



# Colorado Reader

AG IN THE CLASSROOM—HELPING THE NEXT GENERATION UNDERSTAND THEIR CONNECTION TO AGRICULTURE

COLORADO FOUNDATION FOR AGRICULTURE ~ [WWW.GROWINGYOURFUTURE.COM](http://WWW.GROWINGYOURFUTURE.COM)

## Use of Soil in Mined Land Reclamation

Where do we get the products we use every day? Well if it isn't grown, then it must be mined. Mining is the extraction of ores. Mining provides raw materials to manufacture products and for creating energy. For example:

- Much of the U.S. electricity is generated by turbines driven by steam. Coal, which is mined, is burned to heat water to create steam.
- Automobiles are manufactured from mined iron and aluminum.
- Your phone, computer, television, washing machine, refrigerator and many more products have components made from mined materials.
- Highways, sidewalks, buildings and concrete structures are built from mined materials.

Mined materials are used to produce the food we eat. For example:

- Chickens are fed limestone in their diet to produce strong egg shells.



- Phosphorus is a nutrient plants need to grow. Farmers and gardeners may add this mined mineral to their soil so their crops will have the right nutrients for good growth.

When minerals are removed from the ground, soil is moved around and changed. Different layers of soil are dug up.

Early miners gave little thought to what impact their mining had on land, water and air. They would just abandon a mine and move on. Abandoned mines still cause environmental problems today.

Beginning in the 1960s and 1970s, mining laws were passed to protect the environment. These laws include the requirement that mining sites be reclaimed. Mining reclamation is the process of returning mined land to productive and beneficial use. How this is done varies greatly depending on the type of mine, its location and how the land was disrupted.

# Mining Environmental Concerns...

In most mining operations, rock is removed that does not contain enough ore to be processed. This rock is called waste rock or overburden. When the ore is processed, the waste is called tailings. Today mining operations are required to design methods for handling the waste rock to minimize environmental damage. One of the biggest concerns is when this waste rock comes in contact with water. Water can dissolve minerals in the waste rock. This can result in acids being formed or heavy metals being dissolved from the waste rock. This pollution can flow into streams and rivers if it is not contained. It can also seep into groundwater.

Water is used in some mining methods. Best management practices have been developed to reduce water pollution from mining. Some of these practices include:

- build settling ponds to catch stormwater and allow contaminants to settle out of water before it flows into streams, wetlands or rivers
- develop a system of culverts, channels, embankments and barriers to stop or direct the flow of stormwaters from a mine site
- install pumping and drainage systems
- develop recycle and reuse systems for waste waters to reduce the need for fresh water
- continually monitor water quality throughout the mining and reclamation process
- create wetlands to filter water
- recycle processed water

This reader helps achieve the following content standards as interpreted at [www.standardstoolbox.com](http://www.standardstoolbox.com) for Colorado 4th grade:

CO 4 MATH - 4.2 Formulate, represent, and use algorithms to multiply and divide with flexibility, accuracy, and efficiency

CO 4 MATH - 4.2.a Use flexible and efficient methods of computing including standard algorithms to solve three- or four-digit by one-digit multiplication or division problems

CO 4 MATH - 4.2.d Explain why multi-digit multiplication and division procedures work based on place value properties and use them to solve problems

CO 4 SCI - 4.1.a Identify and describe the variety of energy sources

CO 4 Language - 4.3 Knowledge of complex orthography (spelling patterns), morphology (word meanings), and word relationships to decode (read) multisyllabic words contributes to better reading skills

CO 4 SOCIAL STUDIES - 4.1 Organize and sequence events to understand the concepts of chronology and cause and effect in the history of Colorado



A reclaimed mine can become rangeland where cattle and wildlife roam.



A reclaimed mine can become a recreation area.



A reclaimed mine can become farm land.



# Soil in Reclamation

Mining requires a detailed plan of what is going to be mined, how it will be mined, and how the land will be reclaimed. Federal, state and local governments require reclamation plans. These plans determine the conditions of the area before it is mined. Plans show the impact mining will have on land, water, plants, animals, other natural resources and humans.

