River landforms on the River Tees

You need to know:

- an example of a river valley in the UK
- how to identify, describe and explain its major landforms of erosion and deposition.

Student Book
See pages 122–3

Example

Where is the River Tees?

The River Tees is in north-east England and its source is in the Pennine Hills. It flows roughly east to reach the North Sea at Middlesbrough.

Landforms of erosion

High Force (Figure **1**) on the River Tees is in the river's upper course. The waterfall drops 20 m and continues through a gorge.

A resistant band of igneous rock (dolerite) cuts across the valley. Its resistance has led to the development of a waterfall.

Underlying weaker rock (limestone) is undercut.

Waterfall retreats upstream to form a gorge.

Figure 1 *High Force on the River Tees*

Landforms of deposition

The map shows the River Tees south of Darlington. The river is flowing west to east over relatively flat, low-lying land. Along this stretch of the river are examples of meanders, levees, and floodplains.

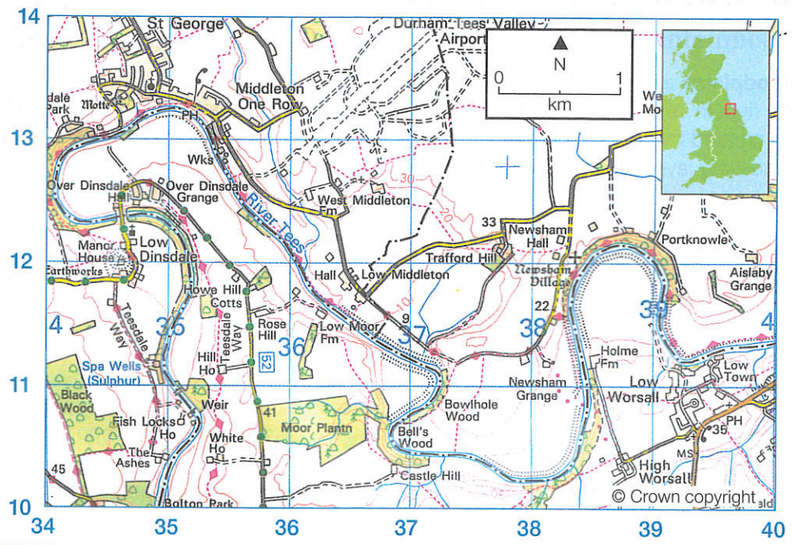


Figure 2 *1:50 000 OS map extract of River Tees, near Darlington*

Six Second Summary

The River Tees has good examples of erosion landforms (High Force waterfall and gorge) and deposition landforms (levées and floodplains).

Over to you

Look at Figure **2** and give a four-figure grid reference for:

- a meander (large bend in the river)
- levees (shown by this symbol ,,,,,,, ,,,,,,,)
- a floodplain (white areas alongside river with few contour lines).

Factors increasing flood risk

You need to know:

- what factors affect the risk of flooding
- what a hydrograph is, and what affects its shape.

Student Book
See pages 124–5

What causes flooding?

- River floods usually occur after long periods of rain – most frequently during winter.
- Sudden floods, called *flash floods*, tend to occur in summer and are associated with heavy rainstorms.
- Physical and human factors can each increase flood risk.

Big Idea

A river flood occurs when a river channel can no longer hold the amount of water flowing in it. Water overspills the banks onto the floodplain.

Physical factors	Human factors (land use)
• *Precipitation* – torrential rainstorms and/or prolonged periods of rain can lead to flooding. • *Geology* – impermeable rocks don't allow water to pass through, so it flows overland into river channels. • *Relief* – steep slopes mean water flows quickly into river channels.	• *Urbanisation* – impermeable surfaces, e.g. tarmac roads, mean water flows quickly into drains, sewers and river channels. • *Deforestation* – when trees are removed, much of the water which had been evaporated from leaves or stored on leaves and branches flows rapidly into river channels. • *Agriculture* – exposed soil can lead to increased surface runoff (especially if ploughing occurs up and down slopes).

What is a hydrograph?

A hydrograph shows how a river reacts to a rainfall event. It shows rainfall and **discharge** – the volume of water flowing in a river measured in m^3 per second (cumecs). *Lag time* shows how quickly water is transferred into the river channel. The shorter the lag time, the greater the risk of flooding.

