SIMCO/PEABODY WETLAND
AN OVERVIEW

by

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INTRODUCTION

A new technology for treating Acid Mine Drainage (AMD) utilizing wetlands as a natural treatment system has recently emerged. Wetland areas dominated by Typha, Sphagnum, certain algae, and other plant species offer the potential to treat small flows of acid mine water moving through them. Wetlands offer a cost effective alternative of treating acid mine discharge to maintain applicable effluent limits.

Recent studies conducted by the U.S. Bureau of Mines indicate that wetlands are a potential natural treatment system for acid mine discharges. Independent field testing conducted by Wright State University[2] and West Virginia University[3] both indicate significant decreases in iron, manganese, magnesium and sulfate, while the pH increased several units as the mine drainage flowed through the wetlands. The organic-rich bottom water of natural wetlands further aids in the iron removal principally as a result of bacterial oxidation.

Based upon the potential shown by these and other investigations[4,5], Simco/Peabody contacted Benjamin Pesavanto of Environmental Analytic in April 1985 to assist Simco/Peabody in the design and construction of a wetland system to effectively treat the discharge from the abandoned Simco No. 4 underground mine.

BACKGROUND

The Simco No. 4 underground mine began operation in 1970 and ceased operation on October 20, 1978. The location of the portal was a pre-existing strip bench operation of 1961. The Simco No. 4 mine operated 3 conventional sections mining the Middle Kittanning coal seam. Run-of-mine coal was delivered to the Columbus & Southern Ohio Electric Conesville Generating Station.

Upon abandonment, the mine was left unsealed and the highwall above the portal was not reclaimed to approximate original contour (AOC). In May 1979 the Division of Mines and the Mine Safety and Health Administration, MSHA, approved the Simco No. 4 underground mine sealing plans. The drift openings were sealed with 2411 concrete or concrete bulkhead constructed with pilasters. One (1) pilaster was used for widths under 161 and two (2) pilasters were used for widths greater than 161. The seals were built into the floor, ribs, and top, and the tops were supported to make the areas safe prior to construction. All three (3) openings at the Mine No. 4 portal were sealed using this procedure, 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 thru 1985.

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

During the period of March 1980 thru June 1985 Simco/Peabody studied several options to effectively seal the mine to eliminate the discharge. One such method proposed sealing the Simco No. 4 underground mine with fixed Flu Gas Desulfurization Sludge (FGD) from the Columbus & Southern Ohio Electric (C&SOE) Conesville Generating Station. However, both the Office of Surface Mining Reclamation and Enforcement (OSMRE) and the Ohio Environmental Protection Agency (OEPA) raised numerous questions and informational 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 decree, demonstration, etc. The regulatory agencies also expressed concern over the sludge fixation agent.

It was thought that the general proposal to attempt such an innovative sealing scheme might have elicited a response from the regulatory agencies relieving liability and setting up a cooperative research effort. However, this did not happen. The basic research and feasibility studies on mine sealing had been along the lines of bulkhead sealing and grouting with more conventional materials.

Since the Simco No. 4 underground mine was under an N.O.V. for its discharge, Peabody developed cost estimates for the double bulkhead seal with center plug.

Complicating the water discharge problem was a Notice of Violation (N.O.V.) issued by the Ohio Department of Natural Resources, Division of Reclamation **(D.O.R.). The N.O.V. 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 O.D.N.R. while Peabody did further development on sealing methods design. While the plans to reactivate the entries and construct hydraulic seals within the mine had ultimately been developed, and final construction details and bid requests were prepared, it was 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 contacted Mr. Benjamin Pesavento to perform a site evaluation of the abandoned Simco No. 4 underground mine. His analysis indicated that a wetland could be constructed which would be sufficiently effective to improve the discharge, bringing it within applicable discharge limits without the use of the existing treatment equipment. A proposal based upon Mr. Pesavento's recommendation was submitted to the 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 at the abandoned Simco No. 4 underground mine (Figure 1) were conducive to construction of a wetland treatment system. 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 a wetland system. The pit floor was graded and a layer of crushed limestone (6 inches) thick was applied in the initial stages of wetland construction. The crushed limestone was covered with an organic-rich.' deep-rooting medium (18 inches) in which lime was incorporated. Typha rhizomes were planted with a density of 3-4 per square yard and other wetland species were interspersed within the planting (Figure 2). The schematic wetland profile is shown in (Figure 3).

