

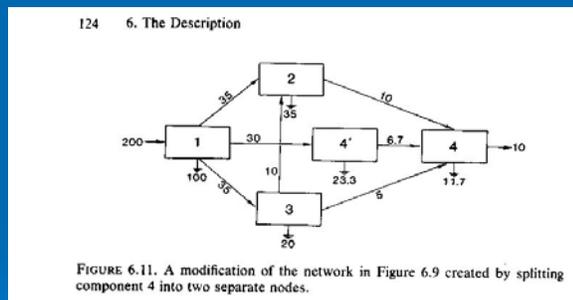
Material Flow: A Central Role for Wastes in Ecological Design

Paul Mankiewicz, Ph.D.
Executive Director
The Gaia Institute
Applied & Theoretical Biogeochemistry
www.gaia-inst.org

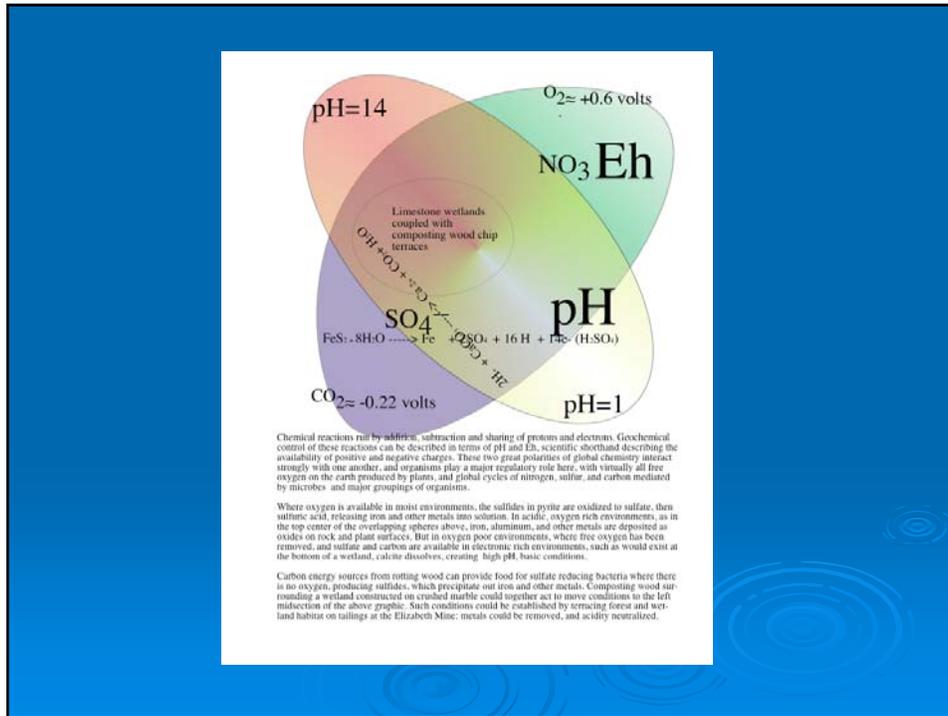
Energy Flows Materials Flow Systems Develop

- Energy flows into and out of the biosphere, within and between organisms and their surroundings, where each energy transfer leaves the system measurably less capable of performing work;
- Material are moved by interactions of the hydrosphere, atmosphere, and lithosphere, as well as the activities of organisms and ecosystems. Specific essential elements normally available in low or limiting concentrations have led to more closed loop material flows, or material cycles, of those elements required by life;
- Food chains/food webs, constrained and ordered by the flow of matter and energy, grow and develop to facilitate the capture and dissipation of energy with the uptake and conservation of essential elements

Additional Levels Can Hold and Keep Energy in an Ecosystem



Partitioning a component can increase the energy or material flow in the system



Energy Flows- human beings now control between 30% and 40% of the net primary productivity on earth

Material Flows- construction, mining and other human earth moving processes are now estimated to have surpassed glaciers, rivers, and other natural processes in terms of quantities of materials moved each year.

