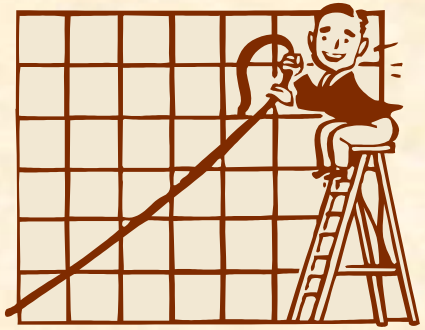
Construction

And

Analysis

Of

Hydrographs



Hydrographs

Special graphs that show a changes in a river's discharge over a period of time, usually in relation to a rainfall event.

River Discharge

Is the amount of water passing a particular point in the river at any given time (basically the amount of water in the river).

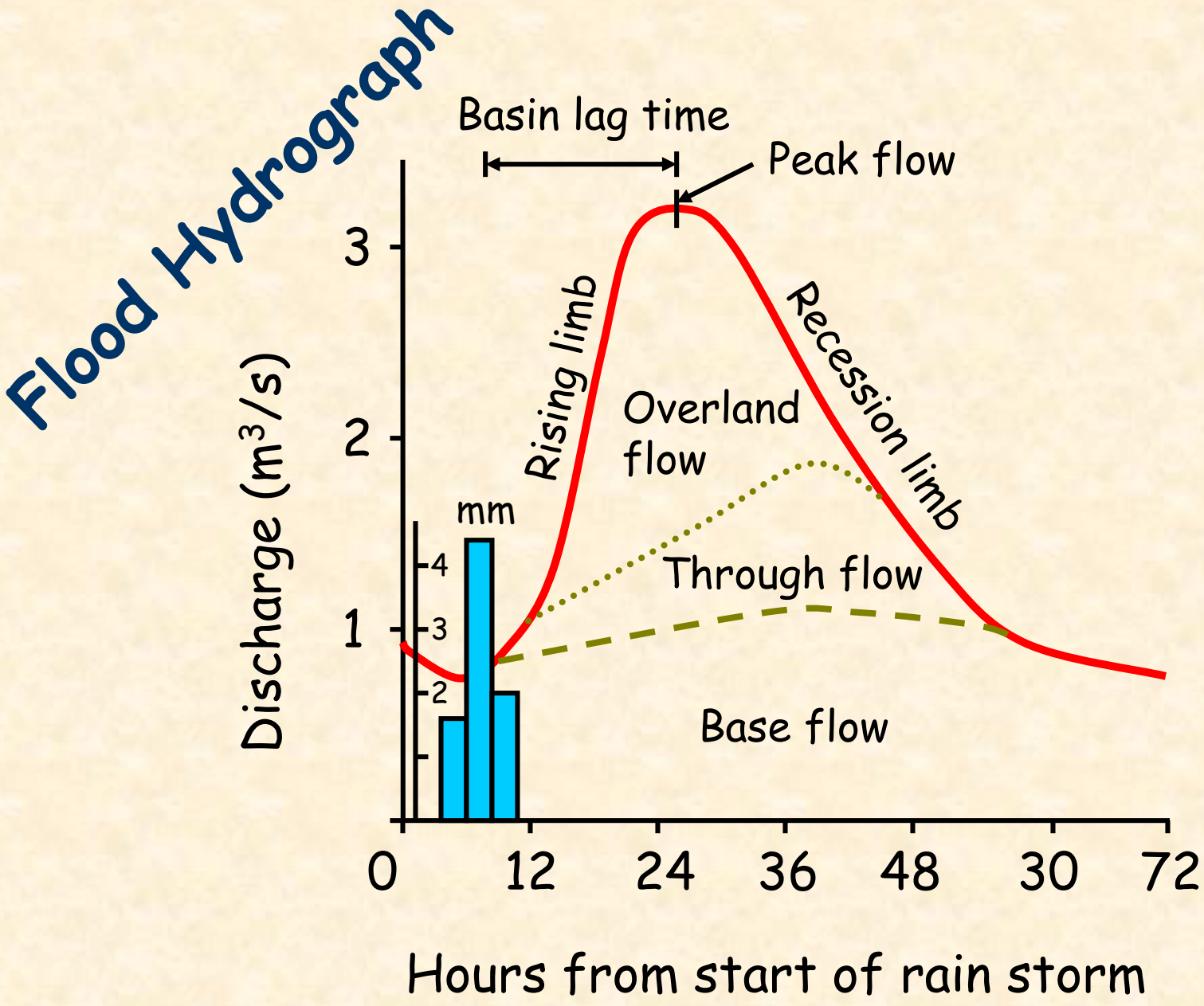
Why Construct & Analyse Hydrographs ?

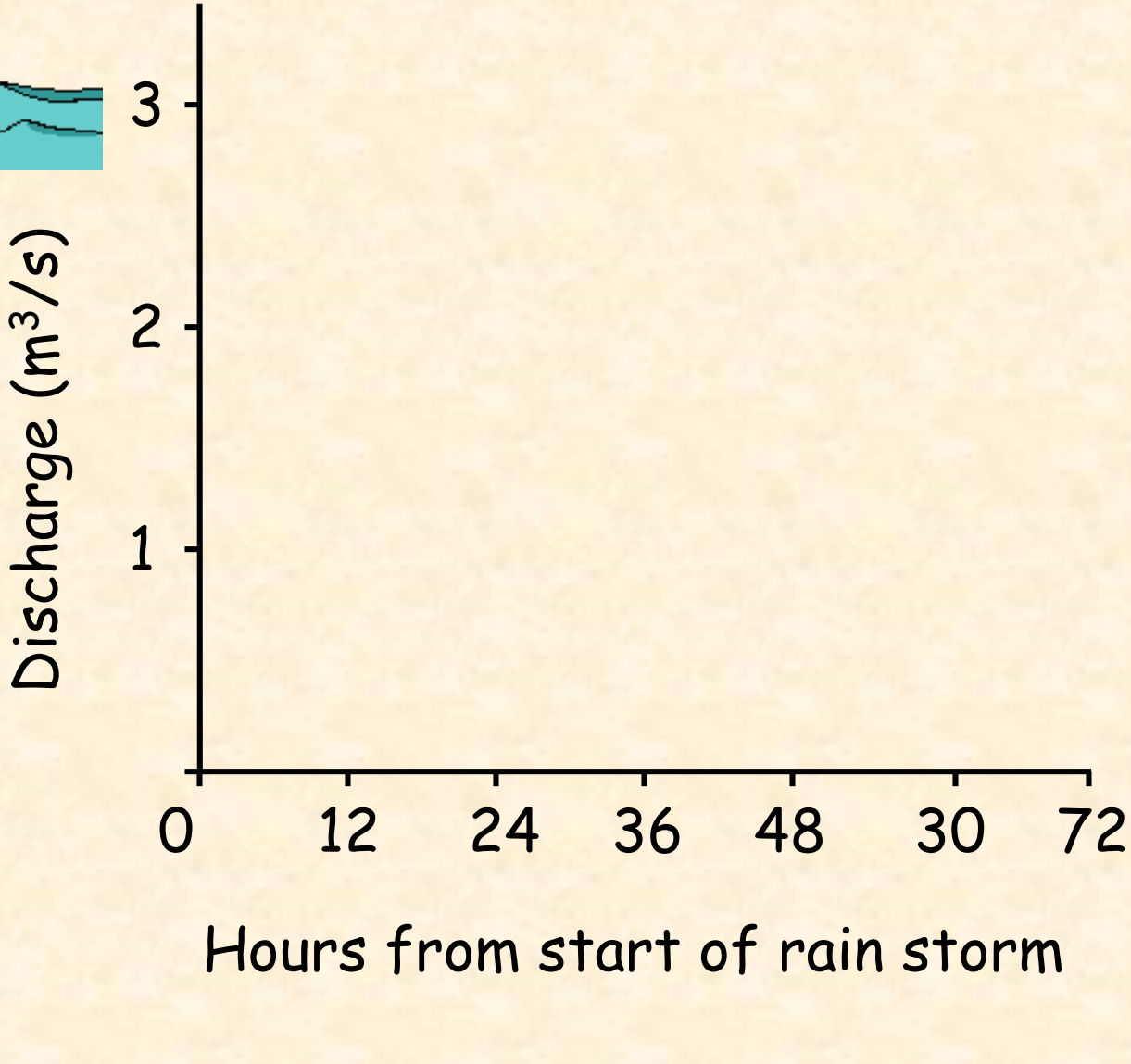
- To find out discharge patterns of a particular drainage basin
- Help predict flooding events, therefore influence implementation of flood prevention measures

