APPENDIX G:

ECONOMIC AND CULTURAL IMPLICATIONS STUDY

Executive Summary of the Research Paper

Title: *The Economic and Cultural Implications of the Triangle Community Road PEL on Atqasuk, Utqiaġvik, and Wainwright*
Authors: Diya Paul, Sudiso Zhang, Vishva Iyer (Carnegie Mellon University, Tepper School of Business)
Date: December 8, 2025

Purpose of the Study

The paper evaluates the **economic, transportation, healthcare, food security, and cultural implications** of constructing an all-season gravel road (the Triangle Community Road) connecting three North Slope communities. It aims to quantify cost savings where possible while acknowledging the **intangible cultural and subsistence values** that are harder to measure.

Key Findings by Topic

1. Transportation (Passengers, Freight, and Mail)

- **Current Conditions:** Communities rely heavily on air travel for people, groceries, freight, and mail, which is expensive and vulnerable to weather disruptions.
- **Passenger Travel:**
    - Average airfare within the region is estimated at **~$400 per trip**.
    - If 75% of travelers switched from air to road travel, **monthly passenger savings could reach ~$286,500**, with total combined savings (passengers + freight) exceeding **$325,000 per month**.
- **Freight and Mail:**
    - Average monthly freight and mail weight is ~235,000 lbs.
    - Ground transport could generate **monthly savings of $13k–$52k**, depending on how much freight shifts from air to road.
- **Overall Conclusion:** An all-season road would substantially reduce transportation costs, improve reliability, and lower dependence on air service.

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2. Fuel Cost Savings for Subsistence Trips

- Subsistence trips currently require **expensive fuel, equipment transport, and heating costs**.
- Average fuel cost per trip (including heating cabins):
    - Utqiaġvik: ~$228
    - Wainwright: ~$236
    - Atqasuk: ~$247
- Road access would lower fuel costs and reduce logistical barriers, particularly for families who currently must pool resources or rely on community sharing to participate in subsistence activities.

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3. Healthcare Access and Costs

- Improved road access could:
    - Reduce the need for **overnight medical stays** in Utqiaġvik.
    - Allow same-day travel for routine or follow-up care.
    - Lower medevac and charter flight use for **non-critical cases**.
- Estimated savings stem mainly from **reduced lodging and travel costs**, not from changes to medical service delivery itself.
- Road access could also improve delivery of medical supplies and support programs like **Community Health Aide Program (CHAP)** logistics.

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4. Food Security and Groceries

- Grocery costs in NSB are estimated at **~56% higher than Anchorage**.
- If even **50% of groceries shifted from air to ground transport**, the study estimates:
    - **~22.7% reduction in grocery prices**
    - **~$1.19 million in monthly household savings across NSB**
- At higher shift rates, total monthly savings could exceed **$1.7 million**.
- These figures exclude indirect savings already captured in freight cost reductions, making them conservative.

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5. Subsistence Practices and Cultural Impacts (Qualitative Findings)

- Interviews highlight that:
    - Subsistence is **deeply communal**, not individual.
    - Roads are viewed primarily as a way to **reduce air dependence**, not to replace ATVs, snowmachines, or boats.
    - Easier hauling of harvested game **from road access points** could meaningfully reduce physical and financial burdens.
- Some concern exists about whether roads might disrupt subsistence areas, but most interviewees emphasized that **subsistence access modes would largely remain unchanged**.
- The road is expected to strengthen **inter-community interaction and cultural exchange**.

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6. Harvest Yield Estimates

- Using CWAT (winter trail) comparisons as a benchmark:
    - Atqasuk could see an **average harvest value increase of ~17.8%**
    - Utqiaġvik ~5.4%
    - Wainwright showed the smallest change
- The study cautions that harvest impacts are **highly uncertain** and depend on behavior, seasonality, and access patterns.

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7. Pullouts and Design Considerations

- The road would require a **~5-ft embankment** for permafrost protection.
- The study identifies **strategic pullout locations (every ~3 miles)** as critical to:
    - Subsistence access
    - Safety
    - Minimizing environmental and cultural disruption

- GIS analysis (supported by ASRC Energy Services staff) was used to rank optimal pullout locations based on proximity to cabins, water, migration routes, and access needs.

Limitations Acknowledged in the Paper

- Heavy reliance on **T-100 air transportation data**, which lacks detailed pricing.
- Limited number of subsistence interviews (5 total).
- Grocery and harvest estimates rely on **national or proxy datasets**, not NSB-specific pricing.
- Results should be interpreted as **order-of-magnitude estimates**, not precise forecasts.

Overall Conclusion

The research concludes that the **Triangle Community Road would deliver substantial economic benefits**, including:

- Lower transportation and grocery costs
- Improved healthcare access
- Reduced logistical burdens for subsistence activities
- Stronger inter-community connectivity

Importantly, the paper emphasizes that **road design choices—especially pullouts and access management—will determine whether benefits are maximized while protecting subsistence and cultural practices**.

The Economic and Cultural Implications of the Triangle Community Road PEL on Atqasuk, Utqiagvik, and Wainwright

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Executive Summary

The North Slope Borough (NSB) is the northernmost county in Alaska, home to 10,891 people. The borough spans the entire width of Alaska and is roughly the same size as Utah. Despite its vast physical area and sparsely distributed population, there are very few roads connecting communities, primarily due to the high cost of construction, transportation of materials, and maintenance costs. Road development in the North Slope is a deeply nuanced issue: although new roads may expand economic opportunities and improve access to subsistence sites, they also raise concerns about increased outside presence and potential disruptions to Iñupiaq cultural practices. Thus, the purpose of our project is to uncover the economic and cultural implications of roads on North Slope communities, focusing on the Arctic Strategic Transportation and Resources's (ASTAR) proposed Triangle Community Road Planning and Environmental Linkage (PEL), connecting Wainwright, Utqiagvik, and Atqasuk.

