THE GREATEST STORY OF MAN AND PERMAFROST

Overview:

The original plans for the Trans Alaska Pipeline System (TAPS) called for the entire structure to be buried. Geologist warned that burying a hot-oil pipe in permanently frozen ground was a mistake, leading to a complete redesign that, for more than three decades, has successfully protected the underlying permafrost. The 800-mile pipeline remains a monumental feat of engineering.

Objectives:

The student will:

- use multimedia and information sheets to become familiar with the timeline of events leading to the construction of the Trans Alaska Pipeline;
- use the Internet to compile information about pipeline history and construction; and
- prepare a three-minute presentation based on Internet research.

Targeted Alaska Grade Level Expectations:

Science

[9] SA2.1 The student demonstrates an understanding of the attitudes and approaches to scientific inquiry by formulating conclusions that are logical and supported by evidence.

[10] SE1.1 The student demonstrates an understanding of how to integrate scientific knowledge and technology to address problems by identifying that progress in science and invention is highly interrelated to what else is happening in society.

[9] SG1.1 The student demonstrates an understanding of changes in historical perspectives of science by identifying those perspectives (i.e., cultural, political, religious, philosophical) that have impacted the advancement of science.

[10] SG1.1 The student demonstrates an understanding of changes in historical perspectives of science by describing how those perspectives (i.e., cultural, political, religious, philosophical) have impacted the advancement of science.

[10] SG4.1 The student demonstrates an understanding that advancements in science depend on curiosity, creativity, imagination, and a broad knowledge base by recognizing the role of these factors on scientific advancements.

Vocabulary:

advocate – one that defends or maintains a cause or proposal

cold permafrost – remains below 30°F/-1°C; may be as low as 10°F/12°C as on the North Slope; tolerates introduction of considerable heat without thawing

consortium – an agreement, combination, or group (as of companies) formed to undertake an enterprise beyond the resources of any one member

frost-heaving – when the active layer freezes, ice forms, pushing the ground surface upward

frost-jacking – when frost heaving occurs, if a structure imbedded in the ground is not properly anchored to resist such movement, the structure will be forced upward along with the ground surface; in most cases, the structure does not return to its original position when the active layer thaws during the following summer and the net upward movement is called "jacking"

ice-rich – 20 percent to 50 percent visible ice

subside – to sink or fall to the bottom

thaw-stable – permafrost in bedrock, in well drained, coarse-grained sediments such as glacial outwash gravel, and in many sand and gravel mixtures; subsidence or settlement when thawed is minor, foundation remains essentially sound

thermosyphon/thermosiphon – a passive heat transfer device installed to remove heat from the ground

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thaw-unstable – poorly drained, fine grained soils, especially silts and clays; such soils generally contain large amounts of ice; the result of thawing can be loss of strength, excessive settlement and soil containing so much moisture that it flows

warm permafrost – remains just below 32°F/0°C; the addition of very little additional heat may induce thawing

Whole Picture:

In response to a massive oil discovery on Alaska's North Slope at Prudhoe Bay in January of 1968, a consortium of oil companies (ARCO, Exxon and British Petroleum) formed the Trans Alaska Pipeline System (TAPS) and began the process of gaining the rights to build an 800-mile hot oil pipeline from Prudhoe Bay to Valdez. To do so required a permit to cross federal lands. In response, President Nixon formed the Federal North Slope Task Force, which tasked the U.S. Geological Survey to analyze the technical aspects of the route.

Two years earlier, in October 1966, Native leaders from across Alaska had come together to form the Alaska Federation of Natives (AFN). Native land claims was the focus. A land freeze imposed by Interior Secretary of State Stewart Udall allowed Alaska Natives time to settle outstanding claims.

The desire to build a giant pipeline forces Alaska to address the Native land claims issues and come up with a resolution. Alaska Natives were concerned the proposed pipeline route crossed traditional lands, bringing disruption but no economic benefit. The Alaska Native Claims Settlement Act (ANSCA) was signed into law by President Richard Nixon December 18, 1971.

