Grade: 6-8 | Time: 4-5 hours

ENERGY ON THE MOVE

Essential Questions:
How is energy transported and distributed?

Overview

Students do research to study one of three energy transportation projects in Alaska, and share their findings through bulletin board displays or notebooks.

Assessment

Can students:

- Compare transportation systems for Alaska's oil, gas, and coal resources?
- Describe how public policy has affected the transportation of fuels in Alaska?

Vocabulary

- Fuel
- Fossil Fuel
- Technology
- Trans Alaska Pipeline System (TAPS)
- Case Study

Alaska Standards Addressed

Science GLEs

The student demonstrates an understanding of:

- how to integrate scientific knowledge and technology to address problems by [6]SE1.1 recognizing that technology cannot always provide successful solutions for problems or fulfill every human need [7,8]SE1.1 describing how public policy affects the student's life and participating in evidence based discussions relating to the student's community.

Geography GLEs

E1) understand how resources have been developed and used;

Library/Information Literacy

B1) state a problem, question, or information need;

2) consider the variety of available resources and determine which are most likely to be useful;

3) access information;

4) evaluate the validity, relevancy, currency, and accuracy of information;

5) organize and use information to create a product; and

6) evaluate the effectiveness of the product to communicate the intended message.

Technology GLEs

E1) evaluate the potentials and limitations of existing technologies;

6) evaluate ways that technology impacts culture and the environment;

Government and Citizenship GLEs

B7) understand the obligations that land and resource ownership place on the residents and government of the state;

F2) be aware that economic systems determine how resources are used to produce and distribute goods and services

Alaska English/Language Arts and Mathematics Standards (2012)

- RSL.6-8.1, RSL.6-8.4, RSL.6-8.7, RSL.6-8.9
- WL.6-8.1, WL.6-8.2, WL.6-8.7, WL.6-8.8
- SL.6-8.1, SL.6-8.2, SL.6-8.4

Teacher Information and Procedure

Prior knowledge for students: Research skills and ability to work in cooperative groups

Source: New. Background Information from previous AMEREF curriculum. (Graphics from depositphotos.com and various other sources used with permission.)

Materials needed

For gear-up activity:

- Buckets or similar containers (4 per group)
- Shovels, baggies, tubing or other items for "tools"
- Water
- Pebbles, clay, or combination of any solid materials

For case studies:

- Resource books and materials
- Display materials(construction paper, sources of photos, glue, etc) and/or
- Several large 3-ring binders and 3-hole punch

What to do in advance

- Prepare liquid and solid containers for the gear-up race
- Gather resource materials.

Teaching the Lesson

Gear-up

Have a "move the fuel" race in the gym, hallway, or outdoors. Divide the class into small teams and give each team two containers: one with 2 or 3 gallons of liquid to represent oil and one with about the same amount of a solid material to represent coal (pebbles, clay, or a mixture of just about anything). Make sure each team's amounts are equal, and give them two empty containers to put at the "finish line". Give each team the task of moving the liquid and solid materials from the full containers to the empty ones (without moving the containers themselves), and give them time to plan their strategy and collect "tools" for their task. Start the race!

Explore

Discuss the race. Which type of fuel was the easiest to move? What if you had to move a gas? Discuss the importance of moving fuel from its sources and distributing it to its users, and the relevance of those issues to Alaska.

Tell the students that they'll be finding out more about three big Alaskan projects that involve the transportation of fuel:

- The Trans-Alaska Pipeline Project
- The Usibelli Coal Mine
- The Proposed Alaska Gas Pipeline

Students are to choose one of the three case studies above to work on, and are to either compile a notebook or produce a display for a bulletin board at school or in the community. (The teacher can choose the assignment or let the student groups choose)

Help students to divide themselves into groups according to their choice of project. Once in the group, each student will be assigned a piece to research. Use the Research Questions handout and the Specific Case Study Handout.

Give students time to conduct their research and compile it in a notebook or display.

Ask each group to summarize the results of their research and share with the class.

Generalize

As a class, compare the three systems. Discuss these questions:

- Are some types of fossil fuels easier to transport than others?
- Why are the fuel transportation systems important to Alaska?
- How and why is the public involved in decisions about transporting fuels? What are some of the types of technology used in fuel transportation?

Assess

Ask students to write in their science journals or on paper:

Identify one or more challenge(s)associated with transporting all types of fuel in Alaska. Describe how public policy affects the transportation and distribution of fuel and the development of new technology.

