SIMCO/WINDSOR WETLANDS

BY

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INTRODUCTION

Several hundred wetlands have been constructed in the coal bearing states of Maryland, West Virginia, Pennsylvania and Ohio to minimize impacts from acid mine drainage. Few, if any, have a synthetic liner to protect slope stability. Conventional treatment methods, particularly chemicals and mechanical aeration, can cost in excess of $60,000/year. High operating cost and lack of potential bond release has encouraged the coal industry to consider wetlands a reclamation alternative to conventional treatment. American Electric Power (AEP) Service Corporation's Fuel Supply Department is actively involved in the overall reclamation plans for its abandoned Simco #4 mine in which the wetland is an important component and the wetland at Windsor Coal Company. This wetland minimizes a refuse pile seep at the Schoolhouse Hollow Refuse Area as well as enhances the area wildlife and environmental quality.

BACKGROUND

Windsor Coal Company's Beech Bottom Mine, is one of the oldest continuously operating mines in West Virginia. It began production in 1899 and AEP purchased an interest in the property in 1918. The Schoolhouse Hollow Refuse Area, on which the wetland was constructed, received refuse from the early 1900's until 1980 when the refuse pile encompassed 30 acres.

Windsor Coal Company, with assistance from AEP Fuel Supply, began reclaiming Schoolhouse Hollow in the fall of 1981 and completed the project 18 months later.

Standard reclamation practices were used at Schoolhouse Hollow with 6-9 meter benches constructed for each 15 meter rise in elevation. The pile was also reshaped so that runoff and seepage water drained to the north side where it was easier to collect for discharge or treatment. Offsite drainage ditches were constructed around the Hollow to prevent runoff water from entering the refuse site and significantly less water enters the refuse area and seeps water quality has improved slightly over the past few years. Seep quantity has been reduced but not eliminated.

Contaminated seepage is collected and channeled to a small pond at the toe of the refuse pile near State Route 2. Collected seepage is treated with sodium hydroxide, which insures an acceptable pH limit. Maintaining a set pH limit has been difficult and fluctuating pH levels have caused occasional elevations of iron. However, the pond's location and size requires that the Fe sludge be removed by the use of vacuum trucks which, even though proven effective, are expensive.

WETLAND CONSTRUCTION

Wetland construction began on August 10, 1987 and was completed on August 14, 1987. It consists of typical wetland components -- 0.5 cm limestone, sterile mushroom compost and cattail (Typha) plants (Figure 1). The wetland was installed on the reclaimed disposal area, 60 meters below the hill crest on a four-to-one slope. Because of stability problems, the wetland was not placed upon the bench, but installing the wetland on the slope could saturate a section of the slope face and create a stability problem.

Available options for minimizing the stability problem, included excavating the wetland area and installing a synthetic Hypalon liner, or installing a clay liner. Suitable clay was not available nearby and delivery to the wetland would have been difficult. Consequently, a 36-mil Hypalon liner was chosen to protect against slope saturation.

The wetland was excavated to 2:1 side slopes with cut material used as fill for the down-slope side. Total excavation was 3.4 meters wide by 26 meters long, for a total surface area of 117 square meters. A rock/pipe drain was installed below the liner to carry water from a 4 1/min seep at bottom grade of the excavation. A one-piece Hypalon liner was placed and keyed into the side berms of the wetland.

A small lined sump was constructed beneath the existing seep collection pipe discharging into the existing riprap ditch (Figure 2), and a 4-inch PVC conveyance pipe was installed from the sump to the wetland.

Cattails were installed on 46 cm centers and seep water was directed into the wetland. Minor weir adjustments ensured even water distribution and flow across the wetland.

CONSTRUCTION COSTS:

Equipment Use:	40 Hrs. - John Deere 310 Hoe @ $60/Hr. =	$2,400.00
	40 Hrs. - John Deere 450-D Dozer @ $60/Hr.	2,400.00
	(above includes mobilization, operator & fuel)	
Materials:	Mushroom Compost - 30 Yds. @ $21/Yd. =	630.00
	Limestone Substrate - 17.8 Tons @ $7.25/Ton	129.05
	Underdrain Stone - 12.23 Tons @ $15.30/Ton	187.12
	Type 316 S.S. Weir	912.37
	36 mil Hypalon Liner	2,896.20
	Misc. Pipe and Fittings	680.86
	Cattail (Typha) Plants	2,275.00
	TOTAL	$12.510.60

WINDSOR

The outflow of the first year of operation has shown a definite spring peak. Aside from the spring peak, the flow has been fairly stable (approximately 1-2 gpm).

