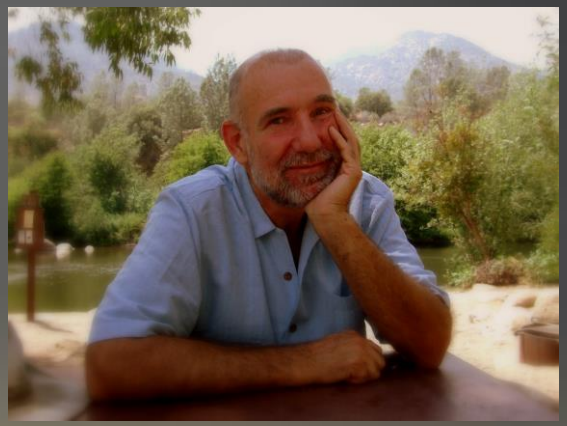
Water On and Under the ground

INTRODUCTION TO EARTH SCIENCE

LECTURE 04
Groundwater and Surface Water

Dr. Gregg Wilkerson and Jack Pierce



Water On and Under the ground

Casey at the Bat

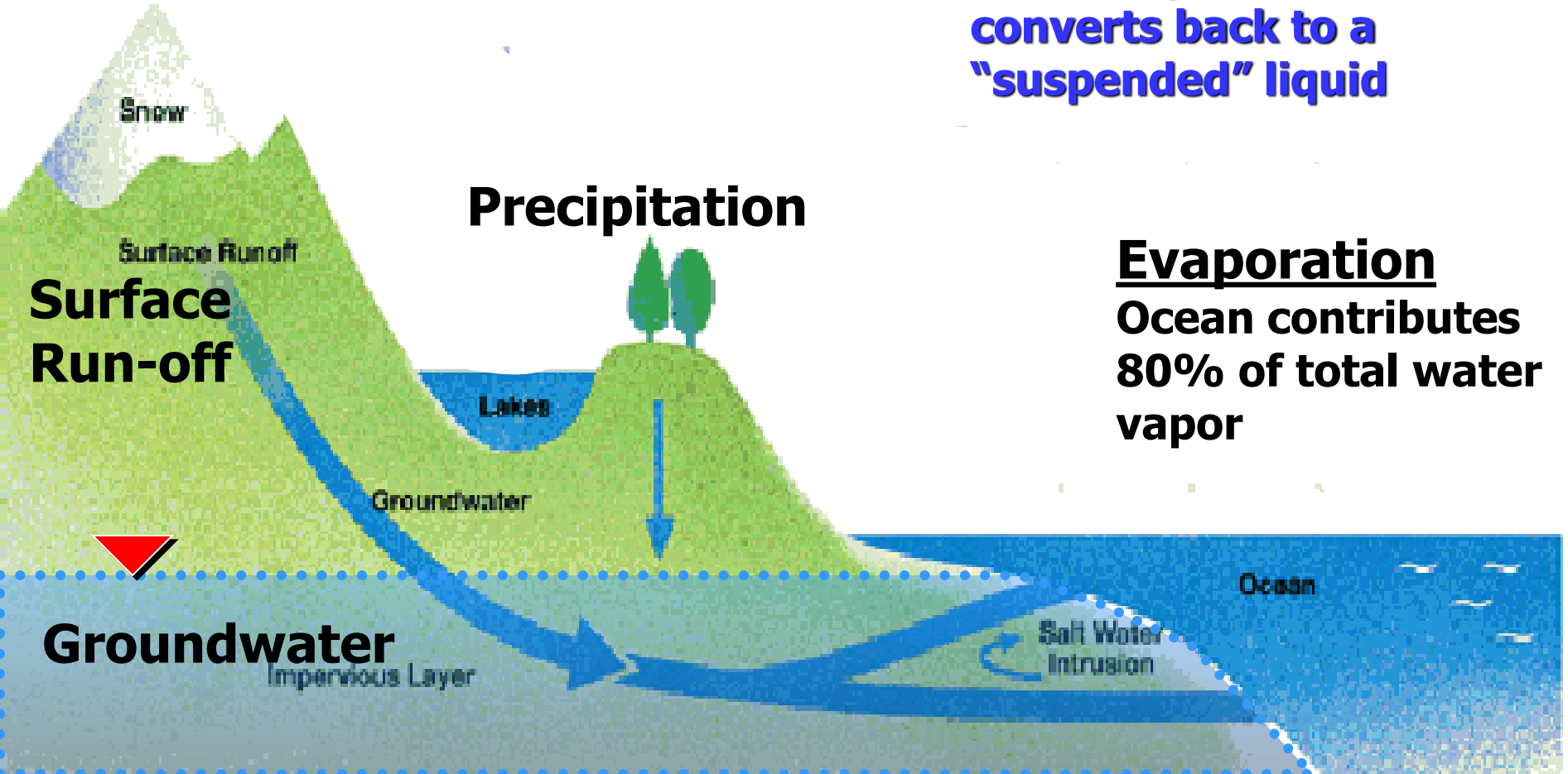
- Ernest Thayer (1863-1940)
- William Randolph Hearst: San Francisco Herald Examiner

Evaporation
liquid converts to a vapor
Condensation
vapor converts to a liquid
Precipitation
"rain"
Runoff
excess water moving into rivers, lakes
Infiltration
water "soaks" into the soil
Evapotranspiration (EvapT)
evaporation + transpiration, evaporation from water bodies and off a plants

The Hydrologic Cycle

Cloud Formation

Condensation
water vapor cools and converts back to a "suspended" liquid



Precipitation

Evaporation
Ocean contributes 80% of total water vapor

I ♥ the HYDROLOGIC CYCLE

Discuss with a friend:

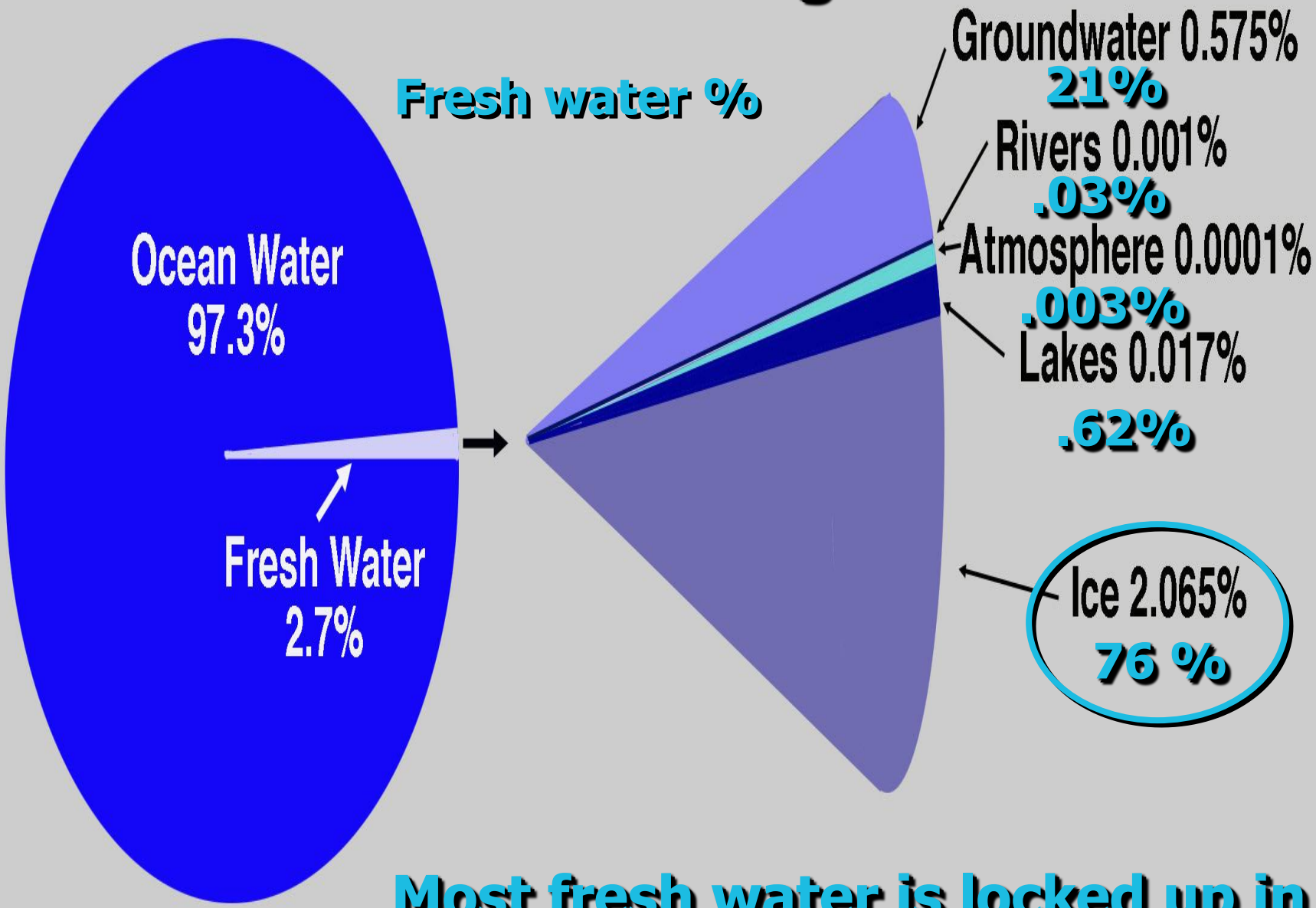
1. Draw the hydrologic cycle from memory
   Include the following:

precipitation	evaporation
condensation	infiltration
surface run-off	groundwater

2. How do each of the above terms relate to one another?

I will get an A on my exams and quizzes.

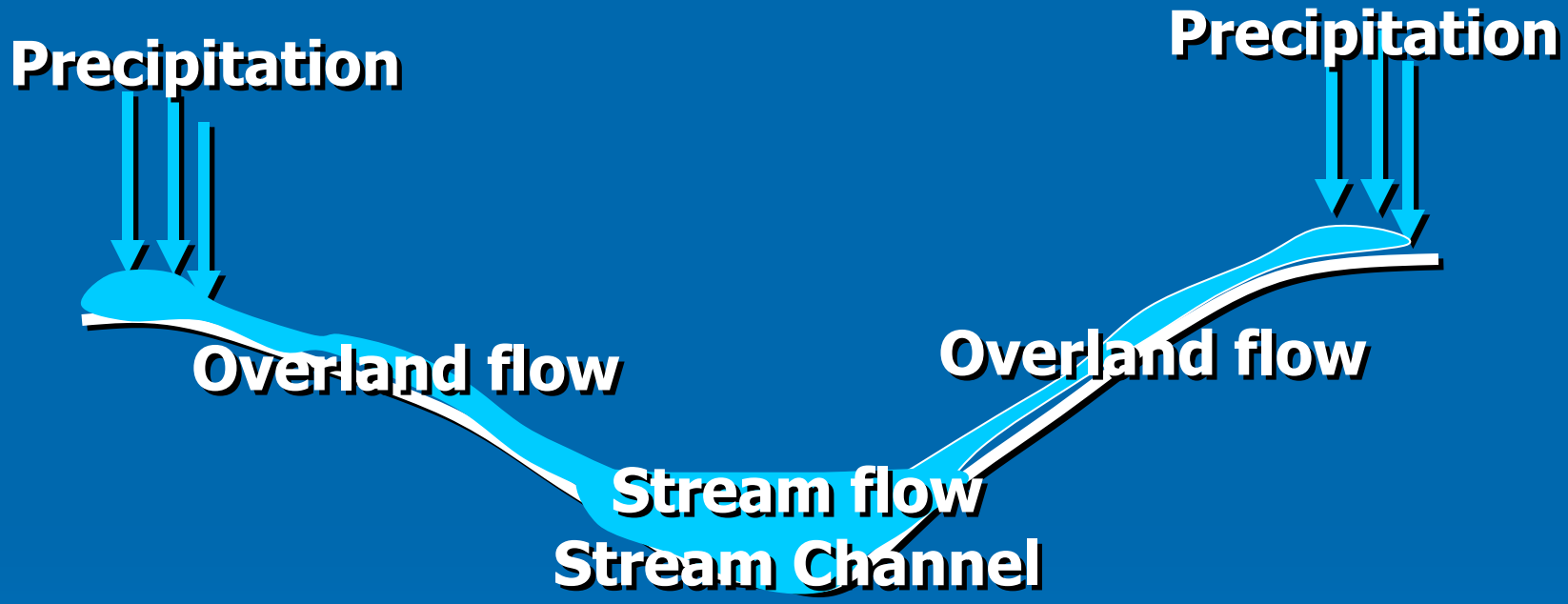
Where has all the water gone ?



