



Lesson 4

Runoff Water Quality

Overview

This section investigates...

- Pollutants of runoff
- Receiving water impacts
- Sources of pollution
- Pollutant removal
 - Mechanisms
 - Efficiencies

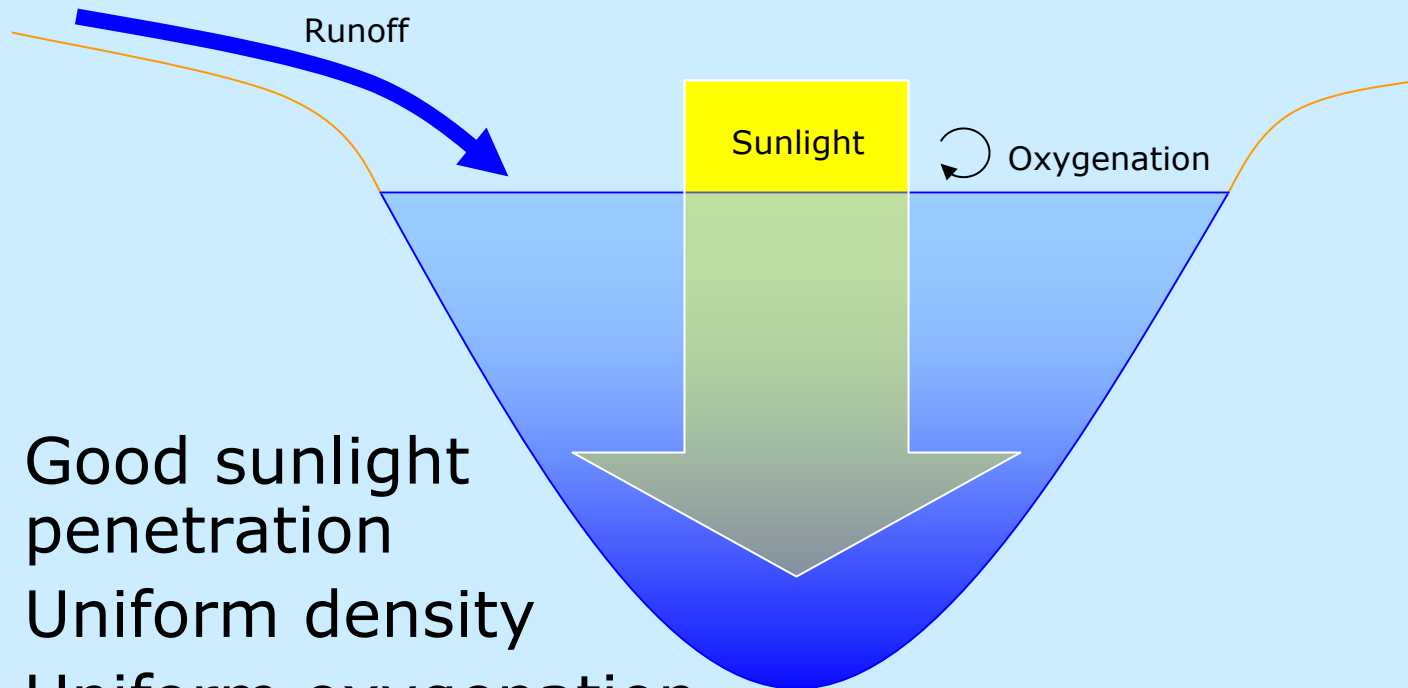
Runoff Constituents

What's in runoff besides water?

