Marine Energy

Students research and build a topographical map of the outer continental shelf and/or hold a town meeting about possible energy development offshore.

SYNTHESIS

Grade Level:

- Intermediate
- Secondary

Subject Areas:

- Science
- Social Studies
- Language Arts

NEED
National Energy Education Development Project

Teacher Advisory Board

NEED Mission Statement

The mission of the NEED Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs.

Teacher Advisory Board Vision Statement

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

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NEED
Putting Energy into Education

Correlations to National Science Standards

(Bolded standards are emphasized in the unit.)

INTERMEDIATE (5-8) STANDARD–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

2. Populations, Resources, and Environments

a. When an area becomes overpopulated, the environment will become degraded due to the increased use of resources.

3. Natural Hazards

b. Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.

c. Hazards can present personal and societal challenges because misidentifying the change or incorrectly estimating the rate and scale of change may result in either too little attention and significant human costs or too much cost for unneeded preventive measures.

SECONDARY (9-12) STANDARD–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

3. Natural Resources

a. Human populations use resources in the environment to maintain and improve their existence.

b. The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and depletes those resources that cannot be renewed.

c. Humans use many natural systems as resources. Natural systems have the capacity to reuse waste but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

Teacher Guide

Intermediate Activity (Grades 7-9)

BACKGROUND

Students construct a topographical map of the United States, including the outer continental shelf (OCS) and Exclusive Economic Zone (EEZ), that shows the major land and underwater formations. Students are then divided into groups to research and prepare short presentations on the various resources, where they are located, how they were formed, how they can be recovered, their uses and economic benefits, and the environmental impacts associated with their recovery.

CONCEPTS

- ➤ The OCS and EEZ contain enormous reserves of many resources of economic and strategic benefit to the United States.
- ➤ Marine resources may be associated with particular land formations.
- ➤ Few marine resources are currently being exploited. However, the future potential for economical recovery of many of these resources is feasible, especially as land-based reserves become depleted or too expensive to extract or may be off-limits for environmental reasons.
- ➤ The exploitation of marine resources will have impacts on the marine environment, just as land-based extraction does.
- ➤ The use of any resource, whether land or marine based, is determined in large part by economic and environmental factors.

TIME

Three to four 45-minute class periods, plus out of class research.

MATERIALS

- ➤ One copy of ***Marine Resources: America's Untapped Treasure*** backgrounder for each student
- ➤ Foam board, salt dough (3 cups salt, 1 cup flour, 1 1/4 cup water), and paints to make topographical map
- ➤ Library and other resources (Minerals Management Service, U.S. Department of the Interior)

PROCEDURE

Step One—Preparation

Make one copy of the backgrounder, ***Marine Resources: America's Untapped Treasure***, for each student.

Prepare the salt dough beforehand and refrigerate, or purchase ingredients for the students to prepare the dough. Divide the students into six working groups, as follows:

- ➤ Petroleum and Natural Gas
- ➤ Methane Hydrate
- ➤ Phosphorite
- ➤ Gold, Platinum, and Heavy Minerals
- ➤ Metallic Sulfide Ores, Manganese Nodules, and Cobalt Crusts
- ➤ Sand, Gravel, and Shell

Step Two—Introduction of Activity

Introduce the activity to your class. Explain to the students that they will be working in small groups to prepare a short presentation on one aspect of marine resources, and that they will select one member from each group to prepare a topographical map.

Give students the time frame within which they are to accomplish their goals. If this will be a graded activity, explain the grading procedure. Discuss briefly the concepts listed above and have the students read the backgrounder, either in class or as homework. After the students have read the backgrounder, answer any questions before proceeding.

Step Three—Preparation of Topographical Map and Presentations

Review the general guidelines for all groups, as follows:

Each group will be responsible for preparing a short presentation on one aspect of marine resources that includes:

- ➤ Where they are located
- ➤ How they were formed
- ➤ How they can be recovered
- ➤ Their uses and economic benefits
- ➤ The environmental impacts of recovering them

One person from each group—preferably a strong art student—will be selected by the group to prepare a topographical map to be used by all groups during their presentations. Each group may want to assign specific tasks to each member of the group—information gathering, developing graphics, writing the presentation, and making the presentation.

Give the students the deadline for the project and explain that they will have one (or two) class periods to work on their projects before the presentations. After the general group instructions have been given, give the students their group assignments. Each group should be given 15 minutes to plan their project, make individual task assignments, and select one member to work on the map.

Give the students working on the map a general description of topographical maps, with specific instructions to include, and label, the following:

- ➤ Continental USA plus Alaska and Hawaii
- ➤ The OCS and EEZ boundaries
- ➤ Major land forms
- ➤ Major sedimentary basins
- ➤ Major volcanic ridges and fault lines
- ➤ Areas where their specific group's resources are located

Monitor the working groups as they work on their map and presentations. Before the presentations, give your students general tips on making effective presentations.

Step Four—Presentations

Let's take the plunge—into the ocean of marine resources.

Ask one of the students who constructed the map to give a brief overview to the class, pointing out the major land forms, ridges, and basins. Have the groups make their presentations, permitting a few minutes for questions and/or discussion between each presentation. Wrap up the activity by reinforcing the concepts listed above and discussing the pros and cons of marine resources development.

Step Five—Grading and Evaluation

If this is a graded activity, you can use the outline below or your own grading system.

Individuals:

- Worked well in group—25 points
- Accomplished assigned tasks—25 points
- Knew material well—25 points
- Shared information with others—25 points

Groups:

- Group work—50 points
- Presentation—50 points

Secondary Activity (Grades 9-12)

BACKGROUND

Students research the pros and cons of recovering one or more of the resources discussed in the backgrounder. Students also conduct a mock town council meeting or permit hearing to decide whether recovery of that resource should be permitted.

CONCEPTS

- The OCS and EEZ contain enormous reserves of many resources of economic and strategic benefit to the United States.
- Marine resources may be associated with particular land formations.
- Few marine resources are currently being exploited. However, the future potential for economical recovery is feasible, especially as land-based reserves become depleted or too expensive to extract or may be off-limits for environmental reasons.
- The exploitation of marine resources will have impacts on the marine environment, just as land-based extraction does.
- The use of any resource, whether land or marine based, is determined in large part by economic and environmental factors.
- All actions that people take, and all products that people make, use resources. All decisions about resource exploitation involve trade-offs.

TIME

Two to four 45-minute class periods, plus out-of-class research.