In this paper, we explore the impact of the Triangle Community Road on transportation, healthcare, and food consumption while also identifying impactful pullout areas on subsistence. Overall, our findings suggest that the Triangle Community Road could meaningfully reduce transportation and delivery costs, improve access to essential services, and support local mobility throughout the year. The all season road promotes cross-community interactions, strengthening Iñupiaq cultural continuity. Furthermore, strategically placed pullouts could expand safe and reliable access to important subsistence areas. Determining the number of pullouts will depend on balancing the North Slope's priorities of consistency or greater impact.

Problem Statement & Context

The North Slope Borough is characterized by a vast tundra landscape, a predominantly Iñupiaq population across seven communities, and a strong subsistence tradition. For generations, the Iñupiaq people have traversed extensive distances to harvest caribou, fish, whales, and other Arctic wildlife vital for cultural continuity and food security. Still, cross-community interaction is necessary for obtaining essential goods and services such as healthcare and education while also maintaining cultural ties between villages. Currently, air travel and seasonal Community Winter Access Trails (CWAT) are the main mode of travel and transportation of goods between NSB communities, the former being costly and unreliable because of Arctic weather conditions and the latter being unreliable due to its seasonality.

Nonetheless, the North Slope's remote location and deep permafrost makes the transportation of materials, construction, and maintenance for roads extremely expensive. As such, there are no all-season roads connecting NSB communities. While creating all-season roads is a contentious debate in the North Slope, there appears to be strong community interest in road development as roads can significantly reduce travel costs, enhance access to subsistence areas, provide reliable transport of goods and services, and open opportunities for employment and economic development.

In response to these community needs, the ASTAR initiative has advanced the Triangle Community Road PEL connecting the NSB's Atqasuk, Utqiaġvik, and Wainwright for which will be available for community review in January of 2026. In this paper, our group seeks to understand the following question: **How can the Triangle Community Road PEL improve access to goods, services, and economic opportunity, while also promoting and protecting subsistence and cultural practices for Atqasuk, Utqiaġvik, and Wainwright?**

Transportation

Passenger, Freight, and Mail

Methodology

For passenger and freight and mail transportation data, we used T-100 Domestic Market and Segment data from the Bureau of Transportation Statistics (BTS). We selected the following variables from this dataset: departures and arrivals performed, origin and destination airport ID, origin and destination state, distance between airports, time period in quarter and month, number of passengers transported, weight of freight transported in pounds, and weight of mail transported in pounds. Out of all the airports in Alaska, we kept the following major airports: Wiley Post-Will Rogers Memorial Airport (BRW), Wainwright Airport (AIN), and Atqasuk Airport (ATK).

Figure 1: Locations of Major Airports Selected

From the T-100 data, we calculated the average number of passengers per month in the post-COVID period (April 2021 – June 2025). Passenger volume has remained below pre-COVID levels, as shown in Figure 2, where the dashed red line at March 2020 marks the onset of the pandemic and the subsequent collapse in air travel. We also calculated the average weight of freight and mail transported to these airports each month. As shown in Figure 3, freight

weight, which is mainly composed of bulk groceries under the Bypass Mail Program, has actually increased since the pandemic, suggesting heightened dependence on air transportation.

Passengers

We used average airfare data (year–to-date, Dec 6, 2025) from BTS by origin airport to make estimations within the triangle region. For all flights leaving from BRW, the average cost is $492.40. There's no data for AIN or ATK, probably due to the small volume of passengers they carry. In addition, we pulled the detailed 2025 T100 segment data and calculated the percentage of passenger flights (excluding freight only flights) from BRW to ATK/AIN out of all flights flown from BRW, which is 26.32%. The rest 73.68% flights are all intra-Alaska, with the farthest to Anchorage; therefore, the average cost of $492.40 does not include any costly international or trans-continental flights. From the interviews we had with locals, they mentioned that flights from BRW to Wainwright or Atqasuk generally range from $300 to $600. As the majority of the flights from BRW are of longer distances and more expensive routes, we use the lower bound of $400 average into our calculation.

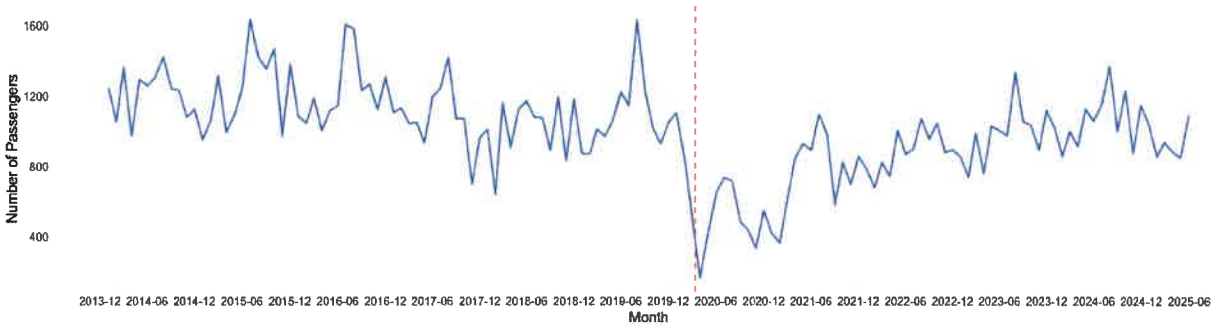


Figure 2: Number of Passengers Traveled **Within** Triangle Region Each Month

Freight and Mail

For freight and mail, using the average air freight cost in NSB and an estimated switch rate from air to ground travel, combined with ground transportation cost estimates from the previous section, we quantified potential cost savings that could result from road construction and the introduction of reliable ground transport options.

From Wright Air Services, the chart below includes the air freight rates per pound for intra-triangle transportation.

