CARBONSAFE PHASE II PROJECT READINESS
Alaska Railbelt Carbon Capture and Storage (ARCCS) Project

PREAMBLE

The Railbelt of Alaska is facing an imminent shortage of natural gas and electricity supply. The Railbelt contains 75% of Alaska's population and extends from Fairbanks to Anchorage and the Kenai Peninsula. A winter peaking load that is not interconnected to a larger grid, the Railbelt is described as "a unique electrical system in the US".[1] For more than 60 years, the Railbelt has depended on natural gas from the Cook Inlet Basin as its primary energy supply for both electricity generation and for direct use. Hilcorp Energy Company (Hilcorp), which supplies ~85% of the natural gas to Southcentral Alaska (Southcentral), recently gave notice that depleting Cook Inlet gas reserves prevent renewal of utility supply agreements beginning in 2025.[2] The need to find other energy sources is urgent.

A dominant electricity producer in Southcentral, the Chugach Electric Association, Inc. (CEA), relies on gas for 80% of its electricity needs. CEA states in its review of gas resources, "Absent sufficient production from the Cook Inlet, and with North Slope [gas] pipeline projects years away, the study concluded it may be necessary for Southcentral utilities to import either liquid or compressed natural gas to fill the gap."[3] Importing liquefied natural gas (LNG) from the Asia-Pacific region creates significant fuel price risk and is expected to substantially increase Southcentral electricity prices.

Alaska's energy demand per capita is the second-highest in the nation. It is the only U.S. state with land north of the Arctic Circle where winters are frequently severe. Concurrent with high energy demand is the high cost of energy: Alaska industrial electricity prices were more than twice the U.S. average as of March 2023, 19.07 vs. 7.91 cents/kWh, respectively.[4] Electricity prices in rural areas can be three to five times higher than urban areas.

To support rural communities, the state has created a financial assistance program to help cover the cost of electricity. This power cost equalization (PCE) program equalizes rural power costs to near the average cost of power in the urban areas including the Railbelt plus Juneau. Residential and community facility buildings in 195 communities are eligible for the reduced electricity rates through the PCE program, and the PCE program furthers rural community development through rural utility assistance and training programs. Thus, through the PCE program, investments that lower electricity costs in the Railbelt will lower electricity costs across the state.[5]

The National Renewable Energy Lab (NREL) completed a Railbelt electrical grid study in 2022, assessing five alternative scenarios for renewable power including a mix of hydro, geothermal, tidal, wind, and solar.[6] Even the highest renewable energy scenarios require fossil thermal-energy backup for reliable power generation and retain at least 75% of the current fossil thermal energy generation capacity.

---

[1] Waterpower, www.waterpowermagazine.com/features/featurehydropower-and-the-alaska-railbelt-9761276 (accessed May 2023).
[2] DeMarban, A., 2022, Hilcorp warns Alaska utilities about uncertain Cook Inlet natural gas supplies: Anchorage Daily News, May 17, 2022.
[3] Chugach Electric Association, 2020, Electric utility tariff: www.chugachelectric.com/system/files/regulatory_affairs/North_District_Operating_Tariff_-_Electric.pdf (accessed January 2023).
[4]U.S. Energy Information Administration, www.eia.gov/state/analysis.php?sid=AK (accessed June 2023).
[5]Alaska Energy Authority, www.akenergyauthority.org/What-We-Do/Power-Cost-Equalization (accessed June 2023).
[6] Denholm, P., Schwarz, M., DeGeorge, E., Stout, S., and Wiltse, N., 2022. renewable portfolio standard assessment for Alaska's Railbelt: Golden, CO, National Renewable Energy Laboratory. NREL/TP-5700-81698. www.nrel.gov/docs/fy22osti/81698.pdf.

Providing carbon capture, utilization, and storage (CCUS) for required fossil thermal power generation could be viewed as a priority over alternative options in the Railbelt and Southcentral.

A statewide screening of CCUS for Alaska concluded the Cook Inlet Basin is the most prospective region for carbon storage adjacent to population centers and existing electrical grid. The study, documented in *The Alaska CCUS Workgroup and a Roadmap to Commercial Deployment,*[7] found high storage potential in the Cook Inlet and in the remote, isolated North Slope. Extensive subsurface datasets are available but lack the integrated assessment required to define carbon storage volumes with high confidence.

Coal-fired power generation with CCUS presents a compelling alternative to imported LNG by providing affordable, reliable, clean electricity to the Railbelt grid at substantially lower than current costs—which through PCE lowers energy costs across the state for both urban and rural customers. Abundant local coal reserves provide low-cost fuel for power generation ($4/MMBtu) at one-half to one-quarter the cost of natural gas (~$10/MMBtu) or diesel and naphtha ($20/MMBtu) per the Alaska Energy Authority forecast. Power generation can commence between 6 and 8 years from the start of front-end engineering design (FEED). CCUS is viewed as critically necessary to address climate concerns and for public acceptance of a new dual-fuel (coal and biomass) power generation facility. With CCUS, a coal-fired power generation plant emits one-quarter to one-half the greenhouse gas emissions of a natural gas-fired plant without CCUS. CCUS is not yet commercially attractive for natural gas-fired power plants in Alaska.

Power generation with CCUS supports the objectives of the Governor and of Alaska's Office of Energy Innovation in accessing a secure and diverse energy mix for safe, reliable, and affordable energy for Alaskans and Alaska's desire for leadership in "both carbon capture, utilization, and storage and building the critical minerals of this state and nation."[8] The Governor's Administrative Order No. 340 places "policies that enable Alaska to capitalize on its vast energy potential in order to lower the cost of energy and enhance the stability of energy delivered to Alaskans" as the first listed purpose of the Office of Energy Innovation.

CCUS in Alaska is well positioned for success, and completion of the Alaska Railbelt Carbon Capture and Storage (ARCCS) project will result in a notably reduced project risk profile by defining the carbon storage capacity in northern Cook Inlet. Favorable storage complex and project attributes for the Cook Inlet Basin include 1) the most mature oil and gas basin in Alaska, with significant CO_2 storage potential in depleted oil and gas reservoirs and saline aquifers and geologic data for these fields are abundant and readily available; 2) the existing oil and gas infrastructure that could support the transport and injection of CO_2; 3) the surrounding communities have longstanding and generally positive relationships with the oil and gas industry, so investment in CCUS is expected to be received favorably. Initial project economic screening incorporating capture; transport; Class VI wells; permitting; and monitoring, verification, and accounting (MVA) suggest commercial-scale CCUS is economically attractive.