The wetland system was constructed in segments so as to provide proper gradients to restrict flow velocities (0.01 to 0.1 fps) and to promote uniform water dispersal throughout the wetland.

Segmenting the wetland system provided a gradual introduction of the discharge water into the wetland, firmly establishing the vegetation prior to the introduction of the entire discharge into the wetland system.

Construction of the wetland was started on October 14, 1985 and was completed on November 20, 1985. The finished area totaled 23,400 square feet, which is approximately 200 square feet/GPM of water to be treated. Two hundred (200) square feet of wetland surface per GPM is an approximate relationship based upon Mr. Pesavento's past experience.

The detailed construction costs for the Simco No. 4 wetland area are summarized in Figure 4.

SUMMARY

Monitoring began on December 4, 1985 and is continuing. As you can see from Figures 5 & 6, the wetland has been successful in controlling pH values at or near the discharge parameter. Total iron concentrations have fluctuated throughout the monitoring period; however, the iron concentrations have always shown an appreciable reduction when the influent and effluent discharges of the wetland are compared. As can be seen in Figure 6, reductions as high as 79 mg/l iron have been realized with as much as a 55 mg/l iron reduction in the first two (2) months of the establishment of the wetlands.

Very little Typha growth, algae growth, or biological activity was noticed in the first four (4) months after establishing the wetlands late in November 1985. However, growth of plant species and biological activity increased dramatically in the summer months.

The existing settling ponds and mechanical aerators have been left in place and the settling ponds are now used as final polishing ponds. All water quality parameters are met at this final discharge point, without the use of the mechanical aerator. Chemical treatment was discontinued in May, 1986.

Simco/Peabody continues to monitor the wetland on a regular basis, performing routine maintenance as required. Under separate contract, Pennsylvania State University is conducting microbiology and plant tissue composition analysis of the wetland. Expanded studies of the wetland are under consideration. If the wetland continues growing well, Typha should cover 50% of the surface area in early 1987. This is an average of approximately 15 stems per square yard.

Simco/Peabody has planned a fertilization schedule for the wetland during the winter months, of 7.5 lbs. of 0-45-0 and 40 lbs. hydrated lime per 1000 square feet of surface area. This is being done to maintain as much algae growth over the first winter as possible.

The collecting pond at the end of cell number 3 is being considered as an additional wetland area in 1987, enhancing the existing site.

Despite problems of channeling, short circuiting, depth of water and muskrats, the system has met our expectations. We believe such a wetland system is a viable alternative to the costly construction and uncertainty of hydraulic seals. The wetland system at the Simco No. 4 underground mine is currently providing a cost-effective control of the acid mine discharge.