The mining company works with governmental agencies to develop a plan to eliminate or repair impacts their mine might have on the environment. The mining company must buy a reclamation bond. This bond sets aside money to insure the reclamation is completed.



scraping topsoil

Presently, mining companies are required to return mined lands to a beneficial use once mining is completed. These uses can encompass many forms but some of the most common are rangeland, pastureland, farmland and wild-life habitat.

To accomplish this, mining companies must thoroughly evaluate the land that will be disturbed prior to mining in order to properly reclaim the land. This is called a baseline analysis. A big part of this analysis focuses on evaluating the soils that are present on the land to be mined along with the vegetation that these soils support. The main areas of the baseline analysis for soils or growth medium are:

- Soil types (sand, silt, clay or a combination of all three)
- Soil fertility (amount of organic matter and required nutrients necessary to grow plants)
- Chemical and physical analysis (pH to determine if soils are too acidic or basic and structure of soil to determine its physical characteristics for removal and replacement)
- Suitability for reclamation (combination of above factors)
- Volumes available to complete reclamation (depth of topsoil or most suitable horizons)

Upon completion of the baseline analysis it is possible to determine how much of each suitable soil type must be salvaged in order to reclaim the land to the approved post-mining land use.

Soil is one of the most important components to properly reclaim lands disturbed by mining. It provides the physical and biological base to re-establish vegetation that existed prior to mining. This creates a stable post-mining landscape that is less likely to erode and lets plants (flora) and animals (fauna) that existed prior to disturbance thrive.



The last sentence in the paragraph above refers to inviting the flora and fauna. What is the best description of flora and fauna below:

- a. microbe and bugs
- b. plant and animal life
- c. minerals found in soil

# What is Soil?

Soil is a natural body of solids (minerals and organic materials), liquid (usually water), and gases (air), with horizons, or layers. It has the ability to support rooted plants and is home to an abundance of microbes and organisms.

Soil is one of our most useful natural resources. From the soil we get food, clothes and materials for the homes we live in. Gardens and farms provide vegetables, fruits and grains grown in the soil. Trees give us valuable lumber and the wood can be used to make paper, paints, and numerous other products.

Our animal food also comes from the soil. Cows eat grass, hay, silage (chopped corn plants), and grain to produce milk, meat and leather products. All animals eat plants or eat other animals that eat plants, and plants grow in the soil. Animals also supply us with raw materials that are used in paints, pet food, rubber, crayons, lotions, soaps, leather, medicines and much more!

The energy that warms our houses, fuels our cars and powers our electricity generating plants comes indirectly from the soil. Coal is made from plants that grew ages ago. Oil and gas also originate from organic materials, including the remains of animals. Some of these things grew in the soil at one time or lived on things that grew in the soil.

Fish from oceans, rivers and lakes live on plants or on other fish who eat plants, and these plants use dissolved minerals that are washed into the seas, rivers, and lakes from the soil.

## Did you know we have a state soil?

It is called Seitz soil. Seitz soils are used mainly for recreation and forest products. The plants found growing on this soil type are spruce and fir trees. Grasses, forbs and shrubs grow underneath these conifer trees. There are about 350,000 acres of Seitz soils in Colorado.

Most soils are formed in layers called horizons. Horizons are important to identify and classify soils.



- O** Layers of soil:
- A** • The "O" horizon is a layer of decomposing organic material.
  - E** • Topsoil, the "A" horizon, is the layer on the surface where plants grow.
  - B** • The E is eluviated horizon which has clay, minerals and organic matter
  - C** • Subsoils, the "B" horizon, is where clay and minerals accumulate.
  - C** • The "C" horizon is the material from which soils develop.
  - R** • "R" horizon is referred to as bedrock and is made up of rocks such as granite, basalt quartz, limestone or sandstone.