MATERIALS

- One copy of ***Marine Resources: America's Untapped Treasure*** backgrounder for each student
- Sample town council meeting or public hearing scenario
- Library and other resources (Minerals Management Service, U.S. Department of the Interior)

PROCEDURE

Step One—Preparation

Make one copy of the backgrounder for each student. If you will be using a sample scenario, make one copy for each student.

Step Two—Introduction of Activity

Introduce the activity to your class. Explain to the students that they will be learning about marine resources, researching the feasibility of exploiting one or more of these resources, and conducting a town council meeting (or permit hearing) to discuss the pros and cons of a specific recovery operation. During this hearing, students will take on different roles in the hearing process; for example, company representatives seeking permit approval, environmental experts, economic experts, citizens groups opposed to and in favor of the operation, members of the town council, etc.

Have the students read the backgrounder, ***Marine Resources: America's Untapped Treasure***, for homework.

Step Three—Preparation for Town Meeting

Distribute a sample scenario from the backgrounder to each student or choose the recovery of another marine resource to research. Possibilities for other hearings include:

- ➤ A company is applying for a permit to mine for gold in offshore Alaskan waters.
- ➤ A company is applying for a permit to mine cobalt along the volcanic ridges in waters off Hawaii.
- ➤ A coastal city wants to renourish its storm damaged public beaches using offshore sand.

Facilitate a discussion of the activity, soliciting a list from the class of the witnesses they think should testify at the meeting. Explain the format of the meeting, as follows:

- ➤ The mayor convenes the meeting and explains the purpose of the meeting.
- ➤ The company requesting the permit presents its petition.
- ➤ Town council members question the company representatives.
- ➤ The expert witnesses and citizens' groups testify.
- ➤ Town council members may question each witness.
- ➤ After all testimony, the town council discusses the permit request and makes a decision.

Assign a role to each student in the class. Explain that each witness will have a maximum of three minutes to present his/her testimony. Assign a date for the meeting, giving the students at least one week to research their topic. If this will be a graded activity, explain the grading system to the students. Consider videotaping the meeting to distribute to other classes.

Step Four—Holding the Meeting

Arrange the classroom so that the town council is seated together in the front, with a podium for the witnesses. If the meeting is being videotaped, make sure the equipment is ready to go.

Ask the mayor to convene the meeting. If there is time remaining, discuss the activity with the students, reinforcing the concepts listed above.

Step Five—Grading and Evaluation

If this is a graded activity, you can use the outline below or your own grading system.

- ➤ Research and understanding of information—50 points
- ➤ Presentation of information—50 points

Marine Resources: America's Untapped Treasure

EEZ AND OCS—THE LIE OF THE LAND

When most people think of the United States, a map of the country comes to mind. Everyone recognizes the outline of the USA and its borders. But our resources aren't confined to those borders—they are much farther reaching. Our borders extend 200 miles into the water from our coastlines and encompass an area bigger than the country itself. The submarine area claimed by the United States includes 3.9 billion acres, whereas the land area of the country includes only 2.3 billion acres.

This vast underwater area is called the Exclusive Economic Zone (EEZ) of the United States. By proclamation of the President in 1983, the United States claimed jurisdiction over all the area within the EEZ and is responsible for protecting and developing its natural resources, both living and non-living.

Other countries are free to travel and fish in the international waters of the EEZ to within 12 miles of the coast, where territorial waters begin. The U.S. has exclusive jurisdiction over this area and foreign vessels cannot enter without permission.

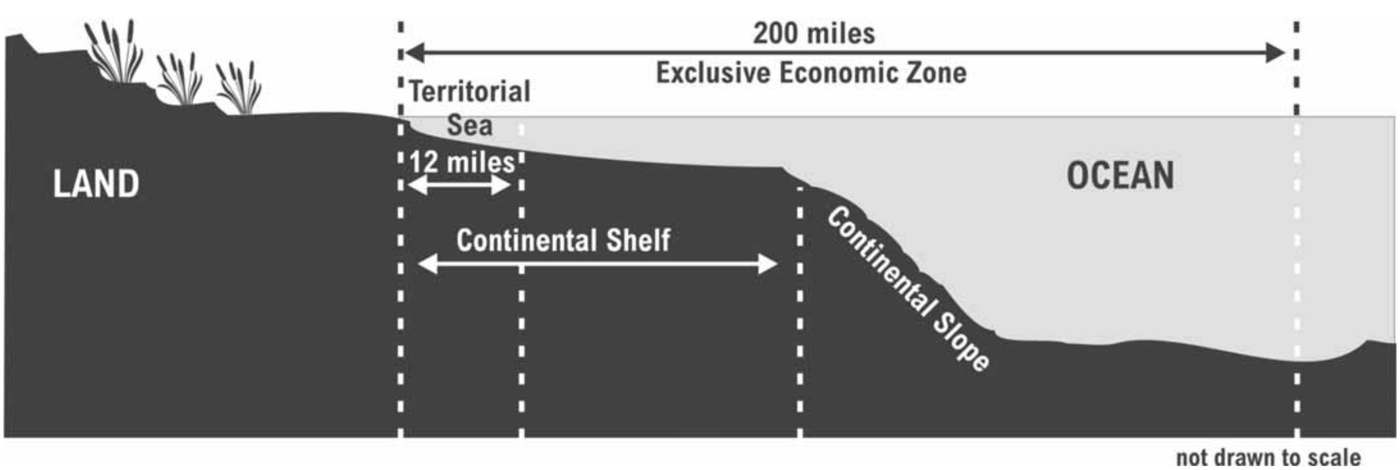
The undersea world extending away from the shore is a fascinating place. In most places, the continent extends into the ocean on a broad shelf that gradually descends to a sharp drop, called the continental slope. This continental shelf can be as narrow as 20 kilometers along the west coast and as wide as 400 kilometers along the northeast coast. The water on the continental shelf is shallow, rarely exceeding a depth of 150 to 200 meters.

This shelf drops off dramatically at the continental slope, ending in abyssal plains that are three to five kilometers below sea level. Many of the plains are flat and featureless, while others are marked with jagged mountain ridges, deep canyons, and valleys. The tops of some of these mountain ridges form islands where they extend above the water. Some ridge crests contain hydrothermal vents—underwater geysers. Rich deposits of minerals and amazing plants and animals have been discovered around these vents.

