This Lecture has been divided into two parts:
This file is Part 1 of 2

ARCH 1250
APPLIED ENVIRONMENTAL STUDIES

CLASS FIVE
HYDROLOGY

John Seitz, RA, LEED AP
Adjunct Assistant Professor

Water

Soon to be the world's most precious commodity

It is already the world's third largest industry (at 400 billion $US annually it ranks only behind oil and electricity)

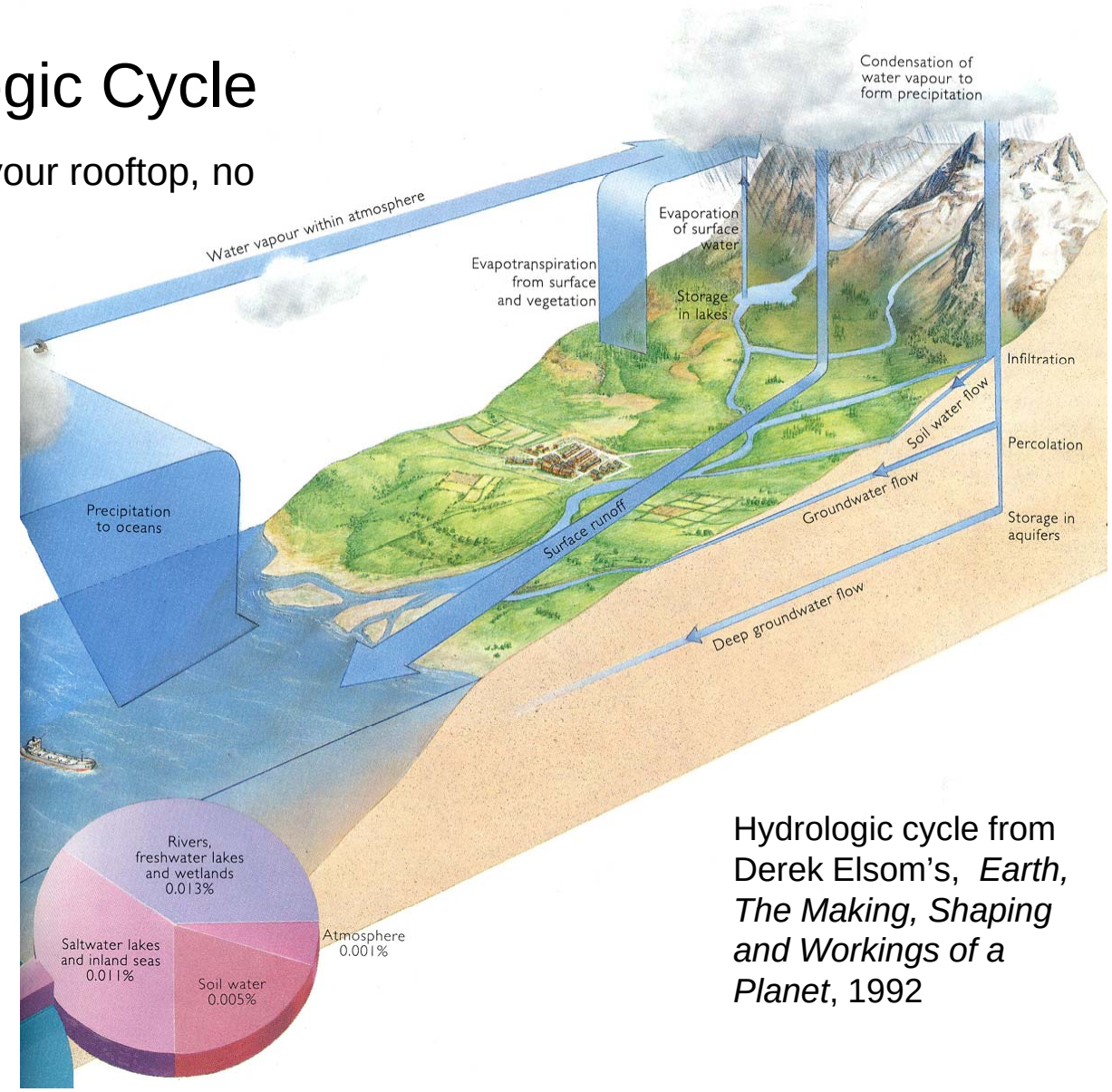
Of the 6 billion people on earth, 1.1 billion do not have access to safe, clean drinking water.

Nearly 1.8 million children under the age of five die annually from diarrheal diseases (such as cholera, typhoid, and dysentery) attributable to a lack of safe drinking water and basic sanitation.

While the average American uses 150 gallons of water per day, those in developing countries cannot find five

The Hydrologic Cycle

Water delivered to your rooftop, no bills included.



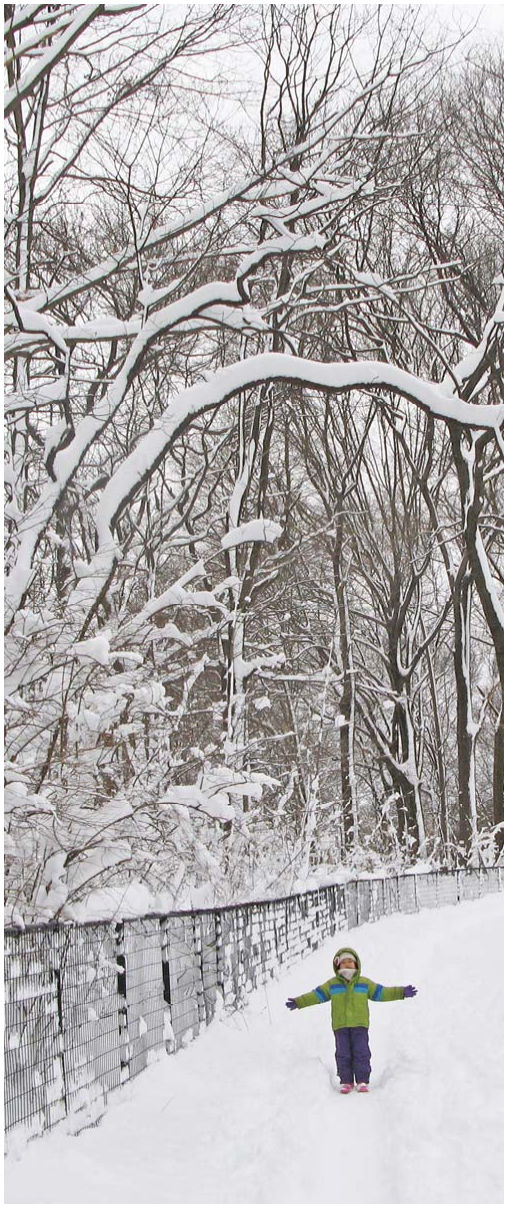
Hydrologic cycle from Derek Elsom's, *Earth, The Making, Shaping and Workings of a Planet*, 1992