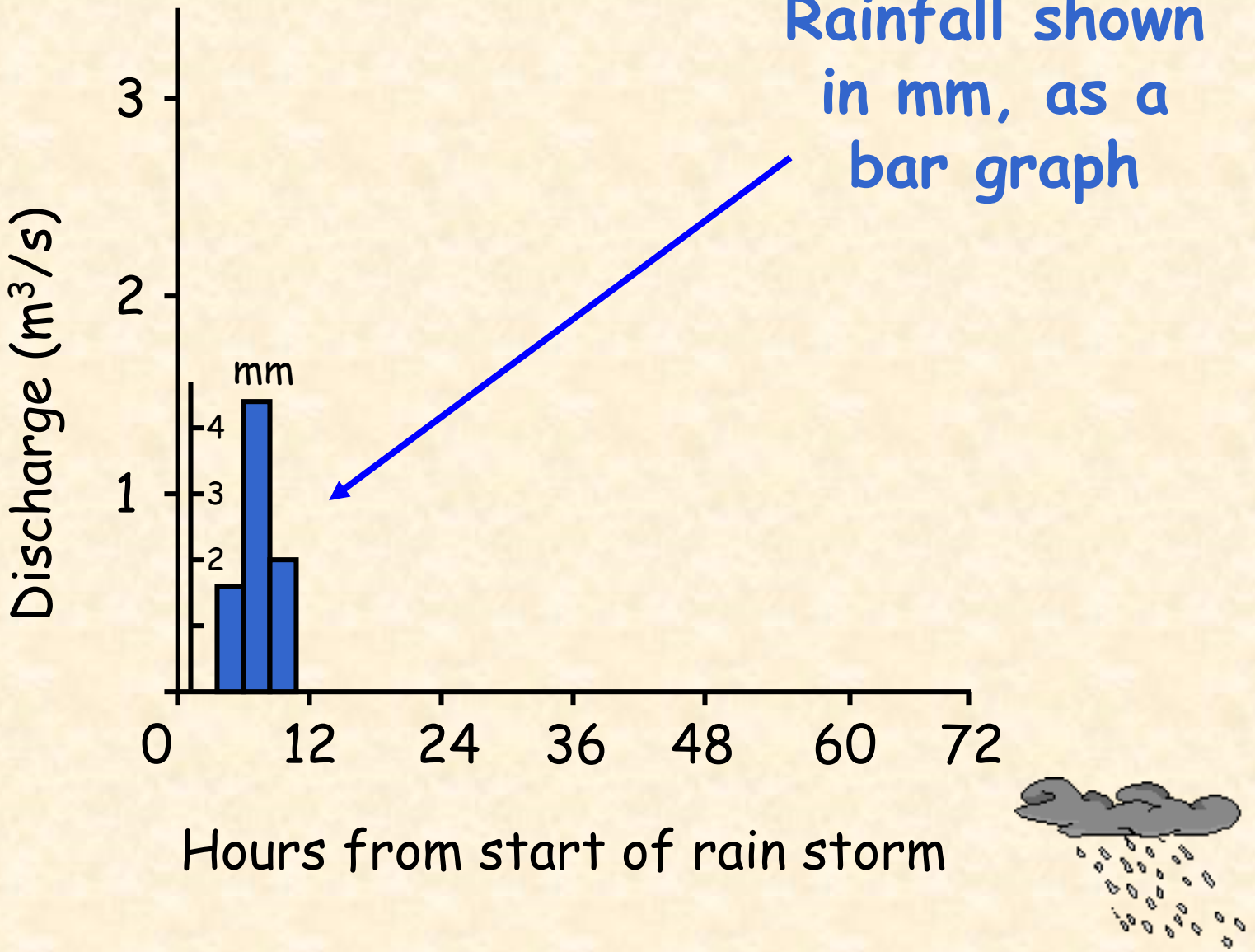
Construction

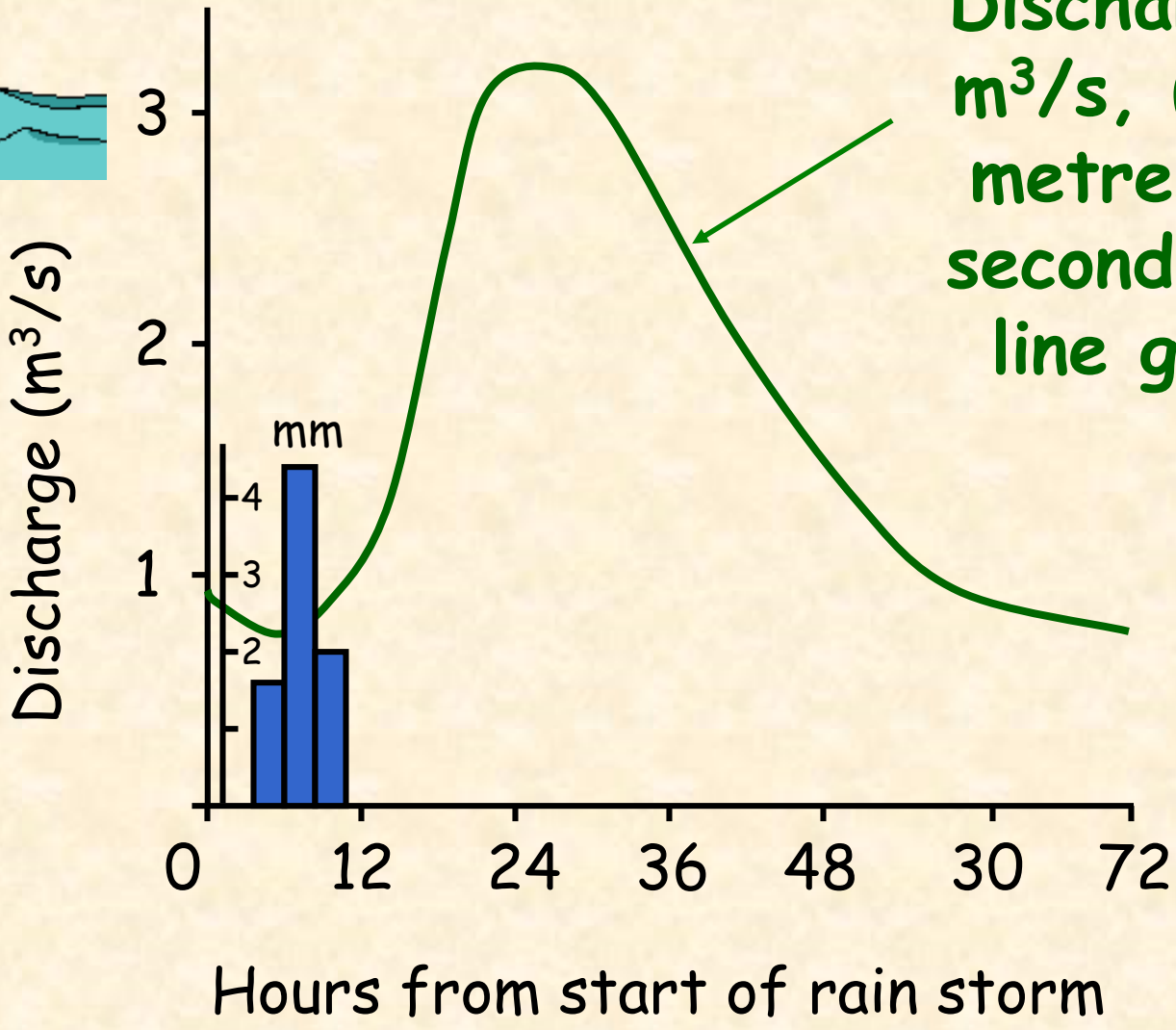
Of
Storm (flood)
Hydrographs

Flood Hydrograph




Discharge (m³/s)
3
2
1
0
12
24
36
48
30
72