Extensions, adaptations, and more resources

Invite a speaker to class to talk about one of the projects. Research fuel transportation in another part of the world and compare the challenges with those in Alaska. With a younger or less experienced class, choose one case study to do as a whole class. Find out about other, smaller pipelines that have been built in Alaska. Study current events involving the gas pipeline. Become involved in the public process by writing letters or attending hearings.

Research Questions

1. What resource is transported (will be transported)?
   Where is it located?
   How much is there?
   Where will it end up?
   What is it used for?
   Important facts like the distance, amount, and costs

2. History – Why was(is) the resource needed?
   What decisions had to be made (will have to be made) about transporting it?
   What happened during construction?
   When did (will) the transport of the resource occur?

3. How was technology used to solve problems (or will be used)?
   What new technology was(will be) developed or used?

4. How many jobs are associated with the project?
   During construction, during operation.
   Pick four different jobs and find out about them.
   What is the work like, what training is needed, how much money can you make?

5. What are environmental and safety hazards associated with transporting "your" fuel in Alaska?
   What accidents have occurred?

Questions to consider

- When was it built, and why?
- What were some of the obstacles to pipeline construction?
- What alternatives were considered?
- Why were some people against building the pipeline?
- Who wanted it built?
- Where does the oil from the North Slope go after it leaves Valdez?
- Who uses it and what for?
- What have been the financial impacts of the pipeline?
- What kinds of jobs were created during construction?
- What kinds of jobs still exist?
- How many times have there been spills or leaks from the pipeline? What caused them? What kind of environmental damage was done?
- How and when was each spill cleaned up?
- How has the pipeline affected wildlife?
- Have there been other environmental impacts from the pipeline?
- What is happening to the pipeline as it ages?
- How long is the pipeline expected to last?

Websites

Alyeska Pipeline Company
http://www.alyeska-pipe.com/default.asp

Encyclopedia Information about TransAlaska Pipeline
http://www.answers.com/topic/trans-alaska-pipeline-system or