Most fresh water is locked up in ice (frozen water)

How Water Affects Land

Do you believe that water runs down-hill Where does it go??????????????????????



Overland flow + Stream flow = Surface Runoff

How does surface run-off affect streams and produce various land forms?

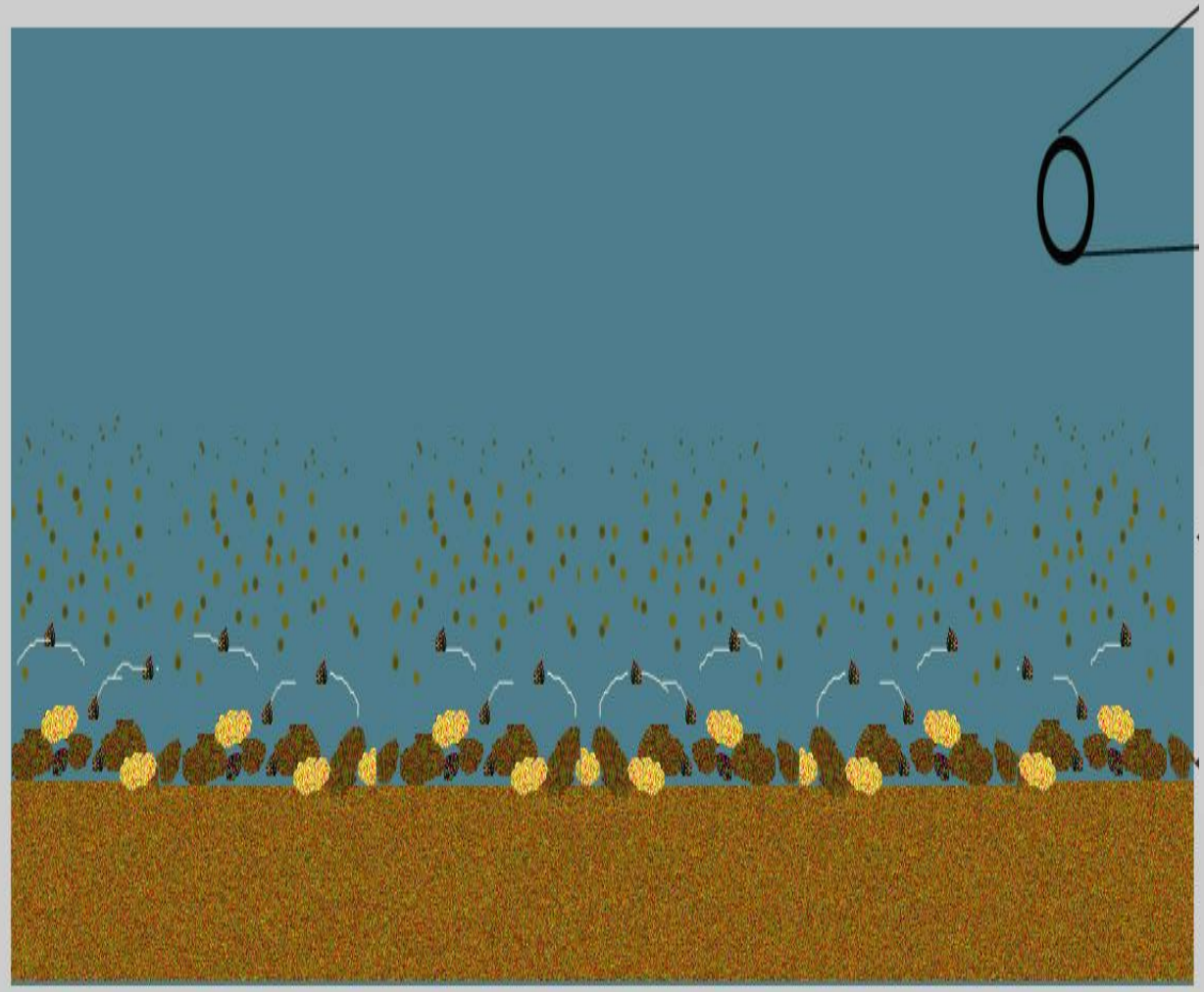
Transportation of Sediment

- **Load**
  type of sediment carried by the stream
- **Gradient**
  the steepness of a stream channel
- **Discharge**
  the volume water exiting the stream (high or low)

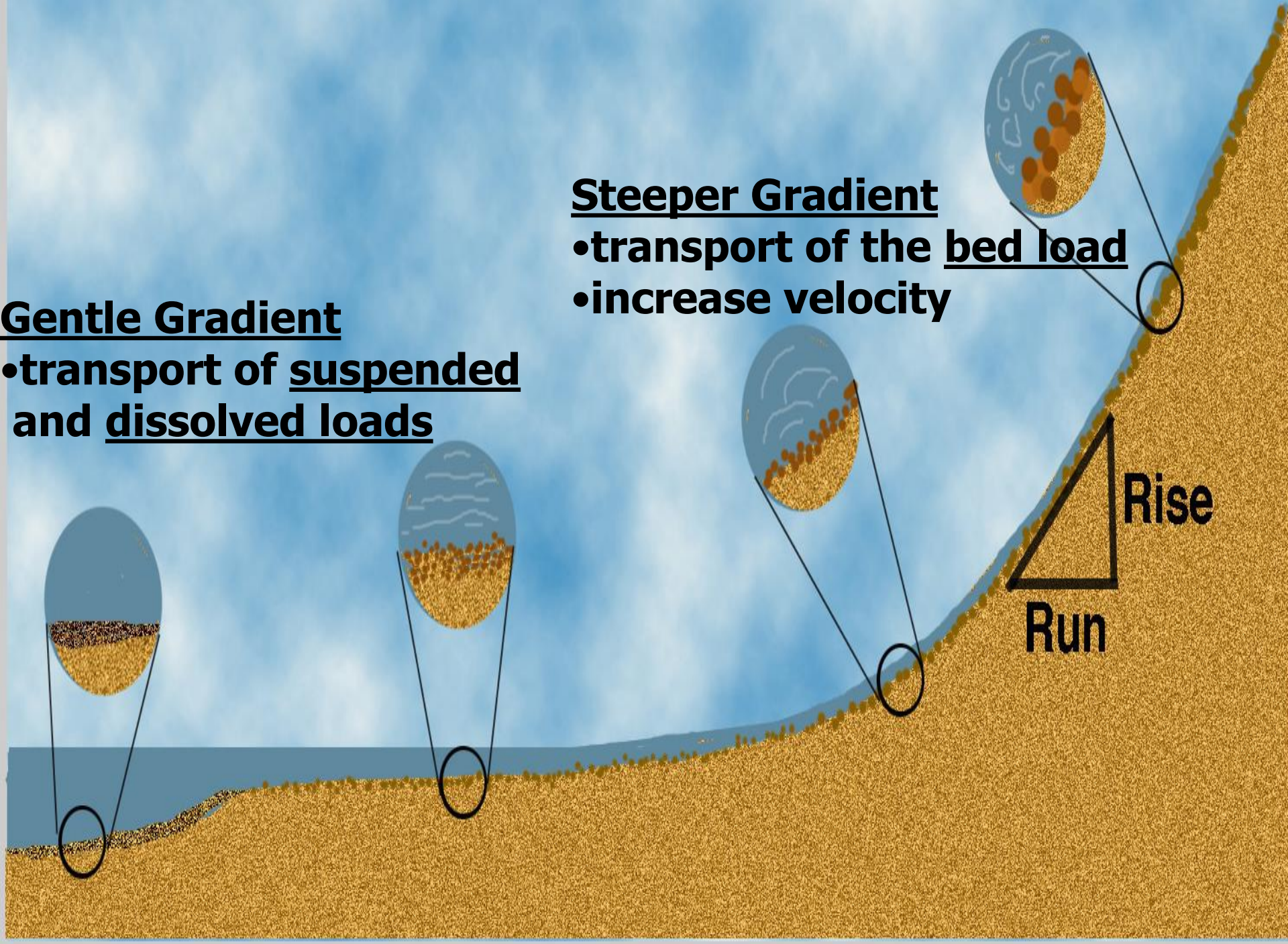
The gradient, load and discharge defines the character of the stream and stream channel.

- how the stream flows
- what land features are formed

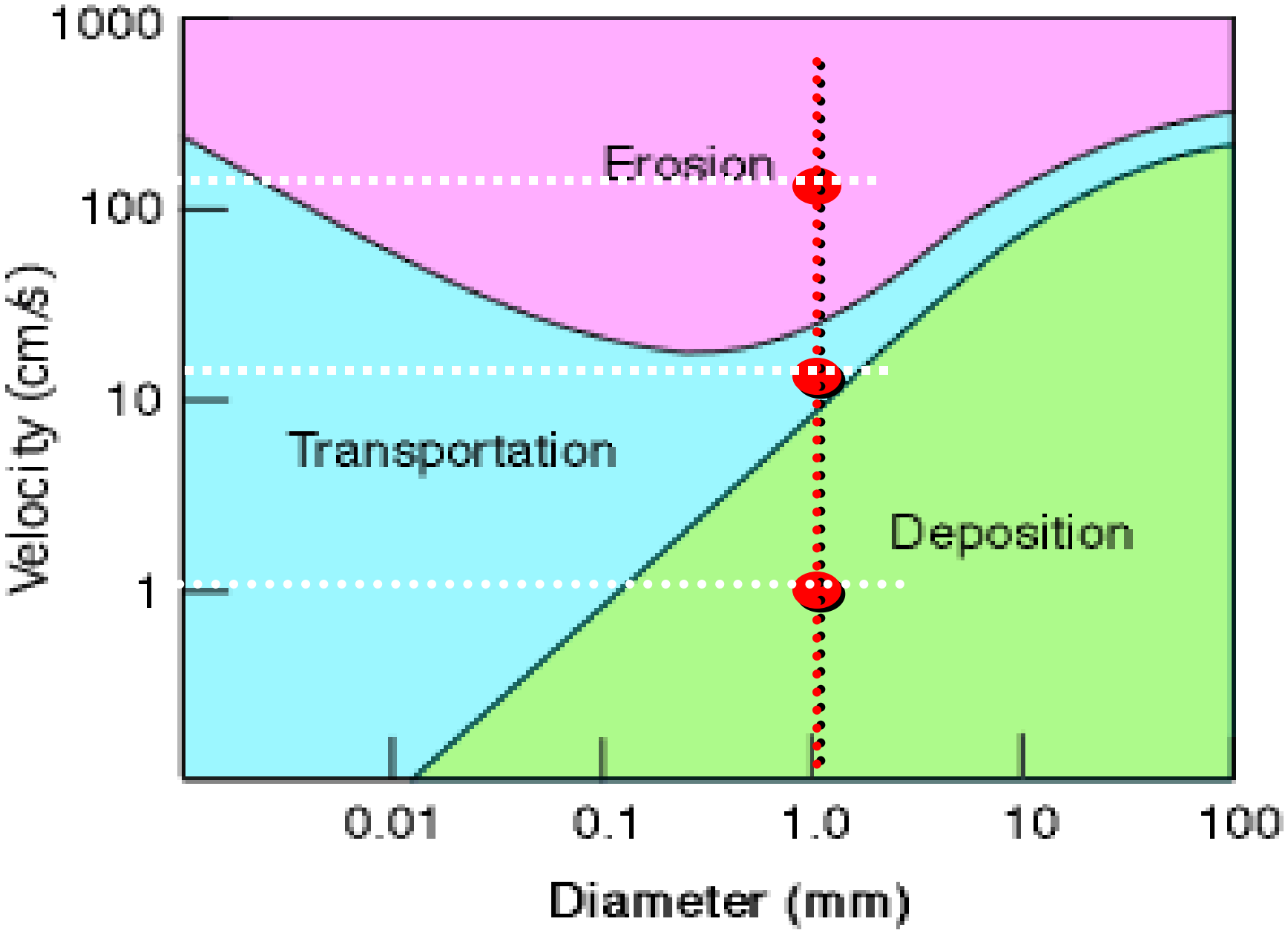
Sediment load types



How does gradient influence the transportation of various types of loads?


Steeper Gradient
•transport of the bed load
•increase velocity
Gentle Gradient
•transport of suspended and dissolved loads
Rise
Run

How much “velocity” is needed (Discharge)



Transportation of Sediment

The type and characteristics of stream can be described by its competence and capacity.

Capacity: represents the maximum load of solid particles a stream can transport

The greater the discharge, the greater capacity

Competence: streams ability to carry various sizes of sediment – not quantity

Flow velocity is the Key: a stream's competence increases proportionately to the square of its velocity.

