said, there has been some progress in this area in recent years. For example, companies such as Hybrid Air Vehicles (HAV) in the UK are working to gain regulatory approval for their use. Other companies, such as LTA Research in the USA, are also actively developing and testing airships for cargo transportation.

Governments around the world are taking notice of the potential of cargo airships, and investing in their research and development. The French government has invested over 350 million Euros in the development of the Flying Whales airship, and this has encouraged the Province of Quebec to invest $60 million to establish a production facility at Montreal with a mandate to serve both North and South America.

Despite these efforts, the widespread adoption of cargo airships is still some way off. Several challenges need to be addressed to develop reliable and safe technology, as well as regulatory approval (airworthiness certification). Airships also require some ground infrastructure, like hangars for maintenance and inspections, and aerodromes landing, mooring and transhipment facilities.

The TR state of readiness of cargo airships worldwide is still in its early stages. The high cost of developing and producing cargo airships remains a barrier to widespread adoption, but progress is being made. The potential benefits of cargo airships, such as increased efficiency, reduced environmental impact, and lower costs, make them an attractive proposition for the future of cargo transportation. More investors will join once they begin to fly and the perceived risk is reduced.

3 AIRSHIP SERVICE: DEMAND CONSIDERATIONS

Airships are a viable yet underutilized mode of transport that can provide cargo capacity to remote locations. These aircraft have existed since the early part of the 20th century. Following an experimental period, designs were refined and flights were taken regularly across the Atlantic Ocean. After WW1, a multi-decade long period of intense research and invention occurred, primarily in Germany, Britain, Italy, France, Russia and the USA. Initially airships were used mainly for military purposes, but evolved to civil passenger and mail carriage. The inherent ability of airships to remain in the air for long periods of time and carry large volumes of supplies allowed them to explore polar regions (1918/19) and circumnavigate the globe (1928) before modern fixed wing aircraft were safe to do so. Regular service routes were established over the North and South Atlantic from Germany to Brazil and the US. The Graf Zeppelin alone made 590 flights totalling almost 1.7 million kilometers.

At a critical junction in their development, two factors derailed the impact of airships as a vital transport modality. In 1937, the Hindenburg accident at Lakehurst NJ sensationalized a potential risk of using hydrogen as a lifting gas. However, due to its otherwise strong safety record, flights to the Southern Hemisphere continued after the accident. At this time the largest concentration of airship designers and engineers were located in Germany. When WW2 broke out, the National Socialists (Nazis) took over ownership of the production facilities and put control under the auspices of the Luftwaffe (German air force). The Zeppelins' duralumin frames were melted down, the immense airship hangers were destroyed. The industry was extinguished, just as it was poised to make an impact.

The second factor that influenced the development was the massive research investments in airplanes made during WW2. Large bombers were built and engine research led to the development of jet aircraft. Passengers prioritized speed over endurance and lifting capacity. Following WW2, competition from jet airplanes drove transcontinental trains, ocean liners and airships out of business.

The feasibility of airships, particularly for long distance, heavy lift requirements, was well-established before WW2. The current application of modern materials and engineering to airship design and manufacture, continues to strengthen their viability as a dependable transportation modality for Canada's northern regions. The ability to transport large, heavy loads, over great distances, with low carbon emissions, make airships ideal for supporting and connecting remote communities. The present generation of cargo airships has the ability to dramatically improve the prosperity, quality of life and environmental sustainability of the North.

3.1 Remote Community Needs

The needs of remote communities are similar to those living in southern Canada, namely adequate, sufficient and affordable housing, food, and household goods, and public services related to education, health care, and other government services. No remote community has a standard of living or living costs comparable to their southern counterparts. The high cost of transportation and limited shipping season results in a significantly higher cost of living in the northern remote communities.

The small population bases in these communities results in a limited property tax base. The Government of Canada provides infrastructure and/or program grants and subsidies of various kinds to attempt to assist the residents. Despite the major investments and contributions made in Canada's north, there remains significant infrastructure deficits and gaps especially related to housing, public institutional buildings, offices and commercial space.

Many communities cannot support new development without addressing some of the basic infrastructure requirements. Up to 80% of Nunavut's water infrastructure is in poor to bad condition and old diesel power plants are several past their operational life. Lack of affordable, fast and reliable telecommunications limits economic development. Transportation infrastructure is expensive for passengers and cargo. But the required capital investment could be much less with cargo airships.

Investments are needed to address the basic infrastructure requirements in remote communities and to create developable land next to the airship landing zones. Funding must also be available to support and help build local and indigenous capacity to take advantage of all the various economic opportunities. Trades people need to be drawn from the local community and trained. Crews and mechanics to fly and operate cargo airships must come from communities within the region.

3.1.1 Food Security, Cost of Food and Poverty

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

The right to adequate food and to be free from hunger is a fundamental right affirmed in multiple human rights instruments. The Government of Canada has pledged to respect, promote, and uphold this right. In 1976, the Government of Canada ratified the International Covenant on Economic, Social, and Cultural Rights, a binding international treaty that affirms the right to adequate food under Article 11.

Decades of endemic poverty, overcrowded housing, food insecurity, boiled water advisories and chronic illnesses make lives difficult and populations vulnerable. The cost of transport is the challenge. The cost to deliver goods and services to communities is high because of their remoteness. Settlements are sparsely populated and spread out over vast distances.

Amongst the towns and hamlets, only 19 of the largest have more than over 1,000 people. Such “thin” markets make it difficult to support competition or economies of size in transportation. Most communities are strictly fly-in/fly-out, with no larger external freight connections, for most of the year. Generally the larger retail food stores are owned by Arctic Co-operatives Limited, the North West Company or la Féderation des coopératives du Nouveau-Québec. About 25% of the food and groceries are non-perishable. The companies try to bring in storable goods by sea or winter roads. Even for non-perishables volume can be limited. For example, most “best before” dates on the packages are not longer than 6 to 8 months. Mayonnaise has to be brought in by air, after about the first three months.

Many residents can supply some of their needs through hunting and fishing (referred to as “country food”). The local grocery stores provide the fruit and vegetables in their diet. The stores also stock other food supplies, like flour, dried lentils, spices, sugar, nuts, canned products, milk, cheese, soda, treats, bread products, etc.

Availability, freshness and affordability are important value considerations. Often the selection quality leaves dissatisfied consumers. Food prices in remote communities are 2.5 to 3 times higher than prices in the southern cities. They have to decide between the best of bad price and value options to feed their families.

Food prices in the remote communities would be even higher if the cost of transporting food were not highly subsidized. The Federal Government, under the Nutrition North Canada (NNC) program, the transport subsidies are restricted to only nutritious food. The NNC food subsidies have three levels depending on their nutrition value[16]. The transportation subsidy has grown to $131.3 million in 2022, and is scheduled to increase about $5 million per year. This is likely an under-estimate given inflation and the rapid population growth in the North. With lower cost cargo airships, this subsidy could go much further to reduce the cost of food in the remote communities.

3.1.2 Availability of Housing

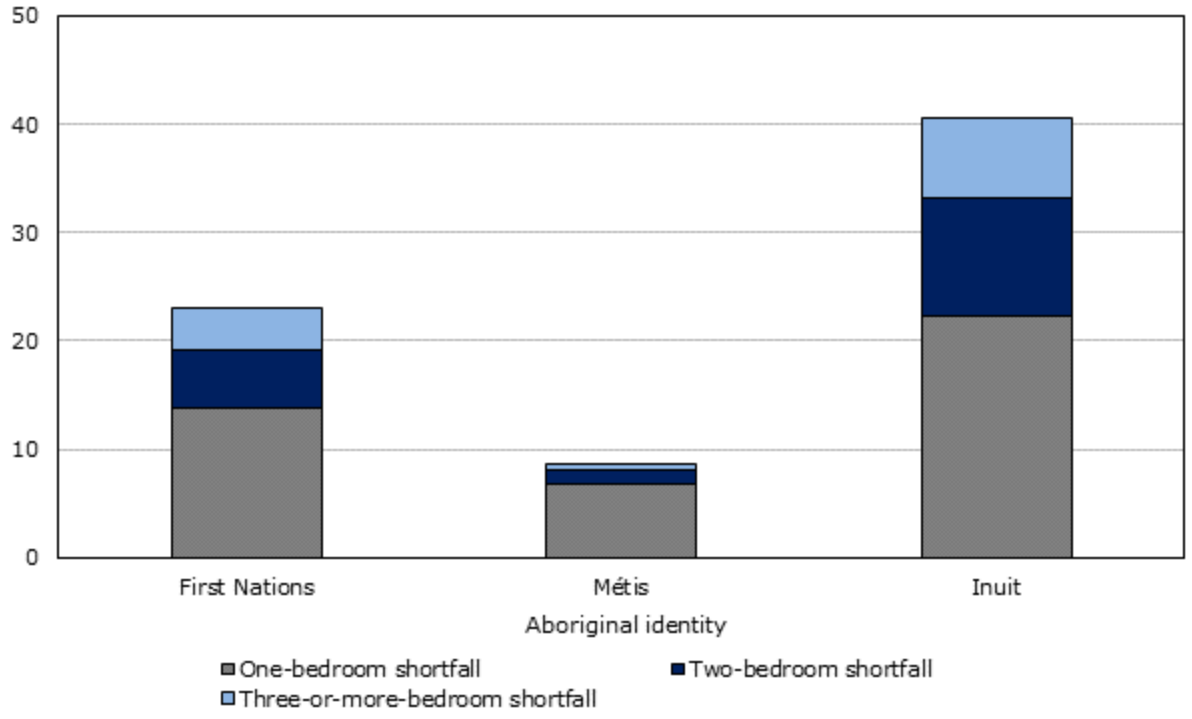
All northern regions and communities lack sufficient accommodation, whether public housing, government staff housing, private sector staff housing or housing available to rent. The vacancy in almost all these

[16] The highest subsidy level covers frozen fruit and vegetables, fresh milk and infant formula (14% of the total). The medium level subsidies all fresh fruit and vegetables, meat, bread, frozen potato products, yogurt, eggs and poultry (78%) . The program’s lowest subsidy includes pizza, unsweetened juice, ice cream, and bacon (8%).

housing types is zero, with long waiting lists - often years long. As such, multiple generations of indigenous residents often live in units that were designed for smaller families. Overcrowded housing leads to faster deterioration that requires more maintenance and repairs.

The issue of overcrowded housing was calibrated by Statistics Canada for 2016.[17] Figure 3-1 presents the proportion of Aboriginal people in Canada that are living in overcrowded housing. In terms of space, the Inuit have the greatest need, with 40 percent of the population short by one bedroom or more. The First Nations have the next largest need at roughly 25% of the houses are overcrowded, however this also depends on location.

Figure 3-1 Proportion of First Nations people, Métis and Inuit living in crowded housing, Canada, 2016



Source: Statistics Canada, Census of Population, 2016.

The report by the Lgui (2019) on the condition of on-reserve housing, reports that 32% of on-reserve dwellings do not meet one or both of the adequacy and suitability standards, whereas the comparable number for off-reserve Aboriginal housing is only 7% .[18] Metis form the last group with less than 10% of the population living in overcrowded conditions.

The number of bedrooms and space for people living in the house impinges on personal privacy for peace and quiet. This can increase social stress and anxiety leading to higher rates of domestic violence. Many victims of domestic violence have no place to go even if a protection/no-contact order is issued against the alleged perpetrator. They have few options other than remaining in a hostile situation. The private housing market offers few alternatives because rents are extremely expensive. For example, in Nunavut, a room in someone else's house rents for $1500+, a one bedroom apartment is $2,000+, a two bedroom is $2,500-3,000+ - effectively Manhattan rents. Lack of affordability often means too many people are

[17] Statistics Canada. (2017) "The housing conditions of Aboriginal people in Canada"Census of Population, 2016. Catalog no. 98-200-X2016021 ISBN 978-0-660-20363-8

[18] Lgui, Brahim. (2019) "Housing Conditions of On-Reserve Aboriginal Households."update of CMHC report: 2011 Census/National Household Survey Housing conditions Series: Issue 8 — Housing Conditions of On-Reserve Aboriginal Households, March 2016.

living in cramped conditions, with inadequate sanitation. The result is adverse health outcomes including chronic stress, mental illness, and lower levels of overall general health.

As a baseline for the report, the housing shortfall is estimated to determine the demand. Table 3-1 presents the most recent CMHC report on Housing Conditions of Aboriginal Households Living On-reserve (published March of 2022) indicates that out of 54,870 band households represented, 40.4% were unable to access suitable housing[19]. When specifically looking at QC, ON, MB, SK, AB that number climbs to over 43%.

Table 3-1 CMHC Report on Housing Conditions of Aboriginal Households Living On-reserve, Canada

Housing Conditions of Aboriginal Households Living On-reserve, Canada, Provinces and Territories, 2016								
	Total # of households	Living in or Able to Access Adequate and Suitable Housing		Living below Adequacy and Suitability Standards and Unable to Access Acceptable Housing				
Geography (GNR)		% of all households	Average Income ($)	Total % below Standards	Average Income ($) of those below standards	% below suitability	% below adequacy	% below both
Canada (5.1%)								
Total	97,500	67.6	64,496	32.4	28,484	5.4	20.2	6.8
Owners	31,055	78.9	68,847	21.1	24,812	2.3	16.3	2.6
Renters	11,570	75.5	55,352	24.5	26,204	6.4	14.0	4.2
Band Housing	54,870	59.6	63,680	40.4	29,863	7.0	23.8	9.7

The Federal Government and the Canadian Mortgage and Housing Corporation (CMHC) are engaged in efforts to improve affordability, availability and energy efficiency of housing in the north. However, the cost of shipping larger construction items, like doors and windows, and the volume of lumber required for homebuilding make housing prices exorbitant in most communities. Modest homes with 2-3 bedrooms and 2 bathrooms become extraordinarily expensive, approaching $1 million in many communities. Due to material shipping costs, lack of available tradespeople and a brief construction season, building costs are about 150% higher in the north.

As challenging as it is to construct new housing, regular repairs and remodeling of existing homes is a difficult undertaking. No hardware store or lumber yard exists to acquire materials for repair. When a broken window cannot be replaced, it is boarded up, when the roof leaks, a bucket is used to catch the water, when molds develop, families just have to live with the health consequences. It is difficult to plan ahead for regular housing repairs and maintenance, when supplies arrive only once a year via sealift. If there is a problem with pack ice and a shipment is delayed, materials may need to be stored. In those situations where proper, secure warehousing space is unavailable, building materials may be exposed to high humidity, salt and moisture that results in molds, rotting, or warping of materials that ultimately cannot be used.

New housing concepts have been designed to be more environmentally and culturally appropriate for northern communities. Some features include; heat recovery pumps, exterior porches for storing hunting equipment, large stainless steel sinks for preparing fish, open-concept living areas for family gatherings, etc. But most houses lack these features, and are simply too few in number.

3.1.3 Cost of Construction

The high cost of construction in remote communities in Canada affects both individuals and communities. The cost of building a home in Canada's North, such as Iqaluit, can exceed $750 per square foot. This

[19] CMHC. (2022) *Report on Housing Conditions of Aboriginal Households Living On-reserve.* https://www.cmhc-schl.gc.ca/en/professionals/housing-markets-data-and-research/housing-data/data-tables/household-characteristics/housing-conditions-aboriginal-households-living-on-reserve

compares with the cost of building a home in Southern Canada, where prices average closer to $170 per square foot. When supplies need to be ordered a year in advance to reserve space on marine vessels, it is impossible to take advantage of sale prices at retail stores.

A primary reason for the high cost of construction in remote communities is the cost of transporting building materials. Most remote communities in Canada are inaccessible by truck or ship except for a narrow seasonal window. Depending on the material dimensions, some items can be brought in by air but this is extremely expensive. The high costs of transportation for materials substantially increase the cost of housing construction.

In addition to transportation costs, the cost of skilled labor is an important contributing factor. In many cases, contractors and tradespeople must travel to these remote communities to work on construction projects. The cost of travel is high and lodging can be challenging to find. The pool of local skilled labour available in the North is very limited. The lack of consistent delivery of materials year round leads to truncated construction periods. This reduces the number of working hours local people can acquire towards receiving “red seal” certification in carpentry, plumbing, and other trades.

High building costs and lack of year-round affordable transportation makes it difficult to attract business investment. Building necessary infrastructure to support economic development is so punitively expensive that often projects are not approved. These lost opportunities are part of the wider economic impacts of being remote. An affordable, consistent, year-round transportation solution would go a long way to helping to alleviate the problems discussed in this section. Airships present a tremendous opportunity to reduce the cost of materials in the North while also enabling them to be delivered all year.

3.1.4 Year Round Service

The only year-round supply line to these communities is by airplane. The capacity of an airplane is limited by weight and the size of the airplane’s door. Larger cargo planes can carry more but they need longer runways and if they are jet powered, they require paved runways. Typically goods are shipped via truck or rail to a terminus point, like Hay River for barges, Pickle Lake for air, Montreal for the sealift. and then flown up further north from there.

Remote communities that are located on the coast have the opportunity to receive shipments via ship between July and November. Often their season is shorter due to ice coverage and pack ice trapping vessels (could be at beginning or end of the season). This unpredictability means shipments for construction projects,or community requirements, can be delayed a full year. Such delays lead to cost overruns for projects and severely disrupt community life.

Inland remote communities depend on winter roads to provide supplies between January and March. They generally operate between mid- January and mid-March but changes in climate patterns are reducing the season. Regardless, delays are inevitable and most houses take two years to complete because some supplies do not arrive.

A significant benefit of using airships for transport in the North is that they can fly year-round, day and night, and in cold temperatures. The larger loads and lower freight rates would provide a steady source of supply for food, building materials and other products, similar to that available in southern communities. Steady supply would result in a normalization of pricing for goods going north, making the cost of living more affordable for northern residents.

3.1.5 Weight of housing

In order to determine a relative starting demand for airships, the approximate weight of the housing required to replace 40% of what is currently existing has been calculated. Assuming 300 sq/ft per person averaging for 4 people per home, a standard 1200 sq/ft home ends up weighing in at about 60 tonnes

net[20]. The total dwellings recorded in the service area proposed is 39,072, 40% of that would be 15,629 homes in total. This gives a total weight of 468,864 tonnes needed across the 128 communities; the breakdown of how much each corridor needs is discussed in section 4.0.

3.1.6 Local Involvement and Acceptance of Airships

Airships would supplement the cargo service offerings now supplied, rather than compete directly. In order to function effectively, airships need to integrate with other modes of transport. Everything starts and ends on a truck. The airships will be privately owned, like airplanes, and have common landing spots with ground-handling equipment. Aerodromes are typically public infrastructure.

Airships would create many new jobs. A short list could include avionics and flight engineers, engine mechanics, pilots/operators, maintenance and repair technicians, parts suppliers, and ground support crews for receiving the airships and transloading the cargo. Each airship gateway would need warehousing for goods to be stored and cross-docked for delivery or pickup. This would create jobs for warehouse staff and forklift drivers. Most of these jobs would be filled by indigenous people who live in the North.

The manufacture of cargo airships would create many jobs in the South, too. Tier 1,2 and 3 input suppliers would feed discrete parts to the manufacturing process. For examples of diverse components include; the airframe, layered outer envelope, electrical engines for propulsion, carbon fibre rudders/flaps, gondola, cargo transfer mechanism, lifting gas cells, air navigation equipment, avionics, communication electronics. Many of these items require advanced manufacturing capabilities, providing a challenging career path and well-paid employment opportunities. Globally, a multi-billion dollar investment is being made in the airship industry. Private sector companies, like LTA Research, Flying Whales, Zeppelin, Atlas, and BASI are working to scale up designs and refine commercial prototypes to build-to-purpose requirements.

Since the Industrial Revolution, no new transportation systems have emerged that did not have strong support and encouragement of governments. Public investment has been necessary for any marine, rail, truck and air modes of transportation to develop because infrastructure costs are high and it only makes sense to share their use. Federal governments in the USA, UK, Israel, France, and China have invested and supported this current stage of the airship industry. The Province of Québec has contributed $60 million to support the advanced materials production facility for Flying Whale's airship in Montreal. Currently no financial support for the airship industry in Canada has been provided by either the Federal Government or the provinces, other than Quebec.

Support from the remote communities and the mining industry needs the full engagement and partnership with Indigenous peoples in the North. Economic development and an improvement in living conditions for northern citizens can only proceed when there are significant educational and training opportunities. These opportunities to gain knowledge and grow skills for residents of the north in various scientific, engineering, and management disciplines will provide pathways for the development of professional occupations and careers in the global airship industry.

3.2 National Needs

At 9.985 million square kilometers, Canada is the world's second largest country by area. Access to the vast reaches of this nation are complicated by complex geography, extreme temperatures and darkness associated with high northern latitudes, reaching 24 hour darkness near the winter solstice. The geography is both a blessing and a curse in that the hinterland and accompanying natural resources are vast yet inaccessible due to the rugged geography and cost of building infrastructure in these areas.

[20] https://applianceanalysts.com/house-weight-calculator/

3.2.1 Arctic Sovereignty

Claims of sovereignty in the Arctic and circumpolar region have been made over hundreds of years by explorers and governments from many different nations. Currently Canada has about 160,000 km of Arctic coastline and claims to this and territory are recognized by the global community. However, the sovereignty of the water passageways is in dispute.

While Canada claims these channels as internal passages, meaning permission must be granted for foreign vessels to pass, several other nations (principally the USA at this point) view the passages as international waterways, requiring no prior permission to utilize. This lack of agreement over whether these channels are internal or international seaways could be strengthened in Canada's favor if a better case for sovereignty over these remote and largely unpopulated regions is demonstrated.

Generally, under international law, a country's claim for sovereignty rests on two pillars; a legal claim of title, and the demonstration of established presence in the area. The Canadian Government's first sponsored expedition through the Arctic Archipelago was between 1913-1918, and visited parts of Melville, Baffin and Ellesmere Islands that approximately defined the outer reaches of the federal government's claim of lands with territorial waters in a triangular northerly direction towards the Pole.

Since the time that the land claim was established, the Canadian Government has endeavored to establish further evidence of presence in the Arctic by establishing RCMP detachments in northern communities to enforce Canadian laws, by conducting a regular census of inhabitants, and by operating Post Offices - all of which are internationally recognized proofs of sovereignty.

The Canadian Arctic Archipelago is 1.4 million km². Even with satellite imaging, radar, and a spread-out military presence, it is unsurprising that interested parties traveling in the region are not immediately discovered. The case for Canada's sovereignty over these waterways would be enhanced immeasurably if there was a demonstrable commercial presence in support of settlements or industry in the area. A regular passage of cargo airships providing supply provisioning of food or building materials to communities on the coasts, would strengthen the claim that the channels are indeed inland waterways of Canada.

Passage by the Canadian Coast Guard and commercial ice-strengthened ships passage is rare. Only a few freighters and tourist vessels make the journey into the Northwest Passage each year. Small sailing ships are occasionally found making their way through the ice-free waterway in summer. As global warming trends continue however, this region will become increasingly ice-free for longer periods, increasing the interest of other nations, and opening the opportunity to further commercial development. Supply and rescue requirements along the route could become increasingly important as traffic increases.

If the Canadian government does not take proactive steps to assert sovereignty throughout the region, other nations and entities could take advantage of the lack of enforcement to dispute/ignore Canadian claims of internal waterways. Currently, Canada is in the position of monitoring transgressions into the Canadian Archipelago and following up diplomatically. Even the closest partner in world affairs, the USA, challenges Canada's claim that this is an inland waterway. Currently, the USA and Canada 'agree to disagree' on whether the Northwest Passage is Canada's sole jurisdiction or a free international waterway.

Since the 1969 voyage of the oil tanker USS Manhattan through the Northwest Passage, successive Canadian governments have discussed the possibility of building a fleet of icebreakers or submarines to monitor activities and enforce Canadian border laws. Two new polar icebreakers are now in production, one at a west coast shipyard and the other on the east coast, at a total cost of $3B CDN.

The Canadian Navy works closely with the Canadian Coast Guard to establish a maritime defense. This presence could be enhanced by regularly scheduled airship services extended from established transportation corridors. Commercial freight services would also help lower the re-supply costs of

operating military bases in the Arctic, the largest of which is Canadian Forces Station Alert at the northern tip of Ellesmere Island.

The Canadian Armed Forces has 'boots on the ground' and a paramilitary presence in many remote communities, through a network of Army Reservists called the 'Canadian Rangers'. Mostly composed of local Inuit, about 5,000 Rangers from about 200 communities across the North train and provide support for sovereignty claims across the Canadian Arctic. Cargo airships could be used to coordinate and connect these community-based forces, as well as re- supply their food and equipment caches.

3.2.2 Arctic Surveillance (Security)

The Canadian Government, in an operational alliance with the USA, has a significant deployment of early warning installations across the Arctic. Their purpose is to detect the intrusion of missiles or hostile aircraft. The Canadian command centre for NORAD (North American Aerospace Defence Command) is located at Winnipeg.

Maritime traffic requires a more physical presence in the Arctic to perform border control functions, ensure the right of safe passage, and interdict illegal intrusions by foreign navy ships, or merchant/ fishing vessels. Regular reconnaissance missions by RCAF aircraft or Canadian Coast Guard/ Navy ships are employed for this purpose. The 2022 report by the Auditor General of Canada has been critical of the gaps in coverage of the Arctic Archipelago.[21]

Normand (2021) suggests that airships could operate a circuit system, as illustrated in Figure 3-2, could be used to provide supplies within 24 hours to any point in the Canadian Arctic.[22] He also includes Nanisivik and Tuktoyaktuk as gateways because of their strategic locations for defense. Nanisivik, which is envisioned as a refueling hub for the Offshore Patrol Ships, is to be sparsely crewed. However, it will need regular shipments of consumable items as well as materials for maintenance and repair.

Figure 3-2 Proposed Dirigible Sustainment Circuit

[21] 2022 Report 6 of the Auditor General of Canada to the Parliament of Canada. *Arctic Waters Surveillance.* https://www.oag-bvg.gc.ca/internet/English/parl_oag_202211_06_e_44152.html

[22] Normand, Lieutenant-Commander Norm A. (2021) *Airship Sustainment in the Arctic*. Canadian Forces College. JCSP 47 2020 – 2021 Service Paper. https://www.cfc.forces.gc.ca/259/290/23/192/Normand.pdf

Airships could complement current assets in the Arctic. They could monitor various 'chokepoints' which surface vessels might use to enter/exit various sea routes (e.g., Amundsen Gulf, Hudson Strait, Davis Strait). Airships can fly low, steady flight patterns. This is ideal for mounting remote sensing equipment that can detect under-ice movements from submarines. In addition, they could carry radiation detection equipment (as Norway has done with Coast Guard drones) to safely measure from a distance, radiation levels of an approaching nuclear-powered submarine or marine vessel.

The 'Canadian Rangers' conduct patrols and participate in annual military exercises with other branches of the Canadian Armed Forces in the Arctic areas. They provide the first line of military presence in the event of any land invasion, for example the deployment of foreign paratroopers/marines into Canadian territory. Airships could provide the logistical backup to maintain personnel, weaponry, vehicles, fuel and supplies to remote locations.

3.2.3 Environmental Surveillance

Immense regions of the Arctic, while highly resilient to the effects of cold weather, are nonetheless sensitive to the effects of climate change and pollutants. Airship transportation corridors can support communities and overall economic development of the northern region, in a sustainable manner. All modern airships are being designed to operate electrically, and most will likely use hydrogen for fuel. This eliminates any carbon emissions. As a form of aerial transport, their only contact with the ground is for landing sites, which can be co-located with existing airfields.

Along the routes of the airship transportation corridors are areas of significant natural and scientific interest. Airships are an ideal platform for surveillance and remote sensing. They are able to travel slowly, steadily and close to the ground, and hover without using any energy to stay aloft. Air and ice monitoring programmes, scientific surveys and wildlife counts can be done affordably, airships could be very helpful in tracking movements of animals.

Often large distances need to be covered, which airships can do with reasonable costs. Movement along the air transportation corridors would permit almost continuous and repeatable observations for wildlife and plant surveys, and rock features and formations for the Geological Survey of Canada, as well as geographical details necessary for improved map making of the regions.

Logistic support for remote arctic research projects is provided by the Polar Continental Shelf Program (PCSP) a service delivery agency under Natural Resources Canada. PCSP supports government, university and independent researchers in their activities to advance the scientific knowledge of northern Canada. These projects occur across the arctic and northern Canada and require significant support across a vast geography. Remote research stations in the Arctic include the Flashline Mars Arctic Research Station, McGill Arctic Research Station, Polar Environment Atmospheric Research Laboratory, Eureka Station and Ward Hunt Island Research Station. In addition to supporting these installations the PCSP also supports seasonal work based out of temporary seasonal field camps. Activities for the PCSP are based out of the Resolute.

3.2.4 Emergency Response (SAR, Spills)

The ability to respond to a Search and Rescue (SAR) incident in the Arctic is part of Canada's international responsibilities to the multi-state Arctic SAR Agreement (along with USA, Russia, Norway, Finland, Sweden, Iceland and Greenland/ Denmark). The region known as the 'High Arctic and West of the Arctic Archipelago' (HAWAA), is supported by the Department of National Defence and Canadian Coast Guard staffers in Trenton, Ontario.. No permanent icebreaker or rescue aircraft is stationed permanently in northern Canada to support the region.

As the Northwest Passage becomes viable for shipping, the risk of accidents will also increase. The sinking of the MS Explorer in Antarctic waters in 2007, due in part to a collision with pack ice, provides a poignant example of the dangers inherent in travel in remote polar regions. The harsh conditions,

remoteness, lack of accurate charts and scant support infrastructure makes fielding a reliable rescue operation complex and demanding.

Currently, the Canadian Federal Government has a moratorium on drilling in Canada's Arctic waters, but the Beaufort Sea is shared with the US. An oil spill or rig blowout in the US drilling and production areas of Prudhoe Bay on Alaska's North Slope would be disastrous for the entire region. Emergency readiness protocols and equipment need to be in place, before an adverse event occurs, because response time is crucial to contain oil spills. Containment booms must be put in place to prevent oil from reaching coastal areas and volunteer teams need to be assembled quickly to assist with wildlife recovery and rescue. Materials used to soak up the oil also need to be transported and disposed of after use.

The availability of cargo airship services in the North would greatly enhance environmental security. Such vehicles could be diverted on a temporary basis to carry the oil booms, supplies and in some cases more importantly accommodation for the crews working on the clean up mission. Most airships can land on ice or water. Consequently, almost any part of the Arctic would be accessible for emergency response.

Regularly scheduled airship service flights in the region would provide a means for monitoring the area for environmental issues on a continuous basis. All communities in Nunavut are powered with diesel generators and require annual fuel re-supply. Fuel is brought to the communities with tankers typically supplied out of refineries in the St. Laurence. Annually these tankers travel to the communities once the ice is melted and unload their cargo to community tanks using floating pipelines. If a tanker ruptures due to navigation errors, faulty equipment or an act of God, there is little capacity for response in the remote arctic passages.

3.3 Resource Industry (Mining) Needs

Many activities involved in the mining process take place near the site of the ore body. Typically, access roads and an airstrip (or port facility) must be built to bring in equipment, supplies and workers to the mine site. Equipment is required for the construction and operation of a new mine: transport vehicles, dump trucks, front end loaders, tunneling, drilling, crushing equipment, support buildings, dormitories, cafeterias, IT and telecommunications equipment. Everything needs to be brought to the new mine site from distribution centers and manufacturers in the south. Cargo airships could reduce the lead time to open a mine, and lower the costs of transporting all the on-going consumable inputs.

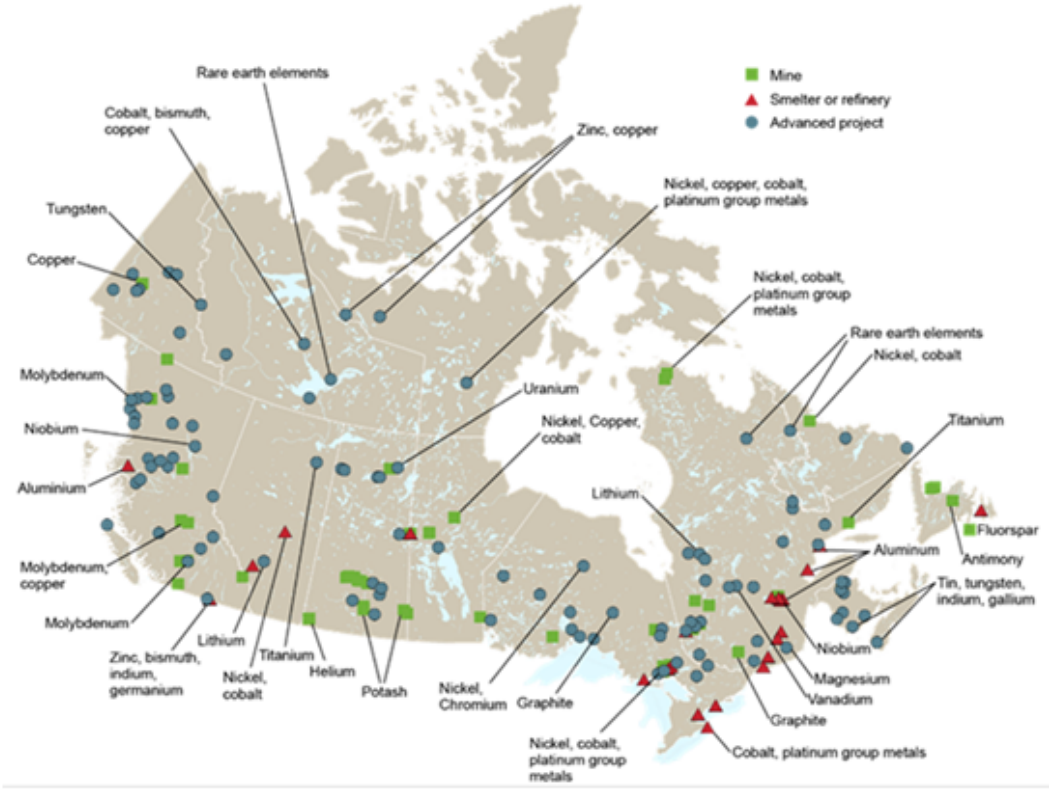
An example of large equipment that needs to be transported to an open pit mine is a CAT 797F Mining Dump Truck, with a 400 tonne haul capacity.[23] Often such equipment is disassembled for transport. Reassembly of this truck at the mine would require a team of 7 mechanics working around the clock for 20 days, plus time to assemble and weld the dump body. Using a 100T lift airship, it would be possible to reduce costs considerably by shipping in the truck fully configured.

The mining of critical minerals is key to the expansion of green technologies, like electric vehicles, batteries, computers, telecommunication and general technologies and will sustain the energy-driven needs of the modern world. The Government of Canada has published its strategy to expand the supply of these rare earths and base metals.[24] The location of known critical mineral deposits is presented in Figure 3-3. Many of these valuable mineral deposits are found in inaccessible areas. As a means of implementing strategy, "Budget 2022 includes a provision of up to $1.5 billion for infrastructure development for critical mineral supply chains, with a focus on priority deposits". While this sounds like a lot, at an average cost of $3 million per kilometer, this would only build about 500 km of gravel roads. An equal investment in cargo airships would enable access to all these production sites and many more that have not been explored because they are inaccessible.

[23] Large haul trucks weigh about 45 metric tons and some other popular manufacturers are; Caterpillar, Liebherr, Komatsu, BelAZ, Bucyrus. All of these are roughly the same size and weight and could be transported by airships.

[24] The Canadian Critical Minerals Strategy. (2022) *From Exploration to Recycling: Powering the Green and Digital Economy for Canada and the World.* https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html

Figure 3-3 Location of Known Critical Minerals in Canada



Source: The Canadian Critical Minerals Strategy. (2022)

The viability of mine sites depends on global commodity prices, the size and accessibility of the ore body and infrastructure needed to transport ore concentrate offsite to a processing facility for purification. Once ore bodies are identified and the financial business case is made that a mine can be profitably developed, an operations plan is created. For example, in the case of rare earth mines, exploration activities (prospecting) may identify geological structures containing a high percentage of rare earth minerals in the rock. The mining process would include digging the ore out of the ground, crushing (milling) it into very fine grains. Chemical and physical treatment of the ore concentrate usually takes place at a location far distant from the remote mine site. Airships would be involved in the transport of the ore concentrate from the mine site to the closest road or railway line for furtherance to a processing facility.Then processing it by separating the rare earth elements (REE) and refining them into high-purity rare earth oxides (REO) that can be sold.

Canadian miners are committed to net-zero carbon, but require large quantities of available power to operate. This is pushing the mining industry towards renewable energy sources. An example is the Diavik Mine in the NWT that used to spend about $70 million annually to truck 50 million liters of diesel fuel over 300 km of winter roads from Yellowknife. With four wind turbines installed, the company saved $5 million and reduced its winter road fuel haul by 75 loads.

Using airships to support the operations of mines in the north would significantly reduce the amount of greenhouse gas production from this industry and go a long way to improve the sustainable performance of the mines themselves. It was an arduous job to assemble the wind turbines at the Diavik site. Each of the 100 meter turbines had three 33m blades. These necessitated building custom trailers for the trucks on the ice roads and ensuring that they articulated properly over varying conditions of terrain and elevation. More than 60 loads were required to ship the pieces 300 km from Yellowknife. In comparison,

30t capacity airships would be able to transport these loads in just a few shipments at a much lower total cost.

An additional benefit from partnering with an open pit mining operation is that the vast open pit could serve as an emergency hangar facility for cargo airships. Some modifications, like the stabilizations of rock faces might be required, but having an emergency hangar in a northern mining area could reduce insurance costs and increase confidence of operators. This idea is discussed further in section 6.1.6.

Airships are ideal for mineral exploration and in particular the geophysical survey known as Airborne Gravity or Aerogravity. Gravity surveys are extremely sensitive and measure minute variations in gravity over the Earth's surface. Every point on the earth surface varies depending upon its elevation and distance from the earth's core and the density of the underlying rocks at or below the surface. Gravity surveys are extremely effective in delineating areas of mineral potential but are slow to perform on the ground. Fixed wing airborne surveys are affected by turbulence and propeller vibrations. In the early 2000's De Beers Group performed a 4,000 km^2 gravity survey in Botswana using a modern Zeppelin NT airship. The airship provided a stable/smooth platform for the sensitive equipment and the data proved to be clean and of excellent quality.

Figure 3-4 DTS Airship on mast

Much of Canada has been explored using airborne magnetic and electromagnetic surveys by government reconnaissance surveys or private corporations. Whilst there is the ability to improve sensors and penetrate deeper and develop new algorithms for these survey types, most of Canada has largely not been explored with airborne gravity.

Different mine types produce different volumes of inbound and outbound freight. For instance, diamond and gold mines produce high value products in small volumes, so their freight demands are mainly inbound shipments of equipment and supplies. Base metal and rare earths mines produce large quantities of concentrates to be shipped out for processing. They have shipments in both directions, but in general more outbound, than inbound.

The Northwest Territories currently has three operating diamond mines. These mines are Ekati, Diavik and Gahcho Kue. They opened in 1998, 2003 and 2016, respectively .

Nunavut has four operating mines: Mary River (iron), Meliadine Gold Mine, Whale Tail Gold mine, and Meadowbank Gold mine. Two other projects Doris North (gold), Sabina (gold and Silver) and Chidiak (gold) are promising deposits for future development. Northern Quebec features the Glencore Raglan Mine, the Canadian Royalties mine, and several mining projects including the prospective Strange Lake rare earth mineral deposit owned by Torngat Metals. Tongat plans to utilize airships to transport mineral contrate to Schefferville instead of using a permanent road.

3.3.1 Access and Investment Risk

The Canadian mining industry has played a significant role in developing a best practices framework, "Towards Sustainable Mining" that puts a focus on environmental, social and life cycle aspects of mining development.[25]

As a nation, Canada has vast areas of land with untapped mineral potential. But the economic benefits of the mines in these areas are much less than what could reasonably be expected, given their richness. Despite considerable prospecting efforts and exploration drilling activities that have gone into identifying areas with suitable levels of mineralization, mines may not be developed due to a variety of reasons. Often the most challenging reason is the remoteness of the potential mine site. The costs are too high for the logistics/ supply chain solutions to provide workers, equipment and fuel to the site and to get the mine product to a smelter for further processing or delivery to an end customer.

Potential mine sites may be hundreds of kilometers away from an existing road, port or airstrip. If such transportation infrastructure needs to be constructed to support the mine's development, the costs are typically in the range of hundreds of millions of dollars. The costs of obtaining access may make the entire project uneconomical. Stranded resources stay in the ground and the benefits of regional economic development do not occur.

Given the tremendous economic potential in Northern Canada, the inability to capitalize on this resource is shocking. For example, throughout all of the NWT and Nunavut (an area as large as Europe from Norway to southern Italy), only seven major mines are currently active. Three gold mines and two diamond mines and one iron ore mine are in Nunavut, and three diamond mines are in NWT. [26]

Currently, many potential mines are unable to raise the level of investment capital needed because risk levels are unacceptable. Often the investment requirements for a mine are extremely onerous, because the site is remote, infrastructure is lacking and cargo shipments may be bulky. A large part of the investment risk is related to whether or not a transportation infrastructure will be in place to handle the mine requirements at each of the different stages of development.

Often the profits for resource industry companies are a direct function of the costs incurred to access and produce the materials in question. This may require the construction of roads or a dedicated rail line. Because of their remote locations, many prospective mines need to consider access routes, involving rail, port facilities or suitable airstrips to transport valuable minerals/ concentrate to world markets for further processing. The most significant issue is gaining access from a landlocked mine site to the nearest coast.

If the logistics and transportation issues could be addressed in a more cost effective manner, it would ignite mining development in Canada and make life in northern communities much more viable. Instead of building a land-based link, airships could be used to transfer heavy equipment or ore concentrate to a coastal port loading facility, or fly south to the nearest railhead terminus. Ultimately, this report aims to be able to provide insights which will enable communities to partner with mining companies in the north to understand their requirements for point to point transport, and the current financial models they use to support mine development.

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[25] The Mining Association of Canada's Towards Sustainable Mining (TSM) standard is a globally recognized sustainability program that supports mining companies in managing key environmental and social risks. https://mining.ca/towards-sustainable-mining/

[26] Two of these mines are in serious financial difficulty.

Mining companies are interested in using airships for transportation requirements, and would prefer if there could be cost and risk sharing with Territorial and Federal Governments for the infrastructure required to support an airship industry serving northern Canada.

Still, the significant risk remaining is the vagueness or lack of airship regulations. This situation may leave companies unsure of where they may stand if they make significant financial investments and projects get held up. Governments could do a lot to de-risk these efforts, by providing capital to build infrastructure and supporting certification and airworthiness efforts that establish a safe operating environment, thereby allowing insurance providers to offset risk for companies.

4 CARGO AIRSHIP LOGISTICS CORRIDORS AND AIRSHIP GATEWAY LOCATIONS

A trade corridor can be described as any pathway that facilitates the movement of goods between two or more locations within a broader network of transportation links and nodes that form an economic region. Hubs and gateways are the nodes that form the integral parts of transportation corridors. Hubs are only found in areas with well-developed road infrastructure that radiates out from the hub to serve smaller centers within its hinterland. Goods are received from the smaller centers at the hub for consumption and transshipment to other locations, and in reverse goods received from distant locations are distributed within the hub's hinterland.

The hinterlands and economic roles of gateways are different from hubs. Most gateways serve only one end of a major corridor that feeds traffic into and out of its region. They have a one-sided, cone-shaped hinterland. Traffic is funneled through a gateway because it sits at a strategic location along a land corridor or a sea route where transportation costs can be minimized. Gateways are located at the most favorable transhipment points between two modes of transport.

Economic forces, geography, and technology determine the use and activity of gateways. As a result the airship gateway locations for the North already exist. Although they will need to invest in infrastructure to make their gateway suitable for airship movements, the majority of the infrastructure already exists to serve the established truck, air, or rail modes in their corridor.

Transport always seeks the easiest, shortest and lowest cost corridors, but most trade routes can offer only two of these three wishes. Figure 4-1 presents a map of the five distinct corridors and their associated primary and supporting gateway to northern Canada. Each of these airship corridors represent service areas of remote communities based on air travel distance.

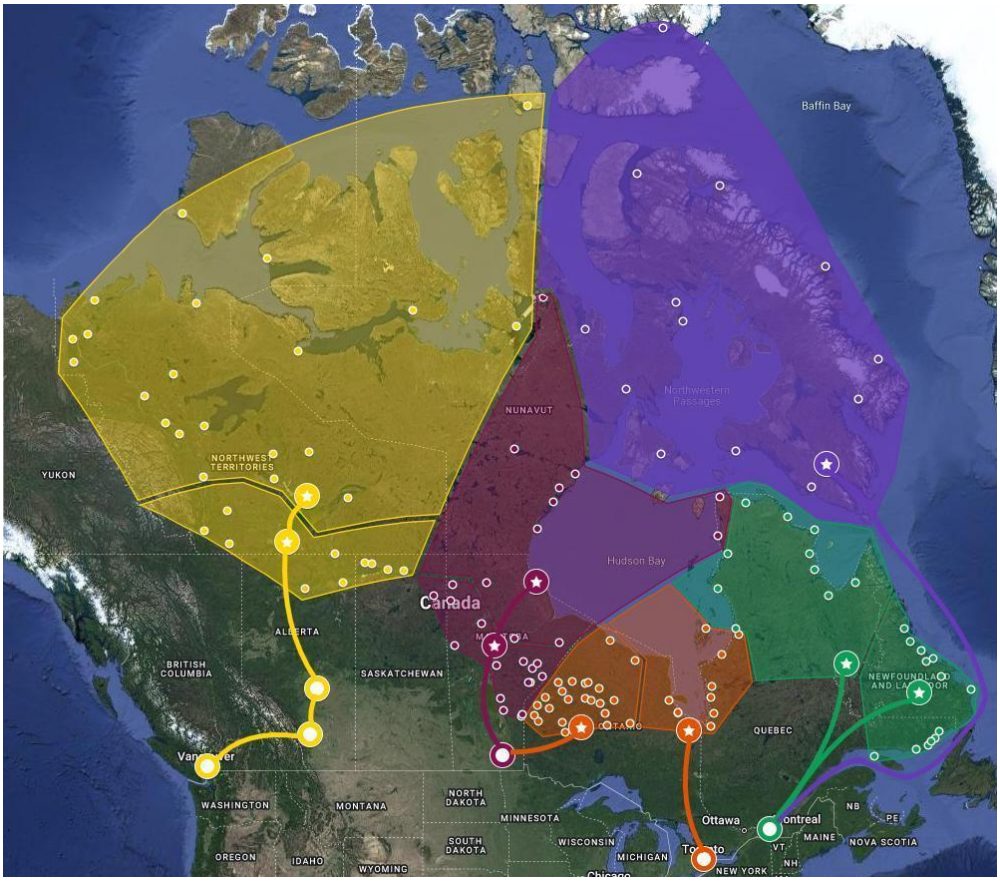
The five airship corridors, with a primary and supporting gateway location are:

1. North West Corridor - Yellowknife / Enterprise with links to Edmonton, Calgary and Vancouver.
2. Central West Corridor - Churchill / Thompson with a link to Winnipeg.
3. Central East Corridor - Moosonee with a link to Toronto / Pickle Lake with a link to Winnipeg.
4. North East Corridor - Schefferville / Happy Valley-Goose Bay with a link to Montreal.
5. North Arctic Corridor - Iqaluit with a sealift link to the Port of Montreal.

The land corridors offer the least cost routes for transshipments from truck or rail to a cargo airship in the first four cases. The gateway at Iqaluit will be served by a sea corridor from the Port of Montreal. Goods will be unloaded at the new dock being constructed at Iqaluit and be transshipped to airships for delivery to its hinterland. These hinterland areas are conceptual, and it is quite possible that communities located near their borders could draw from more than one gateway.

The southern corridors serving existing supply chains will be important contributors to the success of the airship gateways. A combination of Vancouver, Calgary and Edmonton would logistically supply the North West Corridor. Winnipeg would provide service to the Central West Corridor, as well as partial support for the Central East Corridor through Pickle Lake. A route from Toronto, possibly via Timmins would supply the Moosonee portion of the Central East Corridor. Montreal would serve the North East Corridor along with support for the Arctic North Corridor through sealift service to Iqaluit.

Figure 4-1 Cargo Airship Logistics Corridors and Airship Gateway Locations



The next sections provide a thumbnail sketch of the gateways and information on the remote communities in their hinterlands. A more detailed description of each gateway is presented in the Appendices. As previously discussed, it is impossible to obtain data on all the freight moving into the remote communities. In many cases, the companies are private and may be in a monopoly position that would make data release impossible. In order to develop a proxy for the freight demand, this study focuses on home construction building materials. The data on population and dwellings is available and houses provide a discrete unit to represent all goods. The assumption, which can be tested and modified if necessary, is that building materials represent 20% of the total freight demand.

For those who are more interested in the airship costs to deliver building materials through the individual corridors, this is presented in Section 5. The following section provides the demand estimates for each of the gateway regions.

4.1 North West Corridor: Yellowknife / Enterprise Gateways

Most of the remote communities in the North West corridor are located along the Mackenzie River Valley. The second gateway at Enterprise would reduce costs by reducing the average distance to cover by air, and also reduce the trucking distance from the southern supply bases through Edmonton.

4.1.1 Yellowknife Gateway and Market Area

A total of 21 communities were identified as being most appropriately served from through Yellowknife. These communities represent a total population of 14,387 people (2021 census) and growing. The average air distance for this group of communities is 862 kms from the gateway. Yellowknife has a

population of 20,340 (2021 Census). As the primary service location, Yellowknife has the existing infrastructure and population base to allow quick uptake.

