CONSTRUCTED WETLANDS: A NATURAL WATER FILTERING SYSTEM FOR CONSERVATION

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ABSTRACT

Natural wetlands such as marshes, swamps and bogs protect water quality. Constructed or artificial wetland systems mimic the treatment that occurs in natural wetlands by relying on plants and a combination of naturally occurring biological, chemical and physical processes to remove pollutants from water. As of 1999, there were more than 500 constructed wetlands in Europe and 600 in North America. Constructed wetlands are a less energy intensive and more environmentally sound way of treating wastewater and conserving potable water. A small (20’ x 20’ x 4’) constructed wetland can clean all black, gray and other runoff water for the average home. This will supplement harvested rain water. Harvested rain water that is used to flush toilets and for other cleaning uses can be reclaimed using a constructed wetland. The demonstrated effectiveness of constructed wetlands for wastewater treatment provides useful lessons to create buffer zones for various types of contaminated water. Constructed wetlands not only reclaim water but provide needed habitat for wildlife. Even a small one (20’ x 20’) will serve as a lush oasis, attracting birds, butterflies, toads and other animals.

The first single-family home constructed wetland in southern Nevada was completed eight years ago. This wetland has been regularly monitored since then and has shown excellent filtering capabilities. Two larger constructed wetlands, part of the school grounds and science projects in the Albuquerque, New Mexico School District, have had similar success.
WHY CONSTRUCTED WETLANDS?

- WATER CONSERVATION
  Runoff, gray and black water can be recycled and used on site

- ENERGY CONSERVATION
  Reduces pumping between customers and suppliers
  Gravity feed and solar power used
ENVIRONMENTAL PROTECTION

- FEWER CHEMICALS USED TO CLEAN WASTE WATER
- LESS AIR POLLUTION FROM OIL/COAL GENERATION PLANTS
- LESS WATER CONTAMINATION
CREATION OF WETLAND HABITAT FOR WILDLIFE

- LOW TECH
- LOWER COST
- EASY TO MAINTAIN
<table>
<thead>
<tr>
<th>Location</th>
<th>Freshwater (per acre ft)</th>
<th>Desalinated (per acre ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. - Carlsbad, CA</td>
<td>$531</td>
<td>$794*</td>
</tr>
<tr>
<td>U.S. - Tampa, FL</td>
<td>$488 - $570</td>
<td>$811</td>
</tr>
<tr>
<td>Cyprus</td>
<td>$234 - $530</td>
<td>$900</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>$321 - $1,974</td>
<td>$592 - $2,714</td>
</tr>
<tr>
<td>Canary Islands</td>
<td>$1,172**</td>
<td>$1,998</td>
</tr>
<tr>
<td>Malta</td>
<td>$1,172**</td>
<td>$1,630</td>
</tr>
</tbody>
</table>

*Estimate for proposed plant  **Price for consumption exceeding 80,000 gallons.

Currently, 13,600 desalination plants worldwide produce a total of 6.8 billion gallons of water daily, less than 1% of all the world’s water needs.29

FROM “IRRIGATION FOR A GROWING WORLD” RAIN BIRD CORPORATION
WATER FACTS

- Annually more than 4 million children die from waterborne diseases worldwide.
- Annually 1.2 billion people suffer from diseases caused by unsafe drinking water or poor sanitation.
- Unsafe water is responsible for 80% of all diseases and 30% of deaths in the developing world.
- By U.N. estimates, 2/3 of humanity will face shortages of clean freshwater by 2025.

From “Clearwater: One Woman’s Prayer” National Documentary PBS
USES OF CONSTRUCTED WETLANDS

- Individual homes and small businesses
- Small to medium sized communities
- Larger businesses, including factories and schools
BASIC DESIGN

TREATMENT AREA TO BE PLANTED WITH FIRST LEVEL PLANTINGS (SEE PLANT LIST THIS SHEET)
ORNAMENTAL PLANTING SHELF TO BE PLANTED WITH SECOND LEVEL PLANTINGS (SEE PLANT LIST THIS SHEET)

TURF GRASS AS SPECIFIED (EDGE OF GOLF COURSE)
ANCHOR TRENCH FILLED TO DEPTH OF 9” (FROM SURFACE) WITH 1/2” TO 1” RIVER RUN GRAVEL AND RIP-RAP

TRANSITION AREA TO BE PLANTED WITH THIRD LEVEL PLANTINGS (SEE PLANT LIST THIS SHEET)

NATIVE STONE SET PARTIALLY BELOW GRADE IN NATURALIZED ORNAMENTAL GROUPINGS OVER TOP OF ANCHOR TRENCH. 20% OF TRENCH SURFACE TO BE COVERED IN THIS MANNER. OTHER 80% TO BE TREATED AS SHOWN ABOVE WITH GRAVEL AND RIP-RAP.