Environmental groups, however, continued to file suit after suit to block pipeline construction. Among other things, environmentalists claimed the proposed pipeline project violated the National Environmental Policy Act. In July 1973 the U.S. Senate passed the Gravel Amendment which declares that the Department of the Interior had fulfilled all the requirements of the National Environmental Policy Act. This act allowed Alyeska, the consortium formed to build the pipeline, to begin building.

In October of 1973 members of OPEC (Organization of Petroleum Exporting Countries) declared an embargo on oil export to the United States. OPEC's decision was in response to U.S. involvement in Arab-Israeli conflict. The embargo triggered an oil crisis. U.S. Gas prices skyrocketed and gas shortages meant long lines at the gas pump. In crisis, government officials pushed harder to get pipeline construction completed.

The Trans Alaska Pipeline was designed to accommodate the highly varied terrain, including mountains, rivers, permafrost, climate and the considerable level of earthquake activity experienced in the state. It was also designed to address environmental concerns.

More than half of the 800-mile pipeline passes through terrain underlain with permafrost so engineers buried only 380 miles of the line. Four hundred and twenty miles were elevated on supports or pilings to protect the permafrost. Conductive cooling fins were added to further remove heat from the ground. The Trans Alaska Pipeline is an important example of successful construction techniques used in permafrost areas.

Materials:

- White or light-colored construction paper (12" x 18"), (one per group)
- VIDEO: "Timeline: The Alaska Native Claims Settlement Act"
- DVD: *American Experience: The Alaska Pipeline*
- STUDENT INFORMATION SHEET: "The Greatest Story of Man and Permafrost"
- STUDENT INFORMATION SHEET: "TAPS (Trans Alaska Pipeline System)"
- STUDENT WORKSHEET: "Engineering the Pipeline"

Activity Preparation:

1. Preview the 60-minute DVD, The American Experience: The Alaska Pipeline. (See Activity Procedure 1.) The topic of permafrost is discussed within the first 13:50 minutes. The remainder of the show documents other pipeline facts and history. Determine ahead how much of the show you want to share with students. (NOTE: Be aware at the 25:08-minute mark there is a picture shown of a "lady of the evening" on stage in lingerie. The picture is shown for seven seconds.)

2. Explore the Alyeska Pipeline Service Company website: http://www.alyeska-pipe.com/. Find the tab "Pipeline Facts" where the following topics are listed: Pipeline history, pipeline design, pipeline operations, environmental designs, etc. Also note the site holds downloadable PDF files "TAPS Quick Reference Guide" and "TAPS Fact Book." Both contain valuable information for student use in completing STUDENT WORKSHEET: "Engineering the Pipeline."
3. Consider bookmarking the following websites to help students complete research:

General Pipeline Information

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

American Experience:
http://www.pbs.org/wgbh/amex/pipeline/

Alaska Pipeline:
http://fairbanks-alaska.com/trans-alaska-pipeline.htm

Wikipedia:
http://en.wikipedia.org/wiki/Trans-Alaska_Pipeline_System and http://en.wikipedia.org/wiki/Construction_of_the_Trans-Alaska_Pipeline_System

USGS:
http://walrus.wr.usgs.gov/geotech/denaliposter/pipeline.html http://pubs.usgs.gov/fs/2003/fs014-03/pipeline.html

Land Claims

Kids Oasis:
http://www.kidzoasis.com/img/alaska-natives-claims-settlement-act.html

Alaskool:
http://www.alaskool.org/projects/landclaims/LandClaimsTOC.htm

Caution: Please make sure that Urban Dictionary is blocked from student use. This site lists extremely inappropriate references when Alaska Pipeline is used as a search term.

