NORTHEAST OHIO FOUR COUNTY REGIONAL PLANNING AND DEVELOPMENT ORGANIZATION

A Demonstration of a Constructed Wetland for Home Wastewater Treatment

Final Report

June 2000

The preparation of this report was financed through the Lake Erie Protection Fund, with matching funds or services provided by NEFCO's dues-paying members and collaborating agencies.

This report is submitted in fulfillment of Milestone 1, from NEFCO's Scope of Work, for A Demonstration of a Constructed Wetland for Home Wastewater Treatment. The scope calls for NEFCO to demonstrate the use of constructed wetlands as a feasible alternative to treat residential wastewater when conventional treatment systems present an environmental risk. This project built a constructed wetland (CW) at a home site with a failed septic system and is monitoring its performance for three years. Information about the constructed wetland would be disseminated throughout the NEFCO region by newsletters and a final summary report. Cooperative agreements with the City of Akron, Portage County Health Department, and Portage Soil and Water Conservation District (SWCD) are facilitating monitoring and construction.

Mission Statement:

To Improve The Region's Quality of Life, Through Collaborative Planning Efforts with NEFCO's Area Governments, in Order to Ensure:

- *Environmental Quality*
- *Orderly Growth*
- *Economic and Community Development*

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Summary

The purpose of the constructed wetland (CW) project is to demonstrate the feasibility of a CW as an alternative system for failed on-lot wastewater systems. The CW was constructed and monitored to document the progression of the treatment as it responds to the biological dynamics in the CW. The results of this project could be transferred to other areas of the Lake Erie Basin which face limited options for treating waste from home septic systems.

The constructed wetland was built on property owned by the City of Akron. A home on the site had a failed septic system and off-lot discharge was flowing into a tributary to the Cuyahoga River. The CW design is a two-cell submerged flow constructed wetland system; a system adopted in part from designs developed by the Tennessee Valley Authority (TVA). The media in the cells consists of nearly 500 cubic feet of washed river gravel. The first cell is about 14 feet wide and 19 feet long, and the second cell is 15 feet wide and 22 feet long. Wetland vegetation was planted in the first cell to treat the wastewater flowing through the media.

The preexisting system consisted of one septic tank, whereas the CW system required the installation of two new septic tanks to minimize solid loads going into the wetland. The first cell, lined with an impermeable membrane to avoid percolation, contains wetland vegetation, such as narrow leaf cattail, soft stem bulrush and yellow and blue iris. The second cell is unlined to facilitate percolation. It is used as an absorption field and is mulched instead of planted.

The CW is regulated by three flow controller boxes; one located at the front of each cell and the third at the end of the two cells. The function of the controller boxes is to maintain the water level in the cells to avoid the development of nuisance odors and mosquito problems, yet maximize contact with the vegetation roots.

Funding was used to purchase construction materials for the cells, including septic tanks, distribution boxes, PVC pipes, tees, elbows, gravel, mulch, and vegetation. Excavation costs were also included. Oversight and follow-up maintenance of the excavation and construction was provided by the collaborating agencies.

Vegetation was obtained from J&J Tranzplant Aquatic Nursery in Wild Rose, Wisconsin. The cost of the vegetation reflected the need to purchase the entire amount. The first cell was initially planted with narrow leaf cattail, soft stem bulrush, soft rush, dark green bulrush, flowering rush, arrowhead, red cardinal flower, calla lily, yellow and blue iris, sweet flag, duck potato, yellow arum and pickerel weed. After the second planting, the CW contains narrow leaf cattail, soft stem bulrush and yellow and blue iris. The second cell was initially to be planted with ornamentals, however, due to the porous nature of the soils, it was mulched and is used as an absorption field.

Permits for construction of the constructed wetland were obtained from the Portage County Health Department and the State of Ohio Department of Health. The CW was designated as an experimental system.

The constructed wetland can assist in addressing a critical water quality problem in the Cuyahoga River Watershed. The Cuyahoga River Remedial Action Plan (RAP) has identified home septic systems as a major source of nutrients. The Stage 1 Report (1992) noted that many systems have outlived their life expectancy. From values and estimates in the report, the failing system can range as high as 75 percent of the systems in the watershed. This may mean that as much as 550 tons of BOD from failed septic systems are flowing yearly into the Cuyahoga River via tributaries. The Stage 1 Report stated that research was needed on methods to improve the effectiveness of home septic systems.

The demonstration of a CW would help document its potential for use in nutrient reduction to the Cuyahoga River, in the reduction of nuisance conditions, in improving aesthetics, and in increasing the awareness of wetlands' role in water quality protection.

The constructed wetland demonstrates an alternative for remedying failed septic systems in heavy soils. As a tool for the affected local homeowners to use, it can reduce pollution to area waterways and Lake Erie. CWs would also serve as an effective alternative for health departments to consider when faced with a failing/failed septic system in poor soils, and where central sewers are not a practical option.

Getting the word out about the CW was accomplished by using existing newsletters and other public outreach vehicles of the collaborating agencies. Other public outreach activities used by the collaborating agencies included water quality meetings and tours of the CW. The CW project lends itself to be an excellent example of an applied natural system solving a problem.

Introduction

Nutrient reduction has been identified in the Cuyahoga River Remedial Action Plan (RAP) and by the City of Akron as a necessary element in the restoration of water quality in the Cuyahoga River. The RAP noted that home sewage systems are a major source of pathogens and an intermediate source of nutrients in the watershed. The Portage County Health Department has indicated that there are many off-lot systems which are violating water quality in the watershed. The City of Akron identified nutrient reduction as a requirement for preventing water quality degradation in Lake Rockwell, Akron's water supply.

The goal of the project is to demonstrate the use of constructed wetlands as a feasible alternative to treat residential wastewater when conventional treatment systems present an environmental risk or economic liability. To accomplish this goal, the project proposed to build a constructed wetland (CW) at a home site with a failed septic system and to monitor its performance for three years. Information about the constructed wetland would be disseminated throughout the NEFCO region by newsletters and a final summary report. Cooperative agreements with the City of Akron, Portage County Health Department, and Portage Soil and Water Conservation District (SWCD) would facilitate monitoring and construction.

Pollution reduction activities may be more acceptable if alternatives can be used economically. If alternatives are to be recommended, guidelines need to be developed and demonstrated. The use of CWs are documented for treatment of wastewater throughout the U.S., but are relatively untested in northeast Ohio.

Background

NEFCO's demonstration constructed wetland was designed in part after systems developed by the Tennessee Valley Authority (TVA). Management practices for the CW were also adopted from lessons learned by the Lorain County General Health District.

