The Value and Function of Natural and Constructed Wetlands

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Presentation

- Historical perspectives
- Present perspectives
- How wetlands function
- Examples of natural wetlands
- Differences between natural and constructed wetlands
- Examples of constructed wetlands

Historical Perspectives

North America once had vast areas of wetlands associated with virtually every stream, river and lake

- 100 million – 250 million beavers
- Beaver ponds rapidly turn into wetlands

- Runoff was filtered by sod, woodlands, and wetlands
- Particulate and dissolved nutrients were retained on land or were mineralized

Present Perspectives

- >50% of wetlands have been lost to agriculture, settlements, roads
- Now most mammalian biomass is located near the coasts and the Great Lakes
- Wastewaters are no longer filtered though natural systems instead pass partially treated into surface waters
- Formerly harmful algae blooms were restricted to northern latitudes
- Now complexed nutrients unfiltered by sod, forest and wetland are released in our storm, urban, and agricultural wastewaters.
- Complexed nutrients stimulate marine bacteria, which allow dinoflagellates to bloom. Dinoflagellates

Marine algae bloom *Enteromorpha prolifera*
Taken prior to Qingdao, China cleanup prior to summer 2008 Olympics sailing event

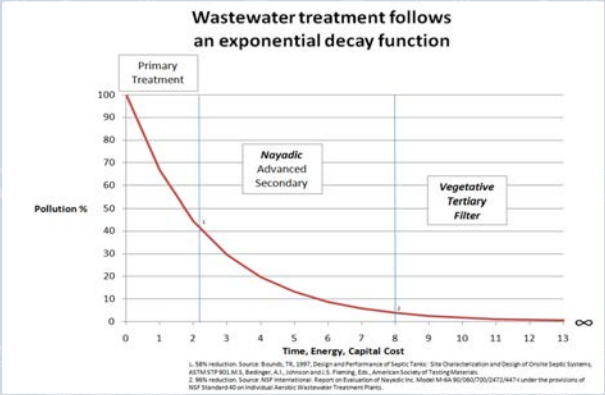
Harmful marine algae bloom

- Ecology of coastal waters did not evolve receiving complexed nutrients
- Harmful algae blooms were largely restricted to higher latitudes on both coasts

Wetlands Have a Myriad of Functions

- Remove and detoxify substances carried by and dissolved in water including persistent organic pollutants
- Nutrient & carbon sinks
- Sequester heavy metals
- Slow water release from storm events
- Recharge aquifers
- Vital wildlife habitat
- Anthropogenically express human and economic values

Theoretical Underpinnings of Contaminant Removal



Multiple Pathways for Contaminant Removal
An incomplete list:

- Sedimentation
- Filtration
- Heterotrophic and chemotropic microbial decomposition
- Precipitation
- Chemical binding
- Re-oxygenation through photosynthesis & gaseous exchange with the atmosphere
- Microbial degradation as wetlands provide vast submerged surfaces area for attachment
- Sunlight
- Alternating oxic and anoxic zones with differing microbial communities & metabolic pathways

One season's growth

Photo by Curt Kerns

Several seasons growth

Photo by Curt Kerns

Surface area of one 3.8 ft^3 bale of peat ≥ 1 dump truck load of coarse sand

Differences between Natural and Constructed Wetlands

Natural wetlands

- Formed by water movement, geological processes
- Occur where terrain is flat, impervious soils and water coexist
- Typically have short circuits through them; consequently actual retention time substantially less than theoretical hydraulic retention period

Differences between Natural and Constructed Wetlands

Constructed wetlands

- Formed by humans typically with the assistance of machines
- Short circuits are carefully avoided so actual retention time (minus volume of biota) approaches that of theoretical hydraulic retention period
- Occur where enlightened citizenry, political pressure, and wastewaters co-exist

Constructed Wetlands

A series of shallow ponds built to treat and remove contaminants from water utilizing the same principals and multiple physical, geochemical, and biological mechanisms as natural wetlands.