If stream velocity doubles then, impact force is 4X greater
If stream velocity triples, then impact force is 9X greater
If stream velocity quadruples, then impact force is 16X greater

I Watching the stream

Discuss with a friend:

1. How are gradient, discharge, and load related to stream channels?
2. What are the three types of loads carried by streams?
3. Define the differences between capacity and competence of a stream.

I will get an A on my exams and quizzes.

Steep Gradient

- increase velocity
- increase load
- increase discharge

Capacity?
Moves large amounts of material – high volume

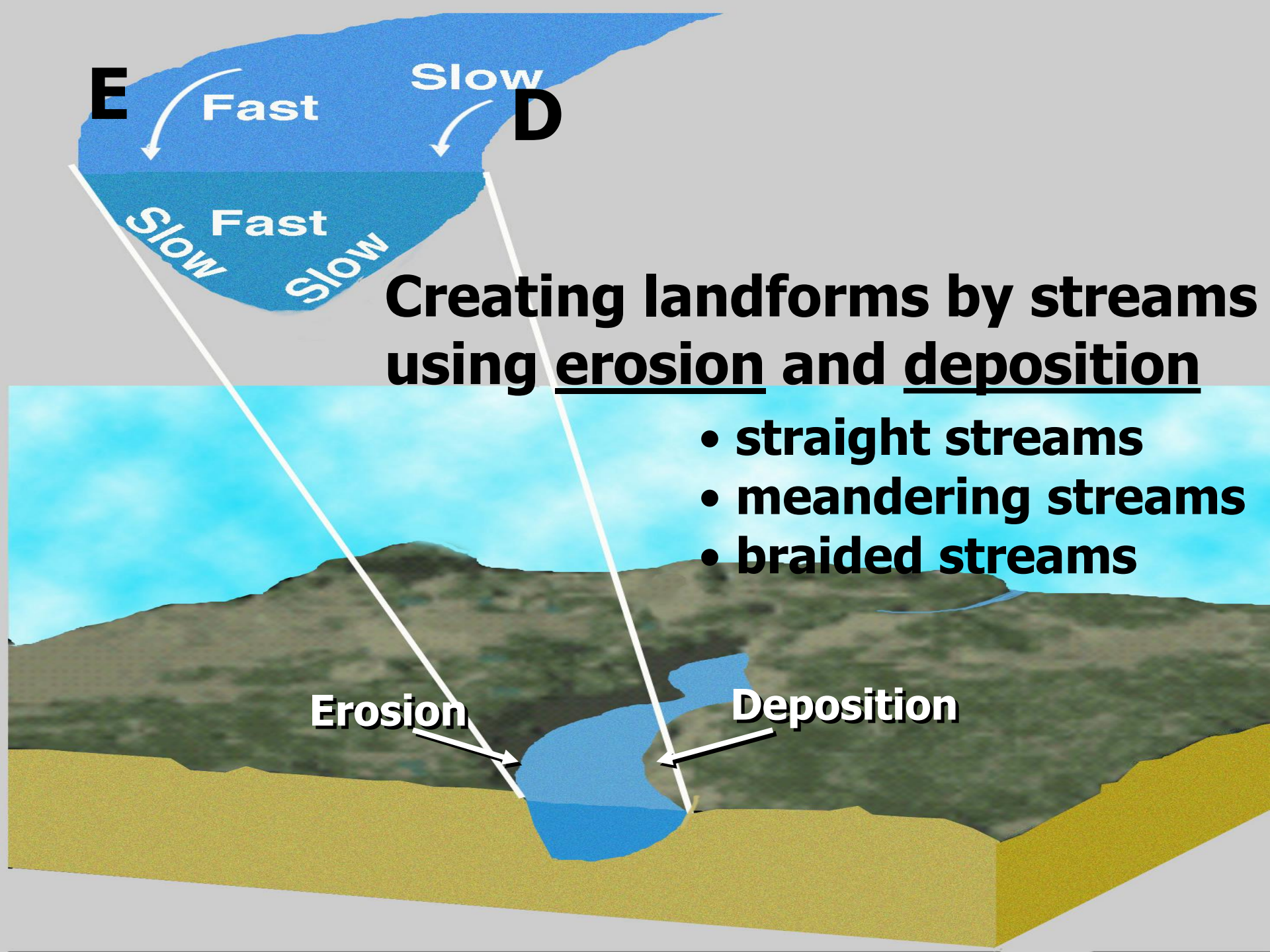
Competence?
Moves "big-stuff" and high impact force – bed load material

Gentle Gradient

- decrease velocity
- decrease load
- decrease discharge

Capacity?
Moves small amounts of material –low volume

Competence ?
Moves small material – suspended/dissolved loads


E
Fast
Slow
D
Slow
Fast
Slow
Creating landforms by streams using erosion and deposition
• straight streams
• meandering streams
• braided streams
Erosion
Deposition

Straight Stream channel

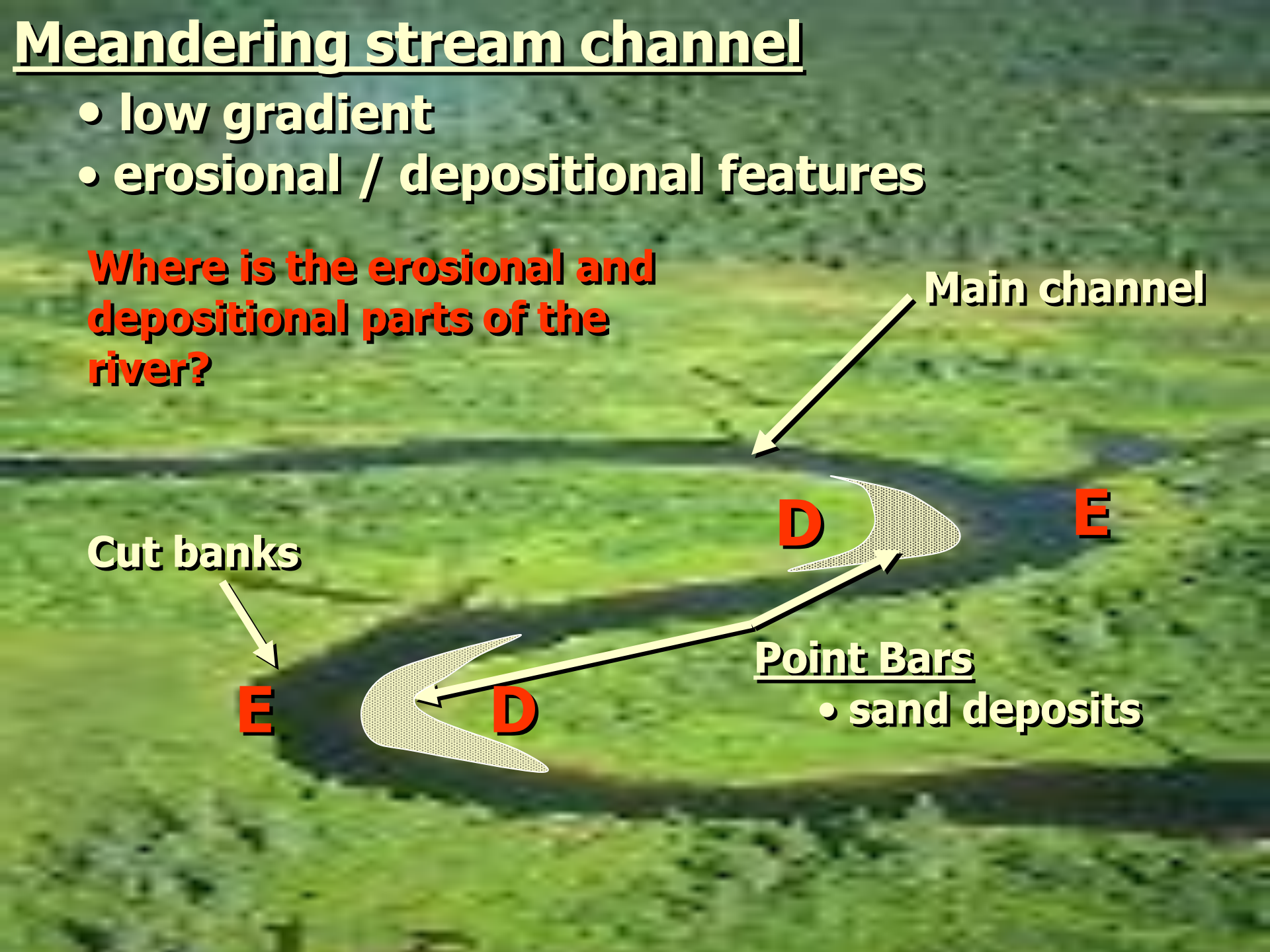
- usually occurs over a short distance
- high gradient (near headwaters)
- takes on the classic "V" shape profile

"V" shaped valley
young stream

Meandering stream channel

- low gradient
- erosional / depositional features

Where is the erosional and depositional parts of the river?



Braided Stream channel

- very low gradient
- large load (lots of sediment) – causing the stream to "move" around the sediment and becoming "choked"

I ❤ watching the stream

Discuss with a friend:

1. List at least 2-characteristics that define a straight, meandering and braided stream channel system.

Characteristics such as:

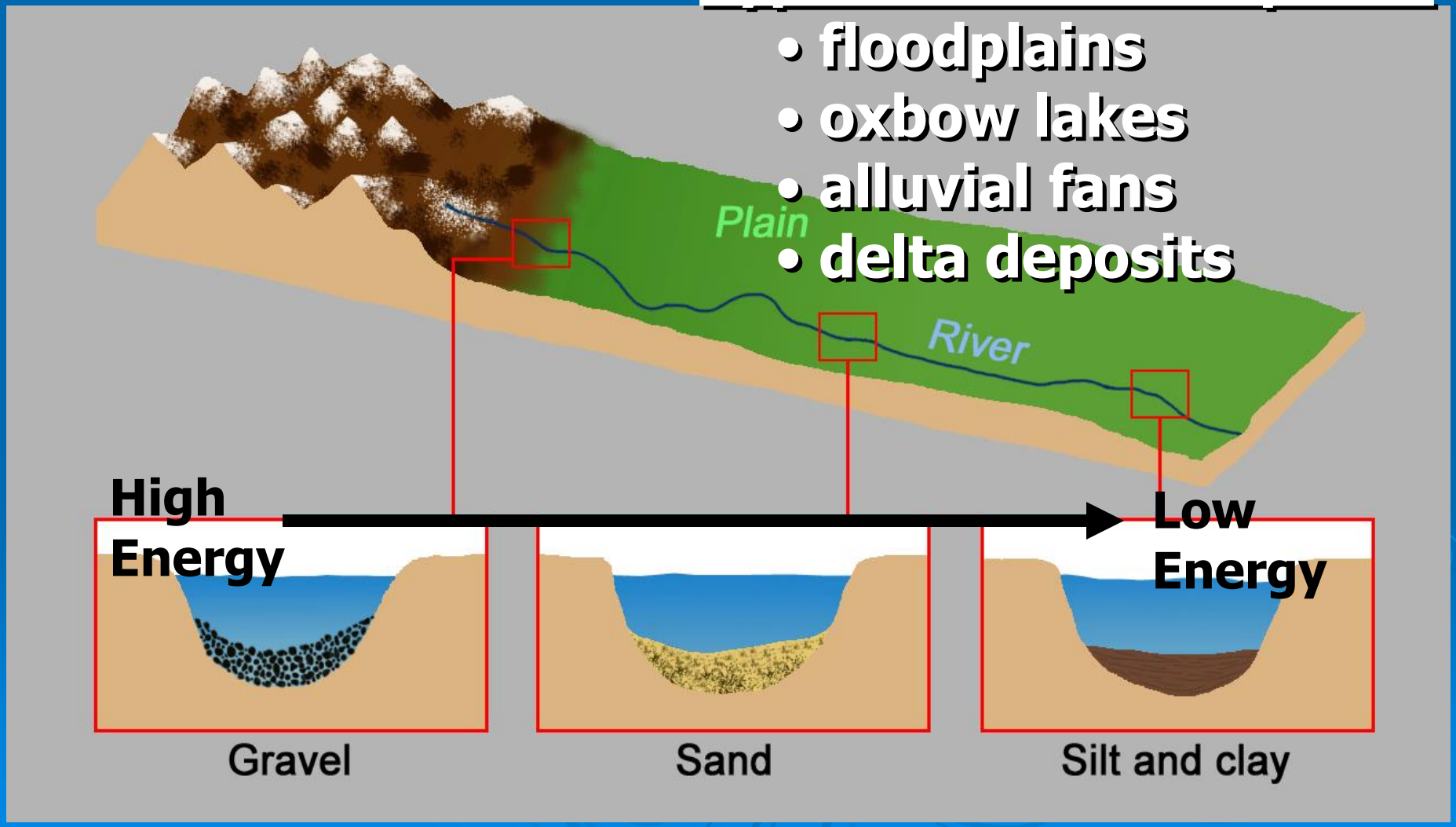
load capacity, gradient and discharge

I will get an A on my exams and quizzes.