The EEZ regions surrounding the Pacific and Caribbean islands have different topographies. The island shelves are composed of volcanic rock on which coral reefs or carbonate sediments have developed. These shelves are very narrow and shallow, dropping off sharply to abyssal plains or deep ocean trenches. The Hawaiian Archipelago, for example, is a chain of volcanic mountains rising from plains 5–7.5 kilometers deep.

Much of this submarine world has not been explored—it is the Earth's last frontier—but scientists do know about some of the resources in many areas. Most of us are aware of the rich deposits of petroleum and natural gas on the outer continental shelf (OCS), especially off the Pacific coasts of California and Alaska and in the Gulf of Mexico.

The EEZ extends 200 nautical miles from the coastline and includes the edge of the continent that extends beneath the sea.



PETROLEUM AND NATURAL GAS

Petroleum and natural gas deposits on the OCS are located in sedimentary rock basins, where the remains of tiny sea plants and animals settled millions of years ago. If the sediments produced the proper conditions of temperature and pressure, this organic material was eventually converted to hydrocarbons (oil and gas). These organic hydrocarbons accumulated in empty spaces in the surrounding rocks, called traps. Finally, an oil-saturated rock—much like a wet sponge—was formed. The traps were overlain with a layer of impermeable rock, such as slate, or a seal of salt or clay, that prevent the oil and gas from escaping to the surface.

Under these conditions, about two percent of the organic material is transformed into hydrocarbons and the sedimentary basin will have oil and gas potential. Thirty basins in the EEZ have been identified that could contain enormous oil and gas reserves. Several of these basins have been explored and are producing oil and gas at this time. It is estimated that 30 percent of undiscovered U.S. gas and oil reserves are contained in the OCS.

Detailed studies have been carried out on many of these sedimentary basins to determine the potential for oil and gas reserves and the possible ecological and environmental impacts of recovering them. Ocean climate and current studies in potential drilling areas have also been done to ascertain the risks associated with the drilling platforms. Test wells have been drilled in many areas to assess the potential for development.

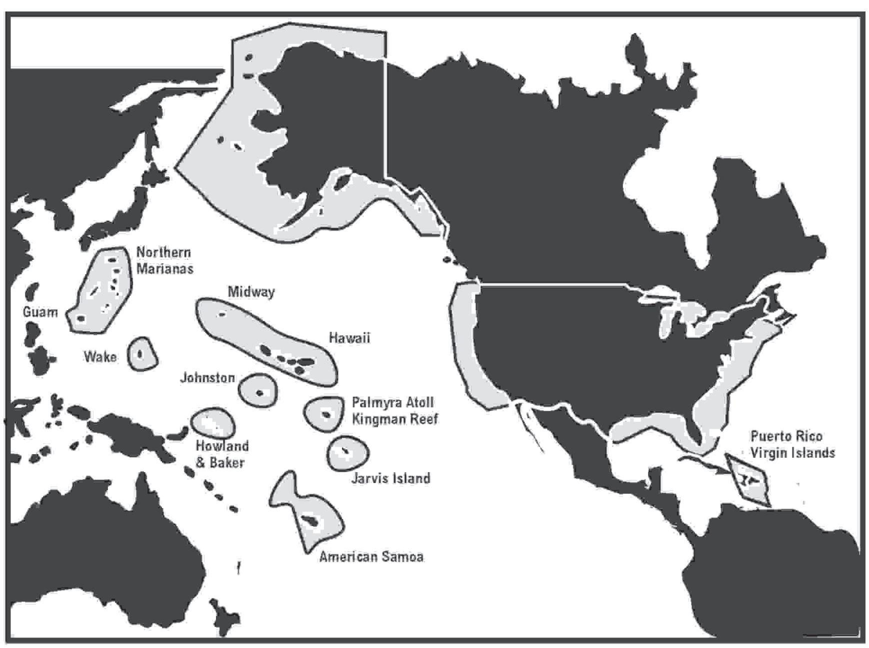
The first offshore drilling was begun in 1897 from a pier in Summerland, California. In 1945, President Truman asserted Federal jurisdiction over all the area of the OCS. In 1953, individual states were given jurisdiction over the lands within three miles of their shore lines. The Department of the Interior, Minerals Management Service, has the authority to lease the remaining lands and regulate all exploration and recovery efforts.

Early drilling was limited to areas where the water was less than 300 feet in depth, but modern drilling rigs can operate to depths of a mile or more. Some drilling platforms stand on stilt-like legs that are imbedded in the ocean floor. These huge platforms hold all the drilling equipment needed, as well as housing and storage areas for the work crews. Once the well has been drilled, the platforms also hold the production equipment.

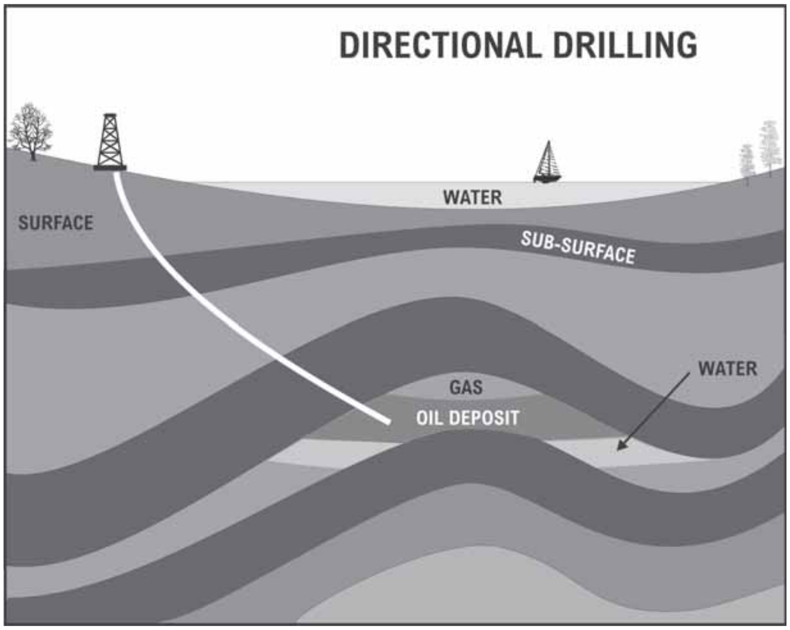
Floating platforms are used for drilling in deeper waters. These self-propelled vessels are anchored to the ocean bottom with huge cables. Once the wells have been drilled from these platforms, the production equipment is lowered to the ocean floor and sealed to the well casing to prevent leakage. Wells have been drilled in 10,000 feet of water using these floating rigs.