REFERENCES

1. R. L. P. Kleinmann, "Treatment of Acid Mine Water by Wetland," Control of Acid Mine Drainage, *BU* Mines IC 9027.
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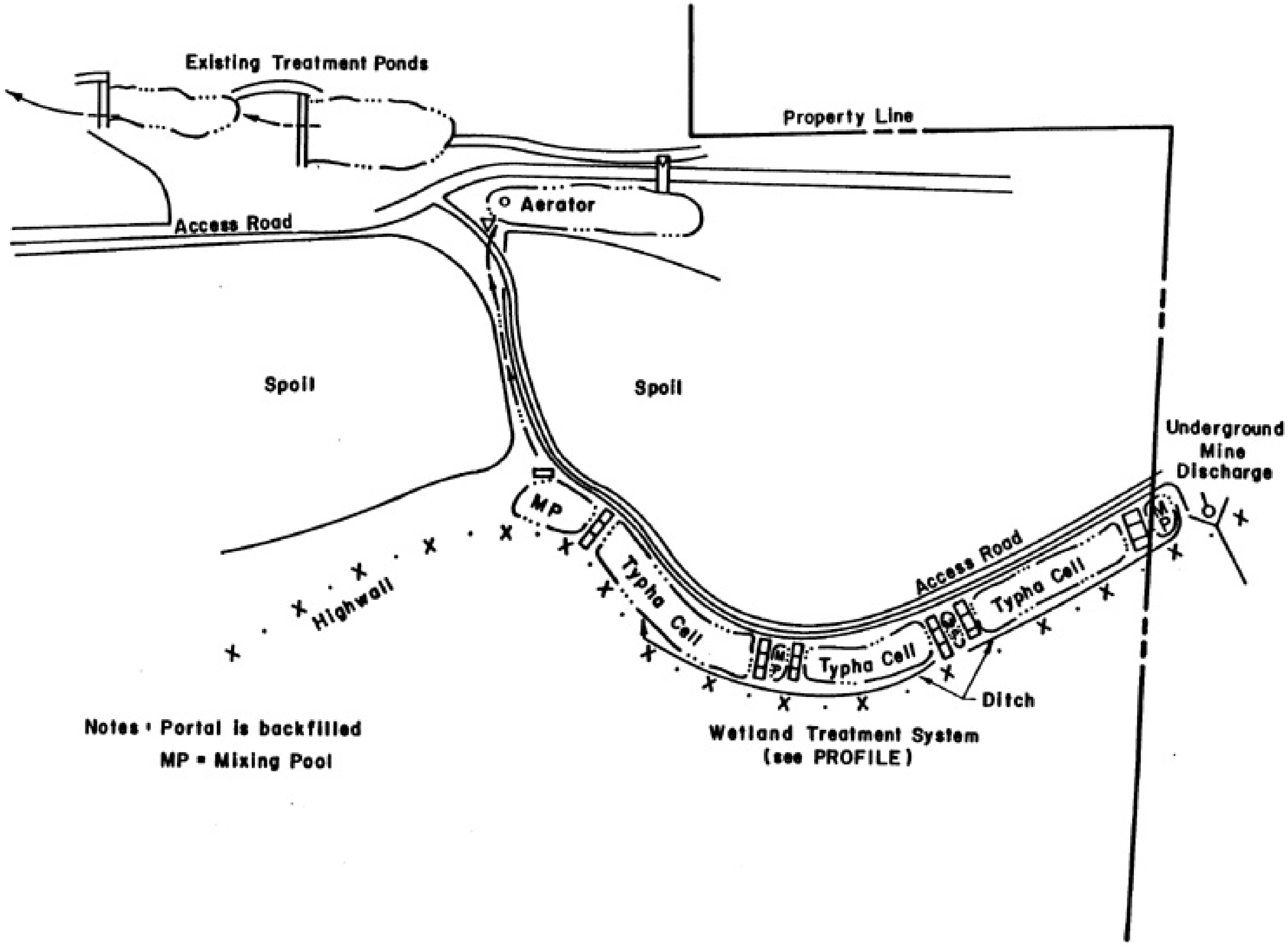
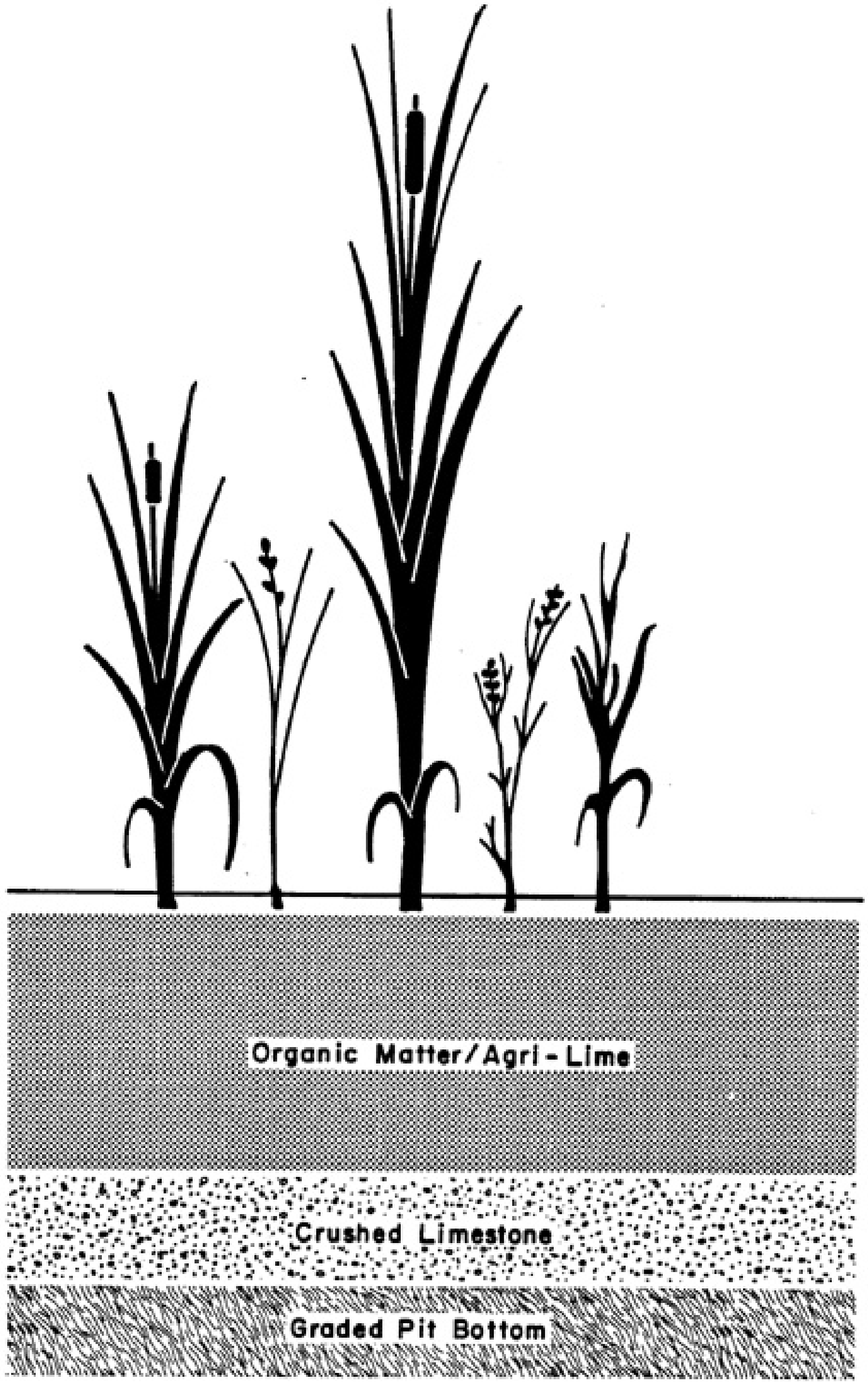
3. R. K. Wieder, G. E. Lang, and A. E. Whitehouse. Modification of Acid Mine Drainage in a Fresh Water Wetland. Paper in Proceedings, Acid Mine Drainage Research and Development, 3rd W. Va. Surface Mine Drainage Task Force Symposium. W. Va. Surface Mine Drainage Task Force, Charleston, West Virginia, 1982, pp. 38-62.
4. R. W. Stone and *B*. G. Pesavento, "Micro- and Macrobiological Characterization of Wetlands Removing Iron and Manganese," Proceedings Wetlands and Water Management on Mined Lands, Pennsylvania State University, State College, Pa., October 23-24-,-1985.5. C. D.
5. Snyder, E. C. Aharrah, "The Influence of the TYPHA Community on Mine Drainage." 1984 Symposium on Surface Mining Hydrology, Sedimentology, and Reclamation (University of Kentucky, LexingtonKentucky 40506-0046, December 2-7, 1984).