Activity Procedure:

1. In a science journal, or on a blank piece of paper, ask students to write the following questions, leaving room for answers and illustrations:
   a. Besides a pipeline, what were two other ways engineers considered to bring oil out of Prudhoe Bay?
   b. What concerns of Alaska Natives brought pipeline plans to a halt? What was the resolution?
   c. What Arctic ground condition ultimately caused a complete redesign of the proposed pipeline?
2. Show students a portion of the PBS Home Video, *American Experience: The Alaska Pipeline*. The focus of this lesson is permafrost. The topic of permafrost is covered in the first 13:50 minutes of the video. Stop the DVD at that mark and allow students to complete any unfinished answers. Students may consult one another for missing information.

   NOTE: The video is 60-minutes and gives a broad overview of pipeline history. Teacher's discretion should determine if there is time for students to view the video beyond the 13:50 minute mark.
3. Hand out STUDENT INFORMATION SHEET: "The Greatest Story of Man and Permafrost." Choose and appropriate reading strategy for the class. Ask students to add the following question in their journal or on their paper. "In 1979 there were two leaks due to permafrost thaw and pipe shift. How would the outcome have been different if engineers had followed the original plans to bury the entire pipeline?" Allow time to answer.
4. Access VIDEO: "Timeline: The Alaska Native Claims Settlement Act." Alaska Native people had been embroiled in a land claims dispute for a century prior to the discovery of oil. The impending pipeline forced a land claims settlement. In 1969 a formal land

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freeze was put into place until the matter was settled. In 1971 Congress passed the Alaska Native Claims Settlement Act. In 1973 President Richard Nixon signed into a law a bill authorizing the construction of a trans-Alaska pipeline.

5. Hand out STUDENT INFORMATION SHEET: "TAPS (Trans Alaska Pipeline System)" and review with students.
6. Divide students into small groups. Hand out STUDENT WORKSHEET: "Engineering the Pipeline." Each group will be assigned a pipeline topic to briefly research and report back to classmates. There are five possible topics to choose from. Students must have Internet access to complete the research. In addition, the assignment requires students to create a poster to accompany an oral presentation. If possible, allow students to print pictures, graphics and other information to include on their poster.

NOTE: As an alternative assignment allow students to use a presentation program such as Microsoft Office PowerPoint or Mac Keynote to prepare a slide show to accompany the oral presentation. Students who are absent during part of the activity should be offered the alternative of creating a simplified timeline poster highlighting significant events regarding the pipeline.

7. Once students have had adequate time to complete the research, put together a brief presentation, and formulate a question (see worksheet), allow each group to present to the rest of the class. Collect all the questions then use them to gauge student learning, such as preparing a quiz, playing a game, or asking students to lead an activity using the questions.

Ideas for Filming:

NOTE: Students will complete a short film about permafrost for the final project associated with this UNITE US unit. Each lesson leading to the final project contains ideas about what students might film as they compile clips. Students are not limited to the list and are encouraged to use their imagination and creativity when filming. Students could film interviews with community members who either worked on the pipeline or remember the time when the pipeline was built and the effects it had on the community.

Extension Ideas:

1. What are some problems that might come up as the pipeline ages?
2. One of the current issues in Alaska is the building of a gas pipeline. How might the lessons learned from the oil pipeline apply? What different issues will there be?

Answers:

All reports and posters will vary. Below are examples of information that should be included.

1. *GROUP 1 - Permafrost and the Pipeline*

   The original plans called for the entire pipe to be buried. Geologists recognized that the plan was flawed because much of the ground contained permafrost. Hot oil traveling through the pipe would thaw the ground, cause shifting and slumping, and tremendous damage to the pipe.

   In the end more than half the pipe, 420 miles, had to be above ground to protect the permafrost. In many areas thermal syphons were installed to further pull heat from the ground to keep it stable.

   Thermal siphons use passive cooling to draw excess heat from the ground throughout the winter to ensure the permafrost is cold enough to remain frozen through the warm months.