Hours from start of rain storm

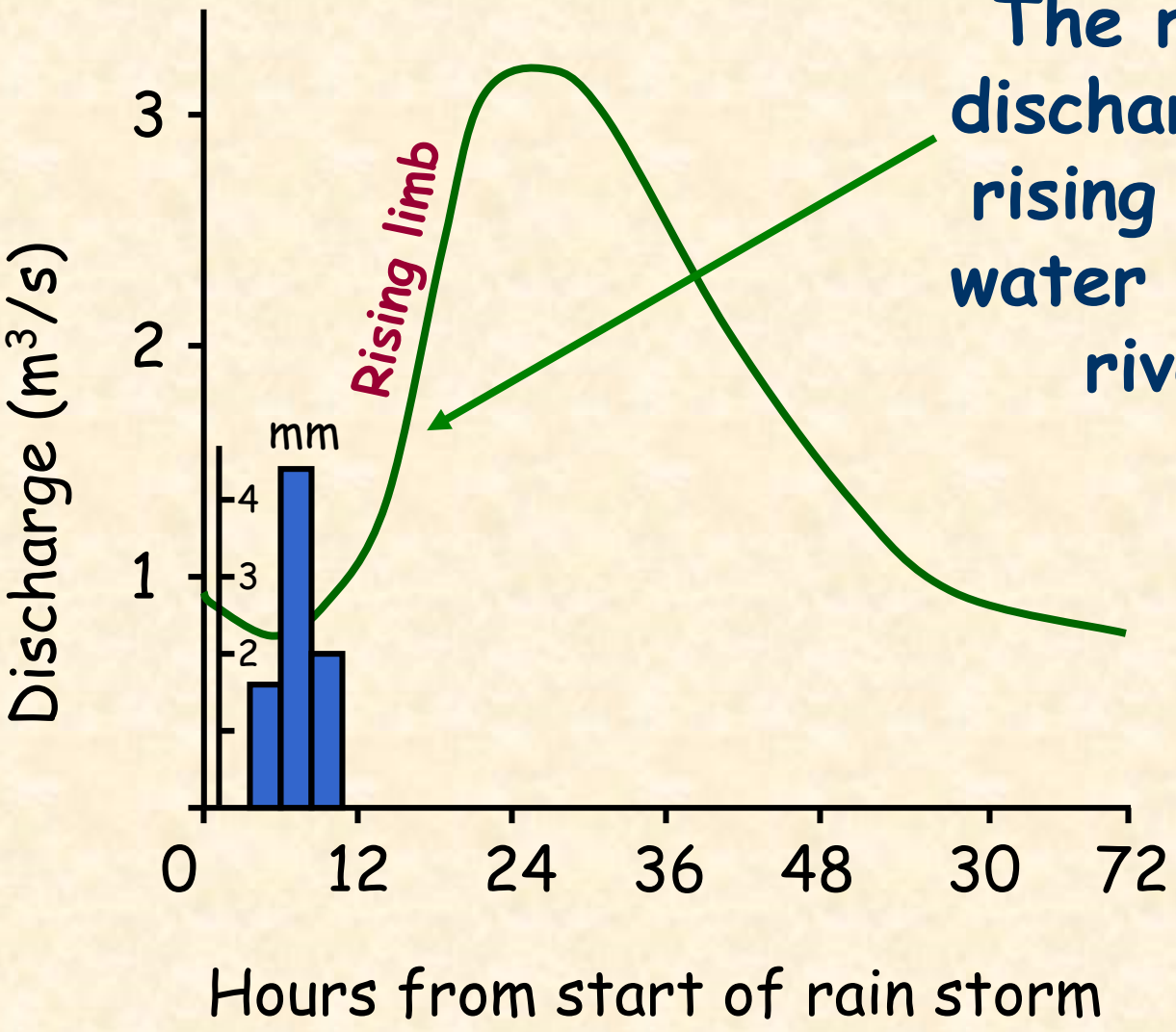

Rainfall shown in mm, as a bar graph
Discharge (m³/s)
3
2
1
mm
4
3
2
0
12
24
36
48
60
72
Hours from start of rain storm