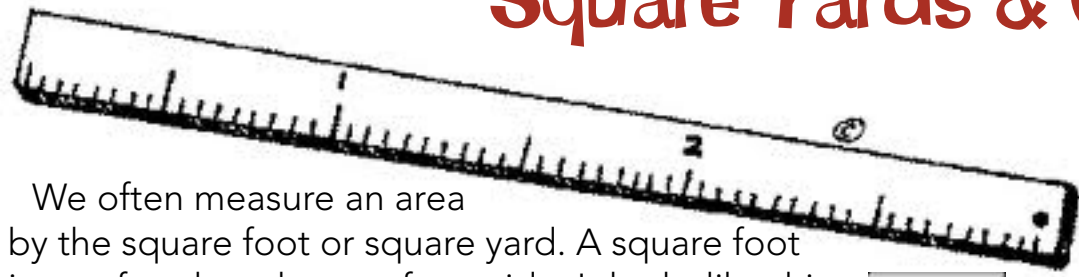
Study the information above to answer the questions.

1. What is the letter of the horizon where bedrock, such as granite, quartz and limestone is found? \_\_\_\_\_
2. What is the letter of the horizon where clay, minerals and organic materials are found? \_\_\_\_\_
3. What is the letter of the horizon where you would find decomposing leaves and other plant material? \_\_\_\_\_
4. What is the letter of the horizon where you would find plants growing? \_\_\_\_\_
5. What is the letter of the horizon that has the material that forms soil? \_\_\_\_\_

**Pedology is the study of soil.**



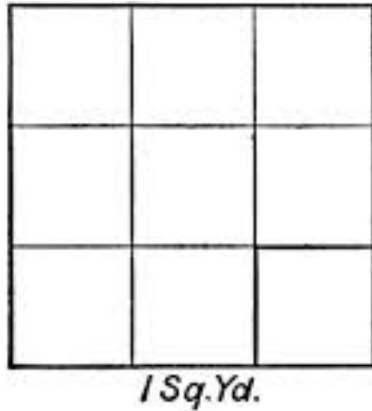
# Square Yards & Cubic Yards



We often measure an area by the square foot or square yard. A square foot is one foot long by one foot wide. It looks like this:



A yard is three feet thus a square yard would be three feet by three feet. It looks like this:



How many square feet are in a square yard? \_\_\_\_\_

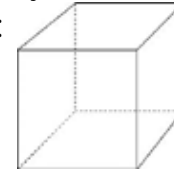
Land is often measured in acres. One acre of ground is 43,560 square feet. If you want to figure out how many square yards there are in an acre, what would you do?

\_\_\_\_\_

How many square yards are in an acre? \_\_\_\_\_

How many cubic yards of soil are needed to cover an acre with one foot of top soil? Show your work.

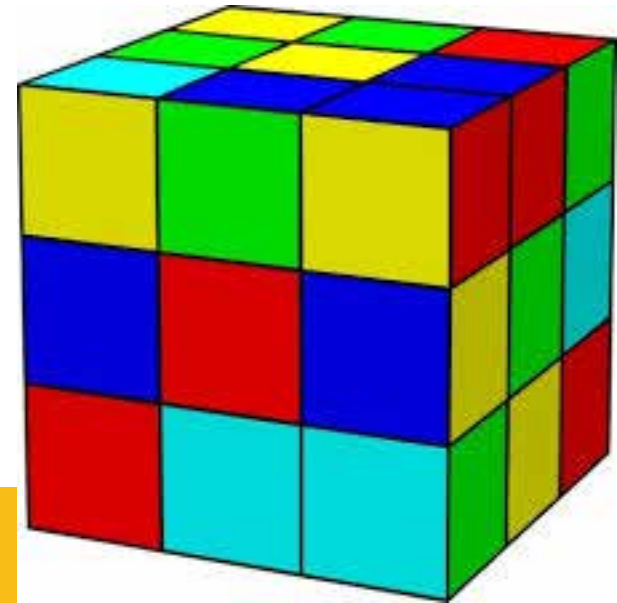
The measurement often used when measuring rock and soil is cubic yards. What is a cubic yard? Let's start by seeing what a cubic foot is. A cubic foot is 1 foot tall by one foot wide by one foot deep. It looks like this:



We know a yard is three feet. So a cubic yard would be three feet tall by three feet wide by three feet deep. It would look like this:

Study this picture, how many cubic feet are in a cubic yard?

