ARTIFICIAL OR CONSTRUCTED WETLANDS

Introduction

Our nation has lost a sizeable portion of its natural wetlands in the past two centuries through development, road building, farm drainage and other practices. Many consider wetlands to be waste areas, prime candidates for drainage and clearing to rid the unworthy sites of snakes and mosquitoes, making them fit for human use and habitation. In recent years environmentally conscious people have come to appreciate the worth of wetlands -- and the term is now one of respect -- as people learn to appreciate the profound diversity of life that are wetlands.

Reversing wetland losses may occur in our own backyard with several beneficial effects. Wetlands:

* can be built in difficult terrain, shallow bedrock, and in odd-shaped lots, where it is difficult or impossible to put leach fields;

* are low-cost and can be built by the everyday do-it-yourselfer following some simple rules;

* efficiently use home waste water and save on lawn or shrub watering;

* couple handily to a home equipped with a dry composting toilet, allowing disposal of greywater (all domestic water from washing and other non-human waste emissions);

* and can have beautiful arrangements of plants growing on the cell surface. Because of this the artificial wetlands can be placed prominently and not hidden on the grounds.

The Rationale

The principle of water purification due to this natural treatment method is quite straightforward. Wastewater enters the cell and comes in contact with aquatic-type plants, which are planted in the gravel media. As oxygen from the air penetrates the surface mulch, beneficial microorganisms and fungi thrive and reproduce in the system. They attach to plant roots and rock media, where they, together with the plants, utilize organic matter and nutrients from the wastewater as food and fertilizer. In addition, fairly large amounts of water may be lost through evapotranspiration. The resulting effluent is treated to a very high degree.

Determining Quantity of Water Effluent

Much depends on the amount of water coming from the building(s). A rule of thumb is one cubic foot of artificial wetland for every gallon per day of waste water effluent, or 120 square foot cell, 1 foot deep, for a single bedroom house. If a dry compost toilet is in use the amount of domestic water use is less than half a similar house containing standard toilets (though volumes may change due to low-flush toilets now being mandated by 1997).

Because of conservation consciousness inhabitants, who use a limited supply from a cistern at the ASPI Solar Demonstration House (about five gallons per person per day), a French drain of about 120 cubic feet of gravel has proven quite satisfactory for a dozen years. However, a desire to demonstrate a more acceptable form of waste water disposal prompted ASPI to install a standard sized cell of 120 square feet in front of the current greywater system for use as a wetland.

When you determine your domestic water use, and it is quite low due to conservation, overbuild rather than underbuild. It is possible to feed surplus water to the wetland in case the domestic supply is insufficient to allow it to support wetland type plants. Some people may wish to use their small quantity of greywater for the greenhouse. It is even possible to have a mini wetland within the greenhouse or enclosed. When this is done the water is used to grow the crops that are more useful to the residents. In other words, artificial wetlands can become part of an edible landscape.