These factors, combined with the University of Alaska Fairbanks (UAF), Advanced Resources International (ARI), and the University of North Dakota Energy & Environmental Research Center (EERC) (the Project Partners) extensive experience with CCUS through the Plains CO_2 Reduction (PCOR) Partnership Initiative and other CarbonSAFE Initiative efforts will ensure a successful Phase II effort. Investing in this ARCCS assessment will enable reliable, affordable, clean power generation for the Railbelt, addresses the imminent natural gas supply energy shortfall, and, by lowering electricity costs

[7]SPE-213051, Alaska CCUS Workgroup and a Roadmap to Commercial Deployment, May 2023, https://doi.org/10.2118/213051-MS.

[8] Alaska Department of Natural Resources, 2022, Hilcorp plan of lease operations, Beluga River K pad expansion application: https://aws.state.ak.us/OnlinePublicNotices/Notices/View.aspx?id=207439.

in urban areas, benefit rural communities across the state by lowering their electricity costs through the PCE program.

1.0 COOK INLET CARBON STORAGE SCENARIO ANALYSIS

1.1 Probability of Storing 50 Million Metric Tons of CO_2 in a 30-Year Period

The ARCCS project in the Cook Inlet region of Southcentral Alaska evaluates storing CO_2 captured from a new 400-megawatt gross (~300-megawatt net with carbon capture plant load) dual-fuel capable power generation plant and two natural gas-processing plants (Figure 1). This feasibility study will evaluate the aggregation of CO_2 captured from these sources for injection into a geologic storage complex on the northern shore of Cook Inlet Basin. This ambitious effort will support the pursuit of a low-carbon, economically affordable, reliable energy supply option to address the pending shortage of natural gas and electricity supply in the Railbelt of Alaska, which contains 75% of Alaska's population and extends from Fairbanks to Anchorage and the Kenai Peninsula.

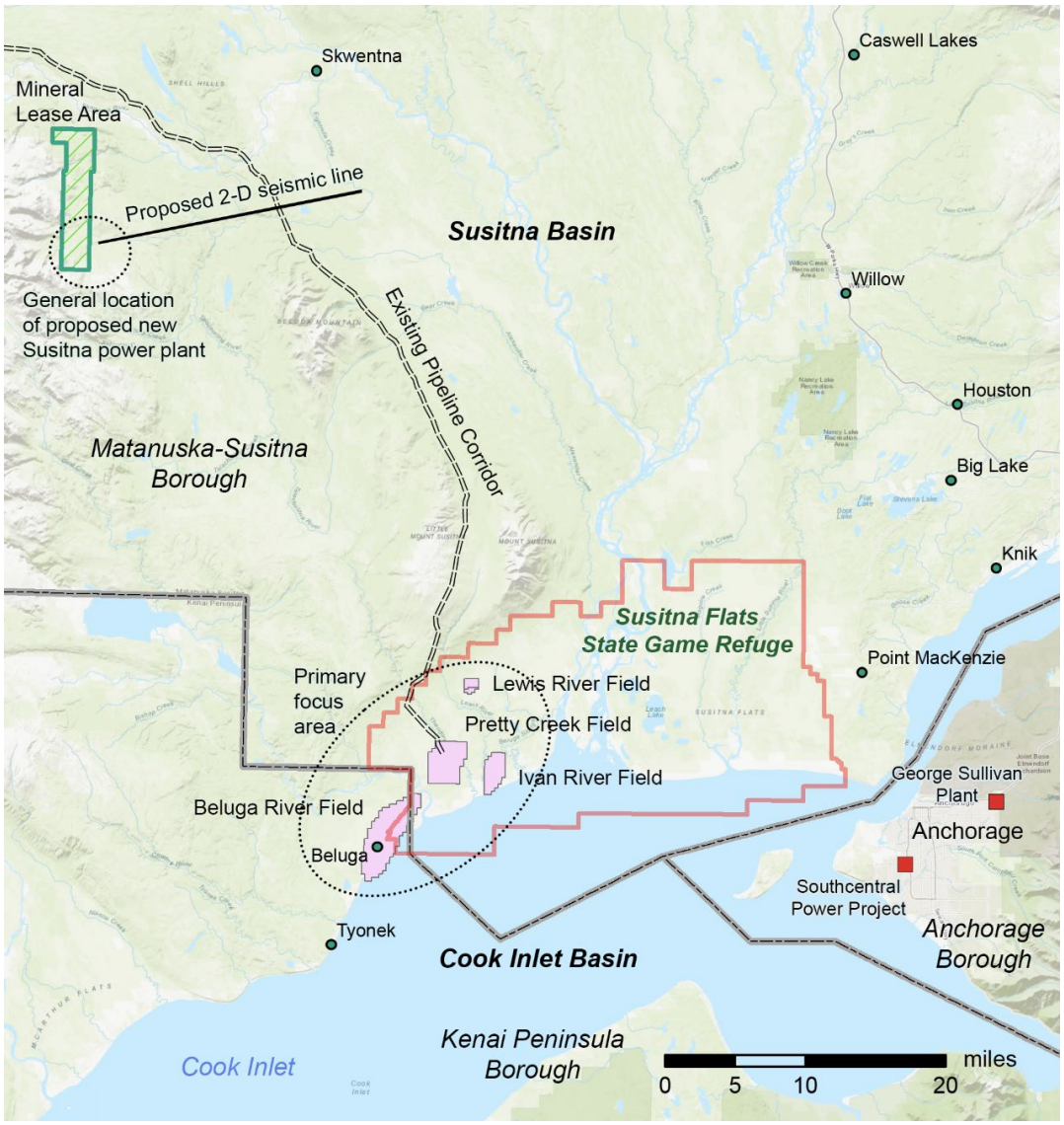

Figure 1. Map of proposed CO_2 storage location and proximity to CO_2 sources. Existing sources are shown as red squares. The location of the proposed Susitna power plant is indicated in the northwest map area.

Capture and storage from the proposed power plant alone over a 30-year period will exceed 60 million tonnes of CO_2. As discussed in Section 2.3, Prospective Storage Resources, the proposed primary CO_2 storage horizon is the production zone of the Beluga River Field, a nearly depleted unitized gas field. Based on gas volumes produced to date and using CO_2 density at reservoir conditions, the prospective CO_2 storage resource for the Beluga River Field is estimated at 157 Mt. This resource estimate is nearly three times what is needed to meet the CarbonSAFE requirements and sufficient for approximately 60 years' worth of storage resource for CO_2 captured from a 400-MW gross power plant (300-MW-net delivered power after CCUS) at 2.6 million tonnes per year. The inclusion of other depleted regional fields could push the total to nearly 200 Mt of storage.