Atqasuk to Wainwright	(0-17 lbs) $35 flat rate	(17+ lbs) $1.91	Oversized $3.82
Utqiagvik to Atqasuk	(0-37 lbs) $35 flat rate	(37+ lbs) $0.87	Oversized $1.74
Utqiagvik to Wainwright	(0-31 lbs) $35 flat rate	(31+ lbs) $1.04	Oversized $2.08

In addition to the basic rates, additional charges include a 6.25% federal air transportation tax and fuel surcharge of 15% as of December 3, 2025 from Lynden Air Cargo. After these adjustments, the rates become:

Atqasuk to Wainwright	(0-17 lbs) $35 flat rate	(17+ lbs) $2.33	Oversized $4.67
Utqiagvik to Atqasuk	(0-37 lbs) $35 flat rate	(37+ lbs) $1.06	Oversized $2.13
Utqiagvik to Wainwright	(0-31 lbs) $35 flat rate	(31+ lbs) $1.27	Oversized $2.54

Based on T100 2024 data, we calculated the weighted per pound rate depending on the actual percentage of flights for each route:

Between AIN and ATK: 20% of total flights within triangle region

Between BRW and ATK: 37.86% of total flights within triangle region

Between BRW and AIN: 42.14% of total flights within triangle region

Thus, the weighted per pound rate is (2.33 * 0.2) + (1.06 * 0.3786) + (1.27 * 0.4214) = 1.402

For ground shipping cost per pound, we took the USPS Office of Inspector General's reported 2010 per-pound costs in NSB (in dollars), where 0.65 and 0.48 represent line-haul cost per pound and ground handling cost per pound respectively. These are the two components of ground transportation cost. They are adjusted to 2025 values using an inflation factor of 1.49. One important thing to note is that this is the cost estimate *without* the proposed gravel roads in the triangle region, so they're going to be higher than actual ground cost.

Alaska Bypass	Amount
Line-haul cost per pound	$0.65
Ground handling cost per pound	$0.48
Total Weight	87 million pounds

Source: OIG analysis of U.S. Postal Service accounting and weight data.

Table 1: Adjusted FY 2010 Financials, Costs per Pound

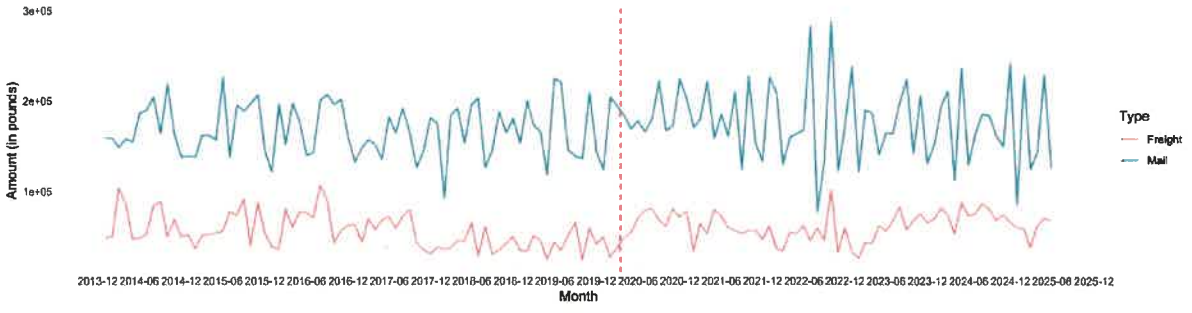


Figure 3: Weight of Freight and Mail (in lbs) Transported **Within** Triangle Region Each Month

Results

The analysis yields the following averages for the post-COVID period (April 2021 - June 2025):

- Average monthly travelers: 955
- Average airfare from BTS: $400
- Average freight weight per month: 60,979 lbs
- Average mail weight per month: 173,901 lbs
- Average freight and mail weight per month: 234,880 lbs

The estimated monthly **ground transportation cost** of freight and mail is calculated as:

$$234{,}880 * (0.65+0.48) * 1.49 * 0.7 = 276{,}827.22$$

A 0.7 adjustment factor was applied to account for expected reductions in handling and warehousing costs under ground transportation, since the per-pound handling rates in Alaska are inflated by approximately 30% due to air-specific service requirements.

The estimated monthly **air transportation cost** of freight and mail is calculated as:

$$234{,}880 * 1.402 = 329{,}301.76$$

For freight and mail total monthly savings, they are estimated based on the percentage of bulk items that are going to be transported via ground transportation instead of air.

$$\text{Monthly Savings} = \text{Percentage of goods Switched} * (329{,}301.76 - 276{,}827.22)$$

Percentage of Freight and Mail Switched	Monthly Savings
25%	$13,118.635
50%	$26,237.27
75%	$39,355.91
100%	$52,474.54

For passenger travel, total monthly savings are estimated based on the percentage of people who would travel by road instead of flying, since we don't have any data on that percentage.

Monthly Savings = Percentage of Passengers Switched * 955 * $400

Percentage of Passengers Switched	Monthly Savings
25%	$95,500
50%	$191,000
75%	$286,500
100%	$382,000

In total, combining freight and mail savings and passenger savings, the monthly benefits range from depending on the switch rates of both of them. If 75% of people and goods are using the newly available ground transportation instead, the savings would be around $325,856 per month. As passenger savings decrease, we find the Triangle Community Road to help promote travel and strengthen cultural ties cross-communities.

Fuel Cost Savings for Subsistence Trips

Methodology

The methodology used to complete the quantitative analysis for the effect on subsistence from the proposed Triangle road project. The goal of this analysis was to calculate how much the average subsistence trip would cost, specifically in terms of fuel, and how much harvests would be impacted by these roads. In order to do so, we gathered data from a number of sources on both fuel and harvest data.

In order to calculate the fuel costs of an average harvest trip, we found data on the average gas mileage (U.S. Department of Energy, n.d.) for the five different vehicles of

transportation: ATVs, snowmobiles, cars, trucks, and boats. Through one of our qualitative interviews, we were able to gather the fuel prices for regular gasoline and diesel, average trip length in both time and distance, and home heating costs which we applied to the costs to heat the cabins during a subsistence trip. (See Appendix for more detailed metrics).

Results

In terms of fuel and average trip costs, we calculated fuel costs based on the vehicle used and the city the hunter is traveling from: Utqiagvik, Wainwright, or Atqasuk. The average price, including fuel for both the trip and cabin heating, is shown in the table below.