http://experts.about.com/e/t/tr/Trans-Alaska_Pipeline_System.htm

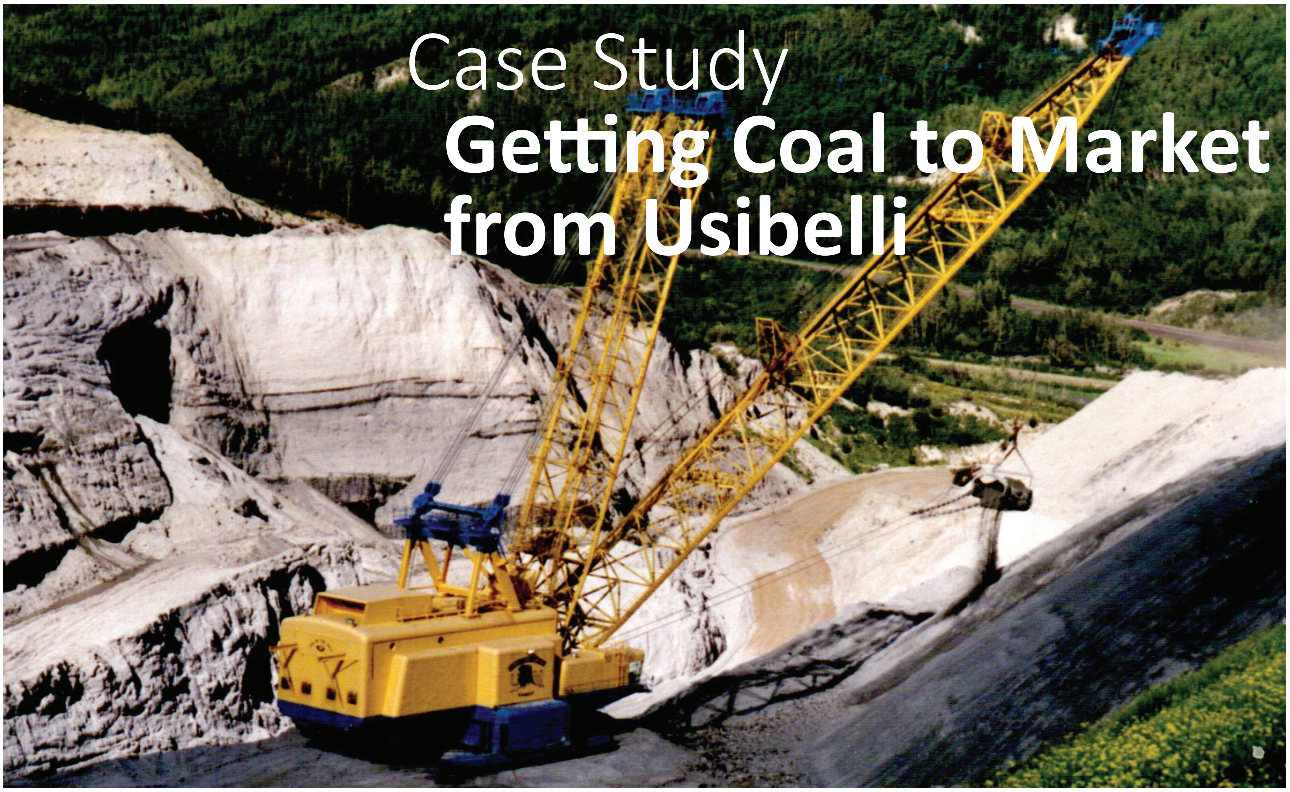
TransAlaska Pipeline History, SLED

http://sled.alaska.edu/akfaq/aktaps.html

TAPS Guide http://tapseis.anl.gov/guide/index.cfm

Joint Pipeline Office and TAPS
http://www.jpo.doi.gov/TAPS/TAPS.htm

Case Study
Getting Coal to Market from Usibelli



Questions to consider

- What are some basic facts about the Usibelli Coal Mine?
- Where is it, who owns it, how old is it, what kind of coal and how much is mined there?
- Where does coal from Usibelli go?
- Who uses the coal and what for?
- How is the coal transported and distributed?
- What have been some problems in transporting the coal and how have they been solved?
- What facilities have been constructed to move coal in Alaska?
- What kinds of jobs are associated with the transportation of coal?
- Where are other coal resources in Alaska and what transportation alternatives are being considered?
- What are safety and environmental hazards associated with transporting coal?

Resources

Website

Usibelli Coal Mine Overview
http://alaskarails.org/industries/UCM2/over.html

Alaska's Gas Pipeline

Background

With the increased demand on natural gas throughout the United States, there is continued and escalating interest in transporting Alaska's North Slope natural gas to the Lower 48. It is proven that there are over 35 trillion cubic feet of natural gas found within the North Slope and there is a potential for more than 100 trillion cubic feet.

North American natural gas supplies are declining while market demands are higher than expected and steadily increasing. Natural gas is now used for cooking and heating in 70% of American homes and it supplies 40% of the US industrial energy needs. Additionally it is the most popular energy source used in electricity generating plants throughout the U.S. It is expected that there will be an increase demand of 54% by 2025 for homes, industry, and electrical production. 85% of the United State's natural gas comes from domestic and Canadian suppliers.

In 1977, President Carter granted permission to pursue a natural gas pipeline in Alaska, but at that time there were too many economic risks for any companies to pursue its development. In order to encourage interest in developing a pipeline, the US Senate, in 2002, passed a federal loan guarantee to companies for up to $8 billion dollars. Since that time, there have been a number of interested parties, including the North Slope oil companies. It is estimated that these projects could cost anywhere from $13 billion to $20 billion and take up to 10 years to permit and complete.

Four different pipeline options have been prepared by various companies.

1. ANGTS – Alaska Natural Gas Transportation System. This system is estimated to cost $18 billion. The new pipeline would begin at the North Slope and follow the existing pipeline to Alaska's Interior where it would then follow the Alaska Highway to the Yukon Territory in Canada. The pipeline would extend across Canada and connect with the existing Canadian natural gas pipeline in Alberta. From there, the gas would be transported to the Lower 48.
2. TAGS – Trans-Alaskan Gas System. This system is estimated to cost $13 billion. It would require plants to turn the natural gas into liquefied natural gas (LNG), transport it along a new pipeline which would follow the existing TAPS line, and then be transported mainly to Asia via LNG tankers out of Valdez.
3. GTL – Gas to Liquids System. The cost of this system is estimated at $13 billion. It would use new plants to transform the natural gas into a more diesel like liquid. This liquid could be moved through the existing pipeline and then loaded on tankers in Valdez headed for the U.S. West Coast.
4. Onshore/Offshore System. This system is estimated to cost $15 billion. It would build a pipeline offshore and onshore, beginning offshore at Prudhoe Bay, traveling in a 30-60 ft underwater trench 326 miles to the MacKenzie River Delta in Canada. There it would go underground and extend through the MacKenzie River Valley to connect with the Canadian natural gas pipeline in Alberta. The gas would then be transferred to the Lower 48.

