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Huslia Tribal Council Biomass Project

A Project to Increase Sustainability and Reduce Energy Costs in Huslia, AK

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Yukon Koyukuk School District
Alaska Native Tribal Health Consortium
Tanana Chiefs Conference (TCC)

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Disclaimer

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Executive Summary:

The Huslia Tribal Council (HTC) and the Tanana Chiefs Conference (TCC), partnering with the City of Huslia, the Yukon-Koyukuk School District, and Alaska Native Tribal Health Consortium, applied to the U.S. Department of Energy Office of Indian Energy for funding of a community biomass boiler system. The biomass system contributes to heating three community buildings in Huslia, Alaska with locally harvested fuels: the clinic, the water treatment plant/washeteria, and the school. The remaining heating needs are supported by in-building oil-fired boilers, burning imported heating fuel. Some issues, such as control set points on the oil boilers, need to be resolved before the biomass heating system is used at full capacity. The project objectives of the community biomass boiler system were cost reduction, carbon reduction, community resilience, and economic development. Once fully operational, the cost reduction from decreased fuel oil usage due to support from the biomass boiler system is expected to more than offset the cost of purchasing locally harvested biofuel, resulting in overall savings to the community. Locally sourced wood is considered carbon-neutral, so the biomass boiler system decreases the carbon footprint of heating the community buildings. The project increases resilience by decreasing dependence on heating oil brought in from elsewhere. Lastly, it produces economic development by employing locals to gather the wood burned in the biomass boiler. This project satisfies all of the objectives that HTC set out to achieve.

Project Objectives:

Huslia is a remote city in Alaska, with a population of about 290 residents, located 250 miles west of Fairbanks and 370 miles northwest of Anchorage. Most of its residents are Koyukon Athabascans. Huslia is accessible by air or snowmachine in winter and by air or river-travel via the Yukon and Koyukuk Rivers in summer. The community experiences average summer high temperatures of 72°F and average winter low temperatures below 0°F, resulting in 14,700 heating degree days[1], annually. Historically, the community heated with cordwood. More recently, many in the community as well as all community buildings depend on imported oil, which is subject to fluctuating prices and high costs due to shipping.

The 2017 Huslia Community Plan envisioned a village that members can return to “after schooling to work and raise families.”[2] Based on this vision, Huslia Tribal Council (HTC) together with the City of Huslia and the Tanana Chiefs Conference identified objectives for future community projects in Huslia. The objectives included reducing costs for the city council, reducing carbon footprint, increasing community resilience, and promoting economic development. Based on those objectives, HTC identified the Community Biomass Project as a viable project.

The community biomass project was planned to heat three community buildings: the Jimmy Huntington School, the water treatment plant/washeteria, and the clinic. Those three buildings alone comprise roughly 60% of the square footage of the community buildings in Huslia. It was this potentially large fraction of community buildings that made the project economically feasible. The plan included a centrally-located biomass boiler building that would be connected via underground glycol loops to the three buildings. Two of the buildings already were heated by oil-fired furnaces that heated glycol loops in the building, and the school was being upgraded to glycol heat.

The biomass system was planned as a secondary heat source, with the oil boilers in each building remaining a primary source and as such always available to carry the needed load. Specifically, the design had the biomass-heated glycol flow into a heat exchanger on the return portion of the existing building loop, before that loop entered the oil boilers. This preheated the glycol before it returned into the oil boilers. If the oil boilers detected that the glycol flowing in was warm enough, they would not start. If the glycol coming in was too cool, the oil boilers would fire up automatically. In addition, if there were to be an issue with cordwood or biomass boiler operator availability, the three buildings would remain heated with oil boilers.

Once operational, the biomass project will create 5-12 part time jobs for wood harvesters and 2 part time jobs for boiler operators. Part time employment fits well with subsistence living practiced by many in the community. Switching to biomass is an easy transition in Huslia because many residents heat homes with cordwood that they harvest themselves. Additionally, one community building, “the Hall”, is heated entirely by a retrofitted dual-chambered wood stove. Huslia anticipates needing 150 cords

1 https://akenergygateway.alaska.edu/community-data-summary/1403644/, *Accessed Feb 2021.*
2 https://www.commerce.alaska.gov/dcra/DCRARepoExt/RepoPubs/Plans/HusliaCommunityPlan2017.pdf, *Accessed Mar 2021.*

of wood per year to fuel the biomass boilers, and plans on purchasing the wood from local residents, ensuring the economic benefit stays within the community. The biomass plant operators will process the wood purchased to ensure it is in optimal condition for the wood boiler at the time of use (20% or less moisture content). The operators will also perform all needed maintenance on the equipment and district heat loop. The Tribal Administrator will oversee the purchase of equipment and supplies.

