ID-220

INDIVIDUAL RESIDENCE WASTEWATER WETLAND

CONSTRUCTION IN INDIANA

This is a joint publication of Purdue University and the Indiana State Department of Health as part of the on-site wastewater disposal project. It is intended for use by homeowners, regulatory personnel and installers of residential on-site systems.

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Photo courtesy of Brooke Pointe Inn, Syracuse, Indiana.

INTRODUCTION

Constructed wetlands can be a good alternative to conventional on-site waste water disposal systems, which usually consist of a septic tank and a soil absorption field. They may be appropriate for environmentally sensitive areas as well as areas where soils are not suitable for conventional trench systems or where space limitations exist.

Constructed wetlands are classified as a pretreatment technology, meaning that they treat the septic tank effluent prior to discharge to an absorption field where final disposal occurs. Pretreatment eases the burden on the soil absorption area by lowering the chemical and biological strength of sewage. It can also serve as a safety net by filtering out most intestinal pathogens. A pretreatment system can buffer the soil absorption field during short periods of saturation and extend its life by providing a cleaner effluent.

This publication describes general procedures for developing a constructed wetland for a single-family residence (see Figures 1 and 2). This guide is designed to be used with the diagrams included.

Note: Drawings are not to scale.

Figure 1

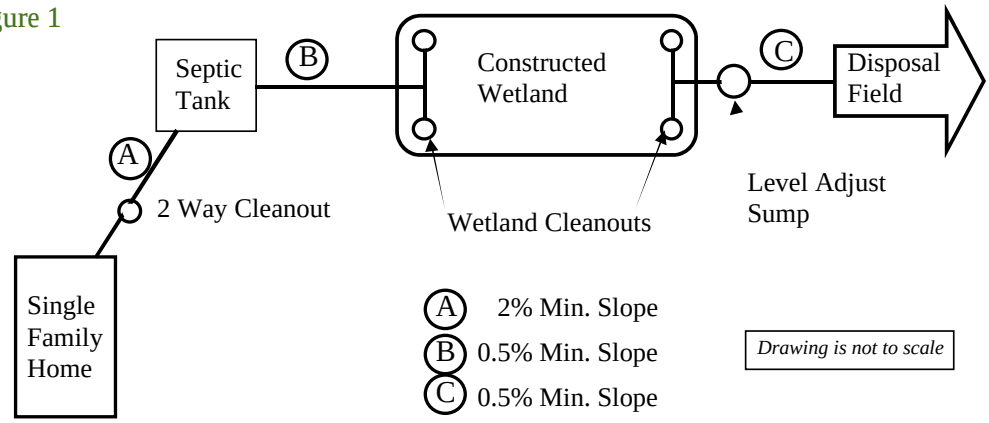
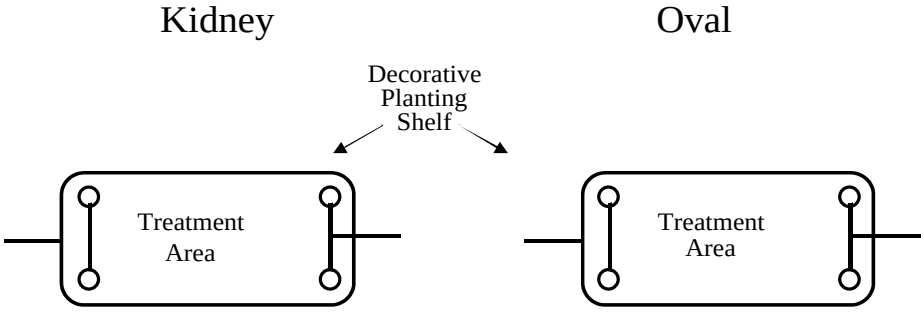


Figure 2



DESIGNING A CONSTRUCTED WETLAND

Locate and flag utilities. Provide temporary fences or barriers around the absorption field site to prohibit traffic and avoid compaction. Remove trees, shrubs, grass, and other vegetation where necessary. If it is necessary to remove soil, reserve for later use. Fill soil should be free of rocks, plants, debris, and frozen clods over two inches.