1.2 Map Showing Sources, Pipelines, Storage Site(s), Footprint of CO_2 and Pressure Plume, Land Use

See Figure 1 for the distribution of candidate sources (Table 1) and notional pipeline route(s). The extent of the CO_2 footprint within each of the depleted gas fields will be constrained by the structural closure of each field. The extent of the critical pressure plume (as defined by the U.S. Environmental Protection Agency (EPA) may reach beyond the edge of the CO_2 plume. More refined dimensions of both plumes will be determined through the data collection, geologic modeling, and subsequent dynamic simulation proposed for this project.

Table 1. Potential CO_2 Sources for the ARCCS Project

Name	Annual CO_2 Emission, metric tonnes per annum
George Sullivan Plant 2, Chugach Electric Association	316,000
Southcentral Power Project, Chugach Electric Association	426,000
Proposed New 300-MW Net Power Plant, Flatlands Energy	2,600,000

1.3 Anticipated Business Contractual Requirements to Address Technical and Financial Project Risks

Several business contracts will need to be negotiated in the pursuit of addressing technical and financial risks associated with a large-scale integrated carbon storage project in the Cook Inlet region of southern Alaska. A number of these potential contracts are enumerated in Table 2, in no particular order.

Table 2. Future Contract Requirements

Contract Description	Purpose
Contract with Drilling and Logging Company to Drill, Core, and Log Stratigraphic Test Well.	Providing subsurface geologic properties of the target formation will allow for an accurate estimation of CO_2 plume size and injection rates.
Establish Pore Space Leasing Contract and Per-Acre Pricing	An early establishment of a fair and comprehensive pore space leasing agreement document will ensure that the process moves forward in a smooth and positive manner.
Secure a Land-Use Permit	A land-use permit from the borough or local land management agency is necessary for the ultimate installation of one or more Class VI wells.
Establish Purchasing or Leasing Agreement to Acquire Land for Ultimately Placing a Class VI Well	Depending on the final site selection for one or more Class VI injection wells, a purchasing or leasing agreement will be required to acquire the land needed for a surface facility and wellsite.
Apply for U.S. Department of Energy (DOE) Guarantee Loan Program and Negotiate Repayment Terms	A successful loan application will provide assurance that the project will proceed to completion.

1.4 Level of Commitment

We have received more than 15 letters of support or commitment regarding the ARCCS project. Each organization is committed fully within their individual scopes and spheres of influence to move CCS forward in a manner that is economically attractive and publicly acceptable.

Governor Dunleavy and his administration strongly support the proposed ARCCS project. As evidenced in the attached Letter of Support, he is committed to working with the legislature to appropriate up to $2.25 million for the ARCCS project. This commitment is the primary reason we have selected a project start date of July 1, concurrent with the beginning of Alaska's fiscal year. The ARCCS project compliments Governor Dunleavy's Carbon Management and Monetization Bill package. Senate Bill 49 and House Bill 50 specifically creates new authorities for State agencies to license, lease, and administer the State's pore space for geological storage; administer pipeline infrastructure for transportation of captured carbon to geological storage facilities and administer injection wells and carbon storage facilities; and protect correlative rights of all subsurface owners. The legislature will resume its consideration of these bills in January 2024.

The applicant team has assembled letters of commitment and other letters of support that included as separate attachments within the proposal package. The cost share letters are summarized here:

- ARI has committed to providing $420,491 to support the proposed project. This contribution speaks to the seriousness of ARI's intent to support the goal of the DOE CarbonSAFE initiative.
- The Alaska Division of Oil and Gas is the agency responsible for holding lease sales for Alaska. Their Resource Evaluation team has committed $137,131 in labor to assist with identifying which reservoirs are most suitable for long term sequestration of CO_2, interpreting log and seismic data, and reviewing work products.
- The Alaska Division of Geologic and Geophysical Surveys (DGGS) has an ongoing Cook Inlet program. An important aspect of the program is to understand how and when these strata were deformed to produce hydrocarbon trapping structures, conduits for fluid migration, and fracture porosity. These results are integrated with the subsurface geology in prospective regions of the basin using available seismic, core, and wireline log data, in an effort to maximize value for the ARCCS project. DGGS activities are calculated to cost $574,466, which is included in the cost share commitment provided by Governor Mike Dunleavy.
- Blueprint Alaska (BPA) is a female-owned, advocacy and strategic communications firm headquartered in Anchorage. They work with a range of Alaskan clients involved in oil and gas, mining, health care, business development, Alaska Native Corporations, and aviation. BPA will provide support to the continuing efforts of the Workgroup described in our Community, Labor and Stakeholder Engagement efforts by assisting with social media and outreach. They are committing $49,875 in cost share.
- Friends of West Susitna (FOWS) is a non-profit grassroots organization made up of long-time Alaskans whose mission is to advocate for the State of Alaska to provide year-round road access to state-owned lands west of the Susitna River. They will assist ARCCS by arranging for outreach to nearby villages and other stakeholders. FOWS is committing $40,000 in cost share.
- Flatlands Energy Corp. has been operating in the Susitna region since 2015. They have completed a multi-year exploration program and is now advancing feasibility of a duel fueled biomass and coal CCS power plant. They are providing cost share of $68,736.
- IRT has worked closely with UAF and DNR to facilitate the public Workgroup meetings for developing a CCS industry in Alaska. They also bring considerable technical expertise to the ARCCS project and have committed $98,764 of cost share.
- Mike Belowich of Belowich Coal Consulting (BCC) is a long-time geologist working in the Cook Inlet Basin. He has an impressive history of drilling core holes and correlating log results yielding new and better understandings of the Cook Inlet geology. BCC is providing cost share of $19,376.

- UAF, a Minority Serving Institution, is looking forward to building capacity within the State by closely working with EERC and ARI. UAF is committing $335,412 in cost share. In addition to utilizing its existing faculty, UAF will grow its expertise by hiring additional faculty, Postdocs, and support four graduate students.