	Average Fuel Cost
Utqiagvik	$228.23
Wainwright	$236.04
Atqasuk	$247.34

Transportation Limitations and Recommendations

This analysis is limited by the lack of price data in the T-100 dataset. While it provides information on passenger counts and freight volumes, it does not include ticket prices or operational costs. As a result, the estimated savings rely on vague assumptions about flight costs, switch rates, and ground transport expenses, making the figures only rough approximations. Future research should incorporate airfare and freight rate data from carriers operating in NSB to better estimate the economic impact of road connectivity and to validate the cost assumptions used in this report.

Healthcare

Benefits

Improved road access can significantly reduce the need for overnight medical stays, lower the number of residents requiring such stays, and shorten their duration overall. These benefits arise because roads enable faster and more flexible travel to regional medical centers, allowing many patients to return home the same day. This analysis does not consider potential increases in local visits to primary care providers, as existing intra-community roads already provide sufficient access to local clinics. The construction of additional gravel roads between communities would likely have minimal effect on these short-distance trips.

Methodology and Results

Due to limited lodging options in NSB, we focused on the three available accommodations in Utqiagvik: King Eider Inn, Top of the World Hotel, and Latitude 71 BnB. As of November 2025, these establishments respectively charge (pre-tax) $230, $291.93, and $300 per night for standard rooms, according to their official websites. Including the 5% Barrow Bed Tax, the average nightly cost for a family of four is approximately $575.

With improved ground connectivity, many residents traveling for routine or follow-up care could return home the same day, avoiding these lodging expenses entirely. Roads would also lower costs for emergency services by enabling ambulance transport between communities, which are cheaper than medevac flights for non-critical cases. Programs Community Health Aide Program (CHAP) would benefit as well, since mobile providers and medical supply deliveries could be completed by road rather than chartered flights. Savings from patient travel and lodging

are considered separately here, as transportation cost reductions have already been incorporated in the previous section.

Limitations

Data availability remains a significant limitation. The T-100 dataset and other federal transportation sources do not include health-related passenger categories, and no public data exist on the operating costs of CHAP or average medevac frequency by community. Additionally, overall lodging data in the entire NSB are limited, since few hotels list rates on Online Travel Agent platforms.

Food Consumption

Subsistence Interview Analysis

Methodology

Subsistence in the North Slope is a vital practice yet complex discussion, especially when attempting to quantify it. Subsistence is defined not only as a way to provide food for families, but also as a deeply cultural, spiritual, and community sustaining practice. In this report, we are trying to capture both the complexity and the tension involved in quantifying subsistence for the purpose of creating concrete metrics, while still honoring the intangible value that subsistence provides to North Slope communities.

To ensure our research reflects the deep significance and intangible value that subsistence provides to North Slope communities, we aimed to gather qualitative data on what subsistence means and what a typical subsistence trip looks like from beginning to end. These interviews helped us collect insights that cannot be captured through numbers alone.

Results

We found several insights from our interviews. Some interviewees viewed roads and subsistence as mostly separate. Roads would make transportation between the three communities easier and reduce dependence on air travel. They would also improve access to health care. However, these interviewees were unsure how roads would affect subsistence, since hunters would still likely use ATVs, snowmobiles, or boats to reach hunting sites. However, others mentioned that people who cannot afford the equipment needed for full subsistence trips might be able to pull over and hunt from the road if they saw wild game, which was easier after the CWAT trails were constructed.

We learned how community oriented the entire subsistence hunting process is. Hunters travel together and share their harvests widely. This is especially evident during bowhead whale season in late spring, when many community members participate in both the harvest and the eating of the whale. This makes it difficult to assign a monetary value to subsistence by household because almost all harvests are shared.

Subsistence trips are extremely expensive because of fuel, cabins, labor, and equipment. Many residents face food insecurity due to the high cost of living, which makes subsistence an important shared activity. People often cannot afford to go on these trips alone and rely on support from their community.

Limitations

The main limitation in our qualitative data collection is the small number of interviews. We were only able to conduct 5 interviews, of which only 3 were regular subsistence hunters.

Therefore, our insights are limited and cannot be generalized to the entire North Slope. Even so, the interviews we did collect provided valuable insight into the current subsistence landscape. If we were to continue our research, we would go through tribal councils to get in touch with more subsistence hunters to develop a more extensive analysis.

Harvest Yield Estimates

Methodology and Results

For harvest yields, we estimated the average yield for four main species: caribou, fish, seal, and geese (Fall, 2018)(Bacon et al., 2009). We calculated the average amount of meat harvested from each animal and translated the pounds into grocery store price equivalents. Although converting wild game to grocery store value is imperfect, especially since three of the four species are not sold in stores, using United States Bureau of Labor Statistics data and Alaska Commercial Company grocery prices allowed us to estimate relative value (see Appendix for all values.)

The data shows that the CWAT trails affected harvests differently depending on the species. We expect the Triangle Road to have minimal impact on marine harvests. Wainwright saw the smallest improvement from the CWAT trails because it already has coastal access, with an average increase of 5.4%. Atqasuk saw the highest improvement at an average of 17.8%. These numbers were calculated by comparing the monetary value of harvests before and after the CWAT trails.