Dewpoint

If we cool air without changing its moisture content, eventually we'll reach a temperature at which the air can no longer hold the moisture it contains. At this point water will condense out of the air, forming dew or fog. This is the dewpoint.

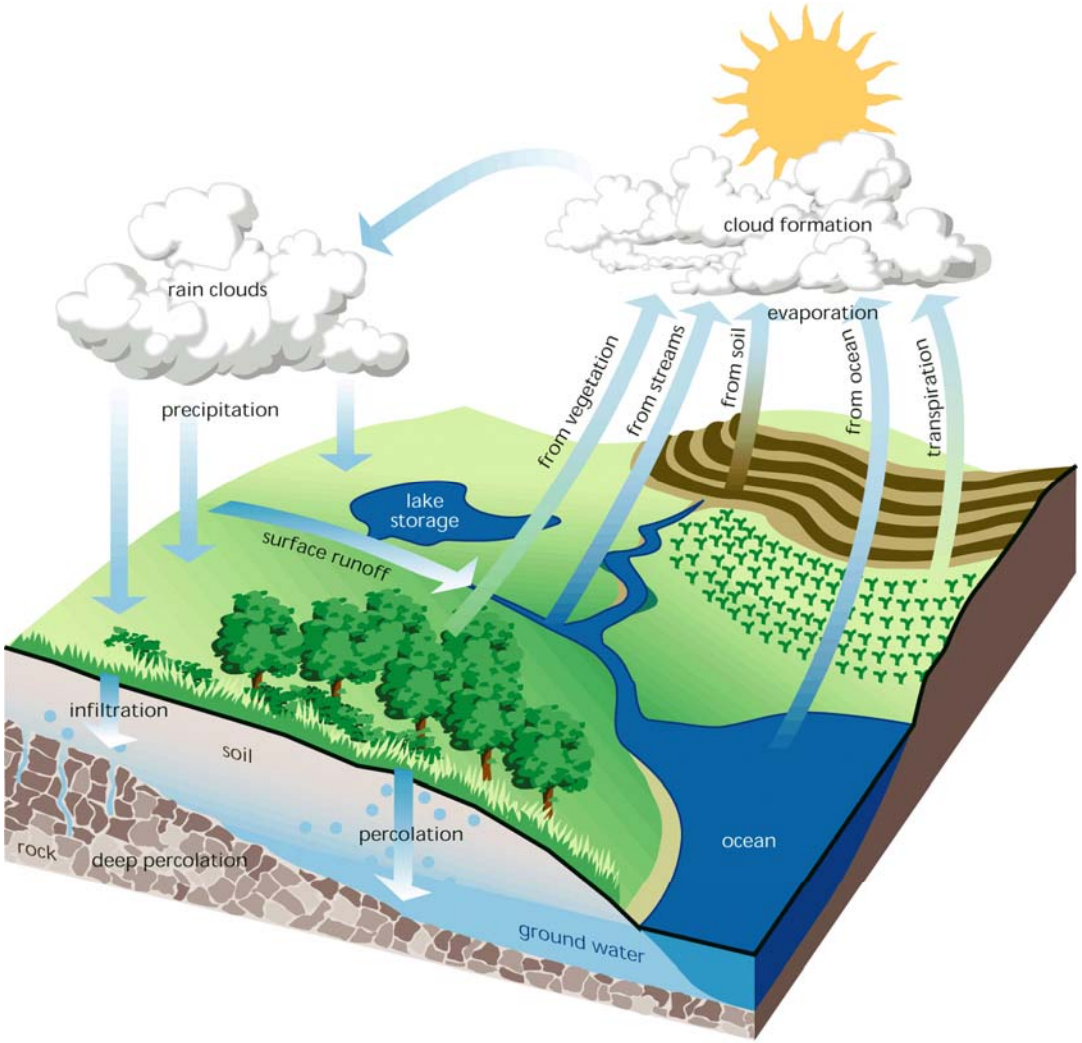
Precipitation

Describes various forms of water vapor condensation that fall from the sky under gravity. This includes rain, sleet, drizzle, snow and hail. Precipitation occurs when a local portion of the atmosphere becomes saturated with water vapour, so that the water condenses and precipates.