\_\_\_\_\_



## Engineered Wetlands

An effective way to treat runoff water from mine sites is to filter it through biological filtering ponds and wetland soils before releasing it into the environment. The water flows through a swamp or marsh; many metals in the water are absorbed by the plants. With the unwanted materials removed, clean water can be released into the environment. This method is inexpensive and can operate with little attention for many years.

The main process of metal removal is bacterial biodegradation. This process breaks down the metal compounds into harmless products by the action of living things, mainly microorganisms.



# Types of Mining



Above is an aggregate mine. It is a surface mine. Do you know what aggregates are? They are rocks, gravel and sand. There are more aggregate mines than any other type of mine. This is because aggregates are used in road and building construction.



Open pit mining is like surface mining only the mines are larger and deeper. Copper, gold, silver, molybdenum, iron, coal and zinc are mined this way.



Dredging is a form of mining conducted under water to recover ores. It can be done using draglines, suction dredges or barges.



This is an underground mine. Ores are dug out from below the surface. Coal, copper, gold, silver, limestone and lead are minerals that can be mined this way.

## What type of soil is it?

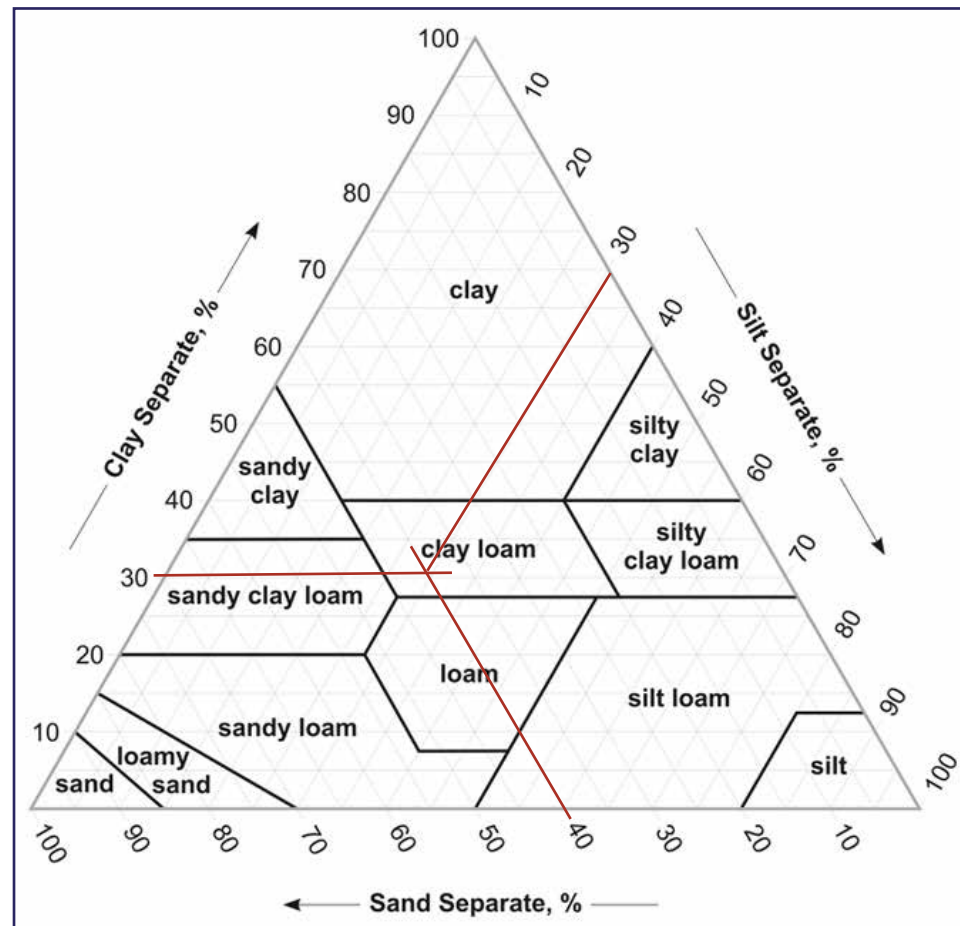
The makeup of soil is based on the percentage of three minerals: sand, silt and clay. The type of soil is identified by the percentage of these minerals in the soil. If you study the triangle on the left you will see one side represents clay, one silt and the bottom represents sand.

