River Landscapes in the UK **Knowledge Organiser**

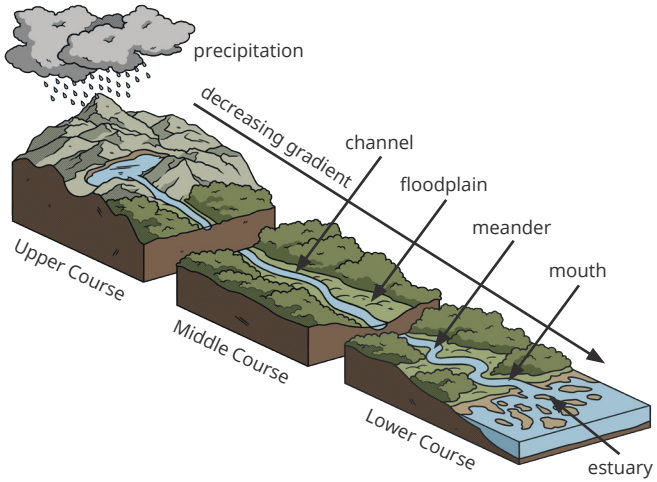
The Shape of River Valleys Change as the River Flows Downstream

Changing Long Profile and Cross Profile of a River

The long profile of a river shows how the gradient of the land changes from the source to the mouth of a river.

The cross profile of the river shows the cross-section of the river and the river valley.

Long Profile of a River



	Upper Course	Middle Course	Lower Course
Gradient	steep gradient	gentle gradient	flat gradient
Velocity	low velocity	faster velocity	fastest velocity
Features	waterfalls, gorges, and rapids	meanders, ox bow lakes, floodplains	floodplains, deltas, estuaries
Channel	narrow and shallow channel	wider and deeper channel	widest and deepest channel

Fluvial Process

Erosion

hydraulic action – The force of the river against the banks can cause air to be trapped in cracks and crevices. The pressure weakens the banks and gradually wears it away.

abrasion – Rocks carried along by the river wear down the river bed and banks.

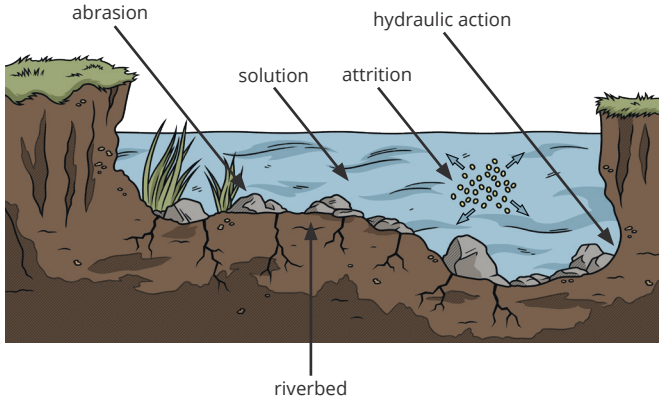
attrition – Rocks carried by the river smash together and break into smaller, smoother and rounder particles.

solution – Soluble particles are dissolved into the river.

Vertical erosion deepens the river, forming a v-shaped valley/channel. High turbulence carries material which wears away the river bed, especially in the upper course.

Lateral erosion widens the river valley/channel, especially in the middle/lower course.

Types of Erosion in a River



Transportation

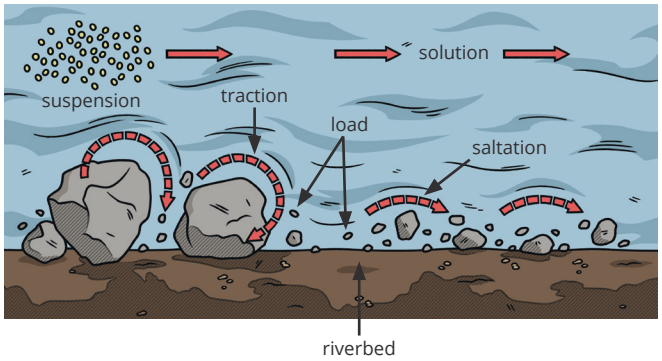
traction – Boulders and pebbles roll along the river bed.

saltation – Material carried by the river bounces along the river bed.

suspension – Rocks carried along by the river wear down the river bed and banks.

solution – Soluble material is dissolved and carried by the river water.