1.5 Estimate of Anticipated Capital and Operating Costs

One of the variables cited as controlling the influence of cost for a CO_2 storage complex is how well-suited the geologic target is for CO_2 storage. The geologic setting represented in depleted gas fields provides evidence of conditions necessary to contain buoyant fluids for millions of years, thus moving the expected costs associated with the geologic storage of CO_2 to the lower range. Following DOE approval of this proposed initiative, UAF and its partners will collaborate on determining the capital and operational costs of the system as follows:

a) Capital cost for the CO_2 capture facilities – estimation of the cost for integrated CO_2 capture facilities at the proposed new electric generation station and associated operational costs of the capture facilities. The same type of information will be generated for the smaller existing CO_2 emission sources, as shown in Figure 1.

b) Capital and operational costs for the transportation of the captured CO_2 from the proposed power plant and other candidate CO_2 sources to the central injection location. A preapproved pipeline corridor in the area will be leveraged for the use of rights of way (ROWs) and to facilitate permitting and construction.

c) Capital and operational costs for the injection wells. The cost for the drilling of stratigraphic or monitoring wells will be included in the estimate for the injection wells.

d) The future costs associated with the monitoring, verification, and reporting (MVR) of the CO_2 plume, pipeline operations, facilities, etc., will be outlined and included as part of the cost of this project.

As a result of the reviews mentioned above associated with the Phase II efforts, a more accurate and precise estimate of the storage costs for future CarbonSAFE Program implementation phases and projects can be realized.

1.6 Anticipated Needs and Strategy to Secure Financing and/or Cost Share

Investment into a regional CCUS facility in the Cook Inlet area can capitalize on several financial leveraging opportunities. From a national perspective, the U.S. government, through its 45Q program, offers an $85/metric ton tax credit for CO_2 securely stored in geologic formations. DOE offers access to capital for large-capacity CO_2 transport projects under the carbon dioxide transportation infrastructure finance and innovation (CIFIA) program. Additional sources of funding to move a pioneering effort like this forward in Alaska could also come from the recently introduced Alaska Energy Independence Fund.

1.7 Strategy for Securing Pore Space Rights

Acquiring the legal right to access and use the pore space of a geologic formation for permanent CO_2 storage is required for commercial CCS projects.[9] The owner(s) of the overlying surface estate and the mineral estate are important considerations for CO_2 injection and storage. Conflicts or shared interests

[9] Peck, W.D., Regorrah, J.G., Doll, T.E., Nakles, D.V., Pekot, L.J., and Connors, K.C., 2021, Pore space—technical and legal considerations for CO_2 storage in North Dakota: Plains CO_2 Reduction (PCOR) Partnership Initiative White Paper for U.S. Department of Energy National Energy Technology Laboratory and North Dakota Industrial Commission, October.

between the oil and gas operator and the carbon storage pore space leaseholder may arise. Currently, in Alaska, pore space is considered a mineral and is therefore controlled by the mineral owner. The state is currently reviewing this aspect of pore space leasing through a recently introduced bill (see Section 1.8). There may be project upsides to working in conjunction with the hydrocarbon-producing field owner, e.g., rather than abandoning certain equipment upon cessation of production, some may be repurposed for the storage project.

1.8 Role of State Incentives/Policies Toward Economics and Public Acceptance

In January of 2023, Alaska Governor Mike Dunleavy introduced a CCUS bill (Senate Bill 49 and House Bill 50) that contains multiple sections, including use of public lands, pore space leasing, allowing CO_2 transportation by pipelines, and addresses ownership of carbon dioxide and ascription of liability. The bill empowers the Alaska Department of Natural Resources (ADNR) and the Alaska Oil and Gas Conservation Commission (AOGCC) to manage unitization, protection of other mineral interests, amalgamation of property rights, and preservation of existing rights. This CCUS bill proposes a competitive licensing and leasing program for carbon storage by allowing operators of CO_2 enhanced oil recovery (EOR) operations to transition straight into CO_2 storage operations. The bill also proposes a robust carbon storage permit process for the AOGCC to administer pore space leasing, manage competing subsurface uses, and ensures the protection of other reservoirs such as nearby hydrocarbon or geothermal production. The bill was generally well-received by the State Legislature and multiple hearings on the bill have gathered public input. It bodes favorably for passage next session (first quarter of 2024) that in 2023, the Legislature authorized the State to seek Class VI primacy from the EPA.

1.9 Potential Sources of Revenue

The current federal incentives, such as the 45Q tax credit, provide a financial incentive for Flatlands Energy to make these investments and provide returns to its shareholders that may not otherwise be available. This provides diversification to Flatlands Energy's portfolio of services that can benefit stakeholders long-term.

The availability of a steady supply of captured CO_2 will also be attractive to potential EOR or enhanced gas recovery (EGR) operators in the Cook Inlet area or beyond. Revenue gained from the potential sales of CO_2 to regional hydrocarbon production companies would be notable.

1.10 Long-Term Liability for Stored CO_2

In early 2023, House Bill 50 was introduced in the Alaskan legislature. This proposed legislation relates to the geologic storage of CO_2 and includes provisions for the long-term liability of the stored CO_2. Once a certificate of project completion is issued by the state, title to, and liability for, the CO_2 storage facility and the stored CO_2 transfers to ADNR. As of June 2023, the proposed legislation was moving through the approval process and will be taken up again by the Alaska State Legislature when the session continues in January 2024.

2.0 TECHNICAL SUBBASINAL EVALUATION

2.1 Storage Reservoir(s)

The primary storage target is the 7.5-mi long by 2.5-mi wide Beluga River gas field. The field produces from two formations: the overlying high-net-to-gross Pliocene-age Sterling Formation and the underlying low-net-to-gross Miocene-age Beluga Formation. These formations consist of thick sequences of nonmarine, fluvial-dominated, volcanic to arkosic sandstone, siltstone, mudstone, and coal. Gross reservoir thickness is up to 3400 feet and consists of dozens of stacked channel belt and crevasse splay sandstone beds separated by laterally continuous, relatively impermeable flood basin siltstone, mudstone,

and coal.[10] There are currently nine producing zones in the reservoir complex, with a net sand average porosity of 32% for the three in the Sterling Formation and 21% for the six in the Beluga Formation. These production zones will be the initial targets for CO_2 injection and storage. In the secondary gas field storage targets (Ivan River, Pretty Creek, and Lewis River Fields), the candidate storage intervals are in the Tyonek and Beluga Formations (Figures 2 and 3).

