Lecture 6

CE 433

Excerpts from Lecture notes of Professor M. Ashraf Ali, BUET.

Waste Assimilation Capacity of Streams (Stream self purification)

- The waste assimilation capacity of streams has its basis in the complex phenomenon termed “stream self purification” – the ability of streams to assimilate wastes and restore its own quality
- The self purification of natural water systems is a complex process and often involves physical, chemical and biological processes working simultaneously
- Chemical and bio-chemical reactions are conversion processes; while physical processes involve removal
- Factors governing self-purification of streams are different for different types of wastes

Various forces helping self purification capacity of streams

- **Physical forces which includes**

  (i) Dilution

  (ii) Dispersion

  (iii) Sunlight (acts through bio-chemical reactions)

- **Chemical forces aided by biological forces** (called bio chemical forces) which includes

  (i) Oxidation (Bio Oxidation)

  (ii) Reduction

Factors affecting self purification capacity of streams

Self purification capacity of a river or a stream depends on following factors

- Temperature
- Hydrographic factors such as the velocity and surface expanse of the river or stream
- Rate of re-aeration
- Amount and type of organic matter
- Available initial DO
- Types of microorganisms present.

Oxygen Demanding Wastes or biodegradable organic waste

- Municipal wastewater, certain industrial wastes
- Organic wastes undergo biochemical process of decay with the utilization of dissolved oxygen
- Utilization of DO increases as temp rises. DO is replenished primarily through reaeration from atmosphere.
- Oxygen holding capacity of water decreases as the temperature rises.
- Thus self purification in case of organic wastes depends on :
  - Stream flow (dilution)
  - Time of passage down the river (or distance from the point of discharge)
  - Water temperature
  - Characteristics of waste and microorganisms
  - Characteristics of stream (affects reaeration as well as degradation process)

Pathogens (Microbial Waste)

- Bacteria, viruses, protozoa etc.
- Dilution takes place in the stream and microbes are destroyed by the unfavorable conditions in the stream
- The decline in numbers of microorganisms is a function of water temperature and time. The warmer the water, the higher the death rate.
- Thus, self purification of pathogens depends on:
  - Stream flow (dilution)
  - Time of exposure
  - Water temperature

Persistent Waste (stable, non-degradable)

- Pesticides, HC compounds, some detergents, salts, heavy metals
- Undergo very little or no change along the water course
- Primary mechanism is “dilution” and hence self purification is almost entirely dependent on
  - Stream-flow
  - A significant portion of organic wastes (compounds) and heavy metals may become associated with the “stream sediment”

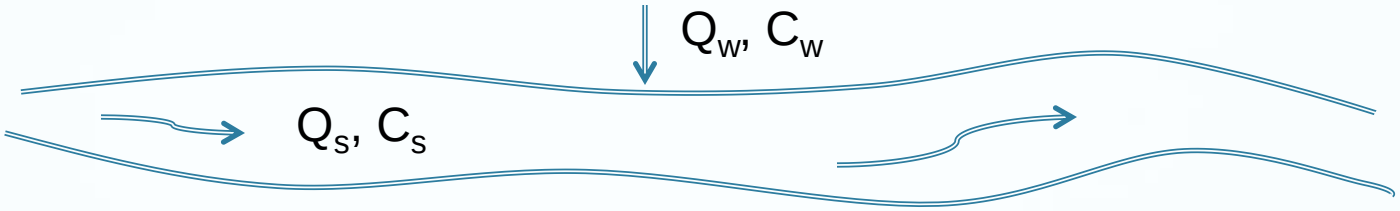
Influence of Physical Channel Characteristics

- Waste assimilation potential, controlled by self-purification processes, depends on the size and behavior of the particular river which in turn depends on the configuration of the drainage area and the physical characteristics of the channel along its course
- For example, where the channel is shallow and steep, the time of passage is rapid and short, good reaeration occurs; where if river is deep and meandering with natural pools, the time of passage is slow and long, poor reaeration occurs

Waste Assimilation Capacity…..

- Thus waste assimilation capacity is not a fixed quantity but rather a range of potential, that depends not only on the characteristics of waste, but also on variations in size and behavior through each reach of the river
- Usually, organic wastes comprise the most significant part of pollution load into surface water bodies
- Therefore, it is usually considered that if the waste assimilation capacity of a stream is adequate to handle the organic wastes, the self-purification capacity is adequate for other classification of wastes as well.

