

Where Should the Trees Go? Judging Three Carbon-Capture Plans

Learning target: I can evaluate competing reforestation plans against criteria and constraints, calculate how much carbon each would capture for its cost, and design and justify a plan that uses the best features of each.

Transfer and design

About 55 min

Pairs

MS-ETS1-2 · assesses

MS-ETS1-3 · practice

MS-ETS1-1 · practice

MS-LS2-3 · supports

engineering design

data analysis

writing

Name _____

Date _____

Period _____

Directions

You are the student advisers to a county board that wants to use a one-time grant to pull carbon dioxide out of the air by planting trees. Read the brief and the site table. Work through the parts in order: turn the brief into criteria and constraints, do the calculations, score each site, then design and defend your plan. Work in pairs, but each of you writes your own answers. All numbers in the site table are a teaching scenario.

You will need: This worksheet, Pencil, Calculator, Scrap paper for calculations

The county's brief — 'We have \$120,000, to be spent once, within the next year. We want the trees to remove as much carbon dioxide from the air as possible and keep that carbon stored for at least 30 years. We need at least 250 tons of carbon captured per year once the trees are established. We will not take land that people are living on or farming. Planting crews must be able to reach the site.'

The three candidate sites (teaching scenario, not real places)

Simulated teaching dataset: the numbers are invented to be realistic, not measured.

Site	Carbon captured per hectare per year once established (tons)	Cost to plant one hectare	Land available (hectares)	Road access	People on the land	Wildfire risk	Note
A: River valley	6.0	\$1,800	30 unused; another 60 is farmed	Yes, paved	40 families farm the 60 ha	Low (wet)	Fast-growing trees; occasional floods but trees tolerate them
B: Dry hills	1.5	\$600	300	Yes, gravel	None	High: brush fire every 10 to 15 years	Slow-growing drought-tolerant trees
C: Remote coast	4.0	\$2,400	80	No road; crews walk in 2 hours	None	Low (foggy)	Without a road, crews can plant at most 25 ha in one year

Carbon figures are tons of carbon stored in new wood, roots and leaves per hectare per year after the trees are established. All values are invented for this exercise.

Part A: Define the problem precisely

- Sort each statement from the brief as a **criterion** (a goal the plan is judged on) or a **constraint** (a limit the plan must stay within), and write how you would test it.

Criterion or constraint?	How you would test whether a plan meets it (a number or a yes/no check)
Captures at least 250 tons of carbon per year	
Carbon stays stored for at least 30 years	
Total cost no more than \$120,000	
No land that is lived on or farmed	
Crews can reach and plant the site within one year	

2. The brief says 'as much carbon dioxide as possible.' Why is that phrase hard to use for judging plans, and how does the 250-ton line help?

Part B: Calculate what each site can do alone

3. Fill in the table for each site **used alone** with the whole budget. Remember: Site A has only 30 unused hectares, and Site C can plant at most 25 ha in a year. Show one full line of work below the table.

Hectares you could plant with \$120,000 (or the most the site allows)	Hectares actually plantable (check land and the one-year limit)	Carbon captured per year (tons)	Kilograms of carbon per dollar
Site A			
Site B			
Site C			

4. Which site gives the most carbon per dollar? Which gives the most carbon per year on its own? Explain why those are not the same site.

Part C: Score the sites

5. Write **yes**, **no** or **at risk** in each cell, using your q3 numbers and the site table. Below the table, explain every 'at risk' you wrote.

250 tons per year?	Stored 30 years?	Within \$120,000?	No people displaced?	Reachable and planted in a year?
Site A alone				
Site B alone				
Site C alone				

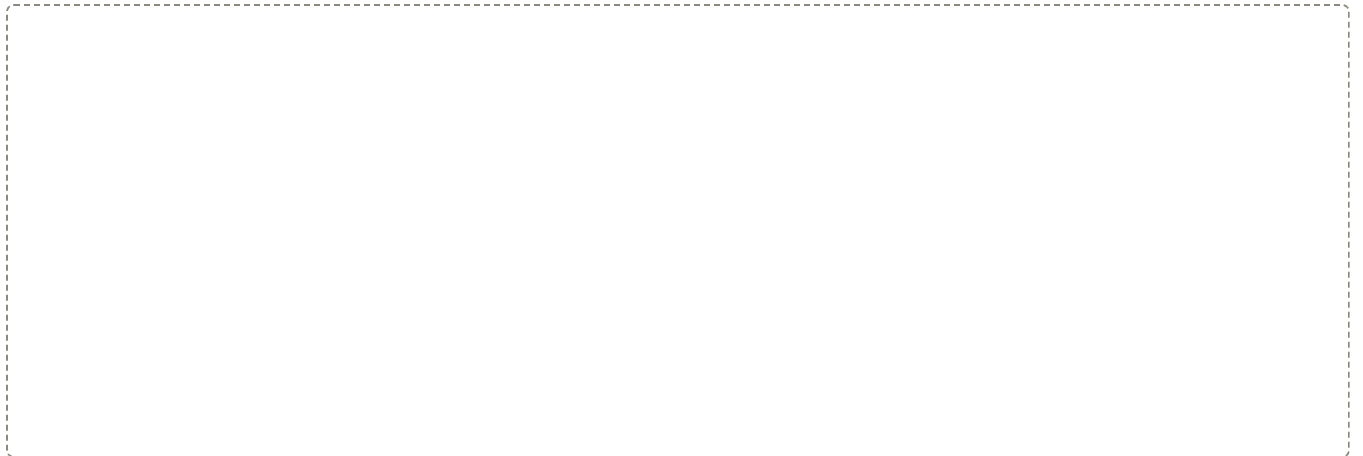
6. Site B is cheap and has the most land, but a brush fire burns the hills every 10 to 15 years. Explain what a fire would do to the carbon the trees had captured and which criterion that threatens.

Part D: Design and defend your plan

7. Design your plan. It may use one site or combine sites. State how many hectares you would plant at each site, the cost of each part, the total cost, and the total carbon captured per year. Show the calculations.

8. Justify your plan to the board. Explain how it meets every criterion and constraint, which plan it beats and by how much, and what trade-off you accepted. If part of your plan is 'at risk' on any criterion, say what you would do about it.

9. Draw a simple carbon model of your plan: the air, the new forest, and the arrows between them, labeled with the process. Add a third box and arrow showing what would happen to the stored carbon if the forest burned or was cut and left to rot.



10. Name one piece of information not in the table that you would want before the board votes, and explain how it could change your decision.

One site at a time, four steps

For each site: (1) divide \$120,000 by the cost per hectare to get the hectares the money could buy; (2) compare that with the hectares the site actually allows and take the smaller number; (3) multiply the hectares by the tons per hectare per year to get tons per year; (4) divide the tons per year by \$120,000 (or by the money actually spent) and multiply by 1,000 to get kilograms of carbon per dollar. Example with made-up numbers: $\$120,000 \div \$1,000 = 120$ ha; site allows 50, so use 50; 50×2 tons = 100 tons per year; $100 \div 120,000 \times 1,000 = 0.83$ kg per dollar.

Buy down the fire risk

Suppose a firebreak and thinning program at Site B costs \$150 per hectare and cuts the chance of losing the trees to fire in any 30-year period from about 90 percent to about 20 percent. Rework your plan with this option: recompute the hectares and tons, and decide whether the extra cost is worth it. Then write a short memo to the board explaining how you weighed 'tons captured' against 'tons likely to still be stored in 30 years,' and why the second number is the one the brief really asks for.