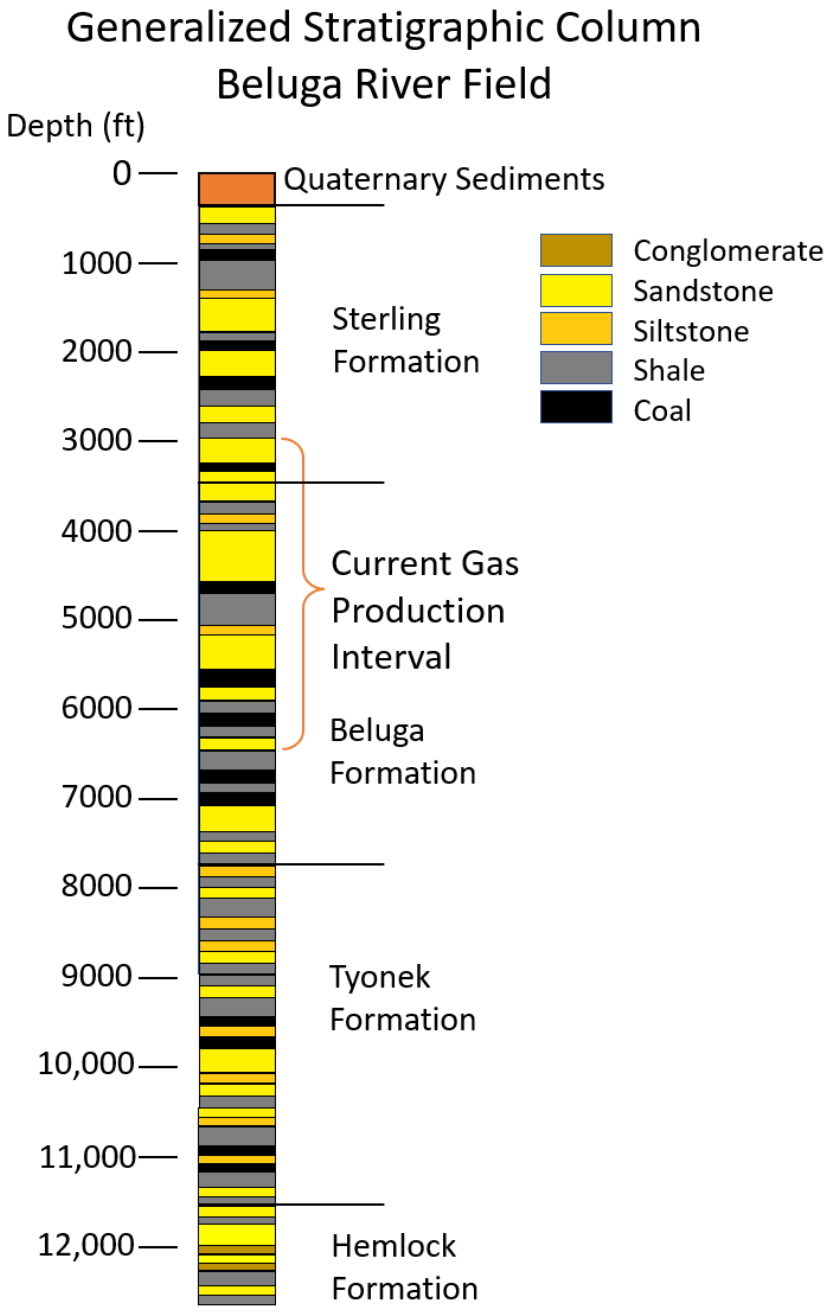

Figure 2. Generalized stratigraphic column of Beluga River Field.

[10] Levinson, R.A., 2013, Beluga River gas field, Cook Inlet, Alaska, *in* Stone, D.M., and Hite, D.M., ed., Oil and gas fields of the Cook Inlet Basin, Alaska: AAPG Memoir 104, p. 245–261.

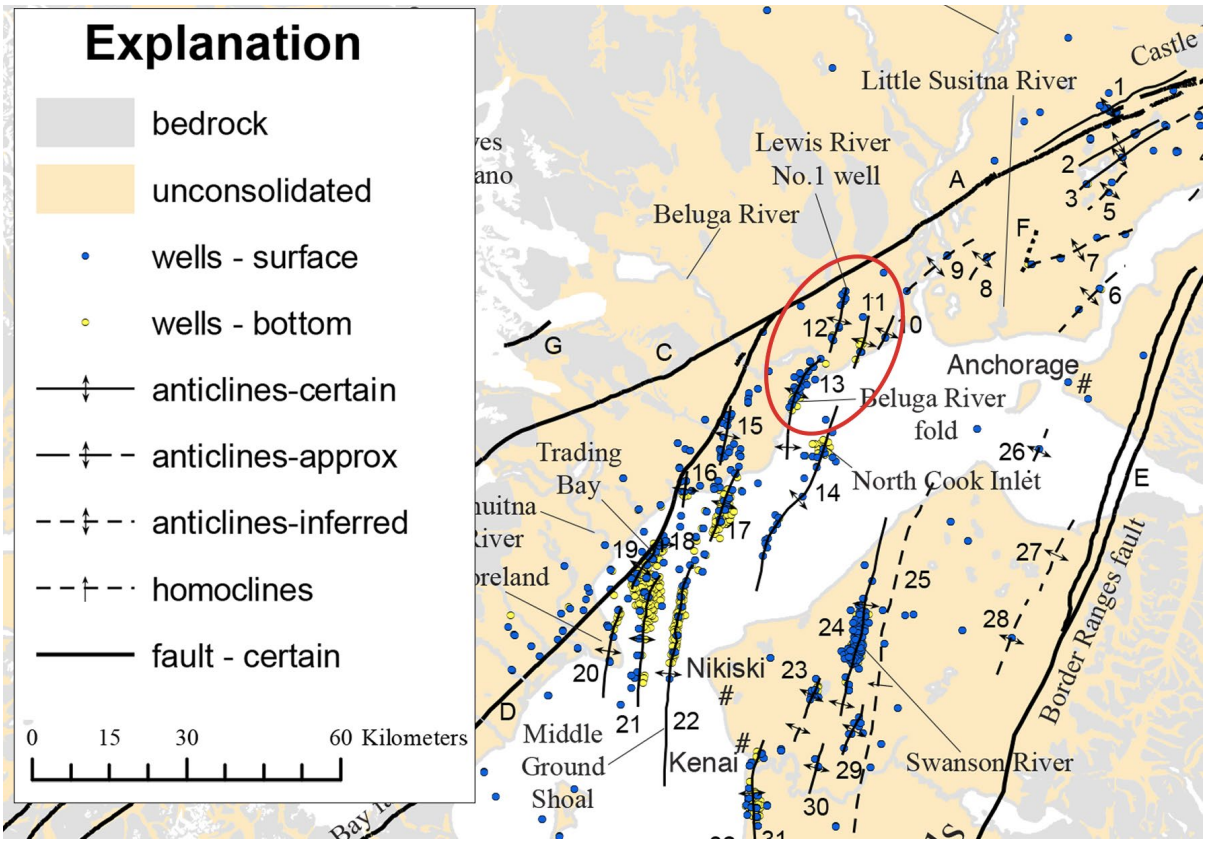

Figure 3. Anticlines and faults of the northern Cook Inlet. Anticlines 11, 12, and 13 correspond to the Ivan River, Lewis River/Pretty Creek, and Beluga fields, respectively. (Modified from Haeussler and Saltus, 2011.)[11]

2.2 Confining System

The stratigraphic confining intervals of the stacked channel belt deposits comprise laterally continuous flood basin siltstones, mudstones, and coals[12] within the Sterling and Beluga Formations. The overall structural trap in each of the prospective gas fields is a broad north-northeast-trending double plunging anticlinal structure with a steeply dipping reverse fault along the west side. In the Beluga River Unit, there is nearly 600 feet of closure on this structure (Figure 4).