The TVA is a regional resource development agency whose main goal is to clean up and protect the waterways within the Tennessee River System. The TVA began their constructed wetland technology in 1986 in response to nonpoint source pollution affecting their streams, which is due in part to the lack of or failure of wastewater treatment systems. Another problem was poor site conditions which do not allow installation and sufficient performance for septic tank-drain fields. The constructed wetland provided an easy to maintain, affordable and effective alternative to wastewater treatment (TVA, p. iv). NEFCO contacted TVA during the research period of the project. TVA sent NEFCO a list of references on literature about constructed wetlands (Appendix A), and a handbook on installing a constructed wetland for wastewater treatment.

The Lorain County General Health District was faced with a similar situation in which failed septic tanks and heavy clay soils increased the risk of wastewater running into area rivers and streams. In response to their wastewater problem, the District initiated an experimental project in 1993, in which the Lorain County Board of Health issued permits, allowing the construction of twelve wetlands. The Health Department recruited twelve single family homeowners to volunteer their yards for the experimental project. The twelve systems were built by the District in 1993 and 1994, at a cost of approximately four thousand dollars per home owner. Ten of the systems are preceded by septic tanks. The remaining two systems are preceded by Home Aeration Systems. An aeration system consists of a septic tank, as well as an additional tank that receives the effluent flow after the septic tank. Within the aeration tank, a propeller is used to stir up the wastewater. The action of the propeller aerates the effluent, adding oxygen to it. This process allows the bacteria to further break down the pollutants within the wastewater before it flows into the constructed wetland.

NEFCO has a collection of additional information regarding constructed wetlands for residential wastewater treatment available upon request.

Function Rationale

An essential function of wetland plants in treating wastewater is their ability to transport oxygen to support their roots growing in anaerobic substrates. The rhizosphere is an aerobic region that envelops each roothair of a wetland plant. The rhizosphere "supports large microbial populations that conduct desirable modifications of nutrients, metallic ions, and other compounds" (Figure 1)(Hammer, 1989, 14).

Wetland plants increase the system's capacity to remove or retain pollutants through interaction with the soil or substrate, water, and air. The plants absorb the pollutants, freeing more soil exchange sites for further pollutant interaction and accumulation (Bastian, 1995, 49). Although wetland plants contribute to the removal of contaminants through absorption, the primary mechanisms that remove pollutants from wastewater are the physical, chemical and microbial interactions.

Pollutants are removed or transformed in wetlands via microbial degradation and mixing into sediments or biota. They can also be released into the atmosphere through such processes as adsorption, filtration, sedimentation, volatilization, ammonification, aerobic and anaerobic microbial decomposition, and plant intake (Bastian, 1995, 21). The anaerobic conditions provided by the wetland sediments is a main factor in absorbing many compounds. Bastian explains, "Reducing (anaerobic) environments allows the conversion of heavy metals into relatively insoluble sulfides and also promotes the removal of nitrate nitrogen through denitrification. Sedimentation of particulates is one way these substances are removed from the water column" (Bastian, 1995, 21).

Due to wetland conditions, many substances are adsorbed into solids including organic compounds, hydrocarbons, ammonium phosphorus, heavy metals, bacteria, and viruses. Pollutants that dissolve are also absorbed to become suspended solids or bottom sediments (Bastian, 1995, 21).

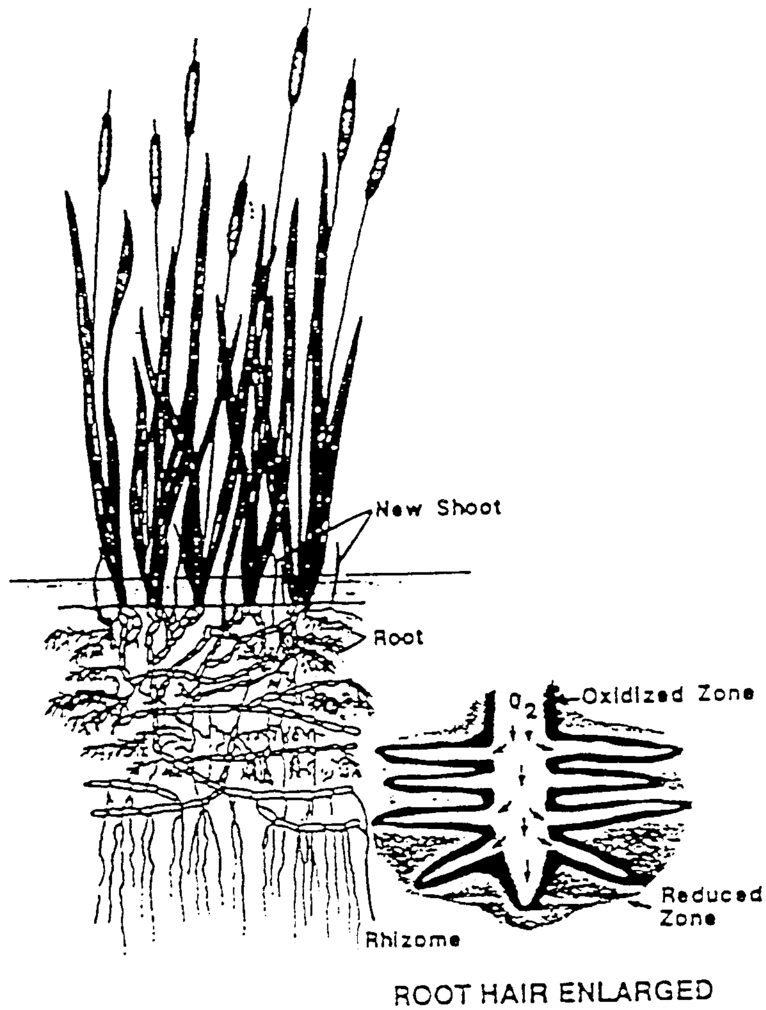
Wetlands provide optimum environments for nutrient cycling and removal, especially for nitrogen. The aerated 'water column' and aerobic upper sediment layer, "promote nitrification and the formation of insoluble phosphorus-metal complexes" (Bastian, 1995, 21). Reducing sediment conditions and the interaction between the aerobic and anaerobic layers supports ammonification and denitrification (p. 21).

Methodology

The constructed wetland (CW) was installed on June 13, 1996, on property owned by the City of Akron. Locating the CW on City of Akron-owned land alleviated any potential liability issues that may have occurred if located on privately-owned land. A number of properties owned by the City of Akron were evaluated. The site chosen for the constructed wetland is located in Ravenna Township at 7509 State Route 14, just south of Lake Rockwell Rd (Figure 2). Of all the sites, this site was considered the most suitable. It had easy access; a failed off-lot discharge system that was in violation of the local health code and in urgent need of repair; no tile field; and it had enough land to install a replacement leach field in case the constructed wetland failed.