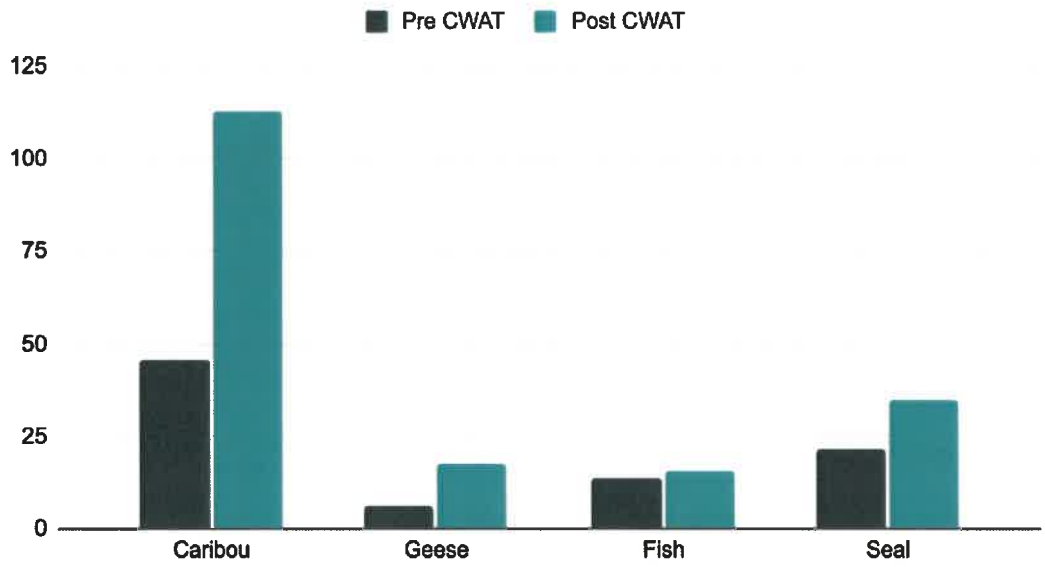


Figure 4: Meals per Person Before and After CWAT

Limitations

There are limitations in the available data, especially for harvest yields. The predicted change in harvests depends on data collected before and after 2018, and consistent data is limited. Due to this, we averaged harvest yields by species depending on the data that was available. These gaps forced us to make assumptions. The predicted increase in harvest yields after the Triangle Road is also based on assumptions drawn from the CWAT trails. Since the CWAT trails are seasonal and only used in winter, the Triangle Road, which would be open during the entire year, could have a different and possibly larger impact.

Through our qualitative interviews, we also learned that some participants believe the main impact of the road would be on general transportation and reducing the dependence on air travel. These interviewees said they did not expect the road to affect subsistence directly because hunters would still rely on ATVs, snowmobiles, and boats to reach subsistence sites. While this

perspective was not consistent across interviewees, using the CWAT trails as a benchmark may not be widely accepted.

Subsistence harvests are also deeply communal and shared among extended families and the broader community. Food obtained on these trips is rarely consumed by the hunter alone. Instead, it circulates widely, often ending up across many households. This makes it even more difficult to evaluate subsistence through the lens of individual costs or benefits, since the value is created through sharing and collective effort rather than personal gain.

Groceries

Methodology

Due to the limited availability of grocery price data specific to NSB, monthly grocery expenses for a typical household are estimated using the U.S. Department of Agriculture's Thrifty Food Plan (TFP). This dataset reports the national weekly and monthly costs of a "nutritious, practical, cost-effective diet" for a reference family of four: one adult male and one adult female (ages 20–50), and two children (ages 6–8 and 9–11).

Based on the national baseline and Alaska-specific estimates (available for recent years), the average cost in Alaska is approximately 127.74% of the national level. Moreover, NSB is classified as a Rural II region due to its remoteness, similar to other areas in Alaska such as Kobuk, Bome, and Wade Hampton. So, its grocery costs are about 56.42% higher than those in Anchorage, which serves as the Alaska TFP baseline. Therefore, the estimated monthly grocery cost for NSB is computed by multiplying the national baseline by 1.2774 and 1.5642.

With this estimate as the baseline, we calculate the potential reduction in grocery prices and the associated household savings that could result from constructing permanent roads that allow ground transportation of goods. The estimates used include:

1. A 93% reduction in transportation costs for groceries, reported by the U.S. Postal Service Office of Inspector General under the Bypass Mail Program
2. A 67–100% pass-through rate from cost reduction to consumer price reduction, based on 2 studies of Canada's Nutrition North Program, which serves as regions with comparable remoteness
3. The percentage of transportation costs in grocery prices. Due to lack of data on this exact percentage, we took 56.42% as this increase in grocery prices in rural II regions compared to Anchorage is mostly due to their remoteness and additional transportation costs incurred.
4. Possible switch rates from air freight to ground transportation for groceries

To avoid overly optimistic projections, we use an average value of 86.5% for the second parameter. Additionally, since direct transportation savings are already calculated in the previous section on transportation, these non-direct grocery savings are not included in this calculation.

Percentage reduction in grocery prices = 0.93 * 0.865 * 0.5642 * switch rate

Percentage of Grocery Transported Switched	Percentage Reduction in Grocery Prices
25%	11.3%
50%	22.7%
75%	34.0%

The combined estimates yield an approximate 22.7% reduction in grocery prices, if half of the groceries currently transported by air switch to ground transportation.

Results

Using the calculated reduction rate and the most recent monthly grocery cost (August 2025), we estimate the total potential household savings based on population data from the 2023 American Community Survey (ACS). The survey reports 2,205 households and a total population of 10,891 in NSB, with an average of 3.3 people per household. Approximately 67% of the population is between 18 and 64 years old.

Since the TFP reference family includes two young children, we apply a multiplier of 1.2 to better reflect NSB's primarily adult population. The total estimated monthly grocery savings are therefore calculated as follows, where 1,980 represents the monthly grocery cost for the reference family.

(2205*1.2) * 1980 * Percentage Reduction

Percentage Reduction in Grocery Prices	Monthly Savings
11.3%	$592,016.0
22.7%	$1,189,271.2
34.0%	$1,781,287.2

Limitations and Recommendations

This estimate is constrained by the limited availability of NSB-specific grocery data. The national TFP baseline reflects inflation and consumption patterns at the national level, which may not accurately capture price dynamics in remote regions such as NSB. For more accurate estimation, future analysis should incorporate region-specific grocery data, transportation cost breakdowns, and locally derived price elasticity estimates.

