Combined Sewer Overflow Lab

Name _____

Date _____

Period _____

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In older cities like Buffalo, one pipe carries sewage from homes and rain from the streets. Find out what happens to that pipe in a storm, and what it does to the river.

☐ I can use a model to explain how a pipe that carries both sewage and rain ends up spilling into a river.

☐ I can use numbers from a simulation to compare ways to cut sewer overflows and defend the best one.

Part 1. One pipe, two jobs (starting settings)

SEP 2, 4 · CCC Systems and System Models

Leave every slider where it starts. Drag the **time slider** under the picture to each hour (click it, then use the arrow keys to move one minute at a time). Read **Homes** and **Storm drains** in the top right corner, the flow on the pipe **to the treatment plant** at the bottom, and the **storage tank**.

1. Fill in the table. Combined flow = homes + storm drains.

Hour	Raining? (yes / no)	Homes (m^3/s)	Storm drains (m^3/s)	Combined flow (m^3/s)	To the plant (m^3/s)	Water in the tank (m^3)
0.5						
2.5						
6.0						
12.0						

2. At hour 2.5, the storm drains carry about _____ times as much water as the homes. (Storm drains ÷ homes.)

3. At hour 2.5, the combined flow is _____ m^3/s, but only _____ m^3/s goes to the plant. Play the storm and watch the box labeled **Regulator**. Describe where the rest of the water goes, in order.

READ FIRST. A **combined sewer** carries sewage and stormwater in one pipe. Hundreds of older U.S. cities, Buffalo among them, still have them. The **interceptor** pipe to the treatment plant can only carry a set amount (here 0.21 m^3/s, three times the normal sewage flow). When more arrives, the **regulator** sends the extra to a **storage tank**. When the tank is full, the water spills over a low wall called a **weir** and out the **outfall** into the river, with no treatment. That spill is a **combined sewer overflow (CSO)**. Raw sewage carries bacteria like *E. coli*, so a beach downstream has to close.

4. At hour 6 it has stopped raining and homes send only about 0.05 m^3/s, yet the plant is still getting 0.21 m^3/s. Use your table to explain where the extra water comes from, and why that makes the tank useful for the *next* storm.

Part 2. Storms and streets (storm presets)

SEP 4, 5 · CCC Cause and Effect

For the first row, use the starting storm (12 mm/h for 2 h). Then press each **storm preset**. The results boxes under **What happened in 24 hours** fill in right away. Total rain = intensity × length.

5. Fill in the table.

Storm	Intensity (mm/h)	Length (h)	Total rain (mm)	Peak stormwater runoff (m^3/s)	Overflow to river (m^3)	Swimming closed (h)
Starting storm						
Light drizzle						
Thunderstorm						
All-day soaker						

6. The thunderstorm rains far harder, but the all-day soaker sends about _____ times as much overflow to the river. Explain why, using total rain and how long the sewer stays above what the plant can take.

7. Set the storm back to 12 mm/h for 2 h. Change only **Paved and roofed area** and record the results.

Paved and roofed area	Peak runoff (m^3/s)	Overflow (m^3)
10%		
65%		
95%		

The same rain fell all three times. Explain why paving a city sends more water into the sewer.

Part 3. Fix the sewer (one change at a time)

SEP 5, 6 · CCC Systems and System Models

Paved area back to **65%**. Press **Thunderstorm**. Make one change, read **Overflow to river**, then put that slider back before the next change. Then do it all again with **All-day soaker**.

8. Fill in the table.

Upgrade	Thunderstorm overflow (m^3)	All-day soaker overflow (m^3)
No upgrade (starting values)		
Double the storage tank (10,000 m^3)		
Green infrastructure 40%		
Double the interceptor (6×)		

9. Doubling the tank cut the thunderstorm's overflow by _____ m^3 and the soaker's by _____ m^3. Why is it the same amount for both storms?

10. Which upgrade worked best for the thunderstorm? _____ For the soaker? _____ Explain why the best fix depends on the kind of storm.

Part 4. The river (Thunderstorm, no upgrades)

SEP 4, 6 · CCC Scale, Proportion, and Quantity

Tank, green infrastructure and interceptor back to their starting values. Press **Thunderstorm**, then change only **River flow**. A **+** means still closed at midnight.

11. Fill in the table.

River flow (m^3/s)	Peak *E. coli* (CFU/100 mL)	Closed (h)
2 (dry summer)		
6		
15 (snowmelt)		

12. The same overflow reached the river all three times. Use the words **dilution** and **flushing** to explain the differences in your table.

13. River flow back to 6. On the graphs, the rain stops at hour 1.5 and the overflow stops at hour _____, but swimming stays closed until hour _____. Use both graphs to explain why the river stays unsafe so long after the overflow ends.

Wrap it up

SEP 7 · CCC Cause and Effect

14. Your city can pay for **one** upgrade: a bigger tank, more green infrastructure, or a bigger interceptor. Choose one: _____. Defend it with at least **two numbers from two different storms**, and name one cost or drawback of your choice.

NYSSLS: building toward HS-ESS3-4, HS-ETS1-3 and HS-ETS1-4 (DCI ESS3.C, ETS1.B). SEP = Science and Engineering Practice, CCC = Crosscutting Concept. A made-up city with real rules: the rational method for runoff, 300 L of sewage per person per day, and the 235 CFU/100 mL beach advisory level.