Types of Transportation in a River



Deposition

Rivers deposit eroded material as they lose speed (velocity) when:

- the river becomes shallower;
- the discharge (volume of water) is reduced;
- the amount of transported material increases;
- the river reaches the mouth.

River Landscapes in the UK **Knowledge Organiser**

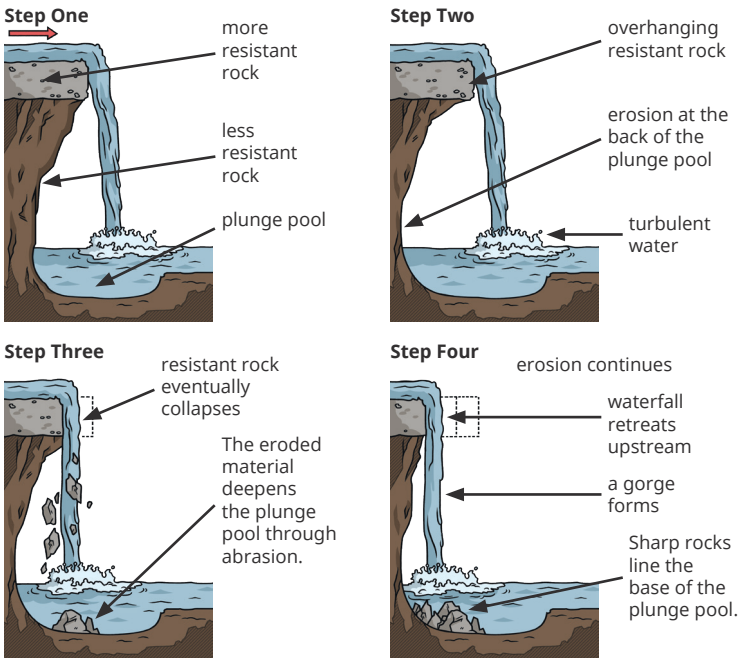
Distinctive Fluvial Landforms Result from Different Physical Processes

Erosional Landforms

Interlocking spurs form in the upper course of a river where vertical erosion creates steep-sided V-shaped valleys. The river winds and bends; avoiding areas of hard rock creating interlocking spurs (which look similar to the interlocking parts of a zip).

Waterfalls form in the upper course of a river where a layer of hard rock overlays a layer of soft rock. The soft rock erodes at a faster rate than the hard rock. This leads to the hard rock overhanging the soft rock. Eventually the hard rock overhang becomes too heavy and collapses causing the river to retreat upstream.

Waterfall Formation



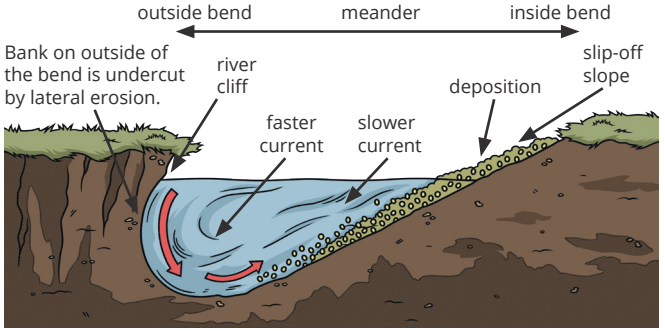
Gorges form where a waterfall has retreated upstream leaving behind a valley with steep sided walls.

Erosional and Depositional Landforms

Meanders form in the middle and lower course where lateral erosion causes the river to widen. The outside of a river bend will erode more quickly as the water is forced to the outside bend as it turns. The water on the outside bend is deeper and faster causing even more erosion, enlarging the bend.