These factors affect its shape:

- basin size
- drainage density
- rock type and permeability
- land use
- relief
- soil moisture
- rainfall intensity
- antecedent rainfall

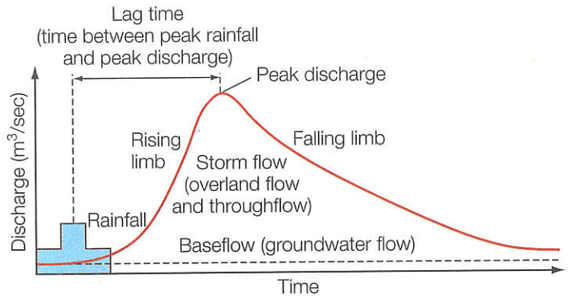


Figure 1 *A flood hydrograph*

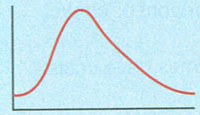
Six Second Summary

- Flooding occurs when a river can't hold the amount of water flowing in it.
- Human and physical factors increase the flood risk.
- A flood hydrograph shows how a river reacts to a rainfall event.
- Different factors affect the shape of a hydrograph.

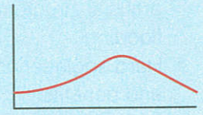
Over to you

Draw a larger version of the two hydrographs below. Annotate each one to explain what factors have affected their shape.

1 'Flashy' hydrograph with a short lag time and high peak



2 A flat hydrograph with a low peak



Managing floods – hard engineering

You need to know:

- what hard engineering is, and some examples of it
- about costs and benefits of hard engineering strategies to manage river flooding.

Student Book
See pages 126–7

What is hard engineering?

Hard engineering involves using artificial structures to prevent, or control flooding. It is usually very expensive and the *costs* have to be weighed against *benefits*.

- Costs include financial costs and negative impacts on people/the environment.
- Benefits are the financial savings and environmental improvements made by preventing flooding.

Dams and reservoirs	Channel straightening	Embankments	Flood relief channels
• Widely used to regulate river flow and reduce risk of flooding. • Often multi-purpose, e.g. flood prevention; HEP generation; water supply. • Can be effective in regulating water flow and can store water in reservoir. • Expensive, and reservoirs often flood large areas of land.	• Cutting through meanders creating a straight channel, speeding up water flow. But can increase flood risk downstream. • Straightened channels may be lined with concrete. This can be unattractive and can damage wildlife habitats.	• Raise the level of a river bank allowing the channel to hold more water to help prevent flooding. • Concrete or stone walls are often used in towns, though mud dredged from the river can be used. This is cheaper, more sustainable and looks more natural.	• These can be built to by-pass urban areas. At times of high flow, sluice gates allow excess water to flow into the flood relief channel, reducing the threat of flooding.

Figure 1 *Hard engineering strategies*

Clywedog reservoir, Llanidloes

The Clywedog reservoir was built in the 1960s to help prevent flooding of the River Severn. The reservoir stretches for nearly 10 km. It fills in the winter and water is released in the summer to maintain a constant flow.

Figure 2 *Clywedog dam and reservoir*

Jubilee River, Maidenhead

The Jubilee River is an 11 km long flood relief channel built to reduce the flood risk on the Thames. It opened in 2002. It has had a positive impact on the environment by creating new wetlands.

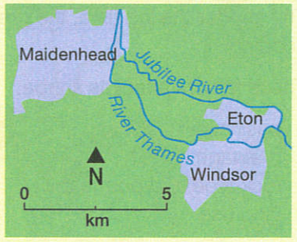


Figure 3 *The Jubilee River*

Six Second Summary

- Hard engineering involves the use of artificial structures to prevent or control flooding.
- Hard engineering schemes have costs and benefits.

Over to you

Use two highlighters to highlight the *costs* and *benefits* of strategies listed in Figure **1**. Summarise each strategy under the following headings:

- What is it?
- How does it work?
- Advantages
- Disadvantages

Managing floods – soft engineering

You need to know:

- what soft engineering is, and some examples of it
- the costs and benefits of soft engineering strategies to manage river flooding
- about preparing for floods.

Student Book
See pages 128–9

What is soft engineering?

Soft engineering involves working *with* natural processes to manage flood risk. It aims to reduce and slow movement of water into a river channel to help prevent flooding. As with hard engineering, there are costs and benefits.

Afforestation (planting trees)	Wetlands and flood storage areas	Floodplain zoning	River restoration
• Trees obstruct the flow of water, and slow down its transfer to river channels. • Water is taken up by trees and evaporated from leaves and branches. • It is relatively cheap with environmental benefits.	• Wetlands are deliberately allowed to flood, forming storage areas. • Reduces the risk of flooding downstream.	• Restricts different land uses to certain zones on the floodplain. • Areas at risk from flooding can be used for grazing, parks and playing fields. • Can reduce losses caused by flood damage. • Can be difficult to implement on already developed land.	• When a river's course has been changed artificially, it can be restored to its original course. • It uses the natural processes and features of a river, e.g. meanders and wetlands to slow down flow and reduce the likelihood of flooding downstream.