Pullouts

Methodology

As the Triangle Community Road will have a 5ft embankment to protect the permafrost from thermal degradation, pullouts are necessary for subsistence hunters to easily access the North Slope's land and waterbodies with snowmobiles and ATVs (ASRC Energy Services, 2020). In order to determine the highest impact pullouts, we used the following methodology:

- **Data Gathering:** GIS data on camps (Alaska Center for Conservation Science, 2019), cabins (Alaska Center for Conservation Science, 2019), anadromous waters catalog (AWC) (Alaska Department of Fish and Game, 2025), and caribou migration (Teshekpuk and Western Arctic Herds) (Alaska Department of Fish and Game, 2019)
- **Reprojection:** CRS (Coordinate Reference System) should be set to EPSG:3338 for mapping and analysis in Alaska
- **Candidate Generation:** set up potential pullout spots every 3 miles on the Triangle Community Road
- **Spatial Network Analysis:** create 10 mile impact buffers or radii around pullout candidates, merge all GIS data, calculate nearest distances of GIS data around candidates, and normalize features
- **Evaluation:** use weighted composite impact scores to produce pullout metrics and ranking the top 10 candidates

As the team did not have any expertise or background in GIS, the methodology and its respective coding was confirmed over a call with part of the ASRC Energy team, a key

stakeholder and partner in the ASTAR project. The team used ChatGPT to assist with parts of the GIS coding.

Reprojection was necessary to analyze the distances of the GIS data within the North Slope boundaries. While the Western Arctic Herd was already in the correct CRS, the Teshekpuk Herd needed to be reprojected. As seen in the image below, reprojection skews the shape of the data but gathers the movement in the correct Alaskan territory.

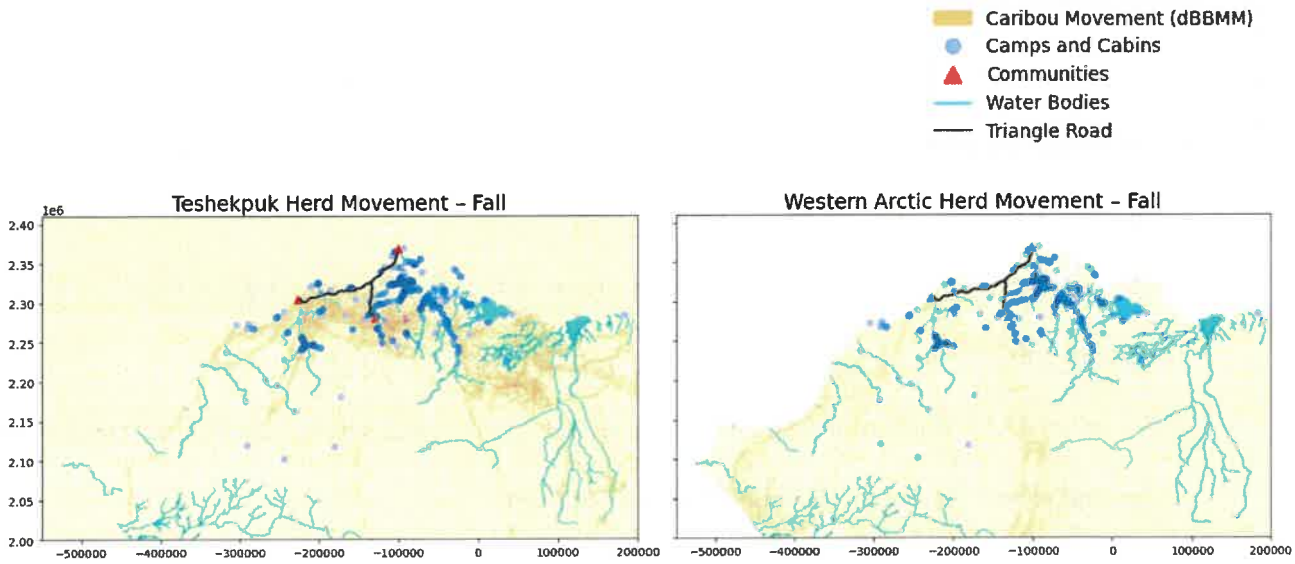


Figure 5: Merged GIS Datasets Across Herds in Fall

Although the picture above only displays Fall, the caribou datasets were spread across these seasons: Winter (Dec 1-Apr 15); Spring (Apr 16-May 31); Calving (June 1-15); Postcalving (June 16-30); Mosquito (July 1-15); Oestrid Fly (July 16-Aug 7); Late Summer (August 8-Sept 15); Fall (Sept 16-Nov 30). From discussions with subsistence hunters from NSB, we decided to focus on the summer and fall seasons when caribou are hunted in our composite metrics, which includes the list from calving to fall season.

Metrics

As mentioned previously, pullout candidates were generated every 3 miles along the Triangle Road, totalling at 45 candidates. After setting up 10 mile radius impact buffers around the pullouts, the following metrics were calculated within each buffer: count of camps, cabins, and AWC features; distance of these camps, cabins, and AWC features from pullouts; mean raster values of Teshekpuk and Western Arctic Herd movement within the buffers. Teshekpuk Herds had data across all seasons, however the Western Arctic Herd did not have migration data for the mosquito and oestrid seasons. So, the weighted composite impact scores were differentiated based on herd type. Across the herds, the weighted composite impact scores were calculated by this equation:

pullout_metrics = 0.3 x num_camps_norm + 0.2 x num_awc_features_norm + 0.2 x dist_camp_min_norm + 0.1 x dist_awc_min_norm + 0.2 x ***_herd_avg_norm

where *** was tch or wah for the respective herd impact scores, camp represented both camps and cabins, and norm meant normalized features.