2.3 Prospective Storage Resources

The proposed primary CO_2 storage horizon is the production zone of the Beluga River Field, a nearly depleted unitized gas field. The reservoir is located approximately 4000 feet deep and has a discovery pressure of approximately 2500 psi. Assuming a surface temperature of approximately 60°F with a geothermal gradient of 0.015°F per foot results in a reservoir temperature of approximately 120°F. Under these reservoir conditions, natural gas has a density of approximately 7.8 lb/ft^3 compared to a density of

[11] Haeussler, P.J., and Saltus, R.W., 2011, Location and extent of Tertiary structures in Cook Inlet Basin, Alaska, and mantle dynamics that focus deformation and subsidence, *in* Dumoulin, J.A., and Galloway, J.P., eds., Studies by the U.S. Geological Survey in Alaska 2008–2009: U.S. Geological Survey Professional Paper 1776–D, 26 p.
[12] Levinson, R.A., 2013, Beluga River gas field, Cook Inlet, Alaska, *in* Stone, D.M., and Hite, D.M., ed., Oil and gas fields of the Cook Inlet Basin, Alaska: AAPG Memoir 104, p. 245–261.

approximately 0.044 lb/ft^3 under standard conditions[13] and when integrated with production to date, results in a total reservoir volume available of approximately 7.3 Bcf.

Under the same reservoir conditions, CO_2 has a density of 46.8 lb/ft3 (749 kg/m^3)[14]. The same 7.3 Bcf of reservoir volume **could be occupied by approximately 157 Mt** of injected CO_2, three times what is needed to meet the CarbonSAFE requirements. At CO_2 capture rates associated with a 400-MW gross power plant (300-MW-net delivered power after CCS) of 2.6 million metric tons per year, this **provides approximately 60 years' worth of storage** resource. The inclusion of other depleted regional fields could push the total to nearly 200 Mt of storage.

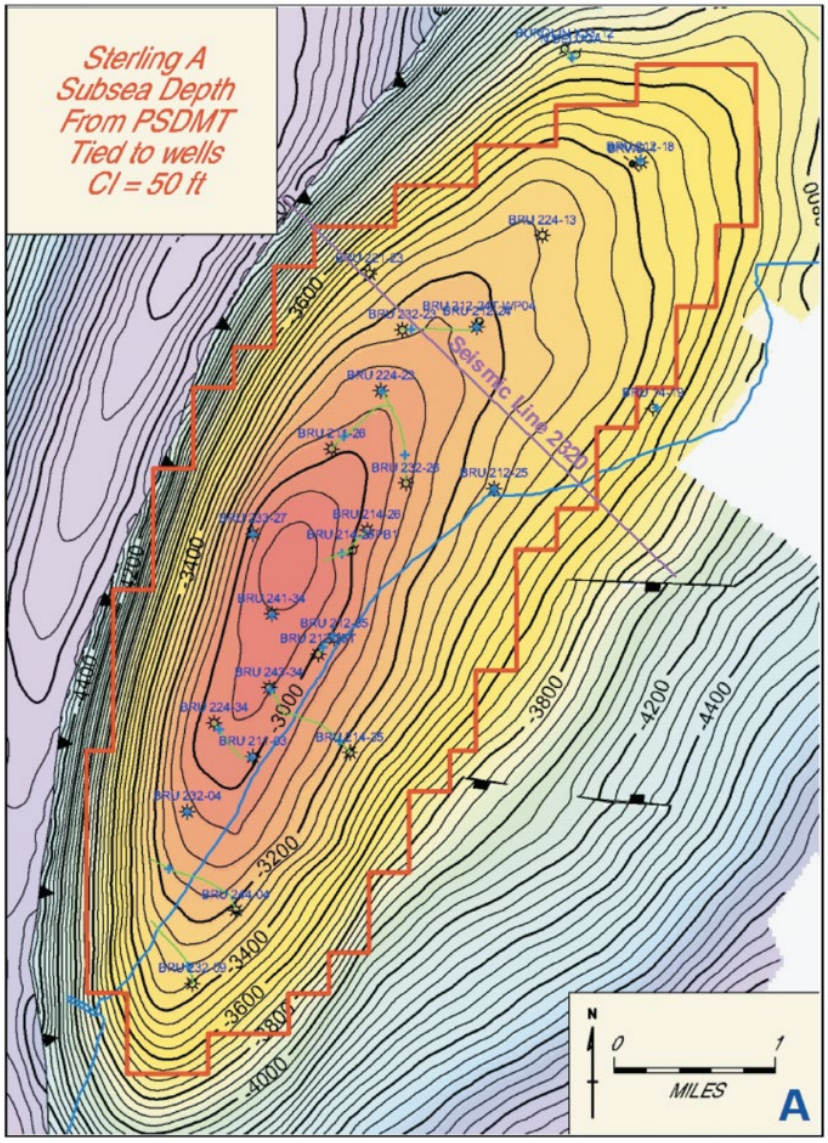

Figure 4. Geological structure map on the top of the Sterling A interval, which is the top of the productive interval of the Beluga River gas field.[12]

[13] Unitrove, 2022, Natural gas density calculator: www.unitrove.com/engineering/tools/gas/natural-gas-density (accessed September 2022).
[14] MegaWatSoft Inc., 2022, September 26. CO_2 tables calculator: Retrieved from www.carbon-dioxide-properties.com/co2tablesweb.aspx (accessed January 2023).

2.4 Summary

The petrophysical properties of the Sterling and Beluga Formations and the presence of effective confining intervals result in favorable conditions for the injection and secure permanent storage of CO_2. These primary characteristics demonstrate viability as a storage reservoir for CO_2 and are summarized in Table 3.