Yellowknife's airport is a 5 minute drive or approximately 5km from the downtown core. Yellowknife serves as an air transportation hub for the rest of the territory plus the western portion of Nunavut especially the Kitikmeot region including the communities of Cambridge Bay, Kugluktuk, Taloyoak, Gjoa Haven and Kuugaruk.

Yellowknife is connected to southern supply bases through the MacKenzie Highway Frontier Trail. Other roads further north out of Yellowknife such as Highway 3 and Highway 4 heading east for approximately 70 km. Most of the roads off of the main highways are unpaved. In addition, ice roads are usable in wintertime when the rivers and lakes are sufficiently frozen.

Figure 4-2 Market Area of North West Corridor: Yellowknife Gateway

Yellowknife, NT	
Population	14387
Avg Air Distance (AAD)	780 /km
Population Weighted AAD	862 /km
Dwellings	5954
40% rule	2382
Potential housing need (t)	142,896
People per Dwelling	2.42
Occupied Dwellings	4906
People Per Occupied Dwelling	3
Materials per Person (t)	9.9
Total Primary Communities	21
Total Backup Communities	16

As Figure 4-2 illustrates 142,896 tonnes of materials will be needed to bring residences up to par and fill the housing gap. Appendix 10.2.1 provides details of all the communities identified to be served over the Yellowknife gateway.

Yellowknife is an ideal geographic candidate as an airship gateway community. It has the right location, population, connected highway and railway access, and existing air services. Yellowknife is served by clean energy through the NTPC hydroelectric network. More information about Yellowknife and the surrounding area can be found in the appendix.

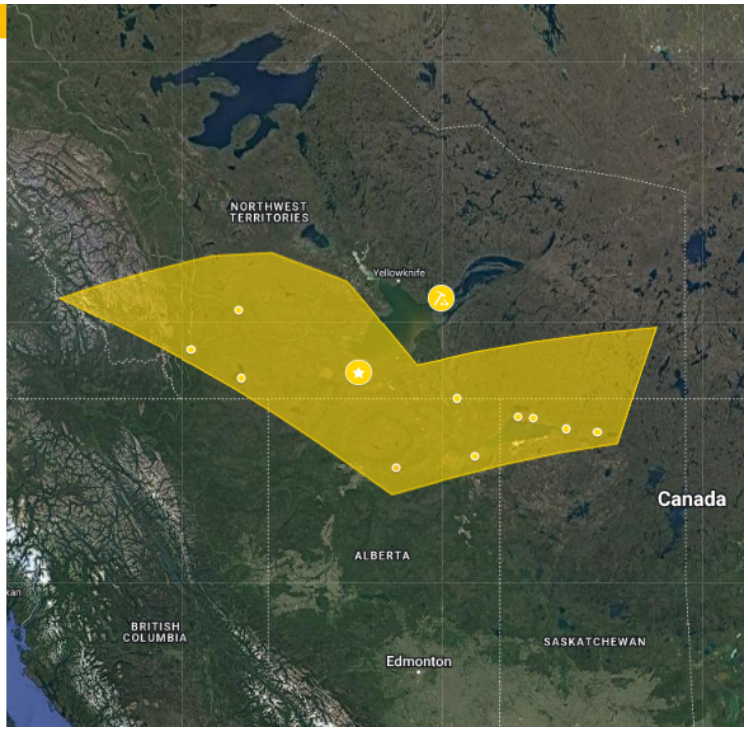
4.1.2 Enterprise Gateway and Market Area

Enterprise has a population of 75 individuals (2021 Census). Its distance to southern communities is not much different than from Yellowknife, but Enterprise is closer to the Alberta highway network. Expansion of this gateway would depend on the capacity at Yellowknife or until a transhipment facility at Enterprise could be established. Figure 4-3 lists the 10 communities that would be lower cost to serve out of Enterprise. This area represents a total of 8,085 people (2021 census) and the average air distance to these communities from Enterprise is 310 kms. These communities would require about 35,232 tonnes of

building materials to bring the 40% of houses now identified as uninhabitable up to acceptable living standards.

Figure 4-3 Market Area of North West Corridor: Enterprise Gateway

Enterprise, NT	
Population	8085
Avg Air Distance (AAD)	373 /km
Population Weighted AAD	310 /km
Dwellings	2936
40% rule	1174
Potential housing need (t)	70464
People per Dwelling	2.75
Occupied Dwellings	2455
People Per Occupied Dwelling	3.29
Materials per Person (t)	8.7
Total Primary Communities	10
Total Backup Communities	17



Appendix 10.2.2 provides details of all the communities identified to be served over the Enterprise gateway.

The location and existing connected road and rail networks make Enterprise an ideal location for a gateway. Enterprise has a connected paved road system on the Mackenzie Highway, and receives railway service from the Mackenzie Northern Railway. Enterprise does not currently have an airport. Enterprise is served by clean energy through the NTPC hydroelectric network. The rail connection and barge service operates through Hay River for oversized cargo to be shipped farther north.

4.2 Central West Corridor: Churchill / Thompson Gateways

The gateways at Churchill and Thompson provide coverage to northern Manitoba and the Kivalliq region of Nunavut, with the possibility of a few communities in northern Quebec. The large number of communities with close proximity to Thompson makes this one of the least cost areas to serve.

4.2.1 Churchill Gateway and Market Area

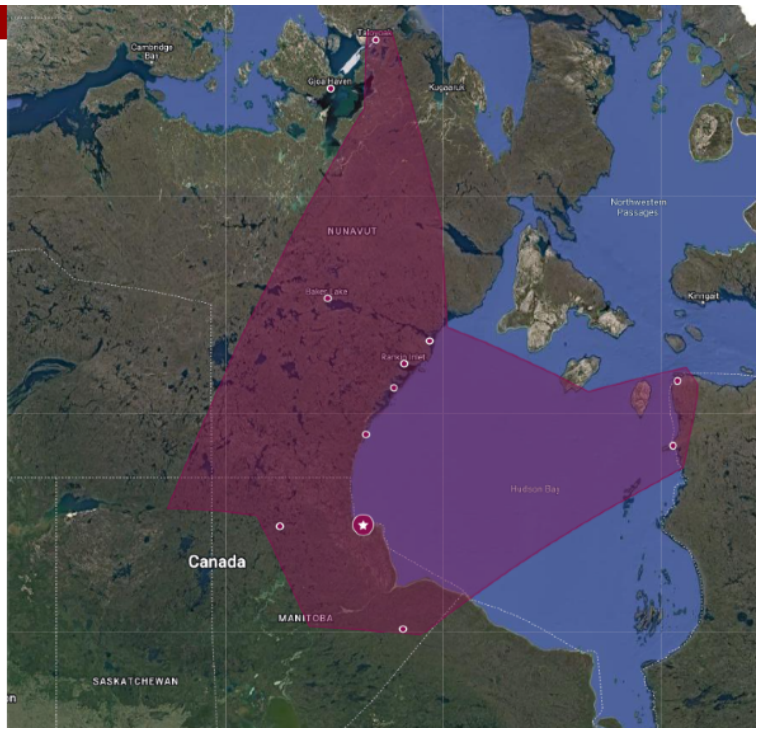
A total of 10 communities were identified as being most appropriately served from this location which represents a total of 12,098 people (2021 census) and growing. The average air distance for this group of communities is 531 kms from the hub point. Churchill has a population of 870 (2021 Census). As a primary service location, Churchill has existing infrastructure to allow quick uptake.

Churchill is the final service point for The Hudson Bay Railway, owned and operated by the Arctic Gateway Group. This railway route is the only affordable year-round, all-weather mode of transportation for both passenger and freight trains to access several northern Manitoba communities. The railway network connects with CN's network in The Pas and also connects to Winnipeg.

Churchill airport is formerly a United States and Canadian military base, and is serviced by Calm Air operating scheduled flights connecting Churchill to Winnipeg. The airport is located 5.6 km or 3.5 miles east southeast of the community of Churchill. Churchill is served by clean energy through Manitoba's hydro electric transmission network.

Figure 4-4 Market Area of Central West Corridor: Churchill Gateway

Churchill, MB	
Population	12098
Avg Air Distance (AAD)	531 /km
Population Weighted AAD	531 /km
Dwellings	3571
40% rule	1428
Potential housing need (t)	85704
People per Dwelling	3.4
Occupied Dwellings	2954
People Per Occupied Dwelling	4.1
Materials per Person (t)	7.1
Total Primary Communities	10
Total Backup Communities	32



As shown in Figure 4-4, about 85,704 tonnes of materials will be needed to allow them to bring the 40% of houses identified as uninhabitable up to par.

Appendix 10.2.3 provides details of all the communities identified to be served over the Churchill gateway. Churchill is an ideal geographic candidate as an airship gateway community. It has the right location, population, connected railway access, deepwater port, clean energy and existing air services. Churchill is already an existing transport gateway for other modes, airships just another option.

4.2.2 Thompson Gateway and Market Area

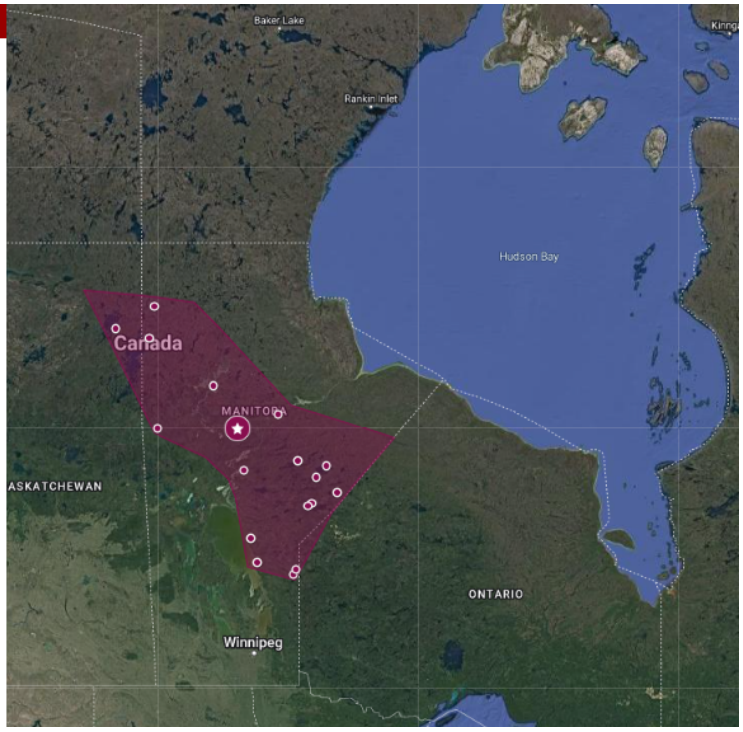
A total of 17 communities were identified as being most appropriately served from this location which represents a total of 17,315 people (2021 census) and growing. The average air distance for this group of communities is 259 kms from the hub point. Thompson has a population of 13,035 (2021 Census). As an important secondary location and backup service provider for the Churchill gateway, Thompson has some important advantages.

The city of Thompson has connected highway service as well as rail access. The community also has a municipal airport served with daily flights by Calm Air. The airport is located 7.2 km or 4.5 miles North North East of the community of Thompson.

Thompson is an ideal geographic candidate as an airship gateway community, both primary and as a backup. It has a good northern location, larger population, connected railway access, clean energy and existing air services.

Figure 4-5 Market Area of Central West Corridor: Thompson Gateway

Thompson, MB	
Population	17315
Avg Air Distance (AAD)	259 /km
Population Weighted AAD	259 /km
Dwellings	4028
40% rule	1611
Potential housing need (t)	96672
People per Dwelling	4.3
Occupied Dwellings	3571
People Per Occupied Dwelling	4.85
Materials per Person (t)	5.6
Total Primary Communities	17
Total Backup Communities	2



As shown in Figure 4-5, the communities identified would require about 96,672 tonnes of materials to allow them to bring the 40% of houses identified as uninhabitable up to par.

Appendix 10.2.4 provides details of all the communities identified to be served via Thompson. Most of these communities are within 350 kilometers of the gateway which means that multiple trips per day could be completed.

4.3 Central East Corridor: Pickle Lake / Moosonee Gateways

This is a relatively more compact area with a higher population that makes it easier to serve.

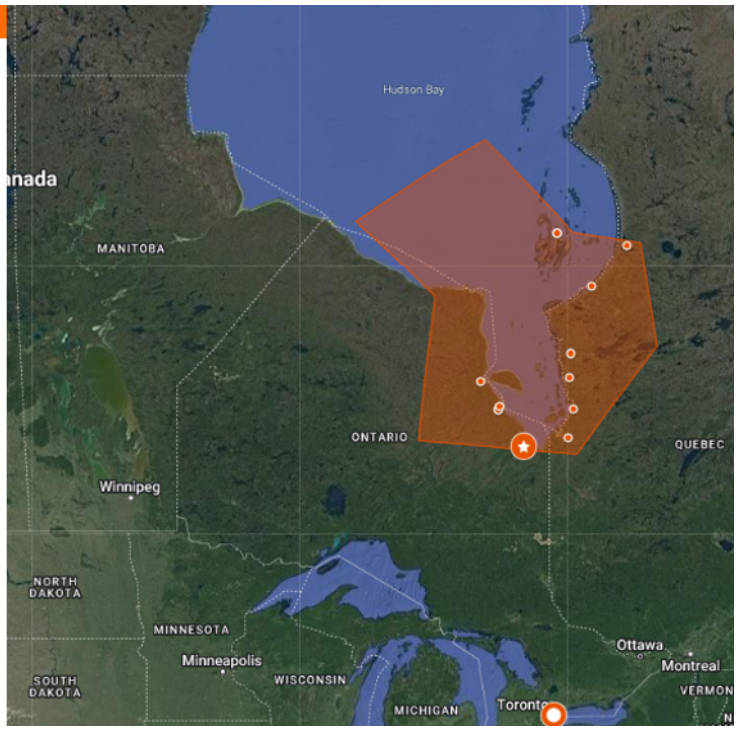
4.3.1 Moosonee Gateway and Market Area

A total of 10 communities were identified as being most appropriately served from this location which represents a total of 16,415 people (2021 census) and growing. The average air distance for this group of communities is 260 kms from the hub point. Moosonee has a population of 1,471 (2021 Census). While there is no road access, it is accessible by plane, train and has a port. Moosonee serves as a gateway to Moose Factory or communities further up the western coast of James Bay.

In 1932, the Temiskaming and Northern Ontario Railway was extended from Cochrane to Moose River Post which was later renamed to Moosonee. Moosonee is the most Northern service point for the Ontario Northland Railway, owned and operated by the Ontario Northland Transportation Commission. This railway route is the only affordable year-round, all-weather mode of transportation for both passenger and freight trains. Figure 4-6 shows the service area that Moosonee gateway is in an ideal position to serve.

Figure 4-6 Market Area of Central East Corridor Moosonee

Moosonee, ON	
Population	16415
Avg Air Distance (AAD)	300 /km
Population Weighted AAD	260 /km
Dwellings	4293
40% rule	1717
Potential housing need (t)	103032
People per Dwelling	3.8
Occupied Dwellings	3714
People Per Occupied Dwelling	4.4
Materials per Person (t)	6.3
Total Primary Communities	10
Total Backup Communities	10



The Moosonee airport is located 3 km northwest of the town and occupies approximately 212 hectares. Airport handles scheduled passenger flights, services both private and commercial helicopter and fixed aircraft. The airport is owned and operated by the Town. Moosonee is served by clean energy by Ontarios's hydroelectric network. Appendix 10.2.5 provides details of all the communities identified to be served over the Moosonee gateway.

This region requires about 103,032 tonnes of materials to allow them to bring the 40% of houses identified as uninhabitable up to par.

4.3.2 Pickle Lake Gateway and Market Area

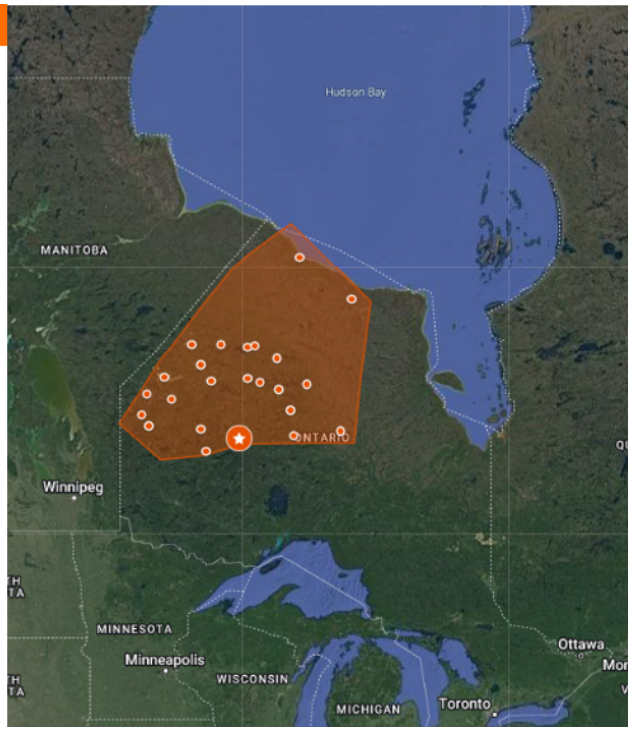
A total of 23 communities were identified as being most appropriately served from this location which represents a total of 16,183 people (2021 census) and growing. The average air distance for this group of communities is 249 kms from the gateway. Pickle Lake has a population of 398 (2021 Census). The community is served by a fully paved highway and is a gateway community for the current winter roads network serving Northern Ontario. Pickle Lake also has a large airport and existing service equipment as an important distribution hub year-round.

The Pickle Lake airport is located 3 km Southwest of the town. The airport handles scheduled passenger flights, services both private and commercial helicopters and fixed aircraft. The airport is owned and operated by the Government of Ontario. Pickle Lake is a part of the electrical grid controlled by the Ontario Power Authority. The power supplied is from a mixture of different generation types.

Pickle Lake is already a critical distribution point for the North already and airships would add another dimension to the existing offerings. More information about Pickle Lake and the surrounding area can be found in the appendix.

Figure 4-7 Market Area of Central East Corridor Pickle Lake

Pickle Lake, ON	
Population	16183
Avg Air Distance (AAD)	250 /km
Population Weighted AAD	249 /km
Dwellings	4467
40% rule	1787
Potential housing need (t)	107208
People per Dwelling	3.6
Occupied Dwellings	3902
People Per Occupied Dwelling	4
Materials per Person (t)	6.6
Total Primary Communities	23
Total Backup Communities	3



As shown in Figure 4-7, the communities identified would require about 107,208 tonnes of materials to allow them to bring the 40% of houses identified as uninhabitable up to par.

Appendix 10.2.6 provides details of all the communities identified to be served from the Pickle Lake gateway. At the present time, most of the locations are served by winter roads that are connected to this gateway. Although a few locations are distant, the majority are under 300 kilometers by air. It is also worth noting that the populations of many of these communities are relatively small.

4.4 North East Corridor: Schefferville / Happy Valley Gateways

The North East Corridor serves only Quebec and Labrador. The communities served from Schefferville are mainly located around Ungava Bay. The Happy Valley gateway serves those in Labrador. In both cases, these are coastal communities that can also receive goods via the annual sealift season. It is worth noting however, that the summer service depends on the ice conditions along the Labrador coast. The dependability of deliveries can leave projects delayed and deadlines missed.

This area also has significant mineral potential that could expand the operations of the airships serving these gateways. An example is the Torngat Mine, which is discussed in more detail in Section 5. More freight will be coming south from this rare earth mine than returning to operate the mine. This could create an opportunity to combine delivery to the north to the communities in Ungava Bay and on the Labrador coast with mineral concentrates coming south. The market areas for the two gateways are described below.

4.4.1 Schefferville Gateway and Market Area

A total of 10 communities were identified as being most appropriately served from this location which represents a total of 11,779 people (2021 census) and growing. The average air distance for this group of communities is 683 kms from the hub point.

Current population is 244 (2021 census) which is up from 130 in 2016. At its peak in the late 1960's, Schefferville had 5,000 residents. When the iron ore mine closed in 1982, most of the 4,000 non-indigenous residents left.

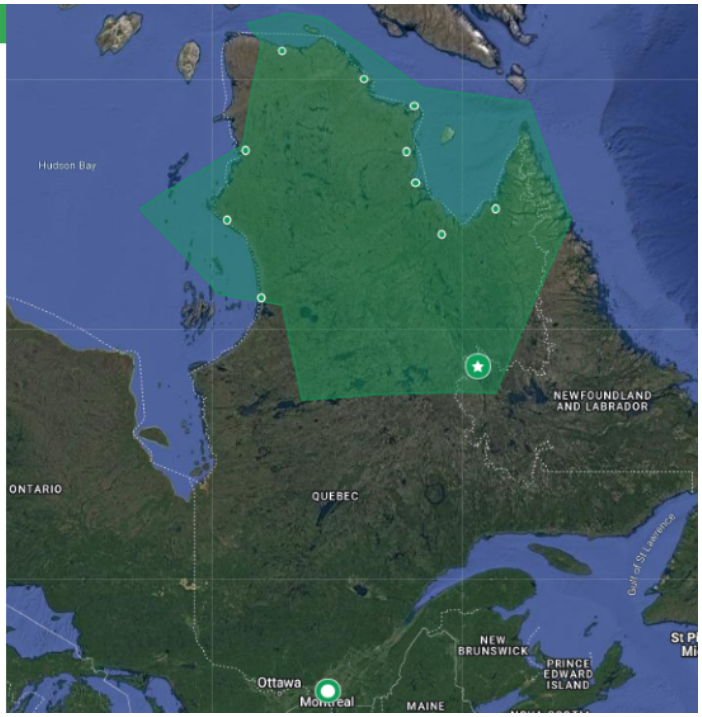
Schefferville has transportation access through connected railway and air transportation services. The airport is situated on the east-south end of Schefferville. It primarily handles flights from Air Inuit for cargo and passenger-cargo combi flights. There are approximately four scheduled flights a week.

Schefferville is the northern terminus of Tshiuetin Rail Transportation with service to Sept-Iles. Approximately 500 km of train track. During the winter there is one train a week from Sept-Ilse to Schefferville and the Schefferville train returns to Sept-Ilse the following day.

Schefferville is served clean energy through Kawawachikamach Energy Services Inc. ("KESI") operates the electricity generating and distribution system for Schefferville and Kawawachikamach under contracts from Hydro-Québec and Nalcor (formerly Newfoundland & Labrador Hydro).

Figure 4-8 Market Area of Schefferville portion of the North East Corridor

Schefferville, QC	
Population	11779
Avg Air Distance (AAD)	674 /km
Population Weighted AAD	683 /km
Dwellings	4227
40% rule	1691
Potential housing need (t)	101448
People per Dwelling	2.8
Occupied Dwellings	3523
People Per Occupied Dwelling	3
Materials per Person (t)	8.6
Total Primary Communities	10
Total Backup Communities	27



As shown in Figure 4-8, the 10 primary communities would require about 101,448 tonnes of materials to allow them to bring the 40% of houses identified as uninhabitable up to par. Several communities have populations over 1,500 people, but air distances from Schefferville are generally over 500 kilometers. This allows a good volume of freight, but fewer trips per day. Appendix 10.2.7 provides details of all the communities identified to be served via the Schefferville gateway. Schefferville is also located well to support the Iqaluit corridor as the main backup for the majority of the planned service communities.

4.4.2 Happy Valley Gateway and Market Area

A total of 13 communities were identified as being most appropriately served from this location which represents a total of 5,718 people (2021 census) and growing. The average air distance for this group of communities is 292 kms from the hub point.

Current population is listed at 8040 (2021 census) which is down from 8109 in 2016. Incorporated in 1973, it comprises the former town of Happy Valley and the Local Improvement District of Goose Bay.

Built on a large sandy plateau in 1941, the town is home to the largest military air base in northeastern North America.

Happy Valley has transportation access through a connected paved highway, air transportation, and water transportation services. Goose Bay Airport is fully equipped for commercial travelers, offering a range of cargo, subleasing, aeronautics and industrial services. The airport is situated in the middle of the community. Also located 7 kilometers from Goose Bay Airport, there is a full service water drome. Air Borealis & Pal Airlines operate air cargo services from this location.

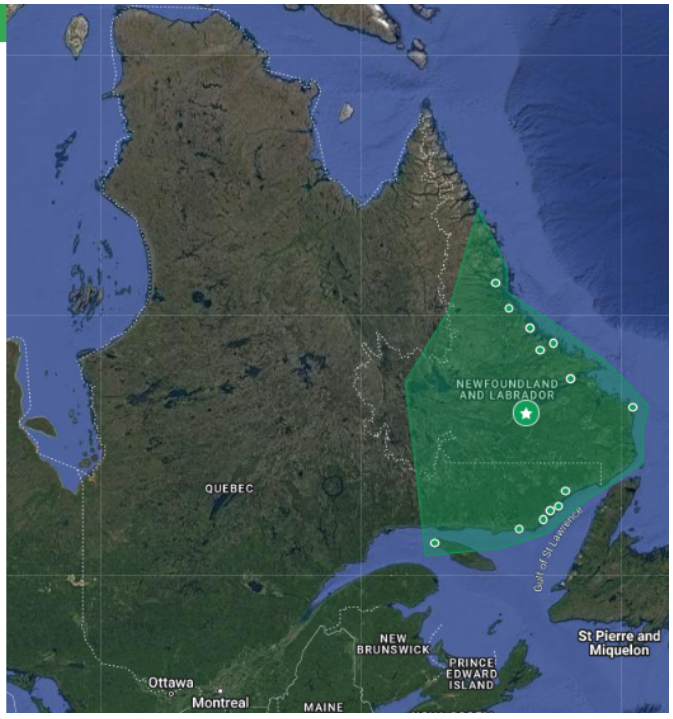
Happy Valley and Goose Bay are connected by the Trans-Labrador Highway with Labrador City and Baie-Comeau in Quebec. The road was extended south to link with an existing road from the Blanc Sablon-St Barbe ferry. It opened in December 2009. Since 1992, the road from Baie-Comeau to Wabush has been connected to an open route year-round to Happy Valley-Goose Bay.

The town is served by boat and container ship via Newfoundland and the port of Montreal. Most of the town's supplies transported by container vessels are brought to the docking facilities located at Terrington Basin. These facilities are operated by Transport Canada. The shipping season usually lasts from June to December. In the summer, a ferry service connects Happy Valley-Goose Bay with Cartwright. Electrical power for the town is provided by Nalcor which generates almost 96% of its electricity from Hydro sources.

As shown in Figure 4-9 the communities identified would require about 62,160 tonnes of materials to allow them to bring the 40% of houses identified as uninhabitable up to par.

Figure 4-9 Market Area of Happy Valley portion of the North East Corridor

Happy Valley, NL	
Population	5718
Avg Air Distance (AAD)	288 /km
Population Weighted AAD	292 /km
Dwellings	2590
40% rule	1036
Potential housing need (t)	62160
People per Dwelling	2.2
Occupied Dwellings	2173
People Per Occupied Dwelling	3
Materials per Person (t)	10.9
Total Primary Communities	13
Total Backup Communities	0



Appendix 10.2.8 provides a list of the populations of the communities to be served via Happy Valley gateway, along with their respective distances. Most of these communities are located within 350 kilometers of the gateway that would permit multiple trips. The populations are relatively small, with all communities having less than 1,000 inhabitants.

4.5 North Arctic Corridor: Iqaluit Gateway

The North Arctic Corridor is unique in this study because it is served by an annual sealift for goods to be transshipped to more northerly communities from the Iqaluit gateway. Given the size and importance of Iqaluit as the capital of Nunavut, it is likely that airship deliveries would be made year-round from either the Churchill or Schefferville gateways. This is not modeled in the current report, but could easily be added.

4.5.1 Iqaluit Gateway and Market Area

A total of 14 communities (including Iqaluit itself) were identified as being most appropriately served from this location which represents a total of 21,455 people (2021 census) and growing. The weighted average air distance for this group of communities is 499 kms from the hub point.

The city of Iqaluit is located on south Baffin Island at the northern end of Frobisher Bay near the mouth of the Sylvia Grinnell River. Current population is 7429 (2021 census). Approximately 60% of the population are Inuit including Inuit from Iqaluit and Inuit from every community of Nunavut and other Inuit regions. The average age is 30 years of age.

Iqaluit has transportation access through connected water and air transportation services. They receive cargo by ship between early July to the end of October – depending on conditions and the shipping companies schedule for deliveries. The Iqaluit deep-sea port should be completed and operational in the summer of 2023. Ships will be able to off-load cargo with the use of cranes, as this is not a roll on and roll off port. Iqaluit has an international airport that serves as an air transportation hub for the Qikiqtani Region and territory with daily flights from Ottawa, daily flights to Qikiqtani communities and flights to the west (Rankin Inlet and Yellowknife) three times a week.

Iqaluit's power is generated by diesel generators. The Government of Nunavut purchases approximately 220,000,000 liters of petroleum products a year. While Iqaluit is one of twenty-five communities with approximately 25% of the territorial population, it consumes ½ of the petroleum product each year. Of the 110M liters of petroleum products used, 1/3 is on electricity, 1/3 on heating and 1/3 for vehicles.

Figure 4-10 shows that about 168,1442 tonnes of materials would be needed to bring 40% of houses identified as uninhabitable up to par.

Figure 4-10 Market Area of the North Arctic Corridor

Iqaluit, NU	
Population	21455
Avg Air Distance (AAD)	726 /km
Population Weighted AAD	499 /km
Dwellings	7006
40% rule	2802
Potential housing need (t)	168144
People per Dwelling	3
Occupied Dwellings	5898
People Per Occupied Dwelling	3.6
Materials per Person (t)	7.8
Total Primary Communities	14
Total Backup Communities	2

Appendix 10.2.9 provides a list of the populations of the communities to be served via Iqaluit along with their respective distances. Although a few are close-by, the majority have some of the longest distances to be served.

5 AIRSHIP FLEET REQUIREMENTS AND COSTING

The potential freight rates of an airship depend on its size, design and manufacturing costs. At the moment, no cargo airships are operating commercially. The performance and purchase price of an airship can be estimated from engineering data. For operating costs, reliable estimates are available for crew and maintenance wages, fuel prices and other inputs, based on existing aviation operations. The assumptions for the airship cost model are stated, and can be used by any airship developer to derive freight rates for their airships.

As a proxy airship for the cost model, this study uses the BASI airship design for a 30t, 60t and 100t capacity airship. The cost data provided by BASI are used to develop reasonable estimates of airship operations. The acquisition prices of the airships are based on the assumption of factory-level production. The input costs for labour, fuel, etc were developed in consultation with fixed-wing operators who serve the North. In addition a gross profit margin was included. In transportation, the gross profit is typically calculated as an operating ratio. This ratio represents the difference between the operating expenses and revenues, ignoring depreciation. In this study, the operating ratio was set at 0.8, which means that for every dollar of revenue, 20 cents goes toward the overhead and investment return.

These freight rates are designed to provide an estimate, rather than a benchmark. Other airship designs would have different cost profiles, but their freight rates are likely to be of comparable order of magnitude. The intent of this section is to illustrate the relative costs of using cargo airships to serve the North that northerners can compare to what they are paying now.

5.1 Freight Movements to Remote Communities

Studies of housing needs in remote communities have estimated that about 40% of the total dwellings are in need of major structural repairs, or outright replacement. This does not include the needs for a rapidly growing population. Table 5-1 presents the total number of dwellings within the service area of each gateway. These data were calculated in Chapter 4 and the details for each community are presented in the appendix.

Table 5-1 Housing need by corridor

	Population	Avg Air Distance (km)	Population Weighted Avg Air Distance	Dwellings	40% rule	Potential housing need (t)
North West Corridor						
Yellowknife, NT	**14387**	**780**	**862**	**5954**	**2382**	**142,896**
Enterprise, NT	**8085**	**373**	**310**	**2936**	**1174.4**	**70,464**
Total	**22472**	**577**		**8890**	**3556**	**213,360**
Central West Corridor						
Churchill, MB	**12098**	**531**	**531**	**3571**	**1428**	**85,704**
Thompson, MB	**17315**	**259**	**259**	**4028**	**1611.2**	**96,672**
Total	**29413**	**395**		**7599**	**3040**	**182,376**
Central East Corridor						
Pickle Lake, ON	**16183**	**250**	**249**	**4467**	**1786.8**	**107,208**
Moosonee, ON	**16415**	**300**	**260**	**4293**	**1717.2**	**103,032**
Total	**32598**	**275**		**8760**	**3504**	**210,240**
North East Corridor						
Schefferville, QC	**11779**	**674**	**683**	**4227**	**1690.8**	**101,448**

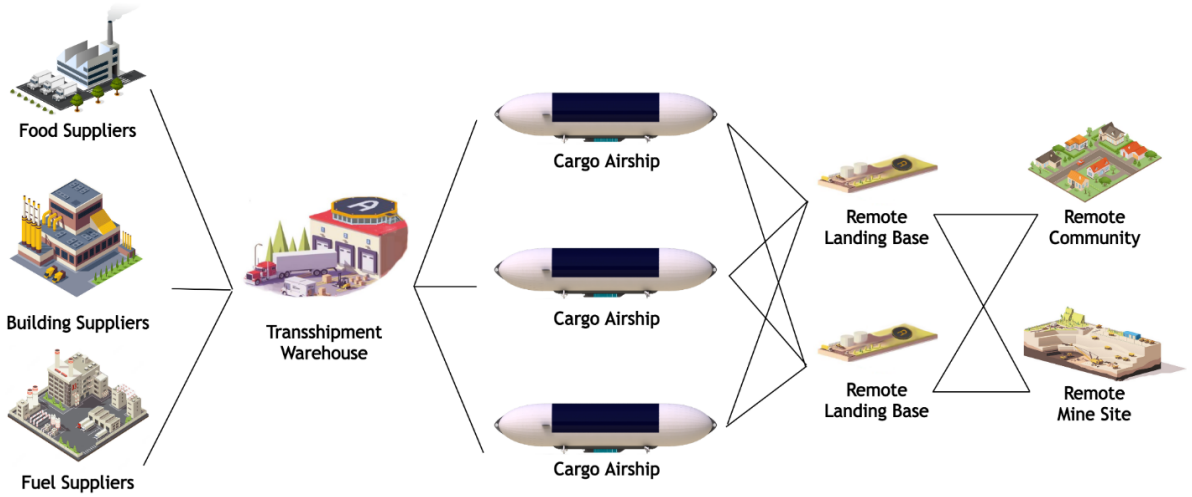
	Population	Avg Air Distance (km)	Population Weighted Avg Air Distance	Dwellings	40% rule	Potential housing need (t)
Happy Valley, NL	**5718**	**288**	**292**	**2590**	**1036.0**	**62,160**
Total	**17497**	**481**		**6817**	**2727**	**163,608**
North Arctic Corridor						
Iqaluit, NU	**21455**	**726**	**499**	**7006**	**2802.4**	**168,144**
Total	**21455**	**726**		**7006**	**2802.4**	**168,144**

The North West Corridor and the Central East Corridor have the largest demands for building materials, but all the communities have significant demands. Initially, they would be served out of the primary gateway. Once a service is established, the secondary gateway could take about half of the traffic and reduce costs.

Although different airship designs have unique solutions for ground-handling and transhipping freight from trucks to airships, they will be operating from and to the same locations. Some airships are designed to land without a prepared base. The BASI airship operates from BARDs. Figure 5-1 presents a cargo airship transportation system and the logistical model for serving the remote communities based on the BASI transportation system.

In this conceptual supply chain model, goods are transported from suppliers in the south to a central warehouse where truckloads are built to be delivered directly to transshipment gateways. If volumes are sufficient, full truckloads could be dispatched directly from shippers to the gateway locations. The trucks are transhipped into cargo airships at the gateway BARD. They are then delivered to a BARD at the destination remote communities or a mining camp where the process is reversed.

Figure 5-1 Cargo Airships Supply Chain from Gateways to Receivers



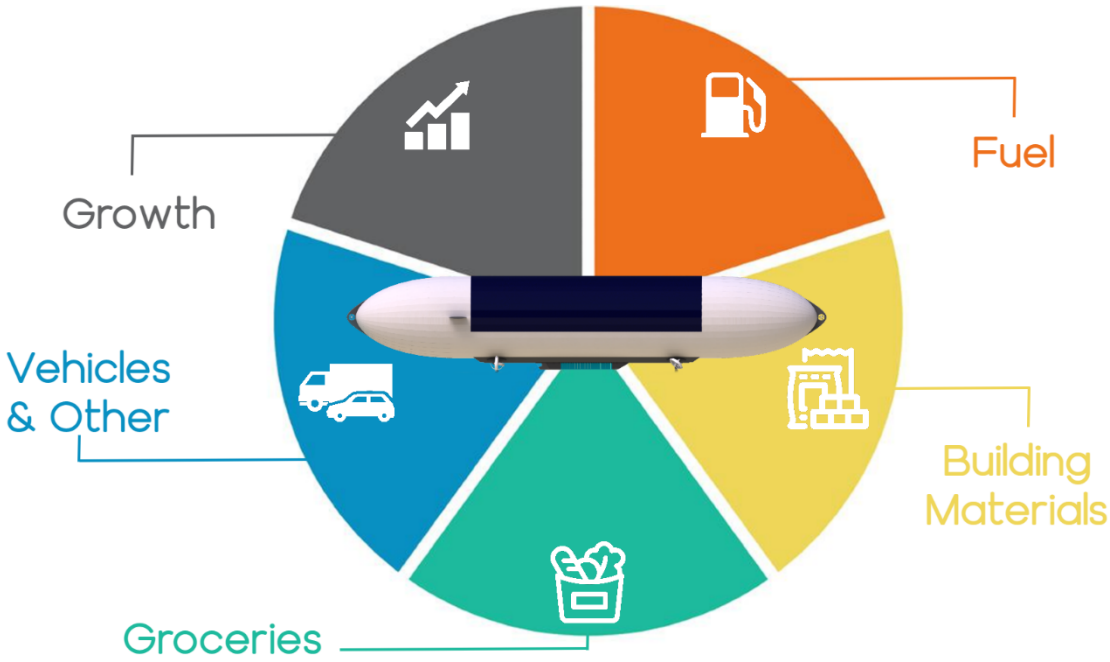
The proportions are difficult to envision from such diagrams, but the airship is approximately 200 metres long, and the Buoyant Aircraft Rotating Deck (BARD) is 35 metres in diameter.

Airships have a constant lift, in this case 30t. If the return load is less than 30t, then water is added to provide the correct weight for flight. Airships that operate between fixed bases can have a supply of water available to serve as ballast.

The BARD has a loading dock for transshipment to trucks, ground-power to operate the turntable and electrical power for the airship when docked. Other peripherals would be a storage tank to hold the fuel for subsequent delivery, and shelter for ground-handling equipment.

The demand for building materials is used as a proxy for the total demand at each location. Figure 5-2 illustrates the assumption of freight demand in the remote communities. Building materials represent approximately 20% of the net demand by weight for each community. Another 20% would be made up by groceries (food, paper products, etc.). Vehicles and other large items (e.g. household furnishing) would account for 20%. Fuel for vehicles and heating (diesel and gasoline) represents 20%. Finally, another 20% of freight would represent the general growth in demand that results from lower freight rates and year-round access to supplies. Based on this demand profile, a demand estimate is made for the number of cargo airships required.

Figure 5-2 Expected Distribution of Freight Demand in the Remote Communities



The number of airships demanded depends on the number of roundtrips the airships can make and their cargo capacity. The utilization of the 30t airship is based on 300 days of operations, with 1 to 1.5-hour transshipment time, and a cruise speed of 150 kmph. The number of roundtrips depends on the average distance of haul. The North West corridor has average mission lengths that are three times longer than the Central East corridor. The Yellowknife gateway could obtain 2.3 trips per day, while the Pickle Lake gateway could do 4.9 trips per day. However, each of the corridors could sustain a fleet of at least 3 airships operating year-round.

Table 5-2 presents the forecast demand for 30t cargo airships required for the first ten years, in the corridors to move building materials and supplies to the remote communities. A total of 18 airships are required. This is a sufficient demand to sustain a regular service and provide a base number for manufacturing. Of course, a fewer number of airships would be required if they were larger, but the absorption capacity of the remote communities must also be kept in mind. Most communities would not wish to receive more than 30t per trip.

Table 5-2 Aggregate Average Airship Demand for 10-year Forecast Period

	10-year Demand Building Materials	10-year Demand For Other Goods	10-year Demand Total	Annual Average Demand	Airship Trips per day	300-day Tonnage	Number 30t Airships
North West Corridor							
Yellowknife, NT	142,896	714,480	857,376	85,738	2.3	20,700	4.1
Enterprise, NT	70,464	352,320	422,784	42,278	4.4	39,600	1.1
Total	**213,360**	**1,066,800**	**1,280,160**	**128,016**			
Central West Corridor							
Churchill, MB	85,704	428,520	514,224	51,422	3.3	29,700	1.7
Thompson, MB	96,672	483,360	580,032	58,003	4.8	43,200	1.3
Total	**182,376**	**911,880**	**1,094,256**	**109,426**			
Central East Corridor							
Pickle Lake, ON	107,208	536,040	643,248	64,325	4.9	44,100	1.5
Moosonee, ON	103,032	515,160	618,192	61,819	4.8	43,200	1.4
Total	**210,240**	**1,051,200**	**1,261,440**	**126,144**			
North East Corridor							
Schefferville, QC	101,448	507,240	608,688	60,869	2.7	24,300	2.5
Happy Valley, NL	62,160	310,800	372,960	37,296	4.6	41,400	0.9
Total	**163,608**	**818,040**	**981,648**	**98,165**			
North Arctic Corridor							
Iqaluit, NU	168,144	840,720	1,008,864	100,886	3.4	30,600	3.3
Total	**168,144**	**840,720**	**1,008,864**	**100,886**			
Total Airship Demand	**937,728**	**4,688,640**	**5,626,368**	**562,637**		**316,800**	**18**

Input cost assumptions for the airship service are presented in Table 5-3. Airships benefit from economies of size in production. The estimated price for a new 30t airship is $50 million. This rises to $75 million for a 60t airship, while the factory price of a 100t airship is $100 million.

Insurance rates will rise in proportion to the airship value, and will likely be much greater for the first few airships than the number used here. This is assumed to be an insurance rate comparable to other aircraft that would develop once the insurance industry has sufficient data to calculate their risk.

Similarly, the depreciation of these aircraft is greater with size and depends on the expected useful life of the airship. In this case, the airships are expected to operate for up to 20 years.

Cruise speed, crew size and maintenance are assumed constant with regard to size. The cost of fuel increases because larger airships have more drag. It is also assumed that ground handling would take somewhat longer, too.

Table 5-3 Airship Specifications and Cost Assumptions

	Airship Price	Insurance /yr (2% value)	Amortized Cost (20 yr)	DEPN per yr (5%)	Speed Km/h	Ops Days	Crew	Crew Flying hr	Fuel Flying hr	Maint Flying hr	Load/ Unload Time
30t Airship	$50 MM	$1 MM	$3.96 MM	$3 MM	150	300	3	$300	$500	$400	1 hr
60t Airship	$75 MM	$2 MM	$5.94 MM	$4 MM	150	300	3	$300	$750	$400	1.25 hr
100t Airship	$100 MM	$2 MM	$7.92 MM	$5 MM	150	300	3	$300	$900	$400	1.50 hr

Table 5-4 lists the costs for the BARDs and Hangars, plus insurance costs. For the purposes of this study, the capital costs for the landing areas and hangars are included in the freight rate calculations. Although airship hangars are still in operation today that were built 100 years ago, the study assumes a 25 year amortization period.

Table 5-4 Airship Ground Infrastructure Cost Assumptions

	Cost	Insurance /yr (2% value)	Amortized Cost (25 yr)
BARD	$2 MM	$0.04 MM	$0.14 MM
Hangar	$50 MM	$1 MM	$4 MM

The infrastructure investments in landing bases (BARDs) and hangars are expected to last 25 years and are amortized at 5% interest rates[27]. Insurance is calculated at 2% replacement value. All the gateways and each community will have a BARD landing system. The hangars will be shared between the gateways.

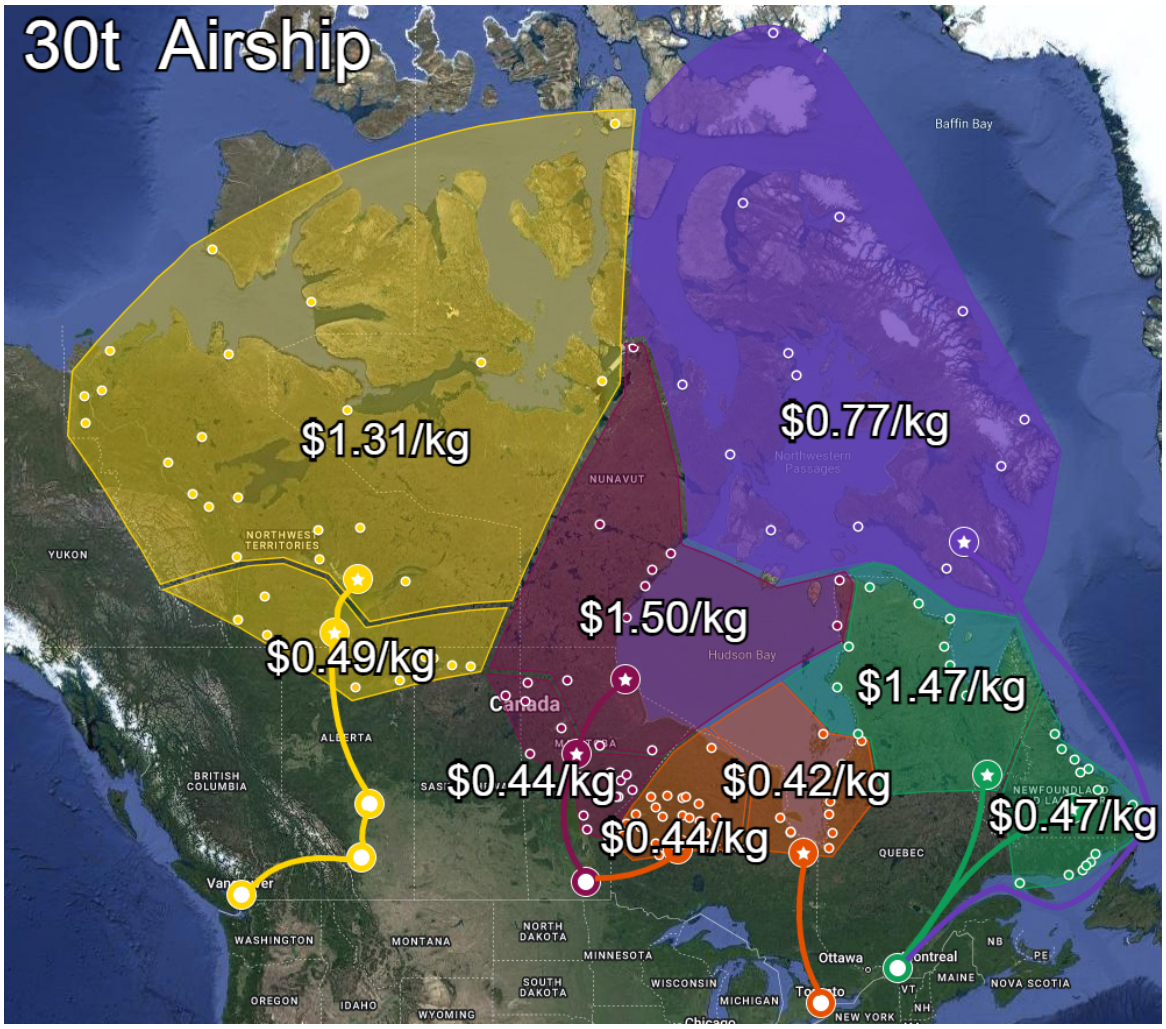
The geographic size of the gateway hinterlands is quite large and many communities have small populations. Averaging only distances for the airships to travel would not represent the reality that larger, closer locations would receive more service. In order to account this, a weighted average of the distances and load was taken for each of the gateways.

Figure 5-3 shown below represents the sustainable freight rates for each zone using 30t airships. The cost of using this size of airship in Manitoba and Ontario is noticeably less than the current fixed wing costs that are over $2/kg. With longer distances to cover the per kg price is considerably higher. The regions served out of Yellowknife and Churchill illustrate this point.

In this model, no backhaul return load is assumed. The cost calculations are for round-trips, returning in ballast. Consequently, these rates apply to one-way trips, with empty returns. To the degree that paying freight could be brought out on the return trip, the inbound freight rate would be reduced.

[27] Airship hangars will actually last much longer than 25 years. Airship hangers that were built in the 1930s are still in use today.