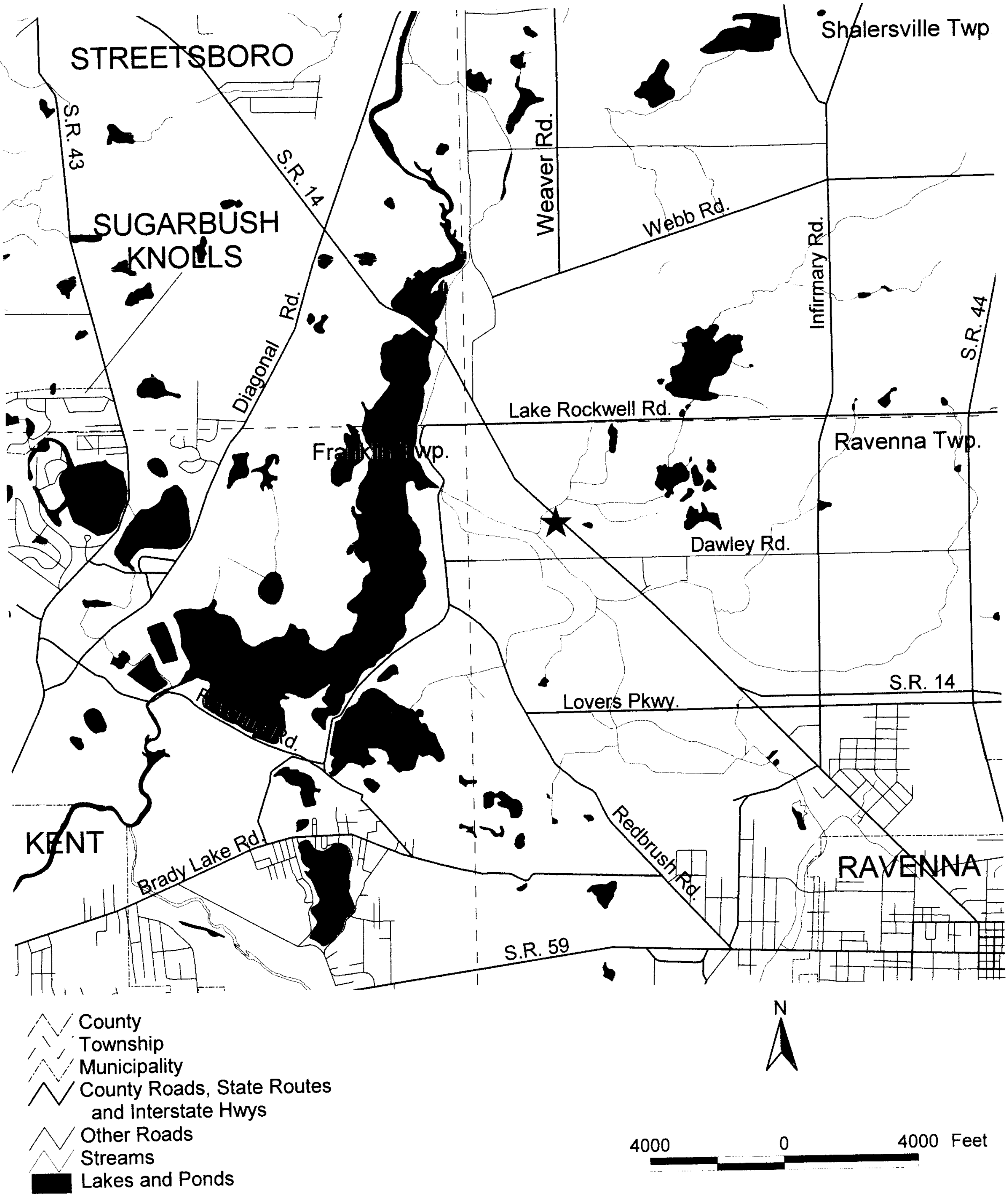
The wetland site is situated on Chili silt loam soil (Figure 3). The Portage County soil survey describes the Chili soil series as "deep, well drained, nearly level to very steep

Figure 1



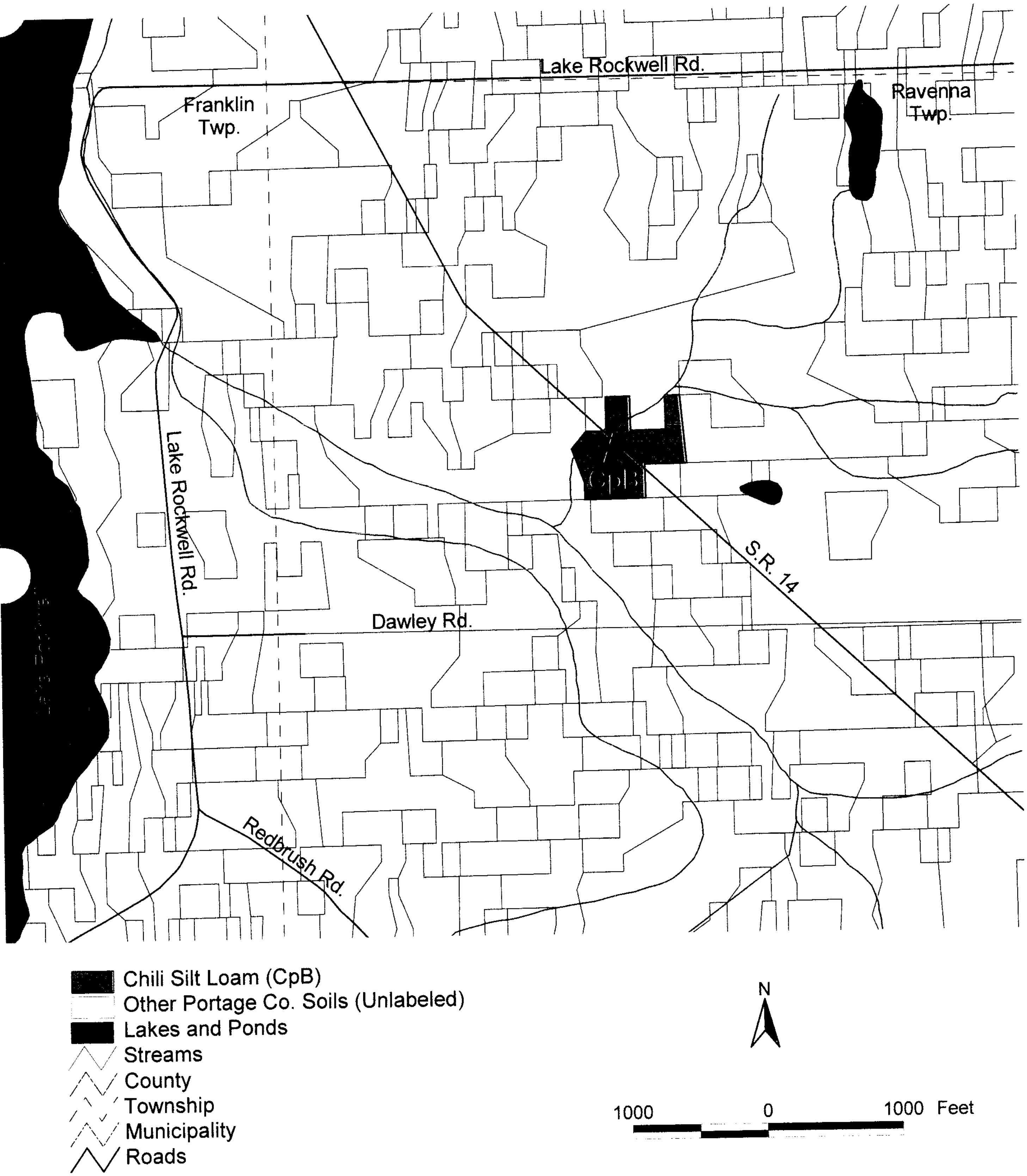
Wetlands plants have the unique ability to transport oxygen to support their roots growing in anaerobic substrates. Modified from Hammer [illegible].