2. *GROUP 2 - Pipeline Bridges*

   The pipeline crosses more than 800 rivers and streams. In all, 13 bridges were built for river crossings.

   There are four types of bridges listed on the Alyeska Pipeline Service Company site: orthotropic box girder, plate girder, suspension and tied arch. Nine of the 13 bridges are plate girder bridges. The Yukon River hosts an orthotropic box girder. There are two suspension bridges and one tied arch.

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A plate girder bridge is what typically comes to mind when you think of a railroad or highway bridge. The main supports are made up of steel plates welded together to form deep, wide support ribs.

An orthotropic box girder, as was used over the Yukon River, is needed to span large distances. The deck is reinforced with plate stiffeners underneath.

A suspension bridge uses large steel cables draped over towers and anchored to foundations to suspend the pipeline.

A tied arch uses a steel arch as a supporting element. Steel members tie the bases of the arch together so they won't move apart.

3. *GROUP 3 - Pipeline and Earthquake Protection*

   The pipeline crosses three major faults: Denali, McGinnis Glacier and Donnelly Dome. The pipeline is designed to allow for movements in the ground, both side to side and up and down. For example, at the Denali Fault the pipeline allows for 20 feet of lateral movement and five feet of vertical movement.

   The pipeline is not anchored to the support members. Instead it rests on Teflon pads, called shoes, that allow it to slide side to side in case of movement. The pipe is also built in a zig-zag shape to allow extra flexibility in side-to-side and up-and-down movement.

4. *GROUP 4 - Pipeline and Wildlife*

   There are approximately 579 animal crossings along the pipeline route, 554 of those are areas where the pipe has been elevated by 10 feet to allow animals to cross beneath. In 23 places the pipe is buried to accommodate animal crossing. In some cases this required refrigeration of the buried pipe.

   There are more than 170 birds that inhabit the pipeline route. Thirty-four species of fish live in the waters crossed by the pipeline. The pipeline company monitors other animals, such as the caribou population, as well.

   The Alyeska website lists contact information for reporting an environmental issue, such as a leak, and gives instructions on what to do. It reads, "From a safe location, call Alyeska Pipeline Service Company collect at (907) 835-4709. You may also contact 911 or other local emergency response numbers."

   Provide your name, location, description of the leak or possible leak and information on how you can be contacted.

5. *GROUP 5 - Pipeline and Alaska Native People*

   As soon as Alaska was purchased from Russia in 1867 the Alaska Native people began a battle for their aboriginal rights to the land they had lived on for thousands of years. When Alaska officially became a state on January 3, 1959, the push for Native land claims increased and by 1966 Native leaders formed the Alaska Federation of Natives, whose goal was to fight for land rights. When oil was discovered in Prudhoe Bay in 1968, the fervor for access to the land that would allow a pipeline forced the government to push for a settlement.

   The Alaska Native Claims Settlement Act was signed into law by President Richard Nixon December 18, 1971, granting Alaska Native people 44 million acres of land and $962.5 million dollars. Twelve regional corporations were formed to administer the settlement. Along with cash compensation, corporations could earn income from investments.

NAME: _____

TAPS (TRANS ALASKA PIPELINE SYSTEM)

The Trans Alaska Pipeline System

In 1994 the American Society of Civil Engineers published a list of what it deemed "The Seven Wonders of the United States." The list is comprised of man-made wonders – feats of engineering that strike awe even in those who were involved in building them. On that list was an Alaska landmark: The Trans Alaska Pipeline. The pipeline is in the company of the Kennedy Space Center in Florida, Hoover Dam in Nevada, the twin 110-story towers of the World Trade Center (destroyed by a terrorist attack in 2001), the Interstate Highway System, the Golden Gate Bridge in San Francisco and the Panama Canal (paid for by America and designed by American engineers). So what makes a long, steel pipe worthy of the attention? It's a pretty amazing piece of engineering.