All of these plans have their own individual sets of pros and cons.

While the natural gas pipeline in Alaska is controversial, many agree that it is a sound choice as it accesses a cleaner fuel, accesses fuel that has already been discovered, and moves the state towards a more sustainable energy source. Some have proposed the following stipulations when considering a natural gas transportation solution:

1. Transportation should follow existing routes to minimize the environmental impact and affect on wildlife.
2. Nothing should be done offshore, nor in the Arctic National Wildlife Refuge, nor the Yukon Flats National Wildlife Refuge.
3. All routes considered should contribute to Alaska's population, economy, and jobs.
4. The public should be involved in all stages of scoping, development, and monitoring.
5. The process should include a citizen's advisory group.
6. Part of the revenue generated from the natural gas commercialization should go to alternative and renewable energy development, especially in rural communities.
7. Money should be put aside for dismantling, removal, and reclamation of the pipeline.

It is estimated that the transportation of Alaska's natural gas could provide $1 billion in revenues per year for the state and produce tens of thousands of jobs. If someone undertakes the challenge of moving natural gas out of the state of Alaska it is expected that the endeavor will be the largest privately funded construction project ever undertaken. At the time of writing this lesson, nothing had been decided, let alone begun. It would be recommended when doing this activity that you research the current status on the natural gas pipeline as it relates to the federal government, controversy in Alaska and out of state, approved plans and corporations, and the initiation of projects.


Beaufort Sea
BARROW
NUIQSUT
GTP Facilities
PRUDHOE BAY
Point Thomson
KAKTOVIK
North Slope
Arctic National Wildlife Refuge
CANADA
ALASKA
ANAKTUVUK PASS
Noatak National Preserve
Gates of the Arctic National Park
WISEMAN
COLDFOOT
Northwest Arctic
EVANSVILLE
BETTLES
Yukon Flats National Wildlife Refuge
ALATNA
ALLAKAKET
Kanuti National Wildlife Refuge
STEVENS VILLAGE
Yukon-Koyukuk
LIVENGOOD
RAMPART
Yukon-Charley Rivers National Preserve
Koyukuk National Wildlife Refuge
MANLEY HOT SPRINGS
MINTO
Fairbanks North Star
FAIRBANKS
NORTH POLE
Nowitna National Wildlife Refuge
NENANA
ANDERSON
DELTA JUNCTION
Southeast Fairbanks
HEALY
Innoko National Wildlife Refuge
Denali
McKINLEY VILLAGE
CANTWELL
Denali National Park
TOK
Tetlin National Wildlife Refuge
Matanuska-Susitna
TRAPPER CREEK
TALKEETNA
GLENNALLEN
Wrangell-St. Elias National Park
WILLOW
WASILLA
PALMER
Valdez-Cordova
Bethel
BIG LAKE
EKLUTNA
KNIK-FAIRVIEW
ANCHORAGE
Chugach National Forest
VALDEZ
Lake Clark National Park
BELUGA
TYONEK
Cook Inlet
Kenai National Wildlife Refuge
NIKISKI
LNG Facilities Lead Site
KENAI
SOLDOTNA
Prince William Sound
Lake and Peninsula
Kenai Peninsula
VICINITY MAP
LEGEND
LNG Facilities Lead Site
Alaska Place Names
Current Preferred Route
Optional Routes Across Cook Inlet
Major Highways
Major Rivers
Borough Boundaries
Federal Lands
0 40 80 160 Miles
DATA SOURCES
(1) Alaska LNG Project Data
(2) Alaska DOT
(3) Alaska DNR
(4) US Census
PREPARED BY: EXP ENERGY SERVICES INC.
SCALE: 1:1,800,000
DATE: 2014-02-20 SHEET: 1 of 1
PROJECT OVERVIEW MAP
FEDERAL LANDS AND BOROUGHS
Alaska LNG

Trans-Alaska Pipeline System: Background

In 1968, oil was discovered in Prudhoe Bay on Alaska's North Slope that proved to be the largest oil field in the United States, estimated then to be 10 billion barrels of recoverable reserves. After much debate, it was determined that it would be beneficial to move the oil from Alaska to the Lower 48 refineries. The best method for doing this was a pipeline that would stretch 800 miles from Prudhoe Bay to Valdez, where the oil would be put on tankers and shipped to the U.S. West Coast.

