

Where Should the Overlook Go? Siting a Deck on a Changing Coast

Learning target: I can use measured rates of cliff retreat and evidence of sudden events to evaluate three competing designs against criteria and constraints, and justify a siting decision for a structure that must last fifty years.

Transfer and design

About 55 min

Pairs

MS-ETS1-2 · assesses

MS-ESS2-2 · practice

MS-ETS1-1 · practice

engineering design

data analysis

writing

Name

Date

Period

Directions

A state park wants a wooden viewing deck above the sea, and three sites have been surveyed. Read the brief, the site notes and the survey data (a teaching scenario with invented but realistic numbers). Do the rate calculations in Part A first; the numbers decide everything. In Part B, restate the criteria and constraints precisely. In Part C, score the three candidate designs in a decision matrix and check one design's arithmetic. In Part D, recommend a design and justify it. Work in pairs; each person completes their own sheet.

You will need: This worksheet, Pencil, Calculator, Ruler, Scrap paper for the decision matrix

The brief from the park — 'We need a deck where visitors can see the three sea stacks. The deck must hold at least 20 people (at least 40 m²). It must stay at least 10 m back from the cliff edge for 50 years without being moved. The path from the parking lot must be accessible: no steeper than 1 in 12 (about 8 percent), and no longer than 150 m. The budget is \$60,000. Park rules forbid building within 30 m of a known landslide scar. The deck must open within one year.'

Distance from each site's survey marker to the cliff edge (teaching dataset)

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

Site	2015 (m)	2020 (m)	2025 (m)
A: Headland	60.0	58.4	57.0
B: Beach Bluff	45.0	41.2	37.0
C: Cove	30.0	29.6	29.0

Simulated survey data for a classroom scenario. Each marker stands at the edge of the parking area for that site, so the distance is also how far the parking lot is from the cliff.

Site notes from the survey team — Site A, Headland: hard bedrock cliff that waves undercut slowly; a grassy slope of about 4 percent from the parking area to the edge; all three sea stacks visible. **Site B, Beach Bluff:** soft sandy cliff; flat approach; closest to the stacks and the best view; chunks fall after most winter storms. **Site C, Cove:** sheltered; slope of about 10 percent from the parking area; two of the three stacks visible. In 1998, a section of this cliff 25 m deep slid into the sea in one night. The 1998 scar is 20 m from where a deck would stand.

Part A: Do the math before you design

- Complete the table. Rate = change $\div$ 10 years. Expected retreat = rate $\times$ 50 years. Engineers double the expected retreat as a safety margin: setback = 2 $\times$ expected retreat. Show one full row of calculations below the table.

Change 2015 to 2025 (m)	Rate (m per year)	Expected retreat in 50 years (m)	Setback with safety factor 2 (m)
Site A: Headland			
Site B: Beach Bluff			
Site C: Cove			

- Site C has the slowest measured rate. Explain why the rate calculation alone underestimates the danger at Site C, and propose a setback for Site C that accounts for the 1998 event. Show your reasoning.

Part B: Define the problem precisely

- Write the three **criteria** from the brief (what the deck must do to succeed), each with its number or test. Then add one criterion of your own about visitor experience, with a way to test it.

4. Write the five **constraints** from the brief (limits the design must stay within), each with its number. For two of them, name a design idea that the constraint rules out.

Part C: Compare three candidate designs

Candidate designs

1 Design 1: Beach Bluff Deck (Site B)

A 45 m² deck 20 m back from the 2025 cliff edge, reached by a flat path 60 m long. Cost \$35,000. Plan: because the cliff retreats, the deck will be unbolted and moved back 15 m every 15 years. Full view of all three stacks from the closest site.

2 Design 2: Headland Deck (Site A)

A 42 m² deck 30 m back from the 2025 cliff edge, reached by a gravel path about 30 m long on the 4 percent grass slope. Cost \$52,000. View of all three stacks, somewhat farther away than at Site B.

3 Design 3: Cove Terrace (Site C)

A 48 m² deck 15 m back from the 2025 cliff edge, 20 m from the 1998 scar. The 10 percent slope is regraded into switchbacks at 7 percent with a retaining wall. Cost \$75,000. View of two of the three stacks; sheltered from wind.

5. Score each design against each criterion: 2 = fully meets, 1 = partly, 0 = fails. In the constraints row, write yes or name every constraint the design breaks. Add the criterion scores for the total, and circle any design that breaks a constraint.

Design 1: Beach Bluff	Design 2: Headland	Design 3: Cove
Criterion: view of the three stacks		
Criterion: 40 m ² for 20 people		
Criterion: 10 m from edge for 50 years, unmoved		
Your added criterion		
Constraints: all met? (yes, or name the one that fails)		
Total score		

6. Check two designs' arithmetic. (a) Design 1 claims that moving the deck back 15 m every 15 years keeps it at least 10 m from the edge. Using Site B's rate, how far from the edge will the deck be just before the first move at year 15? Does the plan work? (b) Design 2 places the deck 30 m back at Site A. How far from the edge will it be after 50 years, and does that meet the 10 m rule? Show both calculations.

Part D: Decide and justify

7. Which design do you recommend, or what change to one of them? Justify your decision using your matrix scores, at least one calculation from Part A or q6, the difference between gradual retreat and a sudden event, and at least one effect on visitors. Then state the strongest argument against your choice and answer it.

8. Sketch your recommended site as a top view: the parking area, the survey marker, the 2025 cliff edge, the expected edge in 50 years, the deck, and the path. Label every distance in meters and the path's slope.



Setback in three lines

For each site, write three lines: (1) $\text{rate} = (\text{2015 distance} - \text{2025 distance}) \div 10 \text{ years}$; (2) $\text{50-year retreat} = \text{rate} \times 50$; (3) $\text{setback} = 2 \times \text{the 50-year retreat}$. Then ask one more question the arithmetic cannot answer: has this cliff ever changed suddenly? If yes, add that sudden loss to the setback. A criterion says what the deck must DO (hold 20 people, keep its view, stay 10 m from the edge); a constraint says what the design CANNOT exceed (money, slope, length, distance from a scar, time).

The 100-year version

The park's director asks what changes if the deck must last 100 years instead of 50. Recalculate the setback for each site, decide whether any site still works within 150 m of parking, and write a short memo explaining whether the park should change the site, shorten the design life, or accept a plan to move the deck once. Include one sentence on why an average rate from ten years of data becomes less trustworthy the farther into the future you project it, and what a sudden event like the 1998 slide does to that trust.