Discharge in m^3/s, (cubic metres per second) as a line graph

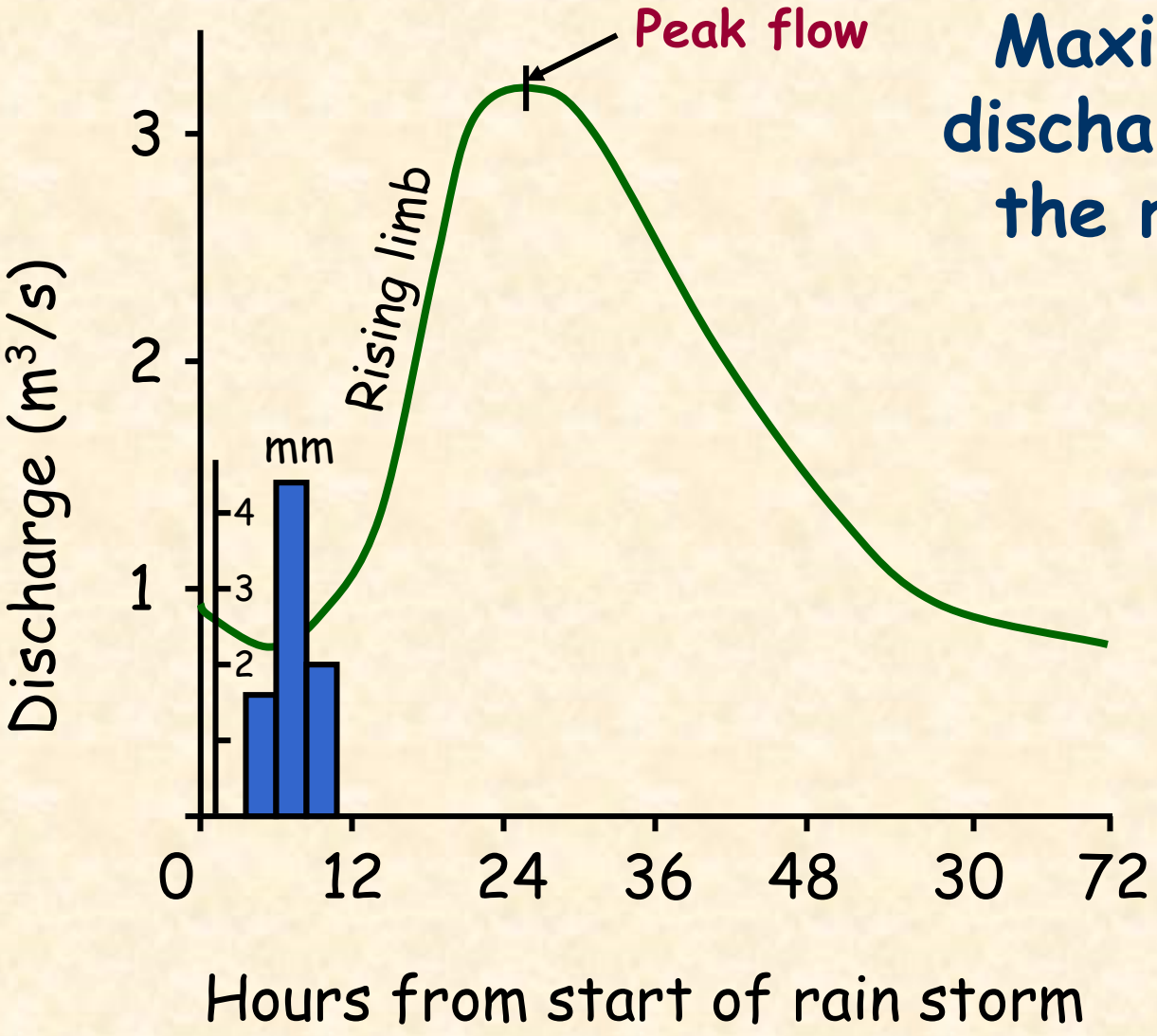
Rising limb

The rising discharge or rising flood water in the river



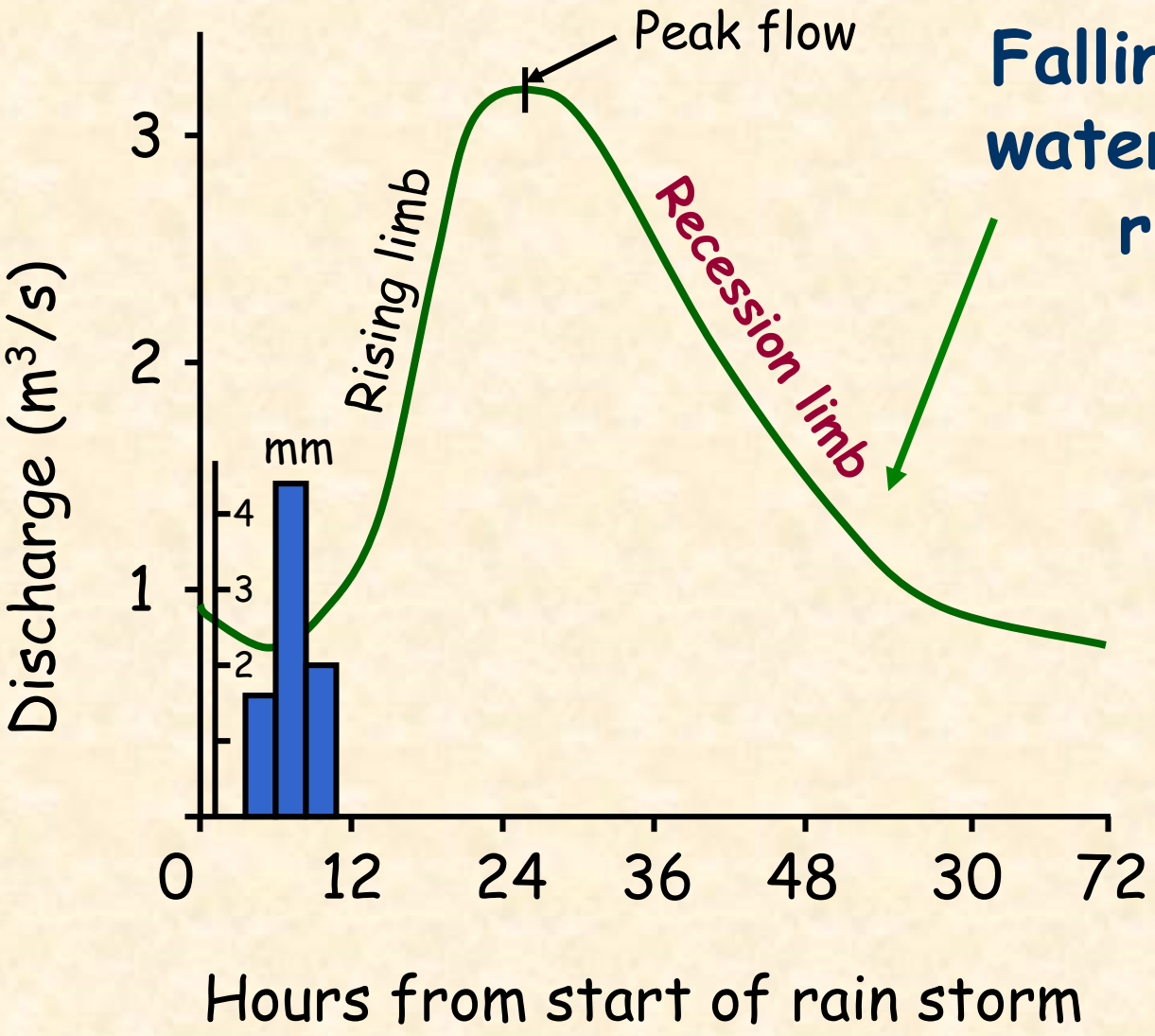
Peak flow

Maximum discharge in the river

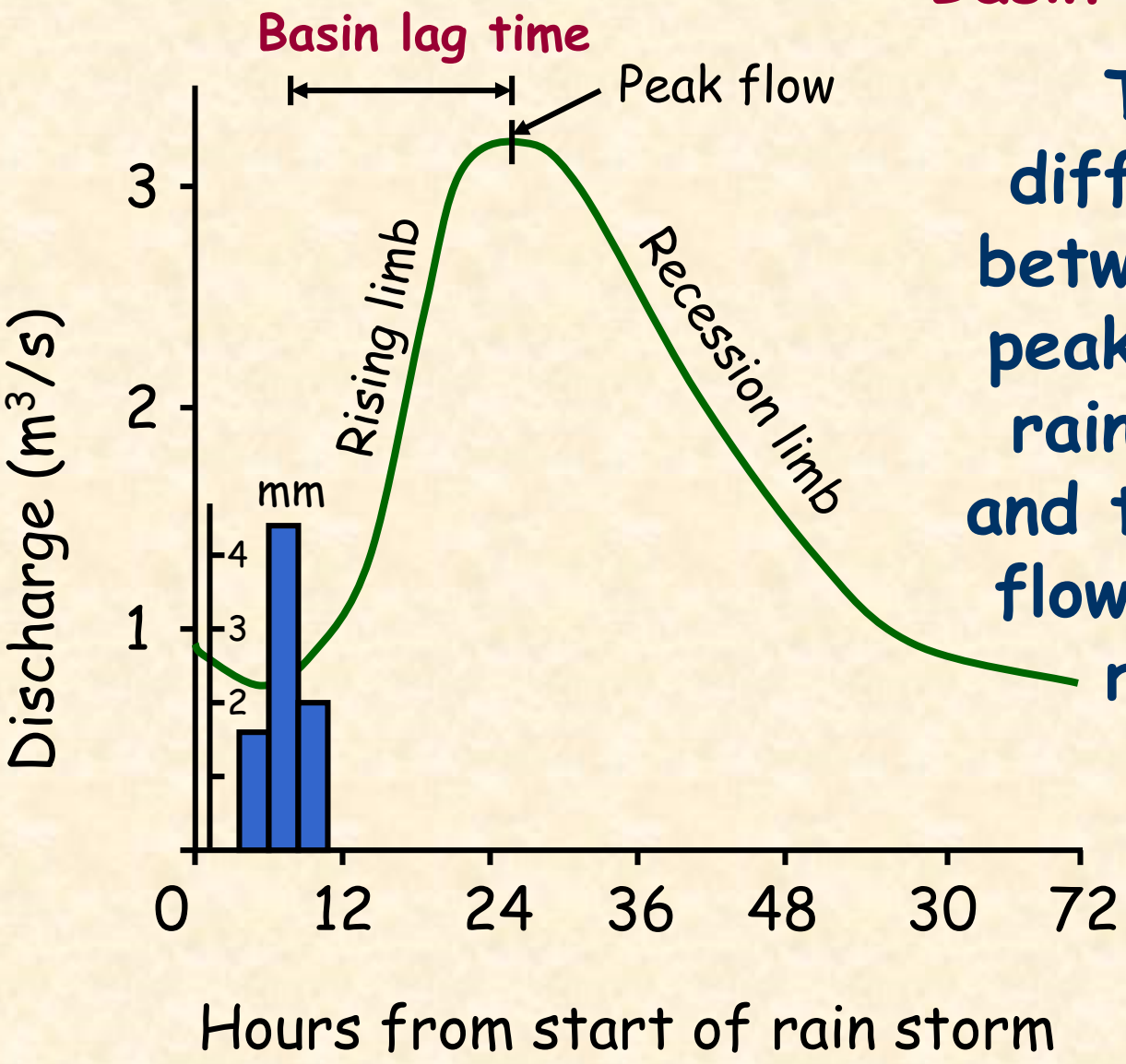


Recession limb

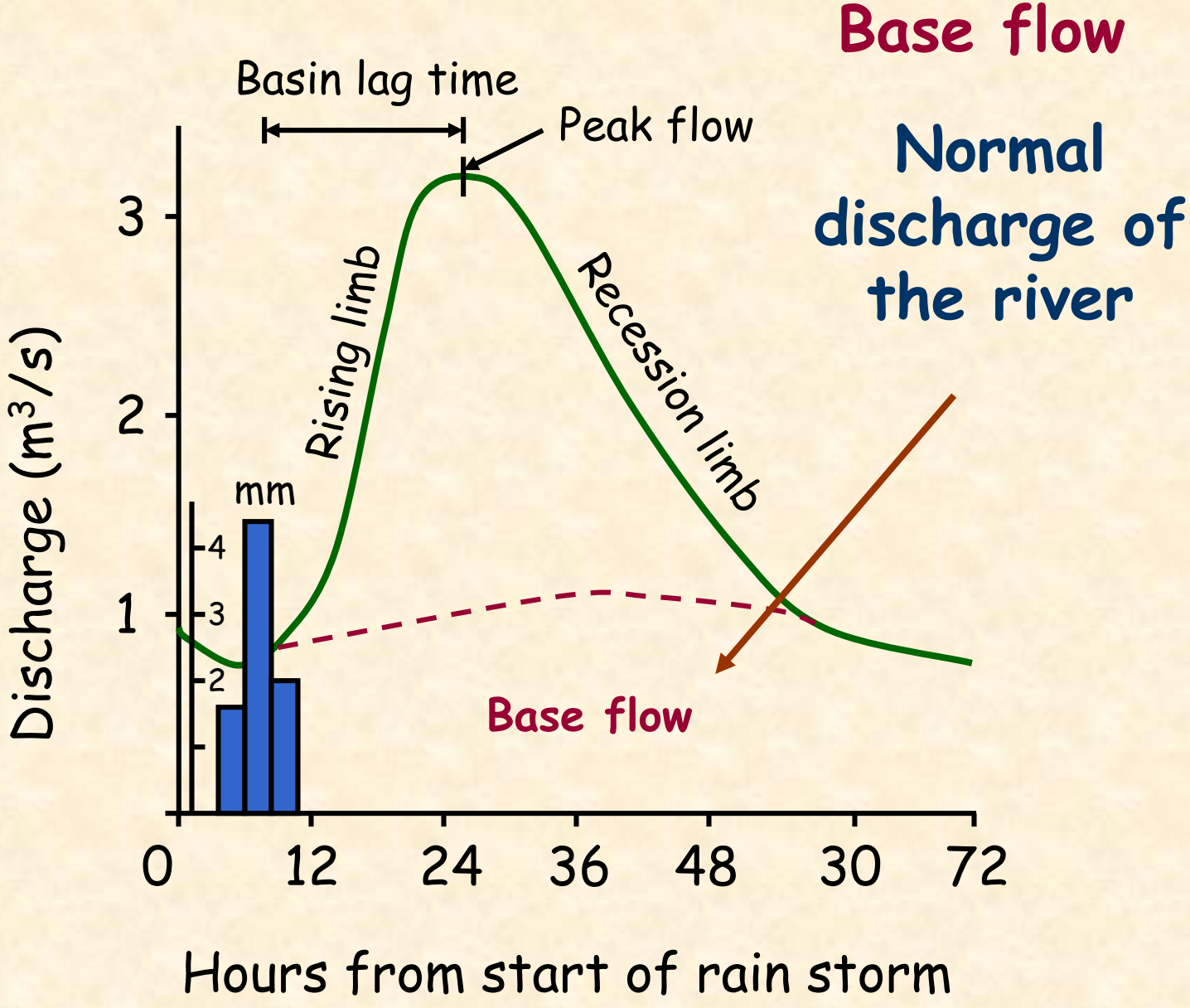