Stream deposits – what happens to the sediment when the stream looses energy – or decreases "gradient"

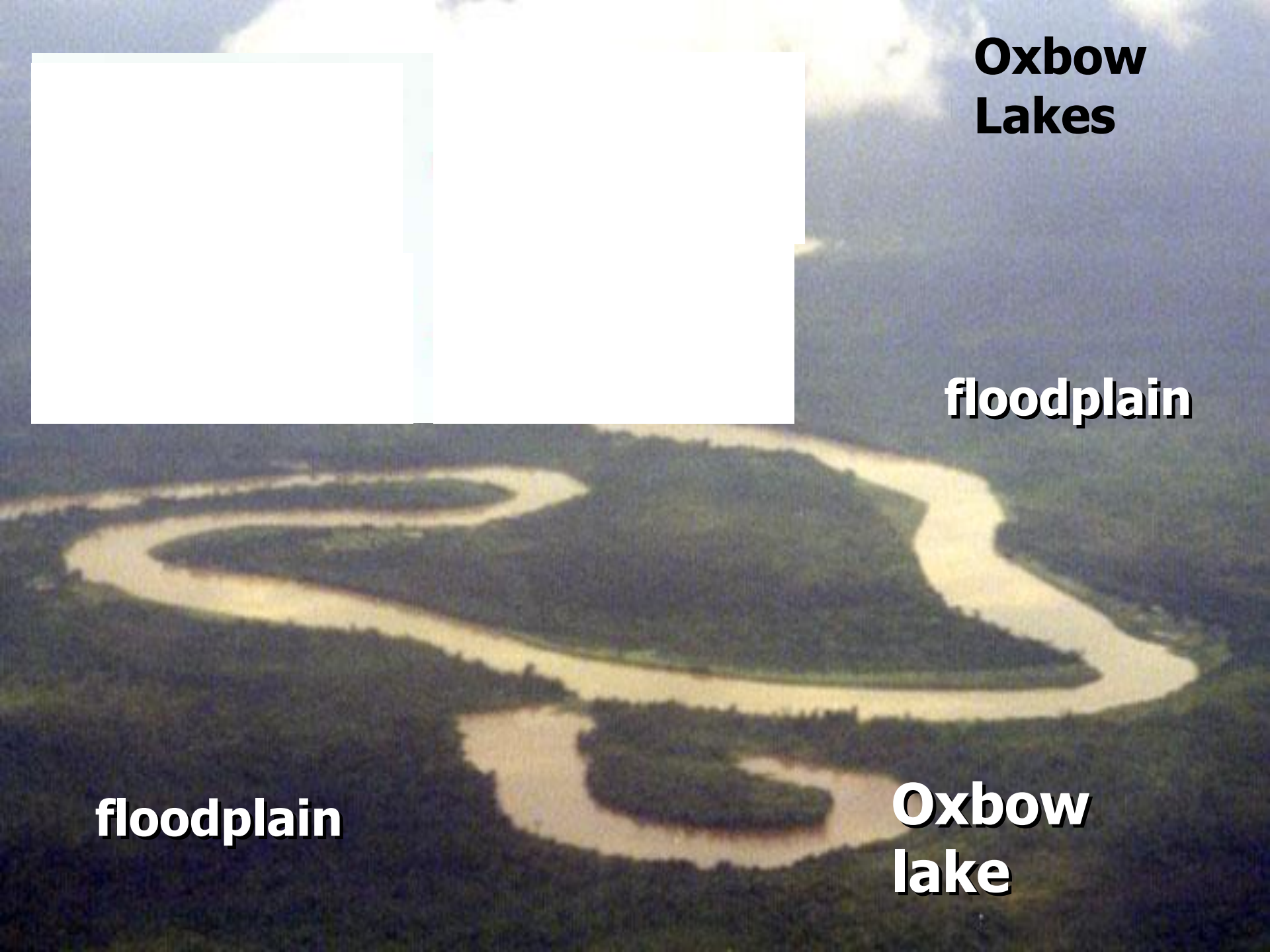
Types of stream deposits

- floodplains
- oxbow lakes
- alluvial fans
- delta deposits



Floodplain

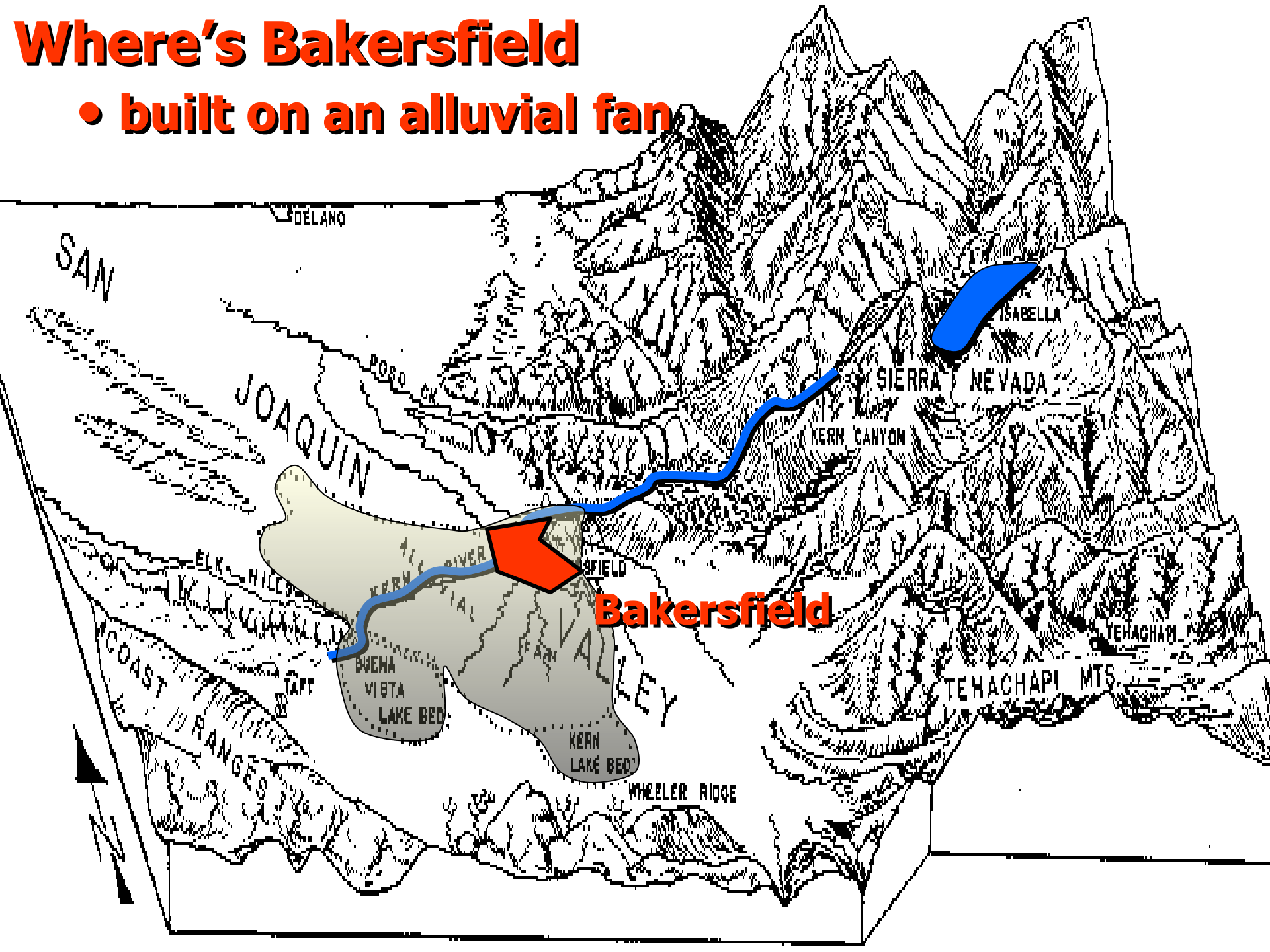
- "flat" area adjacent to a river which is invaded by high river discharge (flooding)


Oxbow Lakes
floodplain
floodplain
Oxbow lake

Alluvial Fans – fan shaped sediment deposit
Steep gradient carrying large sediment load enters an area that is flat

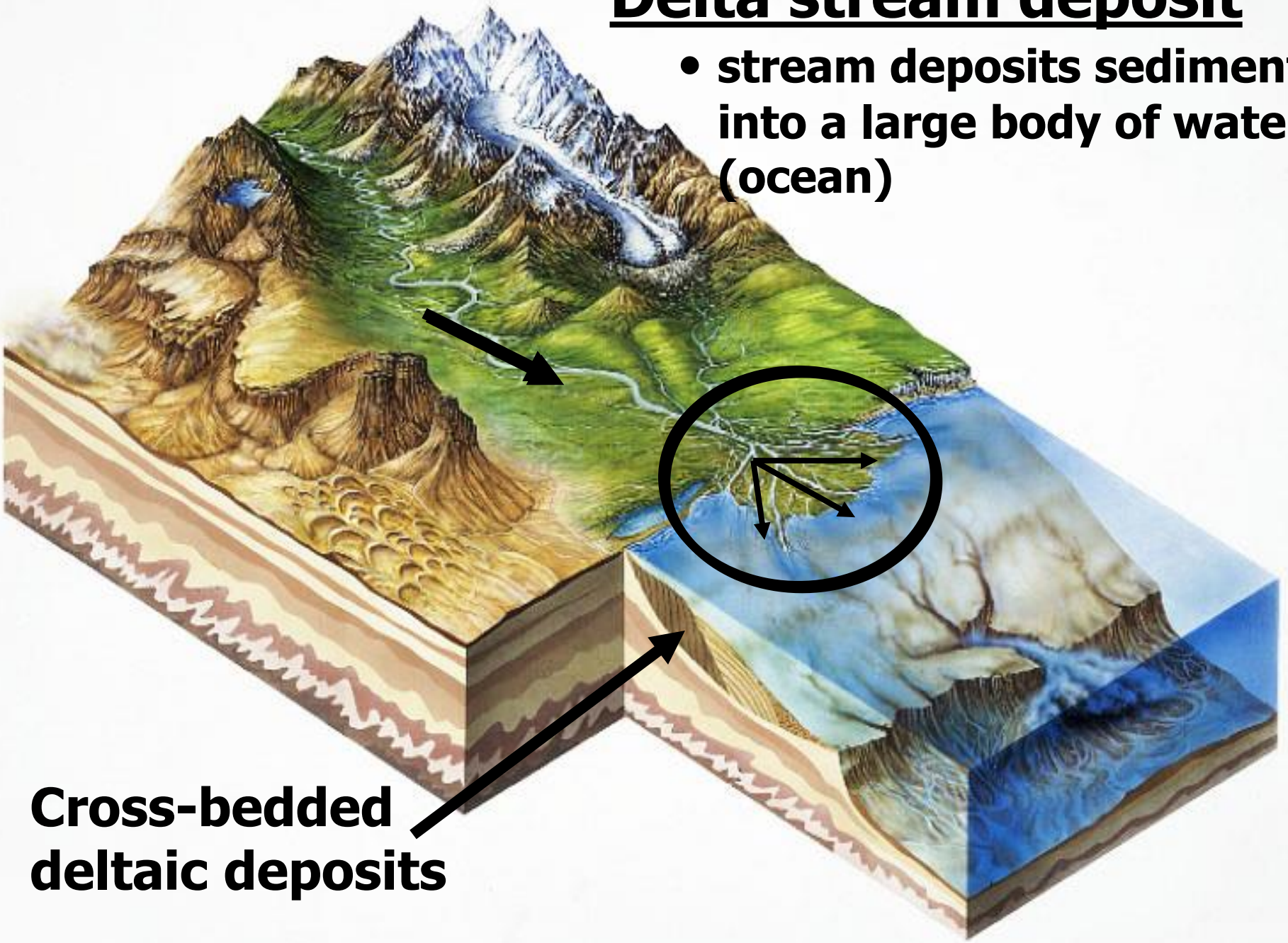
Where's Bakersfield

- built on an alluvial fan.