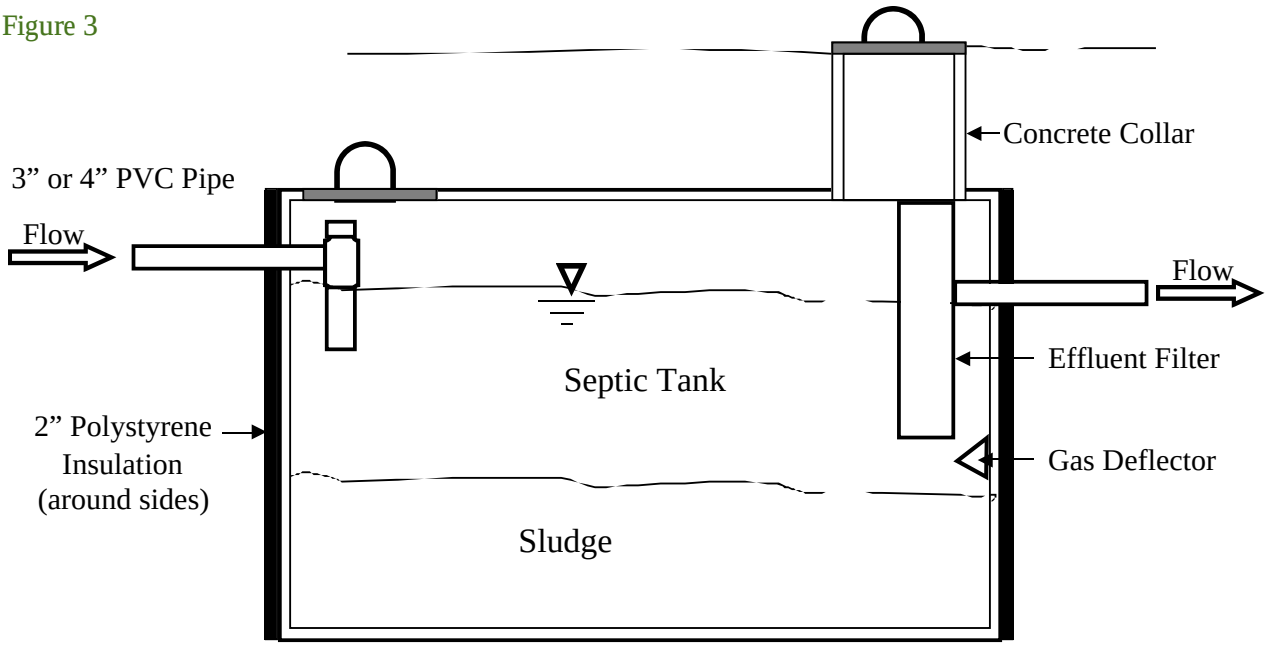
SITE PREPARATION

Grade and level area to be used for constructed wetland cell. Compact fill to the required elevations, especially in any disrupted or low-lying areas. Mechanical compaction is necessary to ensure proper base preparation. The soil may need to be dried or moistened, because maximum compaction occurs when the soil is moist.

CONSTRUCTED WETLAND CELL

Size the wetland cell at one gallon of septic tank effluent per day per square foot of wetland surface area, (or a five-day detention time). This sizing refers to the area between the inlet and outlet manifold pipes. If multiple systems are to be built, conduct a void ratio test on the gravel to estimate the correct detention time. Length to width ratios are 2:1 (or less). For example, a two-bedroom home would require 300 square feet (assuming 150 gal/day per bedroom) of wetland surface area with dimensions of 25 by 12 feet. Likewise, a constructed wetland cell for a three-bedroom home may have dimensions of 30 by 15 feet. (Note: This sizing has been generated using assumptions valid only for small (less than 750 gal/day) residential systems. Sizing is temperature dependent, and values presented here are based on Indiana winter conditions. Sizing generally follows plug flow equations. Details on sizing a range of systems can be found in Reed et al., 1995.