Through November 1988, the pH was elevated an average of 10% by the wetland. However, there does not appear to be a discernible pattern to pH change. Erratic fluctuations have occurred but overall the wetland is not depressing pH.

The Windsor wetland system was immediately effective in lowering iron levels. A lower efficiency corresponds to winter. Higher efficiencies have occurred in summer. The average iron removal efficiency during the first year is 65%.

Manganese levels are lower and relatively uneffected by the wetland.

Following the initial erratic fluctuations over the first seven months, the system appears to have settled down, lowering the acidity an average of 33%. The Hypalon liners seem to be enhancing algae growth. The effect of preventing interaction between wetland plants and the substrate is not known. (See Figure 5.)

BACKGROUND - SIMCO WETLAND

The Simco No. 4 underground mine began operation in 1970 and ceased operation on October 20, 1978. It operated three conventional sections mining the Middle Kittanning coal seam. The coal was delivered to Columbus Southern Power Company's Conesville generating station.

In May 1979, the Ohio Division of Mines and the Mine Safety and Health Administration (MSHA) approved the plans to seal the Simco No. 4 mine. All three openings at the Mine No. 4 portal were sealed and the pre-existing highwall was subsequently backfilled.

In 1980, water treatment was begun for discharge seepage that developed from the mine near the base of the backfill. Discharge specifications were met by treating with soda ash briquettes. During the next several years, the flow increased to approximately 120 gpm. However, the water quality remained relatively constant during the period 1980 through 1985.

pH (S.U.)	6.0 to 6.44
Conductivity (UMHOS)	1800 to 2900
Total Iron (mg/1)	95 to 145
Total Manganese (mg/l)	1.70 to 2.90

As the flow increased, it became increasingly difficult to treat the discharge effectively with soda ash briquettes. In an attempt to improve the treatment system and lower treatment costs, Simco-Peabody decided to use caustic soda and install an aeration system to adjust for pH and to enhance the settling of the iron and manganese.

From 1980 until 1985, Simco-Peabody studied several options to more effectively seal the mine and eliminate the discharge. One such method proposed sealing the Simco N. 4 underground mine with fixed flue gas desulfurization sludge (FGD) from Columbus Southern Power's Conesville Plant. However, both the Office of Surface Mining Reclamation and Enforcement (OSMRE) and the Ohio Environmental Protection Agency (OEPA) raised numerous questions and informal requests on the use of scrubber sludge. Concern was expressed about the long-term liability of the sludge if it were to become hazardous by degree or demonstration. The regulatory agencies also expressed concern over the sludge fixation agent.

Complicating the water discharge problem was a notice of violation issued by the Ohio

Department of Natural Resources, Division of Reclamation. The notice, issued May 1983, required Simco-Peabody to remove all treatment equipment, ponds, and totally reclaim the area. Otherwise, final bond release could not be obtained and the permit could be revoked. Abatement extensions were granted by the Ohio DNR while Peabody did further development on sealing methods design. Although plans to reactivate the entries and construct hydraulic seals within the mine were developed, and final construction details and bid requests prepared, it was eventually decided that such sealing was too costly, time-consuming and would not provide any assurance of complete effectiveness.

WETLAND CONSTRUCTION

Therefore, in April 1985, Peabody decided that a wetland could be constructed which would improve the discharge, bringing it within applicable discharge limits without the use of the existing treatment equipment. A proposal was submitted to ODNR in July 1985. After careful review, the ODNR permitted the installation of the wetland as a possible alternative to hydraulic sealing of the mine.

Site conditions of the abandoned Simco were conducive to construction of a wetland treatment system (Figure 3). The abandoned strip pit west of the backfilled portal area through which the discharge (120 gpm) passed provided more than adequate area and sufficiently low slopes for construction of the wetland system. The pit floor was graded and a layer of crushed limestone, 15 cm thick, was applied in the initial stages of wetland construction. The crushed limestone was covered with 45 cm of an organic-rich, deep-rooting medium in which lime was incorporated. Typha rhizomes were planted with a density of three to four per square yard and other wetland species were interspersed within the planting (Figure 4).

The wetland system was constructed in segments so as to provide proper gradients to restrict flow velocities and to promote uniform water dispersal throughout the wetland.

Construction of the wetland was started on October 14, 1985 and was completed on November 20, 1985. The finished area totals 3,072 square meters.