SIMCO PEABODY NO. 4 UNDERGROUND WETLAND
PLAN VIEW
FIG. I

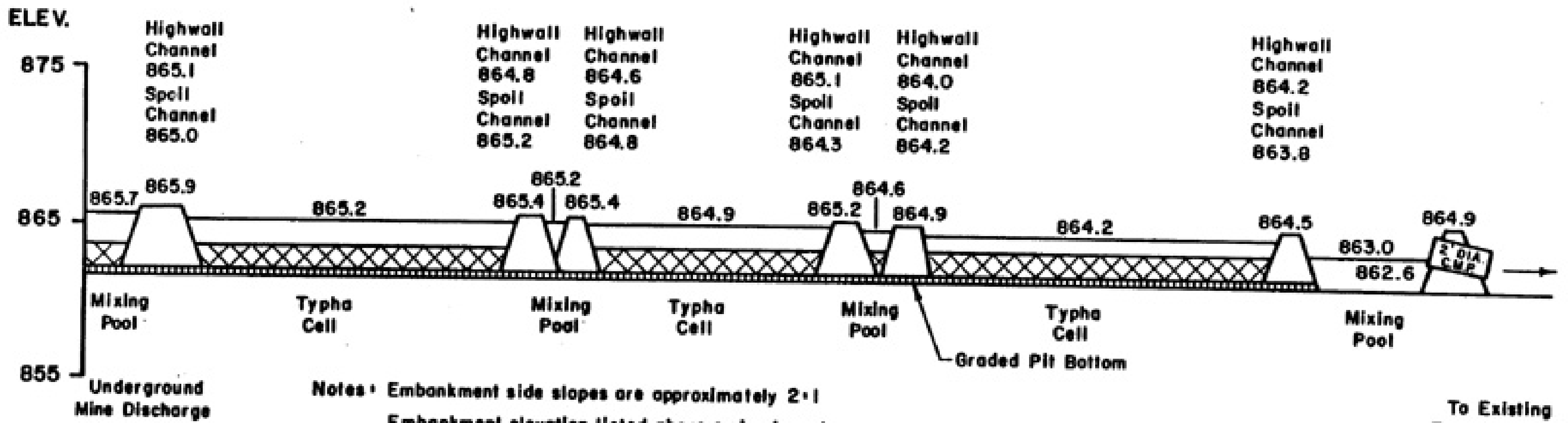


Notes · Portal is backfilled
MP = Mixing Pool



WETLAND GENERALIZED
CROSS SECTION
FIG. 2

SIMCO PEABODY NO. 4 UNDERGROUND WETLAND
PROFILE
FIG. 3



Notes: Embankment side slopes are approximately 2:1

Embankment elevation listed above embankment

Water elevation listed above pools and cells

Water is discharged from the mixing pools and typha cells into the final mixing pool through two outlet channels, one on the highwall side and the other on the spoil side of the embankment (see PLAN VIEW). Channel bottom elevations are listed above each embankment.