If you draw a straight line down the percentages of each mineral soil to the box where they meet, you can identify what type of soil it is. For example, 30% silt, 30% clay and 40% sand meet in the box call clay loam. (follow the red lines)

### Your turn.

What is the name of the soil that is 10% sand, 50% silt and 40% clay? \_\_\_\_\_

What is the name of the soil that is 20% silt, 70% clay and 10% sand? \_\_\_\_\_



The Colorado Reader publication and Ag in the Classroom are projects of the Colorado Foundation for Agriculture. Educational projects are produced in cooperation with the Colorado Department of Agriculture, other state and federal agencies, Colorado commodity groups, Colorado agricultural associations, state universities and colleges and interested individuals. Colorado Readers are provided free to educators requesting them. For more information contact: Bette Blinde, Colorado Foundation for Agriculture, PO Box 10, Livermore, CO 80536 or phone 970 881.2902. Materials can be ordered at: [www.growingyourfuture.com](http://www.growingyourfuture.com). Financial support for this reader has been provided by Colorado Division of Reclamation, Mining & Safety.





# Math Challenge

A surface coal mine operator needs to reclaim 20 acres of a mine site. To reclaim the mine the operator must first use a bulldozer to regrade the spoil. Spoil is the area that was disturbed during the mining process.

After regrading the spoil, the mine operator must use a scraper to replace the topsoil. Finally, the operator needs to use a rangeland drill to reseed the area where the topsoil was replaced.

The operator has determined that there are 12,000 cubic yards of spoil that needs to be regraded, 9,000 cubic yards of topsoil that needs to be replaced and 20 acres of replaced topsoil that needs to be reseeded.

The operator has determined that it will cost \$0.25 to regrade each cubic yard of spoil with a bulldozer, \$1.50 to replace each cubic yard of topsoil with a scraper and \$250.00 to reseed each acre with a rangeland drill. The operator has also determined that a bulldozer can regrade 500 cubic yards of spoil each hour, a scraper can replace 1,000 cubic yards of topsoil each hour and a rangeland drill can reseed 4 acres each hour.

ACTIVITY: Calculate how much it will cost to regrade the spoil, replace the topsoil and reseed the area where the topsoil was replaced. Next, calculate how long it will take to complete each of these tasks. Finally, calculate how much it will cost to reclaim the entire mine and how long it will take to complete the reclamation.



How much will it cost to regrade the spoil?

How long will it take?

How much will it cost to replace the topsoil?

How long will it take?

How much will it cost to reseed the area?

How long will it take?

What will be the total cost to reclaim the area?

How long will the entire reclamation take?



Aerial view of a mine site with each area labeled.

Choose the best answer or fill in the blanks.

1. Mining can be defined as
  - growing of crops for food
  - extraction of ores
  - digging a big hole
  - none of the above
2. The process of reclaiming the land for beneficial use is called:
  - farming
  - ranching
  - reclamation
  - mining
3. Reclamation begins
  - before the mining begins
  - when the mining ends
  - only during the mining process
  - none of the above
4. Rock that does not contain enough ore to be processed is called:
  - waste rock or overburden
  - top soil
  - tailings
  - none of the above

5. Aggregates are
  - gravel
  - rock
  - sand
  - all of the above
6. Some of the problems that might occur when water combines with waste rock are
  - water could become acidic
  - water could dissolve metals in the rock
  - water could become polluted
  - all of the above

7. List two types of mining.

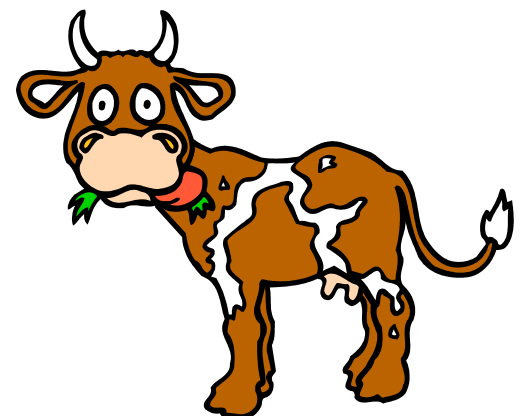
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8. A reclaimed mine can be used for
  - wildlife habitat
  - rangeland
  - farmland
  - all of the above