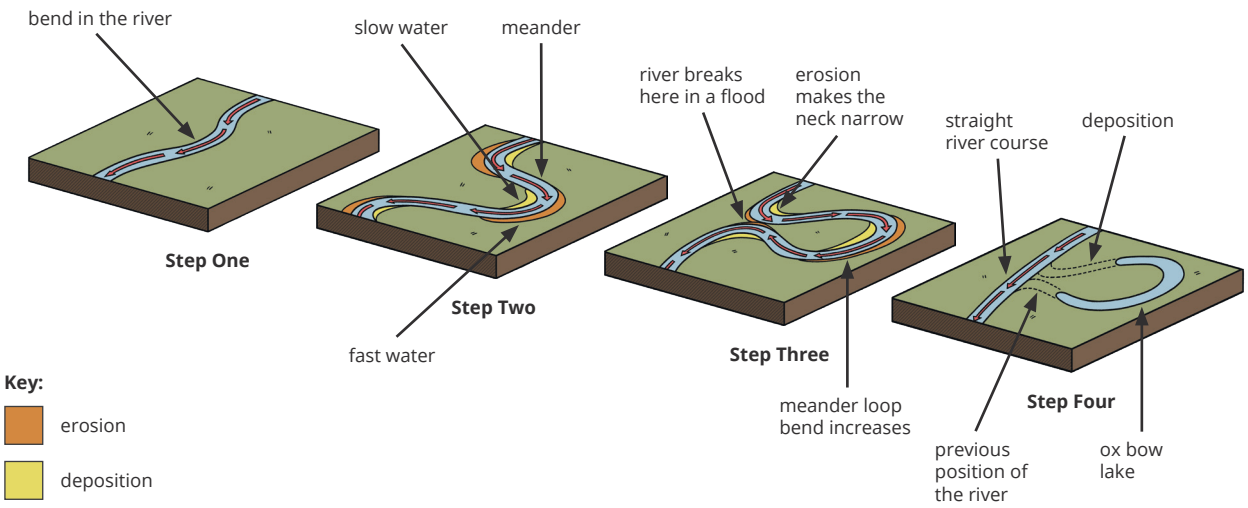
The water on the inside bend of the river is much shallower and slower. As a result, material is deposited (forming a slip-off slope).

Cross Section of a River Meander



Ox-bow lakes form where meanders have become so enlarged that the river breaks through the narrow 'neck'. The river will flow along this new route as it is the shortest course. Deposition will eventually completely cut the old meander loop off from the river channel creating an ox-bow lake.

Formation of an Ox-Bow Lake

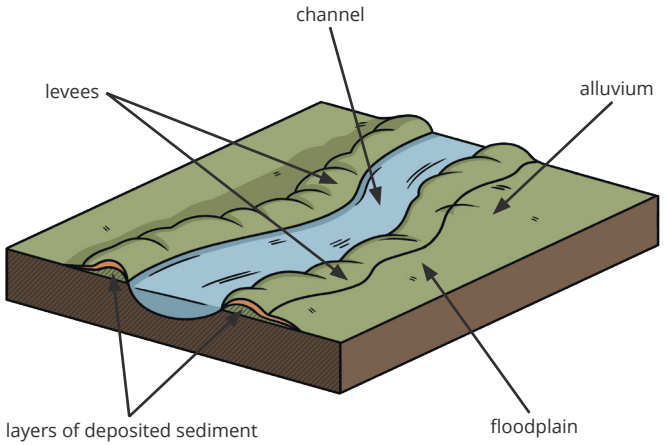


Distinctive Fluvial Landforms Result from Different Physical Processes

Depositional Landforms

Levees form in the lower course of a river along the river banks due to repeated flooding. As water overflows the main channel, it loses energy, depositing material creating natural embankments.