The construction of such an immense pipeline, the largest and most sophisticated of its kind in the world, posed many engineering challenges with Alaska's wildlife, permafrost, and weather. The vested companies came together to form the Alyeska Pipeline Service Company which began construction of the Tans Alaska Pipeline System (TAPS) in 1974. This project included the construction of the haul road to Prudhoe Bay, now called the Dalton Highway or Alaska State Route 1. The project took over 3 years to complete, the first oil flowing through the line in the summer of 1977. The entire project, including the shipping terminal in Valdez cost $8 billion and employed over 20,000 people.

The 800 mile pipeline crosses 34 major rivers, 500 smaller streams, and 3 mountain ranges. It must endure temperature extremes ranging from -80º F to 95º F. Its structure must maintain its stability whether in seasonally thawing areas or in permafrost. Additionally, the pipeline construction takes into account many animal crossings required for minimal affect. It also accommodates earthquakes, roads, rock slides, and avalanches. To do this, the pipeline was elevated at a minimum of 10 feet in 554 places along the route, buried in 23 locations, and refrigerated and buried in 2 locations. Of the 800 miles of pipeline, 420 miles are above ground, 376 miles are below ground, and 4 miles are refrigerated.

In Alaska, one of the major engineering concerns for a pipeline was permafrost, or any rock or soil material that remains below 32º F continuously for 2 or more years. There are several different kinds of permafrost including cold permafrost which has a constant temperature of 30º F or colder. In this condition, considerable heat can be applied without thawing. In these situations the pipeline could be constructed without extensive consideration to thawing concerns. Thaw-stable permafrost is permafrost found in bedrock or in well-drained sediment. If thawing occurs in these conditions, the foundation, and thus stability, remains sound. So again, these conditions do not pose a threat to the stability of the pipeline. The 2 permafrost conditions that pose the most challenge in engineering are thaw-unstable permafrost and warm permafrost.

Thaw-unstable permafrost is found in poorly drained, fine-grained soils, especially silts and clays. In this situation, the soil can contain large amounts of ice. The result of thawing can cause loss of strength, excessive settlement, and sometimes, actual soil flow. Warm permafrost is soil that remains just below 32ºF. The addition of very little heat can bring about significant thawing. When the soil thaws it can move, settle, slide, or flow.

These pilings were designed to resist frost jacking forces and to minimize thawing. In some areas, such as where the pipeline needed to accommodate animal crossings, rock slides, avalanches, and highway crossings, it had to be buried. In these cases, if the area was cold permafrost, then the pipe was buried in a conventional manner without special provisions for thawing. If the area had thaw-unstable conditions, the pipeline was insulated to prevent thawing around the pipe. In some places, the pipe is both insulated and refrigerated to prevent thawing. Approximately 75% of the pipeline crosses permafrost terrain.

When the ground in permafrost areas thaws and refreezes it can cause frost heaving, frost jacking, and thaw settlement. In frost heaving the active layer freezes and ice forms, pushing the ground surface upward. Frost jacking happens when heaving occurs and a structure is imbedded in the ground in that area. If it's not properly anchored to resist the heaving, the structure will be forced upward along the ground surface. Generally, the structure does not return to its original position. This can happened when there is seasonal freezing and thawing in the active layer (top permafrost layer), and is not limited to only permafrost areas. Thaw settlement occurs when ice found in the soil melts in thaw-unstable permafrost. This melting is typically caused by heat from a structure or changes in the natural thermal conditions.

In order to overcome these soil temperature conditions, engineers developed several unique plans. In thaw-unstable permafrost, problems associated with melting permafrost were avoided by constructing the pipeline above ground on an elevated support system.

To help move the oil along the pipeline, 12 pump stations were installed. Pigs, or mechanical devices push through the pipeline. They improve the flow characteristics (scraper), inspect for dents and wrinkles, inspect for pipeline corrosion, and measure pipeline curvatures.

The 48 inch diameter pipeline, with walls approximately ½ inch thick, carries 1.15 million barrels of oil each day moving about 5.5 miles per hour. Therefore, a gallon of oil takes approximately 6 days to get from Prudhoe Bay to Valdez. The 800 miles of pipe, if full, can hold over 9 million barrels of oil.