Pollution Control Measures



1. Reduce concentration of pollutant (C_w) by :

   (i) wastewater treatment

   (ii) industrial in-plant process control

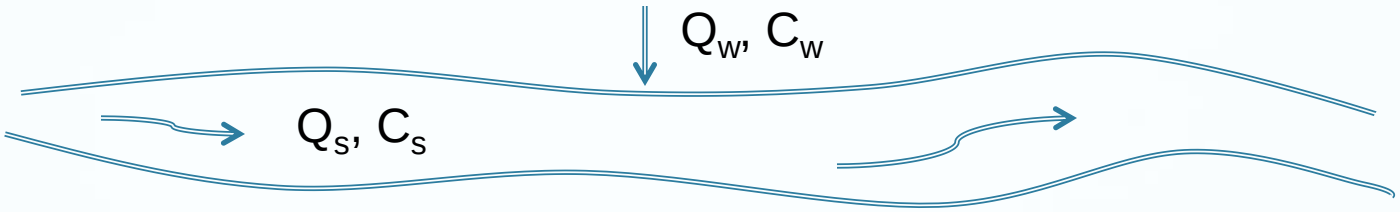
2. Reduce upstream concentration ($C_{s)}$ by controlling upstream point and non-point sources

3. Reduce effluent volume (Q_w) by :

   (i) reduction of industrial discharge volumes,

   (ii) reduction of waste volumes through process modification (in industry)

Pollution Control Measures Contd.

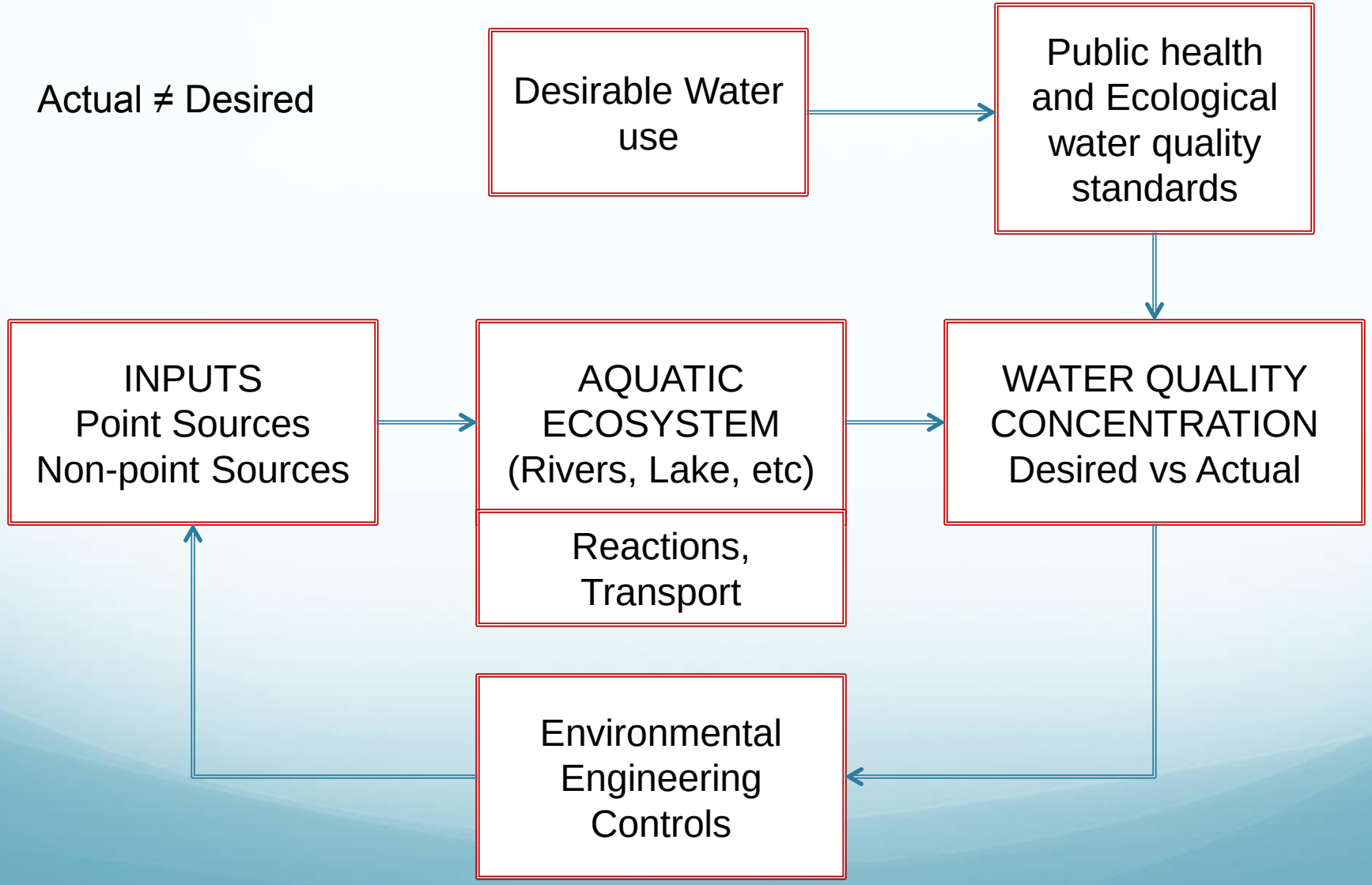


4. Increase upstream flow (Q_s) by flow augmentation (e.g. by releasing water from upstream storage reservoirs, or from diversions from nearby water bodies.
5. Increase environmental/in-stream degradation rate of substances (e.g. use of easily degradable chemicals in industry).