Systems Develop- What are the implications for biodiversity, ecological productivity, and ecosystem services (environmental quality maintenance) where one species controls much of biosphere material and process?

Material Flows:

New York City produces 13,000 tons of residential garbage each day;

NYC consumes about 1.2 billion gallons of water each day, and discharges a like amount of wastewater to Long Island Sound, the Hudson, East, and Harlem Rivers, and Jamaica Bay

The City produces somewhere between 12,000 and 15,000 tons of construction and demolition debris each day

Every inch of runoff from the 307 square miles of the City moves about 5 billion gallons of stormwater into receiving waters

The combined sewer system discharges about 27 billion gallons of untreated wastewater into estuaries surrounding New York

To maintain the Port of New York and New Jersey, approximately 6 million cubic yards of material a years needs to be dredged from channels and pierheads

Material Flows:

New York City Garbage:

2,500 tons of organic waste each day;

Between 600 and 1,200 cubic yards per day of waste styrofoam;

About 2,000 tons of glass each day



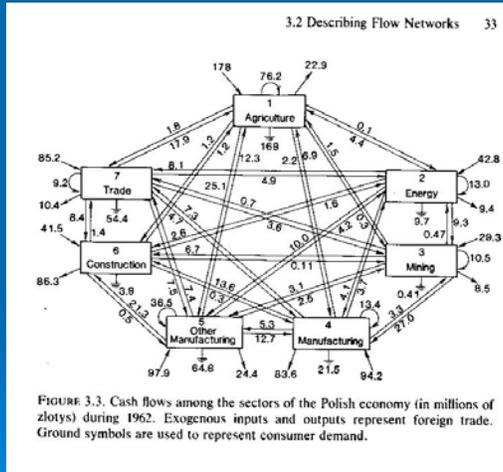
- Plants on a 300 square foot roof at the St. Simon Stock Convent
- Detail of trellis walkway planted with path rush



- St. Simon Stock Grammar School-East View
- South View, past weather station
- Plants are growing on about 30 cubic yards of recycled expanded polystyrene, and 5 cubic yards of composted organics and mulch.



Ecology and Economics: the Problem in Front of Us



Energy Flows
 Materials Cycle
 Systems Develop
 (& in New York)
 Money Talks

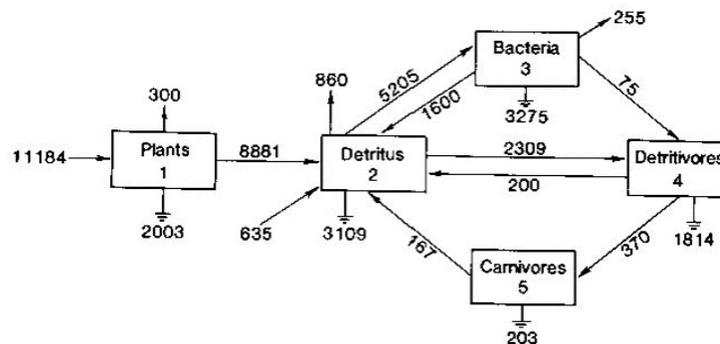
Energy Balance Equation

➤ Q^* (Net All-Wave Radiation) =

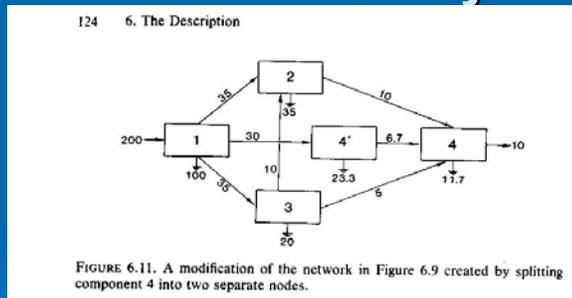
Q_H (Sensible Heat) + Q_E (Latent Heat) + Q_G ("Subsurface" Heat)

Ecology and Economics: the Problem in Front of Us

32 3. The Object



Additional Levels Can Provided Emergent Properties which can Hold and Keep Energy in an Ecosystem