The project satisfied all of the objectives outlined by HTC:

1. Cost Reduction. The project will displace approximately $57k of the fuel used to heat the three buildings with local, sustainably harvested woody biomass. Fuel cost savings over the 25-year life of the project are estimated at approximately $1.5 million.
2. Carbon Reduction. By using locally-grown cordwood, instead of fossil fuels that need to be transported to the city, the project reduces the city's carbon footprint and significantly reduces greenhouse gas emissions.
3. Community Resiliency. The project enhances self-sufficiency and technical capabilities of Huslia residents by increasing the use of a local biomass resource, decreasing the need for imported heating oil, providing technical training for the operators, and reducing money exported from the community for heating oil.
4. Economic Development. The project creates 5 to 12 part-time jobs for wood harvesters and 2 part-time jobs for boiler operators. This provides local jobs for residents, training for system operators, and adds over $40,000/year into the local economy.

Description of Activities Performed:

The project consisted of design, procurement, and installation of a biomass system that serves three Huslia community buildings - the school, clinic, and water treatment plant/washeteria. The biomass system heats glycol, which distributes the heat to the other buildings before returning to the biomass building. The design and installation included the new biomass building, boilers, distribution pipes, tie-in to existing buildings, and some modifications within the existing buildings to accommodate the new system.

The project benefited from recent school renovation of both the school building and its mechanical system. During the renovation, plans for the biomass project were considered, and the school mechanical system was designed to make future connection relatively easy. The biomass building was built in a location near all three buildings it was to serve (Figure 1). All three underground connections were roughly 700 feet total.

Figure 1: Biomass boiler building location with respect to the three buildings it serves in Huslia, Alaska. *Photo courtesy of Google Maps.*

Figure 2: A Ruby Marine Inc. barge - the least expensive, and for the largest items the only, shipping method to Huslia. Items arrive at Nenana docks via truck for the approximately 370-mile push down the Tanana and Yukon Rivers and another 170-mile push up the Koyukuk River. *Photo courtesy of Dave Pelunis-Messier.*

On the project management side, HTC applied for and received the funding from the Department of Energy. HTC managed all of the invoicing and bookkeeping for the project. HTC owns and operates the clinic. The Council then collaborated with the stakeholders and project partners: the City of Huslia, which owns the washeteria and assists with its operation; the Yukon-Koyukuk School District owns and operates the school; and the Alaska Native Tribal Health Consortium that built the clinic and the water treatment plant and created the engineering drawings for this project. Tanana Chiefs Conference assisted with project management. HTC will operate the biomass facility.

The project included much advance planning, including the design and transfer of the land parcel to THC. Another milestone that had to be accomplished before any physical work started was to order and receive the materials in Huslia. Shipping to most Alaska communities requires additional time due to the lack of roads. For Huslia in particular, materials can arrive first via truck to a location on the road system several hundred miles from Huslia, and then to Huslia itself either by barge (Figure 2) from Nenana, or by air from Fairbanks. Shipping by barge is less expensive. Barges typically run from May 15th, if the ice on the rivers is out by then, until the end of September - about four-and-a-half months out of the year. For this project, extra care was taken to order materials early enough so they would arrive in time to be barged into Huslia, and not miss the last barge in the fall.

Once materials arrived, construction of the concrete slab and the biomass building began in summer

Figure 3: Construction of the biomass building. Top left: pouring of the concrete foundation. Top right: raising of the walls plus the trench for the glycol run. Bottom: nearly completed biomass building. *Photos courtesy of Dave Pelunis-Messier.*

2018 (Figure 3). The building foundation was a monolithic concrete slab with insulation laid down under the concrete. This type of foundation has worked well in similar locations, both with respect to the substrate beneath the foundation, as well as being easier to pour.

The building itself was constructed from a steel building kit. TCC has already deployed an identical kit to several other communities in Interior Alaska. The standardization allows TCC to work faster with the communities if any issues come up. The prefabricated building is 30 feet wide by 24 feet deep, with both a garage door and a man door.

