Give rain a route into the ground

Urban roofs, roads and parking lots replace permeable land. More rain travels over the surface instead of entering soil, often reaching streams faster and carrying pollutants with it.

1. CHANGE THE PATH OF THE WATER

Less sealed ground
Keep or restore permeable land

→

More infiltration
Water enters soil

→

Less rapid runoff
Reduce pressure on drains

Reducing runoff can lower flood peaks, streambank erosion and pollutant transport. Infiltration means entry into soil; groundwater recharge occurs only when water reaches an aquifer. Some infiltrated water stays in soil or returns to the atmosphere.

2. FOUR METHODS IN THE SYLLABUS

Permeable pavement	Replace sealed paving with a surface that lets water pass through to an underlying storage layer and, where suitable, into soil.
Plant trees	Leaves and branches intercept rain. Roots support soil structure; water uptake and transpiration also help reduce runoff.
Public transportation	Can reduce demand for roads and parking. Retaining or restoring that land as permeable space supports infiltration.
Build up, not out	Accommodate the same number of people on less developed land, preserving more open soil and vegetation across the watershed.

3. EXPLAIN THE LAND-USE CONNECTION

A bus does not make asphalt absorb water. The benefit depends on reducing paved area or avoiding new pavement. Likewise, compact development can reduce runoff per household and preserve land regionally, even though an individual dense site still produces runoff. Pair efficient land use with on-site stormwater management.

Urban surfaces and flood response: USGS, Effects of Urban Development on Floods.
Methods: College Board, STB-1.B.1; US EPA, Types of Green Infrastructure.
Density and watershed-scale effects: US EPA, Higher-Density Development.

Scope: College Board AP Environmental Science CED, Topic 5.13, p. 109.

Store, soak, reuse or release slowly

Extension: green infrastructure combines soils, vegetation and engineered layers to manage rainfall near where it falls. Different designs change different parts of the water pathway.

1. FOLLOW WATER THROUGH PERMEABLE PAVING

Permeable surface	Rain passes through pores or joints
⩛	
Stone storage layer	Water temporarily fills spaces
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Underlying soil	Water can infiltrate if conditions allow

Some designs include an underdrain that carries stored water away. A lined system can reduce rapid runoff without recharging groundwater. Water passing through paving is not automatically safe to drink.

2. MATCH EACH PRACTICE TO ITS MAIN FUNCTION

Rain garden / bioswale	Plants and soil slow and filter runoff; suitable designs also permit infiltration and evapotranspiration.
Green roof	Growing medium stores rain; plants return water to air. Excess drains away. It does not directly recharge an aquifer.
Rain barrel / cistern	Collect roof runoff for later non-potable use. Available empty storage limits how much the next storm can capture.

3. SLOWER FLOW IS NOT THE SAME AS LESS WATER

Temporary storage can lower the peak discharge by spreading release over time, even if much of the water eventually reaches the stream. Infiltration, evapotranspiration and reuse can reduce the volume leaving as runoff. Evaluate both timing and volume.

Pavement, gardens, roofs and rainwater harvesting: US EPA, Types of Green Infrastructure.
Infiltration, liners and groundwater protection: US EPA, Green Infrastructure and Groundwater.
Runoff timing and volume: USGS, Effects of Urban Development on Floods.

Scope: College Board AP Environmental Science CED, Topic 5.13, p. 109.

Test performance and recognize limits

A method should be evaluated by what happens to water, not just by how green a site looks. A controlled comparison can measure runoff volume, timing and water quality separately.

1. A FAIR SURFACE-COMPARISON INVESTIGATION

Illustrative classroom design: compare an impermeable surface with a permeable one on otherwise matched trays. Apply clean simulated rainfall and collect surface runoff separately from water draining through the base.

Change one factor	Surface type is the independent variable; use the impermeable tray as the comparison condition.
Keep conditions alike	Match tray area, slope, underlying layers, starting moisture, rainfall intensity, duration and collection time.
Measure the response	Record runoff volume and time to first runoff. Collect equal-time samples to estimate flow rate if needed.
Repeat the comparison	Use several independent trials for each surface. Compare averages and variation, not just one favorable result.

2. KEEP THE CONCLUSION WITHIN THE EVIDENCE

Less collected runoff supports a runoff-reduction claim under the tested conditions. It does not prove that all missing water recharged groundwater: some may remain stored in the tray. Turbidity measures cloudiness from particles, not every dissolved pollutant. A short test also cannot establish performance across seasons, extreme storms or years of clogging. Field monitoring complements small-scale experiments.

3. EXTENSION: DESIGN AND MAINTENANCE MATTER

Sediment can clog permeable surfaces, so regular cleaning matters. Saturated or poorly draining soil limits infiltration; storage can fill during intense storms. Polluted runoff or soil can threaten groundwater if infiltration is poorly sited. Choose suitable locations, pretreat where needed, and provide safe overflow routes. No practice eliminates every flood or pollutant risk.

Monitoring example: US EPA, Experimental Permeable Pavement Parking Lot and Rain Garden.
Siting and pollutant risks: US EPA, Green Infrastructure and Groundwater Protection.
Clogging and upkeep: US EPA, Operation and Maintenance of Green Infrastructure.

Scope: College Board AP Environmental Science CED, Topic 5.13, p. 109.