Partitioning a component, or adding a link can increase energy or material flow in the system

Material Flows in NYC

- Residential Waste: 12,000 tons per day
- Drinking Water: 1,200,000,000 gallons per day
- Stormwater runoff: 5,000,000,000 gallon/in runoff

Material Flows:

New York City produces 13,000 tons of residential garbage each day;

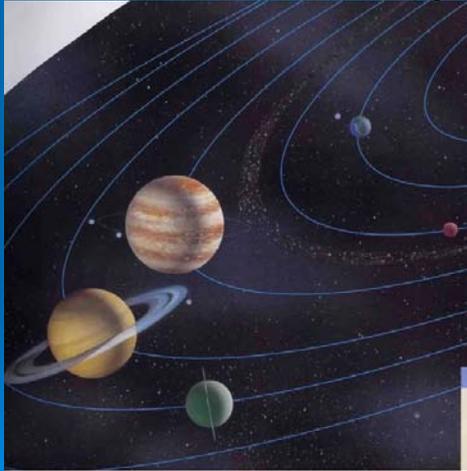
NYC consumes about 1.2 billion gallons of water each day, and discharges a like amount of wastewater to Long Island Sound, the Hudson, East, and Harlem Rivers, and Jamaica Bay

The City of New York produces somewhere between 12 and 15,000 tons of construction and demolition debris each day

Material Flows in NYC

- Residential Waste at \approx \$100/ ton & 12,000 tons per day = \$1,200,000 per day
- Drinking Water: at \$1.50/100 gallons for 1,200,000,000 gallons per day = \$18,000,000 per day
- Stormwater runoff: treated in WWTP at \approx \$1.50/ 100 gal. For 5,000,000,000 gallon/in runoff \approx \$80,000,000 per inch of stormwater

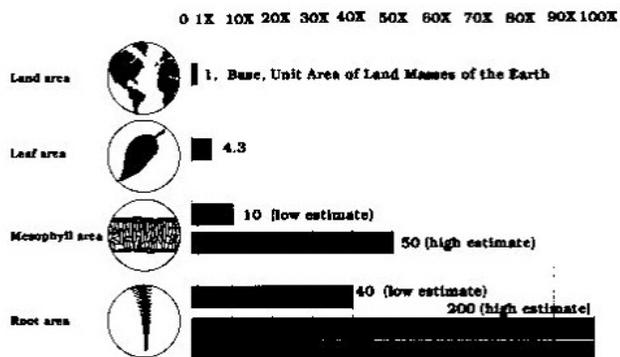
According to Vernadsky, Life on Earth has Increased the Planetary Surface to the Scale of Jupiter