Evaporation

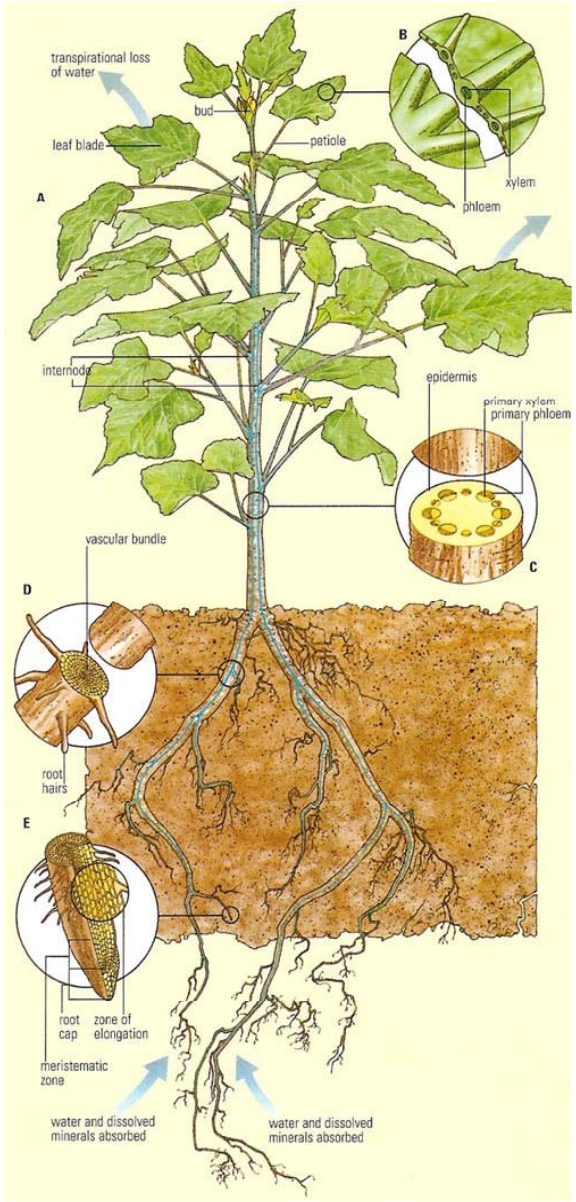
Typically describes the movement of water molecules from a wet surface to the air as water vapor. This may happen at the surface of water bodies, wet soil particles or other site materials and plant stomata (where it is called transpiration)



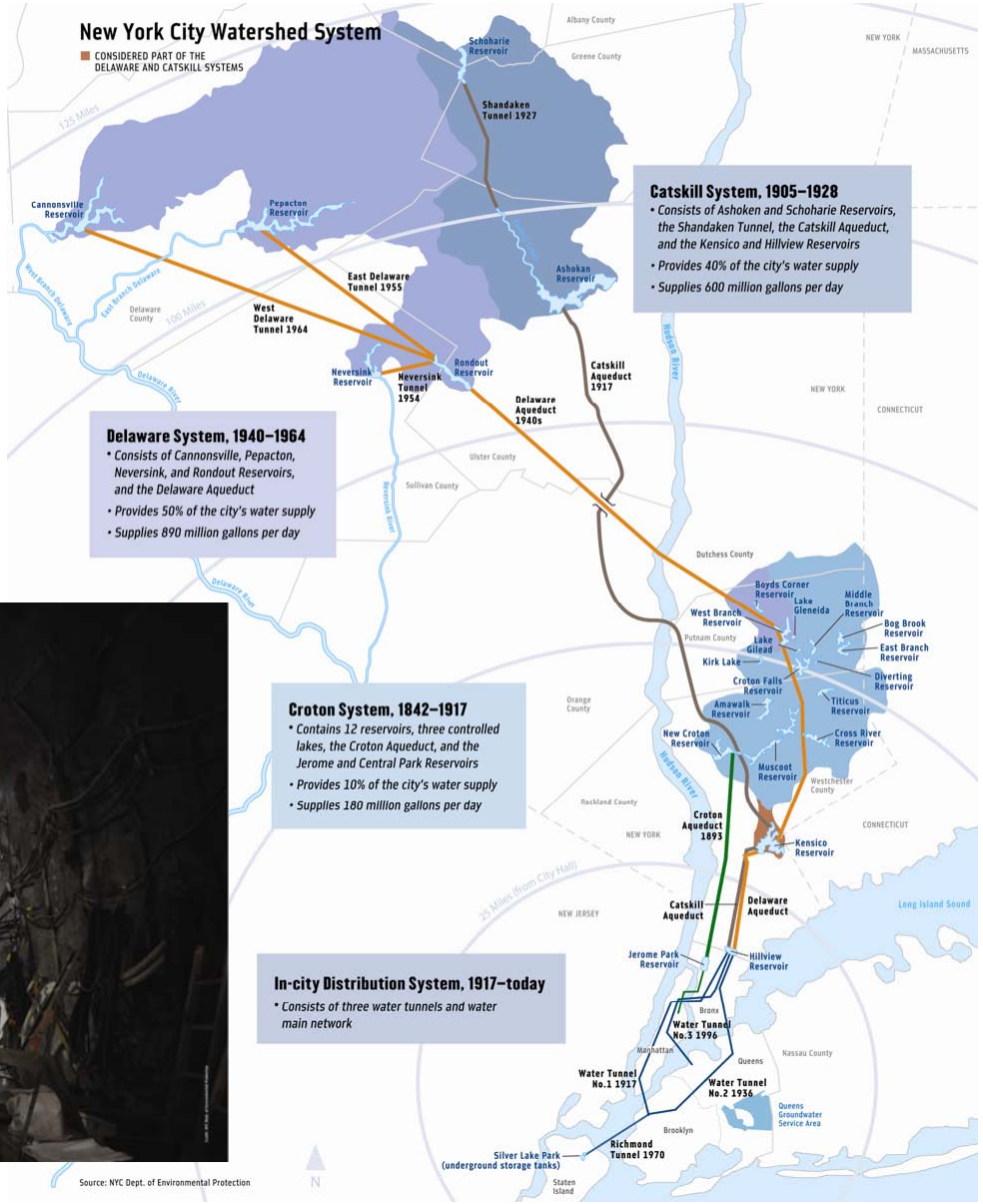
Transpiration

Is a process similar to evaporation. It describes how water absorbed at plant roots, moves upward through the vascular tissues and evaporates through openings known as stomata.