Figure 3



BUILDING A CONSTRUCTED WETLAND

SEPTIC TANK

Septic tnks should either have more than one compartment or contain an effluent filter to prevent transport of solids or scum into the wetland system and must be watertight. The tank should be polyethylene, reinforced concrete, or fiberglass capable of withstanding lateral pressures for intermittent periods between pump-out and liquid filling. The septic tank should contain an internal baffle and connecting tees accessible by surface access risers (see Figure 3). If using an existing septic tank, visually inspect the tank. It should be a minimum of 1,000 gallons, with the inlet and outlet piping in good repair, and show no signs of leaking.

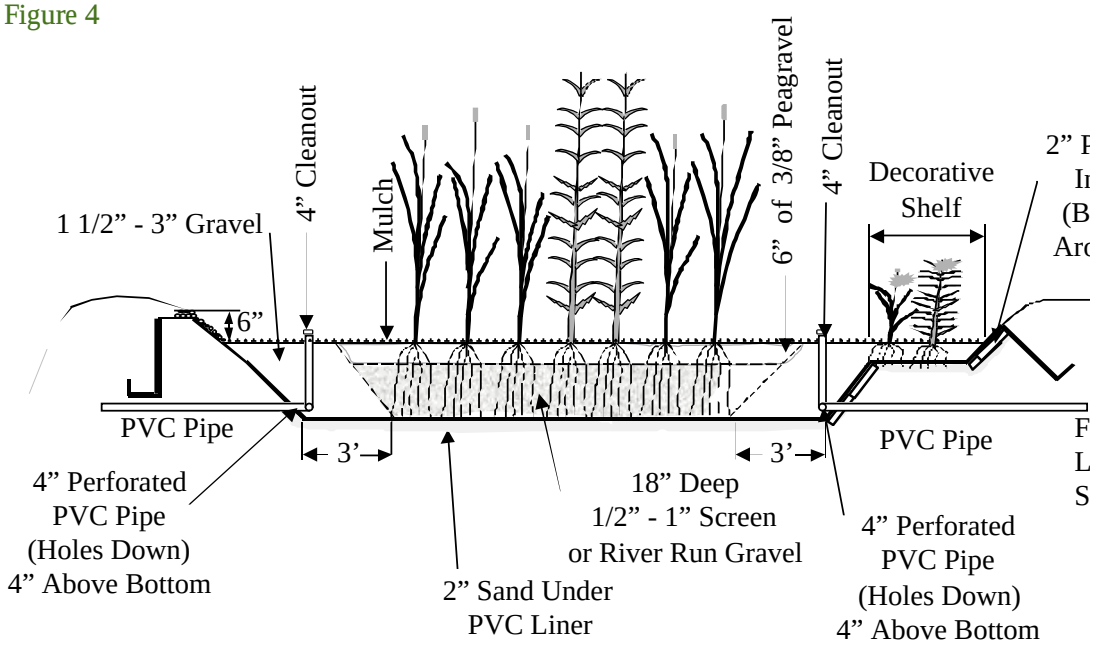
After a new tank is set in the excavation, you may wish to install 1 to 2 inches of polystyrene insulation (blue board) so that it covers the sides and top of the tank. Tank insulation can improve biological treatment, especially in Northern Indiana.

Prior to completion of backfilling, and after installation of piping, fill the tank with water and check for leaks. The tank must hold water level for 24 hours. All connections into and out of the tank and the access riser must be sealed to maintain watertightness.

ABSORPTION FIELD

The requirements for the absorption field will be determined by a soil examination. Consult the Indiana State Department of Health (ISDH) or your local county Department of Health to determine specific sizing regulations for both the wetland and the absorption field. The soil absorption field can often be downsized by 1/3-1/2 of the size required with pretreatment. However, the amount of downsizing allowed is dependent upon the hydraulic conductivity of the soil, depth to groundwater, and other factors.