Three GARN 2000 Wood Heating System cordwood boilers with a total maximum output of 600,000 BTU/hour were installed in the biomass building (Figure 4). A hairline crack was found in one of the boilers, and was field-welded the following summer. Afterwards, an additional, steel stud framed, insulated structure was built around the boilers, within the steel building, to insulate the heat in the 2,000 gallon water tanks once each unit is fired.

Figure 4: Top: Biomass boilers waiting for installation. Middle: Boilers being enclosed. Bottom: Installed biomass boilers visible through the open garage door. *Photos courtesy of Dave Pelunis-Messier.*

Figure 5: Top left: backs of boilers before any connections were made. Top right: back of the boiler enclosure, showing the glycol pipes, exhaust pipe, and hole for inlet air (awaiting a connection). Bottom: all connections to the back of the boilers, completed and labeled. *Photos courtesy of Dave Pelunis-Messier.*

The building construction and initial boiler setup, without electrical or mechanical connections, was completed in summer 2018, then stopped as winter set in. This was partly the result of the mechanical contractor suffering a medical issue that left him initially on the sideline as he recuperated, and even then at a diminished capacity. The Tribe waited for the contractor to recover; ultimately, more than a year later, some of the work had to be re-done because essential elements critical to the design were missing.

In the meantime, two operators from Huslia were trained in Tanacross on biomass systems. Tanacross is a community in Alaska that commissioned its biomass system in 2018, and in 2019 was the location of a hands-on training on operations, maintenance, and troubleshooting of GARN cordwood boilers. The workshop was organized by multiple state and federal organizations and nonprofits in an effort to help with knowledge dissemination as more and more biomass boilers come online in communities across the state.

In Huslia, electrical and mechanical installation for the biomass boiler continued in summer 2019. Both water and glycol piping was installed for each boiler as were the required air intakes and exhaust (Figure 5). All piping and tubing was labeled to aid in future diagnostics. The glycol was run through two inch PEX tubing. Additional insulation was added over the piping and tubing.

More dirt-work was required to connect the biomass building to the three community buildings via a glycol heat loop. A roughly 4-foot deep and 4-foot wide trench was excavated to each end-building (Figure 6). A total of approximately 700 feet of underground pipe was installed and backfilled. The underground pipe is Ecoflex thermal twin, which carries both the supply and return glycol lines in a thermally protected envelope.

In the end-buildings, heating systems were modified to tie the biomass-heated glycol loops into the existing systems' heat loops. This included installing heat exchangers, pumps, and meters. Having the biomass glycol tied in to the return lines in the end-user buildings allows the boilers in those buildings to have pre-heated glycol coming in. If the biomass glycol is hot enough, the boilers in the end-buildings remain off. If the biomass glycol is not hot enough, the end-building boilers turn on. This way the end-buildings are always at a comfortable temperature, whether the biomass boiler is running or not.
In addition to the main biomass infrastructure, a fenced yard and covered wood storage were built to store and cure the cordwood.

The biomass project was partially operational in winter 2019-2020 (Figure 7). Some parts were not operational because a preliminary review found that multiple connections of PEX tubing were missing PEX rings, a ring that crimps the PEX tube onto a fitting and is required on all connections. Plans were made to install all missing PEX rings in summer 2020.

However, the Covid 2019 pandemic shut down most of the United States in March 2020. With not-too-distant memories of the "Spanish" flu that ravaged Alaska communities a hundred years earlier,

Figure 6: Distribution system includes Ecoflex thermal twin pipes carrying the heated glycol underground from the biomass building to the other buildings. Top row, left to right: trench by clinic is ready for the insulated pipe; trench to the water treatment plant is being backfilled. Bottom row, left to right: the pipes come up adjacent to the biomass building prior to connection; once complete, the connections go through the wall, leaving two elbows visible next to the building. *Photos courtesy of Dave Pelunis-Messier.*

Figure 7: Fire in one of the biomass boilers in Huslia. *Photo courtesy of Dave Pelunis-Messier.*

many Rural Alaska communities enacted exceptionally stringent restrictions with regard to travel. It resulted in Huslia severely limiting the people allowed into the city. Huslia restricted air carriers to only bringing freight into the village. People were allowed to travel only for medical emergencies and travel to and from nearby villages was also extremely restricted or cut off altogether. This made it difficult to accomplish the last tasks of the project, especially those that required specialized professionals to travel into the village.

One item that was accomplished during summer 2020 was installation of new snowstops on the roof of the biomass building. The snowstops were sent to Huslia, and they were installed by local contractors.