DISCUSSION

The outflow of Simco #4 Wetland is based upon two years of data and has averaged 89 gpm. Flow has been quite variable for the past three years, with a spring flow in both 1987 and 1988. The range of flow is 30-176 gpm.

The pH has been relatively unchanged by the Simco wetland system. The fact that inlet pH is 6.4 and does not drop while the iron is being removed by the system, is unusual.

Total iron removal efficiency has averaged 66% for three years. The range of removal efficiency is 21% (December 1986) to 97% (August 1988).

As expected summer coincides with peak efficiency, while winter coincides with lowest efficiency. Manganese levels are low (2.5 mg/l) and are unaffected by the wetland.

Over a three-year period, total acidity has been reduced by an average of 79%. Sulfates are lowered by an average of 5%. (See Figure 6.)

SUMMARY

Expanded use of wetlands for treatment of acid mine drainage will depend largely on

a better understanding of the various biological and chemical processes taking place within the wetland's environment. The type of vegetation, water level, water quality inflow and retention time in the wetlands are some of the variables that affect the performance of wetlands used to treat acid mine drainage.

AEP Fuel Supply considers wetlands a valuable natural tool in their reclamation programs. Not only do the wetlands improve water quality, they also provide wildlife valuable habitat and provide for possible bond release in a more timely manner