Pipe inlet elevation listed at pipe in final mixing pool

6" Limestone screenings

18" Mushroom compost

Typha is planted in the mushroom compost

FIGURE 4

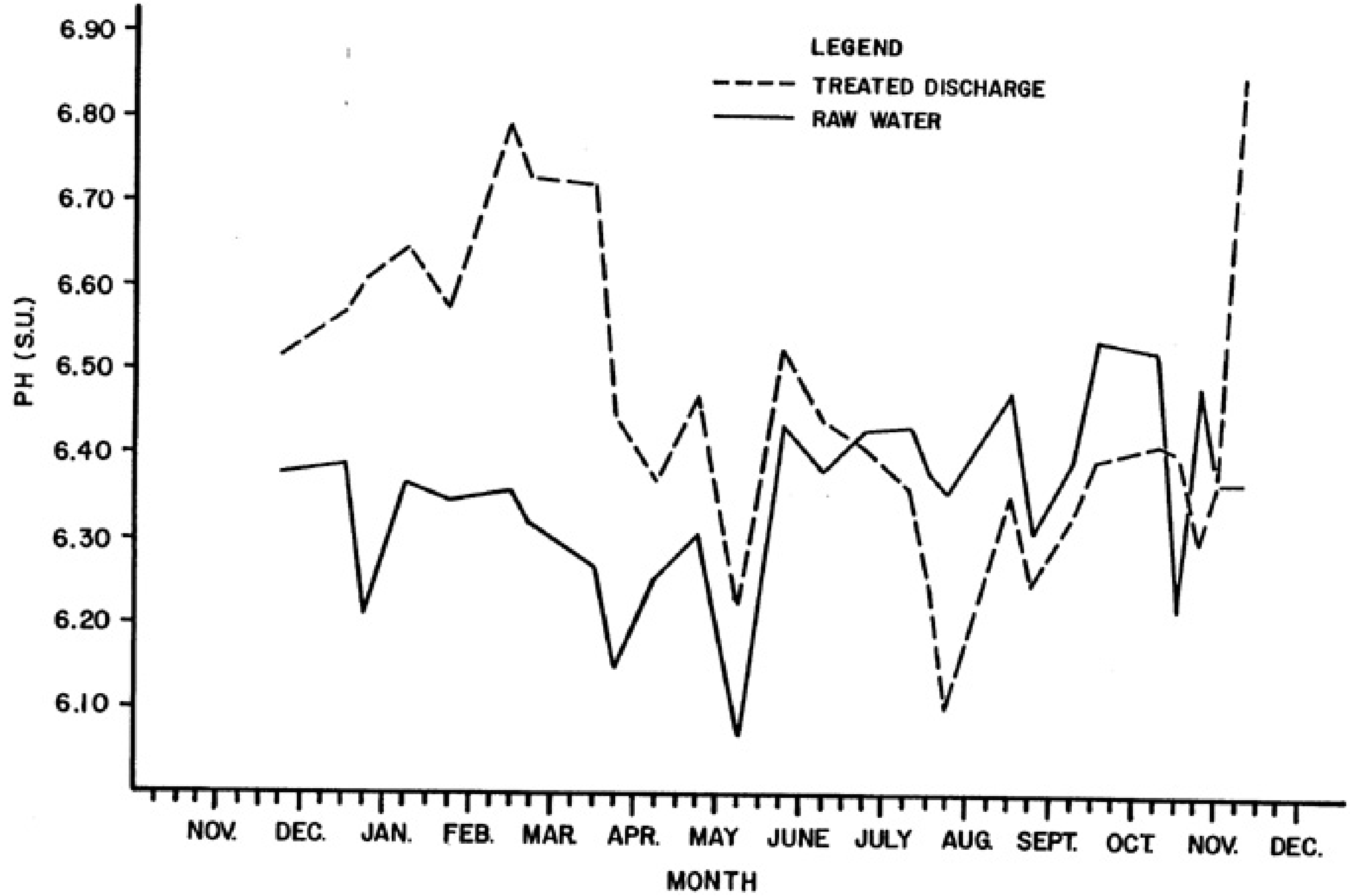
1.	Mining and Reclamation Company (OMRA)	
	Labor and Equipment	$ 9,491.45
	Materials (Lime & Fertilizer)	369.96
2.	C. M. Luburgh Construction Company	
	Labor and Equipment	32,020.00
	Limestone Screenings	2,795.75

C. M. Luburgh Construction Company built access road and dikes, filled to the old pit with spoil, spread compost and set pipes. The fill required in the cells was approximately 12,000 cubic yards.

3.	N.E.A. Enterprises, Inc.	
	Compost (2025 cu. yd. - delivered)	21,640.00
4.	Consultant Fees	2,300.00
	Total Expenditure	$68,617.16

5. In addition to the above, Peabody supervision totaled 143 manhours along with 64 manhours of surveying.

SIMCO PEABODY NO. 4 UNDERGROUND MINE
PH COMPARISON OF WATER ENTERING AND DISCHARGING FROM WETLAND
FIG. 5



SIMCO PEABODY NO. 4 UNDERGROUND MINE
COMPARISON OF TOTAL IRON ENTERING AND DISCHARGING FROM WETLAND
FIG. 6