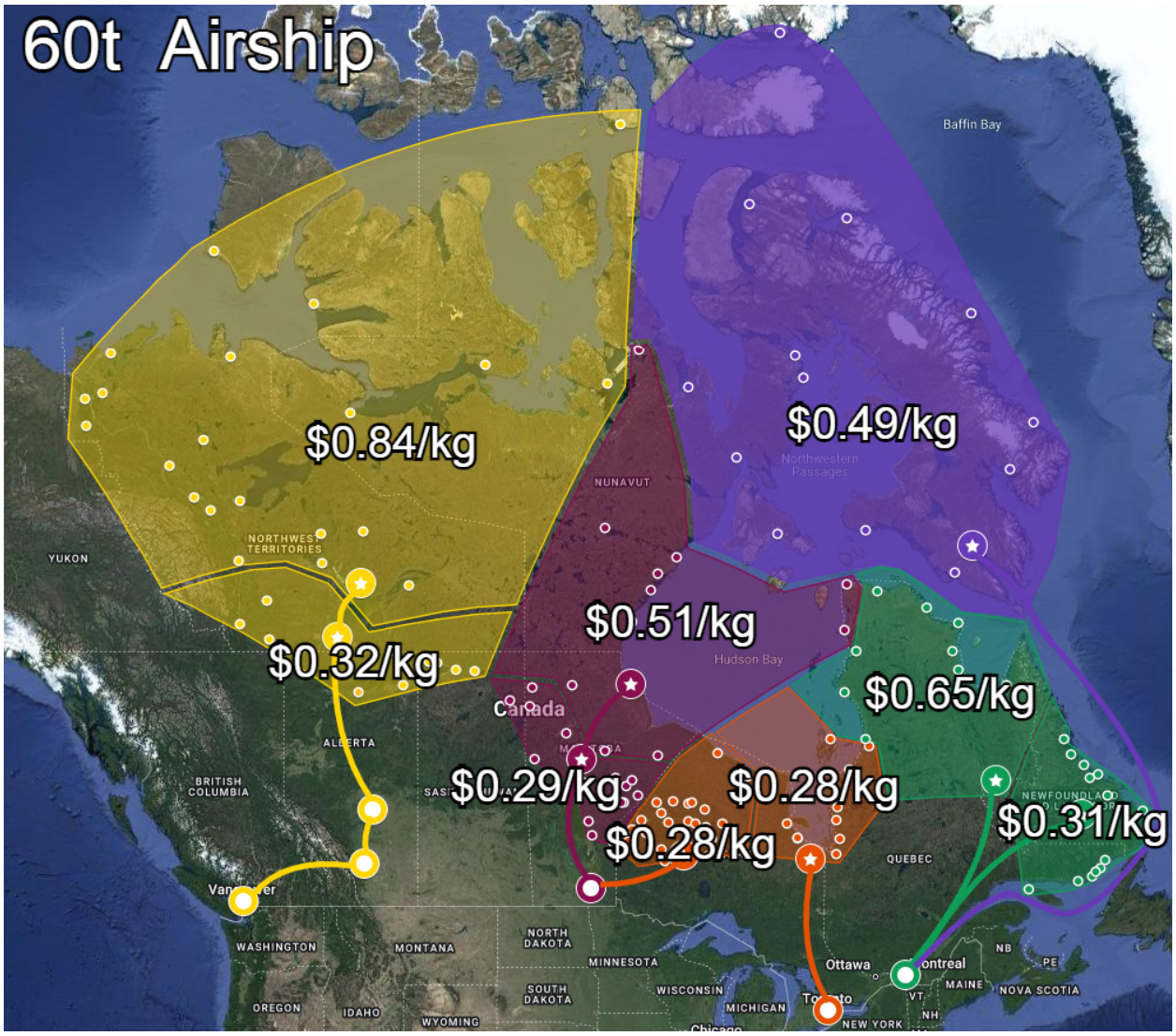
Figure 5-3 30t pricing model



The economic impact of increasing the size of the airship to 60t is presented in Figure 5-4. The per kg cost is reduced considerably in areas such as the Churchill gateway (-$0.99) and Schefferville (-$0.82) and to a lesser extent Yellowknife (-$0.47/kg) and Iqaluit (-$0.22). The gateways with shorter average flying distances also benefit, but the impact is not as dramatic.

It is worth noting that these calculated freight rates only consider weight. In many cases, weight is less important than volume. For example, tractor trailers and airplanes often reach their maximum volume capacity before they hit their weight limit. Airships are different because of their large size, weight is the only restriction. As a result, these freight rates under-estimate the savings for shipping low density products like kitchen cupboards, septic tanks, couches, vehicles, and many other common items.

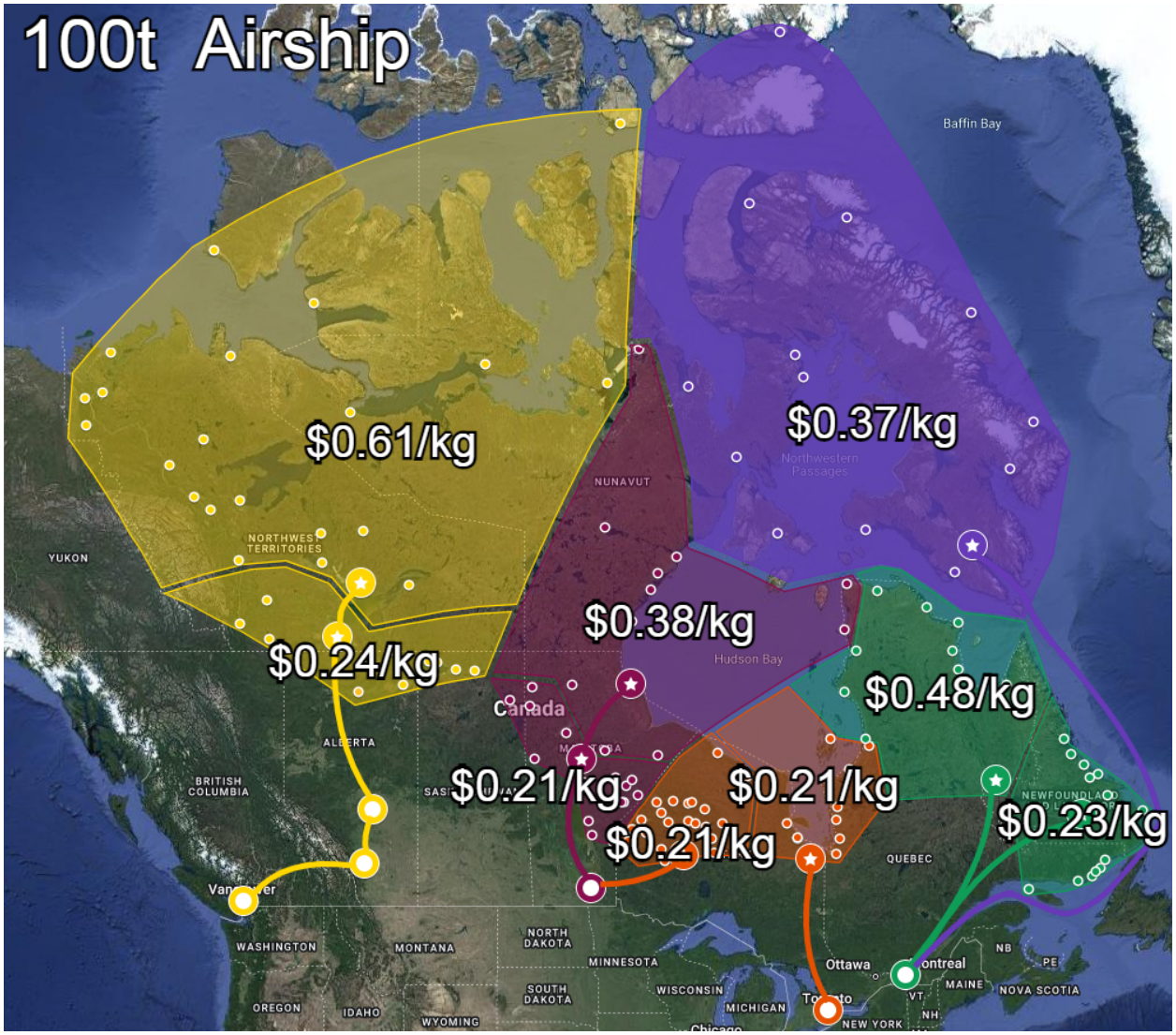
Figure 5-4 60t pricing model



To further illustrate the benefits of size, the freight rates for a third cargo airship that would lift 100t are presented in Figure 5-5. The 100t-lift airship reduces the freight rates for all gateways. In most cases, the freight rates for the 100t-lift airship is only half the freight rate required for a 30t-lift airship. This does not necessarily mean that all airships would be 100t-lift. Many of these communities may be too small to absorb that volume of freight, and would prefer deliveries on a more frequent basis. The larger size airships might be more important to resource developments that have huge volumes to move.

These calculated freight rates ignore another important quality benefit of the airship - gentle handling. Modular homes and other large pieces of freight can be easily damaged when transported by trucks over ice roads. In the case of marine transport, they can require heavy packaging in order to avoid damage. The smooth, vibrationless ride of an airship is guaranteed to deliver goods without damage or need excess packaging that adds to cost.

Figure 5-5 100t pricing model



5.2 Cargo transport options for remote mining

Arctic logistics is expensive because the distances are great, transportation infrastructure is limited, and economic uncertainties are significant. Access is limited to a short window of opportunity when the winter roads are open (generally four to eight weeks depending on latitude). All materials needed for the year's operation of the mine must be moved within the winter road season. The pressures on logistics, heightens the financial risks associated with investing in frontier developments.

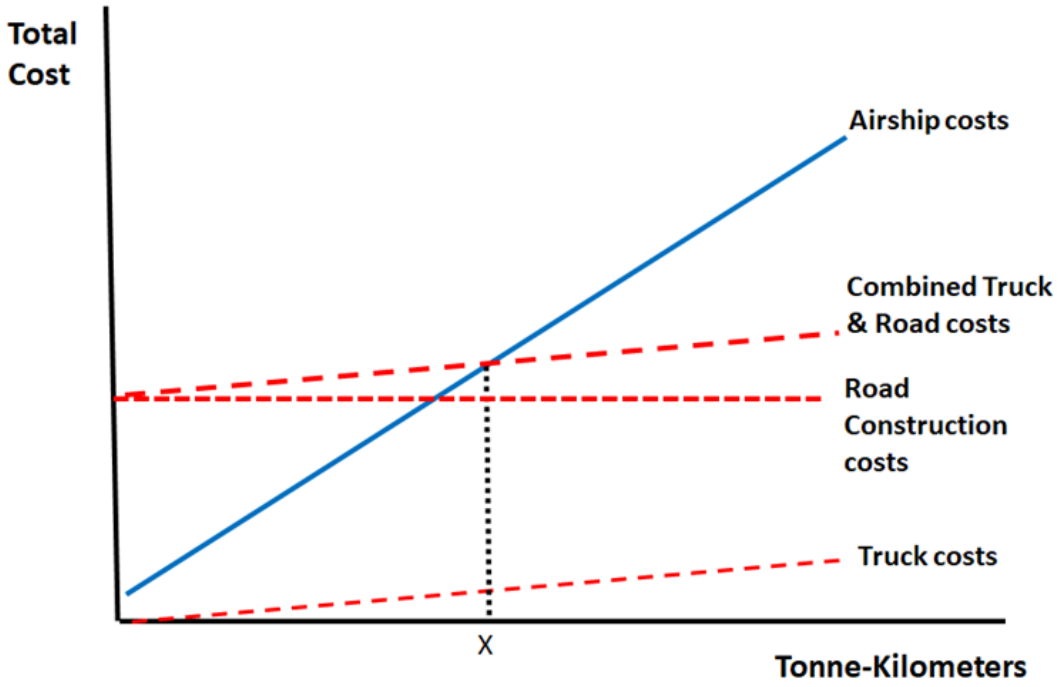
Winter roads can be used to mine diamonds and gold because their output can be flown out weekly in a small airplane. The economics of winter roads do not work for copper, nickel, zinc or rare earth elements. They have greater volumes of output (mineral concentrates) and need year-round transport

Canada has many known deposits of base metals and rare earths that are located far from established infrastructure. They remain untapped because the construction of gravel roads is too expensive. The average cost of building gravel roads is approximately $3 million per kilometer in the Canadian Shield and Arctic regions. A cargo airship is the only other possible means of developing mines in these inaccessible areas.

Trucking is less expensive than airships, but not if all the costs, including building a road to the mine, are included. Which means of transport is better depends on the length of the road, the volume of material to move and the expected economic life of the mine. Most roads can last 40 years with proper maintenance, but if the mine lasts only 15 years, the road becomes a stranded asset. It can also be a liability because in some jurisdictions the company has to remove the road and rehabilitate the area when the mine ends.

A conceptual model that compares the economic trade-off of using cargo airships versus building gravel roads and using trucks is presented in Figure 5-6. The airship costs increase in direct proportion to the volume of mineral concentrates they carry, which is represented as tonne-kilometers (t-km). The costs of building the gravel road are fixed for whatever distance is chosen. The road is represented by a horizontal line. If the road is longer, this line would move up, and down for a shorter road. Maintenance costs could also be included this way.

Figure 5-6 Conceptual Model of Combined Truck & Road Costs vs Cargo airships serving Remote Mining Operations



Source: Prentice, et al. "Cargo Airships Versus All-Weather Roads - A Cost Comparison." *Canadian Transportation Research Forum*. Proceedings Issue: 48th Annual Meeting (2013)

Trucking costs increase in direct proportion to the t-km carried, but at a much lesser slope than the airship. The road construction and maintenance cost is illustrated as fixed at whatever the desired length. A longer road would shift up the construction cost and vice versa. The total costs are calculated by adding the trucking costs to the road construction cost.

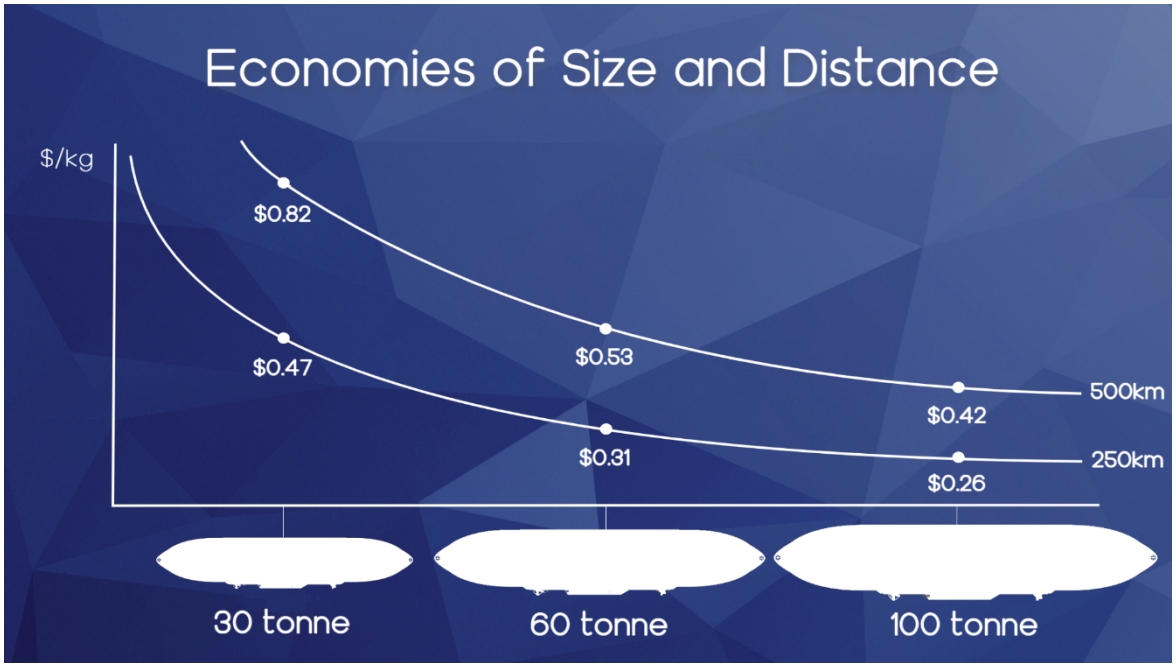
The point where the costs of the airship and the truck-road costs cross determines which mode of transport to use. If the total volume of t-km is less than X, it is more profitable to use cargo airships.

In general this model suggests that if the mine is very large, expected to last a long time, and the distance is relatively short, it is better to build a road. On the other hand, small deposits or larger deposits that are far away from existing road infrastructure, are more economically developed using airships.

Airships in the 30-ton lift size will be quickly exceeded by larger airships once the technology becomes more refined because airships experience significant economies of size. Their unit costs fall as the airships become larger. This also affects the costs related to distance traveled. The shorter the distance,

the more round-trips the airship can make in a given period. This is referred to as cycle time. The greater the distance the longer the cycle time and thus the fewer cycles per year. In order to be economic for longer distances, the airship must be larger. This relationship is illustrated in Figure 5-9. The difference between a 30-ton and a 100-ton airship drops by about half for the same distance, and by about half to cover twice the distance.

Figure 5-7 Costs for 30-ton, 60-ton and 100-ton Airships over 250 km and 500 km Distances



5.3 Freight Movement for Mining: Torngat Case Study

In December 2022, the Canadian Critical Minerals Strategy[28] was unveiled, emphasizing the tremendous potential for Canada in various aspects of critical minerals, including exploration, extraction, processing, manufacturing, and recycling. Natural Resources Minister Wilkinson highlighted the significance of critical minerals as the fundamental building blocks for the green and digital economy. He emphasized that the energy transition and the development of essential technologies like batteries, electric cars, wind turbines, and solar panels heavily rely on critical minerals such as copper, manganese, platinum, rare earth magnets, uranium, lithium, cobalt, nickel, indium, and tellurium. Fortunately, Canada possesses substantial reserves of these critical minerals, along with a skilled workforce, businesses, and communities capable of scaling up their exploration, extraction, processing, manufacturing, and recycling.

Despite Canada's abundance of critical mineral deposits, many of them are situated far from existing infrastructure, leading to numerous undeveloped or stagnant projects. The prohibitive cost of constructing gravel roads or railways poses a significant challenge. While multiuser infrastructure is preferred whenever possible, the geographical separation between deposits and other users often limits such opportunities. However, cargo airships have the potential to unlock the untapped value of Canada's critical mineral deposits.

One crucial distinction between fixed infrastructure, such as roads or railways, and cargo airships is that airships can be a game-changer when it comes to deciding whether to develop a mine. The capital cost of

[28] https://www.canada.ca/en/campaign/critical-minerals-in-canada/canadian-critical-minerals-strategy.html

fixed infrastructure is not only substantial but also irretrievable once invested. Fixed infrastructure cannot be repurposed, unlike airships, which can be redeployed elsewhere. When a mine closes, whether earlier or later than expected, the fixed infrastructure investment may become obsolete or of limited value if others are unable to bear the costs. Additionally, the removal of roads entails high remediation expenses, further burdening the decision to develop a mine. Conversely, airships can be redirected to serve another user if the mine shuts down. Moreover, the time required for permitting and constructing fixed infrastructure is typically measured in several years, whereas airships can significantly expedite the development process, altering the risk profile associated with mining investments.

In addition to the advantages of redeployment and accelerated development, cargo airships can prove to be cost-competitive with fixed infrastructure, depending on the circumstances. However, it is essential to note that not all mining projects will benefit from airship logistics. If road, rail, or port infrastructure already exists or is necessary for other users, utilizing those facilities would generally be more cost-effective than relying on airships. Nevertheless, if existing infrastructure is no longer viable, such as an ice road, or requires replacement, the utilization of airships becomes more favorable in those scenarios.

A hypothetical mining project was examined to compare the feasibility of constructing a road versus employing airships. The parameters of the analysis are as follows:

- The mining project is located in a northern subarctic region and requires the transportation of 200,000 metric tons of ore concentrate from the mine site to a processing plant situated 250 kilometers away.
- The backhaul of supplies and fuel to the mine site, representing 50% of the weight, is also considered.
- The operations in both cases would be year-round, with assumptions for weather days.
- The analysis is done over 22 years, including 2 years for road construction and 20 years of operation. For comparability, airship operations start the same year road operations would start.
- The road would be constructed solely for the mine's use, with limited utilization by others.
- For the road option, the mining company would build and operate a two-lane, all-season gravel road with an upfront capital expenditure of $3 million per kilometer. All capital and operating costs are factored into the analysis.
- Alternatively, for the airship option, the company would contract airship logistics as a service. Each airship with 60 tonne cargo capacity is assumed to cost $100 million, however this cost is anticipated to be lower once an airship industry is fully established. In this situation the use of 2.6 airships would be required. All capital (as a leasing cost) and operating costs, including margins for the airship logistics operating company, are considered.

Table 5-5 Airships versus Roads/Trucks

	Road	**Airships**
Cargo capacity per vehicle (tonnes)	40	60
Speed (km/hour)	40	100
Sum of payments over 22 yrs	$1,118,000,000	$1,304,908,215
NPV of payments @10%	$780,288,903	$555,470,962

The comparison reveals that a mining project requiring a $750 million road would predominantly become first a road project and secondly a mining project. It could likely require government infrastructure funding support as well as significant, stable cash flow. However, even with these considerations, the financial

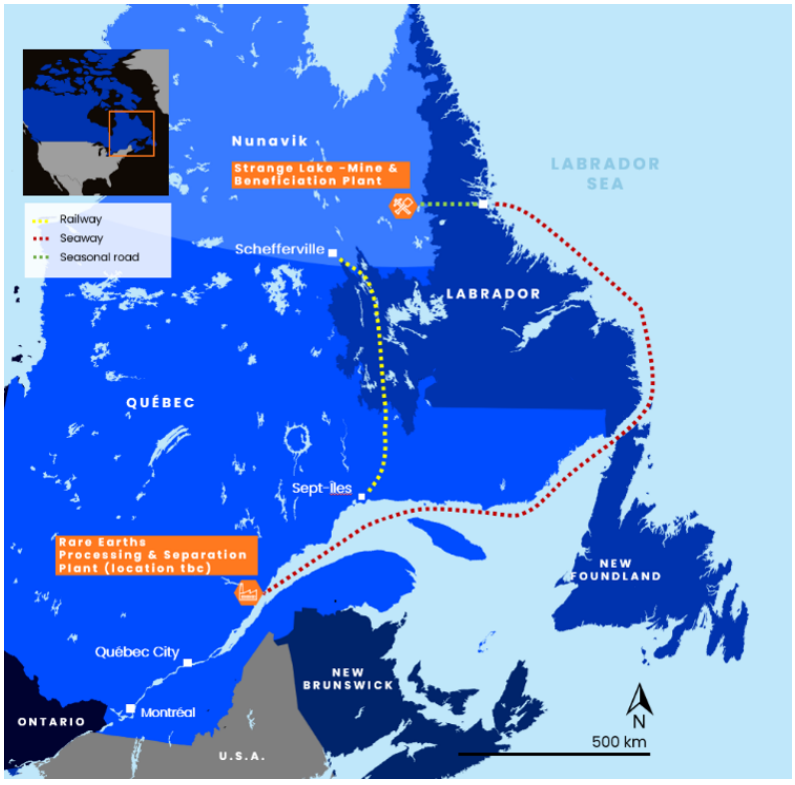
burden remains substantial. In contrast, if airships were commercially available for the aforementioned use case, the investment decision could primarily focus on the mining and processing aspects of the project.

Furthermore, airships offer additional benefits for mining companies. They contribute to a significantly lower carbon footprint, particularly if airships transition to fuel cells. With fuel cells, airships could become a core enabling technology for mining companies striving to achieve net-zero emissions. As demonstrated throughout this report, airships have the potential to facilitate social benefits and opportunities, aligning with mining companies' Indigenous engagement and partnering initiatives.

In the context of a specific mining company, Torngat Metals, they are currently involved in the development of the Strange Lake Rare Earth Project in Nunavik, Québec. This project holds significant importance within the Critical Minerals Strategies of both Canada and Québec. The Strange Lake project stands out due to its abundant quantities of rare earth elements, including crucial elements for electric vehicles, wind turbines, and the green economy. Notably, it possesses substantial quantities of heavy rare earths like dysprosium and terbium, as well as light rare earths such as neodymium and praseodymium.

Torngat Metals intends to establish its facilities in two locations. The first is the mine site in Nunavik, which will feature an onsite concentration plant. The second location is a processing plant in central Québec, where the extracted rare earths will be refined into finished products for the market. Currently, Torngat is in the process of selecting a specific heavy infrastructure park in central Québec through a site selection process. Consequently, Torngat requires a logistics plan to connect the two locations effectively. Outbound from the mine site, Torngat plans to transport up to 200,000 tonnes per year of rare earth concentrate. Conversely, inbound to the mine site, Torngat will transport necessary supplies, materials, and fuel.

Figure 5-8 Strange Lake Mine Development in Northern Quebec



Torngat Metals has identified a crucial gap in the logistics route, particularly the initial leg closest to the mine site. Two possible infrastructure connection points have been identified: one is a sea port located 160 kilometers east on the Labrador Coast (either existing or new), and the other is an existing railhead in Schefferville, which is 240 kilometers southwest. Discussions are underway with both locations to secure access. In both cases, standard shipping containers will be used for all inbound and outbound cargo throughout the entire logistics process. Outbound cargo from the mine site will exceed inbound cargo. On the inbound journey, approximately two-thirds of the containers will be loaded with supplies and materials for the mine site, while the remaining one-third will return empty.

There are two routing options:

- Plan A: Construct a private mine access road spanning 160 kilometers from the mine site to the Labrador coast. The road will be designed for off-road vehicles to travel at low speeds, ensuring the safety of workers, community members, caribou, wildlife, and the environment. All inbound and outbound cargo will be shipped over a few months, necessitating stockpiling at the two plants, which will operate throughout the year. The containers will be transported by a contracted container ship, delivering them directly to the port where the processing plant is situated. Torngat plans to develop Plan A with the option to switch to Plan B in the future.
- Plan B: Contract cargo airship services to transport the concentrate from the mine site to Schefferville and facilitate the inbound transportation of supplies and materials. In Schefferville, the logistics route will connect to the existing railway between Schefferville and Sept-Îles. From Sept-Îles, the final leg of transportation will be by barge to the port where the processing plant is located.

Extensive due diligence has been conducted by Torngat Metals regarding the feasibility of using cargo airships. If cargo airships were certain to become available before 2025, Torngat would choose the airship option due to attractive economics, a lower carbon footprint, reduced environmental impact, minimized land use, and the potential for social benefits and regional economic opportunities.

Torngat has specified several requirements for airships, including the ability to land on the ground without masting or tethering, a cargo capacity of at least 20 tonnes (with future potential for 60 to 100 MT), instrumented flying, high capacity utilization, minimal ground facility requirements, year-round operation with multiple trips per day dedicated to Torngat, fast turnaround time for cargo handling, and the potential to switch to fuel cell power subject to regulatory approval.

While airships will not be commercially available before 2025, Torngat remains optimistic that cargo airship vehicles from one or two developers will enter the market in the coming years. Additionally, the development of an airship ecosystem, including cargo airship operators securing financing and leasing contracts, is necessary. These companies are currently in development, and Torngat is interested in establishing cargo contracts on a $/tonne/km basis. In the meantime, Torngat is proceeding with the construction of the mine access road, which will be designed with future flexibility for a potential transition to airships when they become available. It is anticipated that a few years of transition will occur, during which both the road and airships could be utilized until sufficient airship capacity is accessible. Torngat will engage with local communities to determine the future of the road if it is no longer required.

Apart from the direct benefits to Torngat's logistics, there are numerous other advantages that Torngat seeks to maximize through the commercialization of airships, including alignment with their Environmental Social and Governance (ESG) strategy, the creation of skilled airship industry jobs for local communities in Northern Québec and Labrador, adaptation to climate change, a smaller physical footprint on the land, lower operational, environmental, and social risks, utilizing extra airship capacity for community needs and emergencies, supporting technology adoption by others (e.g., housing materials, fresh food, mobile clinics, biofuels, new businesses in the North, and mining exploration and development), and more.

6 INFRASTRUCTURE AND ENVIRONMENTAL CONSIDERATIONS

Heavy lift cargo airships have the potential to revolutionize the transportation industry by providing an alternative to traditional cargo planes, ships, and trucks. However, before these airships can become a viable mode of freight transport, infrastructure needs and environmental considerations must be taken into account.

The infrastructure required to support large cargo airships is different from that needed for traditional cargo planes. While airports have runways and other facilities to support cargo planes, airships require unique ground handling facilities to accommodate their buoyant nature. The sections below explain handling needs in further detail.

Traditional airships were powered by diesel engines and produced their fair share of carbon emissions. Modern cargo airships will use electrically powered vectoring thrust propellers. This move to electrical power allows for a significant reduction in carbon emissions. Additionally, electric motors are much quieter in operation which leads to less overall environmental disturbance.

Airships are able to operate with minimal ground infrastructure. This allows them to serve remote locations without the impact to wildlife involved with building roads.

6.1 Airship Infrastructure Requirements and Operational Requirements

6.1.1 Hangars

Hangars feature large open spaces for airships to be stored and maintained, as well as high ceilings to accommodate the vertical height of airships. The hangar should have facilities for fuel storage and maintenance, including space for equipment and tools, as well as a repair bay for any necessary repairs or modifications to the airship.

Operational requirements for airship hangars include a dedicated team of maintenance and repair personnel, as well as a system for scheduling and coordinating the use of the hangar. This may include a system for booking time slots for the airship to be stored in the hangar, as well as a system for coordinating maintenance and repairs with the airship's flight schedule. Additionally, the hangar should have strict safety protocols in place, including procedures for handling hazardous materials and emergency procedures in case of accidents or incidents.

Many specialized personnel are required to operate the hangar. These can include mechanics, electricians, and other specialists who have the skills and knowledge needed to properly maintain and repair the airship as well as the hangar itself.

Overall, airship hangars require a significant amount of space and specialized equipment, as well as a notable team of personnel to ensure safe and efficient operation. It is important for the infrastructure and operational requirements to be well-coordinated and maintained to ensure the airship can operate safely and efficiently.

Repurposing of old open pit mines or rock quarries. mine has been contemplated as a novel concept for hangar development.

Airships only require hungering for about 14 days of the year. Half of this is for annual inspections. Like ships of the ocean, airships live in the sky.

Figure 6-1 - Airship Hangar build in 1929 in Akron, OH refurbished by Lockheed Martin in 2011

6.1.2 Landing fields and transshipment gateways

Airships are large aircraft. By way of comparison the current Zeppelin N07-101 that operates in Germany for the Zeppelin corporation is a passenger aircraft and is 75 meters long. A Boeing 747 is 70 meters. The iconic Graf Zeppelin from the 1930's was 237 meters long. They require open space in which to land and takeoff but the preparation of this space is minimal, essentially requiring an obstacle free area twice the length of the aircraft and a level surface that is suitable for the airship's landing gear for hybrid aircraft.

When the airship is moored it must be able to rotate 360 degrees as the wind changes. Airships of the past have landed in clear fields using a mast for docking. The primary consideration is obstacles upon approach and exit. Presuming the mast is at the center of the circle a clearing twice the airship length is required.

It must be noted that a significant portion of this study occurs above the TreeLine in Canada.. Northern Canada is tree free and obstacles are confined to geographic/geologic obstacles like mountains. Larger consideration needs to be given not so much to where the aircraft can land but cargo handling at the landing site for instance ground that a truck and loader can access. Much of Northern Canada is frozen and snow covered for significant portions of the year this enables landing on lakes,fjords, and open snow fields. In snow covered areas landing areas can be easily prepared using tracked snow grooming machines.

Fixed wing aircraft that require a runway oriented to the dominant wind direction. Large cargo fixed wing aircraft Like a C-130 Hercules require an airstrip with a minimum of 5000 feet. Runways must be leveled and either paved or covered with a specific grade of gravel.

Operational requirements for landing areas and transhipment points include a system for scheduling and coordinating the use of the landing area, as well as a system for coordinating landing and takeoff with the airship's flight schedule. Additionally, the landing areas will have strict safety protocols in place, including procedures for handling hazardous materials and emergency procedures in case of accidents or incidents.

Airship masts are tall structures used for mooring airships when they are not inflight. They have a vertical structure with a mooring point at the top where the airship can be attached. Masts are usually made of steel or other stong materials and are securely anchored to the ground although portable mast trucks are commonly used for smaller airships. Masts may also have mechanisms to allow for the movement of the mooring point to accommodate changes in the airships position due to wind

BARDs (explained in Section 2.3.7) serve as a landing platform designed specifically for airships. It enables them to be securely anchored by cables while maintaining the ability to rotate in response to changing winds, all without interfering with cargo transfer operations. This system ensures that the aircraft can safely load and unload without requiring the use of ballast and accommodates a wide variety of airship designs. Airships naturally nose into the wind, allowing this to happen on a turntable keeps everyone safe while allowing the craft to cope with conditions.

6.1.3 Regulatory framework

The aviation industry and all aircraft are governed by the Civil Aviation Services Department of Transport Canada. This includes administration of Canadian Aviation Regulations (CAR). Transport Canada operates under a regional model. The nation is divided into six regions each with jurisdiction over a specific geography as illustrated in Figure 6-2. Most of the north is managed by the Prairie and Northern Region, but the northern regions of the eastern provinces (Quebec and Labrador) are managed separately.

Figure 6-2 Regional Administrative Offices of Transport Canada

Though this strategy document covers northern regions of Canada the dominant region as it pertains to Canada Arctic is the Prairie and Northern Region. The offices for this region are in Calgary, Edmonton, Saskatoon, Winnipeg, Whitehorse and Yellowknife.

Activities of transport Canada and personnel are geared toward dominant aircraft types mainly fixed wing aircraft and helicopters. Eccentric types of aircraft such as hot air balloons, powered parachutes are also administered by TC but often outsourced to outside experts in those respective fields. Airships are contemplated in section 541 of the CAR but have been inactive due to rare use and there are no airship specialists within the department. Categories of aircraft most familiar to Transport Canada and for which

there is an existing administrative structure are ; (1) Aeroplanes, (2) Balloons (3) Gliders (4) Gyroplanes (5) Helicopter (6) Powered Parachutes (7) Ultralights and (8) RPAS (Remote Piloted Aircraft Systems).

Licensing & Registration

Operation of airships in Canada will require the appropriate licensing and registrations. License and registry information from Transport Canada provides a current snapshot of airship operations in Canada.

1. **Pilot Licencing:** In Canada, pilots must be certified and licensed by Transport Canada for the specific aircraft they intend to fly. Pilot licenses are not transferable between different aircraft types. Training involves a prescribed curriculum, a specified number of hours in the chosen aircraft type with a Pilot Instructor, and passing exams and medical assessments. Pilots need endorsements for specific aircraft models, and pilot education can be pursued in public or private institutions. However, there are currently no airship schools in Canada, and only seven pilots in the country are rated for airships.

2. **Aircraft Maintenance Engineers (AMEs):** Aircraft Aircraft Maintenance Engineers in Canada are licensed by Transport Canada to perform aircraft maintenance and repairs. Approved public colleges like Northern Lights College offer training with a core curriculum, focusing on airplanes and helicopters, but with some modules on other aircraft types. Each school may have a specialization, although the core curriculum remains general. After completing the coursework, students undergo an apprenticeship, and their logbook is signed off by certified AMEs to obtain a license. The license is specific to endorsed aircraft types, and further training is required for new aircraft models. Manufacturers or private training companies offer specialized courses for AMEs to expand their certifications. Currently, specialized training for airships requires direct training from the manufacturer or operating company.Maintenace Engineers (AMEs). At present there is no record of how many AME's are licensed for airships.

3. **Type Certificates:** Type certificates are specific to aircraft make and model, certifying that they meet airworthiness standards. This encompasses various aspects such as aircraft design, structure, avionics, electrical and mechanical systems, power plants, miscellaneous equipment, and engineering flight tests. The certification process ensures that the aircraft is suitable for flight, all components function as intended, and the vehicle is safe for commercial use. Airships must obtain a type certificate before operation. Certification can be obtained through the Canadian Certification process under Transport Canada or through bilateral agreements with the FAA and/or EASA. Typically, major aircraft obtain certification from the FAA and EASA, and then acquire certification through bilateral agreements with Canada. According to the Type Certification database five airship types have been certified by Transport Canada process.

Table 6-1 Airship Types Certified by Transport Canada

#	Make	Type	Model(s)	Gas
1	Cameron Balloons Ltd.	AS105	AS105-GD	Thermal
2	Cameron Balloons Ltd.	AS90	AS	Thermal
3	Colt Balloons	Colt	Colt	Thermal
4	Hokan Colting	SPAS	SPAS-396, SPAS-13, SPAS-70, SPAS 62.5	Helium
5	21st Century Airships	VOY1	Voyager Airship	Helium

4. **Aircraft Registrations:** All non-military aircraft in Canada requiring registration with Transport Canada. Registered aircraft are assigned unique callsigns/marks. When the aircraft is inactive it is deleted from the registry. At present there are no airships registered in Canada.

Table 6-2 Airship Registrations in Canada

#	Mark	Model	Owner	Status
1	C-GIAO	AS-105	Carling O'Keefe Breweries	Deleted - 1996
2	C-GZMG	AS-105	Western Canadian Lottery	Deleted - 1989
3	C-GGMR	AS-90	Bulk-MOre Dairy Shops	Deleted - 1991
4	C-FAUP	SPAS-396	Hokan Colting	Deleted - 2014
5	C-GIKI	SPAS-R1	Hokan Colting	Deleted - 2003
6	C-FYOK	SPAS-70	Hokan Colting	Deleted - 2014
7	C-FZRY	SPAS-62.5	Hokan Colting	Deleted - 2015
8	C-FRLM	SPAS-13	Hokan Colting	Deleted - 2014
9	C-FPXS	SPAS-10	Hokan Colting	Deleted - 1995
10	C-FJHH	SPAS-01	Hokan Colting	Deleted - 1993
11	C-FMKK	SPAS-002	Hokan Colting	Deleted - 1992

6.1.4 Human resources: pilots including training, load masters, mechanics, general

Airship operations can be divided into the following categories:

1. Ground Handling - mooring and loading
2. Load Masters (loading/unloading cargo/ securing cargo)
3. Pilots: landing and takeoffs.
4. Aircraft Maintenance Engineers (AMEs)

At present the only operational airship company offering direct pay for training is the Airships do Brasil. That training is specific for their airship. The US military training program on airships concluded with the retirement of the last of the K series blimps.

Presently there is a lack of certified simulators capable of accurately replicating the intricate dynamics of airship flight, particularly the unpredictable shifts in wind conditions. While advancements in simulator technology may occur in the future, the most effective training currently takes place directly within an airship itself. However, this training method incurs substantial costs and requires a significant number of flight hours. For instance, to become an airship captain requires approximately one and a half to two years and 1500 to 2000 hours of flight time.

Typically the manufacturer or the airship operator provides this training. Aspiring pilots enter the field by securing employment with the airship operating company, which then provides them with comprehensive

training tailored to their designated airship model. This approach ensures that pilots are proficiently trained on their specific airship they will be operating. Pilots typically commence their training by piloting smaller airship models, gradually progressing to larger ones as their skill develops.

Of particular note is that most of the experienced airship pilots are of an advanced age underscoring the needs for training new pilots to meet future industry needs.

At the inception of the airship industry, each designer/manufacturer will bear the responsibility of developing their own curriculum specific to their airship make and model. This includes ground handling, load masters, pilots and AMEs. Since the airship industry is still in the process of establishing itself commercially, all training opportunities will primarily be provided by the corporations involved, including both manufacturers and operators.

6.1.5 Cold Weather Testing and Certification

A worldwide race has emerged in which over a dozen companies located in nine different countries are researching and building next generation airships. For these airships to be truly economic however, they must have the capability to operate year round. Moreover, regulatory authorities will require evidence that cargo airships can be operated safely in icing conditions, heavy snow and cold temperatures.

Many locations for cold weather testing are possible, but Thompson, Manitoba has several advantages that could give it a lead. First, Thompson has established itself as a cold weather testing location for automobiles and snowmobiles and jet engines. In addition to this reputation, Thompson has developed hotel accommodations and other services to meet the needs of the technical staff. Second, Thompson has a recognized climate pattern that leads to a consistent and relatively long period for cold weather testing, and is characterized by gentle wind conditions. The climate provides 240 days of cold weather with below freezing temperatures. This allows long periods of light to extreme cold testing. Third, Thompson is one of the most northerly cities that is conveniently served by scheduled airlines, rail and road connections that enables equipment to be delivered and technicians to travel easily. Finally, Thompson has four abandoned open-pit mines that are trench-shaped, and large enough to hold the largest airships being proposed.

Airships need a location where they can be protected from side gusts while being tested for winter weather. Figure 6-3 presents a photograph of the open-pit mines owned by Vale Canada Ltd. Vale's oval shaped open pit mine is an ideal site for an airship research, testing, and maintenance centre. Exposure to the elements is an advantage to simulate events like freezing rain and cold soaking. The conversion of an exhausted mine site (an environmental scar) into an innovative and productive one is a win-win-win proposition.

Figure 6-3 Photograph of the abandoned open-pit mines at Thompson, Manitoba

Thompson can become the centre for cleaner and cheaper mine exploration, cargo shipping and environmental research. Being located in north-central Manitoba, Thompson is an established transhipment location for cargo airship services to remote communities in this province and Nunavut. During the off-season from cold weather testing, this facility could be made available to the initial airship companies to undertake annual inspections and heavy maintenance.

As the airship industry expands, other open pits could be converted into hangars or assembly halls to support a Canadian airship manufacturing industry.

6.2 Environmental Assessment

6.2.1 GHG emissions/savings

Lower carbon emissions: Airships produce significantly lower carbon emissions compared to airplanes, ships, and even trucks. Airships are typically powered by electric or hybrid-electric propulsion systems, which emit fewer greenhouse gases. They have the potential to reduce the carbon footprint of transportation, especially for long-haul and heavy cargo shipments.

The figure below compares the carbon emissions of the AirLander airship versus cars, planes and trains. While is a comparison for passenger movement, the distances are comparable to the movement of freight from the various gateways. As shown in Figure 6-4 airships represent a significant potential to reduce CO2 emissions overall. Given that small airplanes are the only means of year-round transport, the carbon emission reduction of airships is the most relevant comparison. Airships would save about 90% of the carbon emissions of airplanes.

Figure 6-4 Emissions comparison for popular modes of transport

	Distance	Total Journey Time	CO2 Produced
	205km	4 hours 12 mins	4.61kg of CO2 per passenger
	228km	2 hours 30 mins	23.62kg of CO2 per passenger
	238km	3 hours 6 mins	53.15kg of CO2 per passenger
	224km	5 hours 9 mins	7.75kg of CO2 per passenger

Source: https://www.ecowatch.com/air-travel-carbon-emissions-2653215087.html

Fuel efficiency: Airships are relatively fuel-efficient. Their unique design, which utilizes buoyant gas for lift, requires less power to stay airborne compared to traditional aircraft. The use of electric or hybrid-electric propulsion systems further enhances their fuel efficiency.

Reduced infrastructure requirements: Airships can operate from various locations, including remote areas or underdeveloped regions lacking proper infrastructure. Unlike airplanes, they do not require long runways, extensive airport facilities, or complex ground infrastructure. This flexibility in takeoff and landing sites can reduce the need for constructing new airports or expanding existing ones, thereby minimizing land use and environmental disruptions.

Reduced noise pollution: Airships are significantly quieter compared to airplanes or helicopters. The propellers used for propulsion are generally less noisy, leading to reduced noise pollution in surrounding areas. This characteristic can make airships more suitable for sensitive environments, such as wildlife habitats or residential areas.

7 RISKS, THREATS AND MITIGATIONS

Cargo airships may be the most benign form of transport available. They do not use much energy because the lift is provided by the captive gas, and most airship companies are planning to use electric motors. The first airships will likely use gas turbines fueled with aviation fuel to produce electricity because they are already certified for aviation use. As the airship industry develops most will use hydrogen, either directly through a gas turbine, or through fuel cells to power electric motors for propulsion. Consequently, airships should have zero-carbon emissions once the technology matures.

Due to the onboard gas turbines and the hydrogen-filled gas cells, fire is a risk that must be addressed. All flammable fuels must be handled responsibly and if done so, hydrogen gas is less explosive than either gasoline or aviation fuel. Hydrogen is not explosive in its pure form and will not burn at greater than 75% purity. Hydrogen will not burn at less than 4% concentration in the air. This can be mitigated by sensors in the gas cells indicating any potential contamination, which would trigger a venting of the airships. The vented gas will dissipate rapidly because hydrogen is a lighter-than-air gas, meaning that it will rise and clear quickly into the surrounding air.

A problem with the propulsion system does not lead to an immediate crash landing. The airship becomes a balloon and the captain can undertake a controlled descent by venting gas slowly from the gas cells into the surrounding air. The airship would gently sink and slowly come to the ground, where the captain chooses, ideally on a body of water.

The impact of various weather-related events will be mitigated by the extensive testing and certification process for aviation. Airships are designed to operate year-round within the temperature extremes that exist. Precipitation would only affect ground-handling equipment that would be the same for any transportation system. Cargo airships will operate in any weather that airplanes can operate now. Of course, in the Arctic there will be days in which operations must be suspended because of blizzard conditions. During these periods the airships will be held farther south until such storms pass. The threat of a severe weather event resulting in the loss of cargo is something that every transportation company needs to address, typically through insurance policies.

Airships operate close to the ground and can land vertically. They are not affected by fog. In a worst-case scenario, the airship can hover and wait for the weather to clear. Wind could be an issue for the safety of the ground-handling crew, and under such conditions, activities will be suspended. The number of days lost should not have a major economic impact on the airship operators or their customers.

No formal climate risk assessment has been undertaken or planned because the cargo airships have low carbon emissions and in the future none. They also have minimal contact with the ground, where most climate changes are likely to occur. A simple landing area or a landing platform can be located away from shorelines or water courses. The landing platform will need to be connected to a road to the ultimate destination, but the size and construction of the road will be determined by distance and location of the terminal.

Communities are likely to welcome regular airship services, because they can contribute to a steady supply chain in the north for food, building materials and other goods. There may be some unforeseen issues or negative sentiments, but it will not be caused by noise or ground disturbance of the airships. Hopefully, providing lower freight rates and employment opportunities in the airship industry will encourage trust and confidence in these communities that these services are beneficial to individuals, families, businesses and communities in Canada’s north.

Airships do not pose any threat to wild-life or fisheries. Experience with advertising blimps that travel overland to their events is that wild animals ignore them. The airships are relatively slow, fly several thousand feet above the ground and create minimal noise. The greater risk to the airships is individuals who shoot at them from the ground. Bullets will not create fire or cause the airship to crash, but they are a risk to the pilot. Education and enforcement of laws will be necessary if this becomes a problem.

8 SUMMARY AND CONCLUSIONS

The “Cargo Airship Strategy for Northern Canada” is a first attempt to examine whether the remote communities and resource developments in Canada could be served economically by cargo airships. This study is also unique because it sets out the gateways and hinterlands that airships would logically follow. In terms of infrastructure, this study can guide governments with respect to investment in aerodromes, regulations and opportunities to solve the chronic transportation inadequacy problem of the North. For the gateway cities and towns, this report serves as a template for economic development through the delivery of transhipment services. For the mining industry, this report provides a framework to assess whether they can use cargo airships to access mineral deposits that are currently stranded. Finally, for the remote communities, this study of cargo airship services gives hope that the prices of food, building materials and everything else they bring from the south, will become more affordable and available year-round.

The gateways selected in this analysis are based on the need to minimize total transportation and logistics cost. Economics determines that goods should be moved along established road and rail corridors as far north as possible, before being transhipped to cargo airships for final delivery. This study identifies five primary gateways that would be first to be established, followed by four supporting gateways that could reduce total cost in each of their hinterland areas. Similarly, the hinterlands are defined on the basis of least cost. Clearly the borders between these areas could be served by more than one gateway once the airship industry expands.

The demand for a new transportation technology has two dimensions. First, the service must have a cost advantage or unique property that will be attractive to shippers. Second, its demand must be sufficient to create the scale of operations required to provide the service. In practice, this means that enough demand must exist to support a fleet of vehicles year-round. This demand needs to generate sufficient revenue to cover all the fixed and variable costs of the service, and provide a sufficient profit margin.

It is beyond the scope of this report to consider all types of airships and all manner of goods that might be transported to the North. Instead, building materials are considered as a proxy for the materials that would be shipped to the remote communities, and a single rigid airship design is used as a proxy for all airships. The report calculates the total amount of building materials required by the hinterland of each gateway, based on CMHC and Statistics Canada data of the shortfall in housing. The costs of the airship, including a 0.8 operating ratio to represent a gross profit margin, are assessed for a weighted average distance in each hinterland. The results show that the demand would allow for a fleet of three airships to be established at each gateway.

The costs of the airship service are established by round-trips, however freight rates depend on how much freight can be moved in each direction. For the remote communities, all return loads are considered to be empty. This need not be the case in reality, even if only recycled materials are being returned, but for the economic analysis, no remuneration is considered for the return trip. Despite this strong assumption, the estimated freight rates are only one-quarter of the rates charged to the remote communities in Ontario and Manitoba. The remote communities would receive substantial cost savings.

The Critical Minerals Strategy is setting the tone for resource development in the next 50 years. These critical elements are necessary for all the green technologies that are needed to halt climate change. Many known deposits are located in inaccessible locations. While gold and diamond mines can bring in supplies on winter roads and carry out their production in a small airplane, rare earths and base metal concentrates need truckload service. The problem lies in the cost of building gravel roads that average $5 million per kilometer to build. This study demonstrates that cargo airships can compete with roads and trucks on a net present value (NPV) basis.

In conclusion, this study established the prima facie case for the use of cargo airships to reduce the cost and improve transportation services in the North. The need for construction materials for the remote communities, and other freight indicates that sufficient demand exists to estable a small fleet of cargo airships at each of the transhipment gateways.

Similarly, it is clear that airships can provide a viable alternative to the construction of gravel roads. The cost of building a gravel road and operating trucks is compared to an airship service. The results are tested with a 50% increase in the capital costs of the airship, and with a 50% increase in the volume of traffic. In both cases, the airship is still a lower cost alternative. The conclusion is that cargo airships could be competitive without any public subsidy.

9 RECOMMENDATIONS

1. The Government of Canada needs a clear policy statement regarding their support or opposition to the use of cargo airships to serve remote parts of the Canadian Shield and Arctic. Remaining silent creates uncertainty for airship developers and investors. In addition, the government has a role to play in transportation that cannot be delegated. A regulatory framework is needed to certify pilots, mechanics and license aerodromes. There is also a need for public infrastructure to serve transportation needs, like access roads and common use facilities.

2. Transport Canada needs a dedicated employee that is the airship liaison for the industry. At the present time, expertise on airships and airship operations at Transport Canada is difficult to access or non-existent. The liaison person should be knowledgeable in the history, operation and business of airships. All regions should be made aware of who this individual is and how to access the expertise.