Diagram of a River Flood Plain and Its Levees

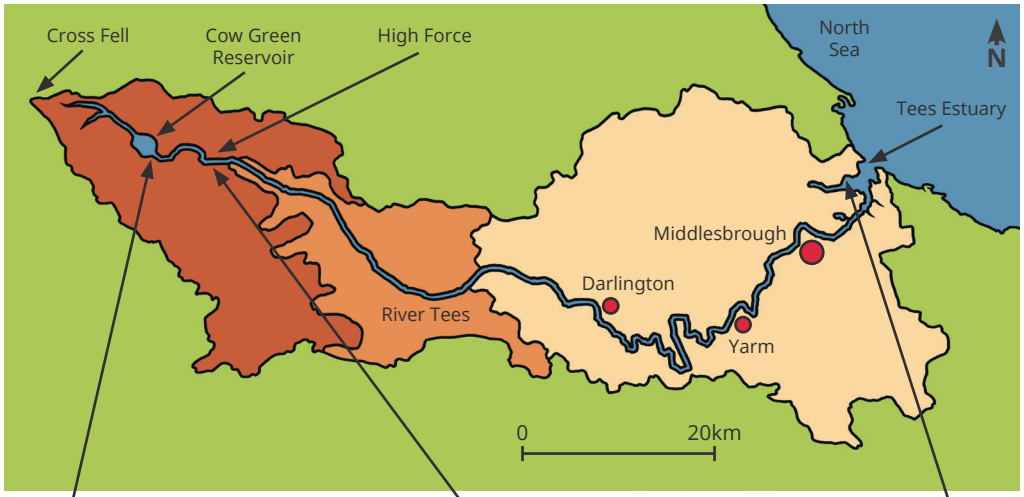


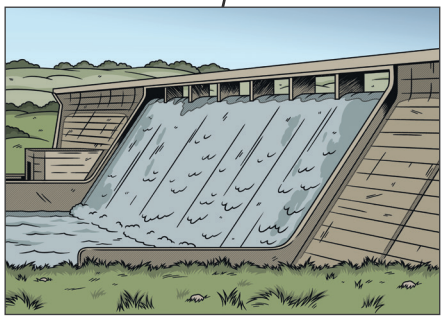
Floodplains are the wide valley floor on either side of the river in the lower course. When the river floods and overflows its levees the water loses energy once it hits the land. This sudden loss of energy leads to deposition of river sediment on the land close to the river channel.

Estuaries are located in the tidal zone at the mouth of a river where the river meets the sea. The water level in the estuary rises and falls with the tide. During high tide, large areas of valley floor will be flooded. As the tide falls, material will be deposited, creating mudflats which will be exposed during low tide.

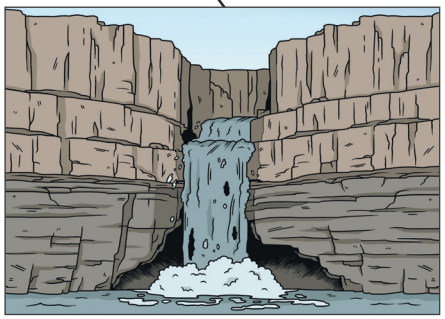
Example of UK River Valley: The River Tees

Map of the River Tees





Cow Green Dam created Cow Green Reservoir (2 miles long and holds 40 000 million litres of water).



High force gorge was created as high force waterfall retreated upstream. At High Force waterfall, the River Tees drops 21m into the plunge pool.

Mudflats have formed around the estuary of the River Tees. Material is deposited as the high tides fall.

Different Management Strategies Can Be Used to Protect River Landscapes from the Effects of Flooding

The Use of Hydrographs to Show the Relationship Between Precipitation and Discharge

discharge – The volume of water which passes a given point in the river over a set amount of time. It is measured in cubic measures per second (cumecs).

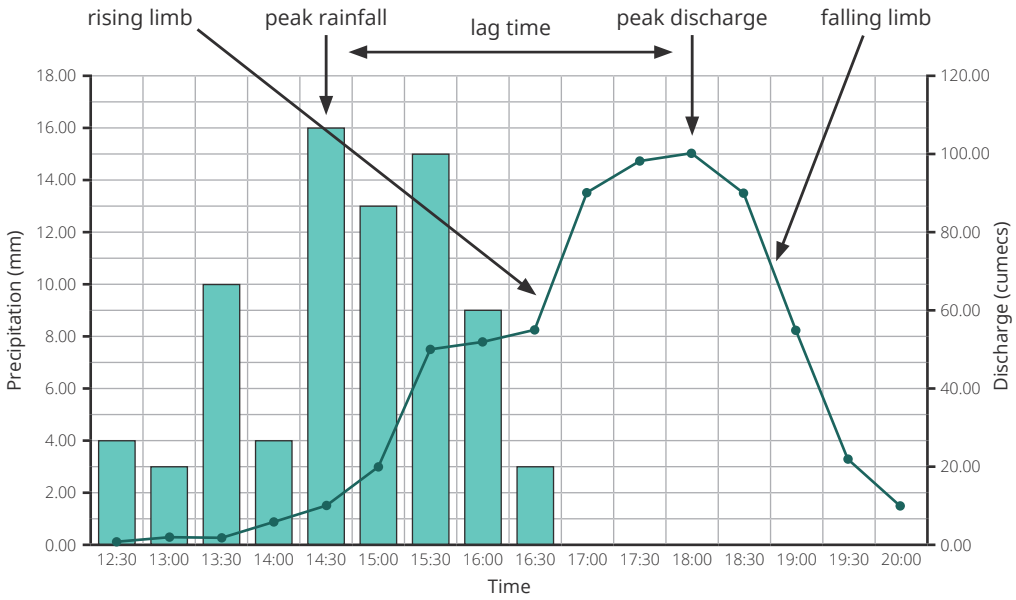
hydrograph – A graph which shows the rainfall (bar graph) and river discharge (line graph) of a river over a period of time.