Figure 1 *Soft engineering strategies*

Preparing for floods

In England and Wales, the Environment Agency issues **flood warnings**. There are three levels:

- *Flood watch* – flooding of low-lying land and roads expected. Be prepared.
- *Flood warning* – a threat to homes and businesses. People should move valuable items upstairs and turn off electricity and water.
- *Severe flood warning* – extreme danger to life and property. People should stay upstairs or leave their home.

The Environment Agency produces flood maps showing areas at risk of flooding. People living in these areas should plan for floods by using sandbags and floodgates to prevent water damaging property.

Local authorities and emergency services use flood maps to plan their responses to floods including installing temporary flood barriers, evacuating people and closing roads.

Six Second Summary

- Soft engineering works with natural processes to manage flood risk, and includes the use of afforestation, wetlands and flood storage areas, floodplain zoning and river restoration.
- The Environment Agency produces flood maps and issues flood warnings.

Over to you

Use two highlighters to highlight the *costs* and *benefits* of strategies listed in Figure **1**. Summarise each strategy under the following headings:

- What is it?
- How does it work?
- Advantages
- Disadvantages

How would you decide whether hard or soft engineering is better if asked in an exam? Give a precise answer – no waffle.

11.9 Managing floods at Banbury

You need to know:

- why a flood management scheme was needed in Banbury
- what the scheme consists of
- the costs and benefits of the scheme.

Student Book
See pages 130–1

Example

Where is Banbury?

- Banbury is about 50 km north of Oxford, in the Cotswold Hills.
- The population is about 45 000.
- Much of the town is on the floodplain of the River Cherwell (a tributary of the Thames).

Figure 1 *Location of Banbury*

Add a WOW! factor

A 200-year flood event is a flood which is expected to happen once every 200 years.

Why was the scheme needed?

Banbury has a history of flooding.

- In 1998 flooding closed the railway station, shut roads and caused £12.5 million of damage.
- In 2007 it was flooded again (along with much of central and western England).

What has been done?

In 2012 the flood defence scheme was completed. Figure **2** shows what was done.

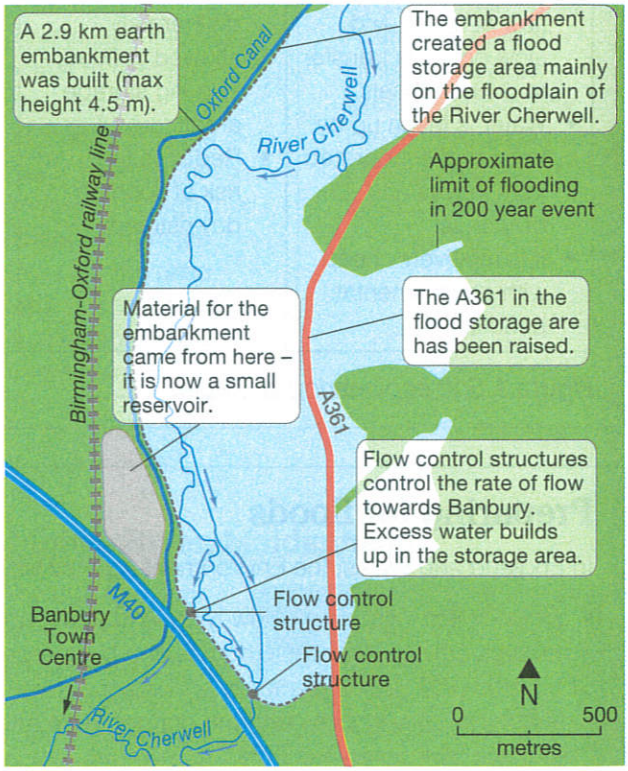


Figure 2 *Features of the Banbury Flood Storage Reservoir. A new pumping station transfers excess water into the river below the town.*

Social	• The raised A361 stays open during a flood avoiding disruption. • Quality of life improved with new footpaths and green areas. • Less anxiety about flooding.
Economic	• The scheme cost £18.5 million, paid for partly by the Environment Agency and Cherwell District Council. • Over 400 houses and 70 businesses protected at a value of over £100 million.
Environmental	• Earth needed to build embankment was extracted locally, creating a small reservoir. • A new habitat has been created with ponds, trees and hedges.

Figure 3 *Costs and benefits*

Six Second Summary

- Banbury is on the floodplain of the River Cherwell and at risk from flooding.
- A flood defence scheme has created a flood storage area and allowed the flow of the river to be controlled.
- The scheme has costs and benefits.

Over to you

Create a poster, flashcards, spider diagram to help you learn this example. You need to know:

- *where* is Banbury?
- *why* the scheme was needed
- *what* the flood defence scheme consists of (what has been done)
- the social, economic and environmental *issues*.