3. The impact of climate change in the northern latitudes is happening much faster than in the south. The future of the ice roads is in doubt and melting permafrost threatens existing infrastructure. The Government of Canada should consider the development of an “X-Prize” style award for the completion of a successful cargo deployment to an arctic destination. In this period of rapid technological development, a competitive process would help accelerate service to the northern remote communities.

4. Education and training for airship operations is lacking in Canada. An airship curriculum should be added to the core coursework for the AME Program and pilot training. This effort should be focused on the development of Indigenous students who will live and work in Northern Canada.

5. A cold weather testing facility for airships is needed in Canada. Thompson, Manitoba has an established reputation for cold weather testing and an existing infrastructure that could be adapted for airships testing and research. This location could also serve as a public maintenance facility for the early operations of cargo airships in Northern Canada.

Appendix 10.1 – Catalogue of Airship Designers & Designs

Appendix 10.1: Catalogue of Active Airship Designers and Designs (2023)

#	Country of Origin	Make	Website	Contact Person	Email	Model	Types	Style	Purpose	Lift (Metric Tonnes)	Lifting Gas	Gas Volume (Cubic Meters)	Concept	Engineered Plans	Research Model	Prototype	Certified (Status/Agency)	Full Scale Model Built & Quantity	Missions
1	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	Dragon Dream	Rigid, Variable Buoyancy	Hybrid	Prototype	6	Helium	Undisclosed	Yes	Yes	Yes	Yes - this is the prototype	FAA Experimental Airworthiness	Yes - prototype	50 plus
2	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	ML866	Rigid, Variable Buoyancy	Hybrid	Cargo	66	Helium	Undisclosed	Yes	Yes	Yes	Yes - Dragon Dream	TC in process	No	0
3	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	ML868	Rigid, Variable Buoyancy	Hybrid	Cargo	250	Helium	Undisclosed	Yes	Yes	Yes	Yes - Dragon Dream	TC in process	No	0
4	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	ML86X	Rigid, Variable Buoyancy	Hybrid	Cargo	500	Helium	Undisclosed	Yes	No	Yes	Yes - Dragon Dream	No	No	0
5	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	Aeros 50	Non-rigid, Near Equilibrium	Classic	Experimental	0.2	Helium	Undisclosed	Yes	Yes	Yes	Experimental	FAA Experimental	Yes	100 plus
6	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	40A Sky Dragon	Non-rigid, Near Equilibrium	Classic	Surveillance Advertising	0.4	Helium	Undisclosed	Yes	Yes	Yes	Serial Production	FAA Experimental / China	Yes	over 1200
7	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	40B Sky Dragon	Non-rigid, Near Equilibrium	Classic	Surveillance Advertising	0.7	Helium	Undisclosed	Yes	Yes	Yes	Serial Production	FAA / EASA	Yes	over 1200
8	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	40D Sky Dragon	Non-rigid, Near Equilibrium	Classic	Surveillance Advertising	1	Helium	Undisclosed	Yes	Yes	Yes	Serial Production	FAA / China / Mexico	Yes	over 1200
9	United States	Aeroscraft Corporation (AEROS)	https://aeroscraft.com	Igor Pasternak, Pres. & CEO	Igor.pasternak@aeroscraft.com	40E Sky Dragon	Non-rigid, Near Equilibrium	Classic	Surveillance Advertising	1.2	Helium	Undisclosed	Yes	Yes	Yes	Production	Undisclosed	No	0
10	United States	Aerovehicles Airborne Solutions	https://aerovehicles.net	Bob Fowler, Pres. & CEO	enquiries@aerovehicles.net	Skyship - 600	Non-rigid	Classic	Surveillance Passenger Advertising Sling Load Cargo	1	Helium	6,666.00	Yes	Yes	Yes	Yes	Yes - CAA Australia and England mid 1970's, FAA 1981, Grandfathered into EASA	Yes(10)	>1,000
11	United States	Aerovehicles Airborne Solutions	https://aerovehicles.net	Bob Fowler, Pres. & CEO	enquiries@aerovehicles.net	AV-10	Non-rigid	Classic	Cargo Passenger	10	Helium	40,500.00	Yes	Yes	Yes	FAA authorization received to build and test full scale prototype.	No	0	0
12	United States	Aerovehicles Airborne Solutions	https://aerovehicles.net	Bob Fowler, Pres. & CEO	enquiries@aerovehicles.net	AeroCat R-12	Semi-rigid	Hybrid	Cargo Passenger	12 VTOL / 21 STOL	Helium	77,000.00	Yes	Conceptual	Yes, engineered and built the SkyKitten RC model utilized by ATG (now HAV)	No	No	0	0
13	United States	Aerovehicles Airborne Solutions	https://aerovehicles.net	Bob Fowler, Pres. & CEO	enquiries@aerovehicles.net	AeroCat R-40	Semi-rigid	Hybrid	Cargo Passenger	30 VTOL / 45 STOL	Helium	90,100.00	Yes	No	No	No	No	0	0
14	Brazil	Airship do Brasil	www.airshipdobrasil.com	Marcelo Augusto de Felippes, CEO	contato@adb.ind.br	ABD3-3	Non-rigid	Classic	Cargo Surveillance	2	Helium	Undisclosed	Yes	Yes	Yes	Yes	Yes - Brazil	Yes	>10
15	United States	AT2 Aerospace	https://at2aero.space	Bob Boyd, COO	info@at2aerospace.com	P-791	Non-rigid	Hybrid	Passenger Prototype	1	Helium	Undisclosed	Yes	Yes	Yes	Yes - P791 Built and Flown	Yes	Experimental/FAA/2005	7

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#	Country of Origin	Make	Website	Contact Person	Email	Model	Types	Style	Purpose	Lift (Metric Tonnes)	Lifting Gas	Gas Volume (Cubic Meters)	Concept	Engineered Plans	Research Model	Prototype	Certified (Status/Agency)	Full Scale Model Built & Quantity	Missions
16	United States	AT2 Aerospace	https://at2aero.space	Bob Boyd, COO	info@at2aerospace.com	Z1	Non-rigid	Hybrid	Cargo Passenger Surveillance	21	Helium	Undisclosed	Yes	Yes	Yes	Yes - P791 Built and Flown	No	Type Certificate/FAA/2026 (est)	0
17	United States	AT2 Aerospace	https://at2aero.space	Bob Boyd, COO	info@at2aerospace.com	Z2	Non-rigid	Hybrid	Cargo Passenger Surveillance	100	Helium	Undisclosed	Yes	Yes	Yes	Yes - P791 Built and Flown	No	To Follow Z1	0
18	United States	AT2 Aerospace	https://at2aero.space	Bob Boyd, COO	info@at2aerospace.com	Z3	Non-rigid	Hybrid	Cargo Passenger Surveillance	500	Helium	Undisclosed	Yes	Yes	Yes	Yes - P791 Built and Flown	No	To Follow Z2	0
19	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	11E17	Non-rigid	Hybrid	Passenger Surveillance	2.5	Helium	11,200.00	Yes	Yes	Yes	Yes - AU-30	No	No	0
20	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	11H17	Non-rigid	Hybrid	Passenger Surveillance	2.5	Helium	11,200.00	Yes	Yes	Yes	Yes - AU-30	No	No	0
21	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	11H24	Non-rigid	Hybrid	Passenger Surveillance	2.8	Helium	12,000.00	Yes	In Progress	No	Yes - AU-30	No	No	0
22	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	Atlant-30	Rigid	Hybrid	Cargo	18	Helium	30,000.00	Yes	Yes	Yes	No	No	No	0
23	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	Atlant-100	Rigid	Hybrid	Cargo	60	Helium	100,000.00	Yes	Yes	Yes	No	No	No	0
24	Israel	Atlas LTA	https://atlas-lta.com	Michael Talesnikov, VP Marketing	mt@atlas-lta.com	Atland-300	Rigid	Hybrid	Cargo	165	Helium	300,000.00	Yes	No	No	No	No	No	0
25	Canada	Buoyant Aircraft Systems International	https://www.buoyantaircraft.ca	Ross Prentice, CEO	prenticers@gmail.com	MB30T	Rigid	Classic	Cargo	30	Hydrogen	50,000.00	Yes	In Progress	Diorama only	No	No	0	0
26	Canada	Buoyant Aircraft Systems International	https://www.buoyantaircraft.ca	Ross Prentice, CEO	prenticers@gmail.com	MB60T	Rigid	Classic	Cargo	60	Hydrogen	100,000.00	No	No	No	No	No	0	0
27	Canada	Buoyant Aircraft Systems International	https://www.buoyantaircraft.ca	Ross Prentice, CEO	prenticers@gmail.com	MB100T	Rigid	Classic	Cargo	100	Hydrogen	166,500.00	No	No	No	No	No	0	0
28	Canada	Buoyant Aircraft Systems International	https://www.buoyantaircraft.ca	Ross Prentice, CEO	prenticers@gmail.com	MB250T	Rigid	Classic	Cargo	250	Hydrogen	416,000.00	No	No	No	No	No	0	0
29	United Kingdom	Cameron Balloons	https://www.cameronballoons.co.uk	Don Cameron, CEO	sales@cameronballoons.co.uk	D-77	Non-rigid	Thermal	Recreational Advertising	0.5	Hot Air	Undisclosed	Yes	Yes	Yes	Yes	Yes	Yes	>1,000
30	France	Flying Whales	https://www.flying-whales.com/en/home/	Pierre-Yves Fouillen, Business Developer	pierre-yves.fouillen@flying-whales.com	LCA60T	Rigid	Classic	Cargo Crane	60	Helium	Undisclosed	Yes	Yes	Yes	No	In Process (2022) - EASA SC-GAS issued in January 2022 (new certification basis for airships)	Planned 2025	No 1st flight planned for 2025

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31	United Kingdom	Hybrid Air Vehicles (HAV)	https://www.hybridairvehicles.com	Nick Udall, Business Developer	nick.udall@HybridAirVehicles.net	Airlander 10	Non-rigid	Hybrid	Passenger / Cargo & Logisitics / Communications & Surveillance	10	Helium	circa. 38000	Yes	Yes	Yes	Yes - prototype flew under Permit to Fly	Pre-production (TRL7) / UK CAA, EASA, FAA / Certified Production aircraft anticiapted 2027	Yes	7
32	United Kingdom	Hybrid Air Vehicles (HAV)	https://www.hybridairvehicles.com	Nick Udall, Business Developer	nick.udall@HybridAirVehicles.net	Airlander 50	Non-rigid	Hybrid	Passenger / Cargo & Logisitics / Communications & Surveillance	50-60 Final Specification not set	Helium	circa. 100000	Yes	Yes	Yes	No	UK CAA, EASA, FAA / Anticiapted 2030	No	0
33	United States	LTA Research	https://www.ltaresearch.com	Alan Weston, CEO	info@ltaresearch.com	Pathfinder-1	Rigid	Classic	Cargo	4	Helium	Undisclosed	Yes	Yes	Yes	Yes	Undisclosed	In Production	0
34	United States	LTA Research	https://www.ltaresearch.com	Alan Weston, CEO	info@ltaresearch.com	Pathfinder-3	Rigid	Classic	Cargo	Undisclosed	Helium	Undisclosed	Yes	Yes	Yes	Yes	Undisclosed	No	0
35	United States	Millennium Airship	https://www.millenniumairship.com	Gil Costin, CEO	info@millenniumairship.com	SF-20	Semi-rigid	Hybrid	Cargo	20	Helium	Undisclosed	Yes	Yes	Yes	No	No	No	0
36	United States	Millennium Airship	https://www.millenniumairship.com	Gil Costin, CEO	info@millenniumairship.com	SF-50	Semi-rigid	Hybrid	Cargo	50	Helium	Undisclosed	Yes	Yes	Yes	No	No	No	0
37	United States	Millennium Airship	https://www.millenniumairship.com	Gil Costin, CEO	info@millenniumairship.com	SF-500	Semi-rigid	Hybrid	Cargo	500	Helium	Undisclosed	Yes	Yes	Yes	No	No	No	0
38	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	AD500	Non-rigid	Classic	Surveillance Passenger Advertising	1.2	Helium	5,153.00	Yes	Yes	Yes	Yes	Not Certified	Yes (1)	Test Flights
39	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 500	Non-rigid	Classic	Surveillance Passenger Advertising	1.2	Helium	5,153.00	Yes	Yes	Yes	Yes	CAA, EASA, FAA	Yes (5)	>1,000
40	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 500HL	Non-rigid	Classic	Surveillance Passenger Advertising	1.4	Helium	6,666.00	Yes	Yes	Yes	Yes	CAA, EASA, FAA	Yes (1)	>1,000
41	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 600	Non-rigid	Classic	Surveillance Passenger Advertising	2.3	Helium	6,666.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (10)	>1,000
42	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 600B	Non-rigid	Classic	Surveillance Passenger Advertising	2.4	Helium	7,100.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (6)	>1,001
43	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 600L	Non-rigid	Classic	Surveillance Passenger Advertising	2.4	Helium	7,100.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (6)	<100
44	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	Skyship 1000	Non-rigid	Classic	Surveillance Passenger Advertising	3.5	Helium	10,000.00	Yes	Yes	Yes	Yes	FAA	Experimental	<100
45	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A60	Non-rigid	Classic	Surveillance Passenger Advertising	0.68	Helium	1,925.00	Yes	Yes	Yes	Yes	LBA, FAA	Yes	>1000

Appendix 10.1: Catalogue of Active Airship Designers and Designs (2023)

#	Country of Origin	Make	Website	Contact Person	Email	Model	Types	Style	Purpose	Lift (Metric Tonnes)	Lifting Gas	Gas Volume (Cubic Meters)	Concept	Engineered Plans	Research Model	Prototype	Certified (Status/Agency)	Full Scale Model Built & Quantity	Missions
46	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A60R	Non-rigid	Classic	Surveillance Passenger Advertising	0.68	Helium	1,925.00	Yes	Yes	Yes	Yes	LBA, FAA	Yes (3)	>1000
47	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A60+	Non-rigid	Classic	Surveillance Passenger Advertising	0.68	Helium	1,925.00	Yes	Yes	Yes	Yes	LBA, FAA	Yes (27)	>1000
48	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A130 (Never Built)	Non-rigid	Classic	Surveillance Passenger Advertising	Undisclosed	Helium	Undisclosed	NA	NA	NA	NA	NA	No (0)	0
49	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A150	Non-rigid	Classic	Surveillance Passenger Advertising	3.6	Helium	4,200.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (8)	>1000
50	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A170	Non-rigid	Classic	Surveillance Passenger Advertising	2.1	Helium	4,822.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (2)	>1000
51	United States	SkyShip Services Inc.	https://skyshipservices.com	Gary Burns, GM	info@skyshipservices.com	A170G	Non-rigid	Classic	Surveillance Passenger Advertising	2.1	Helium	4,822.00	Yes	Yes	Yes	Yes	EASA, FAA	Yes (1)	<100
52	United Kingdom	Varialift Airships	https://www.varialift.com	Alan Handley, CEO	alan@varialift.com	ARH-50	Rigid	Hybrid	Cargo	50	Helium	Undisclosed	Yes	Yes	Yes - 2011	Yes	No	0	0
53	United Kingdom	Varialift Airships	https://www.varialift.com	Alan Handley, CEO	alan@varialift.com	ARH-250	Rigid	Hybrid	Cargo	250	Helium	Undisclosed	Yes	Yes	Yes - 2011	Yes	No	0	0
54	Germany	Zeppelin	https://zeppelinflug.de	Undisclosed	callcentre@zeppelin-nt.de	N07-101	Semi-rigid	Classic	Passenger Surveillance	1.9	Helium	Undisclosed	Yes	Yes	Yes	Yes	Yes	EASA/FAA	>1000

Appendix 10.2 – Climate Change Shortening of Winter Road Seasons

10.2 Climate Change Shortening of Winter Road Seasons

Excerpt from Barrette et al, 2022), reference below.

A number of studies show that the climate is changing in the northern hemisphere. Climate in the Arctic, in particular, has been warming at more than twice the global rate since 1900 (Knoll et al., 2019; Arctic Monitoring and Assessment Programme, 2017). The highest increase of a global surface temperature is projected at about three times the rate of global warming in the Arctic regions relative to 1850–1900, with a very high confidence (IPCC, 2021). The impact of climate change on the cryosphere, including sea ice thickness, snow cover, lake and river ice duration, and permafrost have increased in significance, with adverse consequences on northern transportation infrastructures (Knoll et al., 2019; Palko & Lemmen, 2017).

Over the years, there has been a small body of literature documenting the reduction in the average time window and in the overall quality of winter roads when in operation (Blair & Sauchyn, 2010; Centre for Indigenous Environmental Resources, 2006; Furgal & Prowse, 2008; Hori et al., 2017; Knowland et al., 2010; Mullan et al., 2021, 2017; Provencher, 2005). For example, in the NWT, later ice freeze-ups and earlier spring thaws are already affecting the duration of the Mackenzie Valley winter road season. The average opening date has been delayed by more than three weeks since 1996 (Furgal & Prowse, 2008). In northern Ontario, during the 2005/2006 operating season, there were delays of up to 10 days in opening several sections of the winter road networks, and many winter roads could not carry full freight loads due to thin ice conditions later in the season (Centre for Indigenous Environmental Resources, 2006). Also, the construction of winter roads in northern Manitoba and Saskatchewan was delayed that year due to the warmer weather conditions. The 2016/2017 operating season was one of the shortest winter road seasons across northern Canada, and was highlighted in the news media (e.g. Levin, 2017).

A trend analysis of the historical opening and closing dates for winter travel on the Alaskan North Slope was performed by Hinzman et al. (2005). Opening dates were delayed from early November in the 1970s to early January in the 2000s, and closing dates also moved to approximately three weeks earlier in May, resulting in winter travel duration decreasing from over 200 days in the 1970s to only 100 days in the 2000s.

Hori et al. (2017) examined climatological trends associated with winter road operational lengths in the western James Bay region of northern Ontario. They analyzed the relationship between the number of freezing-degree days (FDD) and the opening and closing dates of the James Bay Winter Road (JBWR) from 2005 − 2015. Results showed that the decreasing trends in FDD are statistically significant, along with increasing trends of monthly averages of both minimum and mean air temperatures during the winter months. Results also indicated the opening dates were more closely linked to the FDD during the preceding months of October through December (herein referred to as winter roads' 'preconditioning' period), than the calculated FDD until the opening dates in January. The time-series of their work were extended by Knoll et al. (2019) with the recent years of data (2016–2018). They identified that the relationship between opening dates and FDD during the preconditioning period of the winter roads was statistically significant for the last 13 years. Hori et al. (2017) estimated the minimum number of FDD required for road opening at about 380.

Barrette, Paul D.,Yukari Hori and Amy M. Kim. (2022) "The Canadian winter road infrastructure in a warming climate: Toward resiliency assessment and resource prioritization." Sustainable and Resilient Infrastructure.

https://www.tandfonline.com/eprint/3VZNSZCTWG4TR5PEEJ4H/full?target=10.1080/23789689.2022.2094124

Accumulated Freezing Degree Days (AFDD)

Freezing Degree Days (FDD) are computed with this simple formula:

$FDD = 0°C - T_{(\text{daily mean})}$

AFDD is the sum of daily FDD over the season

- used to estimate river ice thickness

Thickness (cm) $= \alpha\sqrt{AFDD}$

Ice Cover Condition	α
Windy lake, no snow	2.7
Average lake with snow	1.7-2.4
Average river with snow	0.4-0.5
Sheltered small river	0.7-1.4

Appendix 10.3 – Community Hub Profiles

10.3 Community Profiles

10.3.1 Yellowknife

Yellowknife was founded in 1934. The city is located in the traditional territory of the Dene First Nation who founded the nearby community of Dettah in the early 1930s. The city of Yellowknife has its origins in gold mining. In 1967, Yellowknife was designated as the territorial capital of Northwest Territories.

Neighbouring Indigenous Nations

Dene First Nations and Tlicho

Population

Yellowknife has a population just under 20,000. There are approximately 3,700 under the age of 14; 14,000 between the ages of 15 to 64 and 1,000 over the age of 65. Approximately 24% of the population identify as indigenous (3,000 First Nations, 1050, Metis and 690, Inuit).[29]

Languages

Eighty-two percent (16,485) report English as their main spoken language; sixteen percent (3,340) speak English and French; less than 1% (85) speak French and less than 1% (100) speak another language.

Employment

Yellowknife reached an employment rate of 73.7%, the highest recorded since 2013. Employers in Yellowknife have described a "really hot labour market" as they try to attract staff.[30] The unemployment rate of 5%. The three levels of government combined are the largest employers in Yellowknife.[31] According to the NWT Bureau of Statistics, the public administration sector accounted for about 14% of GDP in the NWT in 2018, 26% of direct employment in Yellowknife.[32]

City of Yellowknife

Mayor: Rebecca Alty

Councillors: Garett Cochrane, Ryan Fequet, Ben Hendriksen, Cat McGurk, Tom McLennan, Stacie Arden-Smith, Steven Payne, Rob Warburton

Yellowknife Economic Sectors

As the capital and largest population centre in the NWT, Yellowknife's economy is inextricably linked with that of the territory as a whole. As such, the economy of Yellowknife is strongly affected by decisions made by other levels of government, particularly the GNWT. The previous economic development strategy, which covered the years 2014 through 2019, emphasized that the City should "consider its economic development responsibilities beyond the municipal boundaries and become a strong voice in the territorial economy." In turn, as the major population centre, the seat of government, the major supply hub, and the primary centre for key services including healthcare, the economic health of Yellowknife can

[29] https://townfolio.co/nt/yellowknife/demographics

[30] https://cabinradio.ca/89807/news/economy/nwts-employment-rate-is-highest-in-almost-a-decade/

[31] https://www.etalentcanada.ca/employment-data/yellowknife/

[32] https://www.yellowknife.ca/en/doing-business/resources/Economic_Development_and_Tourism_Strategy/CITY-OF-YELLOWKNIFE-ECONOMIC-DEVELOPMENT-STRATEGY-2020-2024-FINAL.pdf

directly impact on the quality of life in other communities in the NWT. Yellowknife benefits from a strong NWT economy; the NWT benefits from a healthy Yellowknife.[33]

Yellowknife business sectors most commonly identified included consulting (21%); the mining, quarrying, and oil and gas extraction sector (14%); construction (14%); retail (13%); healthcare services (10%); arts, entertainment and recreation (10%) and tourism (9%).

Economic Development Strategy 2020-2024

https://www.yellowknife.ca/en/doing-business/resources/Economic_Development_and_Tourism_Strategy/CITY-OF-YELLOWKNIFE-ECONOMIC-DEVELOPMENT-STRATEGY-2020-2024-FINAL.pdf

Chamber of Commerce

The Yellowknife Chamber of Commerce mandate is to be a leader in the continued improvement and development of a strong Yellowknife business community in order to support a diversified economy and sustainable growth.[34]

Business Directory

Chamber of Commerce publish an online business directory that can be found here https://business.ykchamber.com/list/

Mining Sector

Three diamond mines operate in the NWT. The Gahcho Kué mine is located about 170 miles northeast of Yellowknife while the Ekati and Diavik mines are each located about 200 miles north of Yellowknife. Apart from diamond production, the mineral industry also generates significant economic activity related to:

Exploration: Exploration expenditures totalled $919 million over the past 10 years including $78 million in 2019. The leading commodities in terms of exploration expenditures included diamonds ($501 million in expenditures over the past ten years), precious metals ($210 million) and base metals ($115 million). Junior companies accounted for $545 million of the $919 million (59%) in exploration expenditures over the 10 years.

Remediation: The Giant Mine operated in Yellowknife just outside of the city centre from 1948 to 2004, generating over seven million ounces of gold. The Government of Canada became responsible for the mine site's environmental liabilities when then-owner Royal Oak Mines went bankrupt in 1999. The $1 billion Giant Mine Remediation Project is funded through the Federal Contaminated Sites Action Plan. Estimates for remediation are now $4.38 billion – and is believed to be the most expensive remediation in Canada's history.[35]

Purchase of products and services: Yellowknife serves as a major distribution, supply, transportation and logistics hub for the mining sector. According to the Conference Board of Canada, the GDP associated with mining services totalled about $91 million in 2018.

Construction: Construction is the third largest sector in the NWT after mining and public administration. Along with commercial, residential and infrastructure development, the mining industry has been a major driver for the construction industry. The size of the construction industry has declined over the past three to four years when development of the Gahcho Kué mine was completed.

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[33] https://www.yellowknife.ca/en/doing-business/resources/Economic_Development_and_Tourism_Strategy/CITY-OF-YELLOWKNIFE-ECONOMIC-DEVELOPMENT-STRATEGY-2020-2024-FINAL.pdf

[34] https://ykchamber.com/about-us/

[35] https://www.ctvnews.ca/climate-and-environment/canada-s-top-five-federal-contaminated-sites-to-cost-taxpayers-billions-to-clean-up-1.6170513

Accommodation and food services: Business travel is also a major component of the tourism and mining industry – as Yellowknife also serves as an important bedroom community for miners. According to the GNWT's 2018 Socio-Economic Agreement Report, the NWT's operating mines generated 1,592 jobs for northern residents in 2017, of whom 819 are Indigenous. Since 1996, when the first Socio-Economic Agreement was signed with Ekati Diamond Mine, the operating diamond mines have generated 27,000 person-years of local employment.

Cumulative diamond mine employment including construction, operations, and closure from 1996 to 2017 was estimated at 56,642 person-years of employment, with 49% of employees being northern residents and 24% northern Indigenous. Significant additional employment is generated in the north and more specifically through the purchase of goods and services by the mines and expenditures in the community by mine employees.[36]

Closures: Upcoming closures of the diamond mines will have a significant negative impact on the economy in Yellowknife. The three diamond mines have reached peak production and, according to estimates provided by Conference Board of Canada, production will begin declining in 2021. According to the Conference Board's 2019 Territorial Outlook Economic Forecast, Diavik's operating life is scheduled to end in 2025, Gahcho Kué's in 2028, and Ekati well into the 2030s (contingent on developing the Jay pipe). The Conference Board projects that GDP associated with non-metal mining (i.e. diamond mining) in the NWT will decline from $1.8 billion in 2018 to $1.0 billion in 2025, which will also impact other economic sectors including government. There is considerable uncertainty regarding timing of the economic shocks.

Airport

Yellowknife's airport is a 5 minute drive or approximately 5km from the downtown core.[37] Yellowknife serves as an air transportation hub for the rest of the territory plus western portion of Nunavut especially the Kitikmeot region including the communities of Cambridge Bay, Kugluktuk, Taloyoak, Gjoa Haven and Kuugaruk.

Airlines

Yellowknife benefits from several airlines flying into and out of this airport including Air Canada, Air North, Air Tindi, Canadian North, WestJet, North-Wright Airways, Nolinor Aviation, and WestJet.

Due to competition, the airfares are more competitive, especially Yellowknife to southern destinations such as Edmonton, Calgary and Ottawa.

Airfares can be as cheap as $250 to $500 one-way or $500 to $1000 return depending on fare class and destination.

Roads

Yellowknife benefits from having a road connecting it to Edmonton, Alberta.[38] This helps reduce the cost of living and cost of business in Yellowknife – as most goods are driven instead of flown in. It is possible to drive cargo year-round into Yellowknife. It takes approximately 19-20 hours to drive on the fully paved 1,500 km road.

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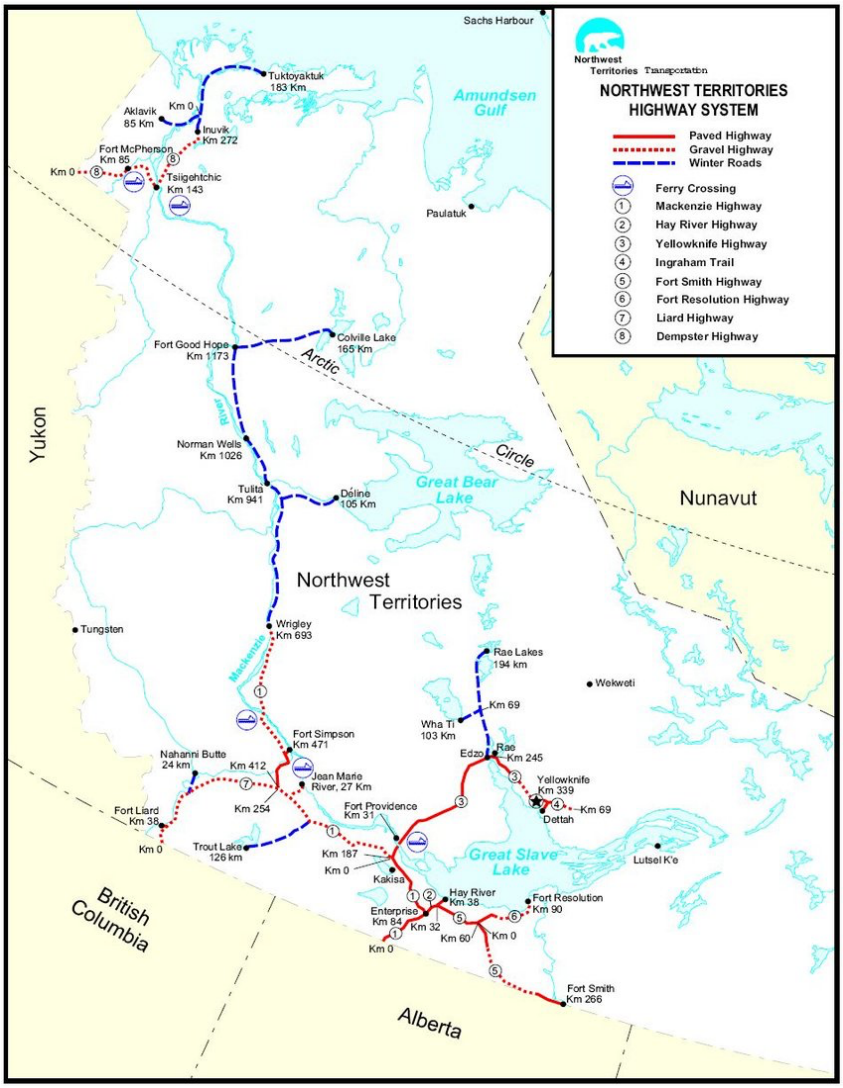
[36] https://www.yellowknife.ca/en/doing-business/resources/Economic_Development_and_Tourism_Strategy/CITY-OF-YELLOWKNIFE-ECONOMIC-DEVELOPMENT-STRATEGY-2020-2024-FINAL.pdf

[37] https://www.inf.gov.nt.ca/en/services/airports/yellowknife-airport

[38] https://ykonline.ca/getting-to-yellowknife-driving/



There are other roads further north out of Yellowknife such as Highway 3 or Yellowknife Highway and Highway 4 heading east for approximately 70 km. Most of the roads off of the main highways are not paved and the ice roads are only usable when the rivers and lakes are sufficiently frozen rivers.

https://www.researchgate.net/figure/Map-of-the-NWT-Highway-System_fig1_242419581

Telecommunications

Yellowknife benefits from having fibre optic cable and there are plans to bring redundancy into the region by building fibre optic from Dawson City, Yukon to Inuvik, NWT.[39] As a result, the telecommunication service and prices are better than those communities served by satellite via NWTel and TeleSat. However, StarLink service is beginning to provide services to Canada's north.

Train: MacKenzie Northern Railway

The Mackenzie Northern Railway is a 602-mile (969 km) Canadian railway operating in Alberta and the Northwest Territories.[40] It is the northernmost trackage of the contiguous North American railway

[39] https://yukon.ca/dempsterfibreproject

[40] Promoting Railway Safety In the Community". *Railway Association of Canada*. 2004-09-07. Archived from the original on 2007-08-14. Retrieved 2009-01-15.

network.[41] Since being purchased by CN in 2006, it has been officially known as the Meander Subdivision.[42] The majority of fuel to NWT is transported on rail. This railway line has struggled with washouts from flooding[43] and wildfires[44] which sometimes also affects the Highway between Alberta and NWT.

NWT Transportation Strategy 2015-2040: Northerners Connected to Opportunities

The purpose of the NWT Transportation Strategy[45] is to provide and promote a safe, reliable and sustainable multi-modal transportation system by strengthening connections, capturing opportunities and embracing innovation.

The stated priority is to continue to maintain and improve our existing transportation system to enhance the level of service, increase reliability, improve transportation safety and build on partnerships. Additionally, commitment to continue to expand the transportation system through partnerships to better connect our communities and support our economic development potential.

A statement to embrace innovation, specifically to improve the way we do business by improving service delivery, modernizing transportation programs and policies, communicating better with the public to improve awareness and safety, applying new technologies, adapting the system to the effects of climate change and promoting environmental stewardship.

There is recognition for new technologies and new vehicle types including airships!

Technology in the transportation sector is developing quickly and the transportation system must be able to adapt to the changes. Fuel efficient, zero emission vehicles are nearing the possibility. High tech electronics may enable vehicles to drive themselves, communicate with each other, with the road and with traffic signals. Vehicles of the future may use vision enhancement devices to help navigate through bad weather and warn of a possible collision with a pedestrian or animal. They may also be able to let you know if you are getting drowsy or straying from your lane. On the freight side, commercial transport vehicles are getting larger, longer and more efficient. For resupply, airships may even become possible. The transportation system must be adaptable to these changes in the future. [emphasis added]

Energy: Power and Heating

The Snare Hydro System provides power to Yellowknife, Behchoko and Dettah, north of Great Slave Lake. The Snare Hydro system is located on the Snare River about 140 km northwest of Yellowknife. It includes four separate hydro plants: Snare Rapids, Snare Falls, Snare Cascades (leased from the Dogrib Power Corporation), and Snare Forks. The system includes about 150 km of transmission lines owned and maintained by NTPC.[46] When hydro drops out, diesel generators at the Jackfish power plant exist as a backup and are expected to kick in almost immediately.

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[41] "Northern Connections: A Multi-Modal Transportation Blueprint for the North" (PDF). Government of Yukon. February 2008. p. 12. Archived from the original (PDF) on 2011-06-11. Retrieved 2009-01-15.

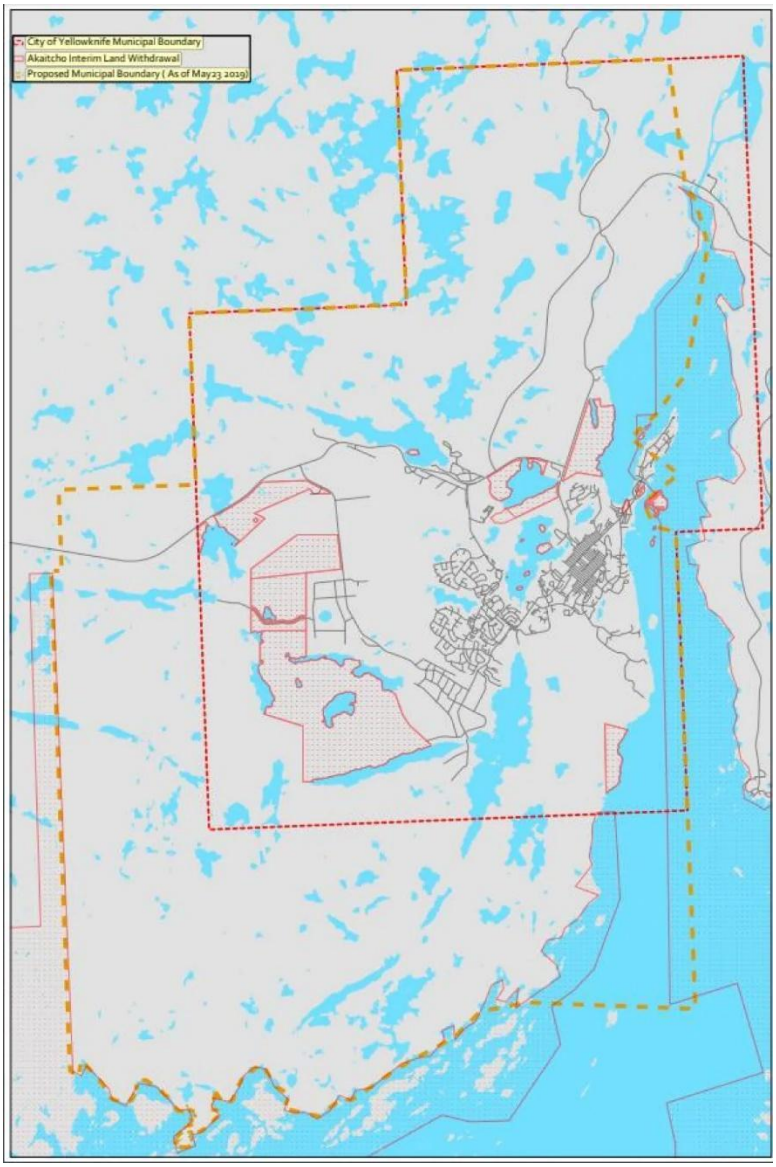
[42] "Fire slows rail service to Hay River". *www.nnsl.com*. Archived from the original on 2016-02-17.

[43] https://cabinradio.ca/92322/news/south-slave/cn-railbed-on-nwt-line-washes-out-in-northern-alberta/

[44] https://www.cbc.ca/news/canada/north/cn-rail-alberta-nwt-link-1.5156557

[45] https://www.inf.gov.nt.ca/sites/inf/files/resources/nwt_transportation_strategy.pdf

[46] https://www.ntpc.com/energy-alternatives/how-we-supply-power/hydro-electric



Power outages are commonplace in Yellowknife compared to most regions of Canada, in large part because there is no connection to any power source beyond the Snare hydro system and local diesel, so there is no redundancy if those fail. In the south, by contrast, cities and provinces can readily lean on the power generated by neighbours.[47]

New Proposed City of Yellowknife Boundary

The City of Yellowknife municipal boundary currently covers 136 square kilometers. The proposed boundary would cover 210 square kilometers. The newly proposed boundary would remove Ndilo from Yellowknife while keeping half of Latham Island within the municipality. It would also remove Jolliffe Island from the city.A map of the city's new proposed municipal boundary. See attached. The change would also see Ndilo and Detah being able to be officially administered together and would also allow both communities to have easier access to government funding. The land freed up through a proposed boundary change is ideal for the city's expansion.[48]

[47] https://cabinradio.ca/104253/news/yellowknife/a-fresh-mystery-what-happened-to-our-diesel-backup/

[48] https://www.cbc.ca/news/canada/north/yellowknife-city-boundary-change-1.5212930

Potential Airship Landing Site/Hanger

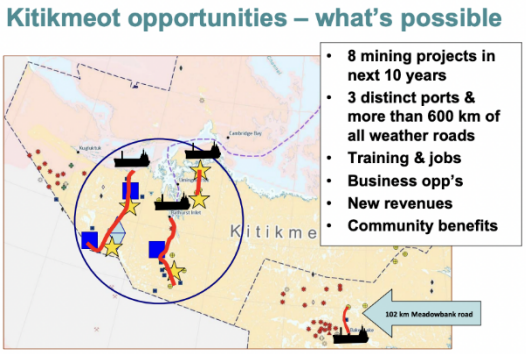
There appears to be a potential airship landing site/hanger not far from the existing Yellowknife airport. More assessment and consultations with the City of Yellowknife and the neighbouring Indigenous communities/nations would be required.

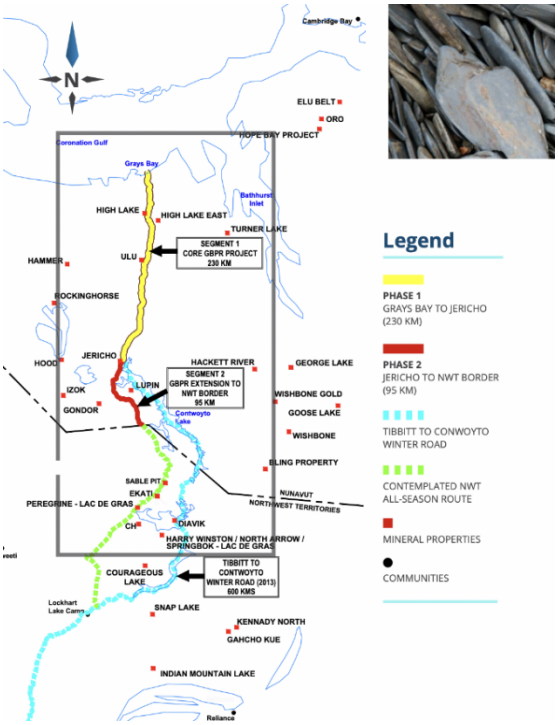
Nunavut

Yellowknife is the main gateway and hub for Kitikmeot, the eastern region of Nunavut. Kitikmeot communities include Kugluktuk, Cambridge Bay, Taloyoak, Kuugaruk and Gjoa Haven. The population of Kitikmeot is 6,500 with Cambridge Bay (1,760) and Kugluktuk (1,491) being the two regional hubs for the region. The majority of the main government departments, Inuit organizations and businesses serving this region are based in these two communities.

Kitikmeot Mines

There is the potential to have 8 mining projects in the Kitikmeot region in the next 10 years or so.[49] The potential can be realized if the various mining owners are able to secure funding and financing both for the mine along with the associated infrastructure necessary for the mine and the region, especially the transportation corridor.





According to the NWT and Nunavut Chamber of Mines, the Kitikmeot mining sector, especially with 3 diamond mines, could create 13,000 person years of northern employment with half being Indigenous representing $8B in northern business with half benefiting indigenous businesses. The mines would need to negotiate Inuit Benefit Agreements which would see training, employment, contracts, scholarships and community contributions and donations.[50]

Grays Bay and Port Project

The Grays Bay Road and Port Project (GBRP) is a transportation system that, once completed, will connect the rich mineral resources of Canada's Slave Geological Province, which straddles Nunavut and the Northwest Territories, to arctic shipping routes. The GBRP consists of a 227 km all season road linking the northern terminus of the Tibbitt-Contwoyto Winter Road to a deep-water port at Grays Bay on the Northwest Passage.[51]

The Kitikmeot Inuit Association and the Government of Nunavut believe that the construction of Grays Bay Port and Road infrastructure will, over a 15-year period, raise Nunavut's GDP by a total of $5.1 billion

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[49] https://www.miningnorth.com/_rsc/site-content/library/THoefer%20Kitikmeot%20Trade%20Show%20Feb1511%20Final%20Slides.pdf

[50] Ibid

[51] https://sencanada.ca/content/sen/committee/421/ARCT/Briefs/2018-10-01_NRC_e.pdf

and Canada's by $7.6 billion. In addition, the infrastructure would support mining exploration and development, increase employment in both Nunavut, NWT and Alberta, provide Nunavut communities greater access to goods and services, reduce the cost of living and improve food security.[52]

Feasibility Study Presentation & Northern Lights Conference Workshop

It is recommended to inform and invite any leaders and representatives of Yellowknife and the Dene if they plan to attend Northern Lights Conference, Ottawa, February 7th – 11th, 2023.[53] A workshop to present Airship Feasibility Study would be beneficial along with seeing if any or all three communities are sufficiently interested to move towards the development of an airship business plan out of Yellowknife, NWT.

If so, then the Canadian Arctic Innovation Association would see how – ideally in partnership with any of the local communities and indigenous nations - to proceed in securing government funding to develop a high-level business case.

Map of the NWT Transportation System

[52] https://sencanada.ca/content/sen/committee/421/ARCT/Briefs/2018-10-01_NRC_e.pdf

[53] https://www.northernlights.events/


Tuktoyaktuk
Aklavik
Inuvik
Fort McPherson
Tsiigehtchic
Paulatuk
Sachs Harbour
Ulukhaktok
Fort Good Hope
Colville Lake
Norman Wells
Tulita
Deline
Wrigley
Gameti
Wekweti
Fort Simpson
Wha Ti
Jean Marie River
Behchoko
Nahanni Butte
Fort Providence
Yellowknife
Ndilo
Dettah
Fort Liard
Kakisa
Lutselk'e
Trout Lake
Hay River
Fort Resolution
Enterprise
Hay River Reserve
Fort Smith


THE Deh Cho
TRAVEL CONNECTION
NORTHWEST TERRITORIES
YUKON
BRITISH COLUMBIA
ALBERTA
Wrigley
Behchokǫ̀
YELLOWKNIFE
Dettah
Fort Simpson
Nahanni Butte
Jean Marie River
Checkpoint
Fort Providence
Mackenzie Bison Sanctuary
Great Slave Lake
Fort Liard
Trout Lake
Kakisa
Hay River
Fort Resolution
Enterprise
Fort Nelson
Indian Cabins
Fort Smith
Prophet River
Meander River
Rainbow Lake
High Level
Pink Mountain
Fort Vermilion
Paddle Prairie
Keg River
Wonowon
Fort St. John
Manning
Hudson's Hope
Taylor
Dunvegan
Red Earth Creek
Chetwynd
Pouce Coupé
Fairview
Peace River
DAWSON CREEK
Mile Zero
Spirit River
GRIMSHAW
Mile Zero
Donnelly
Fort McMurray
Beaverlodge
Tumbler Ridge
Grande Prairie
High Prairie
Valleyview
Slave Lake
Swan Hills
Fox Creek
Whitecourt
Athabasca
Westlock
Grande Cache
Jasper National Park
Hinton
Jasper
EDMONTON
Elk Island National Park
LEGEND
ROUTES
HIGHWAYS
SYMBOLS


Inuvik
Ulukhaktok
Cambridge Bay
Taloyoak
YUKON
NWT
Kugluktuk
Gjoa Haven
Whitehorse
Norman Wells
NUNAVUT
Fort Simpson
Yellowknife
Hay River
Edmonton

Communities served via the Yellowknife Gateway, and Demand for Building Materials

Gateway: Yellowknife, NT						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Aklavik	NT	536	1144	274	109.6	3288
Colville Lake	NT	110	752	43	17.2	516
Deline	NT	573	538	226	90.4	2712
Fort Good Hope	NT	507	803	231	92.4	2772
Fort McPherson	NT	647	687	318	127.2	3816
Gamèti	NT	252	846	104	41.6	1248
Inuvik	NT	3137	1103	1464	585.6	17568
Lutselk'e	NT	333	187	139	55.6	1668
Norman Wells	NT	673	685	404	161.6	4848
Paulatuk	NT	298	881	100	40	1200
Sachs Harbour	NT	104	1154	52	20.8	624
Tuktoyaktuk	NT	937	1140	334	133.6	4008
Tulita	NT	396	615	160	64	1920
Ulukhaktok	NT	408	933	159	63.6	1908
Wekweeti	NT	109	193	55	22	660
Whatì	NT	543	166	162	64.8	1944
Wrigley	NT	117	466	63	25.2	756
Cambridge Bay	NU	1760	852	701	280.4	8412
Gjoa Haven	NU	1382	1087	438	175.2	5256
Kugluktuk	NU	1382	598	438	175.2	5256
Resolute	NU	183	1558	89	35.6	1068
Total Population		**14387**				
Weighted Average Air Distance (km)			**862**			

10.3.2 Enterprise

Enterprise is a hamlet in the South Slave Region of the Northwest Territories, Canada, located between Great Slave Lake and the Alberta border on the Hay River.

Enterprise is at an important junction of the Mackenzie Highway and the road to Yellowknife and was established when two service stations were built to take advantage of traffic along these highways. It has since grown to include a weigh station, Winnie's Restaurant, and a motel to accommodate travelers. Most of the remaining commercial region, however, is currently closed for business and looking for buyers.

It is a significant point on the Northwest Territories highway system, as all traffic that heads to the two largest population centers, Yellowknife to the north, and the nearby town of Hay River to the northeast, must pass through.

Population

In the 2021 Canadian census conducted by Statistics Canada, Enterprise had a population of 75 living in 33 of its 51 total private dwellings, a change of -29.2% from its 2016 population of 106. With a land area of 305.58 km2 (117.99 sq mi), it had a population density of 0.2/km2 (0.6/sq mi) in 2021.

At the 2016 Canadian census there were 30 First Nations, 10 Métis and 10 Inuit. The main languages, besides English, are North and South Slavey, Inuinnaqtun (Inuvialuktun) and German.

Climate

Enterprise has a subarctic climate (Dfc) with the yearly mean temperature being below zero in spite of the relatively warm summers around 22 °C (72 °F) resulting in Enterprise being well below the tree line in the boreal forest. Winter average highs are around −20 °C (−4 °F) with lows being −31 °C (−24 °F), typical of the boreal forests north of the prairies.[54]

Road Access

Highway 1, also known as the Mackenzie Highway, starts at the NWT/Alberta border and continues for approximately 690 kilometers to the community of Wrigley.

The first 220 kilometers are paved, as are 60 kilometers from the junction of the Liard Highway to Fort Simpson. The remainder is gravel, with portions treated for dust control.[55]

Railway Access

Between November 1997 and May 1998 CN sold its lines running from Smith, Alberta, on the former NAR (north of Edmonton) to Peace River and Grimshaw and on through to Hay River to a shortline operator, RailLink Canada. RailLink Canada consolidated these lines under the name Mackenzie Northern Railway.

RailLink Canada was subsequently purchased by RailAmerica, which operated the Mackenzie Northern Railway between Smith and Hay River. Commodities include agriculture and forest products from northeastern Alberta and the southern Northwest Territories, as well as fuel and supplies destined for Arctic communities to be barged across Great Slave Lake and down the Mackenzie River to the Beaufort Sea.