lag time – The time between the peak rainfall and the peak discharge.

rising limb – The part of a hydrograph which shows the increase in discharge as rain enters the river channel. A steep rising limb indicates an increased flood risk as water quickly enters the channel. The lag time occurs because most rain water does not land in the river and has to travel to the river overland (surface runoff) or slowly underground (after infiltration). The lag time can be sped up by steep slopes, saturated ground and impermeable surfaces.

falling limb – The part of a hydrograph which shows the decrease in discharge as the river returns to its usual level.

Example Hydrograph



How Physical and Human Factors Affect the Flood Risk

Precipitation
The amount and duration of precipitation can affect flood risk.

- Heavy precipitation will cause flooding as there is too much water to infiltrate into the ground causing water to run over the land (increased surface runoff).
- Prolonged precipitation will cause the soil to become saturated preventing further infiltration. Precipitation will therefore run over the land (increased surface runoff).
- If surface runoff is increased the discharge of the river will increase, increasing the likelihood of a flood.

Geology
Impermeable rocks (e.g. marble and granite) and clay soils do not allow precipitation to infiltrate; increasing surface runoff. If surface runoff is increased the discharge of the river will increase, increasing the likelihood of a flood. Permeable rocks allow precipitation to infiltrate through to the water table and decreases surface runoff rates.

Relief
Steep slopes will cause surface runoff to enter the river more quickly, less water will infiltrate and as a result more water will end up in the river. If the discharge of the river is increased, increasing the likelihood of a flood.

Land Use
Buildings and roads are often impermeable (e.g. concrete and tarmac) and can increase the likelihood of a flood in two ways:

- less water will infiltrate and more water will end up in the river;
- drains are designed to remove rainwater quickly from urban areas (reducing the lag time). This rainwater is normally directed towards rivers, increasing river discharge.

Trees help to reduce the discharge of a river in two ways:

- trees intercept rainwater which can then evaporate;
- trees can soak up groundwater.

If trees are cut down, more water will end up in the river.

Different Management Strategies Can Be Used to Protect River Landscapes from the Effects of Flooding

The Costs and Benefits of Management Strategies

Hard Engineering

1. **Dams and Reservoirs**
   Reservoirs (artificial lakes) are formed behind a dam (a wall across a river) usually in the upper course.

   Pros – Reservoirs store water and provide a reliable water source. hydroelectric power (HEP) can be generated. Flood risk is reduced.

   Cons – They are expensive to build. Settlements and habitats are often flooded. Alters the river course downstream as land no longer floods, resulting in less fertile land as silt is no longer deposited. Eroded material is trapped behind the dam, which alters river processes and landforms downstream.

2. **Channel Straightening**
   Rivers are artificially straightened.

   Pros – The flood risk is reduced as water is transported away from the area quickly.

   Cons – Water is carried downstream quicker. As a result, flooding and erosion is more likely downstream.

3. **Embankments**
   Raised walls along the river banks.

   Pros – Flooding will be less frequent as the river channel can hold more water.

   Cons – If the river floods severely, flood waters will be trapped on the floodplain. Can be expensive.

4. **Flood Relief Channels**
   Water is diverted from areas that are being protected.

   Pros – Water can be controlled by opening and closing flood gates.

   Cons – They are expensive to build. Water is carried downstream quicker, which means that flooding and erosion is more likely downstream.

Soft Engineering

1. **Flood Warnings and Preparations**
   The Environment Agency alert the public with apps, radio and TV broadcasts.

   Pros – These reduce the impact of flooding by giving people time to prepare (e.g. evacuate and protect their homes/belongings).

   Cons – Flooding can still occur. Some people might not be alerted.

2. **Flood Plain Zoning**
   Building is restricted in parts of the flood plain to reduce the impact of a flood. Hard surfaces would increase the likelihood of a flood.