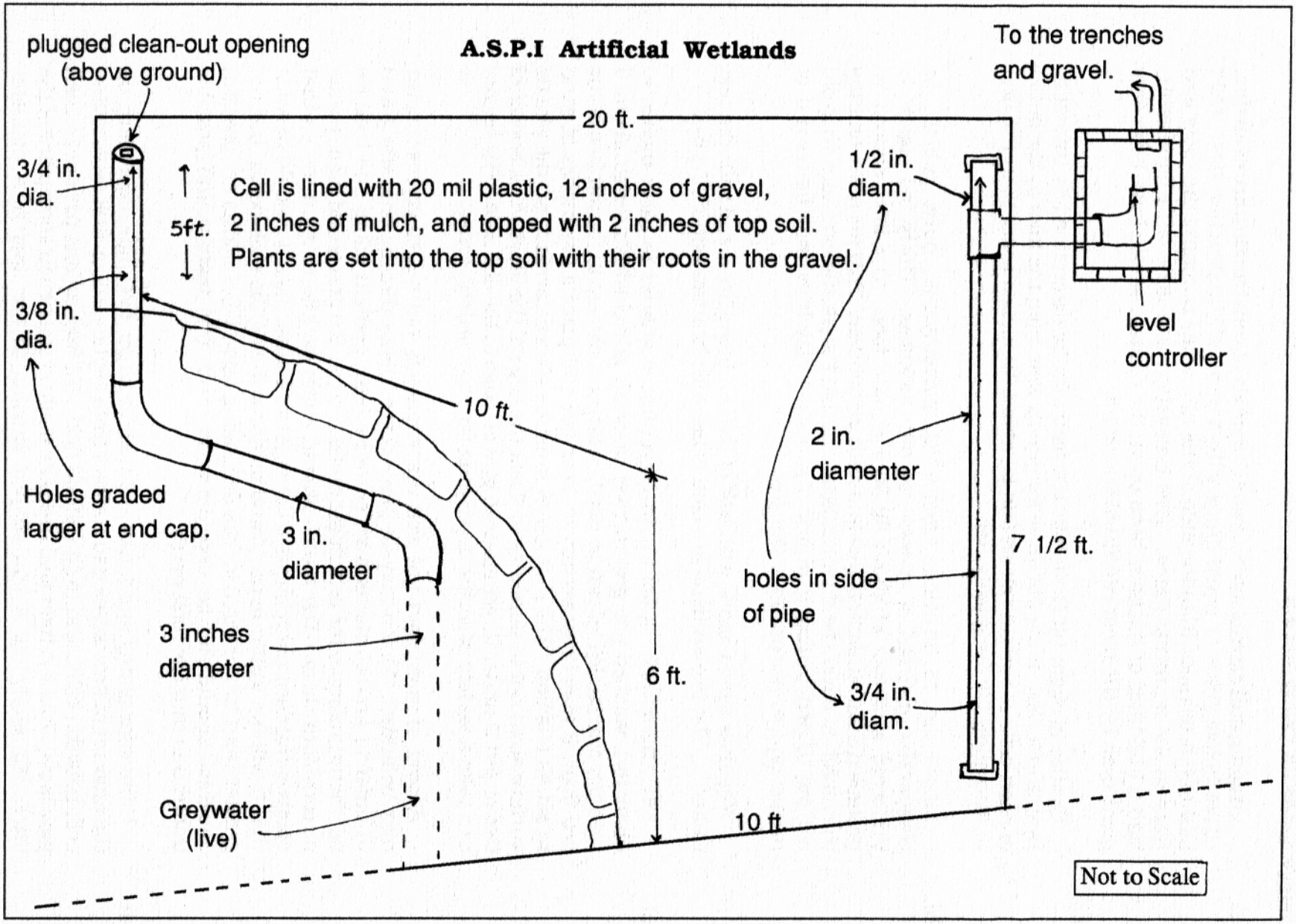
Choosing the Site

The wetland site is very important, for much depends on the quantity of water, the natural topography of the land, access to construction materials, and the placement in respect to the architecture of the house. A proper length to width ratio should be maintained, dependent upon the volume of water entering the field, (e.g., 4 by 90 for a standard three-bedroom house). Most regulatory agencies have lateral overflow field requirements, which need to be considered in the construction of the artificial wetland. The sizing will depend on the nature of the soil conditions, the type and volume of the waste flow, and the particular design features of the system.

Consider placing the wetlands in a prominent place, where it can be seen by visitors. Steep slopes are no bother if one realizes that the shapes of wetland may vary considerably. Curves are not impossible except that it is more difficult to lay out liner in such configurations. The cells may be terraces of a wide variety of shapes depending on the available lands, current vegetation, and the general design of the grounds. Appalachian slopes call for innovative procedures. ASPI has many of its buildings immediately above a flood plain and public road, which do not allow for sweeping artificial wetlands.

Sizing Requirements (Kentucky State Guidelines)
Typical Constructed Wetlands

Bedrooms	Size of Cell	Length of Laterals
1	120sq. ft. (4' X 30')	100 ft.
2	240 sq. ft. (4' X 60')	150 ft.
3	360 sq. ft. (5' X 72')	200 ft.
4	480 sq. ft. (6' X 80')	300 ft.


A.S.P.I Artificial Wetlands
plugged clean-out opening
(above ground)
To the trenches
and gravel.
20 ft.
3/4 in.
dia.
5ft.
Cell is lined with 20 mil plastic, 12 inches of gravel,
2 inches of mulch, and topped with 2 inches of top soil.
Plants are set into the top soil with their roots in the gravel.
1/2 in.
diam.
3/8 in.
dia.
level
controller
10 ft.
2 in.
diamenter
Holes graded
larger at end cap.
3 in.
diameter
7 1/2 ft.
holes in side
of pipe
3 inches
diameter
6 ft.
3/4 in.
diam.
Greywater
(live)
10 ft.
Not to Scale

Suggestions on Construction

a) Grading and excavation -- several methods of construction are available, either below grade or equal grade with a berm of construction ties. ASPI had to cut terraces from the side of the hill, while retaining the roots and trees in the immediate area. This excavation was done with hand tools. Had a bulldozer or backhoe been used, the damage would have been very great even by the most careful of operators.