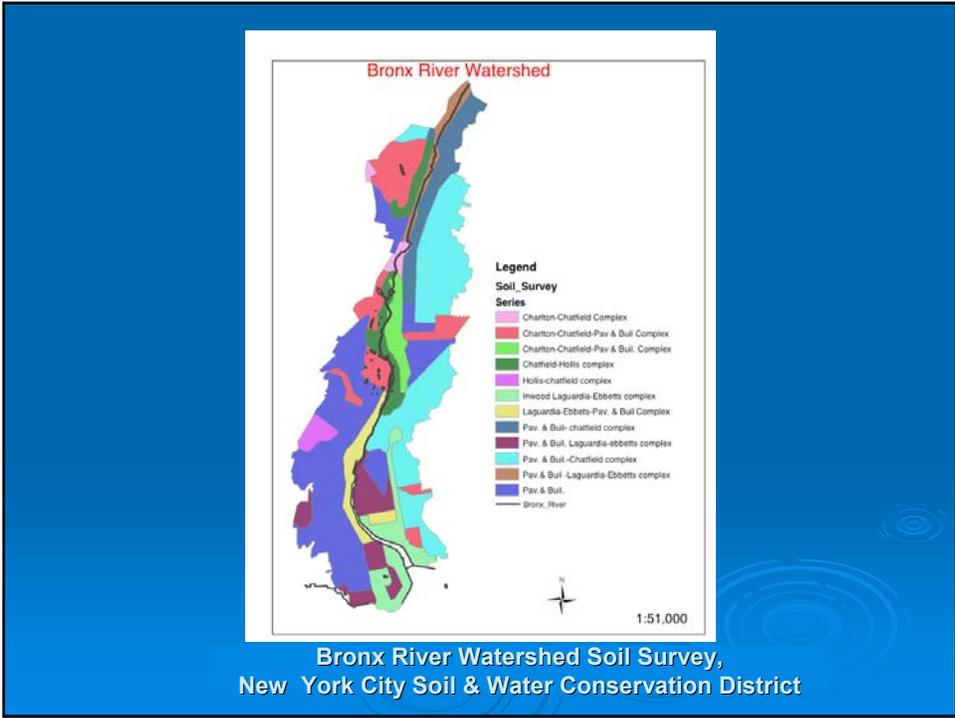


- Ecosystem growth and development increases biomass and energy transfer (Unlanowicz)
- Biotic surfaces increase catalytic or free energy lowering capacity (Kaufman)
- Earth R= 4,000mi
- 2×10^8 sq.mi
- Jupiter R=45,000mi
- 2.5×10^{10} sq.mi.

Plant Surface Area

Plant Leaf and Root Surfaces as Multiples of Land Area of the Earth





Part II: Glaciers

The Land on Which We Live

The top layer of Long Island comes from glaciers that came to Long Island thousands of years ago. The most recent one reached its greatest extent 22,000 years ago and gave the island its terrain. The massive Wisconsin glacier scraped up and carried with it rocks, soil and clay during its travels. Here is how it deposited that debris, forming the land we know as Long Island.

The layers of earth on Long Island

The Extent of the Glaciers

North American glaciers about 20,000 years ago.

- More than a mile deep at its center
- About 500 feet high at the leading edge

Location of future Long Island

Melting

Eventually, a glacier begins to melt at its leading edge. Even then, the glacier's ice-crystal structure is spreading out, pushing debris forward. A glacier begins to recede when melting is greater than the spread of the glacier. Here is an example of what a glacier leaves behind:

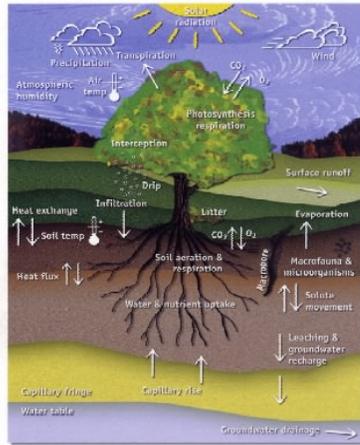
- Moraines**
For a time the glacier's edge may stay in one place, melting back as much as the glacier is creeping forward. Most moraines are made of glacial sediment, which has moved forward within the glacier and is dumped out in a long ridge when the edge melts. **Long Island examples:** Bald Hill in Manorville, Jayne's Hill in Huntington.
- Outwash plains**
Streams of melted ice can rush out well beyond the edge of the glacier, carrying sand, gravel, silt and clay and forming flat, sloping stretches of land that are called outwash plains. **Long Island examples:** Most of the South Shore, Hempstead Plains.
- Kettles**
An isolated mass of ice breaks off and is left behind when a glacier melts. It is surrounded by outwash debris. When the ice melts it leaves a depression called a kettle. If that kettle fills with water, it is a kettle lake. **Long Island examples:** Lake Ronkonkoma, Lake Success.
- Erratics**
Large boulders found as part of the moraine deposits. They remain where they were deposited by ice because they are too large to be carried by meltwater streams. **Long Island examples:** Target Rock, Shelter Rock.
- Ground moraine**
The rock debris the glacier lays down as it moves forward or as it recedes. **Long Island example:** Port Washington peninsula.