   Pros – The impact of flooding is reduced. Floodplain retains its natural function.

   Cons – The development/economic growth of an area could be restricted. This offers limited help to areas already built on.

3. **Planting Trees**
   Trees intercept precipitation, increasing the lag time and reducing discharge.

   Pros – This is a cheap management strategy. Soil erosion is reduced. Habitat creation increases biodiversity of the area.

   Cons – Less farmland is available.

4. **River Restoration**
   Making the river more natural and allowing natural river processes to happen.

   Pros – This reduces flood risk downstream. Increases wildlife through habitat creation.

   Cons – Local flood risk is increased.

Different Management Strategies Can Be Used to Protect River Landscapes from the Effects of Flooding

An Example of a Flood Management Scheme in the UK – Morpeth, Northumberland

The Reasons for Management

- On 6th September 2008, the River Wansbeck flooded Morpeth (a town in Northumberland) following sustained heavy rainfall for twenty-four hours.
- The River Wansbeck valley is narrow and steep-sided.
- Urbanisation has increased surface runoff.
- Nearly 1000 properties were affected in Morpeth town centre, including homes and local businesses (e.g. Smails and Sons ironmongers).
- The cost of the flood was over £40 million.
- Over 400 residents were evacuated and shelter was provided (in Morpeth Town Hall, Northumberland County Hall and King Edwards VI High School). However, 198 properties in the Middle Greens area of the town did not receive a flood warning due to an Environment Agency error.

The Management Strategy

- The flood management scheme cost £26 million.
- Existing flood walls have been improved and strengthened.
- A new flood barrier at High Stanners in the town centre can be closed.
- Installation of tree poles in the River Wansbeck, near Lowford Bridge, prevent large debris/trees from reaching the town centre.
- A flood dam and storage area were built on the Mitford Estate which can store 1.4 million cubic metres of water (enough to fill 560 Olympic-sized swimming pools).
- Local roads have been raised.
- Locking down of storm water manhole covers.
- Drainage on Dark Lane has been improved.

The Social, Economic and Environmental Issues

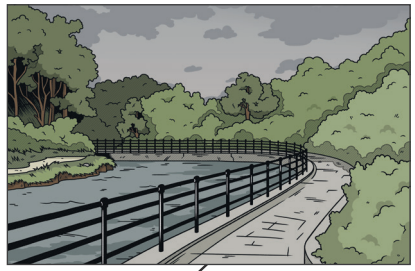
Social – Some local residents were disrupted during the construction/improvement of flood defences.

Economic – Homes and businesses are now protected against a one in 137 year flood event. However, some homes and businesses still cannot get insurance due to perceived risk from insurance companies.

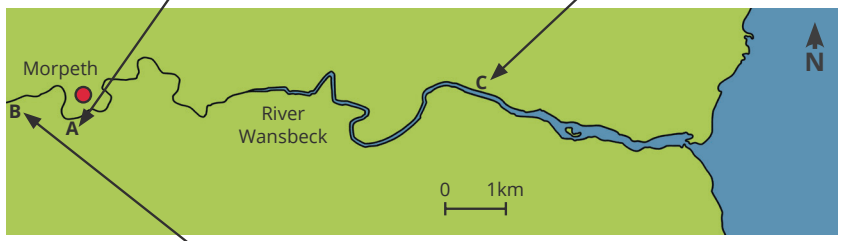
Environmental – The scheme created 42 acres of new habitat which will increase species diversity. 3500 endangered white-clawed crayfish were relocated upstream of the flood defences.

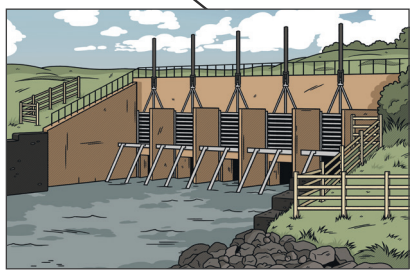
Morpeth Chantry Chapel is located in a high risk area. A wall would extend from the river bed to approximately 50cm above ground level in the garden between the Chantry and the river.

West bank of the River Wansbeck flood defences.



Map of the River Wansbeck





Morpeth Flood Alleviation Scheme located upstream the dam is intended to reduce the risk of the River Wansbeck flooding at Morpeth to one in 137 per year.