During every phase of development and production, precautions are taken to prevent pollution, spills, and significant changes to the ocean environment. All aspects of the operation, from waste disposal to hurricane safety measures, are regulated by the Federal government. Since 1975, when current regulations went into effect, the OCS drilling program has had a safety record of 99.99 percent—only about 0.001 percent of the oil produced has been spilled. During 1993, Hurricane Andrew passed through the Gulf of Mexico with winds of 140 mph and 35 foot seas and produced minimal damage to facilities meeting current standards. No major spills or life-threatening injuries or fatalities were reported.

Offshore production is costly—many times as expensive as land-based production. When the wells no longer produce a sufficient amount of oil or gas to be financially worthwhile, they are abandoned. The wells are permanently sealed and the production equipment and platforms are removed. The area is restored as nearly as possible to its original state.



The EEZ of the United States is larger than its land area.



Offshore production supplies approximately 22 percent of the nation's natural gas production and 35 percent of its total oil production.

At the present time, most of the active wells and proven reserves are in the Central and Western Gulf of Mexico, along with 43 additional wells off California. Although there are no producing wells in other areas, there is believed to be significant oil potential in the Beaufort Sea off Alaska, as well as natural gas potential in the Eastern Gulf of Mexico and in certain basins off the Atlantic Coast.

Although there is serious public concern about development of these areas at the present time, they offer great potential for the future. Today, the U.S. imports about two-thirds of the petroleum it consumes, much of it from politically unstable areas of the world.

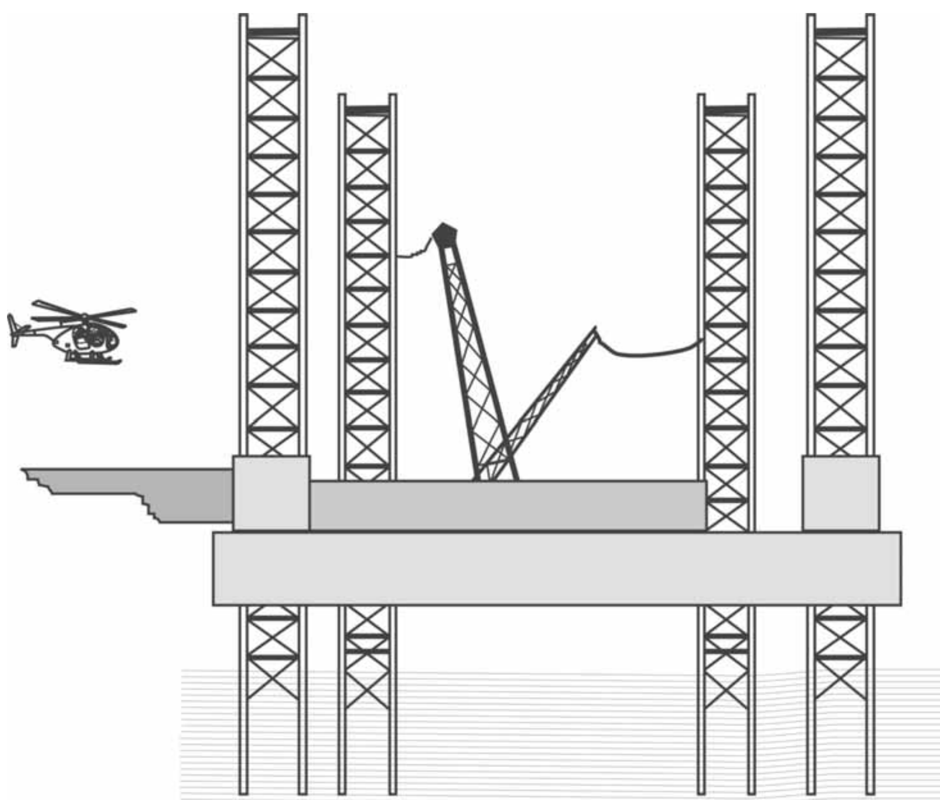
In 1954, there were fewer than 100 wells drilled in the OCS. By 1978, four years after the first oil embargo, there were more than 1,200 wells drilled.

Consumption of natural gas continues to increase as well. In the next ten years, the energy picture might well require the development of offshore resources from areas currently under restriction to meet our industrialized society's demand for energy.

In 1982, oil and gas prices began to decline. The Exxon Valdez oil spill off of Alaska in 1989 raised public concern over offshore production. In 1990, President Bush excluded the Pacific OCS, the North Atlantic and North Aleutian areas, and parts of the Eastern Gulf of Mexico from leasing until the year 2000.

In December 1997, President Clinton extended this drilling moratorium for another ten years. The oil and gas basins with the highest potential for development are included in this moratorium.

By 1992, there were only 600 wells drilled in the OCS. Then the tide turned. Rising natural gas prices and governmental support of the increased use of natural gas were responsible for the development of 800 wells in 1993. Today, there are more than 4,000 platforms in the Gulf of Mexico, servicing thousands of wells.



A jack-up rig can be used in water depths of up to 400 feet.

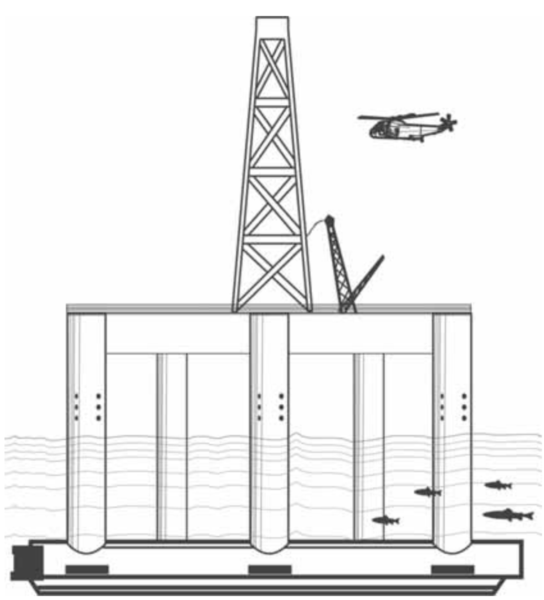
METHANE HYDRATES

Buried in the sediments of the ocean floor is a reserve of methane so vast it could possibly fuel the entire world, or so scientists think. The challenge is to find a way to tap this mighty treasure, discovered only 25 years ago.