The system overall remains partially though not fully operational.

Overview of Data:

Reviewing the savings realized from the biomass system is difficult. More stringent methods of record keeping must be practiced in order to accurately assess fuel oil usage by the community buildings. Huslia receives nearly all of its heating oil via a barge operated by Ruby Marine Inc. Huslia City and Huslia Tribal Council order fuel from Ruby Marine months in advance. When the barge arrives, the appropriate tanks are filled by Ruby Marine's delivery truck. Recorded (invoiced) delivery amounts often do not reflect the actual amount delivered to the community buildings on the biomass heat loop. In fact, the actual fuel usage in each building should always be equal to or less than what is invoiced. Depending on how cold the winter before was and other unpredictable factors, the amount of fuel in the community buildings' tanks at the time of delivery may vary. They are never completely empty and the amounts left often vary in the thousands of gallons. Since the fuel being delivered by Ruby Marine is already paid for and shipping it back down the river is financially unwise, any and all remaining fuel in the delivery truck is delivered elsewhere, if possible. This extra heating oil is usually used to top off other community buildings owned by the respective client that made the order. For instance, after topping off the washateria, Ruby Marine then tops off other tanks at buildings also owned by the City, such as the Community building (used to feed/cook for elders) and the City Office (3-sided-log building). Other, more privatized locations, may also account for some extra fuel delivery. All of these additional layers make it difficult to estimate the savings that the community has experienced from running the biomass boiler, because it appears that yearly standard-size shipments are used entirely by the community buildings. Additionally, the biomass boiler has not been re-commissioned after warranty issues were discovered, and is not yet operating at full capacity.

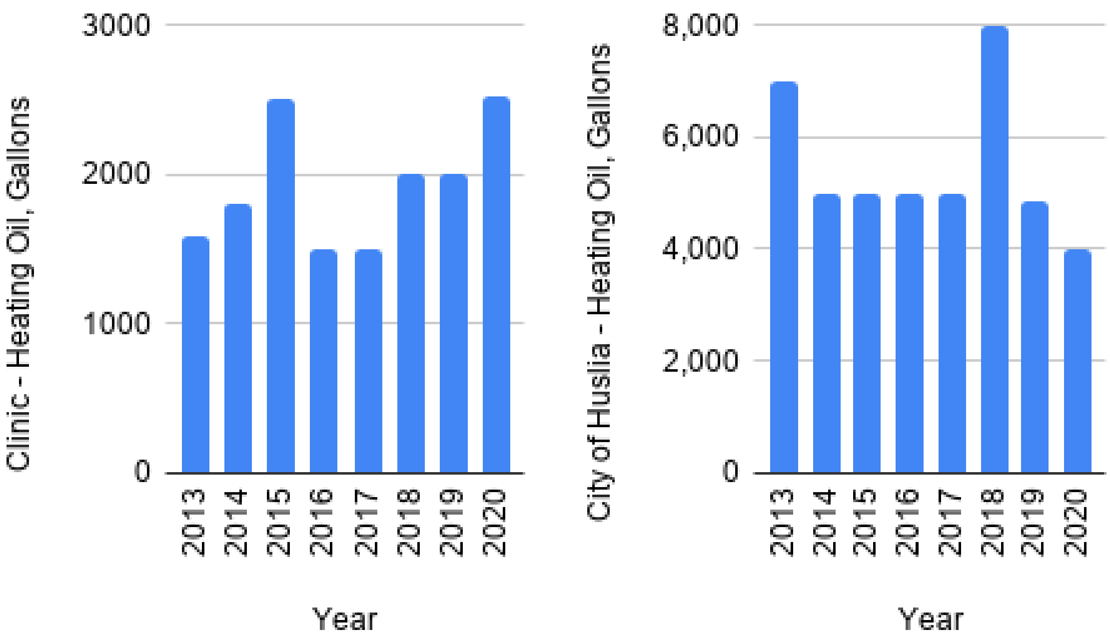

Figure 8: Gallons of heating oil delivered to the clinic (left), and to the City of Huslia, which includes the water treatment plant and washeteria (right). Note that scales differ.