Figure 2
Constructed Wetland Location



Northeast Ohio Four County Regional Planning and Development Organization, 1999.
Source Material: Ohio Department of Natural Resources; Division of Real Estate and Land Management.

Figure 3
Constructed Wetland Soils



Northeast Ohio Four County Regional Planning and Development Organization, 1999.
Source Material: Ohio Department of Natural Resources; Division of Real Estate and Land Management.

loamy soils that formed in loamy material underlain by sand and gravel. These soils are on outwash terraces and kames." The Chili silt loam of this soil series is described as follows: "The surface layer and upper part of the subsoil have more silt than is described as representative of the series. Because it has more silt in the upper part of the profile, this soil has a higher available water capacity than Chili loam or Chili gravelly loam and the surface layer has a greater tendency to crust."

Although this type of CW system is ideal for use in clayey soils (as they can limit the effectiveness of an HSDS), NEFCO and Akron agreed to install the system in a silt loam soil, as soils were not a high priority in choosing a site for the demonstration constructed wetland. More interest was focused on the performance of the first cell in treating the wastewater, in characterizing the plants which perform best in the constructed wetland, and in gaining insight into maintenance needs.

Collaborating Agencies

Three agencies collaborated with NEFCO on the constructed wetland project. The City of Akron, the Portage County Health Department, and the Portage Soil and Water Conservation District (SWCD). Each agency contributed their time and effort toward the project. The City of Akron provided the site in which the constructed wetland was installed (Appendix A). They also conducted all monitoring of the constructed wetland. The Portage County Health Department facilitated permit processing, as well as, provided input into the design and size of the wetland. The size of the wetland must correspond with the amount of wastewater the wetland is able to treat. The Portage SWCD supervised the construction of the wetland, and evaluated the wetland plants.

Each collaborating agency composed a letter of agreement, outlining their contributions to the project, and sent inkind service reports to NEFCO when required.

Bidding Process

NEFCO prepared a bid package which included a description of the project, a list of materials needed to complete the project, and constructed wetland design specifications. The bid package was sent to twenty local contractors. Of these twenty contacted, two replied. NEFCO and the collaborating agencies decided to use J. Helms Electric services to construct the wetland.

Construction

Before the construction of the wetland began, NEFCO and the City of Akron entered a period of settling some legal issues regarding property access liability, that resulted in a delay. Once the legal issues were resolved and all permits were issued (Appendix D), construction of the wetland commenced on June 11, 1996. It took three days to install the wetland, with a cost of $5,600 for materials and labor. With the exception of the vegetation, the wetland was completed on June 13, 1996. The wetland operated for three months before the vegetation was planted. The wetland plants were ordered on September 12, 1996 and were planted that fall.

Design changes were made to the constructed wetland before construction in June commenced. Figure 4 illustrates a copy of the design changes prepared by J. Helms Electric. The changes were as follows: the size of the first cell was decreased to accommodate for the size of the liner; PVC pipes were changed from 4 inch to 2 inch pipes; a small depression was made at the end of the second cell to accommodate for the effluent pipe; the septic tanks were relocated and situated to allow for gravity flow of the effluent; and the inlet to the first cell was made slightly wider to allow for pulse.

Pre-Treatment System

Two 6 by 8 foot, 1,000 gallon septic tanks were used to separate the solids from the wastewater. The dual septic tank system was used to ensure the maximum separation of solids from the wastewater before it enters the wetland.

The pump crock is a cylindrical tank, 5 feet in diameter, that collects outflow from the septic tanks and pumps it to the wetland. The pump crock has a capacity of approximately 250 gallons (Appendix B). Once the crock reaches a preset volume of 55 gallons of effluent, a sump pump activates, pumping the effluent to the first distributor box. A counter was installed above the pump crock to count the number of times the sump pump kicks on and the amount of time the pump stays on. The counter was used to determine flow rates and loading.