Part II appears with the continuation of today's story.
Newsway / Philip Denton

Glacial History

North of Staten Island, many of the physical properties of the surface and subsurface of the environment have been established or highly modified by glacial history

Environmental Soil Physics



DANIEL HILLEL

Physical
Processes
Regulated by
Plant-Soil
Interactions

Soil Water holding-
capacity regulates
ecosystem growth
and development.
It is regulated by:

Infiltration
Macropores
Capillarity

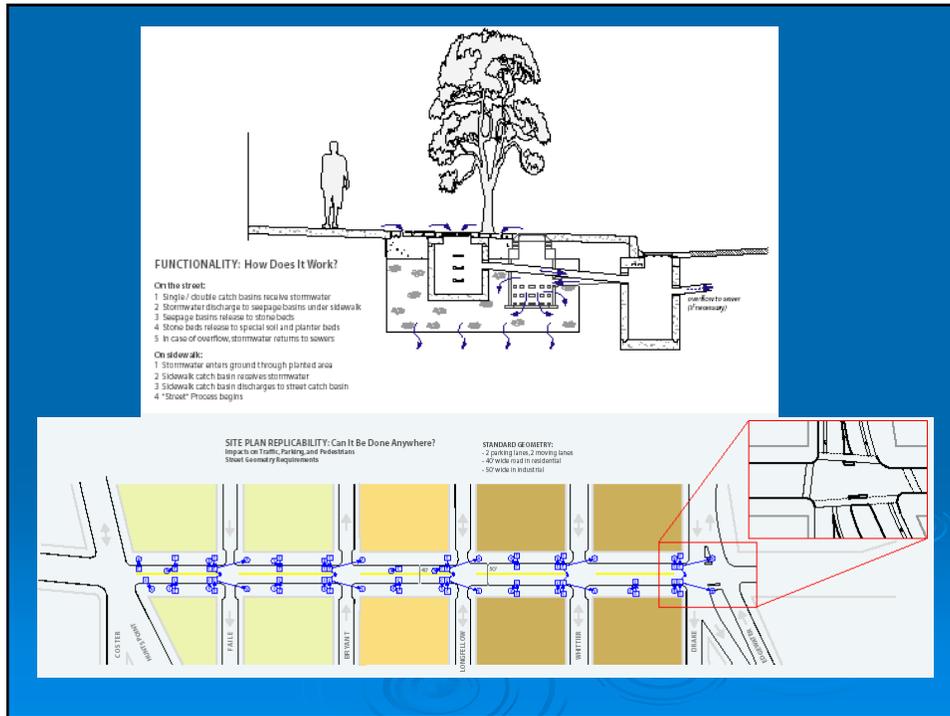




**Lafayette St. Corridor
“Before”**



**Lafayette St. Corridor “After”, capable of
capturing \approx 450,000 gallons of water (ten year
storm)**



East New York, Brooklyn

- Soil buffer and wetland construction for stormwater treatment from Command Bus Depot Parking lot and NYC Street.

ENY BEFORE & AFTER



BEFORE:
compacted urban
wasteland, ragweed
patch adjacent to a bus
depot, infiltration rate <
1/8"/hr.

AFTER:
stormwater capture
park, infiltration rate
12" - 24"/hr.

**Wetland Elements: Landscape,
Clay, Organics, and Native Plant
Communities**





Bobcat mixing clay & subsoils



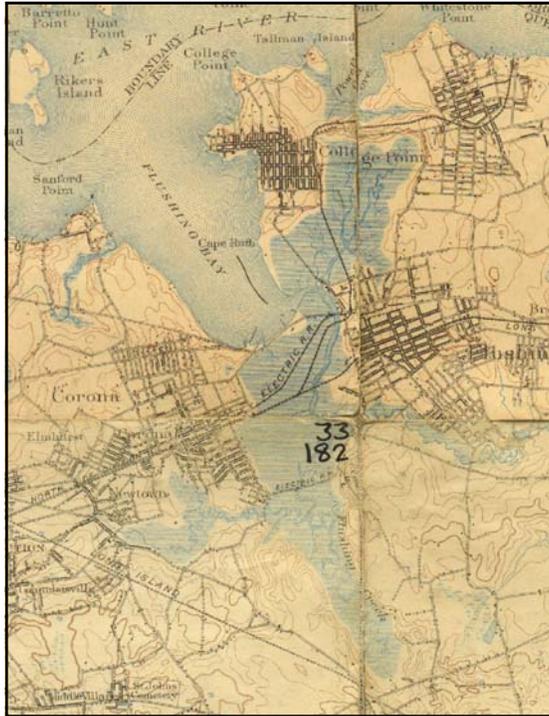
Increasing biomass to improve infiltration