Delta stream deposit

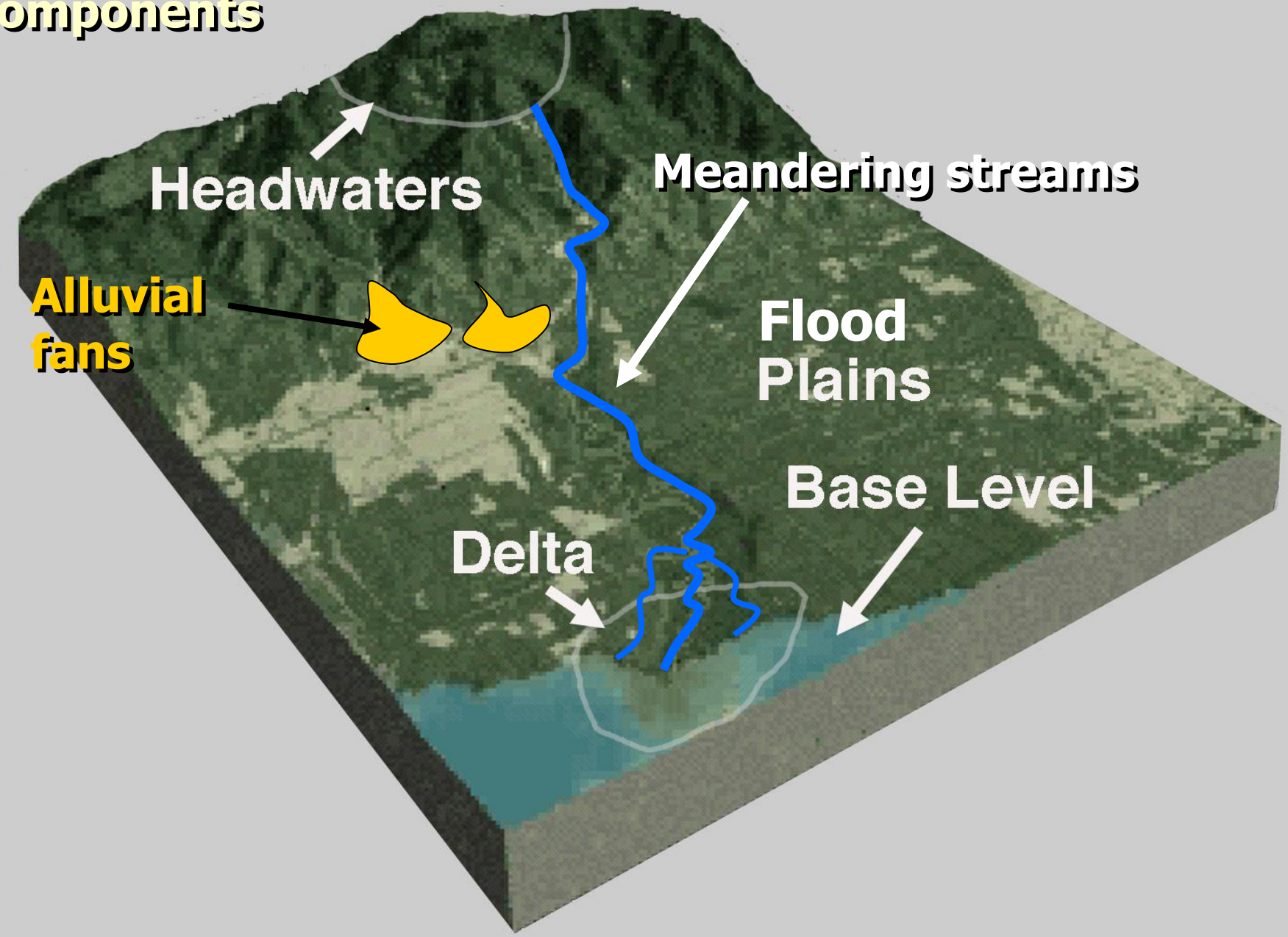
- stream deposits sediment into a large body of water (ocean)



Cross-bedded deltaic deposits

Nile River in Egypt
• deposits sediment into the Mediterranean sea
• Delta means in Greek

Typical stream channel components



I ♥ Watching the stream deposits

1. Define the four types of stream deposits
2. Give at least 2 characteristics of each stream deposit type
3. Describe how an oxbow lake forms

Discuss with a friend

I will get an A on my exams and quizzes

STAR TREK MOMENT

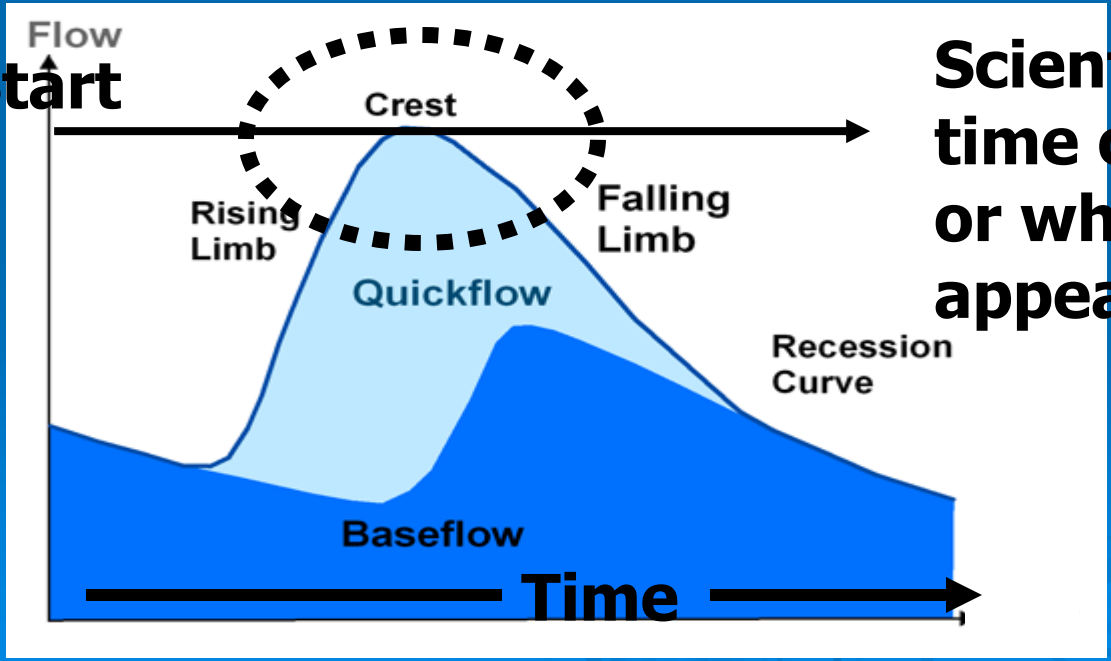
- Familiarity and Death
- Data and Riker
- When a Lieutenant Marsha Aster dies unexpectedly, and tragically on a routine archaeological Away Mission, Data is perplexed by crew behavior. He observes that they ask themselves, and him, how well they knew the deceased and her orphan child….
- WATCH IT

Surface Water as a hazard

Floods

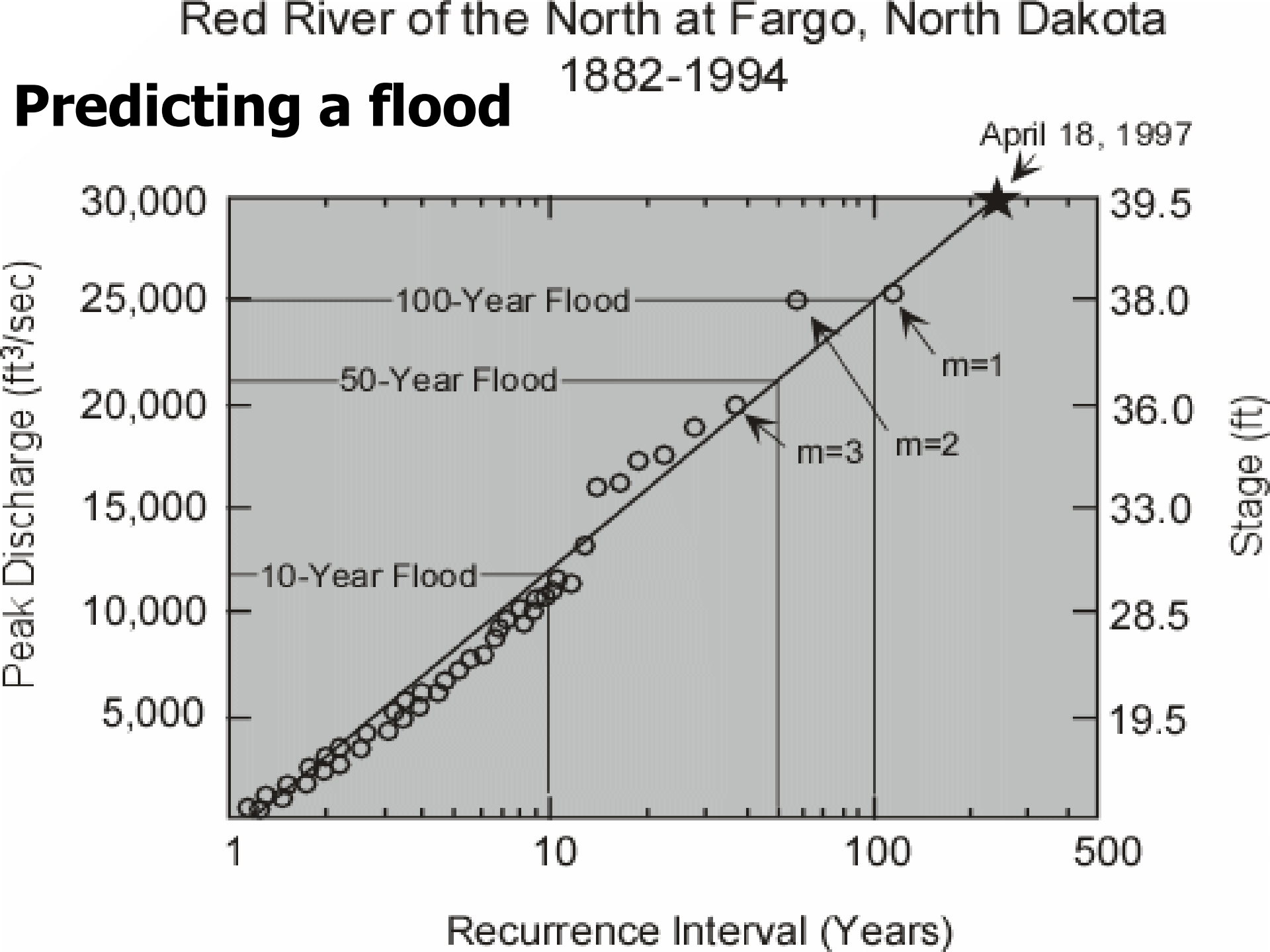
- Floods are NORMAL – only when people live in the area they become a hazard
- Floods can be predicted using a hydrograph