Table 3. Beluga Formation Properties[15]

Property	Value
Thickness	~4500 feet gross thickness
Net-to-Gross (NTG) Ratio	15%–40% NTG
Porosity	12%–28%
Permeability	0.1–100 milliDarcy

3.0 REGIONAL CONSIDERATIONS ANALYSIS/SITE-SELECTION PROCESS

3.1 Protected and Environmentally Sensitive Areas

3.1.1 Water Resources

Any CCUS project must take appropriate steps to ensure the protection of underground sources of drinking water (USDWs). A USDW is defined by the Safe Drinking Water Act (U.S. Code [USC] 42 §300f) as an aquifer that contains water with total dissolved solids (TDS) less than 10,000 mg/L. Also, CCUS projects should be designed and operated in a manner that prevents injected CO_2 from leaking into overlying USDWs. The Cook Inlet Aquifer System encompasses floodplains along the Susitna River, the Matanuska River, and other smaller drainages as well as coastal lowlands along northern Cook Inlet. The aquifer is generally composed of alluvium and glacial outwash. These are relatively thick deposits made up of clay, silt, sand, gravel, and boulders. Where these deposits are locally coarse-grained (sand and gravel), they yield shallow groundwater. Depth to water is likely to be less than 100 feet throughout the system.[16] Nearly 40 shallow groundwater wells are in the project area near the Beluga Field. These wells range in depth from 20 feet to 518 feet deep.

3.1.2 Cultural

A portion of the proposed pipeline route from the mineral lease area to the Beluga River Field follows the Iditarod National Historic Trail. The Beluga Field is bordered on the northeast by the Susitna Flats State Game Refuge and on the southeast by the Cook Inlet (Figure 1).

3.1.3 Habitat

The upper Cook Inlet is designated as a critical habitat for the Cook Inlet Beluga Whale. The Beluga River Field and the adjacent secondary storage fields (Lewis River, Ivan River, and Pretty Creek) are located inside or intersect the Susitna Flats State Game Refuge. The 300,800-acre refuge is managed by the Alaska Department of Fish and Game (ADF&G) to ensure the protection of fish and wildlife populations and habitat and provide public opportunities for wildlife viewing, recreation, and the use of fish and wildlife and their habitats. Extra care will be taken with respect to any activities that could potentially affect these environmentally sensitive areas.

[15] Hilcorp testimony to Alaska Oil and Gas Conservation Commission for Conservation Order 802, April 12, 2022.
[16] Alaska LNG, 2015, www.arlis.org/docs/vol1/AlaskaGas/Report4/Report_AKLNG_2015_DRR/AKLNG-DraftResourceReport2.pdf (accessed June 2023).

3.2 Pore Space Ownership and Surface Owners Potentially Impacted

The Cook Inlet is dominated by rural landscape and agricultural development. Based on a review of landowner maps of the Beluga Field area, it is expected that a contract for pore space leasing with several landowners would need to be arranged. These owners include the State of Alaska and Cook Inlet Region, Inc. (CIRI), an Alaskan Native region corporation. CIRI has submitted a letter in support of this ARCCS project. In the repurposing of a depleted gas field, there may be the need to work with existing mineral owners for the storage of CO_2.

3.3 Population Center Analysis – Potential Conflicts and Mitigation Strategies

The targeted geologic storage complex in this region of Alaska includes the south-central portion of Matanuska-Susitna Borough (Figure 1). The nearest community to the Beluga River Field is Beluga, a census-designated place (CDP) with a population of 34. The nearest community to a proposed secondary storage area is Skwentna with a population of 62. Other population centers in this area of Alaska include Anchorage (pop. 249,252) and Point MacKenzie (pop. 1852). Based on the community analysis, no black swan scenarios (low-probability, high-impact factors) are foreseen due to macro-level social factors for the proposed project. While the potential exists for some landowner/mineral opposition to pore space leasing, if there is at least 62.5% commitment, the Alaska unitization statute allows for the integration of the minority percentage of mineral owners (pore space is considered a mineral in Alaska). Because Phase II is a feasibility study, potential community impacts are minimal. The proposed 2D seismic line acquisition will be entirely in the remote portions of Alaska, and the temporary and de minimis nature of the planned activity along with the lack of any long-term or regional consequences suggest that this part of the project will not present adverse impacts to any communities. At this time, no potential conflicts are expected. However, if conflicts are discovered through the outreach activities of this project, mitigation strategies will be developed in cooperation with local stakeholders.

3.4 Existing Resource Development

The proposed prime CO_2 storage scenario takes advantage of existing resource development infrastructure, ROWs, and knowledge associated with unitized gas fields in the northern Cook Inlet area (Figure 4). The primary CO_2 storage target is the nearly depleted Beluga River Field. This gas field was developed starting in 1962 and now has 25 wellbores.

3.5 Pipeline ROWs

As shown in Figure 1, there is an existing approved pipeline ROW that extends from near the proposed Susitna power plant to the heart of the primary CO_2 storage area. If CO_2 capture were to be installed on the two select existing gas-fired power plants in Anchorage, transportation to the storage facility would follow the existing ENSTAR natural gas pipeline ROW (Figure 4).

4.0 CO_2 TECHNICAL ANALYSIS

4.1 Commitment of CO_2 Sources

A list of potential CO_2 sources is in Table 1. Each of these organizations has provided a letter of support for the ARCCS feasibility study and has expressed consideration of directing captured CO_2 to the storage facility should the feasibility study show a positive result. The identified CO_2 sources would satisfy the minimum contribution of 50 million metric tons of CO_2 within a 30-year period. Letters of support are provided in the proposal package.