SWALE AREA BETWEEN GOLF COURSE TURF AND BERM AROUND WETLAND
## Planting Schedule

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typha latifolia</td>
<td>Common Cattail</td>
</tr>
<tr>
<td>Typha angustifolia</td>
<td>Narrow Leaf Cat.</td>
</tr>
<tr>
<td>Scirpus spp.</td>
<td>River Bulrush</td>
</tr>
<tr>
<td>Scirpus acutus</td>
<td>Bulrush</td>
</tr>
<tr>
<td>Phragmites communis</td>
<td>Reed</td>
</tr>
</tbody>
</table>

## Second Level Planting (Decorative)

<table>
<thead>
<tr>
<th>Latin Name</th>
<th>Common Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zantedeschia aethiopica</td>
<td>Calla Lilies</td>
</tr>
<tr>
<td>Rhodophiala bifida</td>
<td>Oxblood Lily</td>
</tr>
<tr>
<td>Ruellia brittoniana</td>
<td>Ruellia</td>
</tr>
<tr>
<td>Salvia uliginosa</td>
<td>Bog Sage</td>
</tr>
</tbody>
</table>

## Constructed Wetland (Cross Section)

- **Option A**:
  - 6” wide x 18” deep anchor trench
  - 2” Min. Sand Base beneath liner
  - 30 Mil PVC Lining
  - 1/2” to 1” Screen or River Run Gravel
  - 2” Polystyrene Insulation (Blueboard) all around

- **Option B**: 6” wide x 18” deep anchor trench all around

**Minimum Width When Shelf is Present Shall Be 3’-0’**
A greywater wetland.
BUILDING A SMALL CONSTRUCTED WETLAND
BUILDING A SMALL CONSTRUCTED WETLAND
BUILDING A SMALL CONSTRUCTED WETLAND
BUILDING A SMALL CONSTRUCTED WETLAND
BUILDING A LARGE CONSTRUCTED WETLAND
BUILDING A LARGE CONSTRUCTED WETLAND
BUILDING A LARGE CONSTRUCTED WETLAND
SOME IMPORTANT FACTS

- EACH CELL IS 30 ft. X 130 ft. X 38 ins.
- FROM 7,500 gals. TO 25,000 gals. OF WASTE WATER CAN BE CAN PROCESS PER DAY (DEPENDING ON THE NUMBER OF CELLS)
- COST FOR INSTALLATION $175,000 TO $195,000
SOME IMPORTANT FACTS

- MAINTENANCE MOSTLY PUMPS EVERY 6 MONTHS $18 PER PUMP
- AERATION 1 hr. 15 min. 3 TIMES PER 24 hr. PERIOD
PLANT SELECTION

TALL PLANTS IN THE CENTER

LOW & MEDIUM PLANTS ON THE PERIMETER
PLANT SELECTION

- If plants are not primarily for aeration, any plants can be used.
- Use native and native-like plants.
- Choose plants for beauty.
- Choose plants that are less aggressive such as sterile hybrids.
CATTAILS IN THE DESERT
JUST ADD WATER
PLANT SELECTION

- MOST PLANTS WILL GROW IN A CONSTRUCTED WETLAND DUE TO AERATION
- PLACE LARGER GROWING PLANTS IN THE CENTER OF THE WETLAND
- SMALLER PLANTS ON THE PERIMETER
- IF THE WETLAND IS HIGHLY VISIBLE PLANT WITH SEASONAL COLOR & YEAR ROUND BEAUTIFUL
- DON’T PLANT LARGE GROWING WOODY ORNAMENTAL SUCH AS TREES
PLANT SELECTION

- CHOOSE PLANTS THAT WILL ATTRACT TO WILDLIFE
- BUTTERFLIES
- HUMMINGBIRDS
- OTHER BIRDS (SEED PRODUCTION)
- SHELTER AND NESTING SITE
Calla Lily

Variiegated Cattail

Philodendron

Iris

Ornamental plants can be used
BEACH SUNFLOWER AND SWEET POTATO CAN BE USED NON AQUATICS ROSEMARY
AGGRESSIVE PLANTS NEED TO BE HARVESTED OFTEN OVER 6 FT. REEDS, CATTAILS ETC.
WHERE TO FIND INFORMATION

**Site Location**
Newberry County (near Prosperity SC)
Homeowners: Charles and Mildred Tyler

**Pre-Installation Site Conditions**
A conventional septic system was installed in 1994 and malfunctioned within eight months. The soil is a tight clay with a restricted layer. Slope ranges from 5-17 percent. The soil is unsatisfactory for conventional septic systems because of steep slope and slow water infiltration rates. The septic system is within 100 feet of Lake Murray and sewage water surfaced and entered the lake.

