Copper Choices

Compare resource plans by weighing costs, benefits, and impacts.

HS-ESS3-2 "Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios. Clarification Statement: Emphasis is on the conservation, recycling…"

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each cost or benefit for a plan, circle each number, and write A, B, or C in the margin beside the evidence. Use your marks to compare the plans' cost-benefit tradeoffs.

Pipes, Copper, and Choices

1. The following plans and estimates are hypothetical classroom data, not current offers or engineering forecasts. Riverton plans to replace aging water pipes that leak treated water. The project needs 600 metric tons of copper. Engineers are comparing ways to obtain the metal instead of assuming that the lowest purchase price gives the best result. Copper can be recycled repeatedly without losing its useful properties, but scrap must be collected, sorted, and melted. New copper ore must be mined, crushed, and processed. Those steps use land, water, and energy. A third option combines recycled and newly mined copper. The city will compare each plan's direct cost, schedule, resource conservation, and likely effects on nearby land and water.

2. Plan A purchases all 600 tons from a recycler. It costs $5.7 million and takes ten months because the recycler must prepare scrap. Compared with making copper from ore, this plan uses less energy and avoids new mining for this project. Plan B buys newly mined copper from an expanding mine. It costs $4.8 million and takes seven months. The mine's expansion would clear 18 hectares for an access road and tailings storage area. Sediment controls and water monitoring can reduce the chance that storm runoff carries soil into a stream, but they cannot eliminate every impact. Because each plan supplies 600 tons, cost per ton is another comparison.

3. Plan C uses 300 tons of recycled copper and 300 tons of newly mined copper. Its estimated cost is $5.2 million, and its schedule is eight months. Because the mine supplies only half the copper, its expansion would clear 9 hectares, half the area in Plan B. The plan also keeps a market for recycled metal, which can reduce demand for ore. In all three plans, pipe replacement would conserve treated water by reducing leaks. Cost-benefit ratios depend on which benefits and costs decision makers measure, such as money, time, land disturbance, water quality risk, and resource use. Evidence describes these tradeoffs, but it does not choose the city's values.

2 ANSWER WITH EVIDENCE

Use the passage

1. What makes Plan A less useful than Plan B for a time-sensitive project, and what resource-related benefit does Plan A offer?

2. Which plan has the lowest direct cost? Describe one likely land or water impact connected to that plan and one management practice that can reduce the impact.

3. Calculate direct cost per metric ton for A, B and C. Compared with B, how much additional cost per hectare of clearing avoided does C require? Show your calculations.

4. What benefit would occur in all three plans, and why does the evidence not select one plan automatically?

3 YOUR TURN

Your own words

Using the hypothetical estimates, choose a plan that meets a $5.3 million budget, a nine-month deadline and the goal of minimizing clearing. Explain your choice using cost-per-ton and incremental-cost comparisons as well as the constraints. State why the ratios alone cannot decide how much the city should value the avoided clearing.

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PART 1 · READ AND MARK

Underline each cost or benefit for a plan, circle each number, and write A, B, or C in the margin beside the evidence. Use your marks to compare the plans' cost-benefit tradeoffs. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	What makes Plan A less useful than Plan B for a time-sensitive project, and what resource-related benefit does Plan A offer?	**Plan A takes ten months, while Plan B takes seven months. Plan A uses less energy than making copper from ore and avoids new mining for this project.**
2	Which plan has the lowest direct cost? Describe one likely land or water impact connected to that plan and one management practice that can reduce the impact.	**Plan B has the lowest direct cost at $4.8 million. Its mine expansion would clear 18 hectares and could increase the chance of sediment reaching a stream. Sediment controls and water monitoring can reduce that chance.**
3	Calculate direct cost per metric ton for A, B and C. Compared with B, how much additional cost per hectare of clearing avoided does C require? Show your calculations.	**A: $5,700,000/600=$9,500/t. B: $4,800,000/600=$8,000/t. C: $5,200,000/600≈$8,666.67/t. C adds $400,000 and avoids 9 ha relative to B: about $44,444.44 per hectare avoided.**
4	What benefit would occur in all three plans, and why does the evidence not select one plan automatically?	**All three plans would reduce pipe leaks and conserve treated water. Evidence does not select a plan because decision makers may value money, time, land disturbance, water quality risk, and resource use differently.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

C fits the budget/deadline and clears 9 ha versus B's 18. C costs about $8,666.67/t versus B's $8,000/t, an extra $400,000 or $44,444.44 per avoided hectare. A avoids clearing but exceeds both constraints. The ratios quantify tradeoffs; they do not determine the value placed on land, risk or time.

Accept Plan C when students use the stated budget, deadline, and land-clearing goal accurately. Responses should compare Plan C with Plan B and explain why Plan A does not meet the budget or schedule. Accept correctly rounded monetary ratios with units. The incremental ratio uses the cost difference and avoided-area difference, not C's entire cost divided by its cleared area.