The Valdez Marine Terminal was also part of the pipeline construction project. It is located in the ice-free Port of Valdez. The 1,000-acre terminal, with 4 tanker loading areas, can store over 9 million barrels of crude oil. To date over 14 billion barrels of oil have been shipped from the Trans Alaskan Pipeline out of the Valdez Marine Terminal.

Usibelli Coal: Background

THE USIBELLI STORY

Usibelli Coal Mine, Inc. is a family owned business and is the only operating coal mine in Alaska. Joe Usibelli is Chairman of the Board of Directors. Joe Usibelli, Jr. is the President and the grandson of Emil Usibelli, founder of Usibelli Coal Mine, Inc. (UCM).

During the earlier years, Usibelli operated both surface and underground mines; however, by 1962 only surface mining was utilized.

Emil Usibelli died on March 27, 1964 at age 70. His son Joe Usibelli returned from Stanford University to take over the mining operation at age 25. His son, Joe Usibelli Jr., became president of the company on August 1, 1987.

UCM is headquartered in Healy, Alaska and has more than 200 million tons of proven coal reserves on current leases. Annual coal production averages approximately 1.5 million tons of subbituminous coal and UCM could easily double production.

Coal is transported to six Interior Alaska power plants – including five cogeneration plants at Fort Wainwright (U.S. Army), Eielson Air Force Base, Clear Air Force Station, Aurora Energy – a wholesale supplier of electricity and provider of district heat in Fairbanks, the University of Alaska's power plant, and a mine mouth plant - Healy #1 operated by Golden Valley Electric Association.

Usibelli Coal Mine has exported coal to South Korea through the coal terminal at the Port of Seward since 1984. The current contract is for 500,000 metric tons of coal each year for a three-year period. During 1998, a 20,000-ton shipment of UCM coal was delivered to the Russian Far East, a potential market for Alaska business. UCM has also provided test shipments to Chile, Taiwan, and Japan.

The Bucyrus Erie 1300W walking dragline, affectionately named "Ace-In-The-Hole," is Alaska's largest mobile land machine and removes overburden on top of the coal seams. The machine was purchased in 1977. It was transported to Healy on 26 rail cars and 40 trucks and took 11 months to assemble.

The dragline has a total weight of more than 2,200 tons. The dragline buckets move 33 to 37 cubic yards of material. The crew consists of two operators that rotate positions every hour. When they aren't at the controls, they do maintenance and repair. The dragline is electrically powered through a large cable connected to the utility power system.

Mining began at the turn of the century in Healy, Alaska, where natural outcrops of coal are highly visible in the Healy Valley. During 1943, Emil decided to establish a coal mining business of his own. With a one-year contract to supply 10,000 tons of coal per year to Ladd Air Field (now Ft. Wainwright), Emil began operations with a small dozer and a converted logging truck.

Caterpillar 785 haul trucks transport 150 tons of coal or overburden. Maintenance crews fabricate UCM unique tailgates and modify the bed in order to efficiently accommodate the dual duty. The exhaust system runs hot air through the bed to keep it heated in the winter in order to prevent freezing of material to the bed.

Other mining equipment includes:

- Caterpillar dozers, D6XL, D9N, D10N, D10R, D11N and D11RCD
- O&K hydraulic shovels, RH120C and RH170
- Caterpillar loaders, 966C, 966F, 992G and 994D
- Caterpillar graders, 16G and 16H
- Driltech rotary blast hole drill, D60K
- Ingersoll-Rand rotary blast hole drill, DMM2

UCM is equipped with modern, state-of-the-art maintenance equipment and performs most service and repair functions on-site. The warehouse stocks a very large inventory of repair parts.

Usibelli employs 95 full time workers. The 60 operations employees work two 9-hour shifts, five days a week, year-round.

The environment is high priority. Three generations of the Usibelli family grew up in Healy. Because the mine is the family's backyard, it was no surprise that in 1970, six years before Federal law required, UCM pioneered a successful land reclamation program. The ultimate goal of reclamation is to establish a natural landscape on mined land. The earth is contoured and then seeded with a carefully researched mixture of grasses and plants indigenous to northern regions. Local school children help collect alder, spruce, and willow cones to germinate seedlings for planting.

Usibelli Coal Mine's commitment to provide a quality product, on schedule, at a reasonable price utilizing innovative technology and dedication to environmental excellence has earned the mine a position of leadership in Alaska and in the U.S. coal industry.

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