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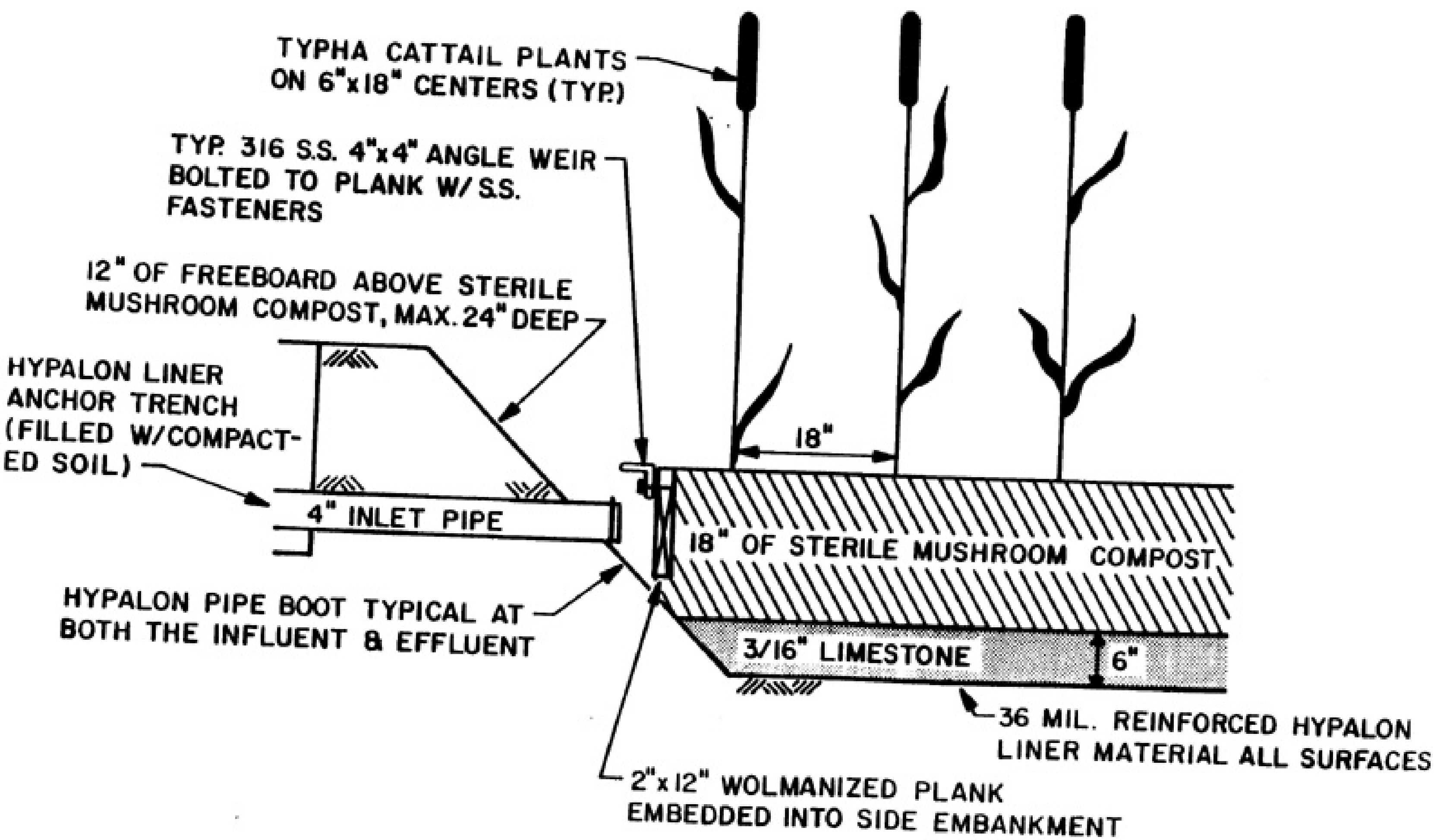