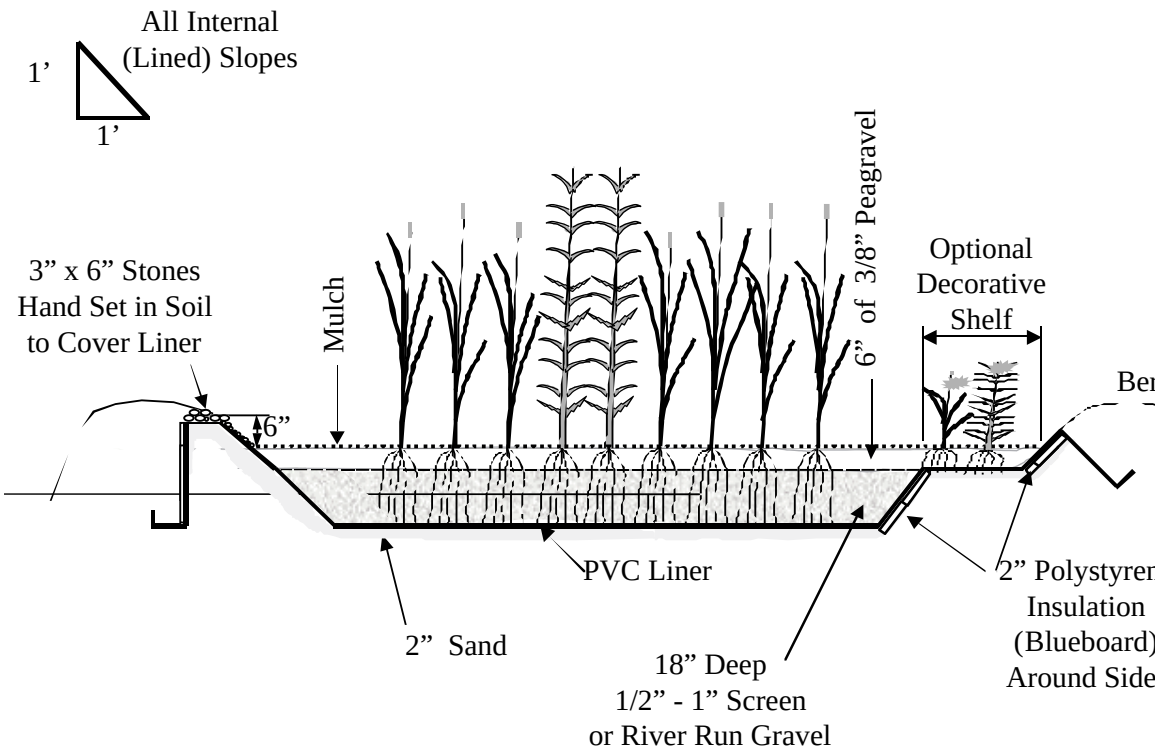
Figure 4



DOSING PUMP

Septic tank effluent may either flow to the wetland cell by gravity, or it may be pumped. Utilize gravity flow whenever possible. If a pump is required, size it for the distribution piping and elevation involved. Pumps should be equipped with automatic restart. Protect the pumps against thermal overload. It is best to add septic tank effluent to the wetland in small doses (at least once a day). Large doses may cause clogging of the gravel.

Figure 5



CONSTRUCTED WETLAND CELL

The bottom of the wetland should be level when excavation is complete. Rip-rap, 3-6 inches in size, can be placed around the septic tank riser and any cleanouts and monitoring wells in and around the wetland to protect them from accidental damage from vehicular traffic. Make sure that surface water is diverted around and away from the wetland cell (Figures 4 and 5). One to two inches of rigid insulation around the sides of the wetland cell is recommended in Indiana. The insulation will help stabilize the wetland during freezing and thawing cycles.

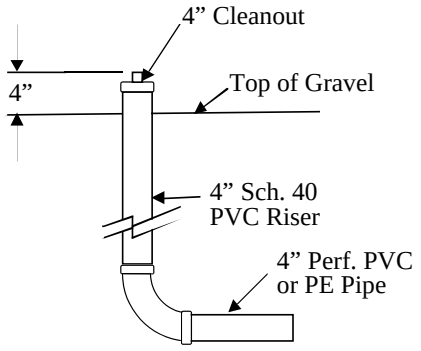
LINERS

Line the wetland bed with an impermeable liner made of polyvinylchloride (PVC), high-density polyethylene (HDPE), polypropolene (PPE), or other approved materials. (Figures 4 and 5) Liner is usually 30 mil. For residential systems, depending upon regulations, 45 mil butyl rubber liner that has been treated for UV resistance may also be acceptable. It is important that the liner be sunlight and weather resistant to protect from UV degradation. It should be free of pinholes and defects. Check the liner for leaks after placement by plugging the overflow pipe and filling with water to a depth of at least 12 inches above the top of the inlet and outlet pipes. Leave this water in the cell to protect the liner from damage during placement of the gravel. Before placing the liner, it is a good idea to line the wetland excavation with geotextile fabric (four ounces per square foot) or 2-3 inches of sand to protect the liner from punctures. Take care that the liner does not leak where the pipe enters and exits. One solution is to have the inlet pipe enter the wetland above the liner.