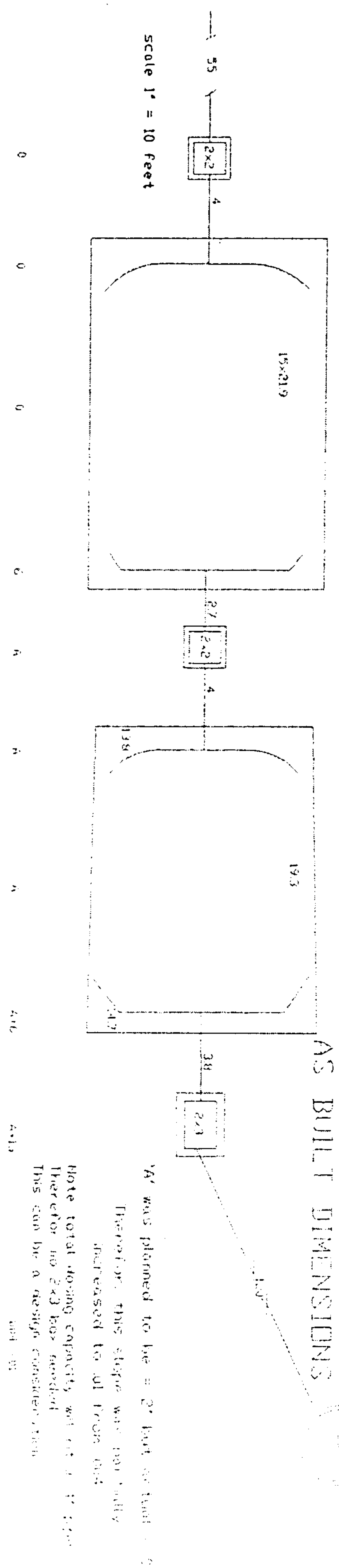
Constructed Wetland Materials

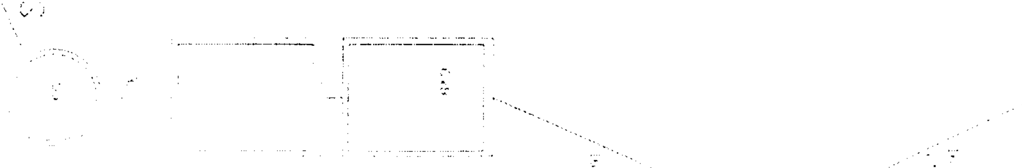
The constructed wetland consists of two wetland cells. The first cell measures 19.3 feet long, 14.7 feet wide at the inlet, 13.8 feet wide at the outlet, and 18 inches deep (Figure 5). The second cell measures 15 feet wide, 21.9 feet long and 18 inches deep. The sides of both wetland cells are bermed. The first cell is lined with a heavy-duty synthetic, impermeable liner that is 3mm thick (Appendix B, and Photos 16, 17 and 18 in Appendix C). The purpose of the liner is to contain the contents of the wetland cell. The second cell was left unlined, to ensure maximum absorption.

Each cell contains 12 inches of washed pea gravel, with larger sized gravel at the inlet and outlet of each cell. The gravel functions as a medium to support the wetland vegetation and provide optimal porosity for the flow of effluent throughout the cells.

The constructed wetland system includes three distributor boxes: one at the inlet of the first cell; one between the two cells; and one at the outlet of the second cell (Figure 5). Each distributor box is made from concrete and measures 2 feet by 2 feet; with the exception of the distributor box located at the inlet that measures 2 feet by 3 feet. The functions of the distributor boxes are to control the water level of each wetland cell. A pipe travels from the pre-treatment system to the first distributor box. The second and third distributor boxes contain swivel pipes. The swivel pipe can be adjusted at various heights to control the level of wastewater in the wetland cells (Photo 57 in Appendix C). At the early stages of growth, the swivel pipe should be positioned so that the opening of the pipe is parallel to just below the surface of the wetland. As the wetland plants

Figure 4





NEFCO Wetland

DESIGN CHANGES:

Slight first cell size change to accomodate standard 25'x50' liner divided by 3. Total wetland size compensated for in second cell.

Piping changed from 4" to 2" per TVA specs. 4" perf pipe same cost as sch 40 2"PVC. Extra labor drilling 2" but savings on valves.

Second cell effluent pipe needs to be surrounded by rock so a small depression is needed at the end of the cell.

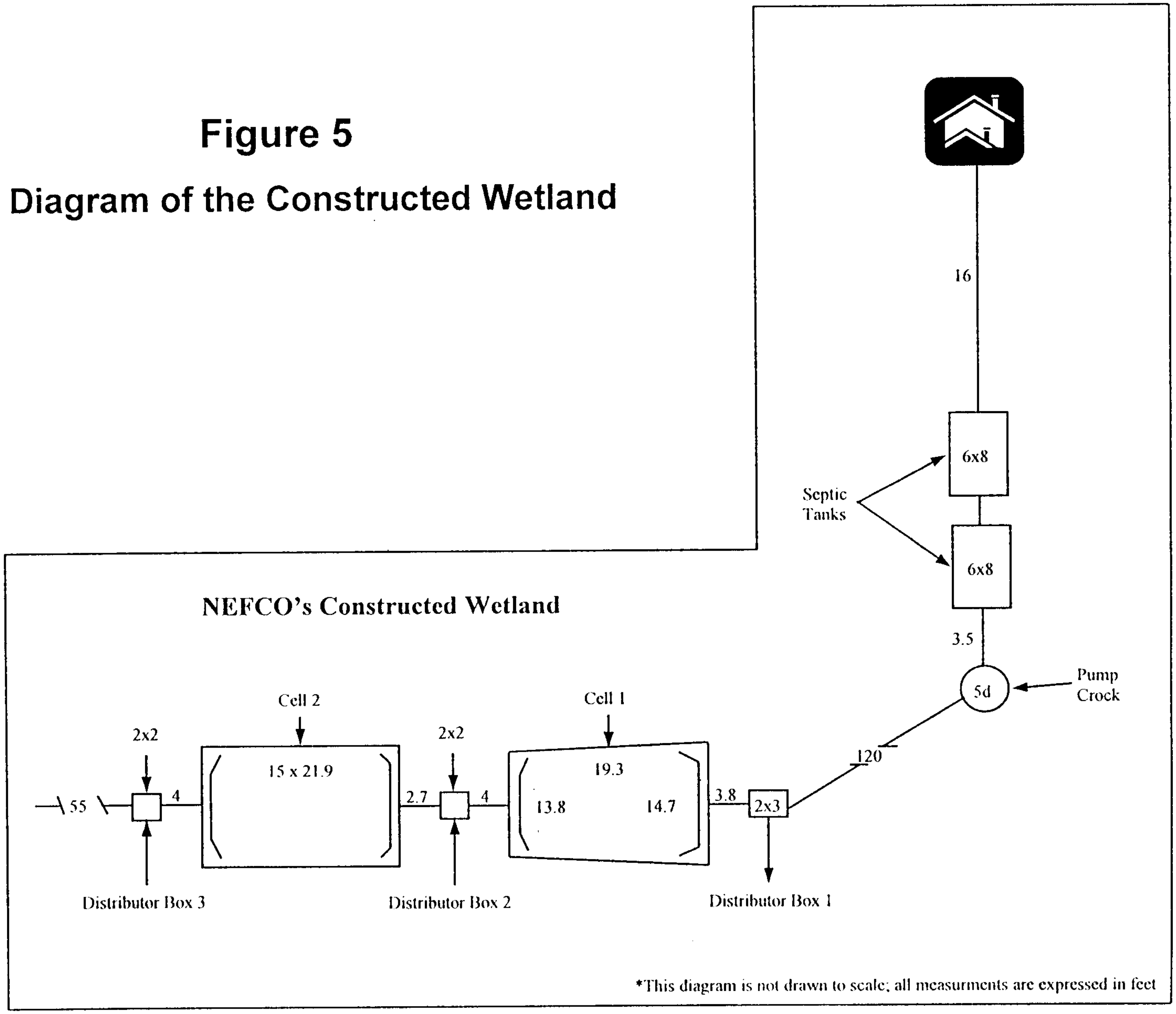
Original placement of septic tanks allowed for the duality of pumping and/or gravity. The main stack in house was not in its presumed location so in retaining gravity option, per CC request, relocation and mounding around septic tanks was neccessary.