Utilized for:

- Stormwater
- Municipal wastewater
- Landfill leachate
- Agricultural runoff
- Acid mine drainage
- Industrial and commercial wastewaters

Types of Constructed Wetlands

- Free Water Surface
- Vegetated Submerged Bed
- Lineal
- Stormwater
- Capillary (*Vegetative Tertiary Filter)*
- Treatment Wetlands (Pretreatment/ Graywater)

Free Water Constructed Wetland at Arcata Marsh and Wildlife Sanctuary, Arcata, California

Photo by Curt Kerns

Free Water Constructed Wetland at Arcata Marsh and Wildlife Sanctuary,
Arcata, California

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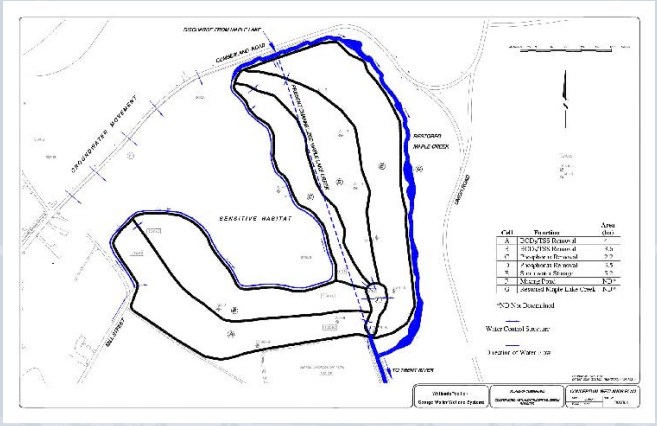
Prince George, BC Constructed Wetland



Cumberland, BC Conceptual Plan

Lighthouse Pub, Port Renfrew
First pond

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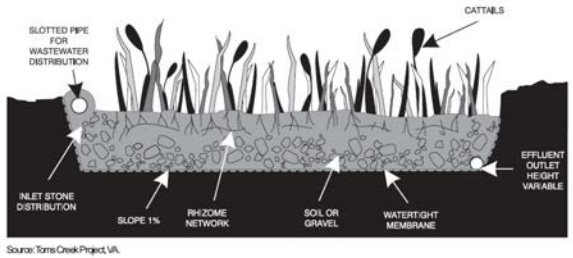
Vegetated Submerged Bed



Source: Toms Creek Project, VA


Vegetated submerged bed in the southern US

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Ditch that flooded, carried polluted water

Linear Constructed Wetland

Lineal Constructed Wetland with Arrowhead *Sagittaria sagittifolia*

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Stormwater Wetland, Arcata, CA

Stormwater Wetland, New York City, NY

Stormwater Wetland, New York City, NY

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Vegetative Tertiary Filter
Installed in after a failed Type I in shallow clay soils

Prior to construction

After construction

Port Renfrew Hotel Gunnera *VTF*

Pre-treatment/Graywater Wetland

Graywater Wetland

Upper (inflow) section

Photo by G. Gye

Graywater Wetland

Closer view of upstream end

Photo by G. Gye

Graywater Wetland

Downstream area facing house

Photo by G. Gye

Review

- Discharge of partially treated wastewaters alters basic ecology of fresh and marine waters
- Wastewater treatment follows an exponential decay function
- Large surface area: volume ratios vital
- FWS Constructed Wetlands have wide applicability
- Stormwater wetlands will become the norm
- Vegetative Tertiary Filters installed in BC & AB in the most difficult onsite situations for

VTF at planting in 2003
12' x 12'

One growing season later

Three years later

June 2005: ***VTF*** after two years, cattails are now 4.5 m x 4.5 m (15 ft x 15 ft), a 56% increase in size with concomitant increase in rhizosphere, the most biologically active soil zone

Oct 2007: ***VTF*** now 7 m x 7 m (24 ft x 24 ft) a 400% increase in size after 4 summers of growth

VTF 7 years after planting, now 10x larger