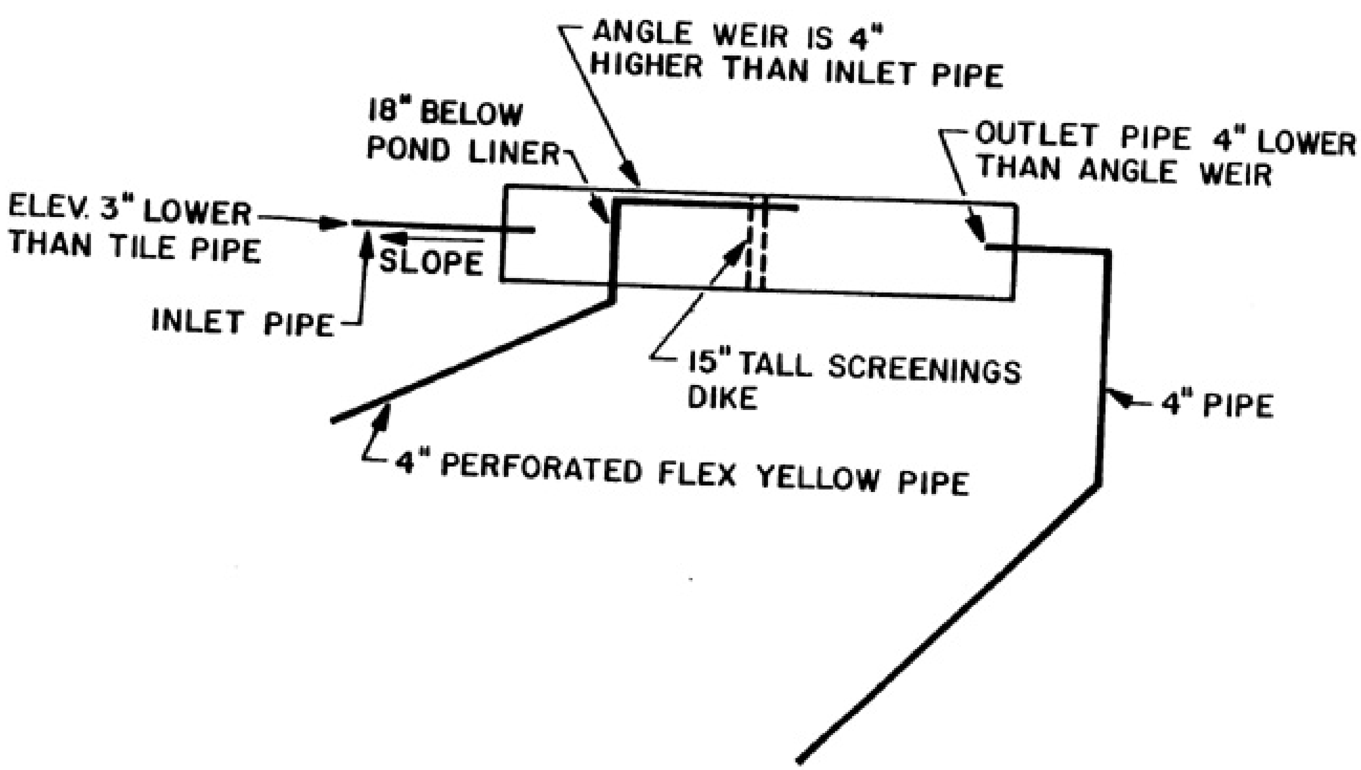
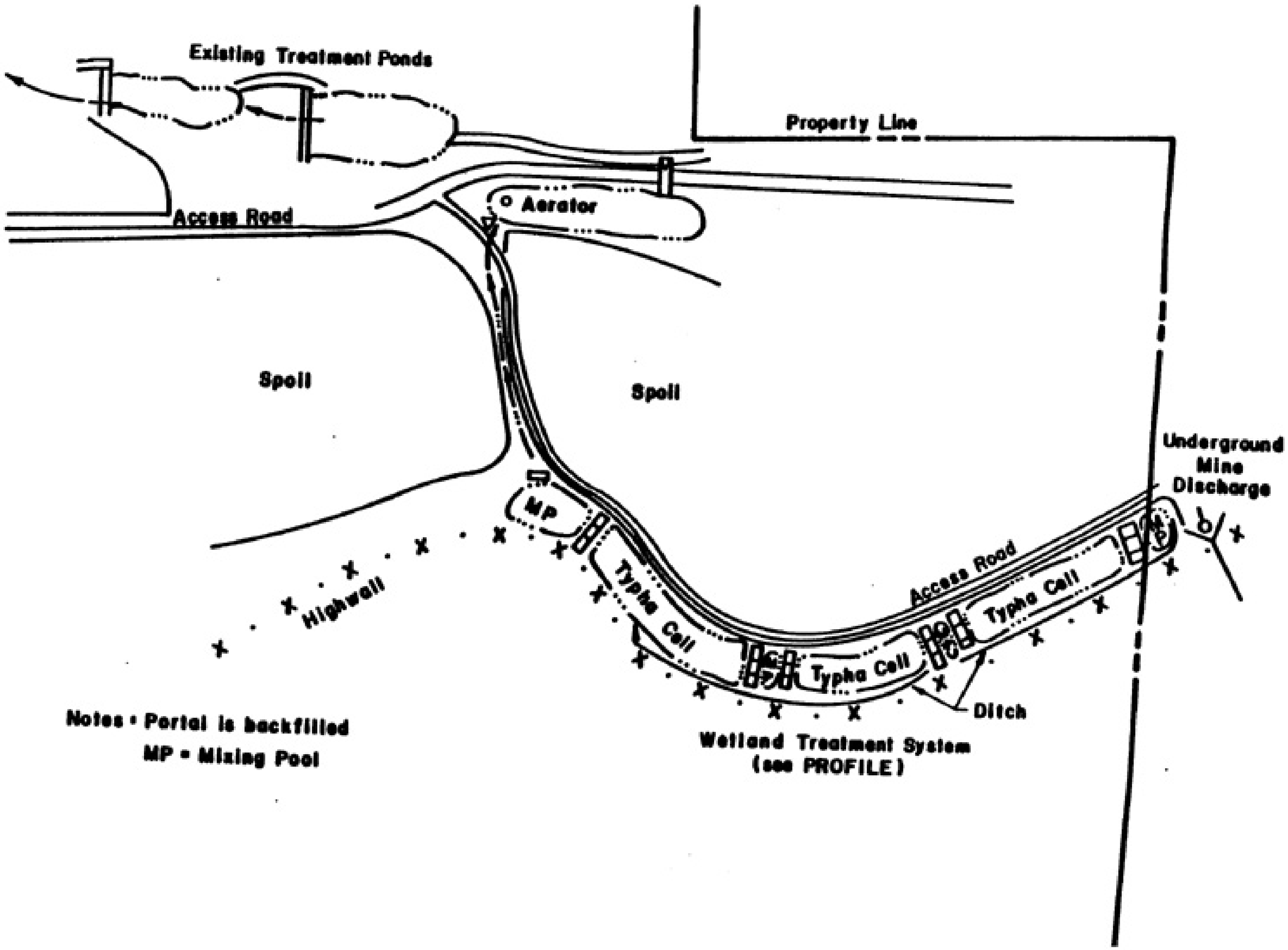
WETLAND TREATMENT AREA DETAIL