9. Soil is often measured by the
  - square foot
  - square yard
  - cubic yard
  - none of the above
10. The process to remove metals from water in wetlands is
  - bacterial biodegradation
  - wetland filtration
  - all of the above



What is nacholite? It is what is used to make baking soda. Nacholite is also used by dairy farmers ~ it's Tums for their cows.



# MINING READER TEACHER'S GUIDE

AG IN THE CLASSROOM - HELPING THE NEXT GENERATION UNDERSTAND THEIR CONNECTION TO AGRICULTURE

## RESOURCES

Additional Resources:

State of Colorado, Department of Natural Resources, Division of Reclamation, Mining and Safety.

This division is responsible for mineral and energy development, policy, regulation and planning. Their website provides information on the division as well as many of the division's projects and other related topics.

1313 Sherman St., Rm. 215

Denver, CO 80203

(303) 866-3567 or fax (303) 832-8106

<http://mining.state.co.us/>

and their page for children is:

<http://mining.state.co.us/kids/dmgkids.htm>

American Geological Institute is a nonprofit federation of 32 geoscientific and professional associations that represent geologists, geophysicists, and other earth scientists.

4220 King Street

Alexandria, Virginia 22302-1507

(703)379-2480

<http://www.k5geosource.org/index.html> is an online Earth science professional development tool for K-5 teachers

American Association of Petroleum Geologists  
P.O. Box 979

Tulsa, Oklahoma 74101

(918) 584-2555

<http://www.aapg.org/k12resources/> is their website intended to assist teachers of K-12 students in finding classroom resources focusing on the earth sciences.

Geological Society of America

3300 Penrose Place, P.O. Box 9140

Boulder, CO 80301

(303) 447-2020

They have teacher's resources at

[http://www.geosociety.org/educate/esw\\_bklist.htm](http://www.geosociety.org/educate/esw_bklist.htm).

Mineral Information Institute

[www.mii.org](http://www.mii.org)

This reader helps students understand the reclamation process and introduces information on soils. Mining disturbs the land. Reclaiming the land is an important part of the mining process. Understanding the soils helps to make sure the reclamation process is successful.

Students will be required to think about the role natural resources play in their lives and consider the origin of these items. Everyone lives, works, plays and eats items made from natural resources. This Colorado Reader explains what it takes to get those items and the materials needed to make them.

It's a challenge of educators to help others learn that while food is bought at grocery stores, it originates with agriculture. The light goes on because electricity flows out of a wall socket, however the source of the energy has a more complicated story. When we do think about how things like cars and appliances are created we might think factories but it's important we take our thoughts all the way to mining. Without mining and minerals we would be hard pressed to grow our food, build our machines, heat and cool our homes, transport our goods or maintain our society beyond a primitive level.

## Page 1 & 2

Activity: Have students look around the room. Pick items and ask students to determine what the item is made from. Ask if it is made from something we raise or something we mine. Talk about the school building. What materials were used to build it? Were they raised or mined?

Ask students if they realize that the gravel pits they see alongside of roads are a form of mining. Explain to your students that aggregate mines are where gravel, sand and rock are mined. Discuss with your students how these products are used in construction of their school, their parking lot, and the roads they travel.

Ask students what they think happens after the mining resources have all been used. What happens to these gravel pits and other mines? This reader explores how mines are reclaimed so the land can be put to use in other ways. Reclaimed mines can become rangeland, recreational areas, wildlife habitat, farm land, lakes, etc.

Comments, suggestions and feedback about the Colorado Reader are welcome.