Falling flood water in the river

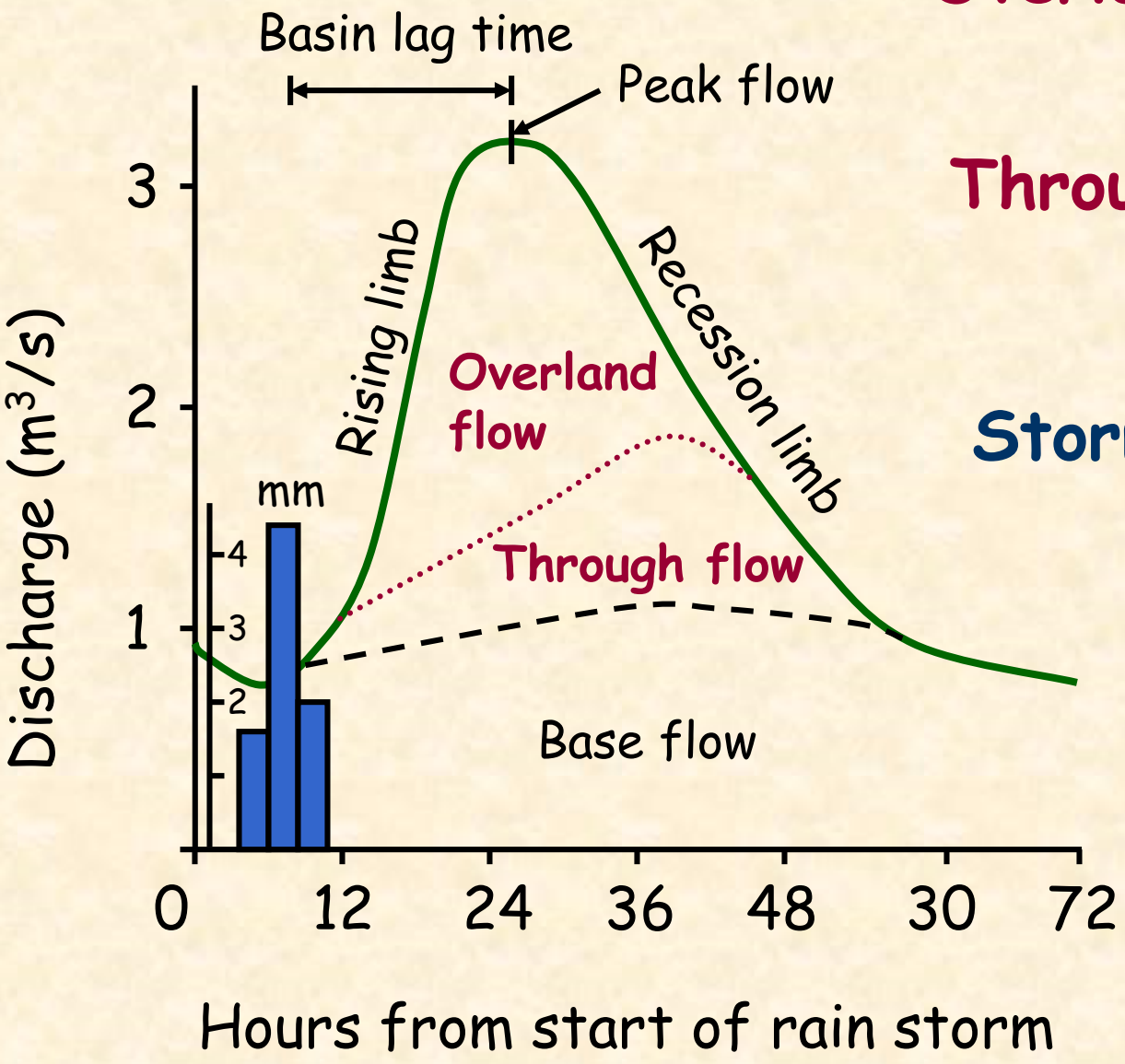


Basin lag time



Time difference between the peak of the rain storm and the peak flow of the river


Base flow
Normal discharge of the river
Basin lag time
Peak flow
Rising limb
Recession limb
mm
4
3
2
Base flow
Discharge (m³/s)
3
2
1
0
12
24
36
48
30
72
Hours from start of rain storm