NYC 2012 Olympics

Flushing Meadow Lakes design for the
2,000 meter rowing course



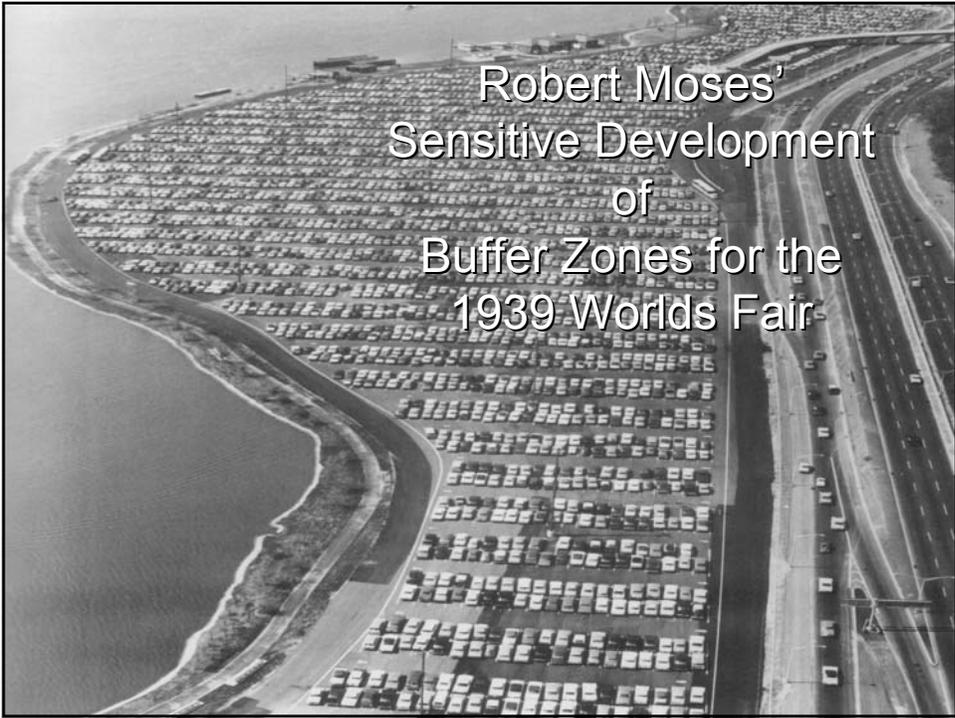


Flushing Creek 1896

The large saltmarsh of Flushing Meadow gathered nutrients for about five thousand years until just after the turn of the last century



The great marsh was filled, in part by the Corona Ash Dump (above), run by Fishhooks McCarthy from the beginning of the 1900's through the 1930s, was famous for its grotesque presence on the landscape. The so-called "Mount Corona" was a mountain of garbage that reached nearly 100 feet high.