In sediments on the ocean floor, tiny bacteria continuously break down the remains of sea animals and plants. In the process, they produce methane gas. Methane is almost always a by-product of organic decay. Under the enormous pressures and cold temperatures at the bottom of the sea, this methane gas dissolves. The molecules of methane become locked in a cage of water molecules to form crystals. These crystals look like ice, and they cement together the ocean sediments. In some places a solid layer of crystals—called methane hydrate—extends from the sea floor down hundreds of meters.

In addition to the methane trapped in crystals, scientists suspect that huge deposits of free methane gas are trapped beneath the hydrate layer. Researchers estimate that there is more carbon trapped in hydrates than in all the fossil fuels—an enormous treasure. Some of this methane is trapped in polar ice, but most is located in the waters off both the East and West Coasts, as well as Alaska. One deposit in a 30-by-100 mile area off the North Carolina coast holds enough methane to supply all the needs of the United States for 100 years.

So far, most of the discoveries have been accidental. Scientists began actively searching for hydrate deposits only a few years ago. They suspect that there are many more deposits all over the world. Japan, which must import almost all of its energy, has begun an effort to locate hydrates along its coastline. The question still remains—can we recover this methane safely and economically? We know that most of the hydrates are not hard to reach. They are located in relatively shallow water—at depths of 1,000 to 3,000 meters. Today, drilling rigs in the Gulf of Mexico operate in much deeper water.



Semi-submersible drilling rigs can be used in deep waters and heavy seas.

And the methane in hydrates is very concentrated. The molecules of methane are packed together more closely in hydrates than in liquefied gas. Hydrates are the richest reservoirs of methane known to exist. Researchers at the U.S. Geological Survey (USGS) think that it may be simple to free the methane from the crystals by reducing the pressure on them. William Dillon, who heads the USGS Gas Hydrate Project explains, "...the most profitable thing to do is start producing that free gas (trapped under the hydrates). As you produce the free gas, you reduce the pressure, and the gas hydrates break down and recharge the reservoir. And we'd have a gas trap that would continue producing gas. This is a feasible thing for the future."

The Russians have used antifreeze to break down hydrates located onshore in Siberia. Some researchers think that warm surface water could be piped to the bottom of the hydrate zone to melt it, while other pipes could vent the gas to the surface. Refining this technique, however, could take years of research. Perhaps the biggest question is the effect that removing the methane will have on the environment. When methane is removed from a hydrate, it loses its solidity and turns into mush. This can cause major landslides and other disturbances to the ocean floor.

Recovery efforts might also cause an increase in methane escaping into the atmosphere. Methane is a greenhouse gas and scientists think that methane from ocean hydrates has had an enormous impact on global climate. During the Ice Ages, for example, sea levels dropped as the water became frozen on land. As the sea level dropped, the pressure decreased, causing hydrates to melt and release huge amounts of methane into the air. Researchers think this caused a greenhouse effect that warmed the earth, moderating the temperatures. In warmer periods throughout history, as glaciers and ice caps melted, the sea levels rose and increased the pressure on the hydrates. Less methane escaped into the atmosphere. This, in turn, moderated the climate. Any wide-scale attempts to harvest methane from ocean hydrates will have to take into account the environmental impacts to the ocean floor and the atmosphere. Much research must be done before hydrates become a viable energy source for the future.

MARINE MINERALS

There are other marine minerals in the EEZ that can provide a wealth of resources to the United States in the future. They are located in or on the sediments of the subseabed and underwater mountain ridges. There are even resources in the muds and oozes, and dissolved in the seawater itself.

The most important marine minerals are sand and gravel, shell, phosphorite, placer minerals such as gold and platinum, and heavy minerals such as titanium, chromium, and magnetite. (Placers are minerals that were deposited in the ocean by the movement of water or glaciers.)

Sand, gravel, and shell are widely distributed along the OCS. The other minerals are found only in certain areas or geologic formations.

Phosphorite

Phosphorite is plentiful in deep depressions and sedimentary basins along stable regions of the continental shelf. It is mainly used in fertilizers, but is also an important ingredient in feed supplements, fireworks, and water treatment.

At the present time, there are abundant onshore resources of phosphorite and the U.S. exports some of its production. In the next ten years, however, it is predicted that we will need to import phosphorite, based on remaining onshore reserves and consumption estimates. As onshore resources become more difficult and costly to extract, and the land is valued more for other uses, offshore deposits may become an important resource.

Gold, Platinum, and Heavy Minerals

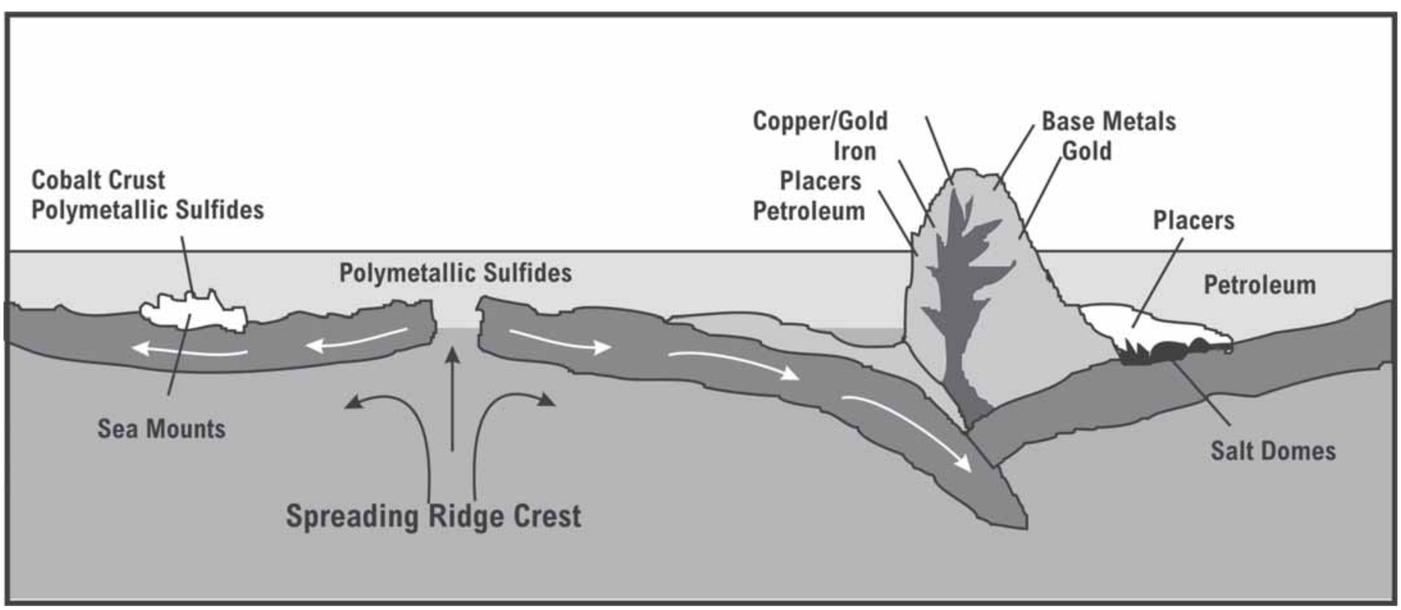
Deposits of placer minerals and heavy minerals are also located in pockets throughout the OCS. The United States has limited onshore deposits of most of these minerals and must import a significant percentage of its demand.