Communities served via the Enterprise Gateway, and Demand for Building Materials

Gateway: Enterprise, NT						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Nahanni Butte	NT	81	367	39	15.6	468
Fort Simpson	NT	1100	315	572	228.8	6864
Sambaa K'e	NT	97	280	49	19.6	588
Fort Smith	NT	2248	242	1009	403.6	12108
Camsell Portage	SK	37	395	10	4	120

[54] https://en.wikipedia.org/wiki/Enterprise,_Northwest_Territories

[55] https://www.inf.gov.nt.ca/en/transportation

Gateway: Enterprise, NT						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Fond-du-Lac	SK	926	516	260	104	3120
Stony Rapids	SK	219	593	132	52.8	1584
Uranium City	SK	91	431	59	23.6	708
Fort Chipewyan / Chipewyan Lake	AB	798	346	387	154.8	4644
Fox Lake	AB	2488	249	419	167.6	5028
Total Population		**8085**				
Weighted Average Air Distance (km)			**310**			

10.3.3 Churchill

Churchill is a town situated in northern Manitoba on the west shore of Hudson Bay. It is often best known as the "polar bear capital" of the world and has benefitted from polar bear tourism. The next closest town is Thompson, Manitoba approximately 400 km to the south and 1000 km away from Winnipeg, Manitoba's provincial capital city.

The Kivalliq Region of Nunavut is situated north of Churchill which consists of seven communities: Arviat, Whale Cove, Rankin Inlet, Chesterfield Inlet, Baker Lake, Coral Harbour and Naujaat (formerly known as Repulse Bay).

History

In 1942, the United States Army Air Forces established a base called Fort Churchill, 8 km (5.0 mi) east of the town. After World War Two, the base served several other purposes including as a Royal Canadian Air Force (RCAF) and a Strategic Air Command facility. Following the demolition of the base it was repurposed into the town's airport.[56]

Naval Radio Station Churchill, call sign CFL, was activated as an ionospheric study station by the Royal Canadian Navy in support of the U-boat high-frequency direction finding (HFDF) net and became operational on 1 August 1943. Around 1949, Churchill became part of the Canadian SUPRAD (signals intelligence) network and remained in that role until it closed its doors in 1968. The Operations and Accommodations building remains today but is abandoned

This area was also the site of the Churchill Rocket Research Range, part of Canadian-American atmospheric research. Its first rocket was launched in 1956, and it continued to host launches for research until closing in 1984. The site of the former rocket range now hosts the Churchill Northern Studies Centre, a facility for multidisciplinary Arctic research.[57] [58]

Coordinates: 58°46′51″N 094°11′13″W

Environment

Churchill is situated at the estuary of the Churchill River at Hudson Bay. The small community stands at an ecotone, on the Hudson Plains at the juncture of three ecoregions: the boreal forest to the south,

[56] Historic Sites of Manitoba: Fort Churchill (Churchill)". *www.mhs.mb.ca*. Retrieved 29 September 2019

[57] Non Profit Field Station". *Churchill Northern Studies Centre*. 26 July 2018. Retrieved 29 September 2019

[58] https://en.wikipedia.org/wiki/Churchill,_Manitoba

the Arctic tundra to the northwest, and the Hudson Bay to the north. Wapusk National Park, located at 57°46′26″N 93°22′17″W[59], is to the southeast of the town.

The landscape around Churchill is influenced by shallow soils caused by a combination of subsurface permafrost and Canadian Shield rock formation. The black spruce dominant tree cover is sparse and stunted from these environmental constraints. The area also offers sport fishing. Several tour operators offer expeditions on land, sea and air, using all terrain vehicles, tundra buggies, boats, canoes, helicopters as well as ultralight aircraft.[60]

Climate

Churchill has a subarctic climate with long very cold winters, and short, cool to mild summers. Churchill's winters are colder than a location at a latitude of 58 degrees north should warrant, given its coastal location. The shallow Hudson Bay freezes, eliminating any maritime moderation. Prevailing northerly winds from the North Pole jet across the frozen bay, leading to a January average of −26.0 °C (−14.8 °F). Churchill's July average temperature is 12.7 °C (54.9 °F).[61]

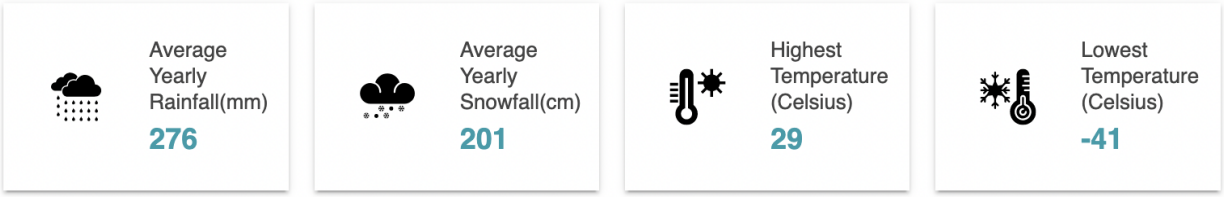

Image: ***https://townfolio.co/mb/churchill/summary***

Population

In the 2021 Canadian census conducted by Statistics Canada, Churchill had a population of 870 living in 389 of its 540 total private dwellings, a change of -3.2% from its 2016 population of 899. With a land area of 50.83 km2 (19.63 sq mi), it had a population density of 17.1/km2 in 2021.[62]

As of the 2021 Canada Census, just over 56% of the population is Indigenous and the rest (43%) are non-native. Of the Indigenous population there were 345 First Nations (69%), 80 Métis (16 per cent), 25 Inuit (5%) and 35 people (7%) had multiple Indigenous ancestry.

The non-native population is largely of European descent, although a small number of Black Canadians (2.3%) and Latin Americans (1%) also reside in Churchill.

22% of the population are 0 to 14 years of age

69% of the population are 15 to 64 years of age

10% of the population is over the age of 65 years of age

36 is the average age of the population

Language

English is the most commonly spoken language, followed by Cree, Inuktitut, French and Dene.[63]

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[59] Wapusk National Park". Geographical Names Data Base. Natural Resources Canada

[60] Churchill Tours". Tripadvisor. Retrieved 12 October 2022; "Everything Churchill". Travel Manitoba. Retrieved 12 October 2022

[61] https://en.wikipedia.org/wiki/Churchill,_Manitoba

[62] *"Population of unincorporated places of 50 persons and over, Manitoba, 1961 and 1956".* 1961 Census of Canada: Population. *Series SP: Unincorporated Villages;* Vol. Bulletin SP—4. Ottawa: Dominion Bureau of Statistics. 18 April 1963. Retrieved 24 October 2021.

[63] Census Profile, 2021 Census of Population Profile table - Churchill, Town (T) Manitoba [Census subdivision]". Statistics Canada. 2 September 2022. Retrieved 12 October 2022

Employment

Estimated local workforce is 410 people with an employment rate of 61.6%, participation rate of 72.6% of employable age persons and an unemployment rate of 15.1%. The median household income is $65,280.[64]

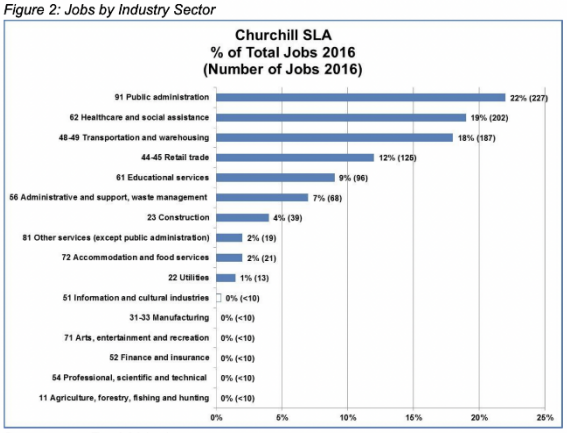
Employment by sector

In 2016, there were 1,037 jobs in the region, an increase of 14.5% (131 jobs) between 2011 and 2016. This compares to an increase of 4.0% for Manitoba. The likely reason for the difference between the number of estimated local workforce in Churchill and number of jobs in the region is a significant number of seasonal/tourism jobs filled by non-residents.

In the Goods producing sectors, there were 61 jobs, an increase of 5 jobs or (8.91%) from 2011.

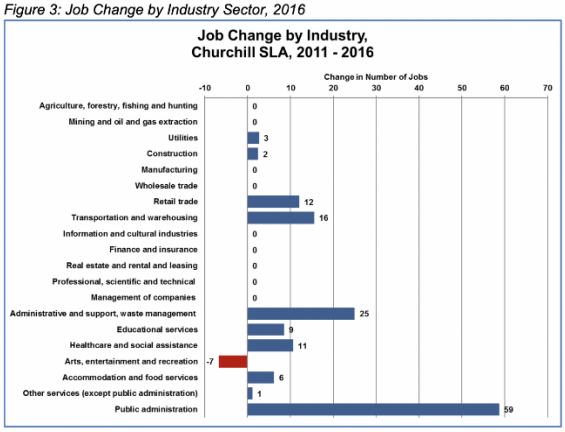
There was an increase in jobs in the Utilities sector of 3 jobs (26.4%) and the Construction sector of 2 jobs (6.8%).

Figure 2: Jobs by Industry Sector



Data source: Emsi 2017.1

Figure 3: Job Change by Industry Sector, 2016



Data source: Emsi 2017.1

For comparison, from 2011 to 2016, Manitoba gained 2,973 jobs or 2.2% in the goods producing sectors

In 2016, there were 945 jobs in the service sector, a gain of 126 jobs (15.4%). This compares to an increase of 4.7% (24,488 jobs) in Manitoba.[65]

Economy

Tourism and ecotourism are major contributors to the local economy, with the polar bear season (October and November) being the largest. Tourists also visit to watch beluga whales in the Churchill River in June and July. The area is also popular for birdwatchers and to view the aurora borealis.

See Link to Churchill and Region Economic Profile

https://www.gov.mb.ca/asset_library/en/looknorth/ep-churchill.pdf

Churchill Economic Development Strategy or Plan – CHECK

Churchill Economic Development Officer – SENT EMAIL to Town

[64] https://townfolio.co/mb/churchill/summary

[65] https://www.gov.mb.ca/asset_library/en/looknorth/ep-churchill.pdf

Churchill Chamber of Commerce

The Churchill Chamber of Commerce mission is to make Churchill Manitoba the best place to live and work by championing sustainable economic growth leading to greater prosperity for business and the community.[66] The website lists only summer hours.

Municipality of Churchill

PO Box 459, Churchill, Manitoba, R0B 0E0 Tel: (204) 675-8871 Email: townofchurchill@churchill.ca

Mayor and Council

Mayor: Michael Spence (re-elected 2022 for 4 years; served 27 years)

Councillors: Verna Flett, Bill Dingwall, Marjorie Spence, Heather Botelho

Heath Centre

The Churchill health centre serves a community of 831 residents as well as patients and clients from surrounding communities in Manitoba and the Nunavut Region, Kitikmeot Region and the Baffin Region. It is an operating division of the Winnipeg Regional Health Authority, has a staff of 129 people, including 6 regular doctors and 4 locums, 18 nurses and 8 health-care professionals and support staff. The health centre also features 21 acute care beds, a nursing ward and two emergency rooms. It provides a wide range of health-care services, including: 24-hour emergency medical care, in-patient care, pre- and postoperative dental surgery, elderly care, emergency obstetrics, patient transport arrangements, interim care of critically ill patients awaiting transfer to a primary care facility, rehabilitation and chronic care.[67] More health information can be found at https://wrha.mb.ca/files/cha-2014-profile-churchill.pdf

Banking

The Royal Bank of Canada has a branch in Churchill. The hours are Monday to Friday from 10:00 am to 3:00pm.

Stores and Restaurants

There appear to be approximately 10 different stores with one main grocery store, the Northern.

There appear to be about the same number of restaurants, some of which are situated in the hotel/motel and bed and breakfasts in the town.

Hotels, Motels and Bed & Breakfasts

There appear to be about 19-20 different hotels, motels and B&Bs in Churchill.[68]

Airport and Runway

Churchill airport is formerly a United States and Canadian military base, is serviced by Calm Air operating scheduled flights connecting Churchill to Winnipeg. The airport is located 5.6 km or 3.5 miles east southeast of the community of Churchill. Although it is a small domestic airport, it handles a relatively high number of passengers throughout the year as Churchill is a major destination for ecotourism and scientific research. Churchill Airport also serves as a transfer airport for passengers and cargo traveling between Winnipeg and remote communities in the Kivalliq Region, Nunavut.[69]

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[66] https://www.churchillchamber.ca/

[67] https://churchillhealthcentre.com/about/

[68] See expedia.com

[69] https://en.wikipedia.org/wiki/Churchill_Airport

The 9,195 feet (2,803 m) asphalt runway is still maintained and the airport serves as a diversion airport for jet aircraft up to the size of a Boeing 747 or Boeing 777 that are forced to make emergency landings. The airport also serves as a Strategic Air Command base housing the 3949th Air Base Squadron of the 813th Strategic Aerospace Division.

Air Travel

Calm Air is the only commercial airline that flies in and out of Churchill. There are direct flights to and from Winnipeg to Churchill on Fridays and on Mondays and Wednesdays the Winnipeg to Churchill flight also stops at Gillam.

Air Fares

Calm Air Winnipeg to Churchill one-way $900-$1000; full fare $1600-$1800

Air Cargo

Calm Air flies cargo into Churchill and into the Kivalliq Region.[70] Additional surcharges to rates published below include 8.5% NAV Canada fees, $0.10 per kg for carbon surcharge (Manitoba only), 5% GST, Dangerous Goods fee $55 per AWB (excluding tax). Transportation charges will be assessed on the gross weight of the shipment based on the greater of actual weight or the cubic dimensional weight.[71]

TARIFF RATES - CHURCHILL

CITY PAIR	WEIGHT	BASE PRICE (PER KG)
Churchill - Winnipeg		
YYQ-YWG	General - Env/Min	$37.564
YYQ-YWG	General (1-9999)	$3.299
YYQ-YWG	Priority - Env/Min	$71.653
YYQ-YWG	Priority (1-9999)	$4.619
YYQ-YWG	C-100	$-
YYQ-YWG	C-202 Rock 1-14	$46.554
YYQ-YWG	C-202 Rock 15	$3.291
Churchill - Baker Lake		
YYQ-YBK	General - Env/Min	$37.564
YYQ-YBK	General (1-9999)	$5.586
YYQ-YBK	Priority - Env/Min	$71.653
YYQ-YBK	Priority (1-9999)	$7.819
YYQ-YBK	C-100	$-
Churchill - Whale Cove		
YYQ-YXN	General - Env/Min	$37.564
YYQ-YXN	General (1-9999)	$5.740
YYQ-YXN	Priority - Env/Min	$71.653
YYQ-YXN	Priority (1-9999)	$8.038
YYQ-YXN	C-100	$-

CITY PAIR	WEIGHT	BASE PRICE (PER KG)
Churchill - Sanikiluaq		
YYQ-YSK	General - Env/Min	$56.192
YYQ-YSK	General (1-9999)	$13.625
YYQ-YSK	Priority - Env/Min	$71.653
YYQ-YSK	Priority (1-9999)	$19.079
Churchill - Coral Harbour		
YYQ-YZS	General - Env/Min	$37.564
YYQ-YZS	General (1-9999)	$7.665
YYQ-YZS	Priority - Env/Min	$71.653
YYQ-YZS	Priority (1-9999)	$10.733
YYQ-YZS	C-100	$-
Churchill - Thompson		
YYQ-YTH	General - Env/Min	$37.564
YYQ-YTH	General (1-9999)	$6.048
YYQ-YTH	Priority - Env/Min	$71.653
YYQ-YTH	Priority (1-9999)	$8.467

CITY PAIR	WEIGHT	BASE PRICE (PER KG)
Churchill - Chesterfield Inlet		
YYQ-YCS	General - Env/Min	$37.564
YYQ-YCS	General (1-9999)	$6.455
YYQ-YCS	Priority - Env/Min	$71.653
YYQ-YCS	Priority (1-9999)	$9.039
YYQ-YCS	C-100	$-
Churchill - Rankin Inlet		
YYQ-YRT	General - Env/Min	$37.564
YYQ-YRT	General (1-9999)	$5.586
YYQ-YRT	Priority - Env/Min	$71.653
YYQ-YRT	Priority (1-9999)	$7.819
YYQ-YRT	C-100	$-

CITY PAIR	WEIGHT	BASE PRICE (PER KG)
Churchill - Arviat		
YYQ-YEK	General - Env/Min	$37.564
YYQ-YEK	General (1-9999)	$2.232
YYQ-YEK	Priority - Env/Min	$71.653
YYQ-YEK	Priority (1-9999)	$3.123
YYQ-YEK	C-100	$-
Churchill - Naujaat		
YYQ-YUT	General - Env/Min	$37.564
YYQ-YUT	General (1-9999)	$7.665
YYQ-YUT	Priority - Env/Min	$71.653
YYQ-YUT	Priority (1-9999)	$10.733
YYQ-YUT	C-100	$-

Railway & Train

The Winnipeg-Churchill train is a semi-weekly passenger train operated by Via Rail.

The northbound train leaves Winnipeg at 12:05 on Tuesdays and Sundays and is scheduled to arrive in Churchill two days later at 09:00. The southbound service departs Churchill at 19:30 on Thursday and Saturday evenings and reaches Winnipeg at 16:45 two days later. An additional weekly service operates in each direction between The Pas (departure at 02:30 on Fridays) and Churchill (departure at 19:30 on Tuesdays). The trip takes approximately 45 hours each way.

Via Rail Railway Fares: Winnipeg-Churchill

Adult Escape One-Way $254.10 Adult Escape Return $508.20

non-refundable; one-way exchangeable with $121 for Escape service fee + taxes + applicable fare difference); 1 carry-on; 1 large item up to 50lbs (23kg); overweight $40 up to 70lbs; over 70 lbs not permitted; additional luggage $40 each up to 3 maximum; oversize item $40 including canoe/kayak per

[70] https://www.calmair.com/cargo/rates

[71] https://www.calmair.com/cargo/rates

direction up to 158 cm to 180 cm or 62 inches to 72 inches. Baggage must be dropped off at least 45 minutes before departure.[72]

Adult Economy One-Way $303.45 Adult Economy Return $606.90

non-refundable; one-way exchangeable with $72.25 for Escape service fee + taxes + applicable fare difference); 1 carry-on; check in 2 large items up to 50lbs (23kg); overweight $40 up to 70lbs; over 70 lbs not permitted; additional luggage $40 each up to 3 maximum; oversize item $40 including canoe/kayak per direction up to 158 cm to 180 cm or 62 inches to 72 inches. Baggage must be dropped off at least 45 minutes before departure.[73]

Adult Economy Plus $383.25 Adult Economy Plus $686.70

Exchangeable and refundable without service charge. A fare difference may apply in case of exchange; 1 carry-on and 1 large item or 2 small items; checked in 2 large items up to 50lbs (23kg); overweight $40 up to 70lbs; over 70 lbs not permitted; additional luggage $40 each up to 3 maximum; oversize item $40 including canoe/kayak per direction up to 158 cm to 180 cm or 62 inches to 72 inches. Baggage must be dropped off at least 45 minutes before departure.[74]

Adult Upper Berth Discounted Return $707.70

Adult Upper Berth Return $1,125.60

Adult Lower Berth Discounted Return $835.80

Adult Lower Berth Return $1,327.20

Cabin for 1 Discounted Return $1,071.00

Cabin for 1[75] Return $1,701.00

Cabin for 2[76] Discounted Return $2,079.00 (1 adult fare) or $2142.00 (2 adult fares)

Cabin for 2 Return $2,551.50 for 1 adult fare or $3,402.00 for 2 adult fares

Cabin for 3[77] Return $4,487.70 for 2 adult fares + 1 child fare (2-11 years old)

Railway Ownership and Issues

The Hudson Bay Railway, owned and operated by the Arctic Gateway Group.[78] The Arctic Gateway is a partnership between 41 First Nation and Bayline communities. This railway route is the only affordable year-round, all-weather mode of transportation for both passenger and freight trains to access several northern Manitoba communities. The railway network connects with the CN in The Pas and also connects to the railway to Winnipeg.

The railway line is prone to service disruptions due to the boggy terrain. The railway was previously owned by US based OmniTrax and shut down after flooding and being washed out in 20 places in 2017 – leaving Churchill residents to air cargo goods. It took 18 months to repair the flood damage. Previously, OmniTrax had also proposed the shipping of petroleum products by rail to the Port of Churchill, but it was abandoned when there were concerns about the possibility of derailment due to vulnerabilities resulting

[72] https://reservia.viarail.ca/search/tripreview.aspx

[73] https://reservia.viarail.ca/search/tripreview.aspx

[74] https://reservia.viarail.ca/search/tripreview.aspx

[75] https://www.viarail.ca/en/plan/cabins

[76] Ibid

[77] Ibid

[78] https://www.arcticgateway.com/

from an unstable environment. However, the Hudson Bay Railway now delivers loads of fuel to Churchill and is stored at the Churchill Marine Tank Farm.[79] As of 2019, cargo ships can get fuelled at Churchill.

In 2018, the Government of Canada pledged $157M to change the ownership of the Hudson Bay Railway and the Port of Churchill plus monies to make repairs and upgrades.

In July 2022, the Government of Canada committed $4.4M to study the current and future permafrost conditions along the Hudson Bay Railway Corridor.[80]

In August 2022, the Governments of Canada and Manitoba announced a combined $133M[81] to support a rail line through northern Manitoba.

Railway Cargo

The Arctic Gateway Group offers cargo services.

Cargo HBF rates can be found at https://static1.squarespace.com/static/617476b0e482f44cefd4fe38/t/620d5603d0b0ec07f4973c3e/1645041156774/HBR+Rate+Tariff+8001.pdf

HBR General Freight Tariff can be found at https://static1.squarespace.com/static/617476b0e482f44cefd4fe38/t/620d5603d0b0ec07f4973c3e/1645041156774/HBR+Rate+Tariff+8001.pdf

HBR Fuel Surcharge Tariff can be found at https://www.arcticgateway.com/tariffs

Port of Churchill

The Port of Churchill is a privately-owned port on Hudson Bay in Churchill, Manitoba, Canada. Routes from the port connect to the North Atlantic through the Hudson Strait. The port is connected to the Hudson Bay Railway, which shares the same parent company, and cargo connections are made with the Canadian National Railway system at HBR's southern terminus in The Pas.

It is the only port of its size and scope in Canada that does not connect directly to the country's road system; all goods shipped overland to and from the port must travel by rail.

The port was built by the Government of Canada and remained under federal government ownership until its sale in 1997 to the American company OmniTRAX. In December 2015, OmniTRAX announced it was negotiating a sale of the port, and the associated Hudson Bay Railway, to a group of First Nations based in northern Manitoba. With no sale finalized by July 2016, OmniTRAX shut down the port and major railroad freight operations along the HBR in August 2016. The railway continued to carry cargo to supply the town of Churchill itself until the line was damaged by flooding on May 23, 2017.

The Port and the Hudson Bay Railway were sold to Arctic Gateway Group — a consortium of First Nations, local governments, and corporate investors — in 2018. On July 9, 2019, ships on missions to resupply arctic communities began stopping at the port for additional cargo, and the port began shipping grain again on September 7, 2019.

The port and railway came under complete community and Indigenous ownership in 2021, after AGT Food and Ingredients and Fairfax Financial transferred their shares in Arctic Gateway to OneNorth – a consortium of community and Indigenous partners which owned the other 50% of Arctic Gateway's shares.[82]

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[79] https://www.arcticgateway.com/churchill-marine-tank-farm

[80] https://winnipeg.ctvnews.ca/feds-investing-4-4m-for-study-of-permafrost-on-hudson-bay-railway-corridor-1.5987560

[81] https://www.cbc.ca/news/canada/manitoba/arctic-gateway-group-churchill-port-hudson-bay-rail-1.6540081

[82] https://en.wikipedia.org/wiki/Port_of_Churchill

The port of Churchill is located closer to 25% of Canada's western grain production than any other port in the world and had previously received and shipped a significant amount of grain. As of 2008, the port had four deep-sea berths capable of handling Panamax-size vessels for the loading and unloading of grain, bulk commodities, general cargo, and tanker vessels - with an unloading capacity of 900 tonnes per hour. There is also a cleaning facility that can clean wheat and durum at a rate of 600 tonnes per hour and canola at 250 tonnes per hour, providing options for bulk grain at different levels of finish.[83]

Port Operations

The port is iced in for much of the year and is accessible only between late July and early November. Shallow waters also restrict its development as an ocean port. Despite these restrictions the port remains useful for shipping grain and other bulk cargo because shipping by rail costs several times as much, per tonne, as shipping by sea.

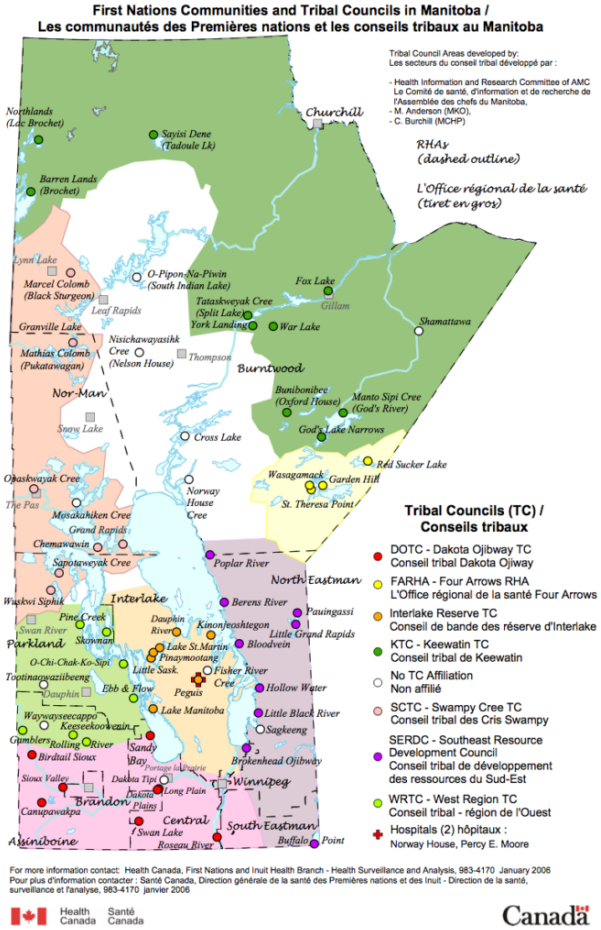
The port is a compulsory pilotage area. Pilotage is provided by the Great Lakes Pilotage Authority, a Crown corporation of the Government of Canada which includes responsibility for pilotage on the Hudson Bay coast of the provinces of Ontario and Manitoba. Pilotage charges between July 20 and October 31 follow a published schedule; outside these dates, the charges are based on cost recovery.[84]

Telecommunications

In 2017 Bell announced and in 2021, Bell recommitted to extending fibre optic in Manitoba including committing to connecting Churchill.[85] High-speed internet is now available in Churchill.[86] The following companies telecommunication services work in Churchill: Bell, Fido, Altima Telecom, Virgin Plus, Netcrawler, TekSavvy, VMedia, DistribuTel, Rogers, Teleus and Xplore.[87]

Energy: Power

In 1987, Manitoba extended the power transmission line to Churchill which ended Churchill's reliance on diesel-powered electric generators.[88] The Churchill River dam was completed in 1976. The Missi Falls Control Structure controls the Churchill River flow and the water level in the Southern Indian Lake.[89]



Indigenous Nations/Communities near Churchill

There are no treaties signed in or around Churchill. The closest treat is Treat 5 signed in 1875.[90] Churchill and the surrounding region is under the Keewatin Tribal Council.

Keewatin Tribal Council

Keewatin Tribal Council (KTC) represents 11 member First Nations located in northern Manitoba. The 11 communities are: Northlands, Sayisi Dene, Barren Lands, Tataskeweyak, War Lake, York

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l_river_diversion/

6

Factory, Fox Lake, Bunibonibee, Manto Spip and Gods Lake Narrows.[91] KTC exists to ensure and achieve self-sufficiency, self-determination and empowerment of the member First Nation communities it serves.[92]

KTC Executive Council

As of October 2022, our Executive Council consists of:

- Chief Betsy Kennedy, Chairperson (War Lake First Nation)
- Chief Evan Yassie, Vice-Chairperson (Sayisi Dene First Nation)
- Chief Hubert Watt, Secretary (Manto Sipi Cree Nation)
- Vacant, Treasurer

Potential Airship Landing Site/Hanger

Potential Airship Landing Site/Hanger options would need to be assessed with the town. There may be space to the existing airport. It also appears that the railway line is not far from the existing airport.

Feasibility Study Presentation & Northern Lights Conference Workshop

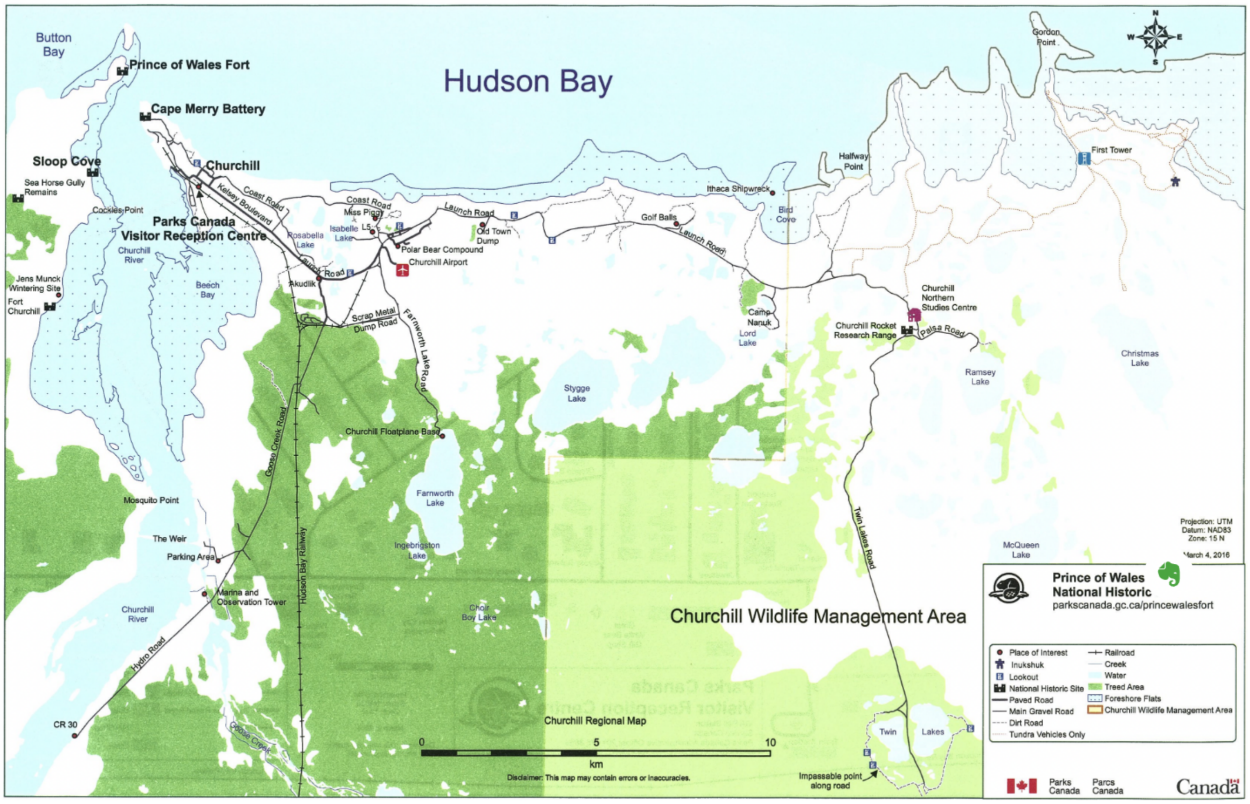
Ajungi recommends to inform and invite any leaders and representatives of Churchill and the Keewatin Tribal Council if they plan to attend Northern Lights Conference, Ottawa, February 7th – 11th, 2023.[93] A workshop to present Airship Feasibility Study would be beneficial along with seeing if any or all three communities are sufficiently interested to move towards the development of an airship business plan out of Churchill, Manitoba.

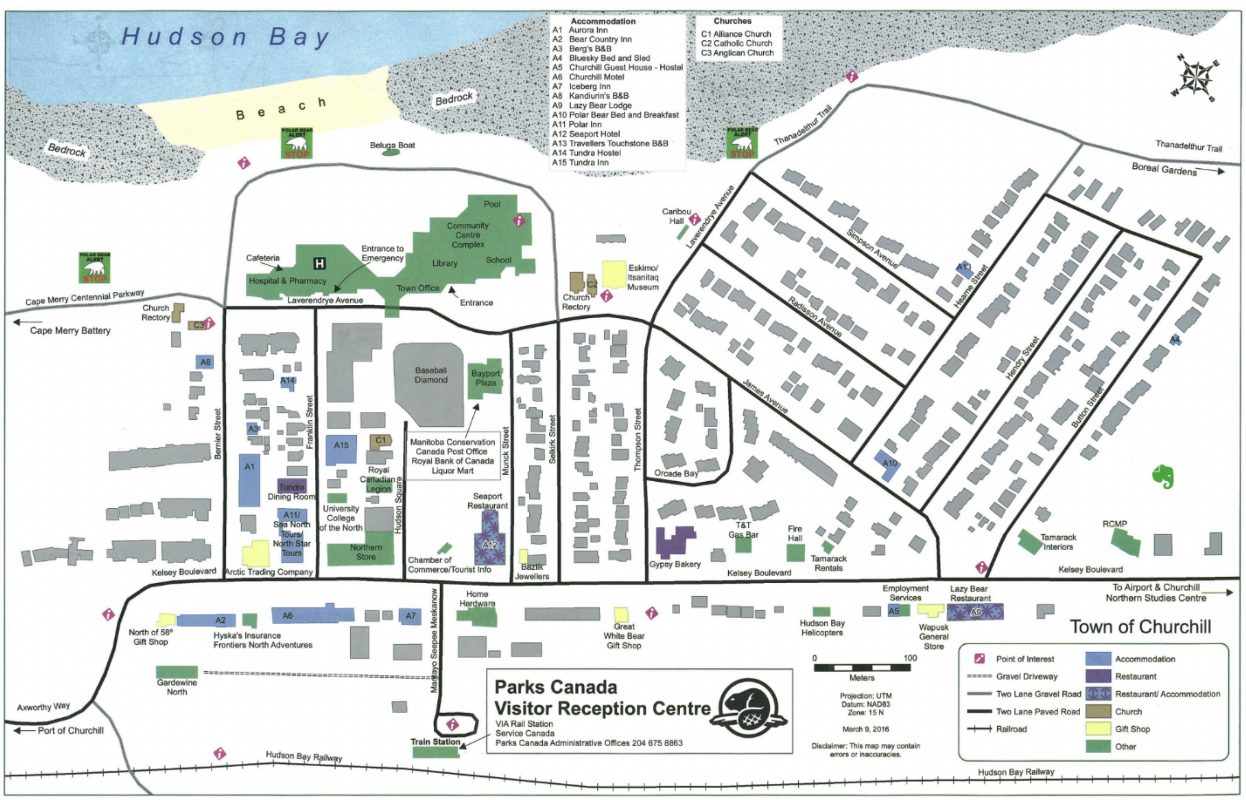
If so, then the Canadian Arctic Innovation Association would see how – ideally in partnership with any of the local communities and indigenous nations - to proceed in securing government funding to develop a high-level business case.

[91] http://www.ktc.ca/up-coming-events/

[92] http://www.ktc.ca/about-us/our-mission-2/

[93] https://www.northernlights.events/


Hudson Bay
Button Bay
Prince of Wales Fort
Cape Merry Battery
Sloop Cove
Sea Horse Gully Remains
Churchill
Cockles Point
Parks Canada Visitor Reception Centre
Churchill River
Jens Munck Wintering Site
Fort Churchill
Beech Bay
Coast Road
Kelsey Boulevard
Rosabella Lake
Isabelle Lake
Miss Piggy
Launch Road
Old Town Dump
Polar Bear Compound
Churchill Airport
Akudlik
Scrap Metal Dump Road
Farnworth Lake Road
Goose Creek Road
Hudson Bay Railway
Churchill Floatplane Base
Golf Balls
Ithaca Shipwreck
Bird Cove
Halfway Point
Gordon Point
First Tower
Camp Nanuk
Lord Lake
Churchill Northern Studies Centre
Churchill Rocket Research Range
Palsa Road
Ramsey Lake
Christmas Lake
Stygge Lake
Farnworth Lake
Ingebrigtson Lake
Mosquito Point
The Weir
Parking Area
Marina and Observation Tower
Churchill River
Hydro Road
CR 30
Twin Lakes Road
McQueen Lake
Churchill Wildlife Management Area
Churchill Regional Map
Twin Lakes
Impassable point along road
0 5 10 km
Disclaimer: This map may contain errors or inaccuracies.
Projection: UTM
Datum: NAD83
Zone: 15 N
March 4, 2016
Prince of Wales National Historic
parkscanada.gc.ca/princewalesfort
Place of Interest
Inukshuk
Lookout
National Historic Site
Paved Road
Main Gravel Road
Dirt Road
Tundra Vehicles Only
Railroad
Creek
Water
Treed Area
Foreshore Flats
Churchill Wildlife Management Area
Parks Canada Parcs Canada
Canada


Hudson Bay
Beach
Bedrock
Beluga Boat
Accommodation
A1 Aurora Inn
A2 Bear Country Inn
A3 Berg's B&B
A4 Bluesky Bed and Sled
A5 Churchill Guest House - Hostel
A6 Churchill Motel
A7 Iceberg Inn
A8 Kandiurin's B&B
A9 Lazy Bear Lodge
A10 Polar Bear Bed and Breakfast
A11 Polar Inn
A12 Seaport Hotel
A13 Travellers Touchstone B&B
A14 Tundra Hostel
A15 Tundra Inn
Churches
C1 Alliance Church
C2 Catholic Church
C3 Anglican Church
Thanadelthur Trail
Boreal Gardens
Pool
Community Centre Complex
Library
School
Cafeteria
Entrance to Emergency
Hospital & Pharmacy
Town Office
Entrance
Caribou Hall
Eskimo/ Itsanitaq Museum
Church Rectory
Cape Merry Centennial Parkway
Cape Merry Battery
Laverendrye Avenue
Simpson Avenue
Hearne Street
Radisson Avenue
Henday Street
Button Street
James Avenue
Baseball Diamond
Bayport Plaza
Manitoba Conservation
Canada Post Office
Royal Bank of Canada
Liquor Mart
Bernier Street
Franklin Street
Hudson Square
Munck Street
Selkirk Street
Thompson Street
Royal Canadian Legion
Tundra Dining Room
Sea North Tours
North Star Tours
University College of the North
Northern Store
Chamber of Commerce/Tourist Info
Seaport Restaurant
Bazlik Jewellers
Orcade Bay
Gypsy Bakery
T&T Gas Bar
Fire Hall
Tamarack Rentals
Tamarack Interiors
RCMP
Kelsey Boulevard
Arctic Trading Company
Home Hardware
Employment Services
Lazy Bear Restaurant
To Airport & Churchill Northern Studies Centre
Town of Churchill
North of 58° Gift Shop
Hyska's Insurance
Frontiers North Adventures
Great White Bear Gift Shop
Hudson Bay Helicopters
Wapusk General Store
Gardewine North
Mattayo Seepee Meskanow
Axworthy Way
Port of Churchill
Train Station
Hudson Bay Railway
Parks Canada Visitor Reception Centre
VIA Rail Station
Service Canada
Parks Canada Administrative Offices 204 675 8863
0 100 Meters
Projection: UTM
Datum: NAD83
Zone: 15 N
March 9, 2016
Disclaimer: This map may contain errors or inaccuracies.
Point of Interest
Gravel Driveway
Two Lane Gravel Road
Two Lane Paved Road
Railroad
Accommodation
Restaurant
Restaurant/ Accommodation
Church
Gift Shop
Other

Communities served via the Churchill Gateway, and Demand for Building Materials

Gateway: Churchill, MB						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Akulivik	QC	642	915	204	81.6	2448
Ivujivik	QC	412	969	136	54.4	1632
Churchill 1 Reserve (Tadoule Lake)	MB	324	254	137	54.8	1644
Shamattawa	MB	1019	342	203	81.2	2436
Arviat	NU	2864	263	694	277.6	8328
Baker Lake	NU	2061	629	661	264.4	7932
Chesterfield Inlet	NU	397	542	131	52.4	1572
Rankin Inlet	NU	2975	464	1026	410.4	12312
Taloyoak	NU	934	1201	251	100.4	3012
Whale Cove	NU	470	390	128	51.2	1536
Total Population		**12172**				
Weighted Average Air Distance (km)			524			

10.3.4 Thompson

Thompson (population 13,678) is the largest city in the Northern Region of Manitoba and is situated along the Burntwood River, 761 kilometers (473 mi) north of Winnipeg. Originally founded in 1956 as a mining town, it now primarily serves as the "Hub of the North", providing goods and services such as healthcare and retail trade to the surrounding communities.

Thompson's trade area is larger than New Mexico, yet it has fewer than 15,000 residents, with many of the smaller communities accessible only by air or winter road. Despite its isolated location in the heart of Canada's boreal forest, it is connected to Winnipeg via paved highway, railway (Via Rail), and Thompson Airport. It also has modern amenities, such as fibre optic internet and a large retail scene, including half a dozen shopping malls and several large chain stores (e.g., Walmart, Giant Tiger, Safeway, Shoppers Drug Mart and Canadian Tire).

History

The Thompson area was first inhabited by nomadic Paleo-Indian hunters around 6000 BC, sometime after the collapse of the Laurentide Ice Sheet.

For a 10-year period beginning in 1946, Inco Limited explored northern Manitoba for nickel deposits; on February 4, 1956, a major ore body was discovered, and the modern history of Thompson began.

Thompson, named after Inco's chairman at the time, Dr. John F. Thompson (1881–1968),[8] was founded following the December 3, 1956, agreement between the Government of Manitoba and Inco Limited. On March 25, 1961, Inco formally opened the first integrated nickel mining-smelting-refining plant in the Western Hemisphere (in Thompson) and the second largest nickel-producing operation in the world (after Inco's Sudbury operations).

Thompson was incorporated as a town in 1967 on Canada's Centennial Anniversary; in 1970 Thompson gained city status in the royal presence of Queen Elizabeth II.[94]

Environment

Thompson is located on the border of plant hardiness zones 1a and 1b, making outdoor commercial agriculture impossible; for comparison, Winnipeg is located within zone 4a.

The dominant coniferous species are white spruce (Picea glauca), black spruce (Picea mariana), jack pine (Pinuus banksiana), tamarack (Larix laricina) and balsam fir (Abies balsamea). White birch (Betula papyrifera) is the most common deciduous species.

Climate

Thompson is marked by a subarctic climate (Köppen Dfc), with long cold winters and short warm summers.

Monthly means range from −23.9 °C (−11.0 °F) in January to 16.2 °C (61.2 °F) in July, and the annual mean is −2.9 °C (26.8 °F). A majority of the annual precipitation of 509 millimeters (20.0 in) falls from June to September. Snowfall totals 1.87 meters (74 in) per year, falling mainly from October to May.

Population

In the 2021 Census of Population conducted by Statistics Canada, Thompson had a population of 13,035 living in 4,676 of its 5,442 total private dwellings, a change of −4.7% from its 2016 population of 13,678. With a land area of 16.62 km2 (6.42 sq mi), it had a population density of 784.3/km2 (2,031.3/sq mi) in 2021.[30]

The number of residents fell substantially between 1971 and 1981, from 19,001 to 14,288 (a 24.8% decrease). Since then, Thompson's population has fluctuated between 13,000 and 15,000 people.

In 2016, people with European ancestry (43.9%) made up a plurality of the population, followed closely by Aboriginals (43.5%), composed of First Nations (32.2%) and Metis (10.8%); the remainder of the population is made up of visible minorities (12.5%), with the largest two visible minorities being South Asian (7.5%) and Black (2.1%).

In 2016, Thompson had the highest percentage of its population as Aboriginal (43.5%) out of all 152 cities (census metropolitan areas and census agglomerations) in Canada.

Language

The most common mother tongues are English (81.3%), followed by Cree (5.2%), Punjabi (2.6%), and Gujarati (2.0%).

Airport

Thompson Municipal Airport (IATA: YTH, ICAO: CYTH) is an airport in Mystery Lake located 3 nautical miles (5.6 km; 3.5 mi) north of Thompson, Manitoba, Canada. It is the third-busiest airport in Manitoba after Winnipeg James Armstrong Richardson International Airport and Winnipeg/St. Andrews Airport.

5,800ft asphalt and 5,079ft gravel/asphalt runways. Owned and operated by the Thompson Regional Airport Authority.

Railway

Thompson receives rail service via the Hudson Bay Railway, mentioned in the Churchill Gateway. The railway network connects with the CN in The Pas and also connects to the railway to Winnipeg.

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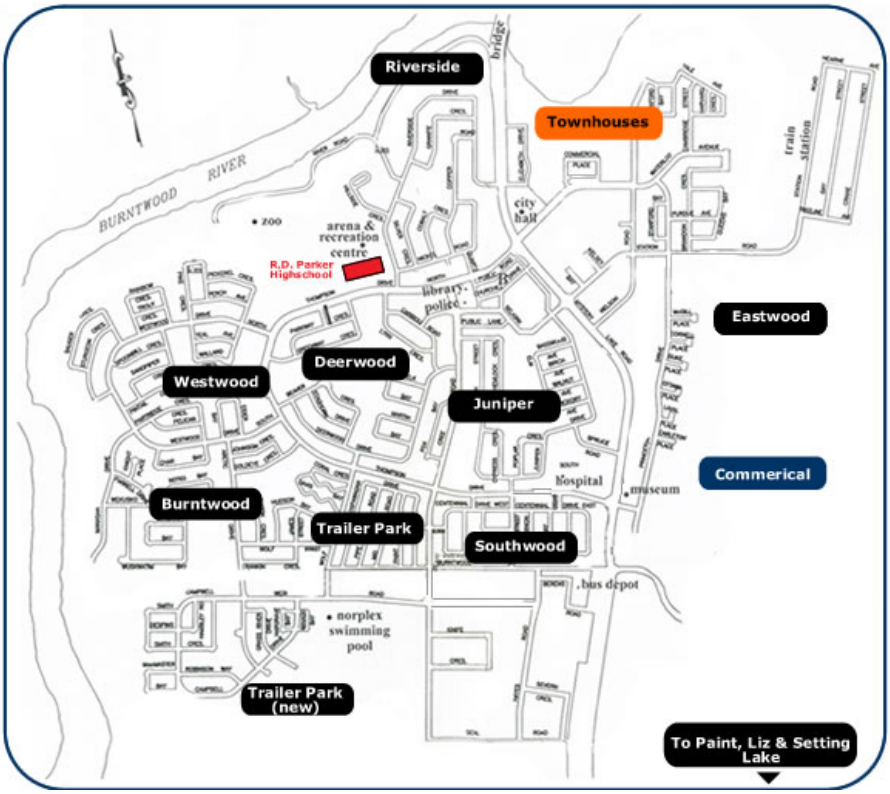
[94] https://en.wikipedia.org/wiki/Thompson,_Manitoba

Energy: Power

Thompson receives clean electrical power from the Manitoba Hydro Electricity grid.



Communities served via the Thompson Gateway, and Demand for Building Materials

Gateway: Thompson, MB						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Berens River	MB	1161	388	321	128.4	3852
Brochet	MB	64	325	31	12.4	372
Cross Lake	MB	2045	128	421	168.4	5052
York Factory	MB	455	114	143	57.2	1716
God's Lake Narrows	MB	1520	256	376	150.4	4512
God's River	MB	809	264	170	68	2040
Island Lake	MB	91	297	30	12	360
Lac Brochet	MB	728	382	178	71.2	2136
Little Grand Rapids	MB	810	446	267	106.8	3204
Oxford House	MB	1955	188	377	150.8	4524
Pauingassi	MB	271	436	96	38.4	1152
Poplar River	MB	866	314	231	92.4	2772
Pukatawagan	MB	1724	216	384	153.6	4608

Gateway: Thompson, MB						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Red Sucker Lake	MB	725	329	181	72.4	2172
South Indian Lake	MB	578	127	147	58.8	1764
St. Theresa Point	MB	3417	292	636	254.4	7632
Wollaston Lake	SK	96	430	39	15.6	468
Total Population		**16860**				
Weighted Average Air Distance (km)			266			

10.3.5 Moosonee

Moosonee is located on the Moose River, twelve miles south of James Bay at a latitude 51N07' and longitude 80W35'. While there is no road access, it is accessible by plane, train and has a port. Moosonee serves as a gateway to Moose Factory or communities further up the western coast of James Bay.[95]

Population and Demographics

Moosonee has a population of 1,471 of which 1,015 identify as indigenous and 450 as non-indigenous. There are 425 under the age of 14; 940 between 15 to 64; and 110 who are 65 years and older. There are 360 families with an average census family size of 3.2 persons per household. [96]

Language

In 2011, mother tongue was 79.3% English, 17.7% Cree, 1.8% French, and 1.2% other languages.

Housing

Statistics Canada reports 633 housing units.[97] There are 180 homes with owners and 305 houses with tenants. The average housing value is $218,000.[98] There is a housing shortage in Moosonee plus nearby Indigenous communities, but housing projects and other much needed infrastructure is delayed due to the lack of sufficient energy to power these additional buildings. As a result, the backlog of housing continues to be an ongoing problem.[99]

Employment, Household Income

Sixty-two percent of resident working age are employed with an additional 5% who are actively looking for work. The unemployment rate is 8.5%. Six-hundred and eighty are employed versus 10 self-employed.