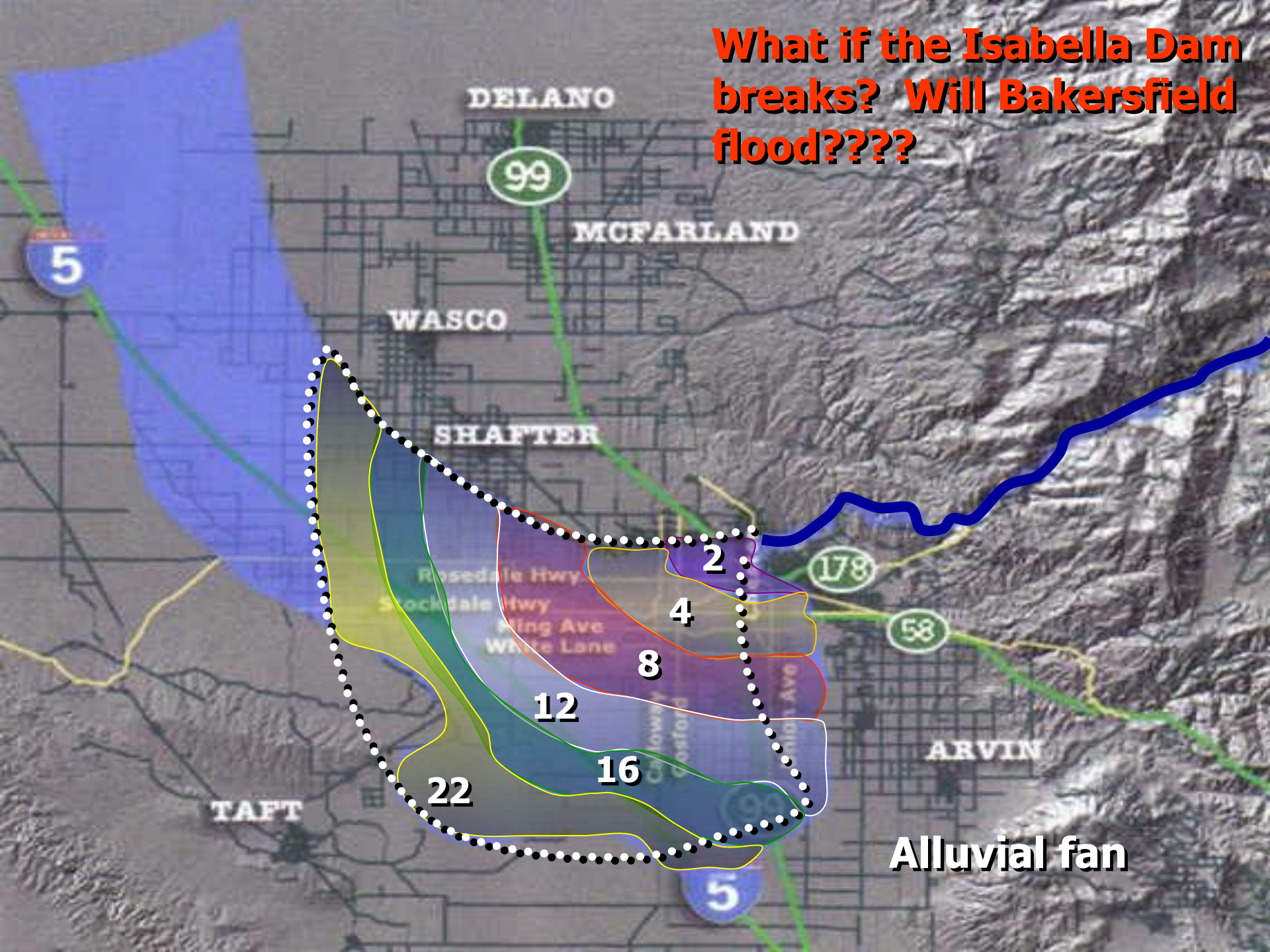
–



Scientists can predict the time of the water surge or when the crest will appear (water wave)

Predicting a flood



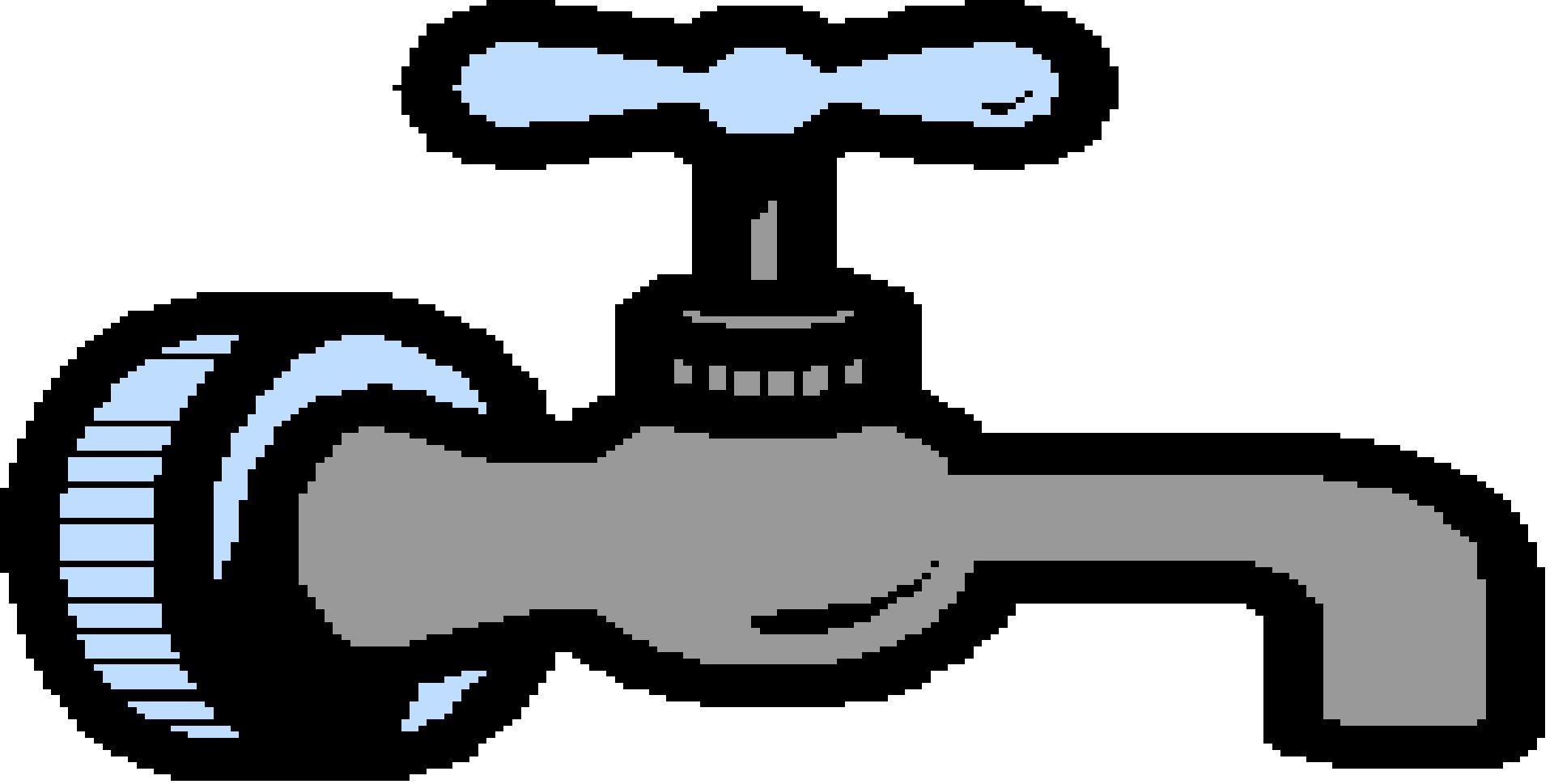

What if the Isabella Dam breaks? Will Bakersfield flood????
DELANO
99
MCFARLAND
5
WASCO
SHAFTER
178
58
ARVIN
TAFT
5
2
4
8
12
16
22
Alluvial fan

I Watching a flood

1. What is a hydrograph
2. How do scientist predict a flood for a particular area?
3. How would you explain the flood map for the Bakersfield area

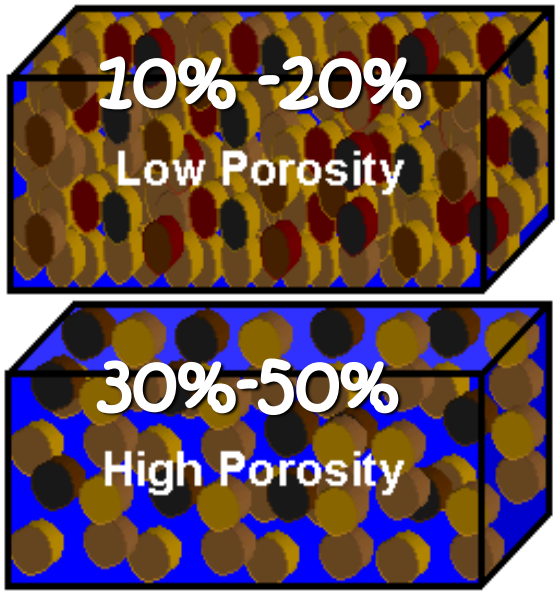
Discuss with a friend

I will get an A on my exams and quizzes



Groundwater distribution and Movement

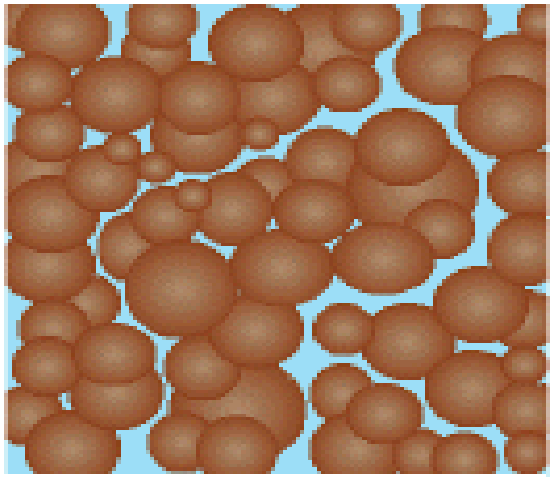
Factors that influence the storage and movement of groundwater



Porosity:

the amount of void spaces available to store water

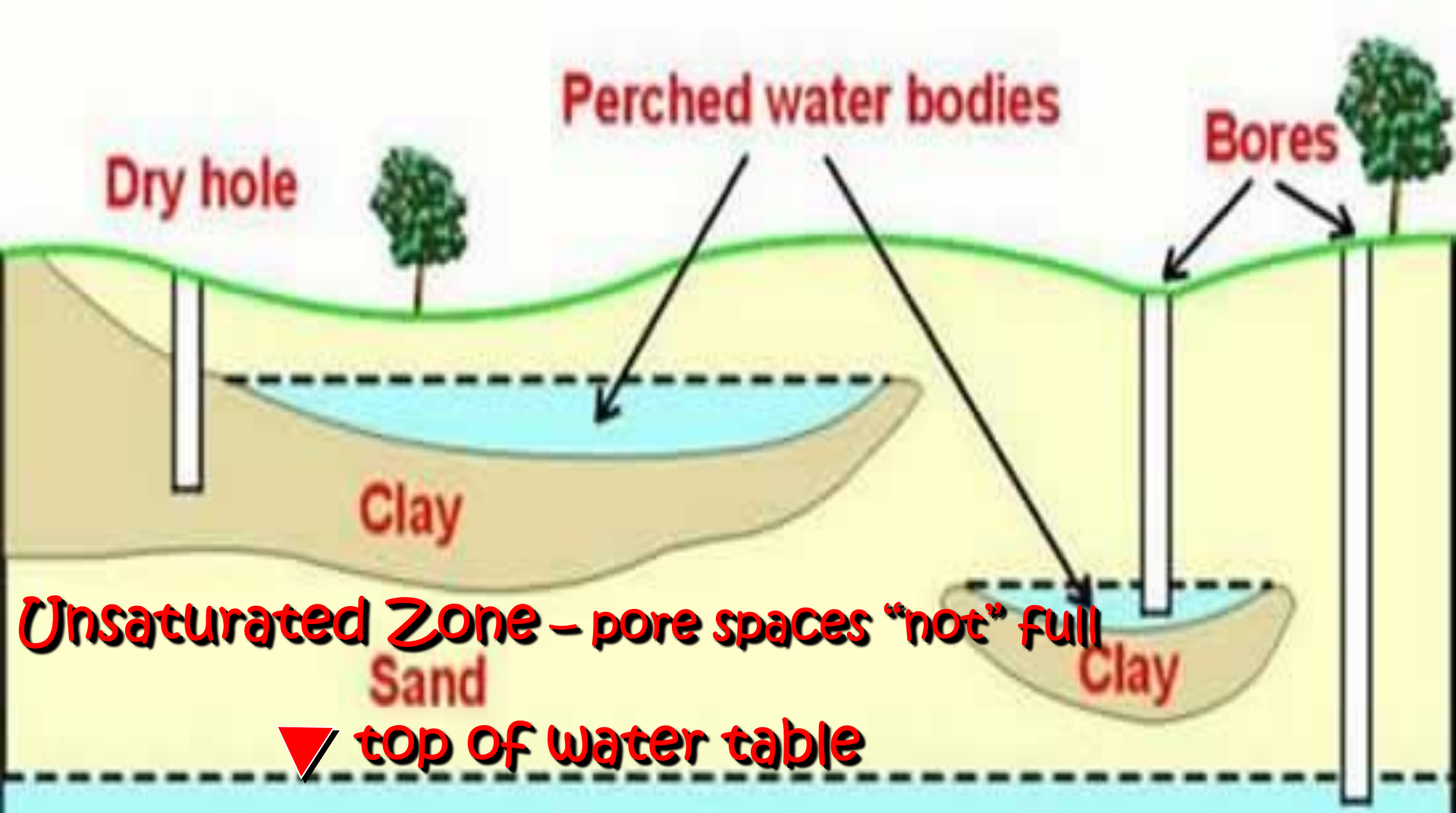
Expressed as a %



Permeability:

the ability for water to move (transmit) through the media

Distribution and Movement of groundwater

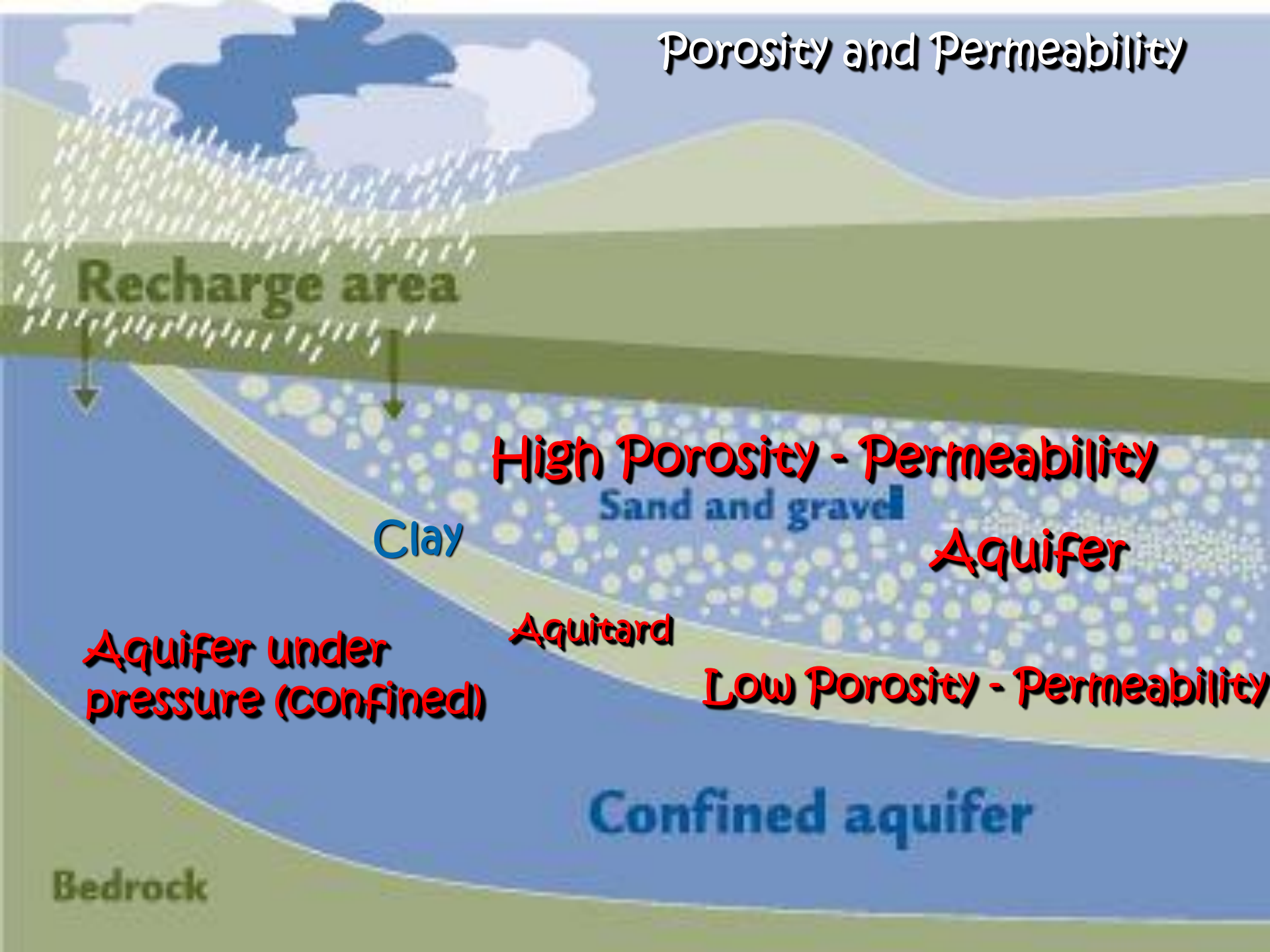


I ♥ Drinking ground-water

1. Describe the differences between porosity and permeability
2. What is needed for an aquifer?
3. Define the following:
    1. Unsaturated zone
    2. Saturated zone
    3. Perched aquifer

Discuss with a friend

I will get an A on my exams and quizzes


Porosity and Permeability
Recharge area
High Porosity - Permeability
Sand and gravel
Clay
Aquifer
Aquitard
Aquifer under pressure (confined)
Low Porosity - Permeability
Confined aquifer
Bedrock

Movement of Groundwater

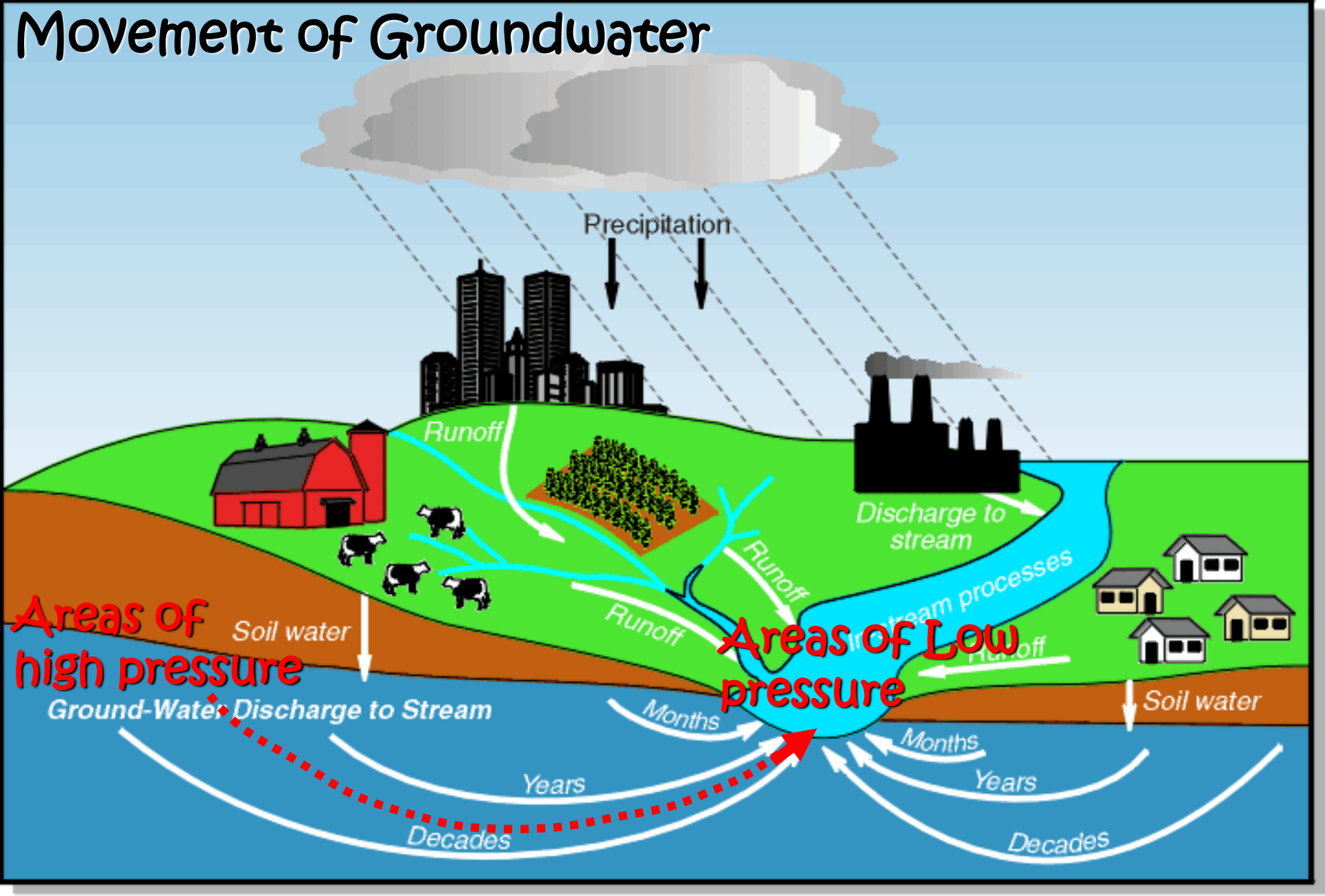


Figure 2. *Nutrient movement in the ground-water-flow system.*

I Groundwater characteristics

1. Describe the differences between an unconfined and confined aquifers
2. What is an aquitard?
3. Describe the general flow of groundwater

Discuss with a friend

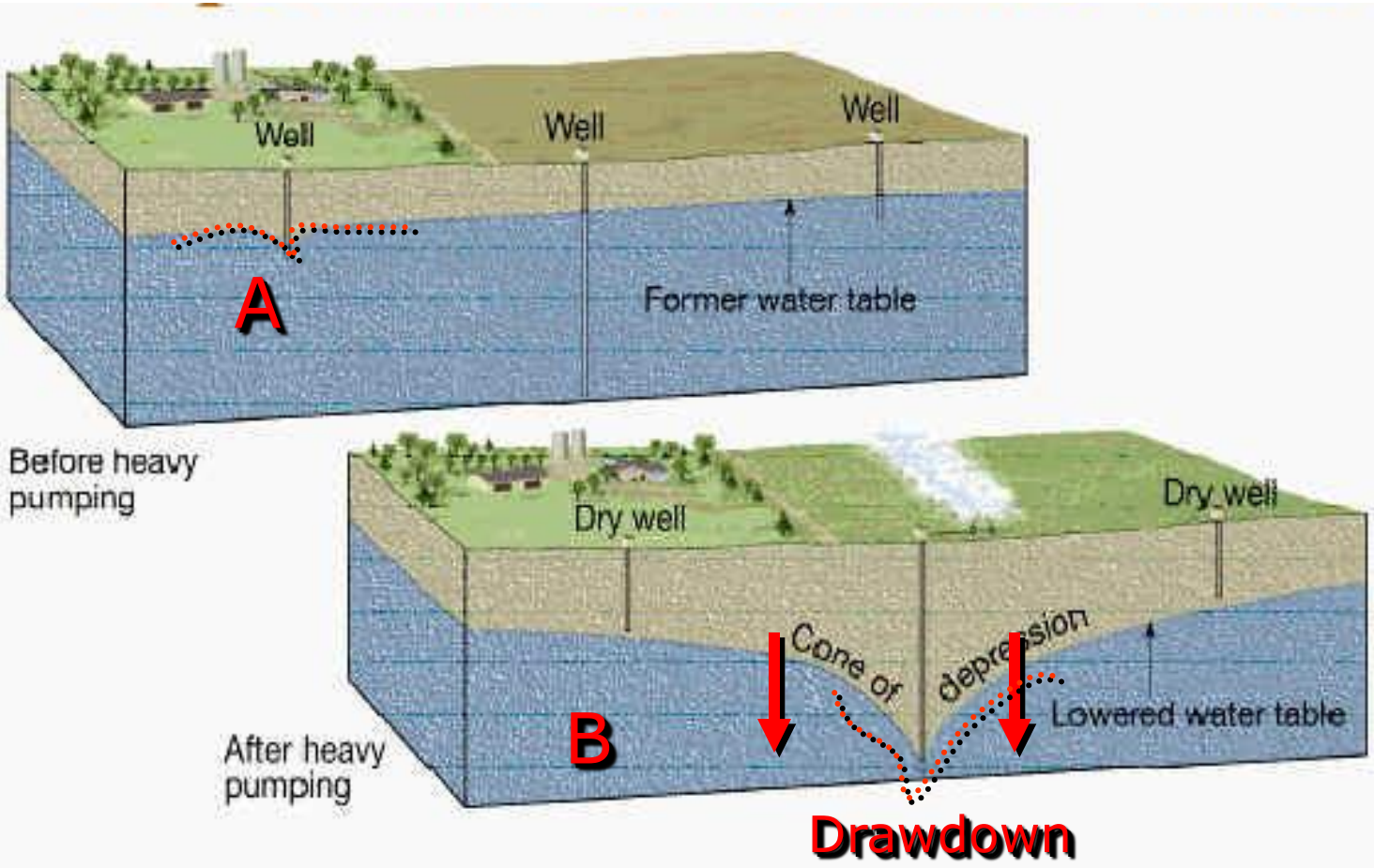
I will get an A on my exams and quizzes

Water Wells

Producing a cone of depression

Residential uses – small cone of depression (A)