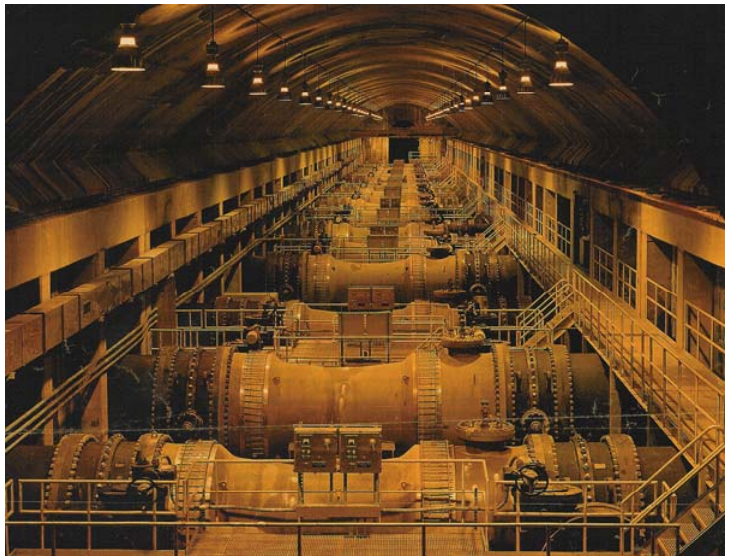
A fully grown tree may lose several hundred gallons of water through its leaves on a hot, dry day. We transplant plants in cooler weather and provide extra water for the first year to reduce stress on the plant through transpirational losses.



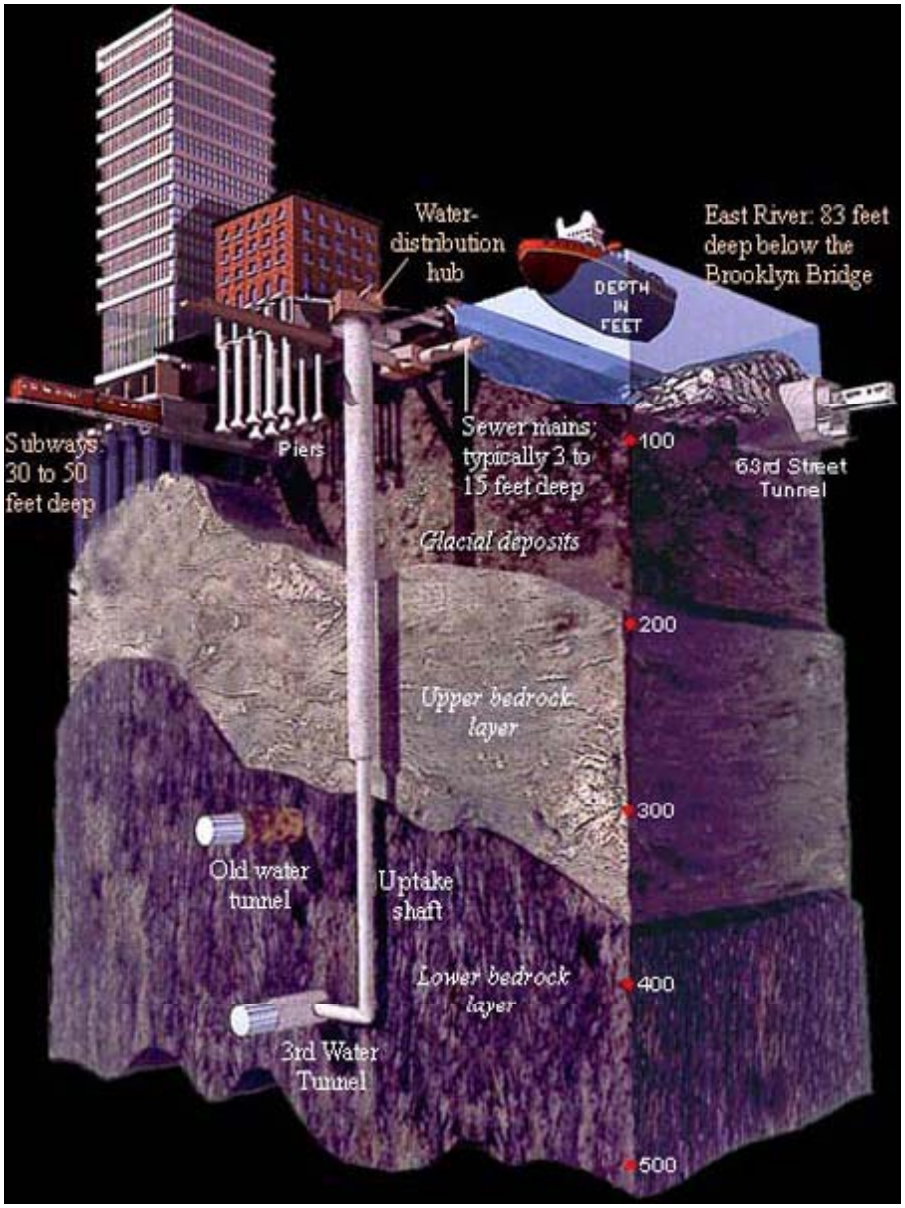
2,000 square miles of watershed send more than 1 billion gallons of water to NYC daily



A 7,000 mile network of water mains, tunnels and aqueducts carry water from 21 reservoirs to your tap