Native Land Claims

In October 1966 Native leaders from across Alaska came together to form the Alaska Federation of Natives (AFN). Native land claims was the focus. A land freeze imposed by Interior Secretary of State Stewart Udall allowed Alaska Natives time to settle outstanding claims.

In March 1968 the discovery of a massive oil field in Alaska's Prudhoe Bay prompted plans to drill for oil and transport it out of state. The desire to build a giant pipeline forces Alaska to address the Native land claims issues and come up with a resolution. The Alaska Native Claims Settlement Act (ANSCA) was signed into law by President Richard Nixon December 18, 1971.

Pipe Dreams

While Native leaders focused on settling land claims, oil companies focused on planning ways to get the oil. Art Lachenbruch, a geologist with the U.S. Geological Survey, heard that oil companies wanted to build a giant pipeline across Alaska and immediately thought of something the original planners didn't: permafrost.

> "I first heard about this in August 1969. I met an old colleague, Irv Tailleur, and he said, 'Art, did you realize the Trans Alaska people have put in a request to Secretary of the Interior Hickel to build a pipeline? The pipeline will be buried in a trench, mostly in permafrost.' And we looked at each other in sort of a manner of disbelief."

In 1970 Lachenbruch released a study explaining what would happen if a pipe filled with hot oil were buried in permafrost. The thawing that would occur would shift the landscape and damage the pipe. Lachenbruch's detailed report led to complete redesign of the pipeline. Instead of burying the entire length, about half the line would be above ground to protect the permafrost.


Tundra Times

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Vol. 9, No. 35 Wednesday, December 22, 1971 Fairbanks, Alaska

NIXON PENS BILL INTO LAW

'I Want You to Be Among the First to Know...' Nixon Says

By MADELYN SHULMAN
Staff Writer

In a ceremony marked only by a special taped message to the convention of the Alaska Federation of Natives the President of the United States signed the Alaska Native Claims Act of 1971 into law shortly before 1 p.m.

The Story Continues

Native land claims, environmental concerns, economic concerns, and labor concerns addressed, President Nixon responded to the oil embargo imposed by OPEC and signed the Trans Alaska Pipeline Authorization Act into law in October of 1973.

NAME: _____

TAPS (TRANS ALASKA PIPELINE SYSTEM)

In September 1974 the highway to the North Slope was complete. In March 1975 pipeline construction began. It was completed in less than three years. The first oil is sent down the line in June 1977.

By 2010 the Trans Alaska Pipeline had successfully transported more than 16 billion barrels of oil.

Elder Perspective

Chief Robert Charlie of Minto vividly remembers when pipeline planning began and contemplates what it still means today.

> There were a lot of meetings with the six villages near the pipeline. A lot of promises were made –promises of jobs and training. People in the villages were mostly for it, especially when negotiating within those six villages for employment opportunities. Things didn't go exactly as people thought they would. Not as many Native people were hired as we would have hoped.
>
> Now that Doyon is involved with the pipeline, though, it is better. More Native people are hired to work on the pipeline. The pipe itself has become part of the landscape. The Permanent Fund comes once a year and Doyon shares are a good source of income.
>
> Now an old pipeline camp in Livengood is being reused for a mining camp. The structure was already there. Those jobs will help the economy in Minto.

Quick Facts

According to the Alyeska Pipeline Service Company website:

- The Trans Alaska Pipeline System was designed and constructed to move oil from the North Slope of Alaska to the northern most ice-free port in Valdez, Alaska.
- Length: 800 miles.
- Diameter: 48 inches.
- Crosses three mountain ranges and over 800 rivers and streams.
- Cost to build: $8 billion in 1977, largest privately funded construction project at that time.
- Construction began on March 27, 1975 and was completed on May 31, 1977.
- First oil moved through the pipeline on June 20, 1977.
- Over 16 billion barrels have moved through the Trans Alaska Pipeline System.
- First tanker to carry crude oil from Valdez: ARCO Juneau, August 1, 1977.
- Storage tanks in Valdez - 18 with total storage capacity of 9.1 million barrels total.
- The Valdez Marine Terminal (VMT), where crude oil is stored and loaded onto tankers, covers a total area of 1,000 acres.