Inlet to cell #1 slightly wider to allow for pulse; magot build up at corners. Because septic not seeded this may be just immature system symptom. The effect of pulse vs slow gravity on effective width of cells is not found in literature.

Bid documents list of materials would indicate volume based on square walls instead of sloped as installed and diagramed (excess material left over.)

Figure 5

Diagram of the Constructed Wetland



mature, the level of wastewater can be lowered to force the roots of the plants to grow in a downward direction.

A distributor and collector pipe are found in each wetland cell. The distributor pipe is a perforated pipe located at the inlet of each cell (Photo 20 in Appendix C). It is buried approximately 10 inches underneath the gravel and extends across the width of the cell. Once the wastewater exits the distributor box, it enters the distributor pipe, which distributes the effluent along the width of the wetland cell. The collector pipe collects the effluent after it has traveled through the wetland cell. From the collector pipe the wastewater flows to the second distributor box, where it enters the distributor pipe in the second wetland cell. From there it flows evenly throughout the cell, where it is absorbed into the ground, or evaporates. Any excess treated wastewater travels to the collector pipe, into the third distributor box and out the overflow pipe.

Vegetation

Extensive research was conducted on the various types of wetland vegetation available for planting in the CW. It was essential to use vegetation that would survive the temperature extremes characteristic of Northeast Ohio, and ensure the highest performance in processing the CW wastewater and nutrients. It was recommended to use native plant species of the area. It was also important to chose plants with relatively fine roots with extensive vertical and lateral root growth. These characteristics will ensure easier and deeper movement of the roots; which, in turn, filters the wastewater more effectively (Steiner and Watson, 1993, 22).

Initially both cells were to be planted; the first cell with hearty wetland vegetation, and the second with ornamental vegetation. The TVA guidance recommend an unlined second cell to enhance percolation with evapotranspiration from plants. Due to the porous nature of the soils, NEFCO was advised that the second cell would act as an absorption field and may not support the wetland plants. As such, it was covered with mulch, rather than planted. This decision meant less maintenance, less plants to care for and less time spent weeding and discarding invasive vegetation. A trade off was that NEFCO would not be able to gauge the effectiveness of treatment from a second cell.

The first planting of the CW took place on September 12, 1996 (Photos 26 to 29 in Appendix C). The first cell was originally planted with 50 narrow leaf cattails (*typha augustifolia*), 50 soft-stemmed bulrush (*scirpus validus*), 50 soft rush (*juncus effusus*), 50 dark green bulrush (*scirpus attrovirens*), 13 flowering rush (*butomus umbellantus*), 33 arrowhead (*peltandra virginica*), 40 red cardinal flower *(logelia cardinalis*), 9 yellow water iris (*iris pseudocorus*), 40 blue iris (*iris versicolor*), 9 sweet flag (*acours calamus*), 13 duck potato (*sagittaria latifolia*), 9 yellow water arum (*calla palustris*), and 33 pickerel weed (*pontederia cordata*).

A planting plan was devised and illustrated in a diagram (Appendix B). Plants were arranged in blocks of similar plants to facilitate an evaluation of survival. Should one species not be able to tolerate conditions then a large space would be apparent in the cell. The primary plants for treatment purposes were the cattails and the bulrushes. The others were placed for ornamental purposes. The ornamentals were placed along edges to create an attractive border of color for the cell.

All wetland vegetation was purchased from J&J Tranzplant Aquatic Nursery of Wild Rose, Wisconsin. The cost of the first batch of plants was $276.05 (Appendix B).

The CW plants survived the first winter, and commenced growth in the Spring of 1997. However, a couple of problems occurred that slowed the maturation process of the plants. The first problem was that invasive local plants quickly became established in the wetland, crowding out the desired CW plants. The second problem was that deer selectively consumed some of the wetland vegetation. The only surviving plants were the yellow and blue iris (*Iris pseudacorus and Iris versicolor, respectively)*, narrow leaf cattail (*Typha angustifolia),* soft rush (*juncus effusus*), and soft-stemmed bulrush (*scirpus validus*). These problems required a replant in the Spring of 1998.

The constructed wetland was completely weeded of invasive vegetation and replanted on April 10, 1998 (Photos 34 to 38 in Appendix C). It was replanted with soft rush and narrow leaf cattail. Since these plants were less desirable to local fauna, it was felt that they would probably have the greatest chance to flourish.

The narrow-leaved cattail (*Typha augustifolia*) is a medium-height to tall, erect herbaceous plant that can grow up to six vertical feet. They are locally indigenous perennial plants with flat, linear basal leaves (1/5 - ½ inch wide), in which each plant usually has no more than ten leaves. Each plant have flowers that are arranged in a cluster to form two terminal cylinder-shaped spikes; a staminate, or male spike and a pistillate, or female spike. The two spikes are separated by a space so that the male spike is situated above the female spike. The male spike is covered with yellow pollen grains at maturity and then disintegrates (nonpersistent). The female spike is green in the spring and brown during the summer at maturity and is persistent in the winter. The flowering period occurs in late May and lasts until July.

This particular species of *Typha* thrives in brackish and tidal fresh marshes; as well as, inland fresh and alkaline marshes. They can be found as far north as Nova Scotia, Quebec and Ontario and as far south as Florida and Texas, and are especially abundant along the coast. Similar species include *Typha latifolia* (broad-leaved cattail) and *Typha domingensis* (Southern Cattail).

The soft rush (*juncus effusus*) is a medium-height, erect grasslike herb that grows up to 3 1/2 feet tall. They are perennial plants that grow in clumps. These plants have soft, thick, ribbed stems that grow up to 8 inches long with a bristled tip. There are no leaves found on these plants, but they do have greenish brown scaly flowers that grow in erect clusters. The flower clusters are found on the upper half of the stem. Fruit capsules containing many tiny seeds can be found on the flower clusters. The flowering period commences in June and ends in September.

Soft rush can be found in tidal fresh marshes, nontidal marshes, wet meadows, shrub swamps, and wet pastures. Their location spans from Newfoundland west to North Dakota, and south to Florida and Texas. Similar species include leathery rush (J. coriaceous).

