Flood Model Choices

Trace how simulations compare linked systems, criteria, and constraints.

HS-ETS1-4 "Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem."

NAME ______________________________ DATE ______________

1 READ AND MARK

Read it twice

YOUR JOB Underline each proposed solution, circle every criterion or constraint, and number the interactions between systems in the passage. These marks show what a simulation must represent and evaluate before engineers choose a design.

Testing a Flood Plan

1 After several streets flooded during intense storms, Riverton considered ways to reduce runoff before it reached the Alder River. Engineers built a computer simulation of the watershed, streets, storm drains, river, and nearby homes. The model used elevation, soil, pavement, rainfall, and drain-capacity data. It also represented interactions: water flowing downhill, pavement preventing infiltration, drains carrying water to the river, and a high river slowing drain discharge. The goal was not simply to move water away; the city needed to lower flood depth at homes without worsening river flooding downstream.

2 The team tested three proposed solutions: a larger storm pipe, permeable parking lots, and a restored wetland beside the river. For each design, the simulation ran the same set of short, intense storms and longer rains. Engineers compared maximum water depth near homes, time needed for streets to reopen, river level downstream, construction cost, and wetland habitat. The city had constraints: a fixed budget, limited public land, pipe work that could not close the hospital access road, and a requirement to protect existing trees. A design could improve one measure yet fail if it broke another limit.

3 Results showed that the larger pipe lowered water depth on two blocks, but it raised peak flow into the river during some storms. Permeable lots absorbed water and shortened street closures, although their benefit dropped when soil was already saturated. The wetland stored water and reduced downstream peak flow, but it required more land than was available at one proposed site. The team then combined smaller permeable lots with a wetland at another site. The model predicted lower home flooding and lower river peaks while meeting the budget and road-access constraints. Because simulations simplify reality, engineers would check soil tests and drainage inspections before building.

2 ANSWER WITH EVIDENCE

Use the passage

1. Which two systems interact when a high river slows drain discharge, and what happens in that interaction?

2. Name two criteria the engineers used to compare designs and two constraints the city had to follow.

3. Explain one tradeoff revealed by the larger storm pipe.

4. Why did the engineers run the same storms for every design, and why would they still check soil tests and drainage inspections?

3 YOUR TURN

Your own words

A high school district wants to reduce dangerous heat on a paved campus during heat waves. Write a simulation plan that names the model's systems and at least three interactions, compares two proposed solutions, lists three criteria and three constraints, states the outputs you would examine, and makes a conditional recommendation plus one real-world check.

ANSWER KEY **Flood Model Choices** HIGH SCHOOL · HS-ETS1-4

PART 1 · READ AND MARK

Underline each proposed solution, circle every criterion or constraint, and number the interactions between systems in the passage. These marks show what a simulation must represent and evaluate before engineers choose a design. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Which two systems interact when a high river slows drain discharge, and what happens in that interaction?	**The storm-drain system and the river interact. A high river slows water leaving the drains.**
2	Name two criteria the engineers used to compare designs and two constraints the city had to follow.	**Criteria include maximum water depth near homes and downstream river level. Constraints include the fixed budget and limited public land.**
3	Explain one tradeoff revealed by the larger storm pipe.	**The larger pipe lowered water depth on two blocks, but it raised peak flow into the river during some storms.**
4	Why did the engineers run the same storms for every design, and why would they still check soil tests and drainage inspections?	**Using the same storms allows a fair comparison among designs. Soil tests and inspections check real conditions because the simulation simplifies reality.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Model the atmosphere, pavement, buildings and cooling equipment, trees, student walking routes, electric grid, and stormwater system. Include sunlight heating pavement and roofs, tree shade lowering surface temperature, air conditioners releasing heat outdoors, hot buildings increasing grid demand, and pavement sending runoff to drains. Compare planting shade trees with installing reflective pavement. Criteria are lower route temperature, less student heat exposure, and lower electricity demand. Constraints are a $90,000 budget, underground utility locations, limited planting space, and no closure of the accessible entrance. Examine hourly air and surface temperatures, shaded-route coverage, cooling load, runoff, and cost. If trees keep routes cooler and meet cost and utility limits, choose trees; otherwise choose reflective pavement. Check predictions with temperature sensors and a utility-site map.

Accept plans that use a computer simulation to compare at least two solutions across connected systems, multiple criteria, and multiple constraints. The recommendation should depend on model outputs and include a reasonable real-world validation step.