Runoff Constituents

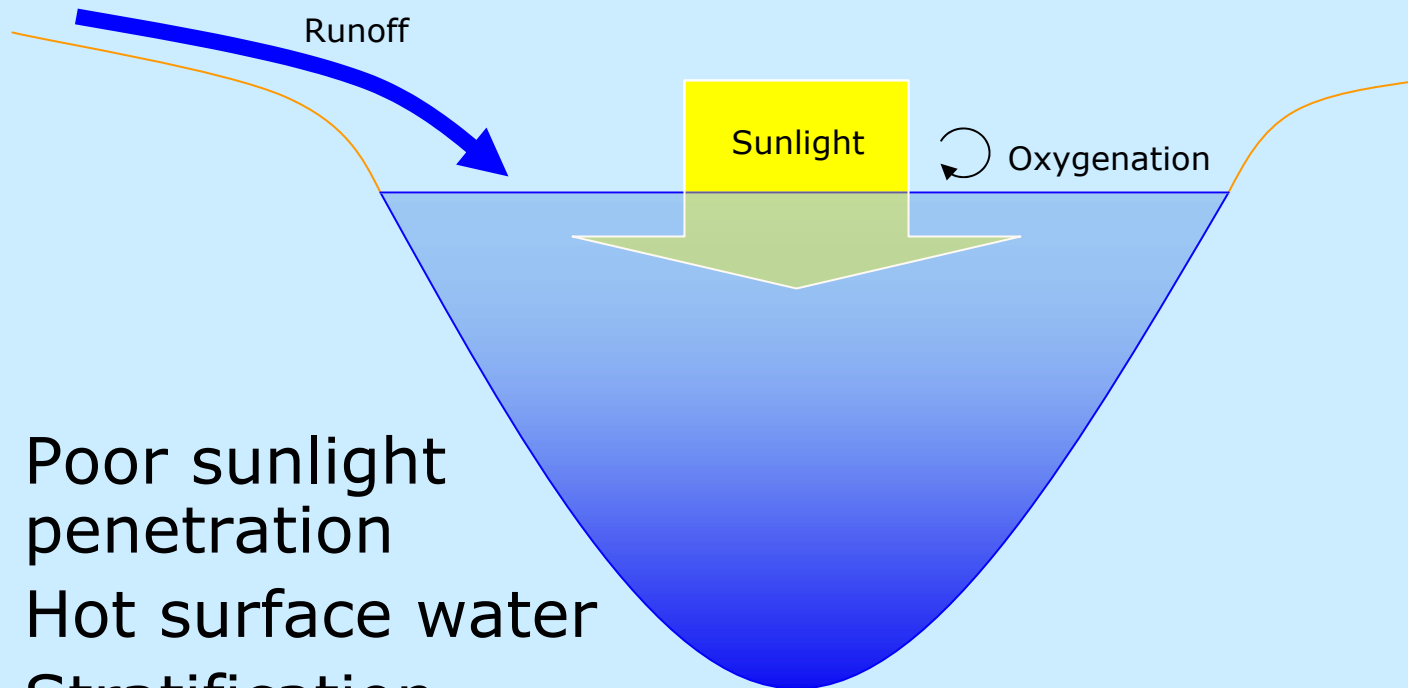
- Sediment and trash
 - Total Suspended Solids
- Nutrients
 - Nitrogen
 - Phosphorus
- Heavy Metals
 - Lead, copper, zinc, chromium, cadmium, etc.
- Petroleum Hydrocarbons
- Pathogens
- Others

Clear Water



- Good sunlight penetration
- Uniform density
- Uniform oxygenation
- Promotes healthy biota

TSS-Laden Water



- Poor sunlight penetration
- Hot surface water
- Stratification
- Anoxic conditions
- Unhealthy for biota

Other TSS Effects

- Some pollutants are attached to sediments
- Removing sediments will help remove those pollutants
- Under anoxic conditions, some pollutants become soluble, raising toxicity

Nutrient Effects

- Nutrients, primarily phosphorus and nitrogen, promote algae growth
- Algae can “bloom” and dominate the dissolved oxygen process
 - Algal photosynthesis causes DO to spike during daylight
 - Algal respiration causes DO to plummet during darkness
- Algae blooms rarely occur naturally since they are extremely detrimental to habitats

Nutrient Effects

- One nitrogen compound is ammonia
 - $\text{NH}_4^+ + \text{OH}^- \leftrightarrow \text{NH}_3 + \text{H}_2\text{O}$
- At higher pH and temperatures, more non-ionized ammonia is required to maintain the equilibrium
- Non-ionized ammonium is toxic to fish

Heavy Metal Effects

- Compounds of heavy metals can be extremely toxic
 - They interfere with reproductive and developmental processes
 - They “bio-accumulate” in the food chain
 - They directly damage habitats as well as human health
- Heavy metal processes and effects are complex and less well understood than other processes