Grades of slight tilt (1 inch in 100 feet) may be determined by transit or by use of levels. It should allow for gravity flow from the inlet to the outlet of each cell. A second cell should be about 12 inches lower than the first to also allow for the gravity flow.

b) Liners are to be made from PVC, polyethylene, butyl rubber, or comparable material of at least 24 mil thickness. Thirty mil plastic is preferred at a cost of about $0.50 a square foot. The liner should be protected from sunlight before and after installment. This means extending the mulch to cover the liner material. Unfold the plastic carefully, to avoid cutting or penetrating it in any manner. A clay liner may be used if of proper type to permeability the area.

Wetlands can be made with half of the bed being lined and with the rest unlined. The two sections are connected with headers and PVC pipe.

c) Filler materials -- Clean road gravel (three quarter to three inches in diameter), washed pea gravel, river or creek gravel which weigh about 5 tons per 120 cubic feet can be used. If larger rocks are in the surface of the cell floor, it may be necessary to clear out and place a few inches of sand to act as cushion. The first gravel must be placed carefully on the plastic surface so as not to puncture it. Tack the edge of the plastic to a border of ties or put it under larger stone to give an edge to the cell area. The border can take a variety of forms depending on one's artistic sense.

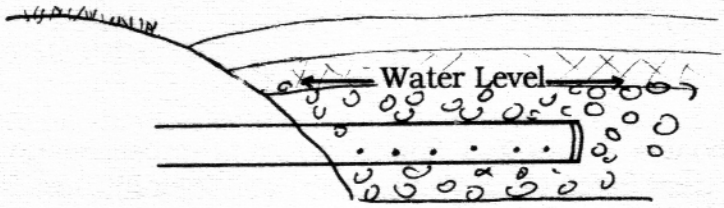
A layer of moist (but not wet) uncompacted, but not clayey, soil cover may be added. Mulch may be placed over this or directly onto the gravel in order to protect plants from summer heat, contain odors and lend an aesthetic quality to the cell. Some prefer to leave the gravel and place plants directly into them. The mulch should either be kiln or air dried so that composting does not occur and damage the plants. Its size should be such that it will not infiltrate the gravel media and clog the rock pores, but not greater than two to three inches depending upon what plants are present. Sawdust should not be used because of its fine texture and possible infiltration into the rock pores.

d) Connector piping and tanks -- 2-inch or larger PVC pipe, depending on the amount of flow is used to connect from septic tank or first tank to first cell, between cells, and to the lateral field. (At 600 gallons per day, 4 inch pipe is required.) A tight seal needs be made at the penetration point of the liner. Carefully cut a star-shaped opening in the liner to a diameter

approximately 1/4 inch less than that of the pipe. The PVC pipe is inserted through the opening. A thin rubber gasket is placed between the liner and the pipe. The liner is then held snugly to the pipe with two plumber's clamps to make a water-tight seal. The hole is cut in the liner carefully to a diameter approximately one-quarter inch less than that of the pipe.

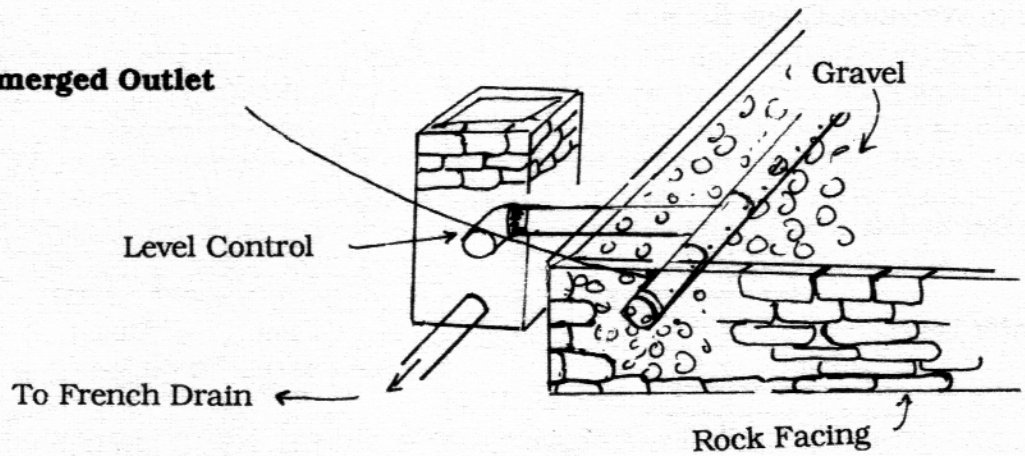
The inlet and outlet headers are made of the same diameter pipe as the lines entering and leaving the wetlands. 1/2 to 3/4 inch diameter holes are drilled in the header about 1 foot apart. For 2 inch pipe 1/2 inch holes are satisfactory. The header is placed across the width of the wetland so that the wastewater will move through the length of the cell. The outlet header could be of smaller diameter pipe or the same size with the holes of similar diameter and spacing as the inlet header. The holes in the headers are placed on the side of the pipe in the direction of the water flow.