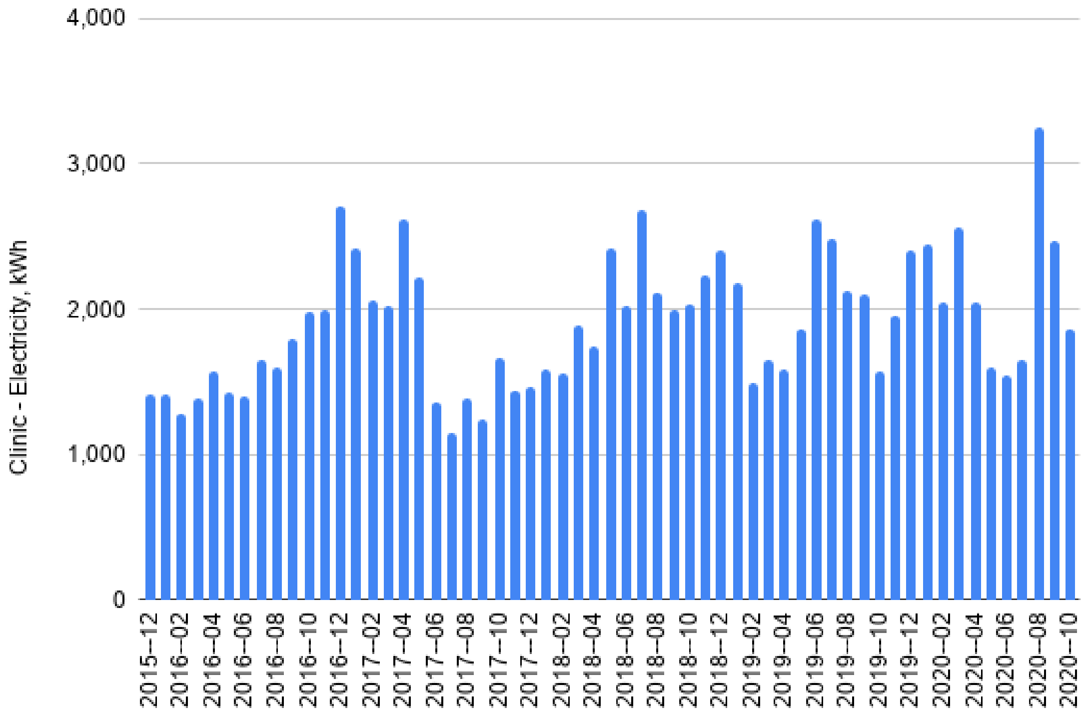

Figure 9: Electricity usage in the clinic for the previous five years.

Figure 8 shows the amount of heating oil purchased by the Tribal Council for the clinic, as well as the amount purchased by the City of Huslia each year. The City of Huslia community buildings include the washeteria and water treatment plants building, as well as others (e.g. City Office). A graph for the school is not included as the biomass connection to the school was not operational as of 2020.

There is no electricity decrease expected due to the biomass project because the buildings were being heated by heating oil and not electric resistance heat. Electricity usage for the clinic is shown in Figure 9, and that of the water treatment plant and washeteria is shown in Figure 10.

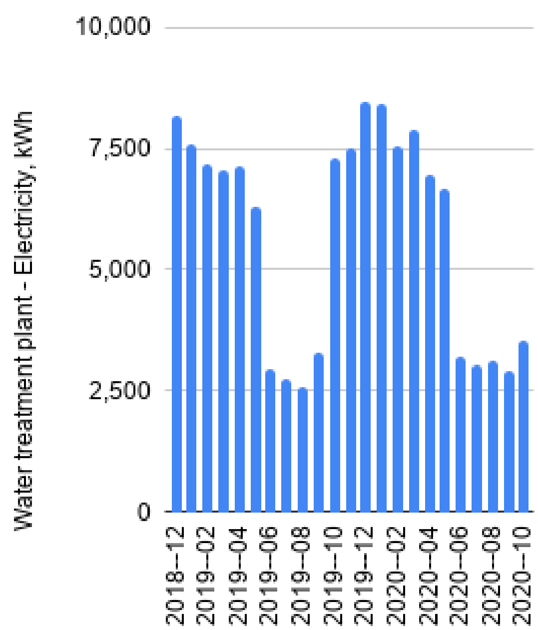

Figure 10: Electricity usage in the water treatment plant and washeteria for the previous two years.

Conclusions and Recommendations:

The biomass project was anticipated to displace approximately $57,000 of fuel used to heat 60% of Huslia community facilities (the new Jimmy Huntington School, the washeteria, and clinic) with local, sustainably harvested woody biomass. The fuel cost savings of the 25 year life of the project are estimated at approximately $1.5 million. It employed about a dozen individuals from Huslia during the construction part of the project. Once re-commissioned after warranty issues are addressed in summer 2021 and fully operational, it is expected to create 5-12 part time jobs for wood harvesters and 2 part time jobs for boiler operators for upcoming years. Due to additional challenges, the project is not operating yet at full capacity, and the actual savings from the project could not yet be verified. Future methods to accurately record individual fuel oil usage in each of the buildings should be practiced.