Pollution Control Measures Contd.

- In choosing particular control measures, should consider:
  - The cost of control
  - The expected benefits of resulting water quality in terms of water use
  - The technological bounds (e.g. available storage for low flow augmentation) on the controls

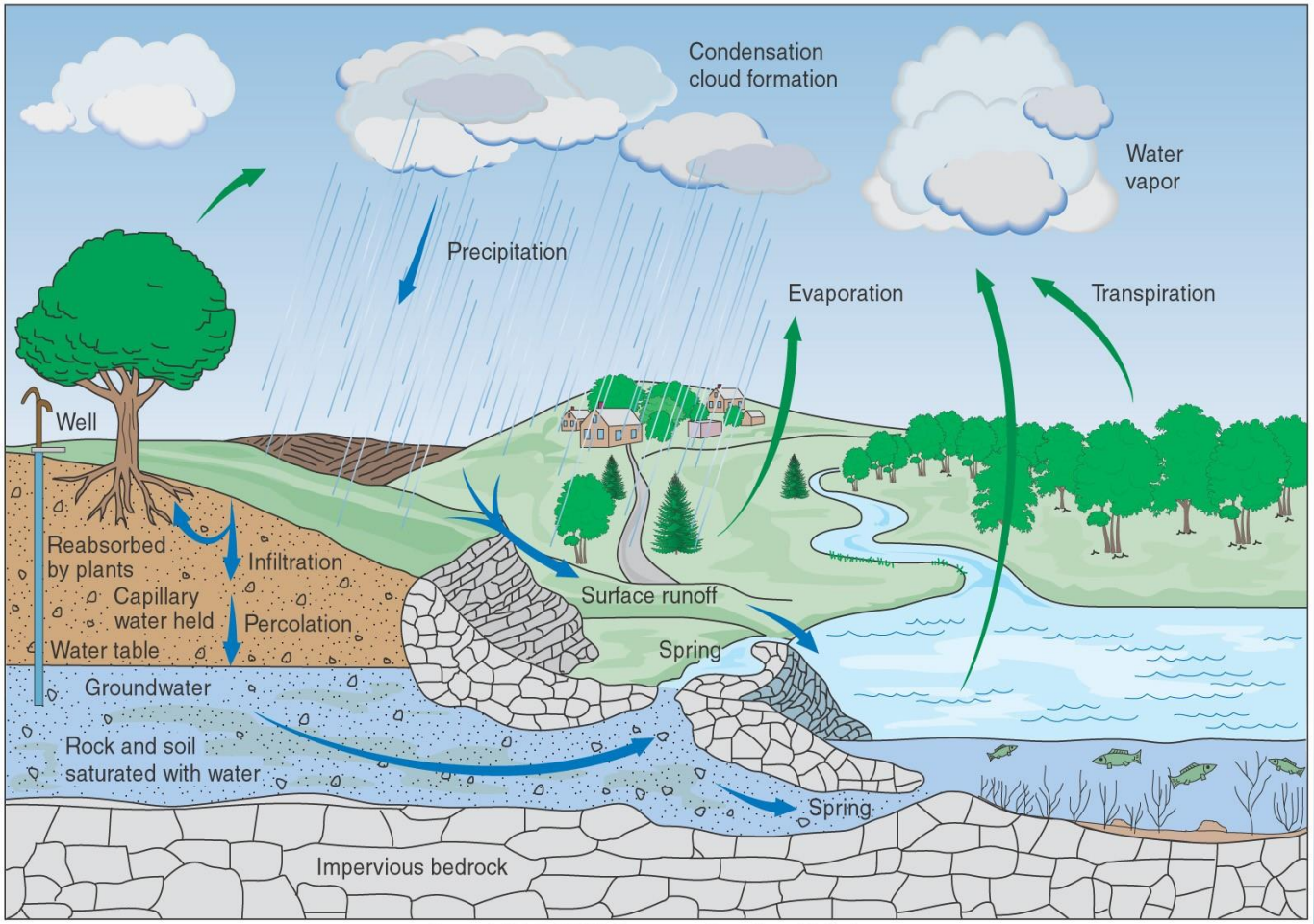
Water Quality Engineering: Flow Diagram



Groundwater Pollution

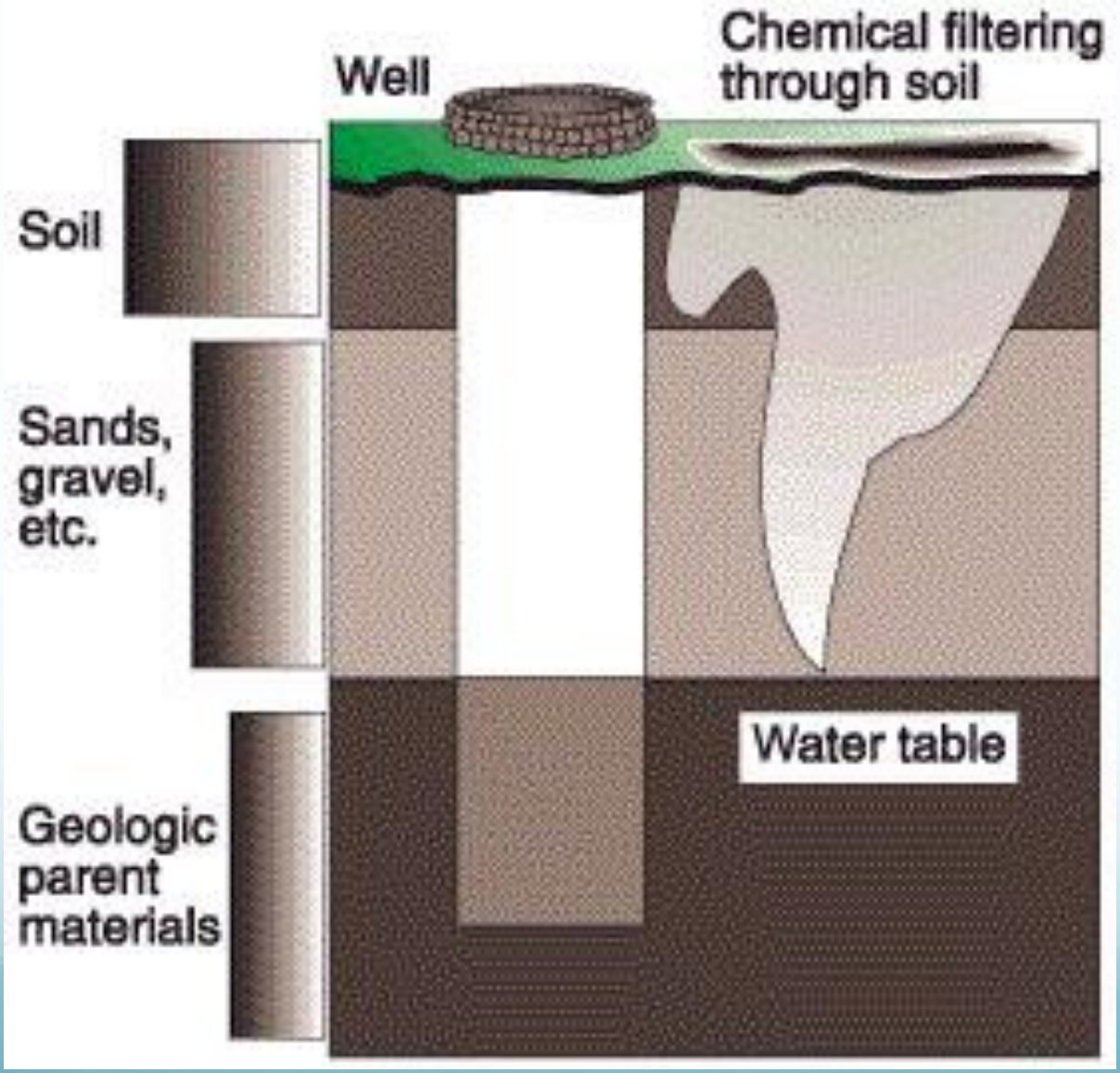
Source: *https://mrsloch.wikispaces.com/file/view/PP+groundwater+pollution.ppt*

How are groundwater and surface water connected?



Percolation and Seepage

Earth = the natural filter



Surface water vs. Groundwater

Which is generally more polluted?

~ Surface Water

Which is harder to clean up?

~ Groundwater

Groundwater pollution sticks around...

- Very cold, no bacterial breakdown
- Very slow water movement: recharge can take 100’s or 1000’s of years
- Pollutants can stick to rocks in aquifer and pollute new water

Sources of Groundwater pollution...

- landfills
- leaky underground storage tanks
- mines
- septic tanks
- hazardous waste - deep well injection
- any pollutant in runoff that percolates

How can we protect groundwater?

- Prevention is the key…
  - Monitor aquifers & landfills
  - Requirements for old fuel tanks
    - Leak detection system
    - Liability insurance
  - Stricter regulations on toxic waste disposal
    - Above-ground storage of toxic waste...but then you have toxic mud spills!