Alaska Science Forum

The Greatest Story of Man and Permafrost

by Ned Rozell
July 16, 2008, Article #1916

This column is provided as a public service by the Geophysical Institute, University of Alaska Fairbanks, in cooperation with the UAF research community. Ned Rozell is a science writer at the institute.

In 1973, Elden Johnson was a young engineer working on one of the most ambitious and uncertain projects in the world—an 800-mile steel pipeline that carried warm oil over frozen ground. Thirty-five years later, Johnson looked back at what he called "the greatest story ever told of man's interaction with permafrost."

Strung over and beneath the surface of Alaska from Prudhoe Bay to Valdez, the Trans Alaska Pipeline, at 31 years old, is entering its second lifetime. The four-foot in diameter, half-inch-thick steel pipe had an original design lifespan of 30 years. The State of Alaska and the U.S. Department of the Interior recently gave the pipeline the green light for another 30 years of operation.

"It's like a car," said Johnson, who works for Alyeska Pipeline Service Company, while standing under the pipeline near Fairbanks during a recent permafrost conference lecture. "As long as you maintain it, it'll continue to work."

Permafrost, frozen ground that is a relic of the last ice age, exists beneath about 75 percent of the pipeline's 800-mile route. When ice-rich permafrost thaws, the ground slumps, causing problems for structures above.

After the 1969 oil discovery at Prudhoe Bay, developers unfamiliar with Alaska wanted to bury the entire supply of Japanese-made pipe. After a review by people who knew the dangers of building on permafrost, a legion of workers constructed a pipeline buried for 380 miles and—in areas of permafrost—built above the ground on platforms for 420 miles.

The initial design was good, but not perfect, Johnson said. He remembered during construction when he and others were inspecting the ground from the Yukon River to Coldfoot. They found unstable permafrost and recommended re-design of sections of the pipeline. Instead of conventional buried pipeline, the engineers called for more expensive and time-consumptive, above-ground pipeline.

"We changed the design for at least 20 percent of that distance," he said. "They were gut-wrenching decisions potentially impacting the startup schedule."

The call to elevate more than half the pipeline turned out to be a good one. Even though engineers bored holes in the ground about every 800 feet to check for permafrost, they didn't find it all. When the pipeline was two years old in 1979, the pipe buckled and leaked in two buried sections because of thawed permafrost. In both cases, the pipeline, which carried oil that left the ground in Prudhoe Bay as warm as 145 degrees Fahrenheit, caused about four feet of settlement. Engineers fixed those and other problems. The two leaks in 1979 are still the only spills caused by permafrost.

Alyeska workers check the pipeline each year for signs of settling and proper operation of the heat pipes that help keep the support posts of the above-ground pipeline anchored in frozen ground. The buried pipeline has become more stable over its 31 years as the rapid thawing of early years has settled down.

"The risk to the buried pipeline right now is becoming minimal," Johnson said.

The pipeline has delivered more than 16 billion barrels of oil since its startup in June 1977, with two brief shutdowns due to permafrost. Johnson estimated permafrost-related maintenance has totaled about 5-to-10 percent of the operating costs over the life of the pipeline.

"It's the cost of doing business in the Arctic," he said.

With a career of work on the massive engineering project Johnson calls "a beautiful thing," he is retiring from Alyeska this winter. His mind won't stray far from the challenges of building pipelines across cold country. His daughter Katie, a mechanical engineering graduate from the University of Alaska Fairbanks, has just signed on to help work with the natural gas pipeline from the North Slope southward.