Lessons Learned:

Probably the most important lesson learned is about the importance of having a review of the design before any other planning starts. An evaluation of the design by outside entities that have worked with or are involved with the particular technology, in this case including the vendor of the GARN units, is absolutely essential in order to ensure that the design is robust and appropriate. The importance of this point cannot be stressed enough.

On the supply chain side, a very important lesson learned is that a good supply chain for biomass fuel doesn't happen by itself, and requires effort and time. Burning biomass is most efficient if the biomass fuel has less than 20% moisture content, i.e. if it is dry enough. Sources of biomass fuel include either dead trees, of which there is a limited amount, or live trees that are harvested and then cured for more than half a year (ideally a year or more), or live trees that are girdled by stripping a horizontal ring of bark, killing the tree that is still upright, and more than half a year later the girdled trees are ready to be harvested. All of this means that a good supply chain needs to be promoted among the community early enough in order to be in place perhaps a year before the biomass system is ready to be fired up, so that green wood can cure, and enough biomass is cured at biomass system startup to sustain full operation. This is especially true because biomass harvesting occurs primarily in one season out of the year - in winter, when the ground is frozen and a blanket of snow allows for snowmachine travel.

Business planning also needs to include all of the stakeholders from the beginning, including the community, the school district and the city, since the community needs to provide the biomass fuel, and the school district and the city own the other buildings involved, the school and the water treatment plant and washeteria, respectively.

Timing of the project with respect to other planning occurring in Huslia was critical. The project was economically feasible only because the school was being renovated and the school district was willing to bring the school into the biomass heating system and put in the appropriate heating system and connections to the planned biomass system.

There was some miscommunication with the school district regarding their scope of work. The school district originally said they would complete the connections through the building wall and into the heat pipe coming in from the biomass side of the building. They did not include the wall penetrations in their specification. Once the missing penetrations were identified, the quote the school district received for them was higher than anticipated. As a result, HTC worked to split the difference with the school district and get the scope of work completed. The school district also required that the BTU meter be mounted at the school, not at the biomass building. The BTU meter quantifies how much heat is being transferred. The school district did not want to be paying for heat lost in transit. This was a change from the original plans.

The design cost estimate of the biomass building did not include geotech work as it was assumed that existing geotech information would be used. Unfortunately, there was insufficient existing information to clarify if the planned foundation was suitable for that location. As a result, the design cost went over budget and Alaska Native Tribal Health Consortium, one of the project partners, was able to cover the excess cost.

Shipping always takes a long time to Rural Alaska communities. The steel building was procured and sent to Nenana to be put on the first barge of the season to Huslia. The underground biomass piping and the three biomass boilers were ordered early enough to both lock in pricing and not be hit by a planned price increase the following year. This included enough lead time for shipment from Minnesota to Nenana on a truck, with time to catch the last barge of the season from Nenana to Huslia.

Some unforeseen cost increases were absorbed by the project. Both the building pad and the building construction estimates were 20% higher than expected.

Flexibility in timing and contracting due to changing and challenging circumstances was important. Although the project started on time, there were significant delays. Specifically, the original mechanical contractor started the mechanical construction, but suffered a major health issue in the fall of 2018, resulting in delay. The contractor intended to complete the project once he recuperated, but was ultimately unable to complete the project. A different contractor was hired to finish the project.

Complications due to the coronavirus pandemic and COVID-19 restrictions have also contributed to delays, including getting the new contractor on-site. When the State of Alaska ordered emergency measures in March 2020, the City of Huslia put restrictions on access to the community. Many of the restrictions continue to be in place at present, a year later. At times, the City of Huslia only allowed freight but no people into the community, with exceptions for residents who left for medical emergencies. A few other exceptions were made. Besides the obstacle of restricted travel to and from Huslia, additional limitations on access to specific buildings (the clinic) also created further delays.

The snow stops on the building were damaged during the first winter. Replacements were shipped to Huslia during summer 2020 and installed by local labor. The project aimed to use as much local labor as possible, regardless, and local labor also was not impacted by the COVID-19 travel restrictions.