Results

After ranking the top 10 Teshekpuk and top 10 Western Arctic candidates, the most impactful pullout candidates are as follows:

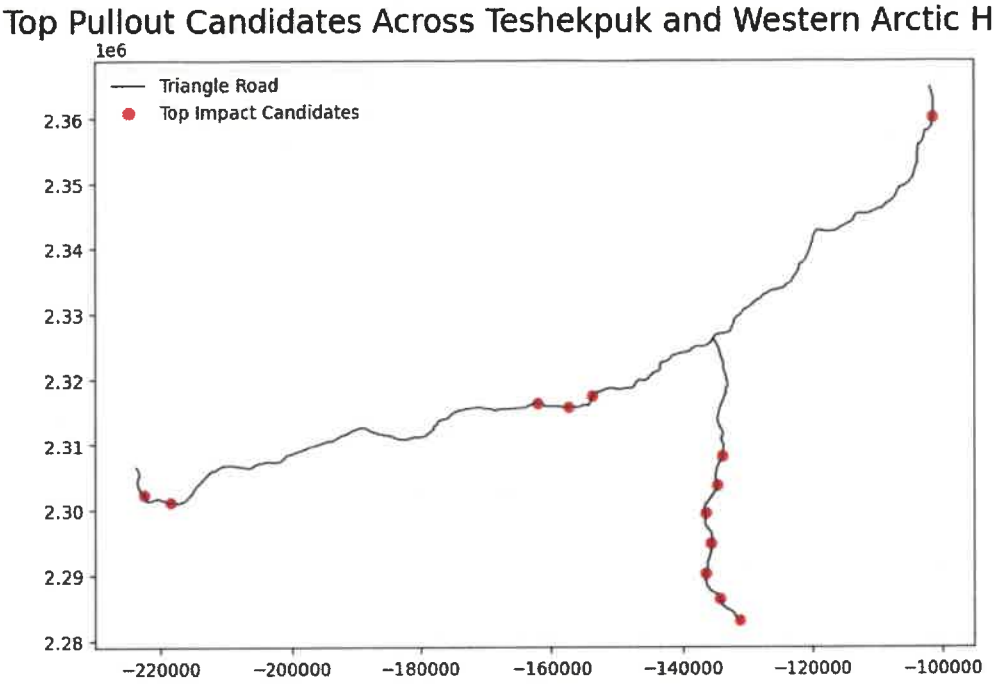


Figure 6: Top Pullout Candidates of Teshekpuk or Western Arctic Herds

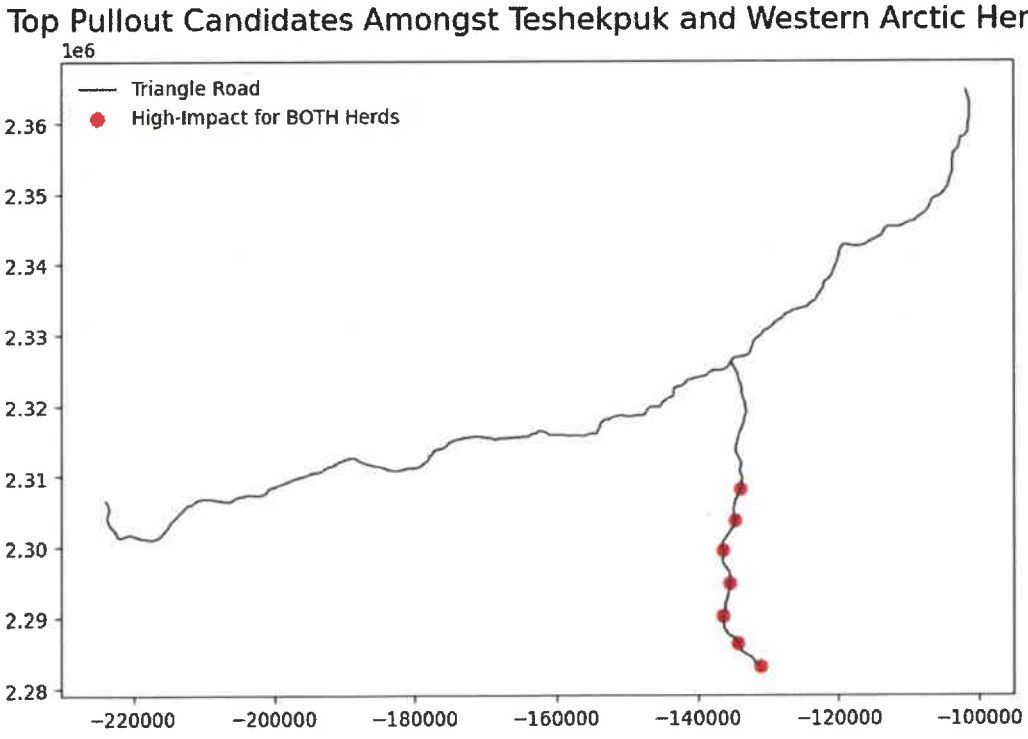


Figure 7: Top Pullout Candidates of Teshekpuk and Western Arctic Herds

The pullout hotspots in Figure 6 show a comprehensive view of all top candidates recorded across the datasets, and the ones in Figure 7 show impact consistently observed amongst both herds (see Appendix for metric amounts and related coordinates across both Figures). From Figure 7, we can see that the Triangle Road will be most impactful for the Atqasuk community in terms of subsistence hunting.

While these spots were identified as having the highest potential impact, it is important to consider the current standard pullout procedures of other NSB roads. The Nuiqsut-Alpine and Willow Project roads designed pullouts every 3 miles along their roads. Still, it is important to consider that both projects continue to consult hunters on pullout locations, follow up with vegetation mapping experts to see how sensitive vegetation is in these areas and to avoid wet areas that ATVs can damage, and get feedback from communities on locations and designs. These measures are important to modify locations, designs, or features in the future (see Appendix).

If ASTAR is seeking consistency in pullouts, we recommend following this 3 mile standard that other North Slope communities have adopted. However, as mentioned before, it is important to stay flexible with changing pullout locations and designs based on continued conversations with hunters and environmental experts, especially as the 3 mile standard is only practiced for these two roads. If ASTAR is seeking high-impact pullout locations while saving the cost of building all 45 pullouts, we recommend building the pullouts found in Figure 6 or 7. By limiting the initial amount of pullouts, ASTAR has higher flexibility in identifying and creating future impactful pullout locations through these continued conversations.

Limitations

Limitations include a lack of GIS data. While caribou and AWC data was available, other actively hunted animals did not have accessible GIS data. While the AWC data helped source waterbodies in NSB, there was no distinction of the waterbodies by name. With distinct names, greater weight within impact buffers would have been placed along these major waterbodies either in or near the Triangle Road: Inaru River, Kugrua River, Niklavik Creek, and Peard Bay. Finally, native allotment GIS data from BLM in Alaska was not comprehensive for NSB allotments, only focusing on other areas in the state. So, the analysis only contained camps and cabins of NSB residents without any weight on native allotments.