"It's kind of a second-generation opportunity to look at the next pipeline," Johnson said.

NAME: _____

ENGINEERING THE PIPELINE

GROUP 1

Permafrost and the Pipeline

Group one will create a poster about the way engineers designed the pipeline to keep permafrost stable. The poster will accompany a three- to five-minute oral presentation.

The presentation and poster must include:

1. An introduction stating the purpose of the presentation.
2. A discussion of what led engineers to redesign the pipeline to keep the permafrost from thawing.
3. An explanation how much of the pipeline travels over ground underlain with permafrost.
4. A description of the thermosiphons mounted on the vertical support members (VSMs) including how many were installed and how they work.
5. Models, diagrams, descriptions and/or pictures of permafrost protection measures.
6. A thoughtful answer to the following critical thinking question: What do you think would happen if climate change caused the permafrost under the current VSMs to thaw?

Remember, your poster should support your oral presentation and be visually appealing as well as informative. Divide parts of the oral presentation between group members.

Begin by visiting Alyeska Pipeline Service Company: http://www.alyeska-pipe.com/. Search under Pipeline Facts and under Safety and Environment for pipeline design information.

HELPFUL HINT: Use an Internet search engine, enter key words and phrases such as "Alaska pipeline design," "pipeline and permafrost," "heat pipes and pipeline," and "thermosyphon."

In the space below write one question classmates will be able to answer after your presentation. Your question must be a "how" or "why" question. Please provide the answer key, as well.

1. Question from Group 1: _____

_____

_____

2. Answer: _____

_____

NAME: _____

ENGINEERING THE PIPELINE

GROUP 2

Pipeline Bridges

Group two will create a poster about the bridges constructed to support the pipeline. The poster will accompany a three- to five-minute oral presentation.

The presentation and poster must include:

1. An introduction stating the focus and purpose of the presentation.
2. An explanation of how many rivers and streams the pipeline crosses.
3. A discussion of the number of bridges that were constructed to support the pipeline and pipeline construction.
4. A description of at least two types of bridges used in pipeline construction.
5. Models, diagrams, descriptions and/or pictures of Alaska pipeline bridges.
6. A thoughtful answer to the following critical thinking question: The foundations of bridges supporting the pipeline are anchored in river banks. What would happen if climate change prompted increased rates of river bank erosion? What options would there be in to maintain the strength and stability of bridges?

Remember, your poster should support your oral presentation and be visually appealing as well as informative. Divide parts of the oral presentation between group members.

Begin by visiting Alyeska Pipeline Service Company: http://www.alyeska-pipe.com/. Search under Pipeline Facts for pipeline design information.

HELPFUL HINT: Use an Internet search engine, enter key words and phrases such as "Alaska pipeline design," "Alaska pipeline bridges" and "building the Alaska pipeline."

In the space below write one question classmates will be able to answer after your presentation. Your question must be a "how" or "why" question. Please provide the answer key, as well.

1. Question from Group 2: _____

_____

_____

2. Answer: _____

_____

NAME: _____

ENGINEERING THE PIPELINE

GROUP 3

Pipeline and Earthquake Protection

Group three will create a poster about the way pipeline engineers protected the pipeline from earthquake damage. The poster will accompany a three- to five-minute oral presentation.

The presentation and poster must include:

1. An introduction stating the focus and purpose of the presentation.
2. A discussion of the number of faults crossed by the pipeline, including the names of the faults.
3. A description of the zig-zag configuration and how it assists with movement from an earthquake.
4. An explanation of the earthquake monitoring system. (Also see the Alaska Earthquake Center.)
5. Models, diagrams, descriptions and/or pictures of Alaska pipeline Teflon© "shoes".
6. A thoughtful answer to the following critical thinking question: What different outcome might have occurred during the magnitude 7.9 earthquake on November 2, 2002 centered along the Denali Fault if pipeline engineers had not built the line to withstand earthquake activity?