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[95] https://www.moosonee.ca/

[96] https://www12.statcan.gc.ca/census-recensement/2021/dp-pd/prof/details/page.cfm?Lang=E&SearchText=Moosonee&DGUIDlist=2021S05101390&GENDERlist=1,2,3&STATISTIClist=1&HEADERlist=0

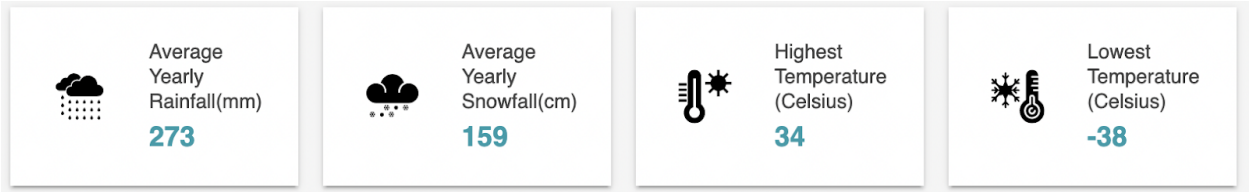
[97] https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/details/Page.cfm?Lang=E&Geo1=CSD&Code1=3556106&Geo2=PR&Code2=10&Data=Count&SearchText=Moosonee&SearchType=Begins&SearchPR=01&B1=All&wbdisable=true

[98] https://townfolio.co/on/moosonee/housing

[99] https://www.fivenations.ca/index.php/about8/history-of-fnei

The majority (265) work in government, education and law; 145 in sales and services; 90 in health; 85 in finance and business with 10 working in sciences.[100] Median household income is $73,370.[101]

Climate

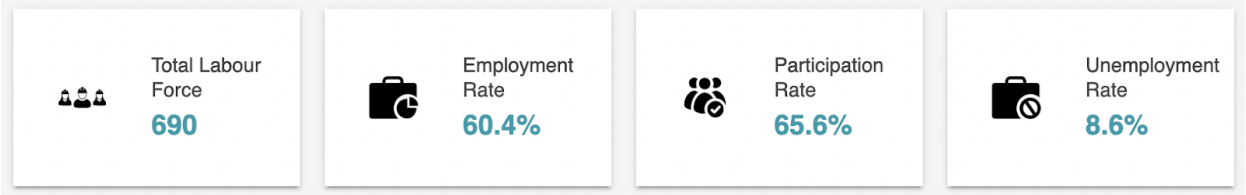


Moosonee has a humid continental climate with subarctic influences, which gives the town warm summers and cold winters, sometimes severe. James Bay acts as a thermal reservoir to moderate spring and fall temperatures. Freeze-up on the Moose River normally occurs between late November and mid-December, with mean daily minimum January temperatures approximately −27 °C (−17 °F). Spring break-up, or spring thaw, usually occurs in April. Precipitation is somewhat higher in summer and severe thunderstorms can occur from time to time. Moosonee used to have a subarctic climate with a yearly mean temperature of −1.3 °C (29.7 °F), but due to global warming that temperature has risen.

Groundwater Problems

Hudson Bay Drainage Baise, in which Moosonee is located, is imperfectly drained; the impeded run-off results in a perched water table. Contributing to drainage problems are widespread permafrost and a short frost-free period. The Albany and Moose Rivers account for 2/3 of the total Ontario arctic watershed discharge with peak flows during spring break-up in May. River levels can reach 15 meters above mid-summer levels. As well, frequent ice jams cause blocked drainage and result in flooding.[102]

Water



Due to concerns regarding water potability and potential contamination of groundwater, water supply is strictly drawn from surface fresh water sources: currently Store and Butler Creeks, in the future Moose River.

Town

5 First St. P.O. Box 727, Moosonee, ON P0L 1Y0 (705) 336-2993[103]

Mayor: Wayne Taipale

Council: Theresa Chavez; Sheldon Ross; Diane Ryder; Carman Tozer

[100] https://townfolio.co/on/moosonee/labour-force

[101] https://www.point2homes.com/CA/Demographics/ON/Moosonee-Demographics.html

[102] https://www.utsc.utoronto.ca/~gwater/IAHCGUA/UGD/moosonee.html

[103] https://www.moosonee.ca/council/

Accommodation

There are six hotel, motel and B&B options in Moosonee.[104]

Strategic Plan

Moosonee will enhance the quality of life of the residents. We will inspire commitment and value through the unique traditions and diversity of all community members. Moosonee embraces change; we dedicate ourselves to being a vibrant community by revitalizing our existing economy and promoting economic prosperity. As a hub of the James Bay coast, Moosonee will endeavor to maintain, develop and promote our unique relationship with First Nations communities. The goal of this relationship is to capitalize on our strategic geographic position so that opportunities will exist for all community members.

MISSION: Moosonee will work with community members to encourage participation in community development while respecting diverse cultures, traditions and values. We will build and promote a safe and sustainable community that provides municipal services in a fiscally responsible manner.[105]

Schools

Moosonee has two elementary schools, Moosonee Public School and Bishop Belleau Separate School (Roman Catholic) that offer kindergarten through grade eight. Bishop Belleau School also provides a French Language Instructional Unit for children who are entitled to be educated in French. There is a public high school, Northern Lights Secondary School, that provides grades nine through twelve. Northern College's Moosonee campus provides some post-secondary programs. As of 2020 a "satellite Trades Centre" was being operated in the community by Northern College "linked to the Timmins Campus"; courses included technology, trades and apprenticeship programs.

Health

Health services are provided through the Moosonee Health Clinic of the Weeneebayko Area Health Authority.

Family Services

Payukotayno (pronounced pay-k-ta-no) Family Services provide child care and social assistance to Moosonee, Moose Factory, Attawapiskat First Nation, Kashechewan, Fort Albany and Peawanuck. Payukotayno is a recognized Ontario Children's Aid Society.

Telecommunications

Western James Bay Network spans from Moosonee along Western James Bay Coast through Fort Albany, Kashechewan and Attawapiskat. It consists of 12 fiber optic pairs along the entire route. WJBTN provides a dedicated, redundant Gigabit of fibre optic transport between Moosonee and each community utilizing DWDM and ethernet technologies.[106]

Energy: Power and Heating

Five Nations Energy Inc. (FNEI) does not generate electricity but delivers it from Moosonee to three power stations in Fort Albany, Kashechewan, Attawapiskat plus to the line that connects the De Beers Canada Victor Diamond Mine north of Attawapiskat. The electricity is delivered over the Omushkego Ishkotayo transmission lines owned by FNEI. FNEI installed fibre optic to carry out better monitoring of its systems. FNEI also restores power in case of outages and emergencies on the main power line, also

[104] https://www.moosonee.ca/accommodations/

[105] https://www.moosonee.ca/wp-content/uploads/2018/11/strategic-plan-2011.pdf

[106] http://wjbtn.com/network.htm

assists the Local Power Corporations (Local District Corporations) with training and support of their operations and maintenance. [107]

One of the problems facing these communities is that the power plants were never built large enough to accommodate future growth. As a result, housing projects, construction of sewage plants, schools, recreation facilities and other infrastructure is delayed while waiting for upgrades to the power plants. Other energy options and solutions are being investigated.

Moosonee's Energy Conservation and Demand Management Plan

The issue of an adequate and reliable supply of electricity to the Town of Moosonee and our area in general, continues to be a concern, and our community is occasionally impacted by the excessive demand during extreme weather events experienced elsewhere in the province, over the past several years. Energy conservation and demand management (reducing energy usage during periods of peak demand) are important measures to help safeguard against an already strained transmission system and to reduce pressure on peaking generating stations.

The Corporation of the Town of Moosonee is committed to allocating the necessary resources to develop and implement an energy conservation and demand management plan that will reduce our energy consumption where possible and improve the related environmental impact.[108]

Airport

The Moosonee airport is located 3 km northwest of the town and occupies approximately 212 hectares. Airport handles scheduled passenger flights, services both private and commercial helicopter and fixed aircraft. The airport is owned and operated by the Town.

Carriers: Air Creebec, Moosonee Water Aerodrome and cargo service through North Star Air.

The maneuvering area consists of two intersecting runways, two taxiways, and a public apron. The primary runway (06-24) is 3999 feet long by 100 feet wide asphalt. The secondary runway (14-32) is 3500 feet (approximately half paved and half gravel by 100 feet).[109]

The airport has operational staff on site 10 hours a day (airside maintenance and administration), Monday to Friday excluding statutory holidays. Normal working hours are 7am to 5pm local time. NavCanada maintains a Flight Service Station (FSS) located at the Timmins Airport, operating 24 hours per day, 7 days per week.

Contact: (705) 336-2993

Train

In 1932, the Temiskaming and Northern Ontario Railway was extended from Cochrane to Moose River Post which was later renamed to Moosonee.

Ferry

As of 2020, the MV Niska 1 ferry was operating between Moosonee and Moose Factory Island, carrying passengers and vehicles.

Winter Road

In 2008, a winter road was opened between Moosonee and the provincial road system at Otter Rapids to support the twinning of the electric transmission lines that run from Otter Rapids to Moosonee. Local

[107] https://www.fivenations.ca/index.php/services-overview/what-we-do

[108] https://www.moosonee.ca/wp-content/uploads/2019/07/ECDM-Plan-2019.pdf

[109] https://www.moosonee.ca/airport/

residents reported it took five or six hours to get to Timmins from Moosonee via Otter Rapids and Smooth Rock Falls. This road was not in service in 2009.

During the winter, ice roads are plowed and maintained on the ice across the Moose River to Moose Factory and winter roads are maintained to the coastal communities of Fort Albany, Kashechewan and Attawapiskat. In recent years, much of the traffic heading up north has been destined for the Victor Diamond Mine operated by De Beers Canada to the west of Attawapiskat.

In January 2021, the 311 km (193 mi) James Bay Winter Ice Road was under construction, to connect Attawapiskat, Kashechewan, Fort Albany and Moosonee. It opened some time in winter 2021 and was said to accept loads up to 50,000 kilograms in weight. The road was operated by Kimesskanemenow LP, "a limited partnership between the four communities it connects".

Moose Cree Group of Companies is managing the Moosonee-Moose Factory ice road for 2022-2023. Cree Aski Ltd. was awarded the contract to do work on the ice road. The road has not been officially open to date.[110]

Permanent All-Season Road

Feasibility studies have been undertaken on the construction of a permanent all-season road to the communities of Moosonee, Fort Albany, Kashechewan and Attawapiskat River. The project, if undertaken, will entail a "coastal road" connecting the four communities with each other, as well as a road to link the coastal road to the provincial highway system at Fraserdale, Kapuskasing or Hearst.

Economy

The primary industries in Moosonee are institutional: schools, hospitals, government) and service oriented to these institutions plus tourism. Moosonee's economy is centered on transportation because it serves as the gateway (train, airport, port) to the north and launching point to further destinations – whether across to Moose Factory or up the northwestern coast of James Bay to neighbouring First Nations communities.

Town of Moosonee has an Economic Development Steering Committee that is supported by the Economic Development Officer Jae Monture. The Manager of Recreation and Tourism will also assist when Moosonee has chosen a consultant to assist in the development of an Economic Development Strategic Plan.[111]

Economic Development Officer: Jay Monture Email: jaymonture@moosonee.ca

Moose Cree First Nation

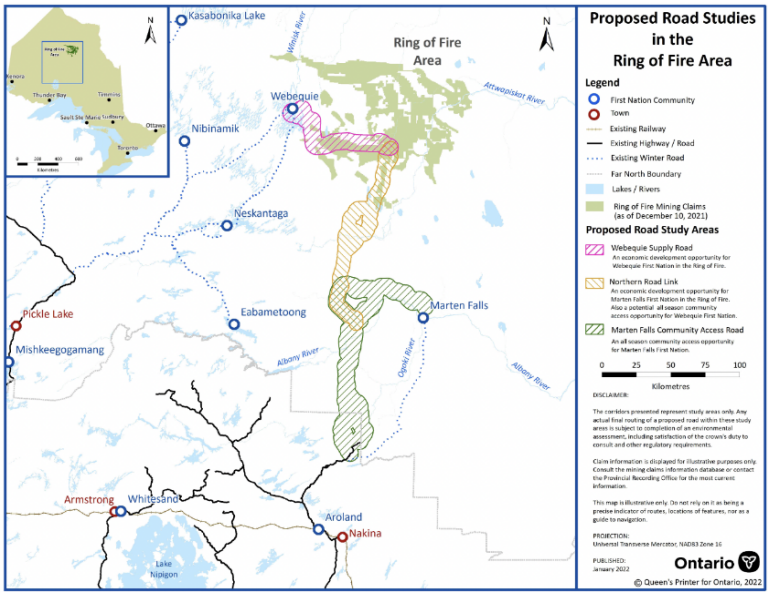
Moose Cree First Nation is located in the community of Moose Factory on an island near the mouth of the Moose River at the southern tip of James Bay. It is 246 km north of Cochrane with the closest major urban centre is Timmins, Ontario.

In 1905, Moose Cree became a signatory to Treaty 9 through which the First Nation was allocated two tracts of reserve land: Factory Island 1 (the northern 2/3 of Moose Factory Island); and Moose Factory 68, a tract of land about 15 km upstream on the Moose River covering 168.82 square kilometers (65.18 sq mi).

Moose Cree First Nation population of approximately 1,700 people, out of a total band population of approximately 3,950 people. The other reserve, located further south of James Bay is in excess of 17,000 hectares in size and is largely unpopulated.

[110] https://www.moosecree.com/ice-road-notice/

[111] https://www.moosonee.ca/economic-development/



The economy of Moose Factory is made up of several main sectors including the public service, tourism, construction, the bush economy and private businesses. Additionally, the First Nation has been seeking to diversify its economy through partnerships and other ventures with the goal of improving the economic outlook for its members.

Recently, the First Nation entered into an agreement with Ontario Power Generation. It is also currently negotiating an agreement with Detour Gold and has completed construction of an Aboriginal eco-tourist project known as Washow Lodge. Each of these projects is expected to result in significant economic benefit to the community. Further, the First Nation has provided facilities such as a shopping complex and indoor arena for the use and enjoyment of its members.[112]

Moose Cree First Nation Economic Development Officer: Stan Kapashesit

Email: stan.kapashesit@mooscree.com

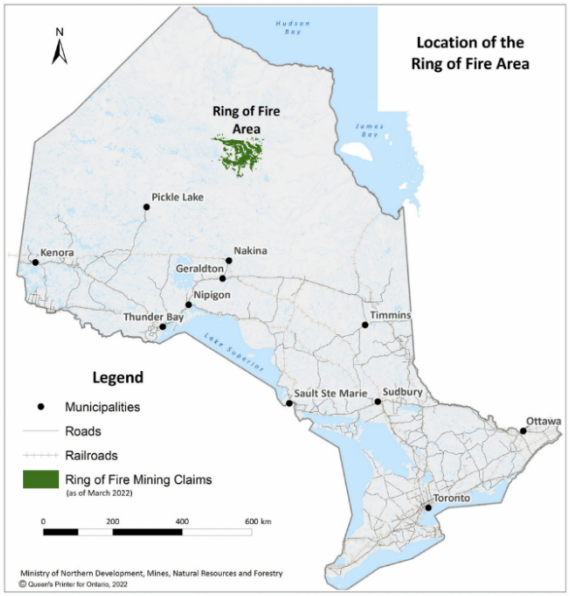
Northeastern Ontario Economies and Opportunities

Tourism

Moosonee is home to an impressive selection of attractions and experiences, making it well worth a visit.[113] Main tourist attractions and activities include fishing, hunting, camping and other outdoor adventures including wildlife watching. More tourism information can be obtained by emailing tourism@moosonee.ca or visitor guide at the Town offices.[114][115]

Mining

There are several mines and other resource development opportunities in this region.



Ring of Fire

Not far from Moosonee is an area called “The Ring of Fire” in Ontario.[116] The Ring of Fire is a priority project for Ontario and will support further critical minerals development. There is a proposed north-south corridor to connect the Ring of Fire area to Ontario’s highway network. Other critical minerals and potential mining developments exist in Northwestern Ontario closer to Moosonee. See attached maps at the back.

fn_020.html

582/

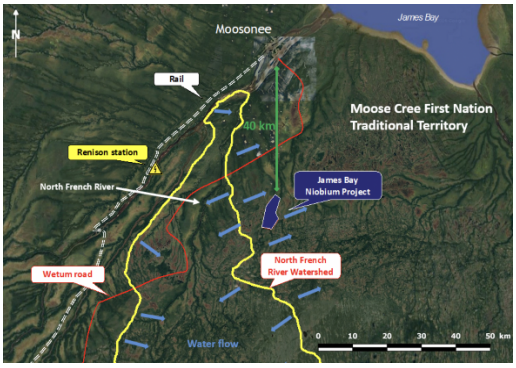
·factory/

Ontario continues to make progress on the "Corridor to Prosperity" leading to the Ring of Fire region by collaborating with First Nations partners on legacy infrastructure development in Northern Ontario. The government is supporting the priorities of individual First Nations, which see potential Ring of Fire developments as opportunities for prosperity. Together, this has led to significant progress.[117]

Ring of Fire All-Season Road

Currently the most northerly roads are to Pickle Lake and Nakina. An all-season road is purported to be an important step to unlocking and creating economic opportunities in the region. Supporters of the road state it can reduce the cost of delivering consumer goods, fuel and construction materials; give communities access to primary health care and other services; and reduce the overall cost of living. Marten Falls First Nation and Webequie First Nation are leading environmental assessments for their individual proposed all-season road projects.[118]

Victor Mine



Victor Mine is a fly-in/fly-out mine located in the James Bay Lowlands of Northwestern Ontario, approximately 90 km west of the coastal community of Attawapiskat First Nations. In operation from 2008-2019, Victor was an open pit mine and Ontario's first diamond mine. The site is now in closure and remediation. Progressive reclamation of the mine site began in 2014 when the first tree and plant seeds were harvested by youth from the nearby community of Attawapiskat. The program continued through 2018 and provided the seed stock from which many of the 1.6 million trees planted to date have been grown.[119]

NioBay Metals

The NioBay property is located 45 km south of Moosonee in the James Bay Lowlands. The property comprises a total of 2,530 hectares. In December 2019, the Company signed a Protection Agreement (PA) with Moose Cree First Nation (MCFN). Exploration activities for the James Bay Niobium Project are currently on pause. NioBay Metals Inc. had received a three-year permit from the Ministry of Energy, Northern Development and Mines to drill about 20 to 30 test holes near South Bluff Creek to look for deposits of niobium and determine the feasibility of a mine. Niobium is used in electronics and to strengthen steel.[120]

Cliffs Chromite Project

Critical mineral significant projects and active mines in Ontario

On November 20, 2013, Cliffs announced that it was indefinitely suspending its chromite project in Northern Ontario. The Cliffs Ferroalloys (Cliffs) had proposed to develop the Black Thor chromite mine, the largest known deposit of chromite ore in North America. The mine is located near McFaulds Lake in the Ring of Fire, on the edges of the

trategy-2022-2027-en-2022-03-22.pdf

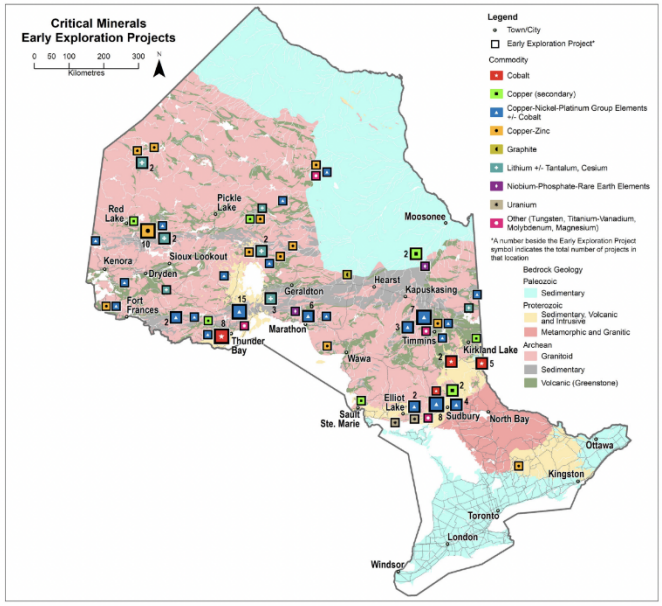
·exploration-program-near-moosonee-put-on-pause-343615

James Bay Lowlands and within the province's Far North planning area, 150 kilometers west of the De Beers Victor diamond mine. The Project is comprised of four components; the Mine Site located near McFaulds Lake; an Ore-Processing Facility, co-located at the Mine Site; an Integrated Transportation System (ITS); and a Ferrochrome Production Facility (FPF) located near Capreol.

The proposed mining operations consisted of an open pit mine with a projected life of approximately 30 years. The Mine Site also includes components of the ITS, an Accommodations Complex, the Ore Processing Facility, a Tailings Management Area, a waste rock management area and a number of supporting and/or ancillary facilities.

The ITS is proposed to facilitate the movement of people and supplies between the Mine Site and the existing road and rail network, including the transportation of concentrate from the Mine Site to the Transload Facility situated adjacent to CN's existing transcontinental rail line located approximately 340 km to the south.[121]

Critical mineral early exploration projects currently underway in Ontario (as of March 2022



KWG Resources Inc.

KWG Resources is an exploration stage company that is participating in the discovery, delineation and development of chromite deposits in the James Bay Lowlands of Northern Ontario, including 1,024 hectares covered by four unpatented mining claims (Fancamp Claims) approximately 280 km north of Nakina, Ontario, which contains the Black Horse chromite deposit, named the "Black Horse Project" and 1,241 hectares covered by seven unpatented mining claims (Big Daddy Claims) approximately 280 km north of Nakina, Ontario, which contains the Big Daddy chromite deposit, named the "Big Daddy Project". The Corporation has a 30% interest in the Big Daddy Project. KWG Resources is seeking its social license for these developments by inviting the most affected First Nations to be both partners in and owners of the development.[122]

ZEN Graphene Solutions

A technology startup company with a high-grade graphite deposit in northwestern Ontario is heading down the path toward production. Formerly known as Zenyatta Ventures, ZEN's Albany graphite deposit, west of Hearst, has an estimated open-pit life of 22 years and the potential to annually produce 33,000 tonnes of graphite.

The processed graphene product is a carbon nanomaterial used in electric vehicle batteries, high strength concrete, water desalination membranes, and auto parts. ZEN is looking at various applications in transportation, aerospace, bio-medical, civil engineering and the water treatment fields.[123]

Potential Airship Landing Site/Hanger

TBD

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[121] https://www.ontario.ca/page/cliffs-chromite-project

[122] https://kwgresources.com/

[123] https://www.northernontariobusiness.com/industry-news/mining/hearst-area-graphite-miner-preparing-to-enter-the-market-2202431

Feasibility Study Presentation & Northern Lights Conference Workshop

It is recommended to inform and invite any leaders and representatives of Moosonee and/or Moose Cree First Nation especially if any plan to attend Northern Lights Conference, Ottawa, February 7th – 11th, 2023.[124] A workshop to present Airship Feasibility Study would be beneficial along with seeing if any or all three communities are sufficiently interested to move towards the development of an airship business plan out of Moosonee/Moose Cree First Nation.

If so, then the Canadian Arctic Innovation Association would see how – ideally in partnership with any of the local communities and indigenous nations - to proceed in securing government funding to develop a high-level business case.

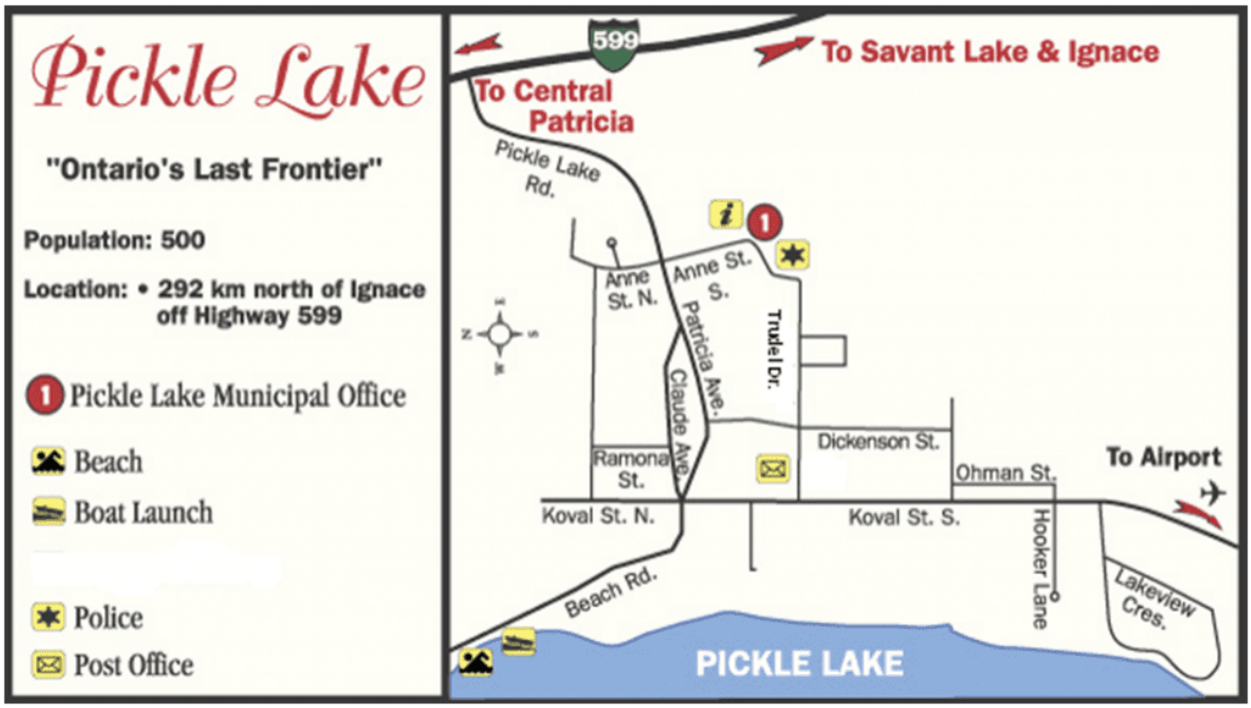
Communities served via the Moosonee Gateway, and Demand for Building Materials

Moosonee, ON							
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**	**Location**
Chassidic	QC	4985	300	1281	3.9	512.4	15372
Eastmain River	QC	924	177	280	3.3	112.0	3360
Kuujjuarapik	QC	792	483	267	3.0	106.8	3204
Tasiujaq	QC	420	615	120	3.5	48.0	1440
Waskaganish	QC	2536	130	626	4.1	250.4	7512
Wemindji	QC	1562	231	493	3.2	197.2	5916
Sanikiluaq	NU	1010	591	252	4.0	100.8	3024
Attawapiskat	ON	1586	220	404	3.9	161.6	4848
Fort Albany	ON	775	125	237	3.3	94.8	2844
Kashechewan	ON	1825	132	333	5.5	133.2	3996
Total Population		**16415**					
Weighted Average Air Distance (km)			**260**				

10.3.6 Pickle Lake

Pickle Lake is a township in the Canadian province of Ontario, and is the most northerly community in the province that has year-round access by road. Located 530 kilometers (330 mi) north of Thunder Bay, highway access is via Highway 599, the only access road to the town from the south. More northerly communities rely on winter roads for access and are cut off to land travel in the summer. Highway 599 meets the Northern Ontario Resource Trail, formerly Tertiary Highway 808, at Pickle Lake.

[124] https://www.northernlights.events/



History

Pickle Lake was founded as a local transportation centre for mining activities after gold was discovered nearby in 1928. From that time until 1995 over 2.5 million ounces of gold were produced in the area. Copper was also mined near Pickle Lake in the 1970s. Exploration for gold and copper in the Pickle Lake area continues to this day.

Population

In the 2021 Census of Population conducted by Statistics Canada, Pickle Lake had a population of 398 living in 155 of its 221 total private dwellings, a change of 2.6% from its 2016 population of 388. With a land area of 247.21 km2 (95.45 sq mi), it had a population density of 1.6/km2 (4.2/sq mi) in 2021.

Climate

Pickle Lake has a humid continental climate that closely borders on a subarctic climate (Köppen Dfb/Dfc), and did have a subarctic climate based on 30-year means as late as 1961 to 1990 before the most extreme impacts of anthropogenic global warming. Winters are cold and dry with a January high of −14.3 °C (6.3 °F) and a low of −24.1 °C (−11.4 °F). Snowfall averages 2.57 meters (101.2 in) with reliable cover from November to April. There are 17.3 nights where the temperature will drop below −30 °C (−22.0 °F).

Airport

Pickle Lake Airport (IATA: YPL, ICAO: CYPL) is located 0.7 nautical miles (1.3 km; 0.81 mi) southwest of Pickle Lake, Ontario, Canada.

Road Access

Highway 599 is the main access point for the town and sections of it have recently been refurbished.[125]

[125] https://en.wikipedia.org/wiki/Pickle_Lake

Electrical Power

There is a large ($2B+ project) called the The Wataynikaneyap Transmission Project. The project is to position high power transmission lines to serve remote communities in Northern Ontario.

Wataynikaneyap Power is an unprecedented partnership of 22 First Nations who have joined together with FortisOntario to build 1,800 km of transmission lines.

Communities served via the Pickle Lake Gateway, and Demand for Building Materials

Gateway: Pickle Lake, ON						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Housing need (t)**
Bearskin Lake	ON	447	282	152	60.8	1824
Cat Lake	ON	651	118	161	64.4	1932
Eabametoong (Fort Hope)	ON	977	157	349	139.6	4188
Fort Severn	ON	364	530	92	36.8	1104
Kasabonika Lake	ON	1060	253	252	100.8	3024
Kingfisher Lake	ON	511	175	127	50.8	1524
Kitchenuhmaykoosib Inninuwug (Big Trout Lake)	ON	1029	264	289	115.6	3468
Marten Falls	ON	243	295	85	34	1020
Muskrat Dam Lake	ON	281	241	112	44.8	1344
Neskantaga	ON	244	169	89	35.6	1068
Nibinamik (Summer Beaver Band)	ON	355	184	113	45.2	1356
North Caribou Lake (Round Lake)	ON	886	179	266	106.4	3192
Peawanuck	ON	247	505	97	38.8	1164
Sachigo Lake	ON	608	300	175	70	2100
Slate Falls	ON	299	107	72	28.8	864
Wapekeka	ON	456	268	135	54	1620
Webequie	ON	723	254	171	68.4	2052
Wunnumin Lake	ON	587	169	145	58	1740
Deer Lake	ON	1087	295	330	132	3960
North Spirit Lake	ON	265	175	91	36.4	1092
Pikangikum	ON	2100	267	450	180	5400
Poplar Hill	ON	663	293	146	58.4	1752
Sandy Lake / Keewaywin	ON	2100	280	568	227.2	6816
Total Population		**16183**				
Weighted Average Air Distance (km)			**249**			

10.3.7 Schefferville

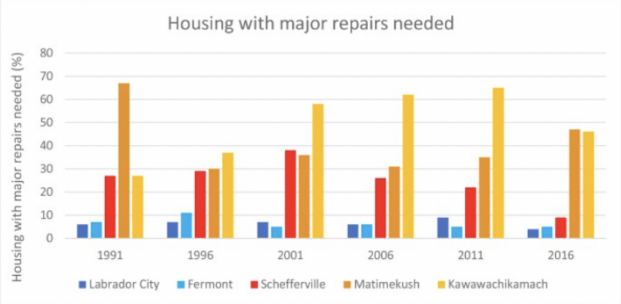
Schefferville, Innu Nation Matimekush-Lac John and Naskapi Nation of Kawawachikamach are more than simply closely geographically situated. These three communities are interconnected and interlinked by socio-economic and political history and current realities. Therefore, it is important to understand both these interrelated aspects of these communities but also appreciate their unique considerations and distinctiveness.

Any major initiative, project or economic opportunity requires all three communities to be adequately engaged and consulted prior to determining if any and all three communities wish to see such an initiative occur in or near their communities and in the region.

Background

Schefferville is located in the Cote-Nord region within the province of Quebec. Schefferville was established in 1964 by the Iron Ore Company of Canada to support their mine in the area. The Innu from Maliotenam and Naskapi from Fort Chimo were moved to Schefferville to assist with exploration work and railway construction.

Schefferville: longitude 66° 49' 11" West and latitude 54° 48' 02" North



Schefferville is situated in the Regional County Municipality of Caniapiscau, in the heart of the Labrador Peninsula between Knob Lake and Pearce Lake.

Schefferville area: 2,733 hectares or 27,330 km2 or 10,550 sq miles[126]

Neighbouring municipalities:

Matimekosh 2km

Lac-John 2.9 km

Lac-Vacher 12.2 km

Kawawachikamach 6.2 km

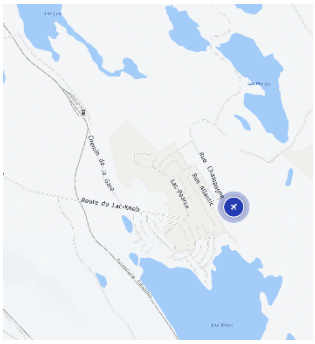
Population size and projected growth

Current population is 244 which is up from 130 in 2016. At its peak in the late 1960's, Schefferville had 5,000 residents. When the iron ore mine closed in 1982, most of the 4,000 non-indigenous residents left.

Sixty-five percent of the population are adults; 40% under the age of 19 and 37% over the age of 50. Estimated 40% of residents identify as indigenous.

Schefferville population estimates for 2021 show 244 people living there.

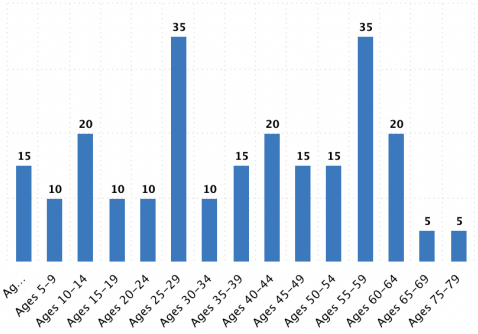
[126] https://www.municipality-canada.com/en/ville-schefferville.html



Schefferville's population decline contrasts strongly with the situation of the Indigenous communities of Matimekosh-Lac John and Kawawachikamach, which maintained their growth in spite of the mine closure in 1982, due in part to their high fertility rate. That does not mean that they were not impacted by mine closure; for example, Matimekush, which is located right next to Schefferville, lost most of the community's buildings and infrastructure when the mine and the government of Québec decided to close and demolish the city of Schefferville. Most of the housing was destroyed but the Innu women of Matimekush succeeded to save the arena, making a human chain around the building to prevent its destruction. Finally, since the early 2000, more than 40% of the Schefferville population has declared an Indigenous identity, this means that non-Indigenous are now a very small minority in the Schefferville region and that Schefferville is in fact an annex of Matimekush.[127]

Housing

Schefferville has 230 private dwellings of which 127 are being occupied. It is one of the few communities with excess housing but uncertain about their condition and suitability for habitation.



https://www.sciencedirect.com/science/article/pii/S2214790X21001799

Transportation: Accessibility

Airport

The airport is situated on the east-south end of Schefferville. It primarily handles flights from Air Inuit for cargo and passenger-cargo combi flights. There are approximately four scheduled flights a week.

Flights

Air (YKL): There are direct flights provided by Air Inuit to Montreal (YUL), Quebec City and Sept-Iles.

Montreal flights: 4 flights a week; return airfare: ~$3,000 to ~$4,000; 5 hours 5 minutes 2 stops DH3

Quebec City flights: 4 flights a week; return airfare ~$2,200 to ~$3,000; 3 hours 45 minutes 1 stop; DH3

Sept-Iles flights: 4 flights a week; return airfare ~$1900 to ~$2300; 1 hour 30 minutes 1 stop DH3

Air Inuit DH3 8 300[128] Cargo Plane

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[127] Schefferville revisited: The rise and fall (and rise again) of iron mining in Québec-Labrador, TRodon, AKeeling, J-Sboutet https://www.sciencedirect.com/science/article/pii/S2214790X21001799

[128] The Series 300 introduced a longer airframe that was stretched 3.43 meters (11.3 ft) over the Series 100/200 and has a passenger capacity of 50–56. The Series 300 also used the Pratt & Whitney Canada PW123 engines. Rated engine power is between 2,380 shp (1,774 kW) and 2,500 shp (1,864 kW). Design service life is 80,000 flight cycles. Under an extended service program launched in 2017, the service life of Dash 8-300 is extended by 50 per cent, or approximately 15 years, to 120,000 flight

Air Inuit De Havilland Dash-8 300 cargo plane can handle 13,5000 pounds of payload off of a 3,500-foot gravel or paved airstrip.

Air Inuit DH3 8 Combi 100[129] *Plane*

Air Inuit De Havilland Dash-8 100 Combi plane can accommodate 29 passengers but can also be reduced to accommodate cargo. This aircraft can land/take off of a 3,500 gravel or paved runway.

Tshiuetin Train

"Tshiuetin, a means of transportation created by the mining industry, now serves the people it once exploited, and stands as a powerful symbol of resilience and self-determination."[130]

Schefferville is the northern terminus of Tshiuetin Rail Transportation with service to Sept-Iles. Approximately 500 km (132.5 miles) train track and takes approximately 12 hours. In 2005, the Iron Ore Company of Canada sold the railway for $1 to a collective of three Indigenous communities: Innu of Uashat Mak Mani-Utenam, Matimekush-Lac John and Naskapi Nation of Kawawachikamach. The Indigenous owners renamed the rail line Tshiuetin which means "north wind". The new owners immediately embarked on repairs and equipment overhauls. The Iron Ore Company and Quebec North Shore & Labrador railway helped provide support so that the Tshiuetin Rail company could acquire the specialized capabilities and knowledge – that continues today. Ninety-eight of the company's employees come from Schefferville and Sept-Isle – with a company commitment to hire locals wherever possible. There is shared recognition that collaboration creates benefits for all especially from responsible development of nearby resources.

Train Schedule

Tshiuetin Rail schedule is available on the company website. Only two months are published. It appears that during the winter there is one train a week from Sept-Ilse to Schefferville and the Schefferville train returns to Sept-Isle the following day.[131]

There are forty-one stops on the Tshiuetin Rail from Sept-Iles to Schefferville. Tshiuetin Rail does not offer services to Labrador City and those traveling there must get off at Emeril Junction and arrange their own travel

rand". *NetNewsLedger*. February 2, 2015.
cargo-300

which is approximately 45 minutes away.[132]

The train also provides Schefferville residents, especially its younger people an opportunity to pursue higher education and employment in the south – while staying connected to family and community.[133]

Train Price

Tshiuetin Rail one-way Sept-Ilse to Schefferville for non-aboriginal fare (ages 12-59) is $96.62 or $174.15 or aboriginal fare (ages 12-59) is $63.42 one way or $114.40 roundtrip. For indigenous persons under the age of 11 or over the age of 59 one-way fare for non-aboriginal is $48.31 or $87.08 or aboriginal one-way fare is $31.70 or $57.14 round trip.[134]

Passenger Luggage

Each passenger is entitled to one carry on and four pieces of luggage up to (23kg) 50 lbs. Excess size is $10 and excess weight is $10 extra per 10 lbs up to 100 lbs. Additional bags are $10 each. Items requiring refrigeration/freezer is $35. A kayak or canoe is $150. Baggage may be dropped off one day prior to departure at Sept-Isle. Pets in carriers in appropriate size travel crates are $15 per pet.

Hotel-Motel & Guest House

Hôtel Motel Royal

182 Rue des Montagnais, Schefferville, QC G0G 2T0 (418) 585-2605

Bookings for this establishment must be made directly with the Hotel-Motel by calling. This Hotel-Motel has a 3.8 rating out of 5 on Google (15 reviews).

Auberge Guest House

550 Rue Star Creek, Schefferville, QC G0G 2T0 (418) 585-2520

Bookings at this establishment must be made directly with Auberge Guest House by calling. This Auberge Guest House has a 4.6 rating out of 5 Google (16 reviews)

Community Services and Facilities

There are very few services and facilities. There is a general store that services Schefferville and Matimekush. There is one restaurant. Several sections of town are derelict. Nearby town of Matimekush is a growing community but still has few services.

Treaties/Modern Day Land Claim Agreement: Innu Nation of Labrador

Innu Nation of Labrador land claim negotiations are still underway. There are approximately 1,700 Innu in Sheshatshiu and 900 Mushuau Innu in Natuashish. The Innu Nation land claim, accepted by the federal government for negotiation in 1978, covers approximately 70% of Labrador. In 1996, a framework agreement was signed by Canada, Newfoundland and the Innu Nation that sets out the ground rules for negotiations. On September 26, 2008, the Tshash Petapen Agreement (jash pey-taah-ben) which translates as the New Dawn Agreement was signed between Innu and Newfoundland. It resolved key issues relating to matters between the province and the Innu Nation surrounding the Innu Land Claims Agreement, the Lower Churchill Impacts and Benefits Agreement (IBA) and Innu redress for the Upper Churchill hydroelectric development. The New Dawn Agreement formed the basis for ongoing negotiation for all three agreements.

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[132] https://www.tshiuetin.net/wp-content/uploads/2021/10/carte-tshiuetin-11-20211007-scaled.jpg

[133] https://www.riotinto.com/can/news/stories/schefferville-on-track-for-growth

[134] https://tshiuetin.net/prices/?lang=en

The New Dawn Agreement represented a significant step in the tripartite land claim negotiation process towards an Agreement-in-Principle as it brought closure to several significant bilateral issues between the Province and the Innu Nation.

The tripartite AIP, the Lower Churchill IBA and the Upper Churchill redress agreement were signed at Natuashish on November 18, 2011. Negotiations among Canada, Newfoundland and Labrador and Innu Nation towards a final land claim and self-government agreement are ongoing.[135]

Schefferville Community Leaders: Mayor and Council, Chief and Band

Mayor: Ghislain Levesque

Community Economy

Mining remains the number one economic opportunity for Schefferville and communities nearby. The train and airlines provide some employment along with the one store, one restaurant, hotel-motel and auberge guest house.

Employment

Seventy-four percent of people of working age are employed with an additional 5% looking for work. Unemployment rate is 6.5%. Of those who are working, 145 are employees and 10 are self-employed.[136]

Labour force by occupation: 70 employed in education (50), law and government; 30 in sales and service; 25 business or finance; 15 trades and transportation; and 10 in Health.[137]

Labour force by industry sector: 50 in education; 40 in public administration; 20 in health care; 15 in retail; 10 in accommodation; and 10 in administration.[138]

Since 1954, McGill University has operated the McGill Subarctic Research Station in Schefferville. The station offers year-round access to a vast lichen woodland (lakes, ponds, streams, and wetlands) and alpine tundra.[139] Up to four students can spend time at the Station plus a summer field work for additional students prior to returning to university to complete degrees.

Telecommunications

Schefferville has a fibre optic network built along the railway from Labrador City. Tamaani secured $29 million to build a terrestrial fibre link between Kuujjuaq and Schefferville, Que., to connect to that community's fibre optic network.[140]

Naskapi Imuun, a wholly owned subsidiary of the Naskapi Nation of Kawawachikamach, provides Internet and cellular telephone services in Kawawachikamach, Matimekush-Lac John and Schefferville. It also provides Internet and VoIP services to Nalcor at the Menihek Generating Station.[141]

Chamber of Commerce

Chamber of Commerce de Schefferville was federally incorporated in 1965. Point person for the Chamber is Felix Gauthier. Address: P.O. Box 141, Schefferville, QC, G0C 2T0

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[135] https://www.gov.nl.ca/exec/iar/overview/land-claims/innu-nation-of-labrador/

[136] https://townfolio.co/qc/schefferville/labour-force

[137] https://townfolio.co/qc/schefferville/labour-force

[138] https://townfolio.co/qc/schefferville/labour-force

[139] https://www.mcgill.ca/science/about/field

[140] https://www.highnorthnews.com/en/nunaviks-fiber-optic-project-has-begun

[141] http://www.naskapi.ca/en/Organizations-1#Kawawachikamach_Energy_Services_Inc.

Economic Development Officers: Nation Innu Matimekush-Lac John and Naskapi Nation of Kawawachikamach

Bande de la Nation Innu Matimekush-Lac John

Address: 170, rue Pearce Lake, Schefferville GOG 2T0

Chief: Real MacKenzie Email: conseil@matimekush.com

4 Councillors:

Economic Development Officer: 415 585-2601

Community website: www.matimekush.com not working

Economic Development Strategy – CHECK

Naskapi Nation of Kawawachikamach

Treaties/Modern Day Land Claims Agreement: Naskapi

Naskapi are signatories to several agreements including: Cree and Northern Quebec Agreement, Northeast Quebec Agreement, Cree-Naskapi of Quebec Act, Northeastern Quebec Agreement Complimentary Agreement and Naskapi-Quebec Partnership Agreement.[142]

Naskapi Landholding Corporation

The Naskapi Landholding Corporation is responsible for negotiating the guaranteed levels of harvesting for the Naskapis, negotiating amendments to the Northeastern Québec Agreement, and representing the interests of the Naskapis at the Hunting, Fishing and Trapping Coordinating Committee.[143]

Naskapi Nation: Department of Public Works

The Naskapi Nation's almost one hundred Municipal Employees operate from the Department of Public Works and undertake the maintenance and operations of the Nation's infrastructure, as well as the construction and maintenance of Nation-owned housing during the construction season.[144]

Naskapi Community Centre and Recreational Centre

Established in 2003, the Naskapi Community Centre is a smoke-, alcohol- and drug-free facility, and has a large hall for community gatherings, youth centre, multi-purpose room, director's office, and kitchen.

The Naskapi Recreation Facility houses a swimming pool, Internet café, snack bar, kitchenette, pool and soccer tables. In recent years, exercise equipment was added to the Recreation Facility, and regular activities include open swim, swimming lessons and water aerobics. The Naskapi Recreation Facility is a smoke-, alcohol- and drug-free facility.[145]

Naskapi Health and Social Services Centre

Naskapi CLSC offers care, basic health and social services that are preventive and curative in nature and rehabilitation and reintegration services to the population that it serves.

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[142] http://www.naskapi.ca/en/Agreements

[143] http://www.naskapi.ca/en/Organizations-1#Naskapi_Landholding_Corporation

[144] Ibid

[145] Ibid

Although the Naskapi CLSC is fully functional, there is still a need to continue to strengthen community control of health services. There is also a need to construct a larger CLSC building with more expanded services to be able to respond effectively to the needs of the community.[146]

Jimmy Sandy Memorial School

Jimmy Sandy Memorial School (JSMS) provides English education to the communities of Kawawa, as well as Naskapi beneficiaries who reside in Schefferville.[147] JSMS is a pre-kindergarten to secondary 5 school with approximately 270 students. JSMS also offers adult education courses in the evening. JSMS operates under the Central Québec School Board.

Naskapi Police Service

The Naskapi Police Force ("NPF") is responsible for providing police services on Category IA-N land, and it works closely with the Matimekush-Lac John Police Force and Sûreté du Québec from time to time. The NPF is composed of three full-time police officers, and one secretary.[148]

Kawawachikamach Volunteer Fire Department

Operating under the authority of Council, the Kawawachikamach Volunteer Fire Department ("KVFD") is responsible for providing fire suppression and rescue, fire prevention and public fire safety education. The KVFD has approximately twenty members under the direction of a Fire Chief. Its equipment consists of a fire truck, and standard fire-fighting equipment.[149]

Power/Energy

Kawawachikamach Energy Services Inc. ("KESI") operates the electricity generating and distribution system for Schefferville and Kawawachikamach under contracts from Hydro-Québec and Nalcor (formerly Newfoundland & Labrador Hydro). Under the direction of two managers, one for the Menihek Generating Station and the other for managing the transmission and distribution system between Menihek and Schefferville/Kawawachikamach, KESI employs powerhouse operators, linesmen and an office administrator. KESI also undertakes additional work in the form of vegetation control for the Hydro companies and other customers in the Schefferville/Menihek area.[150]

Naskapi Development Corporation

The objectives of the Naskapi Development Corporation ("NDC") are to receive, invest and administer the compensation monies received from the signing of the NEQA, and it is also responsible for the joint management of the Naskapi-Québec Partnership Agreement funds.

NDC's mandate is also to relieve poverty of Naskapis, encourage education and to try to make life satisfactory for Naskapis, improve living conditions for Naskapis, and encourage the development of Kawawachikamach, and encourage and assist in the preservation of the Naskapi language, values, culture, and traditions.

Sachidun Childcare Centre

Sachidun Childcare Centre opened its doors in 1993. The Centre employs eight Naskapis and can accommodate up to 26 children. Sachidun offers a wide variety of child development activities that promote self-esteem and self-confidence in children while preparing them for school. The language of communication is Naskapi.

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[146] Ibid and https://www.cisss-cotenord.gouv.qc.ca/carriere/description-des-installations/clsc-naskapi/

[147] https://www.cqsb.qc.ca/en/ecole-jimmy-sandy-memorial

[148] Ibid

[149] Ibid

[150] http://www.naskapi.ca/en/Organizations-1#Kawawachikamach_Energy_Services_Inc.

Innu Nation of Matimekush-Lac John Reserve (Phonetic: Ma-ti-mé-kosh)

The community of Matimekush, which means “little trout”, is located on the shores of Lake Pearce, about 510 km north of Sept-Îles. The community of Lake John was transferred from the provincial to the federal government in 1960, during the golden age of neighbouring iron ore mining exploitation. In May 1998, the Governor in Council granted a decree that set aside 131 acres of land for the use of the Schefferville Innu band.[151]

As of October 2019, the Nation had a registered population of 1,038 people with 851 people living on the two reserves.[152] For Statistics Canada's 2016 Canadian Census, Matimekosh had 613 residents up 13.5% from 540 residents found in the 2011 Canadian Census.[153] Lac-John had 33 residents in 2016 up 57.1% from 21 in 2011.[154] The Nation has a five-member council with a chief and four councillors. For the 2019–2022 tenure, Réal McKenzie is the chief.[155]

The members of the band are Innu people and speak the Innu language, an Algonquian language that is a member of the Cree–Montagnais–Naskapi dialect continuum. The Nation controls two Indian reserves: Matimekush 3 in the center of the Town of Schefferville; and Lac-John located about 2 kilometers (1.2 mi) north of Schefferville. As of October 2019, the Nation had a registered population of 1,038 people, with 851 people living on the two reserves.