PIPING

Piping is usually PVC. Clean all joints and openings prior to cementing. Test all the joints under the design operating pressure before burial. Do not glue the vertical risers located in the water level control sump on the outlet end of the wetland (Figure 6). This should be removable so that the wetland can be completely drained if desired.

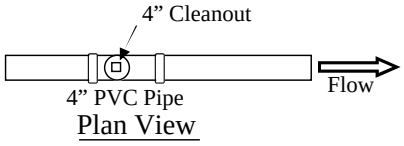
Figure 6a



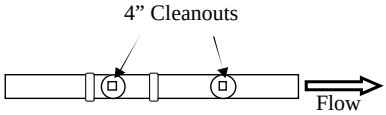
Elevation

Wetland Cleanout

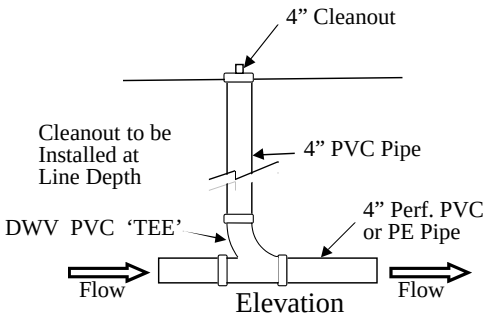
Figure 6b



Plan View

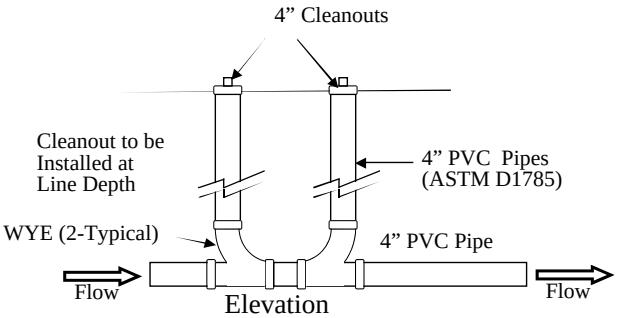


Plan View



Elevation

In-Line Cleanout



Elevation

Two-Way Cleanout

GRAVEL

Gravel should have a minimum Mohs hardness of six. There are three gravel sizes in the wetland (Figures 4 and 5).

•The surface layer should have 3/8-1/2 inch pea gravel over the 1/2-1 inch gravel, 6 inches in depth.

•The area between the ends and below the surface layer should be filled with 18 inches of 1/2-1 inch gravel (INDOT #8).

•The inlet and outlet ends of the wetland should have corse gravel in the range of 1 1/2-3 inches in size (INDOT #1).

Materials delivered to the site should be at least 94 percent free of material smaller than #10 sieve. Gravel should be screened and washed. Gravel with excessive fines is likely to cause plugging and subsequent failure of the wetland. Be careful to keep soil out of the gravel.

The inlet distribution and outlet collection pipes should be placed at the bottom of the wetland gravel. (Figure 7). The 1 1/2 - 3-inch rock should be placed first over the distribution and collection piping at each end to a depth of 24 inches and extend out at least 6 inches from the pipes (Figure 8). After establishing the desired level using the overflow pipe in the level adjust sump, the lined basin should be filled with water. This accomplishes two things: the impact of falling rock on the liner will be minimized, and the water level clearly indicates the finish grade.

The 1/2 - 1 inch gravel should be placed to a depth of 18 inches between the 1-3-inch rock previously placed at the inlet and outlet.

