



Mining and Reclamation to Protect the Environment

Grade/Subject: 5th Science

Strand/Standard 5.3.4 Evaluate **design solutions** whose primary function is to conserve Earth's environments and resources. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution.* Emphasize how humans can balance everyday needs (agriculture, industry, and energy) while conserving Earth's environments and resources. (ESS3.A, ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Lesson Performance Expectations (description): Students will conduct a mining activity with chocolate chip cookies, then design a solution to improve their profits and have a less negative impact on the environment.

Materials:

- Keebler Chips Deluxe cookies (2 per student)
- ¼ inch grid paper
- Flat Toothpicks (enough for multiple per student)
- Round Toothpicks (enough for multiple per student)
- Paper Clips (enough for multiple per student)
- Calculators (optional)

Time: 2 - 60 minute periods

Teacher Background Information:

- Mining and Reclamation [video](#), (9:34 min). Mined minerals provide the materials to make thousands of products that we have come to depend on daily. Mined **coal** provides energy for homes, schools, and businesses. Mining provides jobs to thousands of Utahns and other economic benefits to Utah. There are several different kinds of mining in Utah: **underground mining** (longwall mining and room and pillar mining) and **surface mining** (strip mining and open-pit mining). Most of the mines in Utah are underground mines.
- After mining for these resources, the mining company is responsible for the **reclamation** of the land.
- **What is mining reclamation?** Mining reclamation is the restoration of mined land to a natural or economically usable state. The mining company is responsible for the reclamation. In the past, mine site reclamation was not a priority for mining companies; but today, legislation and regulations are in place to address the effects of mining.
- Mines have to factor in the costs of reclaiming the land when they initially permit it. This means the plan has to be in place before they begin mining: they need to estimate how much reclamation will cost and then factor those costs into how much they need to get out of the mine to make it cost-effective. A multitude of people works on reclamation projects. Mine reclamation has come a long way in recent decades. The process includes decontaminating tailing areas, reforming the area to its former natural appearance, and developing a

Student Background Knowledge:

- Students should have prior knowledge and experience with the Engineering Process.
- Students should know that humans can impact the cycling of matter.

Teacher Step by Step: A 3-d lesson should insist students do the thinking. Provide time and space for the students to experience phenomenon and ask questions. The student sheet provided below provides guidance but is only an example of how students might respond.

1. Introduce *Phenomenon: Kennecott Copper Mine*

- Show students the following two pictures. Give them 5 minutes to list questions on their Student Sheet.
- Discuss effects of mining if students don't bring it up: Why do we mine? What are some items that you use that are made from mined materials? What are the positive effects of mining? What can be negative effects? What can be changed?



2. Mining Activity

Use a Model

- a. Students will conduct a mining activity with chocolate chip cookies. They will do the activity twice, trying to better their profit the second time by designing a better mining or reclamation solution.
- b. Mining Activity guidelines:
 - i. Each student will get a chocolate chip cookie and grid paper.
 - ii. On the paper, the students need to draw a body of water, their choice of size, and placement.
 - iii. Have students place their cookies on their grid paper. It may overlap the water or not.
 - iv. Students will trace the cookie on the grid paper and count the number of squares it covers.
 - v. Students will purchase mining tools - (flat toothpicks, round toothpicks, and paper clips). They can purchase as many as they feel necessary. If one breaks during mining, they cannot use it anymore.
 - vi. Students cannot touch the cookie with any object other than their mining tools.
 - vii. Students will time how long it takes them to mine the chocolate chips. They will have a maximum of 5 minutes. Students will record the cost on their chart.
 - viii. After students have mined the chocolate chips, they must count the number of squares covered by cookie pieces or crumbs (essentially looking at the impact of their mine).
 - ix. The students need to count the number of squares in their bodies of water that have crumbs in them.
 - x. All information will be recorded on the Student Sheet. Students will calculate the total cost and environmental impact of their mine.

Design a Solution

1. Handout the Engineering Design Process Student Sheet
2. Explain the responsibilities that mines have to protect Earth's resources and environments.
3. Explain that the students will need to design a solution to make their mine more profitable and protect the environment with fewer cookie crumbs outside of the original cookie sketch.
4. Allow 10-15 minutes for students to design a solution and fill out the worksheet.

Use a Model

1. Let students rerun the mining activity with their newly designed solution. They should use the same grid paper.
2. Students will fill out the Student Sheet for the second mining activity.
3. Compare results from the first and second mining activities.
4. Lead a class discussion about the students' solutions. Bring out the connections between actual mining and its reflected in their model. You may also have students create a presentation about their solutions.