School

École Kanatamat Tahitipetitamunu: Pre-Kindergarten to Secondary 4. There are 117 students.

Mining

The region still fits the description of a resource-dependent, staples economy, with all the associated fragilities. The fates of these mines and communities are as tied to India, China, and Europe as they are to the US, Canada or their respective provincial governments. We also observed the trends towards technological innovation, production scaling, and flexible employment in the industry that means the local population is less tied to production levels, and employees themselves less tied to the communities.

Established towns like Labrador City and Fermont, where in spite of downturns mining never ceased, are buffered somewhat against industrial cycles, although they are being reshaped by changing employment arrangements.

As a “legacy” mining town, Schefferville is weakly positioned to take advantage of renewed development because it was largely closed down in the 1980s. However, in a reversal from the colonial pattern established by the first staple economies of the region, the Indigenous communities are in a much better position to capture part of the mining rent, through negotiated agreements for employment and royalties.

[151] http://www.nametauinnu.ca/en/culture/nation/detail/67

[152] "First Nation Detail". Indigenous and Northern Affairs Canada. 26 September 2019

[153] "Reserves/Settlements/Villages". Indigenous and Northern Affairs Canada. 26 September 2019

[154] Matimekosh 3". Geographical Names Data Base. Natural Resources Canada

[155] Registered Population". Indigenous and Northern Affairs Canada. 26 September 2019

https://ars.els-cdn.com/content/image/1-s2.0-S2214790X21001799-gr1.jpg

In fact, demographically and perhaps economically, the communities of Matimekush and Kawawachikamach are the future of the Schefferville region; impact and benefit agreements with new mines and especially the recent reconciliation agreement signed between Matimekush and IOC-Rio Tinto are positioning them to diversify their economies, since the Rio Tinto agreement is not tied to mining activities but constitutes a compensation for past impacts and damages. In some ways, the fact that the former mining site was abandoned and that Schefferville was nearly closed may give these communities the ability to imagine a future beyond mining.[156]

Potential Airship Landing Site/Hanger

There are a lot of options when it comes to potential airship landing sites and hangar locations. The best way to assess this is with full and meaningful engagement with the three communities. It also appears that the railway line is not far from the existing airport.

Feasibility Study Presentation & Northern Lights Conference Workshop

Ajungi recommends to inform and invite any residents of Schefferville, Matimekush and Kawawachikamach, leaders and representatives of Innu Nation Matimekush-Lac John and Naskapi Nation of Kawawachikamach if they plan to attend Northern Lights Conference, Ottawa, February 7th – 11th, 2023.[157] A workshop to present Airship Feasibility Study would be beneficial along with seeing if any or all three communities are sufficiently interested to move towards the development of an airship business plan out of Schefferville, Quebec.

If so, then the Canadian Arctic Innovation Association would see how – ideally in partnership with any of the local communities and indigenous nations - to proceed in securing government funding to develop a high-level business case.

[156] https://www.sciencedirect.com/science/article/pii/S2214790X21001799

[157] https://www.northernlights.events/

Communities served via the Schefferville Gateway, and Demand for Building Materials

Gateway: Schefferville, PQ						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Potential housing need (t)**
Aupaluk	QC	233	528	77	30.8	924
Inukjuak	QC	1821	799	588	235.2	7056
Kangiqsualujjuaq	QC	956	436	270	108	3240
Kangiqsujuaq	QC	837	813	321	128.4	3852
Kangirsuk	QC	561	610	197	78.8	2364
Kuujjuaq	QC	2668	380	1253	501.2	15036
Puvirnituq	QC	2129	853	697	278.8	8364
Quaqtaq	QC	453	713	173	69.2	2076
Salluit	QC	1580	966	473	189.2	5676
Umiujaq	QC	541	639	178	71.2	2136
Total Population		**11779**				
Weighted Average Air Distance (km)			**683**			

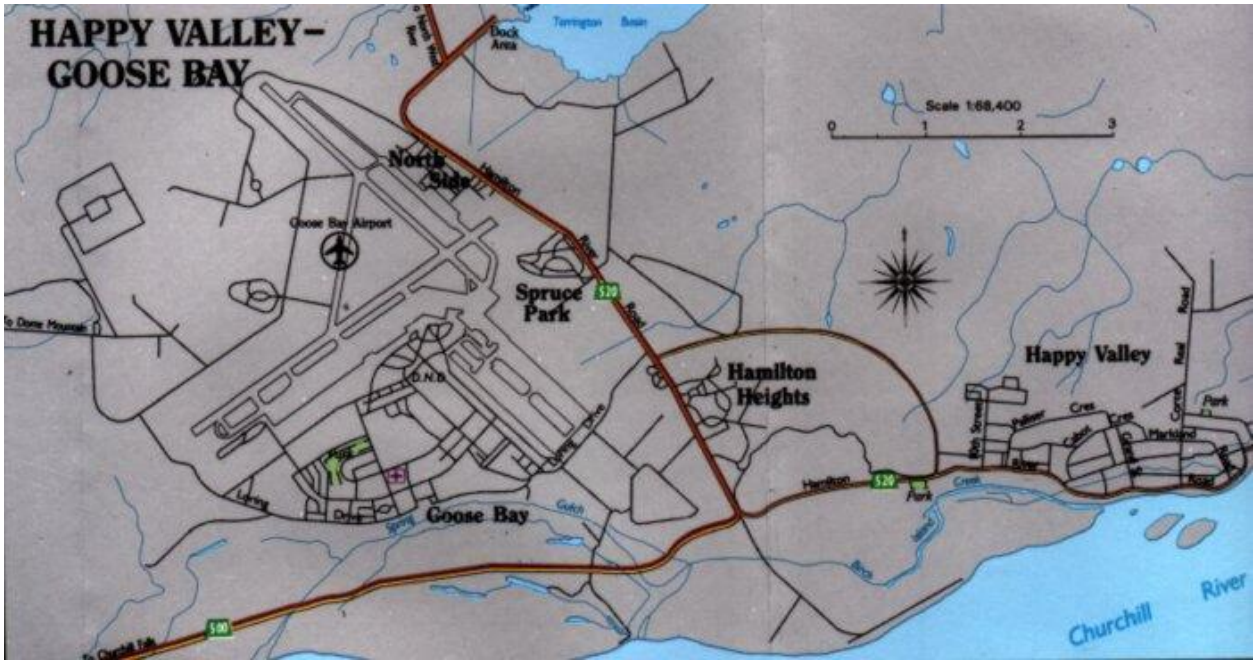
10.3.8 Happy Valley/Goose Bay

Happy Valley-Goose Bay (Inuit: Vâli) is a town in the province of Newfoundland and Labrador, Canada.

Located in the central part of Labrador on the coast of Lake Melville and the Churchill River, Happy Valley-Goose Bay is the largest population centre in that region with an estimated 8,040 residents in 2021. Incorporated in 1973, it comprises the former town of Happy Valley and the Local Improvement District of Goose Bay. Built on a large sandy plateau in 1941, the town is home to the largest military air base in northeastern North America, CFB Goose Bay.

History

In the summer of 1941, Eric Fry, an employee of the Canadian Department of Mines and Resources on loan to the Royal Canadian Air Force, selected a large sandy plateau near the mouth of the Goose River to build the Goose Bay Air Force Base. Docking facilities for transportation of goods and personnel were built at Terrington Basin.



Demographics

In the 2021 Census of Population conducted by Statistics Canada, Happy Valley-Goose Bay had a population of 8,040 living in 3,072 of its 3,390 total private dwellings, a change of -0.9% from its 2016 population of 8,109. With a land area of 304.52 km2 (117.58 sq mi), it had a population density of 26.4/km2 (68.4/sq mi) in 2021.

Water Transport

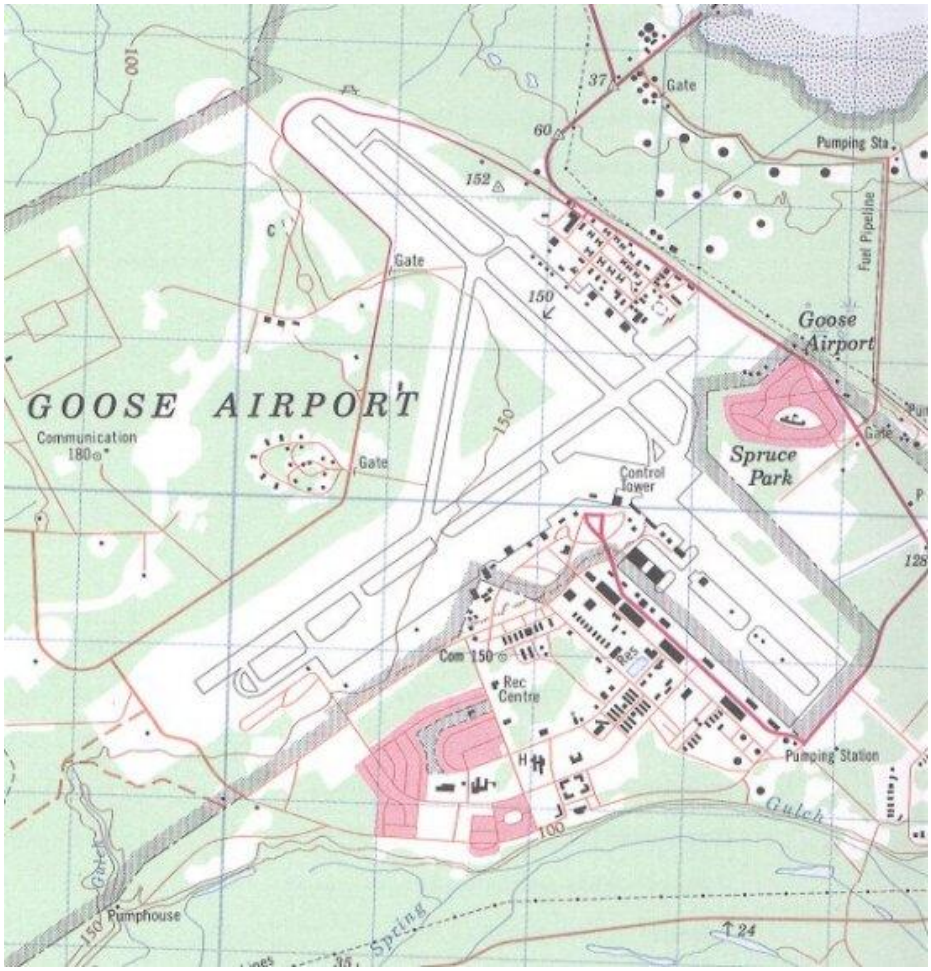
The town was serviced by boat and container ship to the ports from Newfoundland and the port of Montreal. Most of the town's supplies were transported by container vessels brought to the docking facilities located at Terrington Basin. These facilities were operated by Transport Canada. The shipping season usually lasted from June to December. In the summer, a ferry service connects Happy Valley-Goose Bay with Cartwright.

Airport

Air Canada and Eastern Provincial Airways were the first air carriers in the area to carry passengers from outside the area into CFB Goose Bay. Labrador Airways Limited provided air transportation to local communities. Located at Otter Creek is a seaplane base that also provided airlifts to local communities and tourist lodges in the interior of Labrador.

Canadian Forces Base Goose Bay (IATA: YYR, ICAO: CYYR), commonly referred to as CFB Goose Bay, is a Canadian Forces Base located in the municipality of Happy Valley-Goose Bay in the province of Newfoundland and Labrador. It is operated as an air force base by the Royal Canadian Air Force (RCAF). Its primary RCAF lodger unit is 5 Wing, commonly referred to as 5 Wing Goose Bay.

The airfield at CFB Goose Bay is also used by civilian aircraft, with civilian operations at the base referring to the facility as Goose Bay Airport. The airport is classified as an airport of entry by Nav Canada and is staffed by the Canada Border Services Agency (CBSA). CBSA officers at this airport can handle general aviation aircraft only, with no more than 15 passengers.



Runway statistics:

Name	Length
08/26	11,051 ft (3,368 m) concrete with asphalt overlay
16/34	9,580 ft (2,920 m) concrete with asphalt overlay
14/32	5,200 ft (1,600 m) gravel
09/27	1,500 ft (460 m) gravel

Highway Access

Happy Valley and Goose Bay are connected by the Trans-Labrador Highway with Labrador City and Baie-Comeau in Quebec. The road was extended south to link with an existing road from the Blanc Sablon-St Barbe ferry. It opened in December 2009.

Prior to 1954, hardly any license plates were issued to Labrador communities except for Happy Valley and the Goose Bay area. A series of small plates were issued to help fund road development. It was not until the mid-1960s that all of Labrador started using regular Newfoundland license plates.[13]

Since 1992, the road from Baie-Comeau to Wabush has been connected to an open route year-round to Happy Valley-Goose Bay.[158]

Power/Energy

NL Hydro supplies electrical power to the town through their energy network. Over 80% of the energy generated is clean, hydroelectric generation.[159]

Communities served via the Happy Valley Gateway, and Demand for Building Materials

Gateway: Happy Valley, NL						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Potential housing need (t)**
Rigolet	NL	327	158	134	53.6	1608
Postville	NL	188	183	83	33.2	996
Makkovik	NL	365	213	154	61.6	1848
Hopedale	NL	596	240	208	83.2	2496
Saint-Augustin (Cote Nord)	QC	787	257	430	172	5160
La Tabatière	QC	356	289	243	97.2	2916
Natuashish	NL	856	296	239	95.6	2868
Tête-à-La-Baleine	QC	119	296	79	31.6	948
Black Tickle	NL	87	302	72	28.8	864
Chevery	QC	226	318	118	47.2	1416
La Romaine	QC	787	343	430	172	5160
Nain	NL	847	372	266	106.4	3192
Port-Menier	QC	177	477	134	53.6	1608
Total Population		5718				
Weighted Average Air Distance (km)			292			

10.3.9 Iqaluit

The city of Iqaluit is located on south Baffin Island at the northern end of Frobisher Bay near the mouth of the Sylvia Grinnell River. Iqaluit is the territorial capital of Nunavut, the largest and fastest-growing community in the territory. It is also the regional economic, health, education and travel hub for Qikiqtani Region.

History

Iqaluit, formerly known as Frobisher Bay, was a summer camp for Inuit in the region. In 1942, the Americans established an air base. An 8600 ft airfield was constructed for their use. Throughout the 1940s and 1950s the base was used by the both the United States and Canada for transportation

[158] https://en.wikipedia.org/wiki/Happy_Valley-Goose_Bay

[159] http://www.c-and-e-museum.org/Pinetreeline/travel19.html

purposes. In 1953, a radar station was built at the same time Distant Early Warning stations were constructed across the North American Arctic. The base was closed in 1963 when the Americans sold the airport (base) to Canada.

As a result of the Nunavut Land Claims Agreement, the territory of Nunavut was to be formed from the eastern portion of Northwest Territories. Iqaluit was chosen to become the capital by referendum.

Population

The population increased from approximately 3,500 to its current 8,000 residents in 2022. There are approximately 1,000-2,000 non-residents in Iqaluit on any given day due to the four prisons, main Nunatta college campus, only hospital, only courthouse, legislative assembly and majority of Government of Nunavut departments and public agencies, Government of Canada offices, Inuit organizations, Inuit Development Corporations, majority of regional and territorial businesses plus patients, medical escorts, prisoners, contractors, consultants and construction workers.

Iqaluit's population was growing approximately 300 new residents a year until the City of Iqaluit significantly scaled back on development due to the water crisis declared in 2017 due to reduced precipitation.

Size

Municipality of Iqaluit is approximately 52 square km but the majority of the human-built environment is approximately 5 km by 2 km wide.

Demographics

Approximately 60% of the population are Inuit including Inuit from Iqaluit and Inuit from every community of Nunavut and other Inuit regions. The average age is 30 years of age.

Schools

There are six schools in Iqaluit including 4 elementary schools, 1 middle school and 1 high school. One of the six schools is the French school which is expanding to offer high school on site.

Language

Housing

There are 3,140 housing units. There is not sufficient housing to meet the need and demand. Most houses are selling more than $600,000 and higher end homes are selling up to $1M. The average number per household is 6.8 people.[160]

Daycares

There are 5 daycares and some private childcare. The waiting lists are long due to the shortage. The lack of daycares contributes to some parents not participating in the wage economy.

Mayor and Council

Mayor Solomon Awa (elected councilor, appointed Mayor with one year remaining of four year term)

Councillors: Kyle Sheppard (Deputy Mayor; elected, Romeyn Stevenson (Alternate Deputy Mayor; elected), Simon Nattaq (elected), Sam Tilley (appointed), Ookalik Curley (appointed), Paul Quassa (appointed), Kimberly Smith (appointed), and Swamy Amarapala (appointed).[161]

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[160] https://www.iqaluit.ca/visitors/explore-iqaluit/demographics

[161] https://www.iqaluit.ca/city-hall/city-council

Iqaluit Economic Development and Economic Development Officer

Geoff Byrne is the City of Iqaluit's Economic Development Officer. Tel: (867) 979-5619 Email: g.byrne@iqaluit.ca

The Economic Development Department assists the community by spearheading various community and economic development projects. The goal of this department is to collaborate with other departments as well as the community at large to better the City of Iqaluit. The department also takes part in: Business development; Proposal development; Community-based planning; Communications and facilitation; Monitoring and evaluation and Organizational Development.

The department also administers various funding programs for the Department of Economic Development & Transportation of the Government of Nunavut. The economic development officer is available to assist individuals who would like to apply for funding.[162]

Iqaluit's last Economic Development Plan (2015-2019) can be found at https://www.iqaluit.ca/sites/default/files/ced_plan_part1_overview_2015-19e.pdf

Iqaluit Chamber of Commerce

Iqaluit Chamber of Commerce works with local businesses to advance the commercial, financial, industries and civic interests of the capital region.[163] Main contact Chris West, Executive Director, Tel: (867) 979-4654 and Email execdir@baffinchamber.ca

Iqaluit Economy

Iqaluit economic sectors include governments (federal, territorial, municipal), Inuit organizations, and businesses that serve governments and Inuit organizations. Other sectors include fisheries, traditional economies, arts and crafts, mining and tourism. The majority of businesses that offer products and services territorial wide are based or have offices in Iqaluit.

Inuit Rights

As a result of the Nunavut Land Claims Agreement, signed in 1993, Inuit in Nunavut have rights expressly laid out in the Agreement. The representative organizations for Inuit beneficiaries in Iqaluit are Nunavut Tunngavik Inc, (territorial, broadly), Qikiqtani Inuit Association (regional), Amaruq Hunters and Trappers Organization and QIA's Community and Lands Resource Committee (CLARC). Inuit have the right to participate and be consulted on government policies and programs including method of delivery of services plus right to be consulted and benefit from major developments.

Shipping

Iqaluit receives cargo by ship annually between early July to the end of October – depending on conditions and the shipping companies schedule for deliveries. The two companies serving Iqaluit are Nunavut Eastern Arctic Shipping (NEAS)[164] and Nunavut Sealink and Supply Inc. (NSSI).[165] Both companies purport to have their headquarters in Iqaluit but the majority of these companies employees including senior management are based in Quebec.

Customers need to make a reservation request in order to book cargo in order to be able to secure space on the limited ships. Both companies will increase or decrease the number of cargo ships into a community based on booking volume and weight.

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[162] https://www.iqaluit.ca/city-hall/departments/community-economic-development

[163] http://www.iqaluitchamber.ca/

[164] https://neas.ca/about/corporate/

[165] https://arcticsealift.com/subsections/1012/about-nssi.html

Most large items such as construction materials, household and office furniture and equipment, non-perishable items, vehicles, and dangerous/hazardous goods are due to the high cost of air cargo. All items must either be received in shippable condition as per the shipping companies requirements or each of these companies offer packaging.

NEAS Cargo Rates

2022 Rates for cargo can be found at https://neas.ca/wp-content/uploads/Sealift-Rates_2022_Nunavut.pdf and 2023 rates have yet to be published.

NSSI Cargo Rates

Rates can be found at https://arcticsealift.com/subsections/987/tarification_conditions.html

Air

Iqaluit has an international airport that serves as an air transportation hub for the Qikiqtani Region and territory with daily flights from Ottawa, daily flights to Qikiqtani communities and flights to the west (Rankin Inlet and Yellowknife) three times a week.

The main airlines are Canadian North (after merger with First Air), Inuit Nunavut (small charter) and Chrono Aviation (airline flying employees to and from Baffinland mine situated at Mary River and Milne Inlet north Baffin). Iqaluit airport also serves international flights, either due to smaller aircraft requirements for refueling or larger flights for emergencies such as medical reasons.

Canadian North Passenger

This is the main passenger and cargo airline serving Iqaluit and the region. The cost of a one-way ticket from Ottawa to Iqaluit can cost $600 to $1,800 and return tickets from $1,200 to $4,000 depending on the fare class and availability. The costs of traveling from Iqaluit to other Qikiqtani communities range from $1,000 to $5000+ depending on destination, fare class and availability.

Canadian North Air Cargo

Canadian North offers air cargo year-round. Cargo rates can be found at https://canadiannorth.com/wp-content/uploads/2021/06/DOMESTIC-CARGO-TARIFF-RATES_EFF13JUN21.pdf with minimum freight rate, priority rates, dangerous, hazardous goods and subsidized country food rates for Inuit beneficiaries.

This map shows shipping routes. Shipments traveling on routes with daily jet service are considered Trunk Routes (except from Yellowknife into the Kitikmeot Region). Shipments traveling on multiple flights or from northern hubs (Iqaluit, Yellowknife) to northern communities, but without crossing the country, are considered Regional Routes (except Yellowknife-Norman Wells). If your shipment is traveling between east and west, or between Iqaluit and Grise Fiord, it's considered a National Route.[166]

[166] https://canadiannorth.com/cargo/routes-network/#economy-rates

NorthStar Air Cargo

Northern Store uses their own airline NorthStar Air to fly perishable foods and other goods from Winnipeg. This includes regular flights from Winnipeg to Iqaluit. The airline regularly reported flying 100,000lbs of groceries to Iqaluit which was both for Iqaluit and other communities in Qikiqtani Region. Approximately, one-half of the food is designated for Iqaluit.

CargoJet and Chronos Cargo

Arctic Coop used CargoJet until 2021 and now uses both Chronos and Canadian North to ship up approximately 50,000-60,000lbs of food from Winnipeg to Iqaluit a week.

Telecommunications

Currently, Iqaluit is served only by satellite. The options are to purchase service through Internet Service Providers such as Northwestel, SSIMicro/Qiniq, Iristel which are connected to GEOs e.g. TeleSat or since November/December 2022, residents now have the option to purchase equipment and service directly from StarLink. Efforts are underway to bring fibre optic into Iqaluit.

Energy: Power and Heating

Iqaluit's power is generated by diesel power generation. The Government of Nunavut purchases approximately 220,000,000 liters of petroleum products a year. While Iqaluit is one of twenty-five communities with approximately 25% of the territorial population, it consumes ½ of the petroleum product each year. Of the 110M liters of petroleum products used, 1/3 is on electricity, 1/3 on heating and 1/3 for vehicles. The territorial crown corporation Qulliq Energy Corporation provides electricity. Uqsuq delivers residential and commercial heating oil. There are two gas stations in town that serve residents and the private sector. The cost of gas is currently $1.445/liter.

Port

The Iqaluit deep-sea port should be completed and operational in the summer of 2023. Ships will be able to off-load cargo with the use of cranes, as this is not a roll on and roll off port.

Potential Airship Landing Site/Hanger

There aren't many suitable sites for a potential airship landing site and hanger, as there is limited land available for development. There may be suitable sites on the outskirts of Iqaluit to the north. This would need to be further investigated by working with the municipality.

Feasibility Study Presentation & Northern Lights Conference Workshop

Ajungi recommends to inform and invite any leaders and representatives of Iqaluit, Government of Nunavut, Qikiqtani Inuit Association, Iqaluit Chamber of Commerce if they plan to attend Northern Lights Conference, Ottawa, February 7th – 11th, 2023.[167] A workshop to present Airship Feasibility Study would be beneficial along with seeing if any or all three communities are sufficiently interested to move towards the development of an airship business plan out of Iqaluit.

If so, then the Canadian Arctic Innovation Association would see how – ideally in partnership with any of the local communities and indigenous nations - to proceed in securing government funding to develop a high-level business case.

Communities served via the Iqaluit Gateway, and Demand for Building Materials

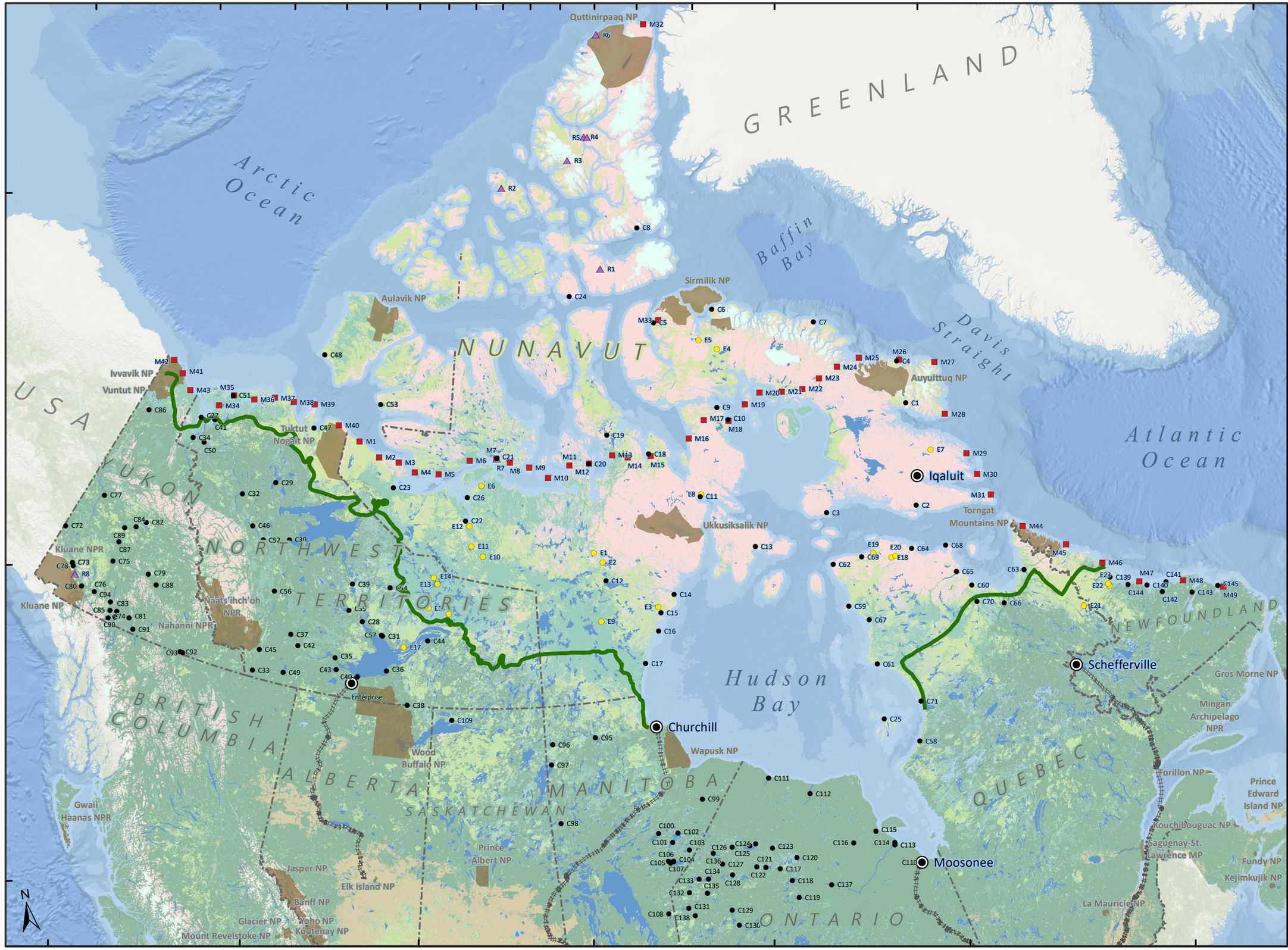
Gateway: Iqaluit, NU						
Location		**2021 Population**	**Air Distance (km)**	**Dwellings**	**40% rule**	**Potential housing need (t)**
Iqaluit	NU	7429	0	3297	1318.8	39564
Kimmirut	NU	426	121	150	60	1800
Pangnirtung	NU	1504	298	456	182.4	5472
Kinngait (Was Cape Dorset)	NU	1396	394	416	166.4	4992
Qikiqtarjuaq	NU	593	471	193	77.2	2316
Coral Harbour	NU	1035	715	303	121.2	3636
Clyde River	NU	1181	748	278	111.2	3336
Hall Beach (Sanirajak)	NU	891	794	205	82	2460
Igloolik	NU	2049	855	468	187.2	5616
Naujaat	NU	1225	880	246	98.4	2952
Pond Inlet	NU	1555	1065	466	186.4	5592
Kugaaruk	NU	1033	1088	225	90	2700
Arctic Bay	NU	994	1228	239	95.6	2868
Grise Fiord	NU	144	1500	64	25.6	768
Total Population		21455				
Average Air Distance (km)			499			

[167] https://www.northernlights.events/

Appendix 10.4 – Community Database and National Map

Airship Transportation Study

Regional Area



Legend

- Potential Embarcation Point
- Community
- Military
- Mines / Minerals
- Research
- Railway
- Treeline
- Minimal Vegetation
- Low Vegetation - Grass
- Low Vegetation - Shrub
- Forest
- Grassland and Parkland
- Glacier
- National Park
- Lake

0 500 1,000 1,500 km

1:40,000,000

Date: 2/10/2023

Map Number: CHI-106a

Coordinate System:
NAD 1983 Canada Atlas Lambert
Projection: Lambert Conformal Conic
Datum: North American 1983

ECOLOGIC environmental consulting

Airship Transportation Study

Regional Area: Key to Place Names

Communities

Nunavut

C1 – Pangnirtung
C2 – Kimmirut
C3 - Kinngait
C4 - Qikiqtarjuaq
C5 - Arctic Bay
C6 - Pond Inlet
C7 - Clyde River
C8 - Grise Fiord
C9 - Igloolik
C10 - Sanirajak
C11 - Naujaat
C12 - Baker Lake
C13 - Coral Harbour
C14 - Chesterfield Inlet
C15 - Rankin Inlet
C16 - Whale Cove
C17 - Arviat
C18 - Kugaaruk
C19 - Taloyoak
C20 - Gjoa Haven
C21 - Cambridge Bay
C22 - Bathurst Inlet
C23 - Kugluktuk
C24 - Resolute
C25 - Sanikiluaq
C26 - Umingmaktok

Northwest Territories

C27 - Aklavik
C28 - Behchoko
C29 - Colville Lake
C30 - Deline
C31 - Dettah
C32 - Fort Good Hope
C33 - Fort Liard
C34 - Fort McPherson
C35 - Fort Providence
C36 - Fort Resolution
C37 - Fort Simpson
C38 - Fort Smith
C39 - Gameti
C40 - Hay River
C41 - Inuvik
C42 - Jean Marie River
C43 - Kakisa
C44 - Lutselk'e
C45 - Nahanni Butte
C46 - Norman Wells
C47 - Paulatuk
C48 - Sachs Harbour
C49 - Sambaa K'e
C50 - Tsiigehtchic
C51 - Tuktoyaktuk
C52 - Tulita
C53 - Ulukhaktok
C54 – Wekweètì
C55 - Whatì
C56 - Wrigley
C57 - Yellowknife

Quebec

C58 - Kuujjuarapik
C59 - Akulivik
C60 - Aupaluk
C61 - Inukjuak
C62 - Ivujivik
C63 - Kangiqsualujjuaq
C64 - Kangiqsujuaq
C65 - Kangirsuk
C66 - Kuujjuaq
C67 - Puvirnituq
C68 - Quaqtaq
C69 - Salluit
C70 - Tasiujaq
C71 - Umiujaq

Yukon

C72 - Beaver Creek
C73 - Burwash Landing
C74 - Carcross
C75 - Carmacks
C76 - Champagne Landing 10
C77 - Dawson
C78 - Destruction Bay

Yukon (cont'd)

C79 - Faro
C80 - Haines Junction
C81 - Johnson's Crossing
C82 - Keno Hill
C83 - Marsh Lake
C84 - Mayo
C85 - Mt. Lorne
C86 - Old Crow
C87 - Pelly Crossing
C88 - Ross River
C89 - Stewart Crossing
C90 - Tagish
C91 - Teslin
C92 - Upper Liard
C93 - Watson Lake
C94 - Whitehorse

Manitoba

C95 - Tadoule Lake
C96 - Lac Brochet
C97 - Brochet
C98 - Pukatawagan
C99 - Shamattawa
C100 - Oxford House
C101 - God's Lake Narrows
C102 - God's River
C103 - Red Sucker Lake
C104 - Garden Hill
C105 - St Theresa Point
C106 - Island Lake
C107 - Wasagamack
C108 - Little Grande Rapids

Saskatchewan

C109 - Uranium City

Ontario

C110 - Moose Factory
C111 - Fort Severn
C112 - Peawanuck
C113 - Fort Albany
C114 - Kashechewan
C115 - Attawapiskat
C116 - Victor Mines
C117 - Nibinamlk
C118 - Neskantaga
C119 - Eabametoong
C120 - Webequie
C121 - Kingfisher Lake
C122 - Wunnunmin
C123 - Kasabonika Lake
C124 - Wapekeka
C125 - Kitchenuhmaykoosib Inniniwug
C126 - Bearskin Lake
C127 - Muskrat Dam
C128 - Round Lake / Weagamow Lake
C129 - Cat Lake
C130 - Slate Falls
C131 - Poplar Hill
C132 - Deer Lake
C133 - Sandy Lake
C134 - Keewaywin
C135 - North Spirit Lake
C136 - Sachigo Lake
C137 - Ogoki Post
C138 - Pikangikum

Newfoundland & Labrador

C139 - Nain
C140 - Hopedale
C141 - Makkovik
C142 - Postville
C143 - Rigolet
C144 - Natuashish
C145 - Cartwright

Military

Nunavut

M1 - Croker River (PIN-1BG)
M2 - Harding River (PIN-2A)
M3 - Bernard Harbour (PIN-CB)
M4 - Lady Franklin Point (PIN-3)
M5 - Edinburgh Island (PIN-DA)
M6 - Cape Peel West (PIN-EB)
M7 - Cambridge Bay (CAM-M)
M8 - Sturt Point (CAM-A3A)
M9 - Jenny Lind Island (CAM-1A)
M10 - Hat Island (CAM-B)
M11 - Gladman Point (CAM-2)
M12 - Gjoa Haven (CAM-CB)
M13 - Shepherd Bay (CAM-3)
M14 - Simpson Lake (CAM-D)
M15 - Pelly Bay (CAM-4)
M16 - Cape McLoughlin (CAM-5A)
M17 - Lailor River (CAM-FA)
M18 - Hall Beach (FOX-M)
M19 - Rowley Island (FOX-1)
M20 - Bray Island (FOX-A)
M21 - Longstaff Bluff (FOX-2)
M22 - Nudluardjk Lake (FOX-B)
M23 - Dewar Lakes (FOX-3)
M24 - Kangok Fjord (FOX-CA)
M25 - Cape Hooper (FOX-4)
M26 - Broughton Island (FOX-5)
M27 - Cape Dyer (DYE-M)
M28 - Cape Mercy (BAF-2)
M29 - Brevoort Island (BAF-3)
M30 - Loks Land (BAF-4A)
M31 - Resolution Island (BAF-5)
M32 - CFB Alert
M33 - Nanisivik Naval Facility

Northwest Territories

M34 - Storm Hills (BAR-BA3)
M35 - Tuktoyaktuk (BAR-3)
M36 - Liverpool Bay (BAR-DA1)
M37 - Nicholson Peninsula (BAR-4)
M38 - Horton River (BAR-E)
M39 - Cape Parry (PIN-M)
M40 - Keats Point (PIN-1BD)

Yukon

M41 - Stokes Point (BAR-B)
M42 - Komakuk Beach (BAR-1)
M43 - Shingle Point (BAR-2)

Newfoundland & Labrador

M44 - Cape Kakivak (LAB-1)
M45 - Saglek (LAB-2)
M46 - Cape Kigiapait (LAB-3)
M47 - Big Bay (LAB-4)
M48 - Tukialik (LAB-5)
M49 - Cartwright (LAB-6)

Research

Nunavut

R1 - Flashline Mars Arctic Research Station
R2 - Isachesen Station
R3 - McGill Arctic Research Station
R4 - Polar Environmental Atmospheric Research Laboratory
R5 - Eureka Station
R6 - Ward Hunt Island Research Station
R7 - Canada High Arctic Research Station (CHARS)

Yukon

R8 - Kluane Lake Research Station

Mines & Minerals

Nunavut

E1 - Amaruq Mine
E2 - Meadowbank Mine
E3 - Meliadine Mine
E4 - Mary River Mine
E5 - Mary River Port (Milne Port)
E6 - Doris Mine / Hope Bay
E7 - Childiak Project
E8 - Naujaat Project
E9 - Ferguson Lake Project
E10 - Back River Goose Project`
E11 - Back River George Project
E12 - Back River Marine Laydown

Northwest Territories

E13 - Diavik Mine
E14 - Ekati Mine
E15 - Snap Lake Mine
E16 - Gahcho Kué Mine
E17 - Nechalacho Rare Earths Mine

Quebec

E18 - Raglan Mine
E19 - Raglan Mine Marine Laydown
E20 - Raglan Mine Airport
E21 - Torngat Minerals

Newfoundland & Labrador

E22 - Voisey's Bay Mine
E23 - Voisey's Bay Marine Laydown

Date: 2/15/2023
Map Number: CHI-106b

ECOLOGIC environmental consulting

Appendix 10.4: Community Database

#	Name	Province	Type 1	Type	Population (2021)	Latitude (dd.ddd)	Longitude (dd.ddd)	50K NTS	Ecozone	Time Zone	Airport Designation	Airstrip	Airstrip Length (ft)	Airstrip Type	Port	Rail	All Weather Road	Ice Road	River/Lake Access	Tide Water
1	Fort Chipewyan	Alberta	Community	Town	798	58.716643	-111.150019	74L11	Boreal Plains	UTC-7(6)	CYPY	Yes	5000	Asphalt	No	No	No	Yes	Yes	No
2	Fox Lake	Alberta	Community	Reserve	2488	58.470974°	-114.533097°	84J10	Boreal Plains	UTC-7(6)	CEC3	Yes	3500	Gravel	No	No	No	Yes-River Crossing	Yes - Ferry	No
3	Berens River	Manitoba	Community	Reserve	1161	52.3548205	-97.05308739	63A06	Boreal Shield	UTC-6(5)	CYBV	Yes	2900	Crushed Rock	No	No	No	Yes	Yes	No
4	Brochet	Manitoba	Community	Village	64	57.881582°	-101.672052°	64F13	Taiga Shield	UTC-6(5)	CYBT	Yes	3500	Crushed Rock	No	No	No	Yes	No	No
5	Churchill	Manitoba	Community	Town	870	58.769311°	-94.165356°	54L16	Hudson Plains	UTC-6(5)	CYYQ	Yes	9195	Asphalt	Yes	Yes	Yes	No	No	Yes
6	Cross Lake	Manitoba	Community	Reserve	2045	54.626157°	-97.775928°	63I12	Boreal Shield	UTC-6(5)	CYCR	Yes	3991	Crushed Rock	No	No	Yes	No	Yes	No
7	Garden Hill	Manitoba	Community	Reserve	3051	53.870247°	-94.639063°	53E15	Boreal Shield	UTC-6(5)	NA	No	NA	NA	No	No	No	Yes	No	No
8	God's Lake Narrows	Manitoba	Community	Northern Community	1520	54.555228°	-94.480931°	53L09	Boreal Shield	UTC-6(5)	CYGO	Yes	3810	Crushed Rock	No	No	No	Yes	No	No
9	God's River	Manitoba	Community	Settlement	809	54.838142°	-94.056434°	53L16	Boreal Shield	UTC-6(5)	CZGI	Yes	3532	Crushed Rock	No	No	No	Yes	No	No
10	Island Lake	Manitoba	Community	Village	91	53.857712°	-94.655527°	53E15	Boreal Shield	UTC-6(5)	CYIV	Yes	4000	Crushed Rock	No	No	No	Yes	No	No
11	Lac Brochet	Manitoba	Community	Reserve	641	58.618230°	-101.489894°	64K11	Taiga Shield	UTC-6(5)	CZWH	Yes	3500	Crushed Rock	No	No	No	No	No	No
12	Little Grande Rapids	Manitoba	Community	Reserve	810	52.040541°	-95.466840°	53D03	Boreal Shield	UTC-6(5)	CZGR	Yes	2798	Gravel	No	No	No	Yes	No	No
13	Oxford House	Manitoba	Community	Village	1955	54.949983°	-95.265749°	53L14	Boreal Shield	UTC-6(5)	CYOH	Yes	3828	Crushed Rock	No	No	No	Yes	No	No
14	Pauingassi	Manitoba	Community	Reserve	271	52.16425	-95.37911	53D03	Boreal Shield	UTC-5	No Airport	No	NA	NA	No	No	No	Yes	Yes	No
15	Poplar River	Manitoba	Community	Reserve	866	53.00001	-97.2864	63A14	Boreal Shield	UTC-6(5)	CZNG	Yes	2500	Crushed Rock	No	No	No	Yes	Yes	No
16	Pukatawagan	Manitoba	Community	Reserve	1724	55.741924°	-101.317326°	63N11	Boreal Shield	UTC-6(5)	CZFG	Yes	2998	Crushed Rock	No	No	No	Yes	No	No
17	Red Sucker Lake	Manitoba	Community	Village	725	54.160000°	-93.567222°	53K04	Boreal Shield	UTC-6(5)	CYRS	Yes	3555	Crushed Rock	No	No	No	Yes	No	No
18	Shamattawa	Manitoba	Community	Settlement	1019	55.861720°	-92.098404°	53N16	Hudson Plains	UTC-6(5)	CZTM	Yes	4006	Gravel	No	No	No	Yes	No	No
19	St Theresa Point	Manitoba	Community	Reserve	3417	53.832766°	-94.849654°	53E15	Boreal Shield	UTC-6(5)	CYST	Yes	3391	Crushed Rock	No	No	No	Yes	No	No
20	Tadoule Lake	Manitoba	Community	Village	311	58.715252°	-98.485493°	64J09	Taiga Shield	UTC-6(5)	CYBQ	Yes	3201	Crushed Rock	No	No	No	Yes	No	No
21	Wasagamack	Manitoba	Community	Reserve	1411	53.910525°	-94.947614°	53E15	Boreal Shield	UTC-6(5)	No Airport	No	NA	NA	No	No	No	Yes	No	No
22	York Factory/York Landing	Manitoba	Community	Reserve	455	56.087732°	-96.095823°	64A01	Boreal Shield	UTC-6(5)	CZAC	Yes	3396	Crushed Rock	No	No	No	Yes	Yes	No
23	Big Bay (LAB-4)	Newfoundland & Labrador	Military	Military - NWS	0	55.741667	-60.428333	13N09	Taiga Shield	UTC-4(3)	No Airport	Unkown	unknown	unknown	No	No	No	No	No	No
24	Black Tickle	Newfoundland & Labrador	Community	Settlement	87	53.461474	-55.7648502	03E05	Taiga Shield	UTC-4(3)	CCE4	Yes	2503	Gravel	No	No	No	No	No	Yes
25	Cape Kakivak (LAB-1)	Newfoundland & Labrador	Military	Military - NWS	0	59.9875	-64.165278	24P16	Arctic Cordillera	UTC-4(3)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
26	Cape Kigiapait (LAB-3)	Newfoundland & Labrador	Military	Military - NWS	0	57.135278	-61.475556	14F03	Taiga Shield	UTC-4(3)	No Airport	Unkown	unknown	unknown	No	No	No	No	No	No
27	Cartwright	Newfoundland & Labrador	Community	Town	439	53.708163°	-57.018011°	13H11	Taiga Shield	UTC-4(3)	CYCA	Yes	3937	Gravel	Yes	No	Yes	No	No	Yes
28	Cartwright (LAB-6)	Newfoundland & Labrador	Military	Military - NWS	0	53.551111	-56.83	13H10	Boreal Shield	UTC-4(3)	No Airport	No	No	No	No	No	Yes	No	No	No
29	Hopedale	Newfoundland & Labrador	Community	Town	596	55.460247°	-60.213010°	13N08	Taiga Shield	UTC-4(3)	CYHO	Yes	2501	Gravel	Yes	No	No	No	No	Yes
30	Makkovik	Newfoundland & Labrador	Community	Town	365	55.086521°	-59.179011°	13O03	Taiga Shield	UTC-4(3)	CYFT	Yes	2592	Gravel	Yes	No	No	No	No	Yes
31	Nain	Newfoundland & Labrador	Community	Town	847	56.542391°	-61.693035°	14C12	Taiga Shield	UTC-4(3)	CYDP	Yes	1986	Gravel	Yes	No	No	No	No	Yes
32	Natuashish	Newfoundland & Labrador	Community	Indian Reserve	856	55.916373°	-61.124289°	13N14	Taiga Shield	UTC-4(3)	CNH2	Yes	2500	Gravel	Yes	No	No	No	No	Yes
33	Postville	Newfoundland & Labrador	Community	Town	188	54.908760°	-59.773326°	13J13	Taiga Shield	UTC-4(3)	CCD4	Yes	2576	Gravel	Yes	No	No	No	No	Yes
34	Rigolet	Newfoundland & Labrador	Community	Town	327	54.179467°	-58.429979°	13J01	Boreal Shield	UTC-4(3)	CCZ2	Yes	2496	Gravel	Yes	No	No	No	No	Yes
35	Saglek (LAB-2)	Newfoundland & Labrador	Military	Military - NWS	0	58.488611	-62.585556	14L07	Arctic Cordillera	UTC-4(3)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
36	Tukialik (LAB-5)	Newfoundland & Labrador	Military	Military - NWS	0	54.714722	-58.358333	13J09	Taiga Shield	UTC-4(3)	No Airport	Unkown	unknown	unknown	No	No	No	No	No	No
37	Voisey's Bay Marine Laydown	Newfoundland & Labrador	Mines & Minerals	Mines & Minerals	0	56.420048°	-62.055916°	14D08	Taiga Shield	UTC-4(3)	No Airport	No Airstrip	NA	NA	Yes	No	No	No	No	Yes
38	Voisey's Bay Mine	Newfoundland & Labrador	Mines & Minerals	Mines & Minerals	0	56.326457°	-62.088647°	14D08	Taiga Shield	UTC-4(3)	CVB2	Yes	5002	Gravel	No	No	No	No	No	No
39	Aklavik	Northwest Territories	Community	Hamlet	536	68.219916°	-135.007788°	107B04	Taiga Plains	UTC-7(6)	CYKD	Yes	3002	Gravel	No	No	No	Yes	Yes - Peel Channel	No
40	Behchoko	Northwest Territories	Community	Community Government	1746	62.830054°	-116.051075°	85K16	Taiga Shield	UTC-7(6)	CRE2	Yes	3372	Gravel	No	No	Yes	No	No	No
41	Cape Parry (PIN-M)	Northwest Territories	Military	Military - NWS	0	70.171389	-124.725	97F01	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
42	Colville Lake	Northwest Territories	Community	Settlement	110	67.038261°	-126.090934°	96M01	Taiga Plains	UTC-7(6)	CYVL	Yes	3935	Gravel	No	No	No	Yes	No	No
43	Deline	Northwest Territories	Community	Chartered Community	573	65.187615°	-123.425469°	96G03	Taiga Plains	UTC-7(6)	CYWJ	Yes	3933	Gravel	No	No	No	Yes	Yes - Great Bear River	No
44	Dettah	Northwest Territories	Community	Settlement	192	62.411928°	-114.308155°	85J08	Taiga Shield	UTC-7(6)	No Airport	No	No	NA	No	No	Yes	Yes	Yes - Great Slave Lake	No
45	Diavik Mine	Northwest Territories	Mines & Minerals	Mines & Minerals	0	64.495583°	-110.274016°	76D08	Southern Arctic	UTC-7(6)	CDK2	Yes	5234	Gravel	No	No	No	Yes	No	No
46	Ekati Mine	Northwest Territories	Mines & Minerals	Mines & Minerals	0	64.722595°	-110.616513°	76D10	Southern Arctic	UTC-7(6)	CYOA	Yes	6411	Gravel	No	No	No	Yes	No	No
47	Enterprise	Northwest Territories	Community	Hamlet	75	60.555862°	-116.144573°	85C09	Taiga Plains	UTC-7(6)	No Airport	No	No	No	No	No	Yes	No	No	No
48	Fort Good Hope	Northwest Territories	Community	Chartered Community	507	66.258185°	-128.629830°	106I07	Taiga Plains	UTC-7(6)	CYGH	Yes	4434	Gravel	No	No	No	Yes	Yes - Mackenzie River	No
49	Fort Liard	Northwest Territories	Community	Hamlet	468	60.239168°	-123.474461°	95B03	Taiga Plains	UTC-7(6)	CYJF	Yes	2946	Gravel	No	No	Yes	No	No	No
50	Fort McPherson	Northwest Territories	Community	Hamlet	647	67.434203°	-134.881810°	106M07	Taiga Plains	UTC-7(6)	CZFM	Yes	3934	Gravel	No	No	Yes	No	No	No
51	Fort Providence	Northwest Territories	Community	Hamlet	618	61.358489°	-117.666045°	85F05	Taiga Plains	UTC-7(6)	CYJP	Yes	2999	Gravel	No	No	Yes	No	No	No
52	Fort Resolution	Northwest Territories	Community	Hamlet	412	61.170875°	-113.672456°	85H04	Boreal Plains	UTC-7(6)	CYFR	Yes	4001	Gravel	No	No	Yes	No	No	No
53	Fort Simpson	Northwest Territories	Community	Village	1100	61.865473°	-121.360128°	95H14	Taiga Plains	UTC-7(6)	CYFS	Yes	6000	Asphalt	No	No	Yes	No	Yes - Mackenzie River	No
54	Fort Smith	Northwest Territories	Community	Town	2248	60.003545°	-111.876927°	75D04	Boreal Plains	UTC-7(6)	CYSM	Yes	6001	Asphalt	No	No	Yes	No	No	No
55	Gahcho Kué Mine	Northwest Territories	Mines & Minerals	Mines & Minerals	0	63.437425°	-109.193281°	75N06	Taiga Shield	UTC-7(6)	CGK2	Yes	5311	Gravel	No	No	No	Yes	No	No
56	Gameti	Northwest Territories	Community	Community Government	252	64.112195°	-117.353985°	88C03	Taiga Plains	UTC-7(6)	CYRA	Yes	4434	Gravel	No	No	No	Yes	No	No
57	Hay River	Northwest Territories	Community	Town	3169	60.812601°	-115.792310°	85B13	Taiga Plains	UTC-7(6)	CYHY	Yes	6000	Asphalt	Yes	No	Yes	No	No	No
58	Horton River (BAR-E)	Northwest Territories	Military	Military - NWS	0	70.016389	-126.943056	97F03	Southern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
59	Inuvik	Northwest Territories	Community	Town	3137	68.363336°	-133.730632°	107B07	Taiga Plains	UTC-7(6)	CYEV	Yes	6001	Asphalt	No	No	Yes	No	Yes - Mackenzie River	No
60	Jean Marie River	Northwest Territories	Community	Settlement	63	61.524915°	-120.627430°	95H10	Taiga Plains	UTC-7(6)	CET9	Yes	2512	Gravel/Clay	No	No	Yes	No	Yes - Mackenzie River	No
61	Kakisa	Northwest Territories	Community	Settlement	39	60.940215°	-117.416280°	85C14	Taiga Plains	UTC-7(6)	No Airport	No	NA	NA	No	No	Yes	No	No	No
62	Keats Point (PIN-1BD)	Northwest Territories	Military	Military - NWS	0	69.672778	-121.671944	97D10	Southern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
63	Liverpool Bay (BAR-DA1)	Northwest Territories	Military	Military - NWS	0	69.604167	-130.893611	107D11	Southern Arctic	UTC-7(6)	No Airport	No	NA	NA	No	No	No	No	No	Yes
64	Lutselk'e	Northwest Territories	Community	Settlement	333	62.405796°	-110.741479°	75L07	Taiga Shield	UTC-7(6)	CYLK	Yes	3003	Gravel	No	No	No	No	Yes - Great Slave Lake	No
65	Nahanni Butte	Northwest Territories	Community	Settlement	81	61.032736°	-123.381601°	85G03	Taiga Plains	UTC-7(6)	CBD6	Yes	2554	Gravel/earth	No	No	Yes	No	No	No
66	Nechalacho Rare Earths Mine	Northwest Territories	Mines & Minerals	Mines & Minerals	0	62.100445°	-112.585482°	85J02	Taiga Shield	UTC-7(6)	No Airport	No Airstrip	NA	NA	No	No	No	Yes	No	No
67	Nicholson Peninsula (BAR-4)	Northwest Territories	Military	Military - NWS	0	69.924167	-128.973333	107D16	Southern Arctic	UTC-7(6)	No Airport	Yes	NA	NA	No	No	No	No	No	Yes
68	Norman Wells	Northwest Territories	Community	Town	673	65.283505°	-126.847923°	96E07	Taiga Plains	UTC-7(6)	CYVQ	Yes	5998	Asphalt	No	No	No	Yes	Yes - Mackenzie River	No
69	Paulatuk	Northwest Territories	Community	Hamlet	298	69.349335°	-124.069450°	97C08	Southern Arctic	UTC-7(6)	CYPC	Yes	4003	Gravel	No	No	No	No	No	Yes
70	Sachs Harbour	Northwest Territories	Community	Hamlet	104	71.985491°	-125.253405°	97G15	Northern Arctic	UTC-7(6)	CYSY	Yes	4002	Gravel	No	No	No	No	No	Yes
71	Sambaa K'e	Northwest Territories	Community	Settlement	97	60.442386°	-121.244653°	95A06	Taiga Plains	UTC-7(6)	CEU9	Yes	3501	Gravel	No	No	No	Yes	No	No
72	Snap Lake Mine	Northwest Territories	Mines & Minerals	Mines & Minerals	0	63.599768°	-110.886004°	75M10	Taiga Shield	UTC-7(6)	CSK6	Yes	5282	Gravel	No	No	No	Yes	No	No
73	Storm Hills (BAR-BA3)	Northwest Territories	Military	Military - NWS	0	68.894167	-133.941944	107B15	Southern Arctic	UTC-7(6)	No Airport	No	NA	NA	No	No	No	No	No	No
74	Tsiigehtchic	Northwest Territories	Community	Chartered Community	138	67.442258°	-133.744801°	106N05	Taiga Plains	UTC-7(6)	No Airport	No Airstrip	NA	NA	No	No	Yes	No	Yes - Mackenzie River	No
75	Tuktoyaktuk	Northwest Territories	Community	Hamlet	937	69.444283°	-133.037724°	107C07	Southern Arctic	UTC-7(6)	CYUB	Yes	4600	Gravel	Yes	No	No	Yes	No	No
76	Tuktoyaktuk (BAR-3)	Northwest Territories	Military	Military - NWS	0	69.443056	-132.998611	107C07	Southern Arctic	UTC-7(6)	No Airport	No	NA	NA	No	No	No	No	No	Yes
77	Tulita	Northwest Territories	Community	Hamlet	396	64.901276°	-125.577580°	96C13	Taiga Plains	UTC-7(6)	CZFN	Yes	3935	Gravel	No	No	No	Yes	Yes - Mackenzie River	No
78	Ulukhaktok	Northwest Territories	Community	Hamlet	408	70.736548°	-117.770487°	87F10	Northern Arctic	UTC-7(6)	CYHI	Yes	4300	Gravel	No	No	No	No	No	Yes
79	Wekweètì	Northwest Territories	Community	Community Government	109	64.190371°	-114.184102°	86B01	Taiga Shield	UTC-7(6)	CYWE	Yes	2999	Gravel	No	No	No	Yes	No	No
80	Whatì	Northwest Territories	Community	Community Government	543	63.146261°	-117.271140°	85N03	Taiga Plains	UTC-7(6)	CEM3	Yes	2991	Gravel	No	No	Yes	No	No	No
81	Wrigley	Northwest Territories	Community	Settlement	117	63.227459°	-123.467897°	95O03	Taiga Plains	UTC-7(6)	CYWY	Yes	3500	Gravel	No	No	Yes	Yes	Yes - Mackenzie River	No
82	Yellowknife	Northwest Territories	Community	City	20340	62.445930°	-114.403159°	85J08	Taiga Shield	UTC-7(6)	CYZF	Yes	7503	Gravel	Yes	No	Yes	Yes	No	No
83	Rankin Inlet	Nuanvut	Community	Hamlet	2975	62.809283°	-92.085632°	55K16	Southern Arctic	UTC-6(5)	CYRT	Yes	6000	Asphalt	No	No	No	No	No	Yes