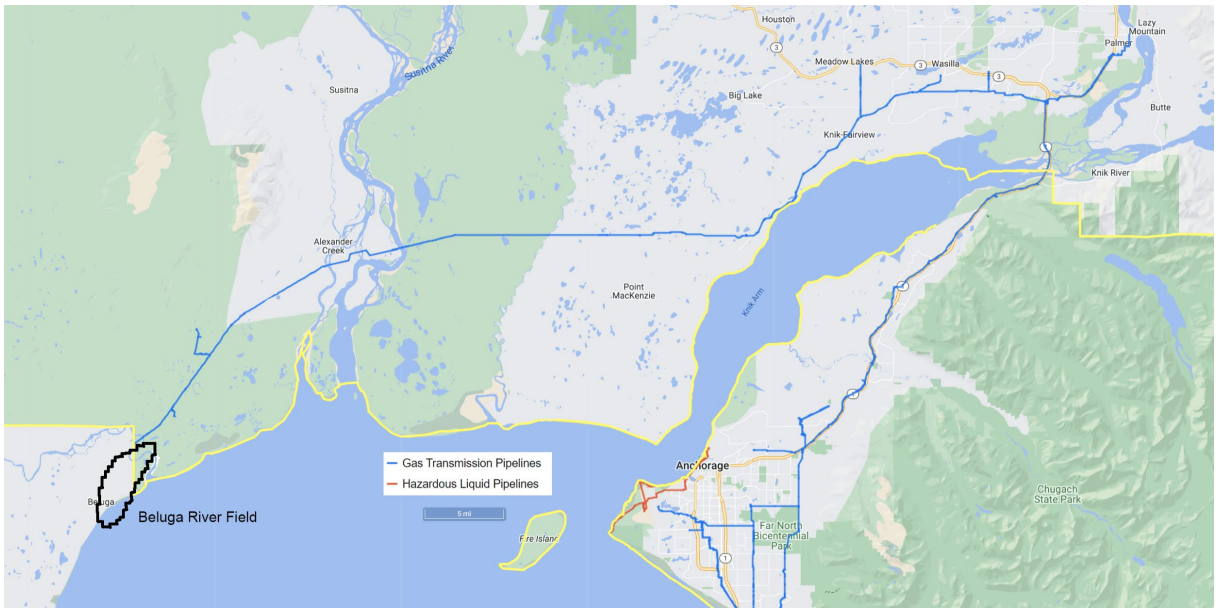

Figure 4. Map showing existing ENSTAR pipeline route from the Beluga River Field to Anchorage. Source: National Pipeline Mapping System (NPMS).

4.2 CO_2 Source Analysis

The planned new Susitna power plant would be designed to deliver its nominally 2.6 Mtpa of captured emissions at a purity of greater than 90% CO_2. The final CO_2 purity level will be determined during a future FEED study. However, any chemical impurity constraints dictated by either the pipeline specifications or the geochemistry of the storage formation will be addressed at the capture facility. Nearly 800,000 mtpa of CO_2 is emitted from the identified existing CO_2 sources (Table 1). Any future CO_2 capture facilities associated with these sources would be engineered to deliver a stream with >90% CO_2 and with levels of impurity low enough so as not to impact pipeline or reservoir integrity/ performance.

4.3 Pipeline Requirements

For any potentially new pipelines, pipeline and construction are permitted through ADNR. Local planning and zoning permits for pipelines will be obtained from the boroughs intersected by the finalized pipeline route. In addition, the State Pipeline Coordinator section of ADNR would regulate the pipeline from the capture facility to the injection well. As such, the pipeline will be designed to incorporate the requirements set out by these jurisdictions as well as to accommodate the CO_2 streams contained within them. The pipeline system will adhere to the monitoring and evaluation requirements set forth by federal, state, local, or other jurisdictions that the pipeline system will intersect or is required to adhere to. In addition, the CO_2 stream will be dehydrated or otherwise treated to maintain the integrity of the pipelines, providing the transportation of the stream from the source to the storage complex throughout the life of the project, with routine monitoring being conducted during the construction, operation, and close-out phases to ensure that the pipeline and associated equipment maintain integrity throughout the life of the system(s).

4.4 CO_2 Pipeline ROWs Analysis

CO_2 captured at the proposed new dual-fuel capable power generation plant would be shipped via a pipeline approximately 60 miles to the Beluga River Field. The CO_2 pipeline would follow a portion of the permitted existing gas pipeline route for the proposed Donlin Gold Mine (Figure 1). If necessary, the distribution of CO_2 to the other abandoned gas fields would follow preexisting pipeline routes (Figure 4).

A portion of the pipeline route would pass through the Susitna Flats Game Refuge managed by ADF&G. The ROW would be within the Pretty Creek public road easement through most of its route through the refuge. Overall, the pipeline would be consistent with the goals of the refuge management plan, and no direct or indirect effects would occur to the state's land use management within the refuge. The portion of the pipeline within the refuge would require a special use permit from ADF&G. Cook Inlet beluga whales are the only Endangered Species Act-listed species potentially impacted by the pipeline project. These whales are common in upper Cook Inlet, including in the vicinity of the Beluga River and Beluga barge landing. Potential effects on beluga whales would be primarily due to the transportation of pipe and supplies via barges for the construction of the pipeline.

5.0 STAKEHOLDER ANALYSIS

The greater project area that may be impacted by the proposed project encompasses three CDPs, Beluga, Skwentna, and Point MacKenzie; and the city of Anchorage (Table 4). Of the four communities mentioned, the prime location of the geologic storage project and resulting CO_2 plume will only have potential impacts on the Beluga CDP which sits directly over the Beluga River gas field (Figure 1).

Table 4. Communities in the Area of the Proposed ARCCS Project

Community	Area, sq mi	Population, 2020	Population Density, persons/sq mi
Beluga CDP	100	34	0.34
Skwentna CDP	450	62	0.14
Point MacKenzie CDP	150	1852	12
Anchorage (urban)	92	249,252	2718

CDPs are a statistical geography representing closely settled, unincorporated communities that are locally recognized and identified by name.

5.1 Community and Stakeholder Engagement Plan

Identifying societal considerations and impacts of the project and creating audience-specific engagement strategies are key elements of effective public engagement where stakeholders can become project partners. As described in the community and stakeholder engagement plan (CSEP) development proposal, the project partners have the extensive regional knowledge, community relationships, and collective experience to produce and implement a plan that will further identify and respectfully engage communities and stakeholders, invite their questions, listen to their concerns, inform their understanding of CCUS, and document the public view of all aspects of geologic CO_2 management within the study region during the feasibility phase and subsequent phases of the project should they be approved.

Engagement activities will be managed by UAF and the EERC. UAF will have final approval of all materials prior to release. In keeping with the best practices outlined in the 2017 update of the Regional Carbon Sequestration Partnerships (RCSPs) Best Practices Manual and based on the experience of the PCOR Partnership, outreach task activities will be coordinated with project development plans and the leadership team. The project team will liaise with other outreach efforts through a project outreach advisory group featuring outreach specialists from project partners and key stakeholders.

Phase II efforts will build on project partner EERC's PCOR Partnership outreach effort, which has been active since 2003; the successful North Dakota CarbonSAFE Phase II project; the ongoing North Dakota CarbonSAFE Phase III project; and the now-commercial Red Trail Energy CCS project with a program of project-focused and broadly based general outreach on CCUS. The PCOR Partnership's project-related outreach activities range from content on the PCOR Partnership public website to participation on outreach advisory panels, custom project-focused outreach materials, and engagement with local

stakeholders. Regional outreach has been accomplished through original documentaries broadcast on public television as well as participation in educator workshops, library conferences, and decision-maker forums. The EERC's core CCUS outreach team is complemented by technical CCUS experts as well as specialists in media relations, graphics, editing, and web programing.