Place six inches of pea gravel on top of the 1/2-1 inch gravel. Finish grade must be level. Again, setting the level adjust pipe and filling the basin with water to a depth of 24 inches will aid in determining finish grades. Fill in low places (where water is visible) and grade the high spots until the finish grade is reached. Gravel depth should be no greater than 24 inches (Figures 4 and 5).

The pea gravel should not be placed directly on the 1 1/2-3-inch gravel at the inlet and outlet since it can infiltrate the larger gravel and contribute to clogging.

Figure 7

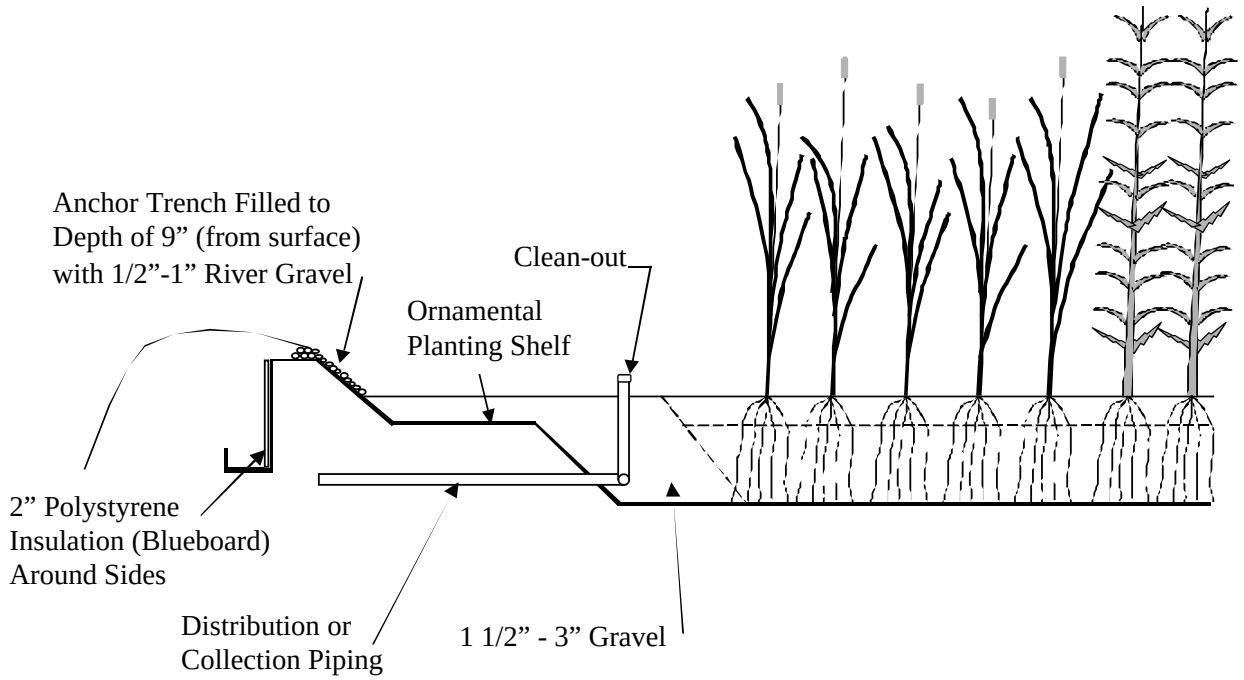
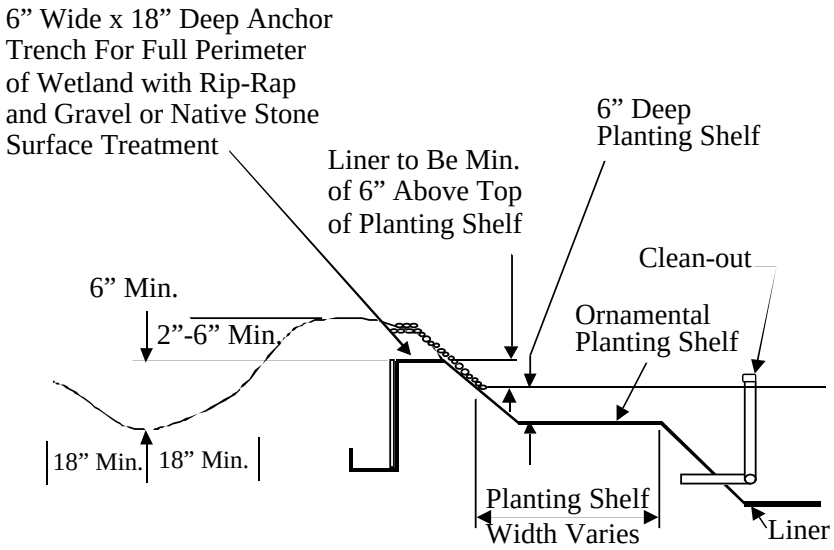