Appendix 10.4: Community Database

#	Name	Province	Type 1	Type	Population (2021)	Latitude (dd.ddd)	Longitude (dd.ddd)	50K NTS	Ecozone	Time Zone	Airport Designation	Airstrip	Airstrip Length (ft)	Airstrip Type	Port	Rail	All Weather Road	Ice Road	River/Lake Access	Tide Water
84	Amaruq Mine	Nunavut	Mines & Minerals	Mines & Minerals	0	65.402726°	-96.698021°	66H07	Southern Arctic	UTC-6(5)	No Airport	NA	NA	NA	No	No	No	No	No	No
85	Arctic Bay	Nunavut	Community	Hamlet	994	73.035879°	-85.154441°	48C02	Northern Arctic	UTC-5(4)	CYAB	Yes	3935	Gravel	No	No	No	No	No	Yes
86	Arviat	Nunavut	Community	Hamlet	2864	61.106557°	-94.055357°	55E01	Southern Arctic	UTC-6(5)	CYEK	Yes	4000	Gravel	No	No	No	No	No	Yes
87	Back River George Project	Nunavut	Mines & Minerals	Mines & Minerals	0	65.9286	-107.4625	76G14	Southern Arctic	UTC-6(5)	CGR3	Yes	5240	Gravel	No	No	No	unknown	No	No
88	Back River Goose Project`	Nunavut	Mines & Minerals	Mines & Minerals	0	65.5513°	-106.436326°	76G09	Southern Arctic	UTC-6(5)	CGS2	Yes	4505	Gravel	No	No	No	unknown	No	No
89	Back River Marine Laydown	Nunavut	Mines & Minerals	Mines & Minerals	0	66.651762°	-107.705497°	76J12	Southern Arctic	UTC-6(5)	No Airport	Yes	unknown	Gravel	No	No	No	unknown	No	Yes
90	Baker Lake	Nunavut	Community	Hamlet	2061	64.319575°	-96.022114°	66A08	Northern Arctic	UTC-6(5)	CYBK	Yes	4195	Gravel	No	No	No	No	No	Yes
91	Bathurst Inlet	Nunavut	Community	Settlement	0	66.839508°	-108.033845°	76J16	Southern Arctic	UTC-7(6)	Airstrip - No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
92	Bernard Harbour (PIN-CB)	Nunavut	Military	Military - NWS	0	68.755278	-114.939167	87A14	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
93	Bray Island (FOX-A)	Nunavut	Military	Military - NWS	0	69.223889	-77.23	37C02	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
94	Brevoort Island (BAF-3)	Nunavut	Military	Military - NWS	0	63.34	-64.158056	25P08	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
95	Broughton Island (FOX-5)	Nunavut	Military	Military - NWS	0	67.534722	-63.786111	16M12	Arctic Cordillera	UTC-5(4)	No Airport	No	NA	NA	No	No	No	No	No	Yes
96	Cambridge Bay	Nunavut	Community	Hamlet	1760	69.119536°	-105.059146°	77D02	Northern Arctic	UTC-7(6)	CYCB	Yes	5076	Gravel	No	No	No	No	No	Yes
97	Cambridge Bay (CAM-M)	Nunavut	Military	Military - NWS	0	69.116111	-105.118889	77D02	Northern Arctic	UTC-7(6)	No Airport	No Airstrip	NA	NA	No	No	No	No	No	Yes
98	Cape Dyer (DYE-M)	Nunavut	Military	Military - NWS	0	66.664444	-61.355833	16K11	Arctic Cordillera	UTC-5(4)	No Airport	Yes	unknown	unknown	No	No	No	No	No	Yes
99	Cape Hooper (FOX-4)	Nunavut	Military	Military - NWS	0	68.4725	-66.800278	27A06	Arctic Cordillera	UTC-5(4)	No Airport	Yes	unknown	unknown	No	No	No	No	No	Yes
100	Cape McLoughlin (CAM-5A)	Nunavut	Military	Military - NWS	0	68.663889	-85.591389	47B10	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
101	Cape Mercy (BAF-2)	Nunavut	Military	Military - NWS	0	64.954722	-63.560556	16D13	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	unknown	No	No	No	No	No	Yes
102	Cape Peel West (PIN-EB)	Nunavut	Military	Military - NWS	0	69.036389	-107.821667	77D04	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
103	CFB Alert	Nunavut	Military	Military Base	approx. 70	82.498039°	-62.343617°	120E05	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Gravel	No	No	No	No	No	Yes
104	Chesterfield Inlet	Nunavut	Community	Hamlet	397	63.337698°	-90.712301°	55O07	Southern Arctic	UTC-6(5)	CYCS	Yes	3600	Gravel	No	No	No	No	No	Yes
105	Childiak Project	Nunavut	Mines & Minerals	Mines & Minerals	0	64.242303°	-66.356122°	26B01	Northern Arctic	UTC-5(4)	No Airport	Yes	1150	Natural	No	No	No	No	No	No
106	Clyde River, Nunavut	Nunavut	Community	Hamlet	1181	70.473019°	-68.588925°	27F08	Arctic Cordillera	UTC-5(4)	YCY	Yes	3501	Gravel	No	No	No	No	No	Yes
107	Coral Harbour	Nunavut	Community	Hamlet	1035	64.138738°	-83.161731°	46B03	Southern Arctic	UTC-5	CYZS	Yes	5006	Gravel	No	No	No	No	No	Yes
108	Croker River (PIN-1BG)	Nunavut	Military	Military - NWS	0	69.266667	-119.216667	87C05	Southern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
109	Dewar Lakes (FOX-3)	Nunavut	Military	Military - NWS	0	68.650556	-71.232778	27B12	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
110	Doris Mine / Hope Bay	Nunavut	Mines & Minerals	Mines & Minerals	0	68.139285°	-106.620773°	77A03	Southern Arctic	UTC-7(6)	CHB3	Yes	5002	Gravel	Yes	No	No	No	No	Yes
111	Edinburgh Island (PIN-DA)	Nunavut	Military	Military - NWS	0	68.485833	-110.863889	77B06	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
112	Eureka Station	Nunavut	Research	Research Facility	0	79.9945	-85.812	49G15	Northern Arctic	UTC-6(5)	CYEU	Yes	4802	Gravel	No	No	No	No	No	Yes
113	Ferguson Lake Project	Nunavut	Mines & Minerals	Mines & Minerals	0	62.890203°	-96.907213°	65I15	Southern Arctic	UTC-6(5)	No Airport	Yes	NA	NA	No	No	No	No	No	No
114	Flashline Mars Arctic Research Station	Nunavut	Research	Research Facility	0	75.433038°	-89.863661°	58H07	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
115	Gjoa Haven	Nunavut	Community	Hamlet	1349	68.624381°	-95.872217°	57B12	Northern Arctic	UTC-7(6)	CYHK	Yes	4400	Gravel	No	No	No	No	No	Yes
116	Gjoa Haven (CAM-CB)	Nunavut	Military	Military - NWS	0	68.644167	-95.869444	57B12	Northern Arctic	UTC-7(6)	No Airport	No	NA	NA	No	No	No	No	No	Yes
117	Gladman Point (CAM-2)	Nunavut	Military	Military - NWS	0	68.68	-97.810556	67A10	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
118	Grise Fiord	Nunavut	Community	Hamlet	144	76.418464°	-82.894395°	49A06	Northern Arctic	UTC-5(4)	CYGZ	Yes	1675	Gravel	No	No	No	No	No	Yes
119	Hall Beach (FOX-M)	Nunavut	Military	Military - NWS	0	68.760833	-81.226389	47A15	Northern Arctic	UTC-5(4)	No Airport	No	NA	NA	No	No	No	No	No	Yes
120	Harding River (PIN-2A)	Nunavut	Military	Military - NWS	0	68.836111	-116.968056	87B16	Southern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
121	Hat Island (CAM-B)	Nunavut	Military	Military - NWS	0	68.317222	-100.069167	67B08	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
122	Igloolik	Nunavut	Community	Hamlet	2049	69.376233°	-81.802580°	47D07	Northern Arctic	UTC-5(4)	CYGT	Yes	4095	Gravel	No	No	No	No	No	Yes
123	Iqaluit	Nunavut	Community	City	7429	63.747806°	-68.522390°	25N10	Northern Arctic	UTC-5(4)	CYFB	Yes	8605	Asphalt	Yes	No	No	No	No	No
124	Isachesen Station	Nunavut	Research	Research Facility	0	78.786224°	-103.515556°	69F13	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	unknown	No	No	No	No	No	Yes
125	Jenny Lind Island (CAM-1A)	Nunavut	Military	Military - NWS	0	68.741944	-101.854722	67B10	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
126	Kangok Fjord (FOX-CA)	Nunavut	Military	Military - NWS	0	68.6475	-69.129722	27B10	Arctic Cordillera	UTC-5(4)	No Airport	No	unknown	unknown	No	No	No	No	No	No
127	Kimmirut	Nunavut	Community	Hamlet	426	62.847419°	-69.869203°	25K13	Northern Arctic	UTC-5(4)	CYLC	Yes	1899	Gravel	No	No	No	No	No	Yes
128	Kinngait	Nunavut	Community	Hamlet	1396	64.231867°	-76.543329°	36C02	Northern Arctic	UTC-5(4)	CYTE	Yes	3988	Gravel	No	No	No	No	No	Yes
129	Kugaaruk	Nunavut	Community	Hamlet	1033	68.533104°	-89.825714°	57A10	Northern Arctic	UTC-7(6)	CYBB	Yes	5000	Gravel	No	No	No	No	No	Yes
130	Kugluktuk	Nunavut	Community	Hamlet	1382	67.825850°	-115.098636°	86O14	Southern Arctic	UTC-7(6)	CYCO	Yes	5502	Gravel	No	No	No	No	No	Yes
131	Lady Franklin Point (PIN-3)	Nunavut	Military	Military - NWS	0	68.479167	-113.225556	87A07	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
132	Lailor River (CAM-FA)	Nunavut	Military	Military - NWS	0	69.110556	-83.539722	47D04	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
133	Loks Land (BAF-4A)	Nunavut	Military	Military - NWS	0	62.506111	-64.518333	25I10	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
134	Longstaff Bluff (FOX-2)	Nunavut	Military	Military - NWS	0	68.898889	-75.138889	37A13	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
135	Mary River Mine	Nunavut	Mines & Minerals	Mines & Minerals	0	71.325772°	-79.374254°	37G05	Northern Arctic	UTC-5(4)	CMR2	Yes	6505	Gravel	No	No	No	No	No	No
136	Mary River Port (Milne Port)	Nunavut	Mines & Minerals	Mines & Minerals	0	71.884831°	-80.896415°	47H16	Northern Arctic	UTC-5(4)	unknown	Unkown	unknown	unknown	Yes	No	No	No	No	Yes
137	McGill Arctic Research Station	Nunavut	Research	Research Facility	0	79.415076°	-90.749093°	59H06	Northern Arctic	UTC-7(6)	No Airport	Unkown	unknown	unknown	No	No	No	No	No	Yes
138	Meadowbank Mine	Nunavut	Mines & Minerals	Mines & Minerals	0	65.017740°	-96.073798°	66H01	Northern Arctic	UTC-6(5)	CMB2	Yes	5359	Gravel	No	No	No	No	No	No
139	Meliadine Mine	Nunavut	Mines & Minerals	Mines & Minerals	0	63.036734°	-92.224696°	55N01	Southern Arctic	UTC-6(5)	No Airport	NA	NA	NA	No	No	No	No	No	No
140	Nanisivik Naval Facility	Nunavut	Military	Military Base	0	73.067917°	-84.552692°	48C01	Northern Arctic	UTC-5(4)	No Airport	Closed (NDB)	unknown	Sand/Gravel	Yes	No	No	No	No	Yes
141	Naujaat	Nunavut	Community	Hamlet	1225	66.524589°	-86.238357°	46L09	Northern Arctic	UTC-6(5)	CYUT	Yes	3400	Gravel	No	No	No	No	No	Yes
142	Naujaat Project	Nunavut	Mines & Minerals	Mines & Minerals	0	66.592384°	-86.121281°	46L09	Northern Arctic	UTC-6(5)	No Airport	No Airstrip	NA	NA	No	No	No	No	No	No
143	Nudluardjk Lake (FOX-B)	Nunavut	Military	Military - NWS	0	68.619444	-73.2125	37A10	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
144	Pangnirtung	Nunavut	Community	Hamlet	1504	66.146558°	-65.701218°	26I04	Northern Arctic	UTC-5(4)	CYXP	Yes	2920	Gravel	No	No	No	No	No	Yes
145	Pelly Bay (CAM-4)	Nunavut	Military	Military - NWS	0	68.436944	-89.726111	57A07	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
146	PEARL Station	Nunavut	Research	Research Facility	0	80.053360°	-86.416532°	340B04	Northern Arctic	UTC-7(6)	No Airport	No Airstrip	NA	NA	No	No	No	No	No	No
147	Pond Inlet	Nunavut	Community	Hamlet	1555	72.696919°	-77.959996°	38B10	Northern Arctic	UTC-5(4)	YIO	Yes	4006	Gravel	No	No	No	No	No	Yes
148	Qikiqtarjuaq	Nunavut	Community	Hamlet	593	67.555598°	-64.025680°	26P09	Arctic Cordillera	UTC-5(4)	CYVM	Yes	3803	Gravel	No	No	No	No	No	Yes
149	Resolute	Nunavut	Community	Hamlet	183	74.697985°	-94.828712°	58F11	Northern Arctic	UTC-6(5)	CYRB	Yes	6504	Gravel	No	No	No	No	No	Yes
150	Resolution Island (BAF-5)	Nunavut	Military	Military - NWS	0	61.596389	-64.638889	25H10	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
151	Rowley Island (FOX-1)	Nunavut	Military	Military - NWS	0	69.066944	-79.065278	37C04	Northern Arctic	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
152	Sanikiluaq	Nunavut	Community	Hamlet	1010	56.543593°	-79.223952°	34D11	Southern Arctic	UTC-5(4)	CYSK	Yes	3807	Gravel	No	No	No	No	No	Yes
153	Sanirajak	Nunavut	Community	Hamlet	1010	68.792547°	-81.239806°	27A15	Northern Arctic	UTC-5(4)	CYUX	Yes	5410	Gravel	No	No	No	No	No	Yes
154	Shepherd Bay (CAM-3)	Nunavut	Military	Military - NWS	0	68.792778	-93.440278	57B15	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
155	Simpson Lake (CAM-D)	Nunavut	Military	Military - NWS	0	68.594722	-91.956667	57A12	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
156	Sturt Point (CAM-A3A)	Nunavut	Military	Military - NWS	0	68.963056	-103.759444	67B13	Northern Arctic	UTC-7(6)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
157	Taloyoak	Nunavut	Community	Hamlet	934	69.537627°	-93.542843°	57C10	Northern Arctic	UTC-7(6)	CYYH	Yes	4009	Gravel	No	No	No	No	No	Yes
158	Umingmaktok	Nunavut	Community	Settlement	0	67.699601°	-107.929008°	76O12	Southern Arctic	UTC-7(6)	Airstrip - No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
159	Ward Hunt Island Research Station	Nunavut	Research	Research Facility	0	83.100000°	-74.441933°	340E15	Northern Arctic	UTC-5(4)	No Airport	Unkown	unknown	unknown	No	No	No	No	No	Yes
160	Whale Cove	Nunavut	Community	Hamlet	470	62.172885°	-92.579749°	55K02	Southern Arctic	UTC-6(5)	CYXN	Yes	3937	Gravel	No	No	No	No	No	Yes
161	Attawapiskat	Ontario	Community	Reserve	1586	52.922862°	-82.429095°	43B16	Hudson Plains	UTC-5(4)	CYAT	Yes	3945	Gravel	No	No	No	Yes	Yes - Attawapiskat River	No
162	Bearskin Lake	Ontario	Community	Reserve	447	53.924334°	-90.969402°	53G15	Boreal Shield	UTC-6(5)	CNE3	Yes	3503	Gravel	No	No	No	Yes	No	No
163	Cat Lake	Ontario	Community	Reserve	651	51.724873°	-91.827027°	52O12	Boreal Shield	UTC-6(5)	CYAC	Yes	3963	Gravel	No	No	No	Yes	No	No
164	Deer Lake	Ontario	Community	Reserve	1087	52.651672°	-94.057442°	53D09	Boreal Shield	UTC-6(5)	CYVZ	Yes	3506	Gravel	No	No	No	No	No	No
165	Eabametoong	Ontario	Community	Tribal Area	977	51.557836°	-87.905056°	42M12	Boreal Shield	UTC-5(4)	CYFH	Yes	3497	Gravel	No	No	No	Yes	No	No
166	Fort Albany	Ontario	Community	Reserve	775	52.212696°	-81.680340°	43A04	Hudson Plains	UTC-5(4)	CYFA	Yes	3601	Gravel	No	No	No	Yes	Yes - Albany River	No

Appendix 10.4: Community Database

#	Name	Province	Type 1	Type	Population (2021)	Latitude (dd.ddd)	Longitude (dd.ddd)	50K NTS	Ecozone	Time Zone	Airport Designation	Airstrip	Airstrip Length (ft)	Airstrip Type	Port	Rail	All Weather Road	Ice Road	River/Lake Access	Tide Water
167	Fort Severn	Ontario	Community	Reserve	364	55.990302°	-87.632427°	43M13	Hudson Plains	UTC-5(4)	CYER	Yes	3518	Gravel	No	No	No	Yes	Yes - Severn River	No
168	Kasabonika Lake	Ontario	Community	Reserve	1060	53.530836°	-88.611824°	53H10	Boreal Shield	UTC-6(5)	CYAQ	Yes	3520	Gravel	No	No	No	Yes	No	No
169	Kashechewan	Ontario	Community	Reserve	1825	52.290604°	-81.641751°	43A05	Hudson Plains	UTC-5(4)	CZKE	Yes	3903	Gravel	No	No	No	Yes	Yes - Albany River	No
170	Keewaywin	Ontario	Community	Settlement	420	53.005231°	-92.796011°	53F02	Boreal Shield	UTC-6(5)	CPV8	Yes	3500	Gravel	No	No	No	No	No	No
171	Kingfisher Lake	Ontario	Community	Reserve	511	53.029831°	-89.822989°	53H04	Boreal Shield	UTC-6(5)	CNM5	Yes	3520	Gravel	No	No	No	Yes	No	No
172	Kitchenuhmaykoosib Inninihwug	Ontario	Community	Reserve	1029	53.819220°	-89.898156°	53H13	Boreal Shield	UTC-6(5)	CYTL	Yes	3906	Gravel	No	No	No	Yes	No	No
173	Moose Factory	Ontario	Community	Indian Reserve	1376	51.259537°	-80.600557°	42P07	Hudson Plains	UTC-5(4)	No Airport	No Airstrip	NA	NA	No	No	Yes	Yes	Yes - Moose River	No
174	Moosonee	Ontario	Community	Town	1512	51.277383°	-80.636902°	42P07	Hudson Plains	UTC-5(4)	CYMO	Yes	4001	Asphalt	No	Yes	No	Yes	Yes - Moose River	No
175	Muskrat Dam	Ontario	Community	Reserve	281	53.414253°	-91.776458°	53G03	Boreal Shield	UTC-6(5)	CZMD	Yes	3508	Gravel	No	No	No	Yes	No	No
176	Neskantaga	Ontario	Community	Reserve	244	52.203860°	-88.015186°	53A01	Boreal Shield	UTC-5(4)	CYLH	Yes	3484	Gravel	No	No	No	Yes	No	No
177	Nibinamlk	Ontario	Community	Tribal Area	355	52.740894°	-88.506394°	53A10	Boreal Shield	UTC-5(4)	CJV7	Yes	3509	Gravel	No	No	No	Yes	No	No
178	North Spirit Lake	Ontario	Community	Settlement	265	52.505922°	-93.022103°	53C11	Boreal Shield	UTC-6(5)	CKQ3	Yes	3518	Gravel	No	No	No	No	No	No
179	Ogoki Post	Ontario	Community	Settlement	243	51.657448°	-85.906900°	42N12	Hudson Plains	UTC-5(4)	CYKP	Yes	3514	Gravel	No	No	No	No	No	No
180	Peawanuck	Ontario	Community	Settlement	247	55.010520°	-85.423421°	43N03	Hudson Plains	UTC-5(4)	CYPO	Yes	3518	Gravel	No	No	No	Yes	Yes - Winisk River	No
181	Pikangikum	Ontario	Community	Reserve	2100	51.804189°	-93.988026°	52N13	Boreal Shield	UTC-6(5)	CYPM	Yes	3508	Gravel	No	No	No	No	No	No
182	Poplar Hill	Ontario	Community	Reserve	663	52.114815°	-94.259385°	53D01	Boreal Shield	UTC-6(5)	CPV7	Yes	3508	Gravel	No	No	No	No	No	No
183	Round Lake / Weagamow Lake	Ontario	Community	Reserve	886	52.950264°	-91.345263°	53B14	Boreal Shield	UTC-6(5)	CZRJ	Yes	3613	Gravel	No	No	No	Yes	No	No
184	Sachigo Lake	Ontario	Community	Reserve	608	53.872579°	-92.172264°	53F16	Boreal Shield	UTC-6(5)	CZPB	Yes	3506	Gravel	No	No	No	No	No	No
185	Sandy Lake	Ontario	Community	Reserve	2100	53.065656°	-93.330507°	53F03	Boreal Shield	UTC-6(5)	CZSJ	Yes	3507	Gravel	No	No	No	No	No	No
186	Slate Falls	Ontario	Community	Settlement	299	51.150495°	-91.612238°	52O04	Boreal Shield	UTC-6(5)	CKD9	Yes	3507	Gravel	No	No	Yes	No	No	No
187	Victor Mines	Ontario	Community	Mines & Minerals	unknown	52.819581°	-83.907428°	43B13	Hudson Plains	UTC-5(4)	CVM2	Yes	4921	Gravel	No	No	No	Yes	Yes - Attawapiskat River	No
188	Wapekeka	Ontario	Community	Reserve	456	53.844439°	-89.530919°	53H13	Boreal Shield	UTC-6(5)	CKB6	Yes	3609	Gravel	No	No	No	Yes	No	No
189	Webequie	Ontario	Community	Reserve	723	52.962512°	-87.373144°	43D14	Boreal Shield	UTC-5(4)	CYWP	Yes	3507	Gravel	No	No	No	Yes	No	No
190	Wunnunmin	Ontario	Community	Reserve	587	52.932984°	-89.298434°	53A14	Boreal Shield	UTC-6(5)	CKL3	Yes	3511	Gravel	No	No	No	Yes	No	No
191	Akulivik	Quebec	Community	Village Nordique	642	60.810850°	-78.186062°	35D16	Northern Arctic	UTC-5(4)	CYKO	Yes	3521	Gravel		No	No	No	No	Yes
192	Aupaluk	Quebec	Community	Village Nordique	233	59.302703°	-69.605847°	24N05	Southern Arctic	UTC-5(4)	CYLA	Yes	3521	Gravel		No	No	No	No	Yes
193	Chevery	Quebec	Community	Settlement	226	50.467654	-59.617466	12J05	Boreal Shield	UTC-4	CYHR	Yes	4500	Asphalt	Yes	No	No	No	Yes	Yes - Ferry
194	Chisasibi	Quebec	Community	Settlement	4985	53.78612	-78.902717	33E15	Taiga Shield	UTC-5(4)	CSU2	Yes	3789	Gravel	No	No	Yes	No	Yes	Yes
195	Eastmain River	Quebec	Community	Settlement	924	52.224957	-78.522794	33D02	Hudson Plains	UTC-5(4)	CZEM	Yes	3512	Gravel	No	No	Yes	No	Yes	Yes
196	Inukjuak	Quebec	Community	Village Nordique	1821	58.455121°	-78.105103°	34L08	Southern Arctic	UTC-5(4)	CYPH	Yes	3520	Gravel		No	No	No	No	Yes
197	Ivujivik	Quebec	Community	Village Nordique	412	62.417009°	-77.915185°	35K05	Northern Arctic	UTC-5(4)	CYIK	Yes	3521	Gravel		No	No	No	No	Yes
198	Kangiqsualujjuaq	Quebec	Community	Village Nordique	956	58.693727°	-65.956663°	24I12	Taiga Shield	UTC-5(4)	CYLU	Yes	3520	Gravel		No	No	No	No	Yes
199	Kangiqsujuaq	Quebec	Community	Village Nordique	837	61.598465°	-71.953943°	25E12	Southern Arctic	UTC-5(4)	CYKG	Yes	3520	Gravel		No	No	No	No	Yes
200	Kangirsuk	Quebec	Community	Village Nordique	561	60.018325°	-70.004134°	25D01	Southern Arctic	UTC-5(4)	CYAS	Yes	3521	Gravel		No	No	No	No	Yes
201	Kuujjuaq	Quebec	Community	Village Nordique	2668	58.107528°	-68.400154°	24K01	Taiga Shield	UTC-5(4)	CYVP	Yes	6000	Asphalt		No	No	No	No	Yes
202	Kuujjuarapik	Quebec	Community	Village Nordique	792	55.279087°	-77.759141°	33N05	Taiga Shield	UTC-5(4)	CYGW	Yes	5082	Gravel		No	No	No	No	Yes
203	La Romaine	Quebec	Community	Settlement	787	50.218308	-60.661069	12K02	Boreal Shield	UTC-4	CTT5	Yes	3933	Asphalt	Yes	No	No	No	No	Yes - Ferry
204	La Tabatière	Quebec	Community	Settlement	356	50.833797	-58.968781	12J15	Boreal Shield	UTC-4	CTU5	Yes	1649	Gravel	Yes	No	No	No	No	Yes
205	Port-Menier	Quebec	Community	Settlement	177	49.817926	-64.351548	22H16	Boreal Shield	UTC-5(4)	CYPN	Yes	4888	Asphalt	No	No	No	No	No	Yes - Ferry
206	Puvirnituq	Quebec	Community	Village Nordique	2129	60.035742°	-77.279416°	35C03	Southern Arctic	UTC-5(4)	CYPX	Yes	6299	Gravel		No	No	No	No	Yes
207	Quaqtaq	Quebec	Community	Village Nordique	453	61.044056°	-69.626398°	25F04	Southern Arctic	UTC-5(4)	CYHA	Yes	3520	Gravel		No	No	No	No	Yes
208	Raglan Mine	Quebec	Mines & Minerals	Mines & Minerals	0	61.687500°	-73.678056°	35H12	Northern Arctic	UTC-5(4)	No Airport	No Airstrip	NA	NA	No	No	No	No	No	No
209	Raglan Mine Airport	Quebec	Mines & Minerals	Mines & Minerals	0	61.662460°	-73.315847°	35H11	Northern Arctic	UTC-5(4)	CTP9	Yes	6500	Gravel	No	No	No	No	No	No
210	Raglan Mine Marine Laydown	Quebec	Mines & Minerals	Mines & Minerals	0	62.145486°	-74.694955°	35J02	Northern Arctic	UTC-5(4)	No Airport	No Airstrip	NA	NA	Yes	No	No	No	No	Yes
211	Saint-Augustin (Cote Nord)	Quebec	Community	Settlement	787	51.225273	-58.64926	12O02	Boreal Shield	UTC-4	CYIF	Yes	4595	Asphalt	No	No	No	No	Yes	Yes - Ferry
212	Salluit	Quebec	Community	Village Nordique	1580	62.203781°	-75.643383°	35J04	Northern Arctic	UTC-5(4)	CYZG	Yes	3523	Gravel		No	No	No	No	Yes
213	Schefferville	Quebec	Community	Village	244	54.801944°	-66.815055°	23J15	Taiga Shield	UTC-5(4)	CYKL	Yes	5002	Asphalt	No	Yes	Yes	No	No	No
214	Tasiujaq	Quebec	Community	Village Nordique	420	58.695617°	-69.928374°	24K12	Taiga Shield	UTC-5(4)	CYTQ	Yes	3519	Gravel		No	No	No	No	Yes
215	Tête-à-La-Baleine	Quebec	Community	Settlement	119	50.703262	-59.322963	12J11	Boreal Shield	UTC-4	CTB6	Yes	1639	Gravel	No	No	Yes	No	Yes	Yes
216	Torngat Minerals	Quebec	Community	Mines & Minerals	unknown	56.35	-64.2	24A08	Taiga Shield	UTC-5(4)	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	No
217	Umiujaq	Quebec	Community	Village Nordique	541	56.552885°	-76.550493°	34C10	Taiga Shield	UTC-5(4)	CYMU	Yes	3521	Gravel		No	No	No	No	Yes
218	Waskaganish	Quebec	Community	Settlement	2536	51.477554	-78.749892	33M07	Hudson Plains	UTC-5(4)	CYKQ	Yes	3511	Gravel	No	No	Yes	No	Yes	Yes
219	Wemindji	Quebec	Community	Settlement	1562	53.022093	-78.749028	33E02	Taiga Shield	UTC-5(4)	CYNC	Yes	3511	Gravel	No	No	Yes	No	Yes	Yes
220	Camsell Portage	Saskatchewan	Community	Village	37	59.61174	-109.257864	74N11	Taiga Shield	UTC-6	CJP6	Yes	2870	Gravel		No	No	No	Yes - Lake Athabasca	No
221	Fond-du-Lac	Saskatchewan	Community	Settlement	926	59.330188°	-107.187753°	73O06	Taiga Shield	UTC-6	CZFD	Yes	3805	Asphalt	No	No	No	Yes	Yes	No
222	Stony Rapids	Saskatchewan	Community	Settlement	219	59.257299°	-105.837912°	74P05	Taiga Shield	UTC-6	CYSF	Yes	5052	Asphalt	No	No	Yes	No	Yes	No
223	Uranium City	Saskatchewan	Community	Village	91	59.569321°	-108.610511°	74N10	Taiga Shield	UTC-6(5)	CYBE	Yes	3935	Asphalt	No	No	No	Yes	Yes - Lake Athabasca	No
224	Wollaston Lake	Saskatchewan	Community	Settlement	96	58.110705°	-103.151958°	64L06	Boreal Shield	UTC-6	CZWL	Yes	3793	Asphalt	No	No	No - Barge	Yes	Yes	No
225	Beaver Creek	Yukon	Community	Settlement	78	62.382120°	-140.879840°	115K07	Boreal Cordillera	UTC-7	CYXQ	Yes	3745	Gravel	No	No	Yes	No	No	No
226	Burwash Landing	Yukon	Community	Settlement	64	61.355895°	-138.993390°	115G07	Boreal Cordillera	UTC-7	CYDB	Yes	5007	Gravel	No	No	Yes	No	No	No
227	Carcross	Yukon	Community	Settlement	354	60.170278°	-134.709496°	105D02	Boreal Cordillera	UTC-7	CFA4	Yes	2200	Gravel	No	No	Yes	No	No	No
228	Carmacks	Yukon	Community	Town	588	62.089597°	-136.290016°	115I01	Boreal Cordillera	UTC-7	CEX4	Yes	5000	Gravel	No	No	Yes	No	No	No
229	Champagne Landing 10	Yukon	Community	Indian Settlement	22	60.785994°	-136.481671°	115A16	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
230	Dawson	Yukon	Community	Town	1577	64.059428°	-139.431373°	116B03	Boreal Cordillera	UTC-7	CYDA	Yes	5003	Asphalt	No	No	Yes	No	No	No
231	Destruction Bay	Yukon	Community	Settlement	40	61.252294°	-138.800982°	115G07	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
232	Faro	Yukon	Community	Town	440	62.228525°	-133.352265°	105K03	Boreal Cordillera	UTC-7	CZFA	Yes	3997	Gravel	No	No	Yes	No	No	No
233	Haines Junction	Yukon	Community	Village	688	60.754919°	-137.512216°	115A13	Boreal Cordillera	UTC-7	CYHT	Yes	5002	Gravel	No	No	Yes	No	No	No
234	Johnson's Crossing	Yukon	Community	Settlement	10	60.483931°	-133.307477°	105C06	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
235	Keno Hill	Yukon	Community	Settlement	20	63.909767°	-135.309165°	105M14	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
236	Kluane Lake Research Station	Yukon	Research	Research Facility	0	61.027701°	-138.409127°	115G01	Boreal Cordillera	UTC-7	No Airport	Yes	unknown	Sand/Gravel	No	No	Yes	No	No	No
237	Komakuk Beach (BAR-1)	Yukon	Military	Military - NWS	0	69.594615°	-140.180384°	117C09	Southern Arctic	UTC-7	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
238	Marsh Lake	Yukon	Community	Unorganized	746	60.515313°	-134.332870°	105D09	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
239	Mayo	Yukon	Community	Village	188	63.594148°	-135.896533°	105M12	Boreal Cordillera	UTC-7	CYMO	Yes	4843	Gravel	No	No	Yes	No	No	No
240	Mt. Lorne	Yukon	Community	Hamlet	468	60.449797°	-134.845560°	105D07	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
241	Old Crow	Yukon	Community	Settlement	236	67.569634°	-139.828784°	116O12	Taiga Cordillera	UTC-8(7)	CYOC	Yes	5020	Gravel	No	No	No	Yes	Yes - Porcupine River	No
242	Pelly Crossing	Yukon	Community	Settlement	316	62.824565°	-136.576078°	115I15	Boreal Cordillera	UTC-7	CFQ6	Yes	3305	Gravel	No	No	Yes	No	No	No
243	Ross River	Yukon	Community	Settlement	355	61.979916°	-132.450491°	105F16	Boreal Cordillera	UTC-7	CYDM	Yes	5113	Gravel	No	No	Yes	No	No	No
244	Shingle Point (BAR-2)	Yukon	Military	Military - NWS	0	68.922778	-137.260556	117A15	Southern Arctic	UTC-7	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
245	Stewart Crossing	Yukon	Community	Settlement	10	63.374559°	-136.676806°	115P07	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No
246	Stokes Point (BAR-B)	Yukon	Military	Military - NWS	0	69.330303°	-138.736020°	117D06	Southern Arctic	UTC-7	No Airport	Yes	unknown	Sand/Gravel	No	No	No	No	No	Yes
247	Tagish	Yukon	Community	Settlement	311	60.306916°	-134.277042°	105D08	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	Yes - Tagish River	No
248	Teslin	Yukon	Community	Settlement	258	60.164037°	-132.725069°	105C02	Boreal Cordillera	UTC-7	CYZW	Yes	5028	Gravel	No	No	Yes	No	No	No
249	Upper Liard	Yukon	Community	Settlment	130	60.050666°	-128.911878°	105A02	Boreal Cordillera	UTC-7	No Airport	No Airstrip	NA	NA	No	No	Yes	No	No	No

Appendix 10.4: Community Database

#	Name	Province	Type 1	Type	Population (2021)	Latitude (dd.ddd)	Longitude (dd.ddd)	50K NTS	Ecozone	Time Zone	Airport Designation	Airstrip	Airstrip Length (ft)	Airstrip Type	Port	Rail	All Weather Road	Ice Road	River/Lake Access	Tide Water
250	Watson Lake	Yukon	Community	Town	1133	60.064679°	-128.709516°	105A02	Boreal Cordillera	UTC-7	CYQH	Yes	5504	Asphalt	No	No	Yes	No	No	No
251	Whitehorse	Yukon	Community	City	30699	60.722293°	-135.063734°	105D11	Boreal Cordillera	UTC-7	CYXY	Yes	9500	Asphalt	No	No	Yes	No	Yes - Yukon River	No

Appendix 10.5 – Figure References

10.5 Figure References:

Figure 1-1 Primary and Secondary Gateway Locations for each corridor
BASI Generated image.
Figure 1-2 Photo of the Graf Zeppelin, passenger airship
https://commons.wikimedia.org/wiki/File:LZ_130_Graf_Zeppelin_in_flight.jpg
Figure 1-3 Photo of a US Navy Blimp at its mooring mast
Navy K-Type Blimp Catalogue # 80-G-K-13315 https://www.history.navy.mil/research/archives.html
Figure 1-4 Photo of a US Navy Blimp at its mooring mast
https://commons.wikimedia.org/wiki/File:USS_Akron_approaches_mooring_mast.jpg
Figure 1-5 Photo Semi-Rigid airship Norge.
https://commons.wikimedia.org/wiki/File:Norge_airship_in_flight_1926.jpg
Figure 1-6 Photo Non-Rigid airship US Navy K-Class.
Navy K-Type Blimp Catalogue # USN 1053773
https://www.history.navy.mil/research/archives.html
Figure 1-7 Photo Graf Zeppelin
Graf Zeppelin Uruguay Coast - 1934 - Private Collection
Figure 1-8 Photo Airlander 10
Airlander 10 Source: www.hybridairvehicles.com
Figure 1-9 Photo Russian DP-27 Anyuta
DP-27 Anyuta Lenticular Airship Source: https;//dkba.ru
Figure 1-10 Photo 21st Century Airships Spherical Airship
SPAS Airship www.21stcenturyairships.com
Figure 1-11 Photo Canadian Solarship
Solarship Wolverine https://commons.wikimedia.org/
Figure 1-12 Photo Cameron Balloons D-77 Thermal Airship
Source: Cameron Balloons https://www.cameronballoons.co.uk
Figure 2-1 Annual Temperature Ranges for Primary Airship Gateways
https://weatherspark.com/
Figure 2-2 Projected Temperature Changes in Canada, 2052-2080
https://i0.wp.com/prairieclimatecentre.ca/wp-content/uploads/2017/10/2051-2080-RCP85-Mean-Temp-Delta-December.jpg?ssl=1
Figure 2-3 Rigid, Cigar-shaped Airship Design
Lighter than Air (LTA) Research - The Future of Airships (ltaresearch.com)
Figure 2-4 Project Freight and Crane Delivery
https://www.aerovehicles.net/wp-content/uploads/2023/05/AV10-MINING-hovering_Photo-4.jpg
Figure 2-5 Heavy-lift, Logging Resource Extraction
Flying Whales website, https://www.flying-whales.com/en/wood/
Figure 2-6 Hybrid, Catamaran-shaped Airship Design
https://at2aero.space/
Figure 2-7 Airlander 10 interior design image
https://www.designq.co.uk/airlander-10
Figure 2-8 Buoyant Aircraft Rotating Deck
BASI Provided Image

BASI Generated Image

Figure 5-7 Costs for 30-ton, 60-ton and 100-ton Airships over 250 km and 500 km Distances

BASI Generated Image

Figure 5-8 Strange Lake Mine Development in Northern Quebec

Torngatmetals.com supplied map image.

Figure 6-1 - Airship Hangar build in 1929 in Akron, OH refurbished by Lockheed Martin in 2011

https://inhabitat.com/lockheeds-hale-d-blimp-is-a-solar-powered-spy-satellite/rsz_lockheed-haled-blimp-4/

Figure 6-2 Regional Administrative Offices of Transport Canada

https://tc.canada.ca/en/corporate-services/regions

Figure 6-3 Photograph of the abandoned open-pit mines at Thompson, Manitoba

BASI supplied image

Figure 6-4 Emissions comparison for popular modes of transport

https://www.ecowatch.com/air-travel-carbon-emissions-2653215087.html

Table References:

Table 2-1 Numeric Temperature Averages for Primary Gateway Locations
https://weatherspark.com/
Table 3-1 CMHC Report on Housing Conditions of Aboriginal Households Living On-reserve, Canada
https://www.cmhc-schl.gc.ca/en/professionals/housing-markets-data-and-research/housing-research/research-reports/housing-needs/socio-economic-housing-conditions-on-reserve-aboriginal-households#:~:text=one%20third%20of%20On%2DReserve,in%20dwellings%20needing%20major%20repairs
Table 5-1 Housing need by corridor
BASI Generated Table
Table 5-2 Aggregate Average Airship Demand for 10-year Forecast Period
BASI Generated Table
Table 5-3 Airship Specifications and Cost Assumptions
BASI Generated Table
Table 5-4 Airship Ground Infrastructure Cost Assumptions
BASI Generated Table
Table 5-5 Airships versus Roads/Trucks
Torngat Metals Generated Table
Table 6-1 Airship Types Certified by Transport Canada
David Willis Generated Table
Table 6-2 Airship Registrations in Canada
David Willis Generated Table

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Appendix 10.6 – Transport Canada Summary

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251x Remote Sites Evaluated

1) Northern Communities (173x)
2) Military Installations (49x)
3) Research Installations (7x)
4) Mining Sites (22x)

5x Airship Corridors (aggregate 5,965,179 km^2)

1) Northwest Corridor (2,258,925 (km^2)
2) Central West Corridor (376,999 km^2)
3) Central East Corridor (713,223 km^2)
4) North East Corridor (1.112,478 km^2)
5) Arctic North Corridor (1,503,554 km^2)

9x Embarkation Communities

1) Yellowknife (NT) - Primary
2) Enterprise (NT) - Supporting
3) Churchill (MB) - Primary
4) Thompson (MB) - Supporting
5) Moosonee (ON) - Primary
6) Pickle Lake (ON) - Supporting
7) Schefferville (PQ) - Primary
8) Happy Valley (NL) - Supporting
9) Iqaluit (NU) - Primary

5x Market Segments

1) Short-Haul and Long Haul General Freight Markets
2) Project Freight and Aerial-craning
3) Resource Extraction
4) Military & Logistical Missions
5) Tourism & Luxury Tourism

6x National Needs

1) Freight Movement to Remote Communities
2) Arctic Sovereignty
3) Arctic Surveillance (Security)
4) Environmental Surveillance
5) Emergency Response (SAR, Spills)
6) Resource Industry (Mining) Needs / Critical Minerals

14x Airship Designers & Manufacturers (54 aggregate airship models)

1) Aeros Airship Company (USA) - 9x models
2) Aerovehicles Airborne Solutions (USA) - 4x models
3) Airship do Brasil (Brazil) - 1x model
4) AT2 Aerospace (USA) - 4x models
5) Atlas LTA (Israel) - 6x models
6) Buoyant Aircraft Systems International (Canada) - 4x models
7) Cameron Balloons (United Kingdom) - 1x model

8) Flying Whales (France) - 1x model
9) Hybrid Air Vehicles (United Kingdom) - 2x models
10) LTA Research (USA) - 2x models
11) Millennium Airship (USA) - 3x models
12) Skyship Services Inc. (USA) - 14x models
13) Varialift (United Kingdom) - 2x model
14) Zeppelin GmbH (Germany) - 1x model

5x Leading Cargo Airship Operators

1) Straightline Aviation - United Kingdom
2) Hybrid Air Freighters (HAF) - France
3) Helion Aviation - Sweden
4) Flying Whales - France
5) Aerovehicles - USA

2x Potential Lifting Gases

1) Helium
2) Hydrogen