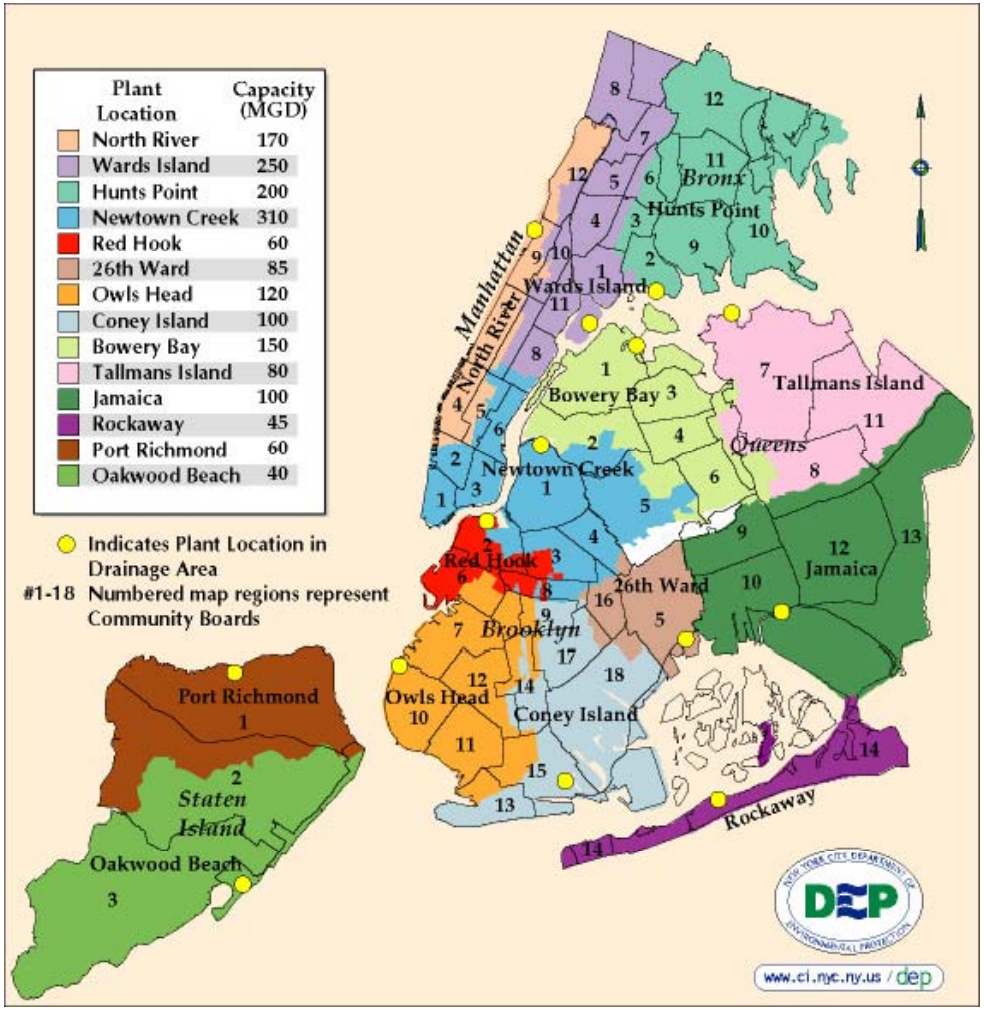
A valve chamber beneath Van Cortland Park in the Bronx



7,400 miles of sewers carry waste to 14 waste treatment plants throughout the city

North River Waste Treatment Plant with Riverbank State Park above

Newtown Creek Waste Treatment plant



More than 460 Combined Sewer Overflows (CSO's) still release raw sewage into the harbor during major rain events

Water in Culture

If there is magic on the planet, it is contained in the water.

-Loren Eisley

By means of water, we give life to everything.

-Koran, 21:30

LECTURE FIVE

HYDROLOGY

- THE HYDROLOGIC CYCLE
- **WATER in CULTURE**
- WATER in ECOSYSTEMS
- SITE HYDROLOGY
  - GROUNDWATER
  - STORMWATER
  - EROSION CONTROL
  - IRRIGATION SYSTEMS
  - CATCHMENT SYSTEMS
  - TREATMENT SYSTEMS
  - THE WATER BALANCE

ARCH 1250 APPLIED ENVIRONMENTAL STUDIES

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LECTURE FIVE

HYDROLOGY

Cairn and Tide, Andrew Goldsworthy, 1999

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Water in Ecosystems

Ecological systems have developed a variety of infrastructures to conserve, protect and cleanse water. Many plants and animals have developed regulating mechanisms that allow them to conserve water in dryer times (and in some cases store it in wetter times). Forests and layers of vegetation create protective canopies and microclimates that retard water loss. Wetlands, soil systems and streams support a host of organisms that clean our waters.

Wetlands:

- An area of land whose soil is saturated with moisture either permanently or seasonally
- Wetlands include swamps, marshes, and bogs and may have salt, fresh or brackish waters.
- Wetlands are the most biologically diverse of all ecosystems.
- Wetlands are often part of an integrated sustainable site design where they absorb and filter storm water runoff
- Despite many state and federal protections wetland loss continues at the rate of nearly 60,000 acres per year.

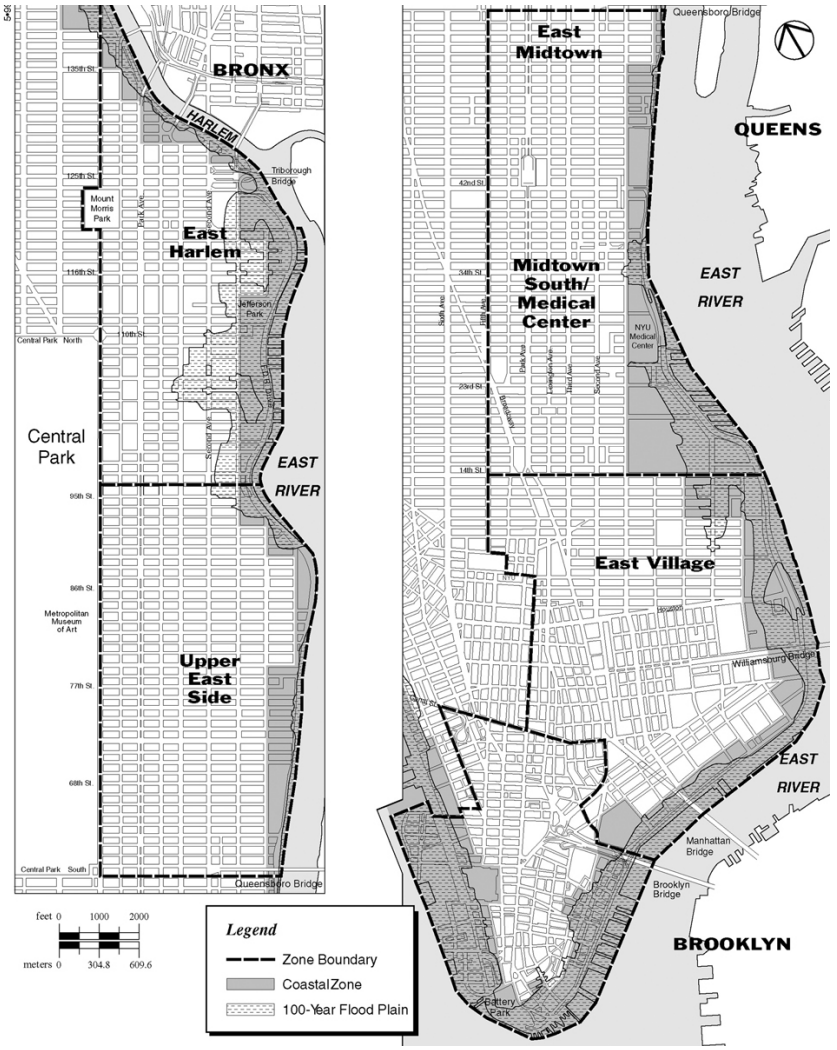
The Viele water map of lower Manhattan (1864) illustrates how quickly the original outlines and contours disappeared and pushed outward.