Petroleum Effects

- Petroleum and other hydrocarbons
 - Are toxic
 - Contaminate stream sediments and groundwater
 - Are a nuisance (taste)

Pathogen Effects

- Any organism or virus that can cause disease is a pathogen
- Pathogens are pollutants by definition
- Common examples found in runoff include
 - Fecal coliform and streptococci
 - *Cryptosporidium*
- Illness and disease is the primary concern
- Habitat health can also be affected by pathogens

Pollutant Sources

- Highways
- Areas adjacent to highways
- *Discuss: What will pollutant load at any one location depend on?*

TSS Sources

- Creation and movement of soil in natural watershed
- Agricultural and urban erosion
- Construction activity
 - Vegetation clearing
 - Grading
- Urban stormwater facilities
 - Runoff from impervious areas

Nutrient Sources

- Agricultural fertilizers
- Lawn fertilizers
- Human and animal waste
- Industrial processes
- Nitrogen cycle (nitrogen fixation)
- Weathering of the earth's crust

Petroleum Sources

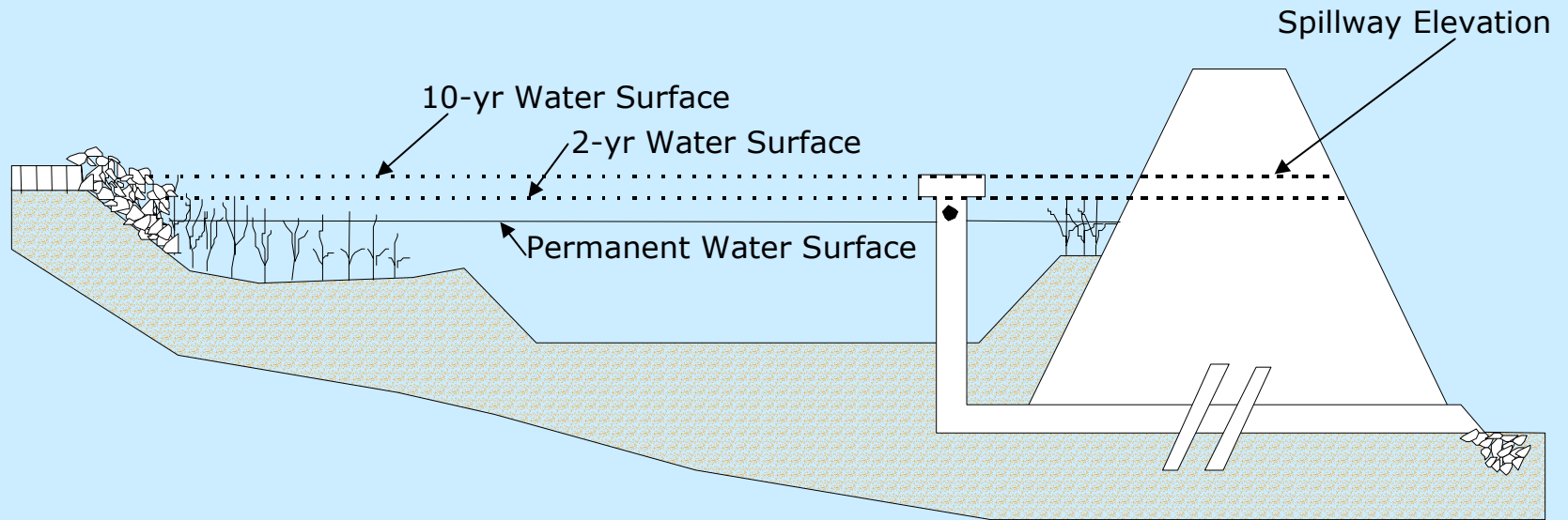
- Spills
- Maintenance activities
- Underground storage leaks
- Incomplete combustion
- Industrial processes
- Paints and household chemicals

Pollutant Removal

Discuss:
How do you currently address runoff water quality?