Existing Conditions and Problems

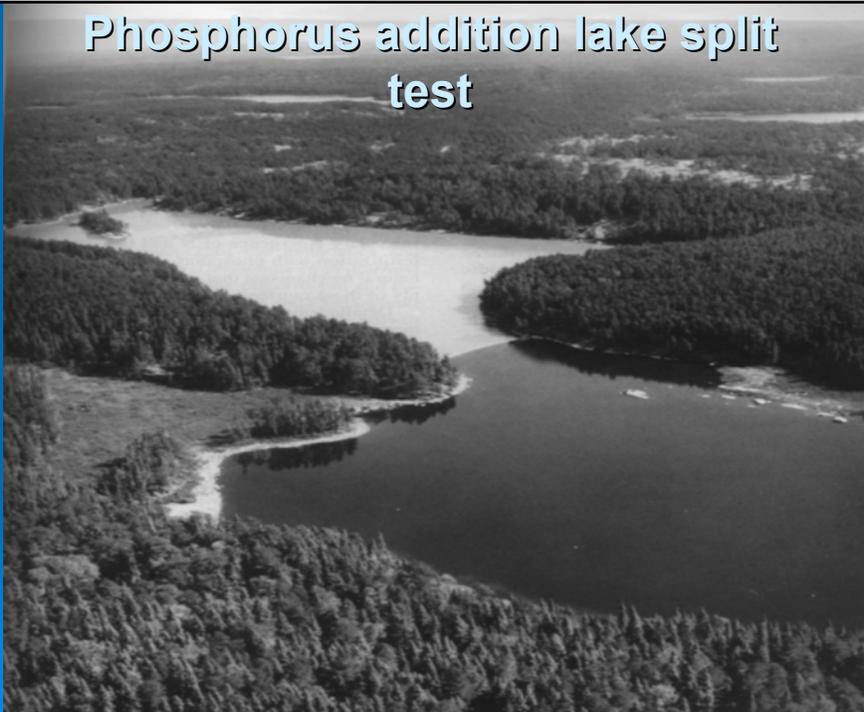
Good water is the life of terrestrial landscapes. Three structural features of the twin lakes in Flushing Meadows negatively impact the quality and quantity of water:

Ringed by roadways that cut the landscape off hydrologically from surrounding ecological communities, while discharging pollutants into the lakes, disturbing and disrupting habitat.

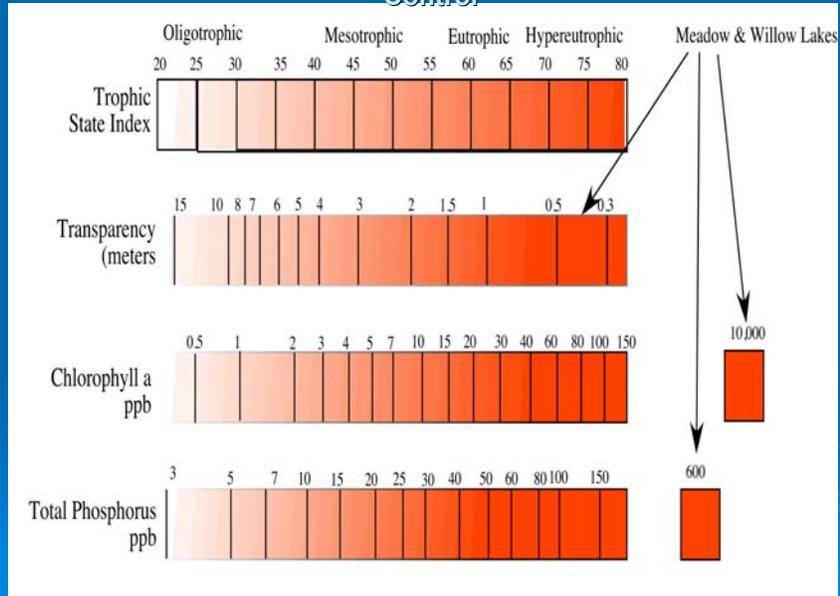
Stormwater is diverted out of the watershed. Less water flowing in means a reduced flushing rate in terms of throughput, as well as less water to support plant community growth.

High nutrient content in the underlying sediments from historic salt marsh is compounded in Meadow Lake by the grassy lake edge, attracting geese that deposit droppings and yet more nutrients to the water.