Titanium is the only important mineral in this group that the U.S. exports in significant amounts, and its supplies are limited. Titanium is an essential mineral in the aerospace industry because of its ability to withstand high temperatures and is widely used as the white pigment in paints, paper, and plastics. There is no substitute for titanium at this time that is effective and economical.

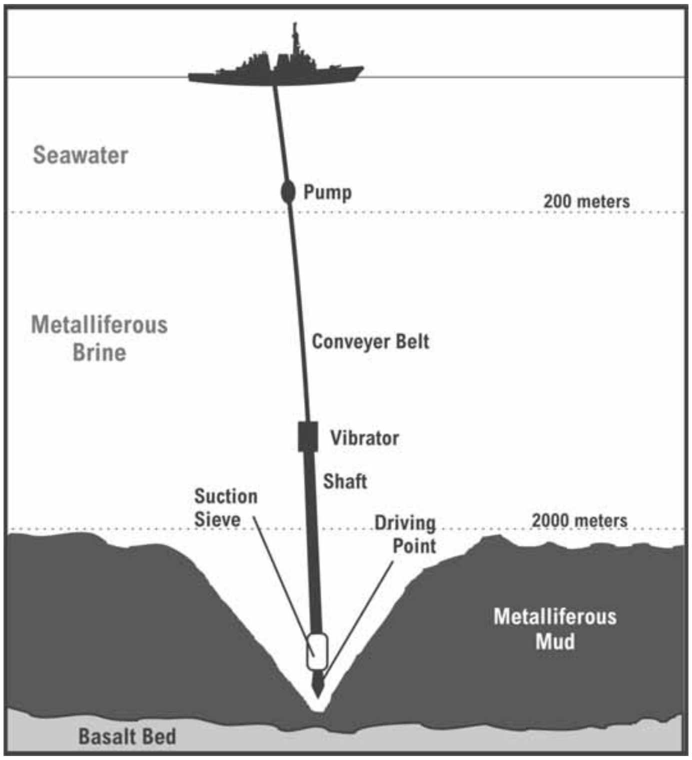
The United States imports almost 100 percent of the platinum we use, mostly from South Africa and the former Soviet Union. Most people think of jewelry when platinum is mentioned, but 97 percent of its demand is for industrial applications, especially in the auto industry.

With the federally mandated phase-out of leaded gasoline, the demand for platinum has increased dramatically in the last few years. Automobiles that run on unleaded gasoline require catalytic converters, which are made with platinum. The demand for platinum will continue to increase in the near future, unless breakthroughs occur in experimental technologies for catalytic converters.

Chromium is another mineral essential to the economic welfare of the country. Chromium is used in the manufacture of stainless steel and for other industrial purposes.



Spreading ridges and opening hydrothermal vents produce rich mineral deposits.



Barges vacuum minerals from mud on the ocean floor.

Chromium is considered a National Defense Stockpile item because of its importance in the production of cars, planes, and trains. At present, the U.S. imports more than 80 percent of the chromium it requires, mostly from South Africa.

Gold is used for many purposes. Jewelry accounts for 70 percent of U.S. use, but gold is also important to the electronics and aerospace industries, as well as to medicine and dentistry. Currently, the U.S. is the second leading producer of gold after South Africa and exports a small amount to other countries. Two dozen gold mines account for most of the gold production in the U.S. today.

In today's economy, there is little incentive to recover offshore resources of platinum, chromium, and gold. Considering the limited onshore resources and the political instability of major suppliers, however, they may become important resources for the U.S. in the future.

Metallic Sulfide Ores

The hydrothermal vents located along volcanic ridges contain metallic sulfide deposits that are rich in zinc, manganese, iron, lead, and silver. Active vents (smokers) produce new deposits whenever they erupt. These minerals are used in many products, including batteries, paint, weights, crystal glass, jewelry, photographic and electronic equipment, plastics, and in the construction and transportation industries.

Recently, deposits have been discovered off the coast of Oregon and around the Pacific Islands. Most of these deposits are located in water as deep as 10,000 feet and are considered uneconomical to mine at the present time, but their potential is significant.

The crust deposits associated with hydrothermal vents are rich in cobalt, manganese, and phosphorite. Cobalt is especially important to the aviation industry to make lightweight superalloys that can withstand high temperatures. The U.S. produces no cobalt—we import 75 percent of our supply and the remaining fourth is recycled from scrap. There has been some interest in recovering cobalt from offshore deposits near Hawaii.

Manganese is also found in nodules on the Blake Plateau off the southeast coast and on the abyssal plains of the Pacific Ocean floor. It is used extensively in the manufacture of steel and in other industrial products, and is considered critical to national security. Nearly 100 percent of U.S. supply is imported and there is no satisfactory substitute.

Sand and Gravel

The most abundant and important marine mineral resource for the near future is sand and gravel. These minerals are found in large quantities along the seabed of the OCS. The sand and gravel can be mined using several types of dredges that remove it from the ocean floor and deposit it on barges or even pipe it directly to shore. Some dredges use suction to bring the sand and gravel to the surface, while others raise it in large buckets or scoops.

Mixtures (aggregates) of sand and gravel are used in huge quantities in the construction of buildings, roads, railroad beds, dams, and airports, and in the restoration of shorelines. Historically, construction aggregate has been produced onshore in the United States because land resources have been plentiful and cheap. This situation is changing, however, for several reasons: economical sources are being depleted, lands with resources are more valuable for other uses, environmental concerns preempt use, and available resources are too far from markets.

Construction aggregate is a low-cost item. A very small increase in price per ton can add dramatically to the total construction cost of a project. Transportation of the aggregate from the production site to the construction site is the largest cost—most aggregate is transported by truck. Therefore, to keep the transportation cost down, the aggregate must be produced locally. In many areas, there will soon be no local, land-based deposits, especially in big cities.