Overland flow

+

Through flow

=

Storm Flow

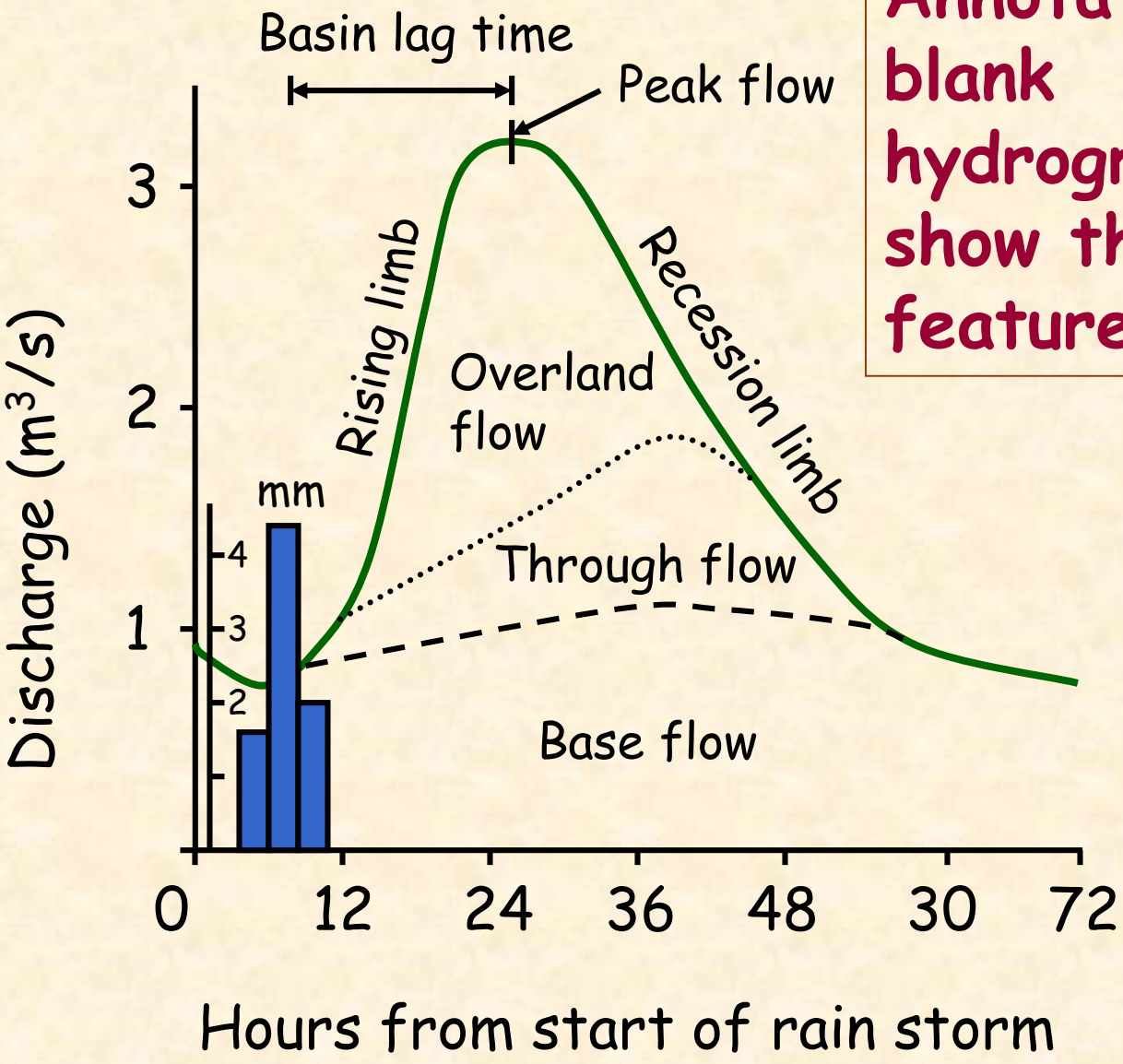
Overland flow

Volume of water reaching the river from surface run off

Through flow

Volume of water reaching the river through the soil and underlying rock layers

Annotate your blank hydrograph to show the main features

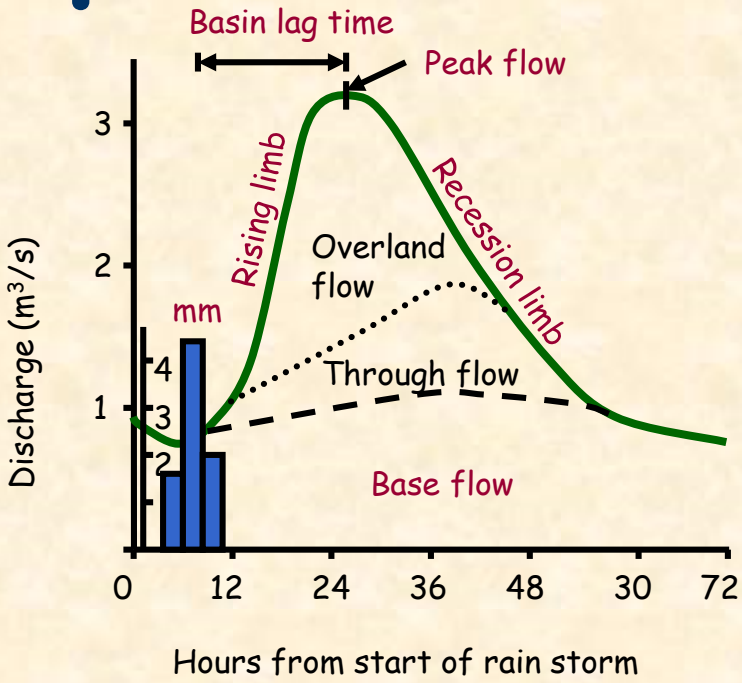


Analysis

Interpretation of Storm Hydrographs

You need to refer to:

- Rising Limb
- Recession Limb
- Lag time
- Rainfall Intensity
- Peak flow compared to Base flow
- Recovery rate, back to Base flow



Exam Question

Using your annotated hydrograph, explain the changes in the discharge of the river over the period of time shown?

Writing Frame

- Say what the discharge is like to start with (give amount). Explain why.
- Say that the river is supplied by baseflow at this point. Explain this.
- Say when the rainfall starts and when it peaks (what is the peak amount?).
- What happens to discharge as a result (comment on the rising limb)?
- When is the river supplied by throughflow and overland flow? Why do these processes happen?
- When does the discharge peak and what is the amount?
- What is the lag time? (difference in hours between peak rainfall and peak discharge). Explain the time delay.
- When does the discharge start to fall? (comment on the recession limb). Why has it decreased?
- At what time does the discharge return to its original base flow level?

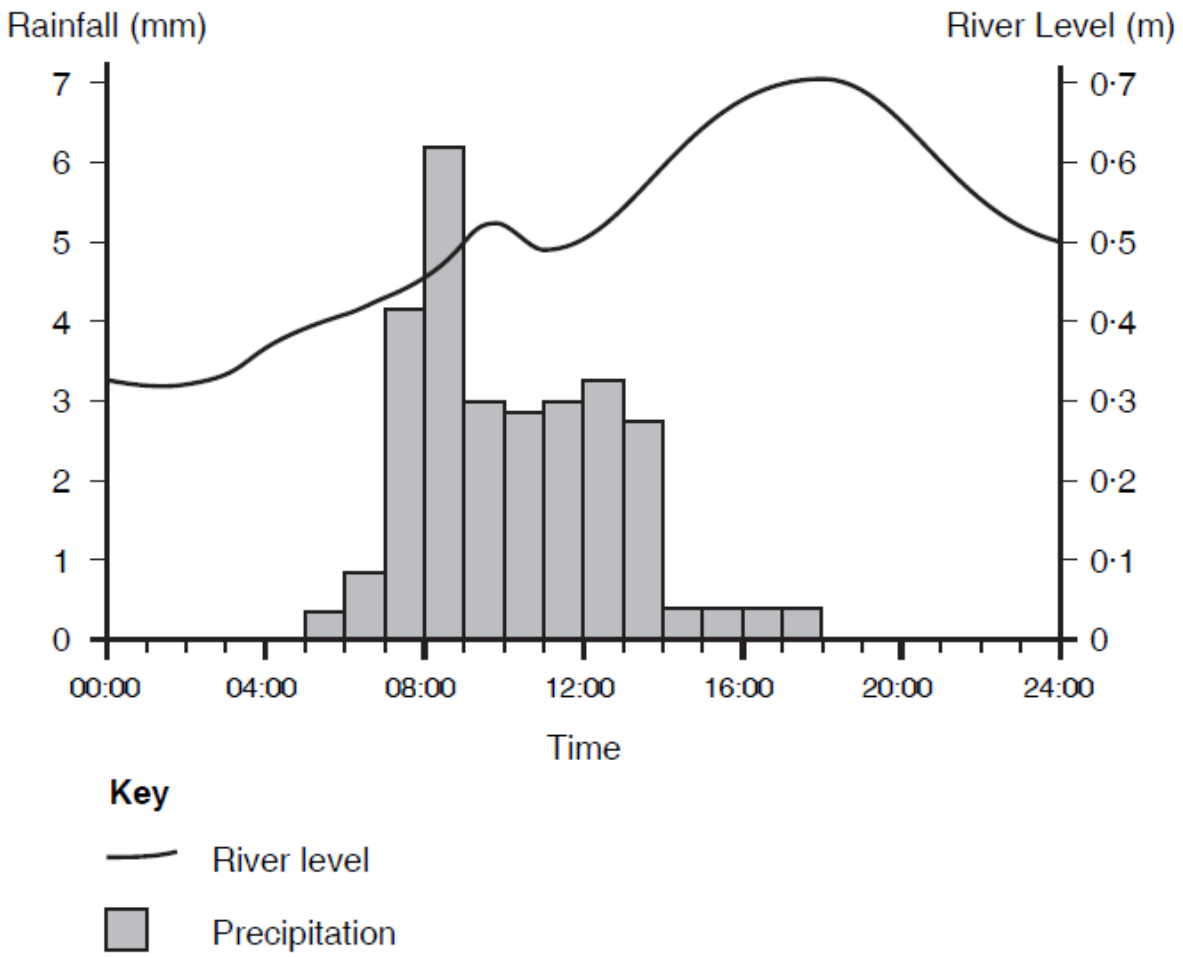
A Model Answer!!!!