The soft-stemmed bulrush (*Scirpus validus*) is a tall, erect herbaceous plant that grows up to 10 feet high. They are perennial plants with slender rhizomes and soft stems. They are leafless plants that are grayish green in color. The flowers are arranged in an open cluster style of many stalked, budlike spikelets (1/5 - 4/5 inch long). The spikelets are coated with reddish brown scales found just below the top of each stem. The fruit found on the spikelet clusters are a brownish gray color. The flowering period commences in June and lasts until September.

The soft-stemmed bulrush are found in brackish and tidal fresh marshes; as well as, inland shallow waters, shores and marshes. They can be located as far north as Newfoundland, and as far south as Florida; as well as, west to the Pacific coast. Similar species include the *Scirpus acutus* (Hard-stemmed Bulrush) and *Scirpus smithii* (Bluntscale Bulrush).

The *Iris versicolor* (Blue Flag) are moderately tall, erect herbaceous plants that grow as tall as 1-3 feet tall. They are perennial plants with flat sword-shaped leaves (½ - 1 inch wide) that ascend from a thick rhizome in a dense cluster. The flowers are large blue or violet irislike flowers (21/2 - 4 inches wide). Each flower has six petals connected on a tube. The larger petals tend to have yellow, green or white and purple veins. The smaller petals are erect and are supported by a long stalk (8 - 32 inches tall). The fruit are bluntly shaped three-angled capsules. The flowering period lasts 2 months, starting in May and ending in July.

Blue Flag are found in tidal fresh and slightly brackish marshes, and shores. They are located as northeast as Newfoundland, west to Manitoba, Minnesota and as south as Virginia. Similar species include *Iris pseudacorus* (Yellow Flag) which share the same characteristics with the Blue Flag, except that the Yellow Flag has yellow flowers and valves of dry capsules that spread widely at maturity.

Since the second planting, the plants have fared quite well and there has been no reason to do any subsequent planting.

<u>Onsite Hydrology</u>

With the exception of vegetation, the system was completed and running on June 13, 1996. The wastewater exits the residence and enters the first septic tank where pretreatment (settling of solid material) begins. The wastewater flows to the second septic tank where it continues the pretreatment settling process and ensures the maximum separation of solids from the wastewater. From the septic tanks, the wastewater flows into the pump crock. Once the pump crock reaches a preset volume of 55 gallons of effluent, a sump pump activates, pumping the effluent to the first distributor box. From the first distributor box, the wastewater flows through a pipe into a perforated distributor pipe, which distributes the effluent along the width of the wetland cell. Bacteria on the roots of the plants in Cell 1 process the wastewater and its nutrients. The nutrients are then transported to the leaves and stems and incorporated into the biomass; some water is released as water vapor through evapotranspiration. The water that remains flows into a collector pipe at the other end of the cell. From the collector pipe, the water enters the second distributor box. The second distributor box contains a swiveling standpipe which controls the water level within the wetland. The treated wastewater flows from the second distributor box to a distributor pipe in the second cell. Once the effluent is distributed throughout Cell 2, it percolates into the ground. Due to the permeability of the Chili silt loam soil type, the second cell was mulched. It could be planted with wetland plants to facilitate the evaporation of water, however, that entails more maintenance. In case of overflow, the effluent would enter the second collector pipe, where it would then enter the third distributor box. From there, the treated wastewater would be channeled through an outflow pipe onto a forested swale. The CW has not experienced any discharge to the swale thus far.

Public Outreach

Constructed Wetland Tour

NEFCO hosted a constructed wetland tour on Thursday, August 20, 1998 from 10:00 am-12:00 pm. Approximately 40 individuals attended the tour, including representatives from local government agencies, local newspapers and area citizens. Each tour participant received a brochure about the constructed wetland. The brochure provided a summary of the project, including construction materials, vegetation, funding, collaborating agencies, color photos and a diagram of the wetland, and a step by step explanation of how the wetland functions (refer to Executive Summary). NEFCO staff explained how the system worked and answered any questions from the tour participants. The news release, tour announcement, sign-up sheet and newspaper articles are included in Appendix D. Photos of the CW tour can be found in Appendix C, Photos 44 to 54.

Results

The City of Akron performed tests on samples taken from the influent and effluent of the first cell of the constructed wetland. This testing was essential in documenting the effectiveness of the constructed wetland in treating residential wastewater. Testing was performed on a monthly or bimonthly basis. The parameters that were tested were fecal coliform, total phosphorus, suspended solids, nitrates, ammonia, and Biochemical Oxygen Demand (BOD). After 37 months of testing, the sampling results were compiled and tabulated (Table 1). There is a notable drop in fecal coliform from influent to effluent, which indicates that the first cell of the CW is effectively removing fecal coliform (Appendix E, Figure 6). Total phosphorus is being reduced at a moderate rate from influent to effluent (Figure 7). This tells us that the first cell of the cw is working to lower phosphorus discharge, however, the reductions are inconsistent. This is