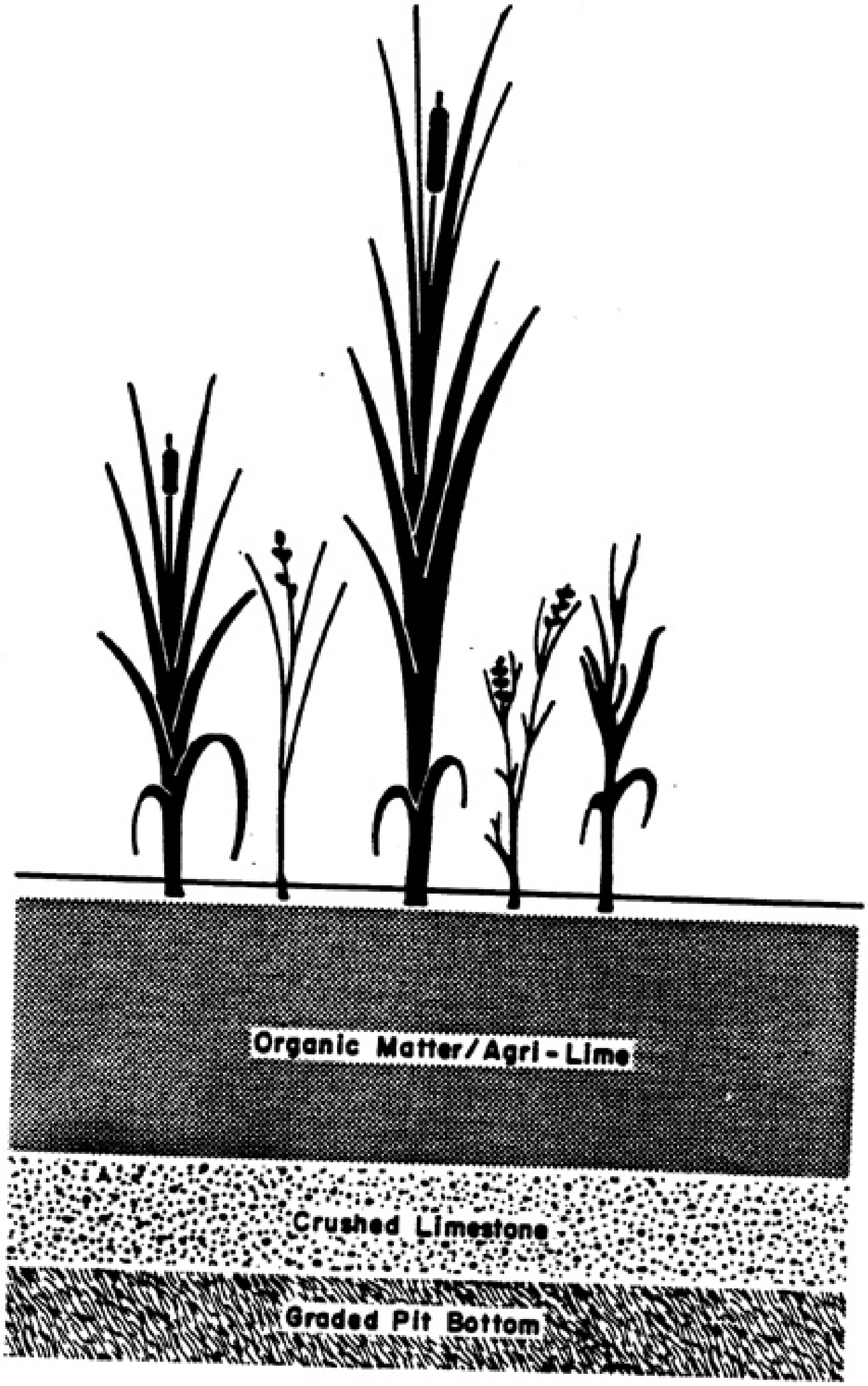
TYP. POND PLAN VIEW



SIMCO PEABODY NO. 4 UNDERGROUND WETLAND
PLAN VIEW



Notes • Portal is backfilled
MP = Mixing Pool



WETLAND GENERALIZED
CROSS SECTION

FIGURE 4

WINDSOR WETLAND SUMMARY: WATER

AVERAGES, SEPT 1987 – NOV 1988

	Flow (gpm)	pH (S.U.)	Fe Tot. (mg/L)	Mn Tot. (mg/L)	Acidity (mg/L)
IN	----	3.55	69.9	2.53	532.0
OUT	3.0	3.89	24.5	2.71	358.0
EFFICIENCY (%)	----	+10%	–65%	+7%	–33%

SIMCO #4 WETLAND: SUMMARY

AVERAGE WATER QUALITY, 1985–1988

	Outflow (GPM)	pH (S.U.)	Tot. Fe (mg/L)	Tot. Mn (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	T.S.S. (mg/L)	SO_4 (mg/L)
DNO1(in)	----	6.44	112.0	2.0	106.0	90.0	38.0	1183.0
DNO2(out)	89.0	6.34	38.0	2.5	22.0	25.0	43.0	1119.0
Efficiency	----	−2%	−66%	+25%	−79%	−72%	+13%	−5%
(N)	(76)	(77)	(78)	(77)	(74)	(73)	(74)	(55)