LECTURE FIVE

HYDROLOGY

Protecting floodplain functions

Cedar Rapids, Iowa, 2008



100 year floodplain map for lower Manhattan

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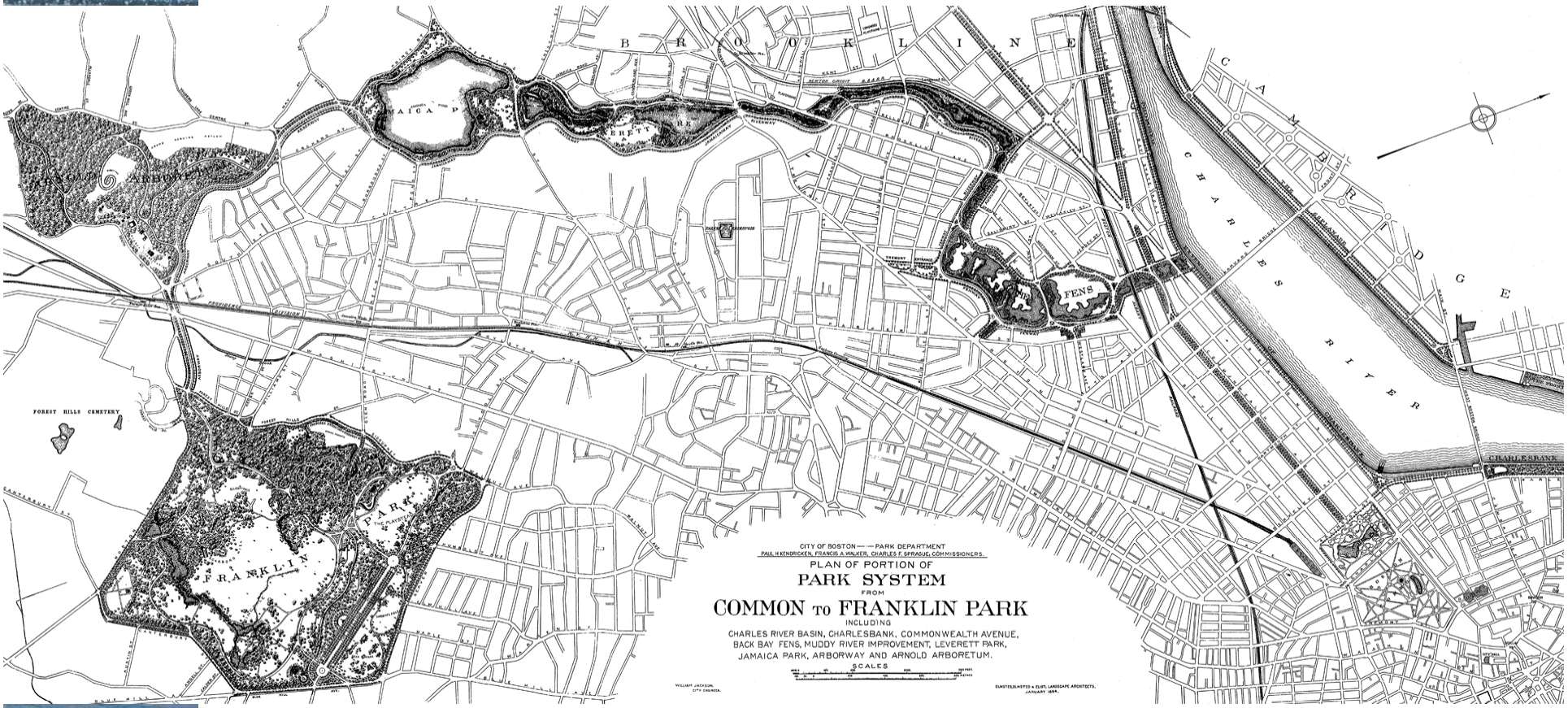

Emerald Necklace, Metropolitan Boston, 1878-1896 by Frederick Law Olmstead

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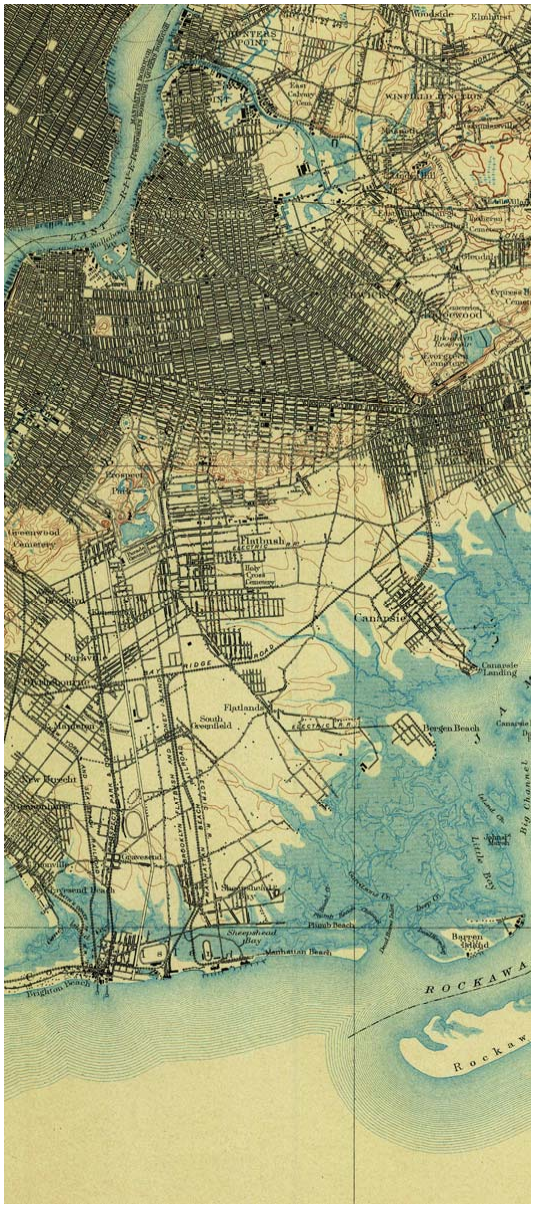
Brooklyn was once ringed by salt marshes, some of the most ecologically productive land in the world.