Remember, your poster should support your oral presentation and be visually appealing as well as informative. Divide parts of the oral presentation between group members.

Begin by visiting the Alyeska Pipeline Service Company website: http://www.alyeska-pipe.com/. Search under Pipeline Facts for pipeline design information.

HELPFUL HINT: Use an Internet search engine, enter key words and phrases such as "Alaska Earthquake Information Center," "Alaska pipeline and earthquakes," and "faults and the Alaska pipeline."

In the space below write one question classmates will be able to answer after your presentation. Your question must be a "how" or "why" question. Please provide the answer key, as well.

1. Question from Group 3: _____

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_____

2. Answer: _____

_____

NAME: _____

ENGINEERING THE PIPELINE

GROUP 4

Pipeline and Wildlife

Group four will create a poster about the way pipeline engineers designed the pipeline to accommodate wildlife. The poster will accompany a three- to five-minute oral presentation.

The presentation and poster must include:

1. An introduction stating the focus and purpose of the presentation.
2. A description of what kinds of animals Alyeska Pipeline Service Company is monitoring.
3. A discussion of two ways pipeline engineers designed the line to accommodate and protect wildlife.
4. Models, diagrams, descriptions and/or pictures of wildlife accommodations.
5. Information about how and where to report an issue with wildlife or the environment involving the pipeline.
6. A thoughtful answer to the following critical thinking question: If there is a direct conflict between harvesting natural resources and protecting wildlife, what recommendations would you suggest as the best way to approach a solution?

Remember, your poster should support your oral presentation and be visually appealing as well as informative. Divide parts of the oral presentation between group members.

Begin by visiting the Alyeska Pipeline Service Company website: http://www.alyeska-pipe.com/. Search under Safety and Environment for pipeline environmental protection information. Also visit the website that accompanies the DVD viewed in class, American Experience: http://www.pbs.org/wgbh/amex/pipeline/peopleevents/e_environment.html

HELPFUL HINT: Use an Internet search engine, enter key words and phrases such as "wildlife and the Alaska pipeline," "environmental issues and the Alaska pipeline," and "caribou and the Alaska pipeline."

In the space below write one question classmates will be able to answer after your presentation. Your question must be a "how" or "why" question. Please provide the answer key, as well.

1. Question from Group 4: _____

_____

_____

2. Answer: _____

_____

NAME: _____

ENGINEERING THE PIPELINE

GROUP 5

Pipeline and Alaska Native People

Group five will create a poster about the way pipeline construction impacted Alaska Native people. The poster will accompany a three- to five-minute oral presentation.

The presentation must include:

1. An introduction stating the focus and purpose of the presentation.
2. A brief summary of events leading up to the settlement of Alaska Native land claims.
3. A brief summary of the terms of the Alaska Native Claims Settlement Act.
4. News stories, descriptions and/or pictures of the ANCSA process.
5. A thoughtful answer to the following critical thinking question: How do you think construction of the Trans Alaska Pipeline changed Alaska Native communities?

Remember, your poster should support your oral presentation and be visually appealing as well as informative. Divide parts of the oral presentation between group members.

Begin by visiting Alaskool at: http://www.alaskool.org/projects/landclaims/LandClaimsTOC.htm, Arctic Circle at: http://arcticcircle.uconn.edu/SEEJ/Landclaims/, or visit the website that accompanies the DVD viewed in class, American Experience: http://www.pbs.org/wgbh/amex/pipeline/peopleevents/e_claims.html

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HELPFUL HINT: Use an Internet search engine, enter key words and phrases such as "Alaska Native Claims Settlement Act," "ANSCA and the pipeline," and "Native land claims in Alaska."

In the space below write one question classmates will be able to answer after your presentation. Your question must be a "how" or "why" question. Please provide the answer key, as well.

1. Question from Group 5: _____

_____

_____

2. Answer: _____

_____