Conclusion

All in all, we find the Triangle Community Road to shape better subsistence access, foster economic opportunities, and promote community ties within the North Slope Borough. The cost savings for residents in terms of transportation, groceries, fuel, and healthcare will be extremely helpful as the North Slope is already so expensive. While the current costs of the Triangle Community Road is also high, we find the road to be beneficial for residents in the long run.

In terms of subsistence hunting and food security, we expect that this project will be more impactful than the CWAT trails as it allows more hunters to easily capture wild game all year. We expect that this will primarily benefit those who cannot afford all of the equipment required to regularly participate in subsistence trips but own a car or truck. Overall connectivity between these three communities will greatly improve, leading to better health outcomes and lower fuel costs on individual families.

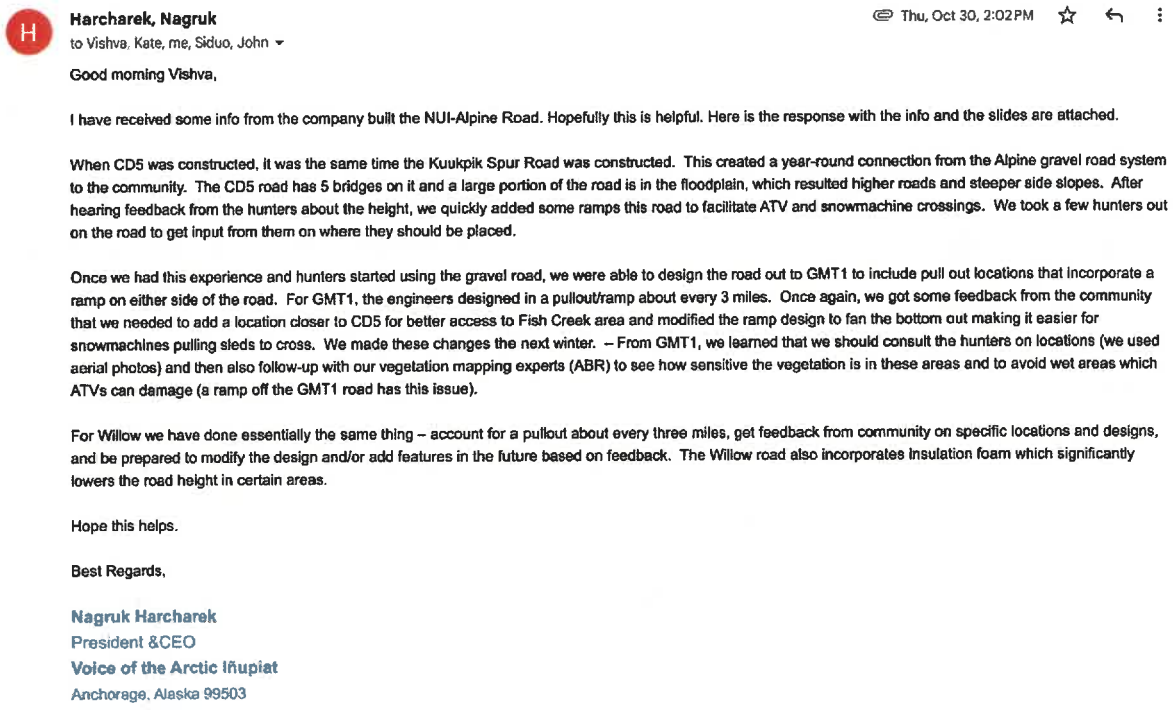
For more accurate and impactful research in the future, the team highly recommends the NSB to focus their efforts on systematic and long-term data collection as a significant challenge to creating this report included working with limited datasets and creating various assumptions. Future research would benefit from more comprehensive wildlife movement data and environmental datasets based on permafrost and wildlife sensitivity. Furthermore, more comprehensive qualitative data collection would be helpful in understanding the significance of subsistence culturally. By expanding data collection and promoting its public use, future analyses can be less dependent on assumptions, more accurate, and bring about more ecologically and community driven recommendations.

Appendix

All T100 Data Used

All Thrifty Food Plan Data

Fuel Costs, Harvest Yields, and Pre vs. Post CWAT Analysis



Harcharek, Nagruk
to Vishva, Kate, me, Siduo, John

Thu, Oct 30, 2:02 PM

Good morning Vishva,

I have received some info from the company built the NUI-Alpine Road. Hopefully this is helpful. Here is the response with the info and the slides are attached.

When CD5 was constructed, it was the same time the Kuukpik Spur Road was constructed. This created a year-round connection from the Alpine gravel road system to the community. The CD5 road has 5 bridges on it and a large portion of the road is in the floodplain, which resulted higher roads and steeper side slopes. After hearing feedback from the hunters about the height, we quickly added some ramps this road to facilitate ATV and snowmachine crossings. We took a few hunters out on the road to get input from them on where they should be placed.

Once we had this experience and hunters started using the gravel road, we were able to design the road out to GMT1 to include pull out locations that incorporate a ramp on either side of the road. For GMT1, the engineers designed in a pullout/ramp about every 3 miles. Once again, we got some feedback from the community that we needed to add a location closer to CD5 for better access to Fish Creek area and modified the ramp design to fan the bottom out making it easier for snowmachines pulling sleds to cross. We made these changes the next winter. – From GMT1, we learned that we should consult the hunters on locations (we used aerial photos) and then also follow-up with our vegetation mapping experts (ABR) to see how sensitive the vegetation is in these areas and to avoid wet areas which ATVs can damage (a ramp off the GMT1 road has this issue).

For Willow we have done essentially the same thing – account for a pullout about every three miles, get feedback from community on specific locations and designs, and be prepared to modify the design and/or add features in the future based on feedback. The Willow road also incorporates insulation foam which significantly lowers the road height in certain areas.

Hope this helps.

Best Regards,

Nagruk Harcharek
President &CEO
Voice of the Arctic Iñupiat
Anchorage, Alaska 99503

Pullout Metrics and Coordinates

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