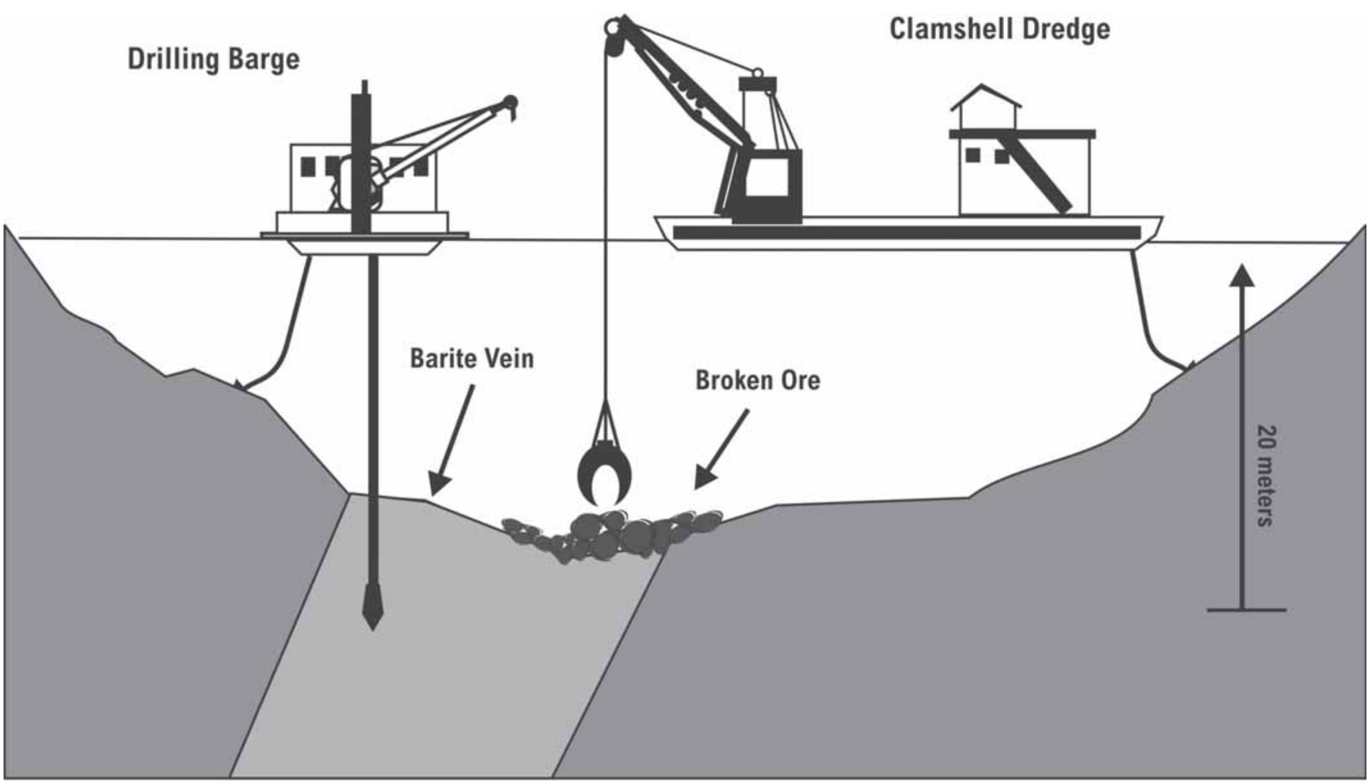
The greatest demand for construction aggregate is in major metropolitan areas, where land prices are high and land use is restricted. Land development has made many of the local deposits unreachable; furthermore, the land is so valuable that communities don't want to use it for aggregate production. In New York City, for example, aggregate costs are now three times the national average and researchers have predicted that available resources will be completely depleted within ten years.

New York is not an isolated case. In the United States today, half of the population now lives within 50 miles of a U.S. coastline, mostly in metropolitan areas. Since 1980, the biggest increase in population growth has been in the coastal states. And where population increases, construction increases. Where will the construction industry get the materials it needs at reasonable prices?

One answer is from the oceans. The United States extracts very little sand and gravel from the OCS right now, but other countries have been doing it for years. Almost 25 percent of the sand and gravel produced in Japan comes from offshore mining. The United Kingdom has been mining sand and gravel from the ocean since 1925; 15 percent of their total production is from marine mining. The Netherlands and Denmark also obtain much of their sand and gravel from offshore sites. These countries have developed sophisticated mining equipment and have conducted numerous studies to determine the impacts of marine mining on the fishing industry and the environment.

The technology is available to recover sand and gravel from the OCS economically, but the United States' sand-dredging industry is comparatively small and designed for near-shore work. Federal law at this time requires that any equipment used to mine minerals in the EEZ or transport them must be built in the U.S.; therefore, America's ship builders may have to adapt equipment for deeper water projects. U.S. companies cannot buy the barges and dredges from countries already well-skilled in the business.

Transportation of the aggregate is another consideration. Transportation costs will continue to increase for land-based mines, as production sites are located farther from metropolitan areas. Marine transportation by barge, on the other hand, costs about one-third as much per ton as trucking.



Dredges scoop up minerals and bring them to the surface.

TODAY AND TOMORROW

One established area in which the United States uses marine sand is in the restoration of beaches. A substantial portion of the nation's coastline is eroding severely, causing damage to beaches, wetlands, and coastal properties. The traditional approach of building jetties has become very expensive and has often proved ineffective in the long run.

Many coastal communities have been restoring their beaches using sand dredged from the ocean or from nearby navigational channels as part of their maintenance programs. Restoring the beaches with sand from the ocean is a cost effective approach, though studies are showing that sand cannot be dredged too near the shoreline without altering the current and wave patterns, which could intensify erosion.

Crushed shell from the OCS is also used in some areas as a foundation for roadbeds and in the manufacture of fertilizer. Shell is not evenly distributed along the OCS, but in areas where it is abundant, it can be an economical alternative to onshore products.

ECONOMIC AND ENVIRONMENTAL IMPACTS

Of course, the mining and transport of marine minerals does have an impact on the environment of the oceans, just as land-based mining affects the environment. During the period of active mining, there are disturbances of the water, with an increase in turbidity and noise. (Turbidity is the amount of sediment suspended in the water.) These disturbances may affect the plant and animal populations near the site.