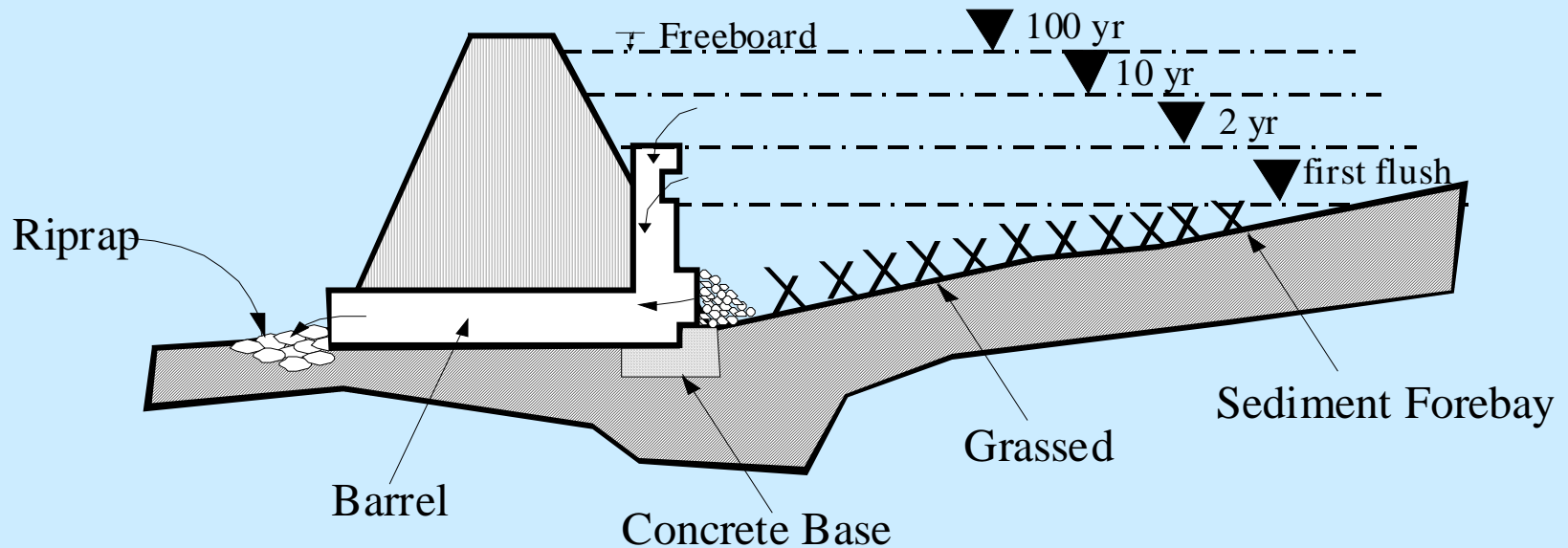
Effectiveness of Settling

Typical Wet Pond Design



Effectiveness of Settling

Typical Dry Pond Design



Effectiveness of Settling

<i>Pollutant</i>	<i>Removal Efficiency (%)</i>
TSS	50-70
TP	20-40
TN	10-20
Pb	75-90
Zn	30-60
Hydrocarbons	50-70
Bacteria	50-70

Other Removal Mechanisms

<i>Mechanism</i>	<i>Pollutants Affected</i>	<i>Promoted By</i>
Filtration	Solids, pathogens, P, N, metals	Dense vegetation, constructed filters
Soil Incorporation	All	Medium-fine texture
Chemical Precipitation	Dissolved P, metals	High alkalinity
Adsorption	Dissolved P, metals, synthetic organics	Neutral pH, high soil organics
Oxidation	Petroleum, synthetic organics	Aerobic conditions
Photolysis		High light
Volatilization	Volatile petroleum and synthetic organics	High temperature and air movement
Plant Uptake	P, N, metals	High plant activity and surface area
Mortality	Pathogens	Vegetative excretions

Determining Removal Rates

- Effectiveness of water quality measure can be measured
- Required data are
 - Influent and effluent flow rates
 - Influent and effluent pollutant loading
- This is usually reserved for research program due to high cost
- Most removal standards are “technology based,” not “performance based”

ASCE BMP Database

- Technology description
- Effectiveness studies
- <http://www.bmpdatabase.org/>

WQ for Site as a Whole

- Removal efficiency for specific devices is useful, but:
- Reducing discharge of runoff alone reduces pollutant loads into receiving waters (can be analyzed on annual basis)
- Capturing bulk of runoff, produced by small storms, also controls pollutant discharge

Questions? Answers!

Q & A