USGS Maps of Brooklyn from 1900 and 2010

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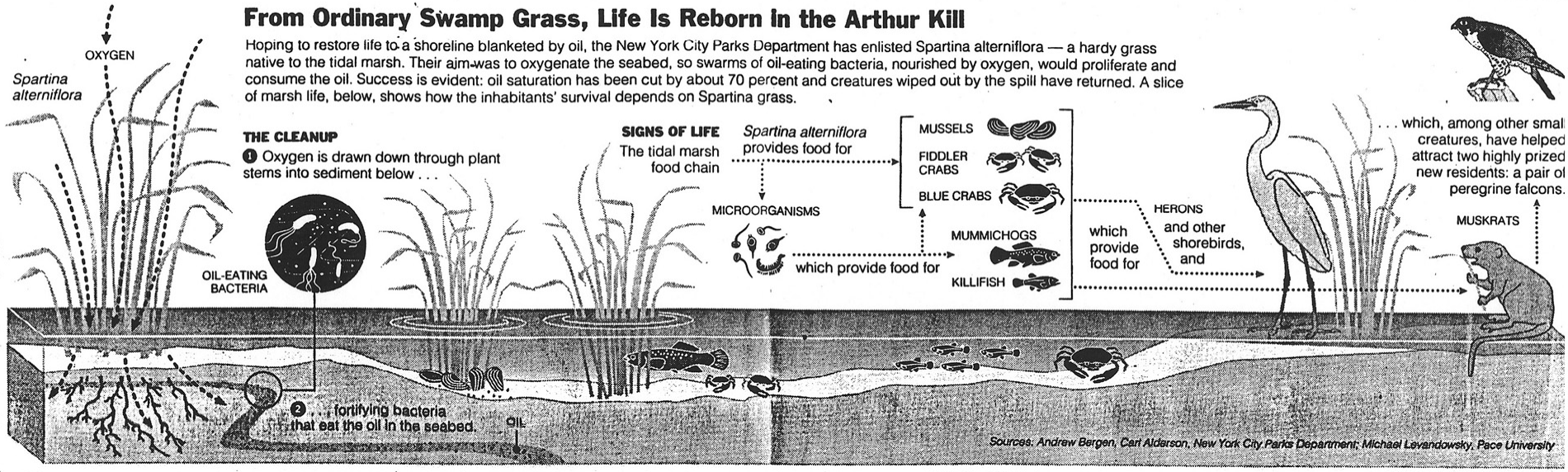
From Ordinary Swamp Grass, Life Is Reborn in the Arthur Kill

Hoping to restore life to a shoreline blanketed by oil, the New York City Parks Department has enlisted Spartina alterniflora — a hardy grass native to the tidal marsh. Their aim was to oxygenate the seabed, so swarms of oil-eating bacteria, nourished by oxygen, would proliferate and consume the oil. Success is evident: oil saturation has been cut by about 70 percent and creatures wiped out by the spill have returned. A slice of marsh life, below, shows how the inhabitants' survival depends on Spartina grass.



Megan Jaegerman/The New York Time

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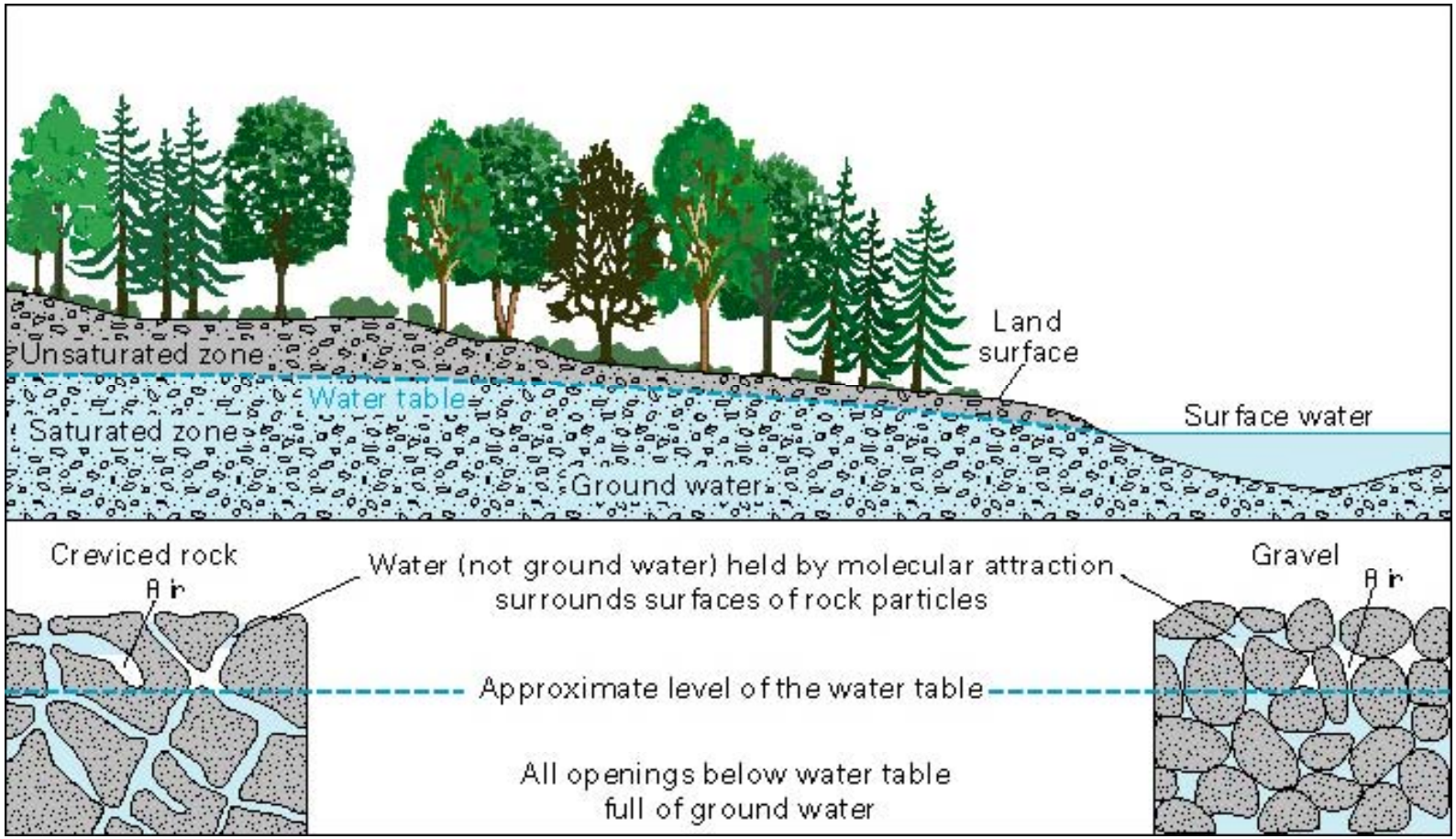
Site Hydrology - Groundwater