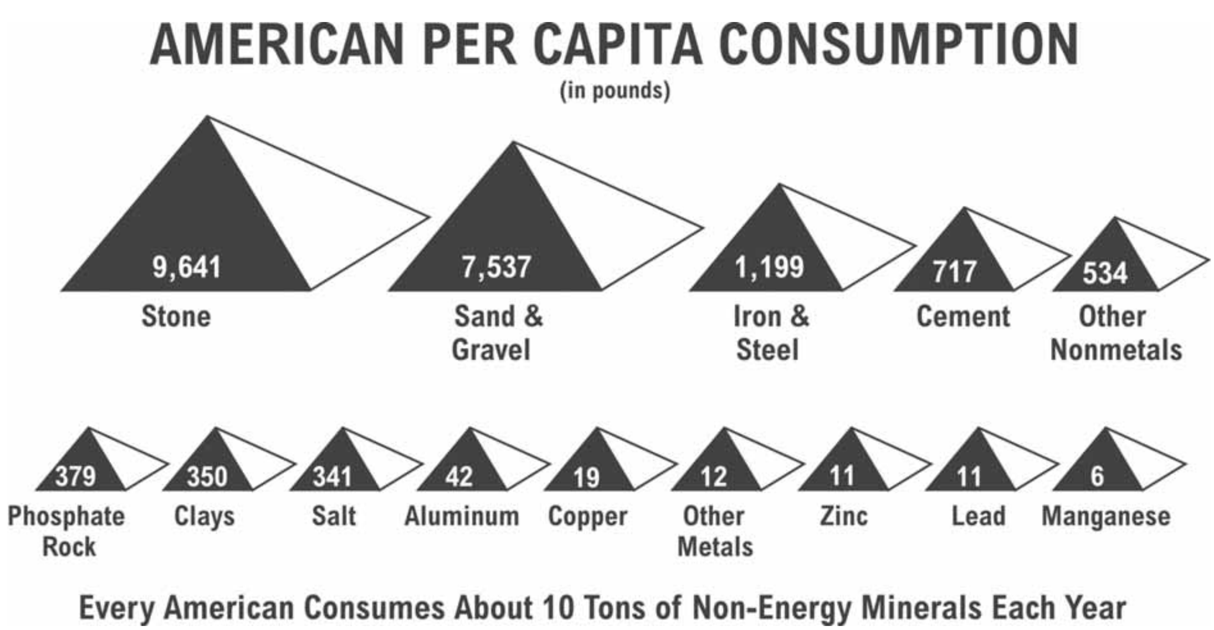
Effects that should be considered before permitting dredging activity might include changes to the topography of the sea floor and to marine plant and animal communities on the site, as well as broader changes to the composition of the area's ecological systems. Studies are being conducted to determine how quickly the plant and animal communities in dredged areas reestablish themselves.

Sometimes alterations caused by mining cause problems for fishermen; discarded mining equipment and rough terrain can damage their nets. Fish populations can also be disturbed, at least during the time of active mining, and breeding grounds can be affected. Studies have shown that many of the changes to the marine environment are short-term or can be mitigated with careful management.

The ecology of the different areas of the EEZ is varied and complex. Marine mining in some areas will produce completely different effects than in others. Site by site environmental impact studies will need to be undertaken to protect the integrity of the EEZ, as is required of land-based mine sites. In many cases, the effects of marine resource recovery will be more economical and less damaging to the environment than the effects of recovering the same resource from the land.

The EEZ contains an underwater treasure of resources for the United States. With careful management, these resources can be wisely and economically used and protected.

For more information on marine mineral development in the EEZ, contact INTERMAR, Education Services, Minerals Management Service, U.S. Department of the Interior, 381 Elden Street, Herndon, Virginia 22070.



Sample Scenario One

SAMPLE PUBLIC HEARING SCENARIO

In January 2007, XYZ Production Company applies to MMS to lease a tract of 100,000 acres located two miles off the coast of Pensacola, Florida. They submit all required documents, environmental impact studies, and detailed plans to drill up to 12 natural gas exploratory wells. If the exploratory wells find natural gas deposits that prove economical to develop, then production platforms will be built, as well as a pipeline on the ocean floor from the platforms to an onshore processing plant.

The Tourist Board of Pensacola, however, is concerned about how the platforms will change the look of and possibly pollute their beach front. The Tourist Board is also concerned about the potential for blow-outs (uncontrolled releases), especially during hurricanes. They request a public hearing before any leases are granted.

Sample Scenario Two

SAMPLE TOWN COUNCIL MEETING SCENARIO

New Town, population 1,200,000, is located on the Atlantic coast and is planning a major downtown development to be completed in the next five years. The town will need to purchase 520,000 tons of construction aggregate to complete the project.

Company A is located 50 miles inland in another county; several suburban communities are located between New Town and the production site. Company A can provide the aggregate for $5/ton plus transportation costs of $18 per truckload of 25 tons. Company A must clear 10 acres of mature deciduous forest to mine and process the aggregate. Company A's fleet of trucks has been converted to operate on CNG.

Company B will recover the aggregate from a sedimentary basin located one mile offshore, and process the aggregate at a shore-side facility of two acres to be located one mile south of the downtown area on city-owned land. Company B can provide the aggregate for $5.25/ton plus transportation costs of $8 per truckload of 25 tons. The area of the continental shelf where the dredging would take place is wide, relatively featureless, and similar to the other areas of the shelf for miles to the north and south.

New Town is also considering negotiating with the U.S. Government to acquire sand from federal waters four miles offshore.

MARINE ENERGY
Evaluation Form

State: ___________ Grade Level: ___________ Number of Students: __________

1.	Did you conduct the entire activity?	Yes	No
2.	Were the instructions clear and easy to follow?	Yes	No
3.	Did the activity meet your academic objectives?	Yes	No
4.	Was the activity age appropriate?	Yes	No
5.	Were the allotted times sufficient to conduct the activity?	Yes	No
6.	Was the activity easy to use?	Yes	No
7.	Was the preparation required acceptable for the activity?	Yes	No
8.	Were the students interested and motivated?	Yes	No
9.	Was the energy knowledge content age appropriate?	Yes	No
10.	Would you use the activity again?	Yes	No

How would you rate the activity overall (excellent, good, fair, poor)?

How would your students rate the activity overall (excellent, good, fair, poor)?

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:

NEED Project
PO Box 10101
Manassas, VA 20108
FAX: 1-800-847-1820

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