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**Activity:** Have your students look around your school and see if they can identify how aggregates were used in their school. Some areas they should identify:

- concrete to build the building and sidewalk
- in the parking lot
- in the structure of the building
- in the playground

#### Page 4

1. What is the letter of the horizon where bedrock, such as granite, quartz and limestone is ? **R**
2. What is the letter of the horizon where clay, minerals and organic materials are found? **E or B**
3. What is the letter of the horizon where you would find decomposing leaves and other plant material? **O**
4. What is the letter of the horizon where you would find plants growing? **A**
5. What is the letter of the horizon that has the material that forms soil? **C**

#### Page 5

How many square feet are in a square yard? **9**

To figure out how many square yards are in an acre you would divide **43,560 by 9 = 4840 square yards in an acre**

How many cubic feet are in a cubic yard? **27 cubic feet**

How many cubic yards of soil are needed to cover an acre with one foot of top soil? **43,560 divided by 27 = 1,613.33 cubic yards to cover an acre**

#### Page 6

What is the name of the soil that is 10% sand, 50% silt and 40% clay?

**It is on the border between silty clay and silty clay loam**

What is the name of the soil that is 20% silt, 70% clay and 10% sand?

**clay**

#### Page 7

How much will it cost to regrade the spoil?

**12,000 cubic yards x .25 = \$3,000**

How long will it take?

**12,000/500 = 24 hours**

How much will it cost to replace the topsoil?

**9,000 cubic yards x \$1.50 = \$13,500**

How long will it take?

**9,000/1,000 = 9 hours**

How much will it cost to reseed the area?

**20 acres x \$250/acre = \$5,000**

How long will it take?

**20 acres/4 acres/hr. = 5 hours**

What will be the total cost to reclaim the area?

**\$3,000 + \$13,500 + \$5,000 = \$21,500**

How long will the entire reclamation take?

**24 hours + 9 hours + 5 hours = 38 hours**

#### Page 8

**Activity:** Have your students study the map of the mine.

Ask: What is being mined in this picture?

**Coal**

Has coal already been removed from this mine? How do they know? **Yes, because part of the area has been reseeded**

Ask the students to explain what they think the overburden stockpile is; do the same with the topsoil. Ask why would they stockpile these two items? **They use the stockpile to cover over the areas to be reclaimed.**

#### Answers

1. Mining can be defined as **extraction of ores**

2. The process of reclaiming the land for beneficial use is called: **reclamation**

3. Reclamation begins **before the mining begins**

4. Rock that does not contain enough ore to be processed is called: **waste rock or overburden**

5. Aggregates are **all of the above**

6. Some of the problems that might occur when water combines with waste rock are **all of the above**

7. List two types of mining.  
**underground mining  
dredging  
open pit mining  
surface mining**

8. A reclaimed mine can be used for **all of the above**

9. Soil is often measured by the: **cubic yard**

10. The main process of metal removal from water is: **all of the above**



Mining ~ Please take a few minutes to evaluate your students' knowledge of this topic.

You can also fill out this evaluation online at:

[www.growingyourfuture.com](http://www.growingyourfuture.com)

How many students used this reader?  
\_\_\_\_\_

How many of your students can name two different types of soil?  
\_\_\_\_\_

How many of your students understand they use something from mining every day? \_\_\_\_\_

How many of your students can describe one process involved in reclaiming a mine? \_\_\_\_\_

How many of your students can identify at least two different types of mines?  
\_\_\_\_\_

How many of your students can describe one new technology being used in reclamation? \_\_\_\_\_

How many of your students can identify two ways reclaimed mines can be used for other beneficial purposes? \_\_\_\_\_

How many of your students were successful at solving the math problems about the cost to reclaim the mine?  
\_\_\_\_\_

How many of your students can explain what reclamation is? \_\_\_\_\_

**Please return this evaluation form for a chance to win \$100 VISA card.**

Please rate:	Good		Average		Poor
Student Activities Throughout Reader	5	4	3	2	1
Teacher's Guide	5	4	3	2	1
Reading Level	5	4	3	2	1

I would like to see more activities like: \_\_\_\_\_  
\_\_\_\_\_

School: \_\_\_\_\_

Grade Level: \_\_\_\_\_ Subject: \_\_\_\_\_

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E-mail: \_\_\_\_\_

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