Water table diagram per USGS 2012

Site Hydrology - Stormwater

As more and more land becomes paved, reducing infiltration and absorption by plants, the destructive force of stormwater has increased significantly. Municipalities across the country now require many new developments to hold storm water surges and provide strategies to reduce suspended solids before release into public sewer systems.

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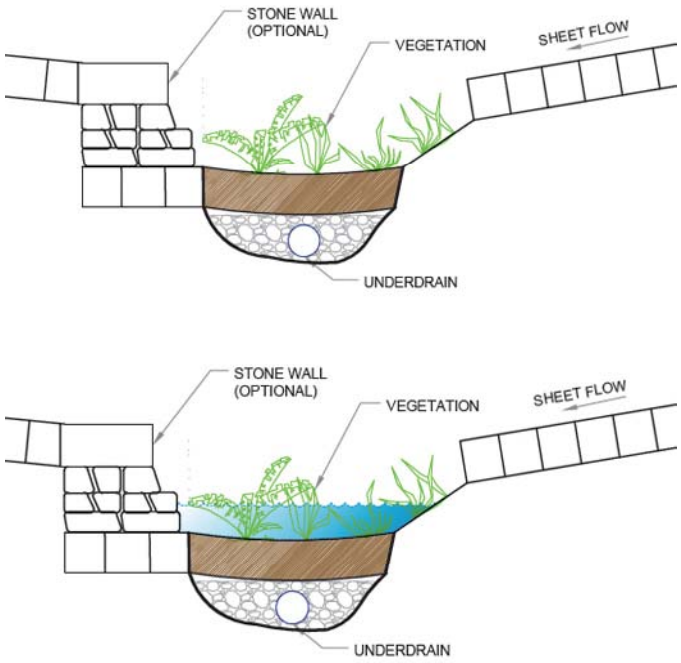
Designed wetlands - Bioswales



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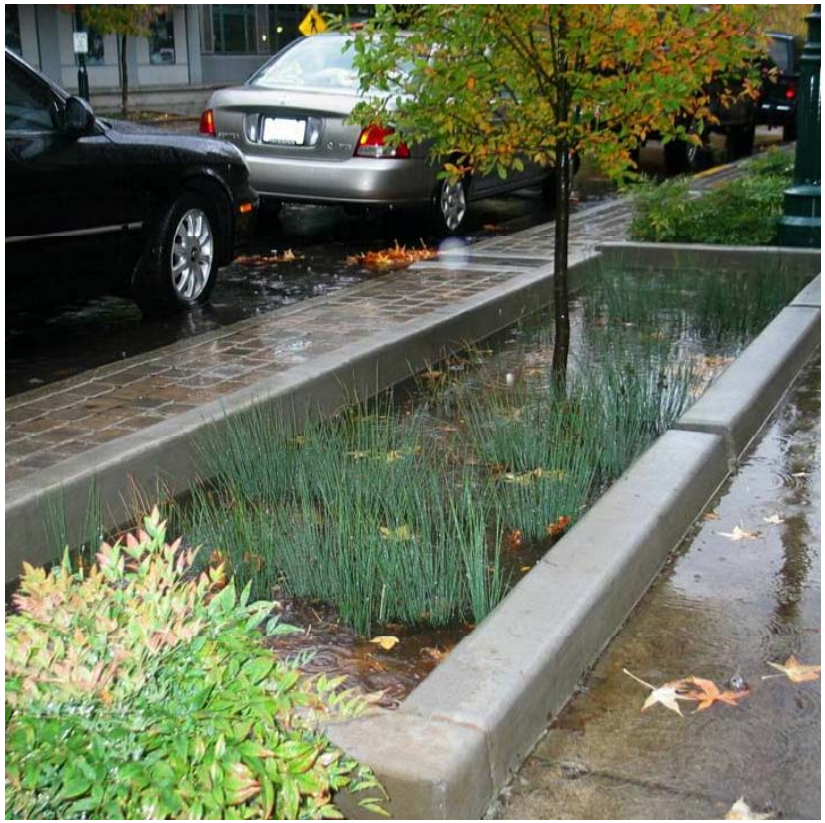
Open planted trenches designed to gather, treat and slowly move rainwater from adjacent hardscape areas. Silt and pollutants are removed through mechanical and biological processes.

Designed wetlands - Rain Gardens



Planted depressions that provide a temporary holding place for rainwater from adjacent hardscape areas. Water may leave through a combination of plant transpiration, evaporation or absorption (images from City of Portland)