Gather Information

1. Show this video about [Rio Tinto Mines](#) and their efforts to protect the environment (*length 1:10*).

Assessment of Student Learning. The summary should have a clearly stated claim with one solution for minimizing the environmental impact identified. Evidence statements should come from the data collected on the table and their mining process. The reasoning should be thoughtful and complete based on which evidence and why they think it is most compelling. Students should include the engineering process in their text.

Standardized Test Preparation:

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1. What problems are created by abandoned mines? Choose all that apply.
 - a. Minerals enter water resources.
 - b. Plant cover is reduced.
 - c. The mine is harder to reuse.
 - d. The mine provides few homes for wildlife.

2. What is the first step in the reclamation of a mine?
 - a. Plant trees and grasses
 - b. Bring in native wildlife
 - c. Place the waste materials into the ground.*
 - d. Smooth the surface over the mine.

3. What do mining operations have to keep in mind as they build a mine? Choose all that apply.
 - a. What it will cost to reclaim when they are done.*
 - b. What the profit of the mine will be.*
 - c. How much equipment they will need.*
 - d. Who will work at the mine.*

4. How can mines minimize the impact of mining on the environment? Choose all that apply.
 - a. Keep the mine from disturbing as little land as possible.*
 - b. Reclaim the land when they are finished.*
 - c. Remove the wildlife for their protection.
 - d. Take all the mining equipment away when finished.*

Extension of lesson:

- Rio Tinto is a company that mines in Utah. Have students research the company and its process of reclamation. Have students interview someone from the company about their job.
- Have students research a mine that has gone through the process of reclamation. How is the land being used now?

Career Connections: Potential careers related to this activity are Environmental Scientist and Mining Engineer

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Phenomenon: Observe the pictures. Write down three questions about what you see and what you are wondering.

- 1.
- 2.
- 3.

Mining Activity

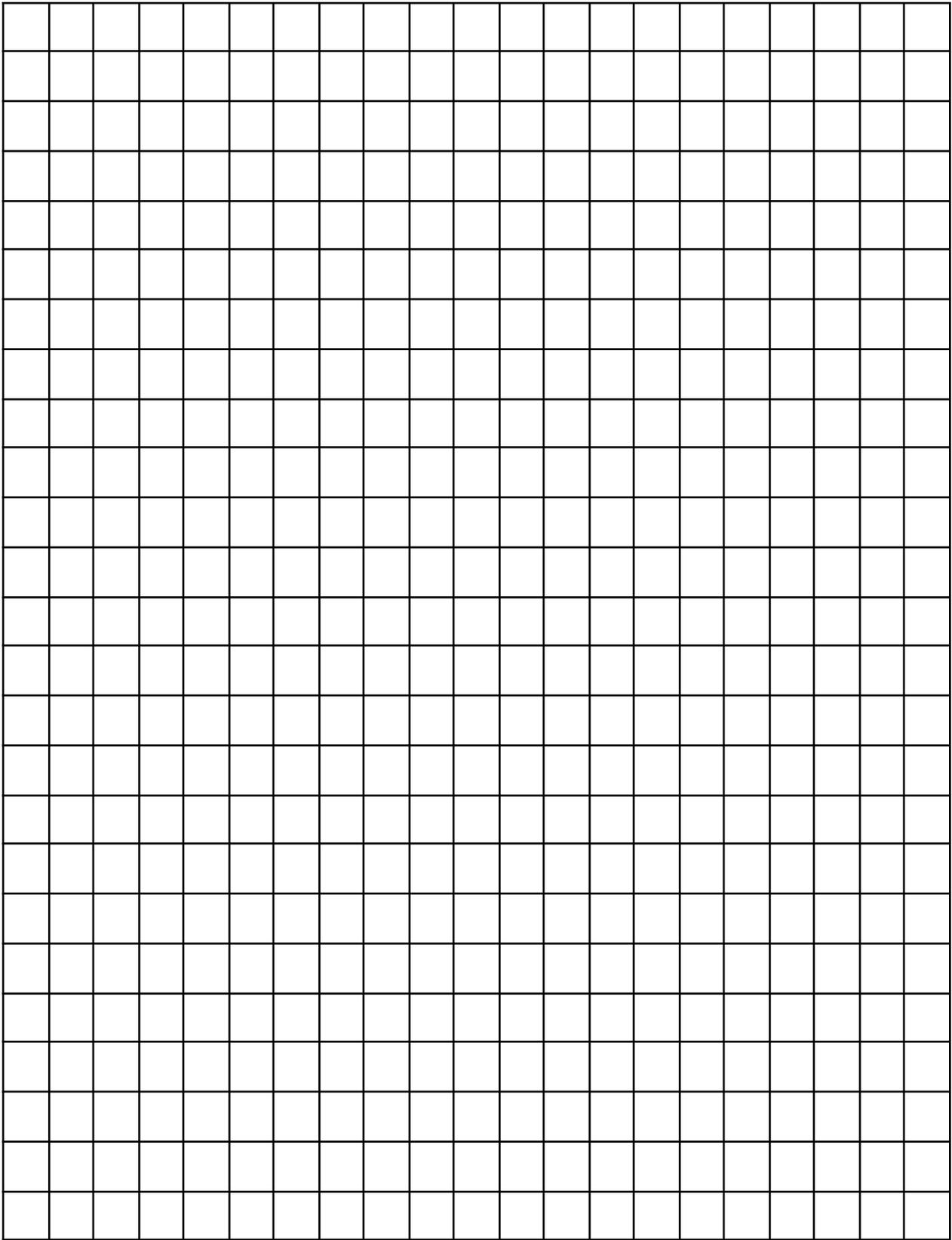
After you conduct your first mining activity, calculate the cost and profit of your mine using the table below.