Submerged Inlet



Place the inlet and outlet headers between 1 and 3 feet from the cell's end walls to encourage better distribution and collection. Lateral distribution piping to receive the outflow of the wetland follows standard procedures for the given location.

Submerged Outlet



e) Bordering -- ASPI has topped the front wall with another railroad tie to hold the edge of the liner in place. Rock, ties, treated wood, dirt and stone may be used to add an artistic flare to the artificial wetland according to available material and the impulse of the builders.

Plants in the Artificial Wetlands

Wetland plants should be installed as soon as possible, dependent upon weather, conditions, waste flow amounts and other factors. In many places the final inspection is not approved until the system is one hundred percent completed. The plants should be spaced a maximum of three feet apart, or as required by the particular plant species. The lined portion of the wetland can grow water-loving species and the unlined can grow plants requiring less water, which can root in the subsoil below the gravel bed.

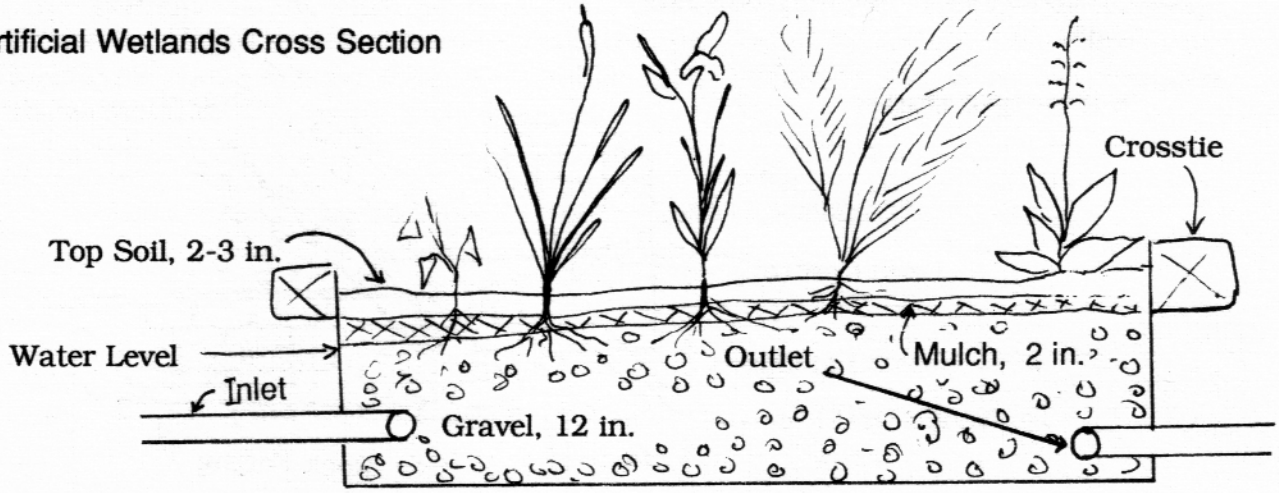
Special attention need be given if one wishes to grow edible landscaping, whether the edible be for human consumption or for birds or other wildlife. Some prefer ornamental plants for the sake of beauty. Plants recommended for Kentucky include:

* Common cattail (edible as shoots)
* Canes or wild reed (decorative & building materials)
* Soft stem bulrush
* Marsh milkweed
* Pickerelweed
* Blue water iris
* Sweet Flag

Also good candidates -- cardinal flower, water primrose, columbine, Virginia meadow beauty, water crest (open water only), spearmint, tiger lily, crooked stem aster, lizard's tail, black-eyed susan, sensitive fern cinnamon fern, and royal fern (for shade), calla lily, conna lily, elephant ear, ginger lily, turtlehead, monkey flower, water willow, marsh blue violet, mist flower, nodding bur marigold and day flower. Many of these make good providers of nectar for bees.

Note: The plants should be mature and placed below the optional soil layer and within the gravel one, though not necessarily at the very bottom.

Artificial Wetlands Cross Section



References: Ask for further details and plans at your local health department or environmental engineering agency.

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