To begin with the river discharge is relatively low, below1m_3/s. This is caused by the lack of rainfall in the drainage basin. The main source of water in the river at this point is that supplied by base flow which means that water is filtering into the river as groundwater flow. After 6 hours there is heavy rainfall in the drainage basin, reaching a maximum (peak rainfall) of 4.25 mm 2 hours later. This rainfall causes a corresponding increase in discharge levels, as shown by the steep rising limb. As discharge levels rise above 1m_3/s the water in the river is supplied by throughflow as the groundwater is already saturated. As levels rise further (from 1.25 to 3m_3/s) overland flow becomes the main source of water transfer to the river as no further water can soak into the soil. The peak discharge is 3.25m_3/s and occurs 24 hours after the start of the rainfall event. The basin lag therefore is 16 hours. The time delay is caused by the time taken for water to infiltrate the soil and percolate into the groundwater. As rainfall decreases the discharge of the river falls, noted by the recession limb. Overland flow stops and 48 hours after the storm, the river is supplied by water throughflow and baseflow. After 60 hours throughflow also stops, returning discharge levels to normal (below 1m_3/s) and supply of water comes only from baseflow.

Your turn!

(*b*) **Describe** and **explain** the changing river levels on the River Thaw at Cowbridge on 26 July 2007.

Diagram Q6B: Flood Hydrograph for the River Thaw at Cowbridge, 26 July 2007

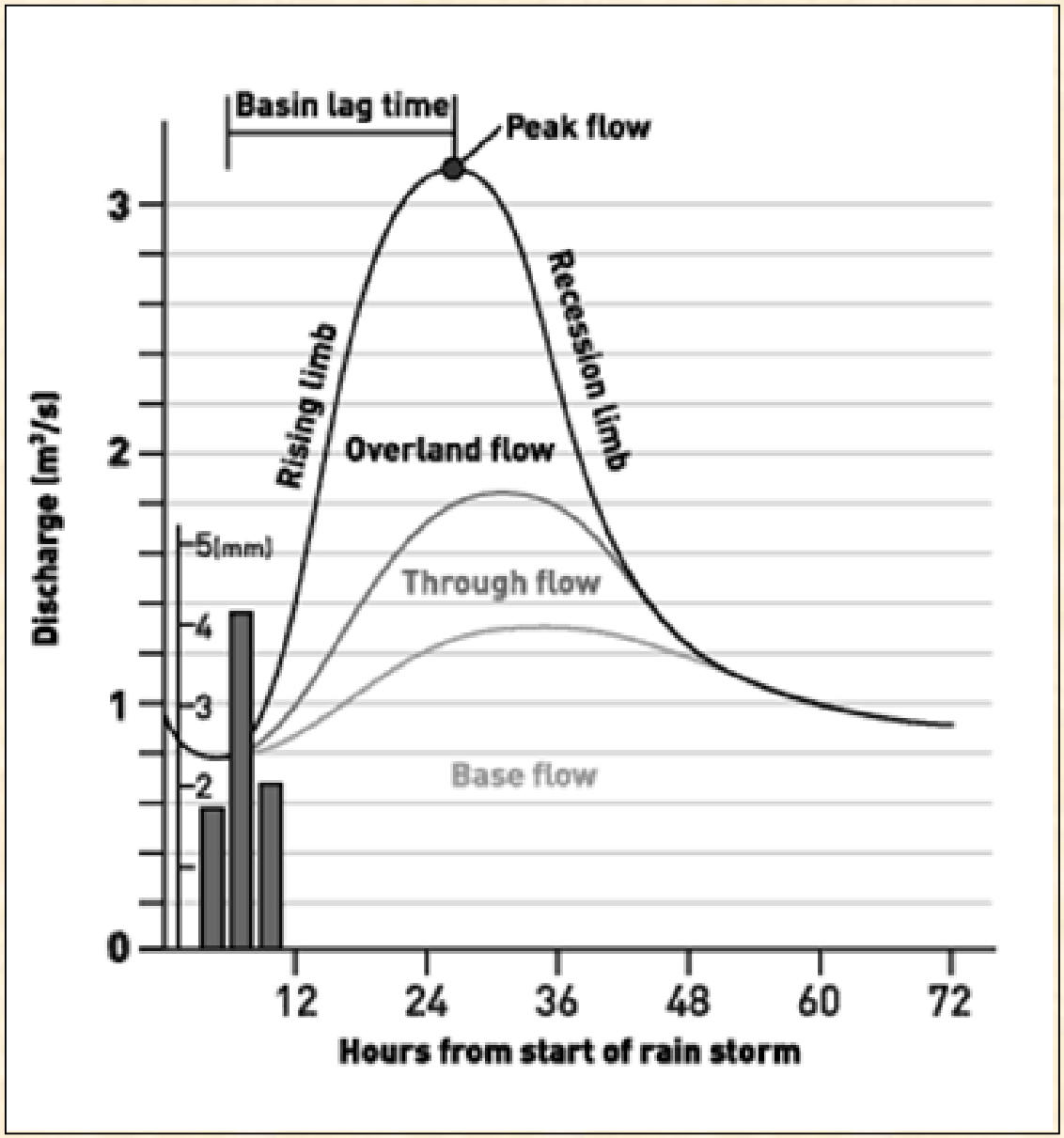


Mark scheme

Answers should identify various parts of the river level graph.

- Steady river level (under 0.4m) until 03:00 hours due to an initial lack of rain and then small amounts of rain at 05:00 hours (0.5mm) and 06:00 hours (0.8mm) infiltrate the soil (after interception by vegetation) and the river level starts to increase slowly.
- The river level continues to rise at a steady rate from 07:00 hours to 10:00 hours, due to the increase in rainfall totals and duration. The heavier rain is filling up storages in the soil because of throughflow and groundwater. The soil is now saturated, so water runs off the land and enters the river quickly leading to a potential flood situation.
- The peak rainfall occurs at 08:00 hours (6.2mm) and the peak river level occurs at 18:00 hours (0.7m). This is a basin lag time of approximately 10 hours. This could be accounted for by vegetation cover, or by reference to geology or soil infiltration rates.
- From 14:00 hours to the end of the graph the rainfall declines and stops at 18:00 hours. The recession limb falls back towards base level as the supply of water is reduced.

Another example



Describe and *account for* the changes in discharge levels of the river over the time period shown.

Factors Affecting The Shape of Flood Hydrographs (collect spider diagram)

Area

- Large basins receive more precipitation than small therefore have larger runoff

- Larger size means longer lag time as water has a longer distance to travel to reach the trunk river

Area	Rock Type	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Shape

- Elongated basin will produce a lower peak flow and longer lag time than a circular one of the same size

Area	Rock Type	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Slope

- Channel flow can be faster down a steep slope therefore steeper rising limb and shorter lag time

Area	Rock Type	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Rock Type

- Permeable rocks mean rapid infiltration and little overland flow therefore shallow rising limb

Area	**Rock Type**	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Soil

- Infiltration is generally greater on thick soil, although less porous soils eg. clay act as impermeable layers

- The more infiltration occurs the longer the lag time and shallower the rising limb

Area	Rock Type	Drainage Density
Shape	**Soil**	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Land Use

- Urbanisation - concrete and tarmac form impermeable surfaces, creating a steep rising limb and shortening the time lag

- Afforestation - intercepts the precipitation, creating a shallow rising limb and lengthening the time lag

Area	Rock Type	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Drainage Density

- A higher density will allow rapid overland flow

Area	Rock Type	**Drainage Density**
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Precipitation & Temperature

- Short intense rainstorms can produce rapid overland flow and steep rising limb
- If there have been extreme temperatures, the ground can be hard (either baked or frozen) causing rapid surface run off
- Snow on the ground can act as a store producing a long lag time and shallow rising limb. Once a thaw sets in the rising limb will become steep

Area	Rock Type	Drainage Density
Shape	Soil	Precipitation / Temp
Slope	Land Use	Tidal Conditions

Remember these influencing factors will:

- Influence each other
- Change throughout the rivers course

Task:

Glue the spider diagram of factors affecting hydrographs into your folder, then use it to complete the questions below:

1) Explain how the following will affect the rising limb, lag time and discharge of a hydrograph:
   a) Planting trees in a drainage basin
   b) Laying concrete in a drainage basin
   c) a drainage basin consisting of permeable rocks
   d) a drainage basin containing impermeable rocks.
2) Glue in the diagrams of the drainage basins and respective hydrographs for Drainage Basins A and B (Fig 17.6). Now **DESCRIBE** and **EXPLAIN** the **differences** between them (Fig 17.7 in Blue Wider World will help you).