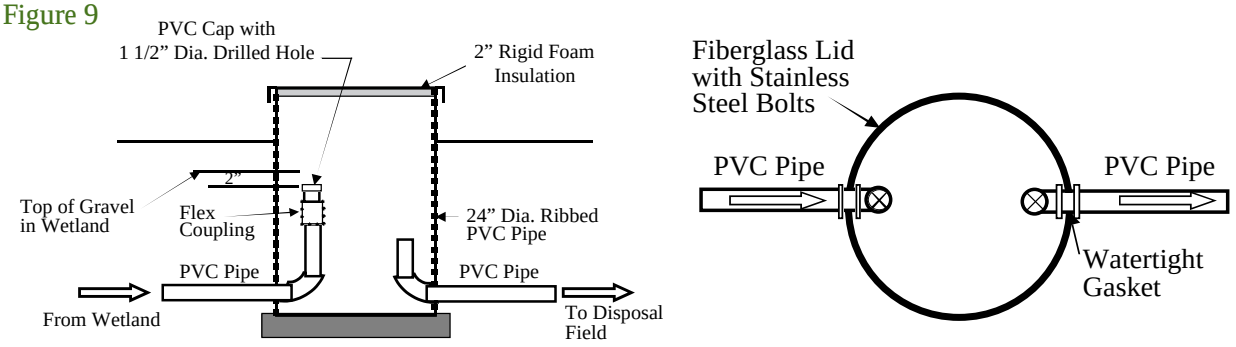
Figure 8



LEVEL ADJUSTING BASIN OR SUMP

A sump should be located at the outlet end of the wetland to provide the ability to adjust the water level to 2 inches below the surface of the gravel. One way to adjust the water level in a constructed wetland cell is by manually raising or lowering a PVC pipe in the slip-joint (socket) elbow located in the bottom of the level-adjusting basin (Figure 9).

Figure 9



PLANTS

Cattails (Typha), bulrush (Scirpus), rushes (Juncus), and sedges (Carex) are usually the preferred species for the wetland treatment area. Reeds (Phragmites) are considered an undesirable invasive species in Indiana and should not be used. Use locally grown and adapted plants whenever possible. Look for wetland perennials with deep, dense, fibrous root systems and winter tolerance. Locate the wetland where it receives full sunlight. Consult your Extension botanist or horticulturist, a local wetland plant nursery, or a wetlands consultant for recommendations. Select two to five different species, but plant same species together. Other wastewater treatment technologies may be more appropriate for heavily shaded sites that cannot be modified.

Do not use soft tissue ornamentals, such as lilies, in the treatment area. They require harvesting and may actually increase the BOD5 (five-day biological oxygen demand) and nitrogen concentrations that the system must handle. If these plants are desired, place a small decorative planting shelf immediately adjacent to the treatment area (Figure 2, 7, and 8).

PLANTING

Make sure the plants are free of disease and mold. Keep roots moist at all times. Plants should be inserted into the pea gravel bed to a depth of 2 to 4 inches with the shoots slightly exposed. Roots must be placed in water.

Planting should be done six weeks prior to the wetland receiving wastewater. Rows and plant spacing may be 18 inches apart and staggered 9 inches. Rows should be perpendicular to the direction of the flow. Planting should be done in the spring for best performance. It should always occur at air temperatures above 40˚F and should be completed before August 24 (Northern Indiana) or September 1 (Southern Indiana). If after six weeks the plants do not seem to be taking hold and growing, replant in between the original plants in a similar pattern.