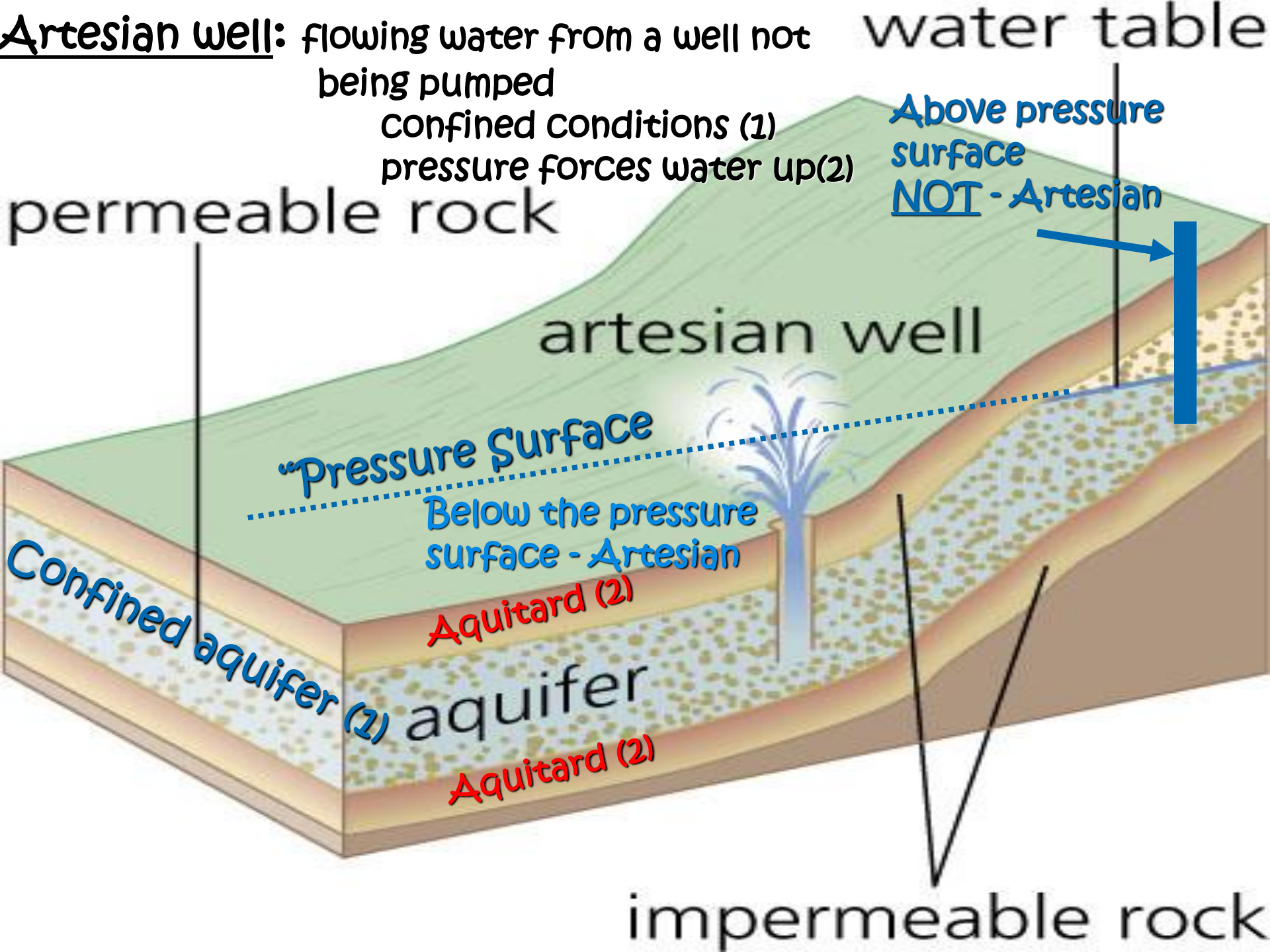
Industrial uses – large cone of depression (B)



Artesian well: flowing water from a well not being pumped

confined conditions (1)

pressure forces water up(2)

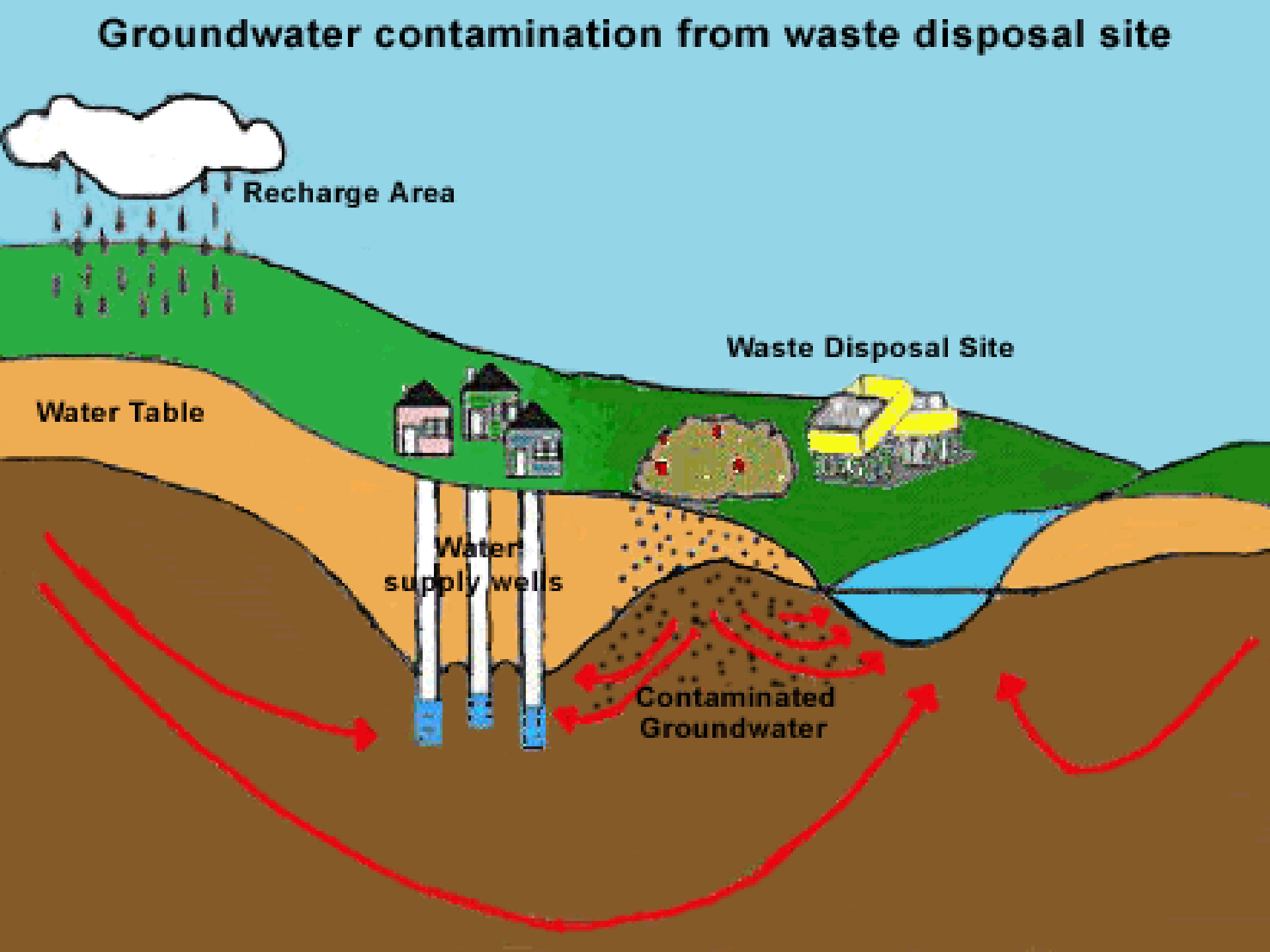


I ♥ Watching the stream

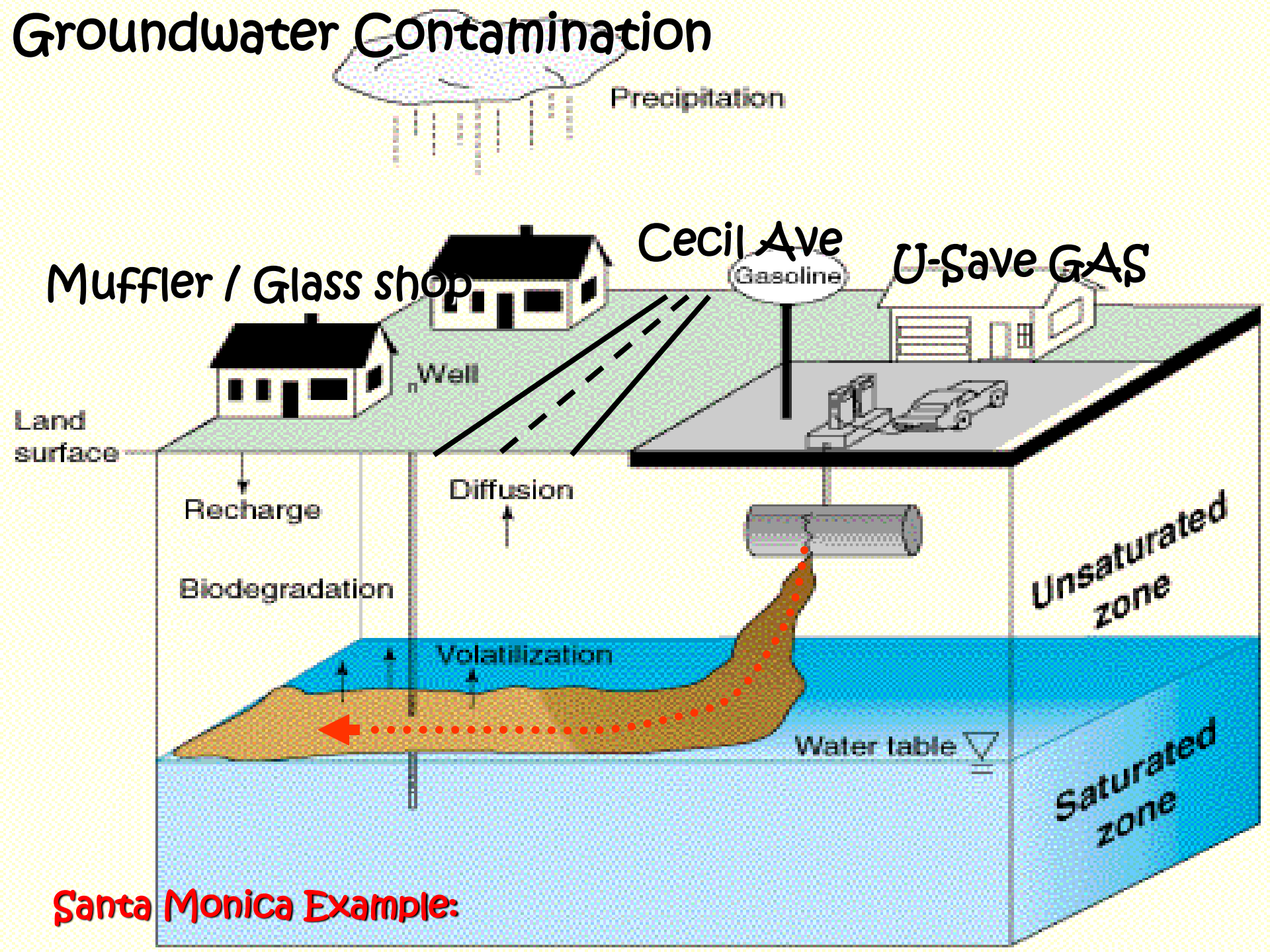
1. How would you describe a "cone of depression?
2. How can groundwater wells influence other people living in an area?
3. What conditions are necessary to produce an artesian well?

Discuss with a friend

I will get an A on my exams and quizzes


Groundwater contamination from waste disposal site
Recharge Area
Waste Disposal Site
Water Table
Water supply wells
Contaminated Groundwater

Groundwater Contamination



Santa Monica Example:

FIGURE 2 – Groundwater Basins Subject to Critical Conditions of Overdraft

Basin/Subbasin Number*	Basin/Subbasin Name
3-001	Santa Cruz Mid-County
3-002.01	Pajaro Valley
3-004.01	180/400-Foot Aquifer
3-004.06	Paso Robles Area
3-008	Los Osos Valley
3-013	Cuyama Valley
4-004.02	Oxnard
4-006	Pleasant Valley
5-022.01	Eastern San Joaquin
5-022.04	Merced
5-022.05	Chowchilla
5-022.06	Madera
5-022.07	Delta-Mendota
5-022.08	Kings
5-022.09	Westside
5-022.11	Kaweah
5-022.12	Tulare Lake
5-022.13	Tule
5-022.14	Kern County
6-054	Indian Wells Valley
7-024.01	Borrego Springs

**See Appendix B, Figure B-2 for an explanation of the California groundwater basin/subbasin numbering system.*

Map created from B-118 basin boundary data – updated by DWR on October 18, 2016. The list of basins with critical conditions of overdraft was finalized in 2016, after the revisions to the B-118 basin boundaries were finalized.

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