**Design Considerations**
- This design is based on a 3-bedroom house allowing for 350 gallons of water use per day.
- A 1,000-gallon baffled septic tank with a sewage filter was installed to minimize solids and organic loading to the constructed wetlands system.
- Because of site conditions, a submersible pump was used to carry sewage water from septic tank to the treatment cell which is located up-slope.

**Construction**
- The treatment cell is lined with 45 ml synthetic rubber which prevents seepage into ground water.
- The lined treatment cell, the sewage water flows through gravel and the roots of aquatic plants. The water is maintained at a depth of 12 inches. The top 3 inches of the gravel surface remains dry.
- Sewage water is pumped into the treatment cell. Micro-organisms that grow in the gravel bed digest the organic material and the aquatic plants absorb nutrients and assist with water disposal through transpiration into the atmosphere. Some of the water will pass into the atmosphere through evaporation.
- Any remaining treated water is released into the underground disposal cell which consist of 18 inches of sand and gravel.
- Aquatic vegetation consists of native lilies, blue and yellow flag, iri, elephant ear, pickerelweed, giant bursh and giant cattails.

**Maintenance**
- Property owners agree to:
  - Maintain designated water level in treatment cell.
  - Monitor aquatic vegetation in treatment cell.
  - Perform periodic pump-out of septic tank and cleaning of sewage filter.

In the spring of 1999, eight constructed wetland demonstration sites in South Carolina were installed on failed septic systems by the South Carolina Resource Conservation & Development (RCD) Council. Three demonstration sites will serve as an evaluation of constructed wetlands as an alternative for malfunctioning non-functional septic systems, as well as offer opportunities to allow on-site owners current technology in treating septic systems in South Carolina. Each site will be monitored for 12 to 18 months to determine the effectiveness of constructed wetlands in reducing pollutants in household sewage water.
The Decentralization of Private and Municipal Wastewater Treatment Through the Development of a Constructed Wetlands Policy

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University of Nevada Cooperative Extension

Rationale and objectives for this policy

As the nation's population continues to grow, development is pushing further from the centralized wastewater treatment plants and more into rural areas. In many areas, the conventional septic tank/field line systems have proven inadequate for wastewater treatment. Various reasons for this are high upon water tables or poor soil percolation rates. In the United States, there are over 25 million septic tanks in use of which 25,000 are in Southern Nevada. Nationwide septic tank failures run from 36% to 72%. It has long been recognized that natural wetland such as marshes, swamps, and bogs, help protect water quality. Constructed or artificial wetlands systems mimic the treatment that occurs in natural wetlands and by relying on plants and a combination of naturally occurring biological, chemical, and physical processes, to remove pollutants from water. As of 1999, there were more than 500 constructed wetlands in Europe and 600 in North America. With many of the centralized wastewater treatment plants aging and in need of upgrading, less energy intensive and more environmentally sound ways of treating wastewater and conserving potable water are needed.

The USEPA publication "Response to Congress on Use of Decentralized Wastewater Treatment Systems" lists the following benefits of decentralized systems:
1. Protect public health and the environment, and promote better watershed management by avoiding the potentially large transfers of water from one watershed to another (wetlands have been able to remove 78.8% BODs, and up to 99% fecal coliform)
2. Appropriate for low density communities
3. Appropriate for varying site conditions
4. Protection of ecologically sensitive areas by removal of nutrients (40.2% to nearly 100% of ammonia has been removed from the wastewater by wetlands)
5. Promote cost savings due to lower capital investment and maintenance costs. The Tres Rios pilot project in Arizona cost $3.5 million to build compared to the $625 million estimated to upgrade the existing facility. Only $80 million more was needed to turn the pilot project into a comparable full-scale treatment facility. This reflected a savings of over $542 million over upgrading. In addition, local aquifers were recharged and other water reuse opportunities such as wildlife habitat were provided. The Kingman, Arizona facility was designed without environmental wetlands attractions because of liability concerns. Such features would attract the public. Yet, these wetlands still attract wildlife. This is especially true in desert areas where water is so scarce. Urban residential areas are provided with wildlife and ornamental value without the use of potable water.

References


DuFay, John A. "Constructed Wetlands Systems Aeration for Nitrification/Denitrification"

Ogden, Michael H.P. "Constructed Wetlands for Small Community Wastewater Treatment." (final draft to be published later 2000)


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CONSTRUCTED WASHES
CATCH RUNOFF
EXAMPLES OF A WORKING SYSTEMS
THIS WATER CAN THEN BE FILTERED IN CONSTRUCTED WETLANDS
REMEMBER WE ALL CAN CONSERVE WATER
FOR MORE INFORMATION CONTACT

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