Check Your answers

Drainage basin A has a steeper rising limb than Basin B. This is because it has more streams in it, therefore water is collected quickly and transferred into the main river much faster than basin B which has a lower density of streams. Basin A also has steep slopes, whereas B ‘s slopes are more gentle. This speeds up the run-off time in A, giving a steeper rising limb and shorter lag time (23 hours) than B (51 hours). Basin B contains forest which means more Interception and therefore a delay in water reaching the river, hence the longer lag time. This also explains the lower discharge of the river, as there is more potential for water storage.
The soil in A is very thin, which results in less infiltration than B which has deeper soil. This is another reason why the rising limb is steeper and lag time shorter in A where water transfer is more likely to be by run-off. Also, the impermeable rock in Basin A prevents percolation of water down through the soil and rocks, so again increases speed of water transfer to the River, compared to B which has permeable rocks.

Example exam question

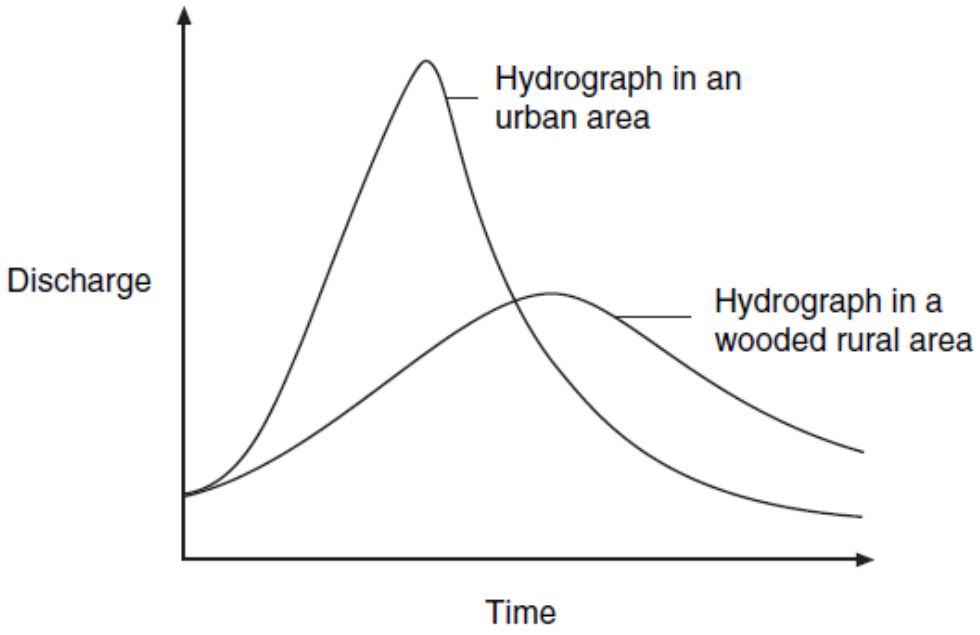
Question 6: Hydrosphere

(*a*) With the aid of a diagram explain the global hydrological cycle.

(*b*) Study Reference Diagram Q6.

Explain the **differences** in discharge between the urban and rural hydrographs shown in the diagram following a heavy rain storm.

Reference Diagram Q6 (Flood hydrographs)



Mark scheme

Question 6 – Hydrosphere

(a) Diagrams should include the key processes within the global hydrological cycle:

- Precipitation.
- Evaporation/Transpiration.
- Condensation.
- Infiltration/Run-off/Melting.
- Storage ie ice, ground water, ocean.

No diagram = no full marks

(b)

Differences could include:

Interception

- Rural – there is a longer 'lag time' between the rainfall and peak discharge in the rural hydrograph because vegetation (eg woodland) will intercept precipitation and store/absorb it thus preventing the water reaching the soil/ground water/river quickly.
- Urban – concrete/tarmac/buildings will channel precipitation to gutter/drains and straight into the sewer/river system with a correspondingly shorter 'lag time'.

Surface run-off

- The rising limb is much steeper in the urban hydrograph because natural water courses will overflow and drain into marshy areas/fields on the flood plains in times of flood whereas urban water courses will be lined and embanked to contain and speed up the flow of water.

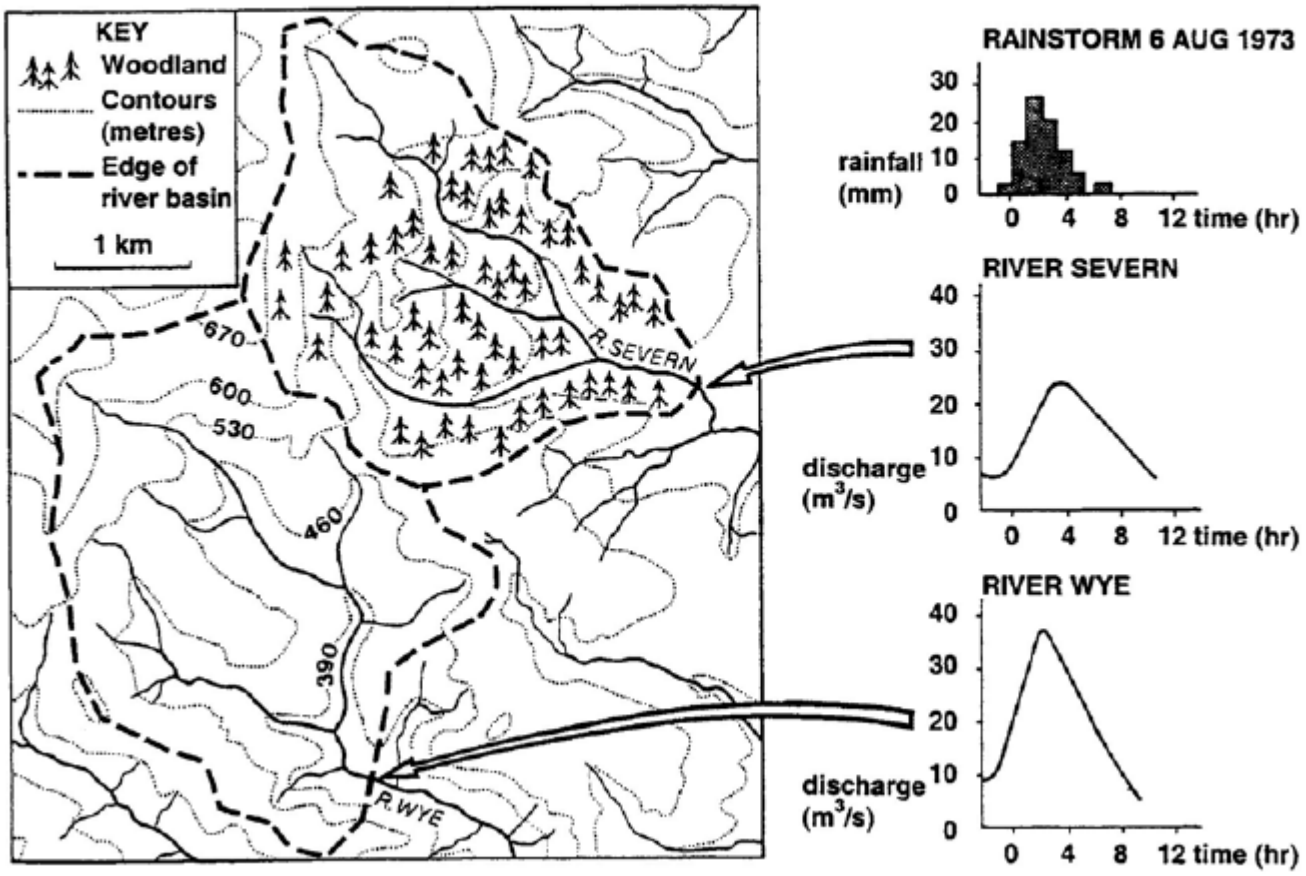
Storage

- The falling limb on the urban hydrograph is much steeper due to the lack of infiltration/percolation/underground storage of water. In rural areas water will continue to flow into the river many hours after the rainstorm through underground and through flow via the soil and rocks. The return of the river to the base flow will therefore be much slower with a more gentle falling limb.

(a) Study Diagram A – Hydrographs of the Rivers Severn and Wye.

Describe **and** explain the hydrographs for the River Severn and the River Wye after the storm of 6 August 1973.

Diagram A – Hydrographs of the Rivers Severn and Wye



Mark Scheme

The discharge in both rivers reaches a peak between three and four hours after the beginning of the storm.

The River Severn has a smaller maximum discharge and peaks slightly later than the River Wye due to the forest cover slowing down the infiltration rates and intercepting the rain as it falls. After peaking the discharge falls more gradually, due to slower release of water into the river.

The River Wye has a greater maximum discharge and peaks more steeply and rapidly than the River Severn due to the moorland cover which allows for faster infiltration and less interception by vegetation. After reaching its peak the discharge rapidly declines.

Candidates must compare and contrast for full marks.