Phosphorus addition lake split test



Eutrophication Indices-Hypereutrophic equals beyond Biotic Control

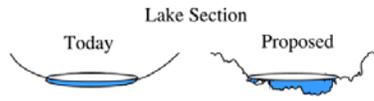


Principles Informing Ecological Design (Biogeochemical Enhancement)

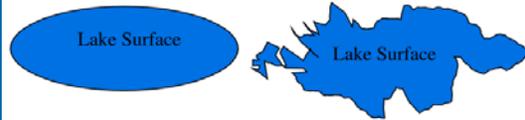
- *Structural Diversity Can Increase Free Energy Lowering Capacity: Hypothesis: Ecosystem Growth and Development Moves Natural Systems Far from Thermodynamic Equilibrium*
- *Hypothesis: The Evolution of Terrestrial Life Increased Land Surface Structural diversity.*
- *The Biota Increased the Filter & Exchange Area of the Earths Surface. Life on Earth Has Changed the Hydroperiod of the Terrestrial Biosphere.*

The Geometry of Ecological Enhancement

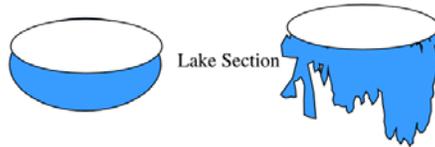
Increase in complexity/structural diversity



Increase in Lake Edge Length and the Number of Promontories and Coves



Increasing Lake Volume and Benthic Structure and Habitat

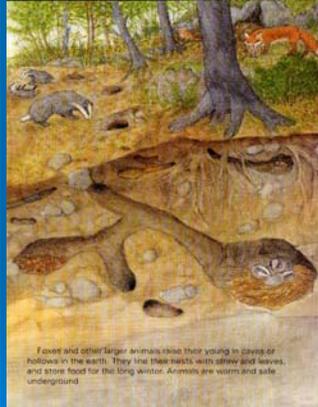
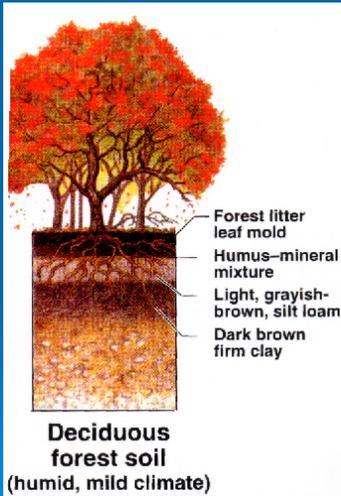


Fractalizing Edges

Controlling Erosion



Increasing biomass to improve soil quality



Meadow & Willow Lakes Today



2000 Meter Rowing Course with Soil & Wetland Buffers



El Jardin del Paraiso



Lower East Side: El Jardin del Paraiso: Stormwater capture and lead mitigation cap

NOTES

Turf operation

Refrain from any on-site turf activities until the cap is installed. (This means edge erosion or equipment activity.)

Attention: Turf patterns will be 15' x 15'. Grading depth will be 110'.

Full coverage of soil exposed under final 1.5m storm cap to avoid soil damage (Storm impact damage is minimized) under trees and adjacent to them and building edges. Excavate will be required using hand tools and tools.

Capping

Mulch, mulch/soil, or approved equivalent

12" Min. compost layer

2"± sand layer

Approx. 6" biosolids

Jeroloff soil depth

Typical cap cross section, not to scale

Only to be installed under active site.

No cap will be needed until the 12" top of all the traffic or above exposed the mat.

Overwater will maintain composition of biosolids during installation.

The surface will be mulched with woodchips or equivalent material.

- One foot of compost from NYC DOS and/or Green Thumb
- Two to several inches of clean sand or ground brick, concrete, & rock
- Several inches of composted NYC DEP biosolids
- Fill presently on site, left in place, unmodified

El Jardin del Paraiso



Penn & Fountain Ave Landfills



Pelham Bay Landfill



The sectional area of the Earthstone Creek/Hackensack River estuary between the Pelham Bay landfill and Rodmans Neck from the Show Road bridge to the northerly bank of Turtle Cove would be decreased by a dike with a containment facility attached as shown. This would lead to relatively small changes in the structure of the channel's bed, with increases in Bay- side and French tides ranging between about 20% and 50%. Flow changes in other areas of Earthstone Bay adjacent to the containment facility, would be less significant.