Item	Cost	Running total Total starting amount \$25.00
Land Acquisition <ul style="list-style-type: none"> ● Cost of Cookie = \$7 	\$7	\$18.00
Size of Cookie <ul style="list-style-type: none"> ● 1 square = \$1 		
Equipment <ul style="list-style-type: none"> ● Flat Toothpick = \$ 2 ● Round Toothpick = \$4 ● Paper Clip = \$6 		
Time Spent Mining <ul style="list-style-type: none"> ● Each Minute = \$1 		
Reclamation Each land square = \$1		
Reclamation Each water square = \$2		
Total cost of mining		\$ _____

Number of Chocolate chips = \$2 each		
Total profit = Remaining Mining money + money from chocolate chips		\$ _____

Mining and Reclamation Game Instructions

1. You will start with \$25 in your account. First, you must buy your own “mining property,” one cookie.
2. Place the purchased cookie on the grid paper. Use a pencil to trace its outline. Count each square that falls inside the circle. Count partial squares as an entire square. Add this number to your chart.
3. Buy your “mining equipment.” You can purchase more than one piece of equipment. Students can not share equipment. If the mining tools break, they are no longer usable, and students must purchase a new tool. Mining equipment for sale:
 - a. Flat toothpick — \$2
 - b. Round toothpick — \$4
 - c. Paper clips — \$6
4. Mining costs are \$1 per minute with a maximum of 5 minutes.
5. After the cookie has been “mined,” count how many cookie crumbs cover the ‘squares’. Reclamation costs are \$1 for each square covered outside the original outline.
6. Also, count the number of squares in the water body with crumbs. Reclamation costs are \$2 for each water square with a crumb in it.
7. Total your mining experience.
8. The sale of one mined chocolate chip results in a \$2 profit. Students can combine broken chocolate chips to make one whole chip. Total your mining profits and write it on your chart.
9. Add your profits to the remaining money from your mine purchases.



Name: _____

Design a Solution

Design a solution that will increase the profit of your mine and decrease the environmental impact.

The Problem:	
Criteria:	Constraints:
Solution:	

Second Mining Activity

After you conduct your second mining activity, calculate the cost. Compare the original cost and environmental impact to your first mine.

Item	Cost	Running total Total starting amount \$25.00
Land Acquisition <ul style="list-style-type: none"> ● Cost of Cookie = \$7 	\$7	\$18.00
Size of Cookie <ul style="list-style-type: none"> ● 1 square = \$1 		
Equipment <ul style="list-style-type: none"> ● Flat Toothpick = \$ 2 ● Round Toothpick = \$4 ● Paper Clip = \$6 		
Time Spent Mining <ul style="list-style-type: none"> ● Each Minute = \$1 		
Reclamation (Count the number of squares with cookie crumbs and pieces outside of original size) <ul style="list-style-type: none"> ● Each land Square = \$1 		
Total cost of mining		_____

Number of Chocolate chips = \$2 each		
Total profit = Remaining Mining money + money from chocolate chips		_____

Write a Claim statement: The summary should have a clearly stated **claim** with one solution for minimizing environmental impact identified. **Evidence** statements should come from the data collected on the table and the process of your mining. The **reasoning** should be thoughtful and complete based on which evidence and why they think it is most compelling. Students should include the engineering process in their text.