If planting cannot take place earlier than six weeks before the expected date of the first hard frost, postpone until spring. If the wetland will receive wastewater prior to planting, spread mulch 2 inches deep over the wetland, (Figure 4). Select mulch that will not contaminate the wetland with undesirable weed species. The mulch can be covered with a woven biodegradable netting or jute to hold it in place. Prior to mulching, place a durable material such as porous landscape fabric over the gravel to prevent the mulch from clogging the wetland. The mulch will help insulate the bed to minimize freezing during the winter. Plants typically take two to three years to fully mature.

WATERING AND FERTILIZING

If effluent is not available soon after planting, keep the wetland flooded to within 2 inches of the top of the gravel. Apply an all-purpose water-soluble plant food at the manufacturers lowest recommended rate for lawns every three weeks until effluent is available to load the wetland. Do not let the water reach a level above the top of gravel, because plant survival will be less than 50 percent under these conditions.

The water level must be maintained within 1-2 inches below the surface of the gravel for at least one full growing season. Failure to do so can result in the death of the plants and require replanting.

MAINTENANCE AND MONITORING

MAINTENANCE

Constructed wetlands require minimal maintenance, however, they should be inspected every six months. The most common maintenance activities are pulling out undesirable plant species such as willow tree saplings, removing dead vegetation (not dormant vegetation), and cleaning pipes. Other maintenance activities include tank pumping, replanting, fertilizing, cleaning/brushing screens and pipes, and installation of barriers to exclude deer. The need to control turtles and burrowing animals has also been reported.

Septic tanks should be inspected and pumped every three to five years, depending on the tank size and number of people in the home. If applicable, make sure the distribution box is level and check any pumps and controls associated with the system. Effluent filters in the septic tank must be periodically cleaned and replaced. Do not mow grass on the absorption field shorter than 3 inches.

If residents are planning to be away from the home for longer than six to seven days, arrange to have water added to the wetland cell every two to three days.

Cap all exposed pipes and maintain the water level 2 inches below the wetland's gravel surface to control/eliminate odors. After extended use, the gravel at the inlet end of some systems can clog, requiring the first 1-2 feet of gravel to be replaced. Dosing with small doses helps to prevent this. Another management technique used to prevent clogging is to completely drain and refill the wetland two to three times a year during the growing season. This also encourages root penetration to the bottom of the wetland, particularly in the first few years of operation.

IF MONITORING IS REQUIRED

Constructed wetlands are considered experimental by the Indiana State Department of Health, and as such, monitoring may be required. A considerable amount of water can be lost through evaporation and transpiration (evapotranspiration) in the summer. Therefore, judging wetland performance based solely on nutrient concentrations leaving the wetland may be misleading, because the wetland both treats and concentrates the wastewater. Therefore, measure the flow going into and out of the wetland. From these measurements a mass balance (flowrate times concentration) can be calculated. When this information for the inlet is compared to the outlet, wetland performance can be more accurately evaluated.

When constructing the absorption field, include 3-4-inch diameter monitoring wells in the trenches. These wells consist of PVC pipe with 3/8 inch holes or slots located in the bottom 3-6 inches to allow water movement into the pipe. Place the pipe in the trench or bed before the addition of gravel. The bottoms of the monitoring wells are not capped

MORE INFORMATION:

• Natural Systems for Waste Management and Treatment. Second Edition, S.C. Reed, R.W. Crites, and E.J. Middlebrooks, 1995, McGraw Hill.

• Constructed Wetlands Wastewater Treatment Systems for Small Users Including Individual Residences, Second Edition, G.R. Steiner, J.T. Watson. 1993. Tennessee Valley Authority, Water Management Resources Group. (Available from National Small Flows Clearinghouse, Design Manual Number 65: General Design, Construction, and Operation Guidelines, Publication WWBLDM65. (800) 624-8301).

• Residential Sewage Disposal, Indiana State Department of Health, 2 North Meridian Street, Indianapolis, IN 46204, (317) 233-7177.

• National Small Flows Clearinghouse, (800) 624-8301. West Virginia University, P.O. Box 6064, Morgantown, West Virginia 26506-6064. http://www.estd.wvu.edu/nsfc/NSFC_homepage.html

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