

# TUNNELWORKS

## KS4 SCIENCE LESSON 1 WORKSHEET

### CLEAN AND FRESH: WATER LEVELS

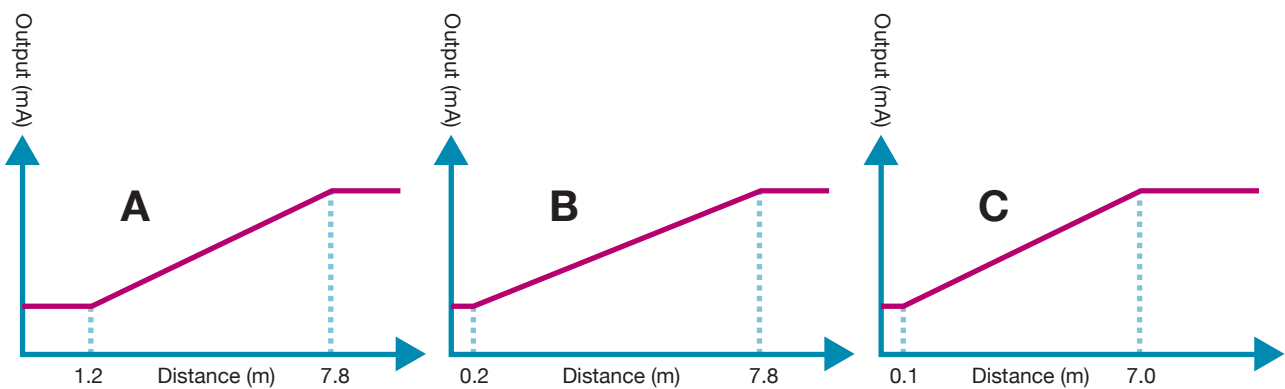
**Specification:**

The water level in the Tunnel must be measured along its length. This will help control the rate at which captured water is treated at Beckton Sewage Treatment Works. Accurate measurements are essential to ensure that as much sewerage as possible is captured and then treated.

The Tunnel will use ultrasound sensors to measure the water level at regular intervals.

**Challenge 1: The right sensor for the job**

Different models of ultrasonic sensors have different ranges (the minimum and maximum distance they can sense). The Tunnel's inner diameter is 7.2m. Identify which sensor is best for the job, and why:



Your choice and explanation: \_\_\_\_\_

**Challenge 2: Calibrate your sensor**

You need to double check that your chosen sensor works as specified. Connect it to a test circuit that gives you two measurements:

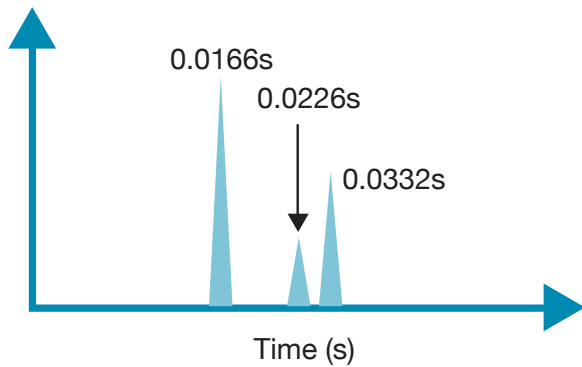
- The time delay between transmission and reception in an empty Tunnel is 0.042s.
- The wavelength of the ultrasound is 0.8575cm

Sound travels through air at 343m/s. The sensor should operate at 40,000 Hz +/- 1%.

**Is it working properly?**

### Challenge 3: What's going on?

The Tunnel is part-filled with water. You turn up the transmitter output and receiver sensitivity to their maximum settings, to see what happens. Your test rig now shows three potential time delays:



- Think about what cause each reflection. Which one represents the level of the water, and what is the level?
- Draw a diagram to explain what's happening to the ultrasound pulses in the Tunnel and the timings of the three spikes in the graph. The speed of sound in water is 1450m/s.