Table 1

Demonstration Wetland (Rt. 14) Monitoring Results for October, 1994 to Deceber, 1998												
Sample	BOD mg/l		NH3 mg/l		NO3 mg/l		TP mg/l		SS mg/l		Fecal Coliform per 100 ml	
Date	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent	Influent	Effluent
10/12/1994		2,770		46				22.6		1,480		
11/19/1994		594		41.3				19.8		980		
06/12/1996		0		88.2			7.45	67.4		2,223		
09/10/1996	10	116	30.2	19.6	15.9	2.35	3.95	0.67	24	33	>6,000	>6,000
09/24/1996	134	32.9	30	14.6	<2.5	<2.5	7.45	2.9	27	15	45,000	7,600
10/16/1996	114	26.4	40.5	29.7	<0.1	<0.1	6.76	0.43	50	16	1,390,000	150,000
10/29/1996	149	46.7	LA	21.8	<2.5	<2.5	6.60	1.69	25	38	LA	LA
11/12/1996	149	103	41.9	39.1	<2.5	<2.5	5.70	2.15	39	18	4,720,000	410,000
11/20/1996	158	87.4	38.4	29.2	<2.5	<2.5	6.15	1.7	35	26	4,600,000	1,200,000
12/03/1996	402	76	42.4	38.1	<2.5	<2.5	6.40	3.38	59	32	6,100,000	4,900,000
12/16/1996	146	67	35.8	29.2	<2.5	<2.5	6.15	2.25	33	22	LA	465,000
01/28/1997	147	118	37.5	37	<2.5	<2.5	11.80	5.6	87	69	8,480,000	6,360,000
02/24/1997	ND	ND	ND	ND	ND	ND	13.50	7.5	40	42	ND	ND
03/01/1997	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
03/31/1997	ND	ND	ND	ND	ND	ND	ND	7.4	29	47	ND	ND
04/01/1997	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
05/30/1997	ND	ND	ND	ND	ND	ND	5.60	3.25	35	47	TNTC	TNTC
06/09/1997	ND	ND	ND	ND	ND	ND	6.15	3.05	43	65	590,000	100,000
07/29/1997	ND	ND	ND	ND	ND	ND	13.10	4.45	26	70	830,000	300,000
08/01/1997	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
09/22/1997	109	16.4	27.5	11.7	<2.5	<2.5	4.80	2.7	30	30	370,000	140,000
10/14/1997	95.7	15.8	29.5	20.6	<2.5	<2.5	3.95	1.3	14	17	<1,000	<1,000
11/17/1997	175	37.9	29.8	19.3	<2.5	<2.5	4.90	1.28	47	26	112,000	<1,000
12/08/1997	123	51.7	28.7	14.6	<2.5	<2.5	4.70	1.78	17	16	66,000	600
01/20/1998	157	47.9	28.9	22.4	<1	<1	5.62	3.02	25	17	550,000	360,000
02/14/1998	206	34.5	31.4	20.2	<2.5	<2.5	5.53	1.83	24	26	2,400,000	290,000
03/23/1998	220	69	31.3	22.4	<2.5	<2.5	5.95	3.25	26	41	43,000	3,000
04/21/1998	282	18.5	40.2	19.8	<1	1.14	6.85	2.2	43	39	270,000	13,000
05/26/1998	108	19.3	24.7	24.3	<2.5	<2.5	4.10	1.95	22	38	260,000	20,000
06/23/1998	83.2	12.7	7.72	11.7	7.86	2.5	2.80	1.95	16	28	156,000	5,000
07/20/1998	140	12.1	27.4	9.42	<0.05	<0.05	4.50	2.15	42	29	1,780,000	3,000
10/27/1998	109	6.25	23	5.99	<0.05	<0.05	4.20	4.15	8	3	22,000	1,000
11/23/1998	103	6.59	26.8	9.29	0.075	0.802	5.48	4.45	23	5	30,000	1,000
12/14/1998	151	12.7	24.9	13.9	<0.05	<0.05	5.28	3	27	21	51,000	100
01/11/1999	183	108	32.0	24.5	ND	ND	4.75	2.25	19	63	4,000	1000
02/02/1999	165	41	42.75	20	ND	ND	4.30	1.83	19	19	13,800	340
03/02/1999	133	66	39	25.38	ND	ND	4.30	2.68	24	31	3,400	480
04/05/1999	223	65	36	30.5	ND	ND	4.15	2.4	24	24	46,000	610
08/03/1999	120	12	19.75	16.5	ND	ND	1.45	1.05	14	7	61,000	3,400
09/20/1999	110	5	24.75	9	ND	ND	2.88	1.05	20	30	11,000	100

LA=Lab Accident | ND=Not Done | TNTC=Too Numerous To Count

Figure 6
Concentrations of Fecal Coliform
Constructed Wetland

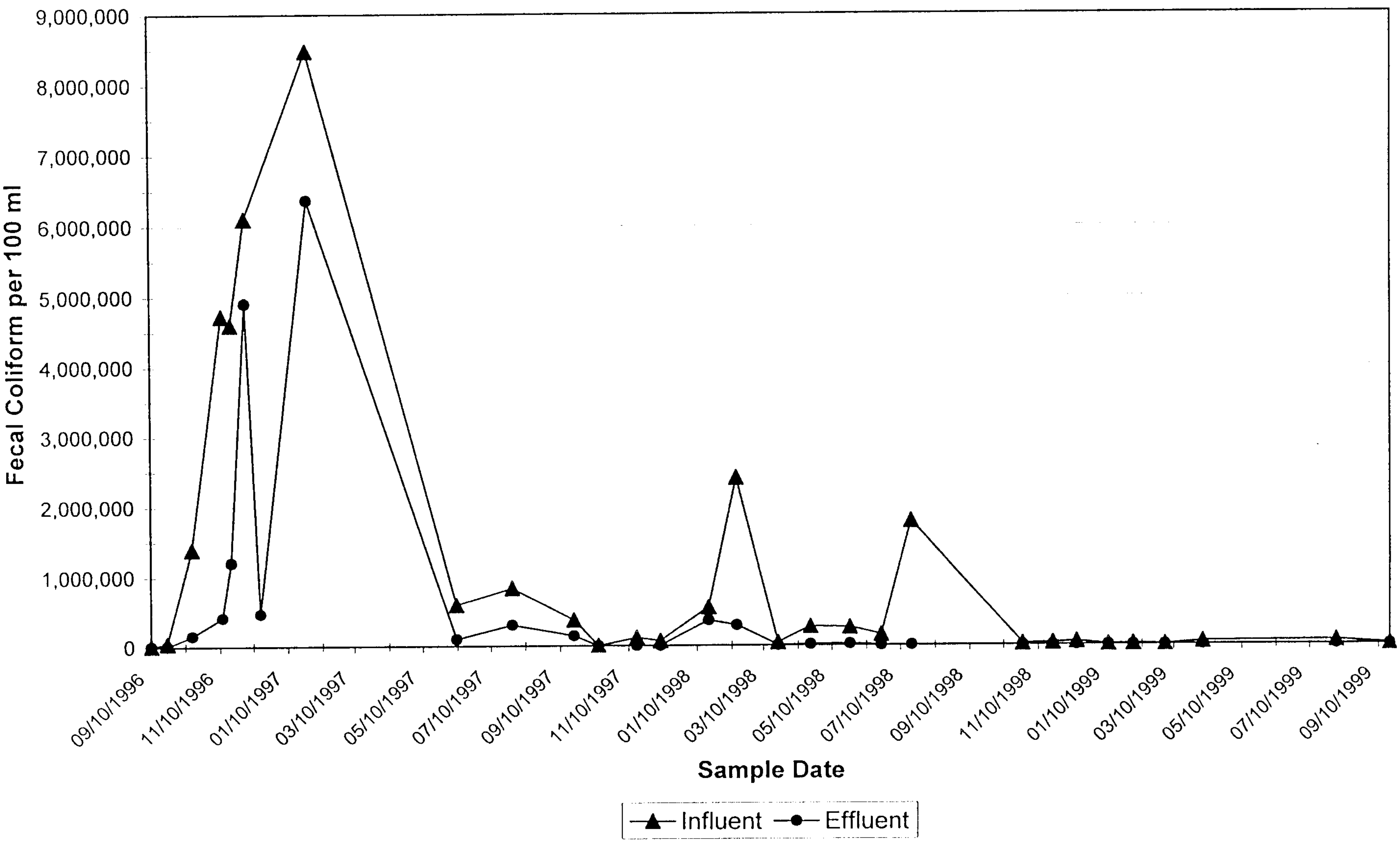
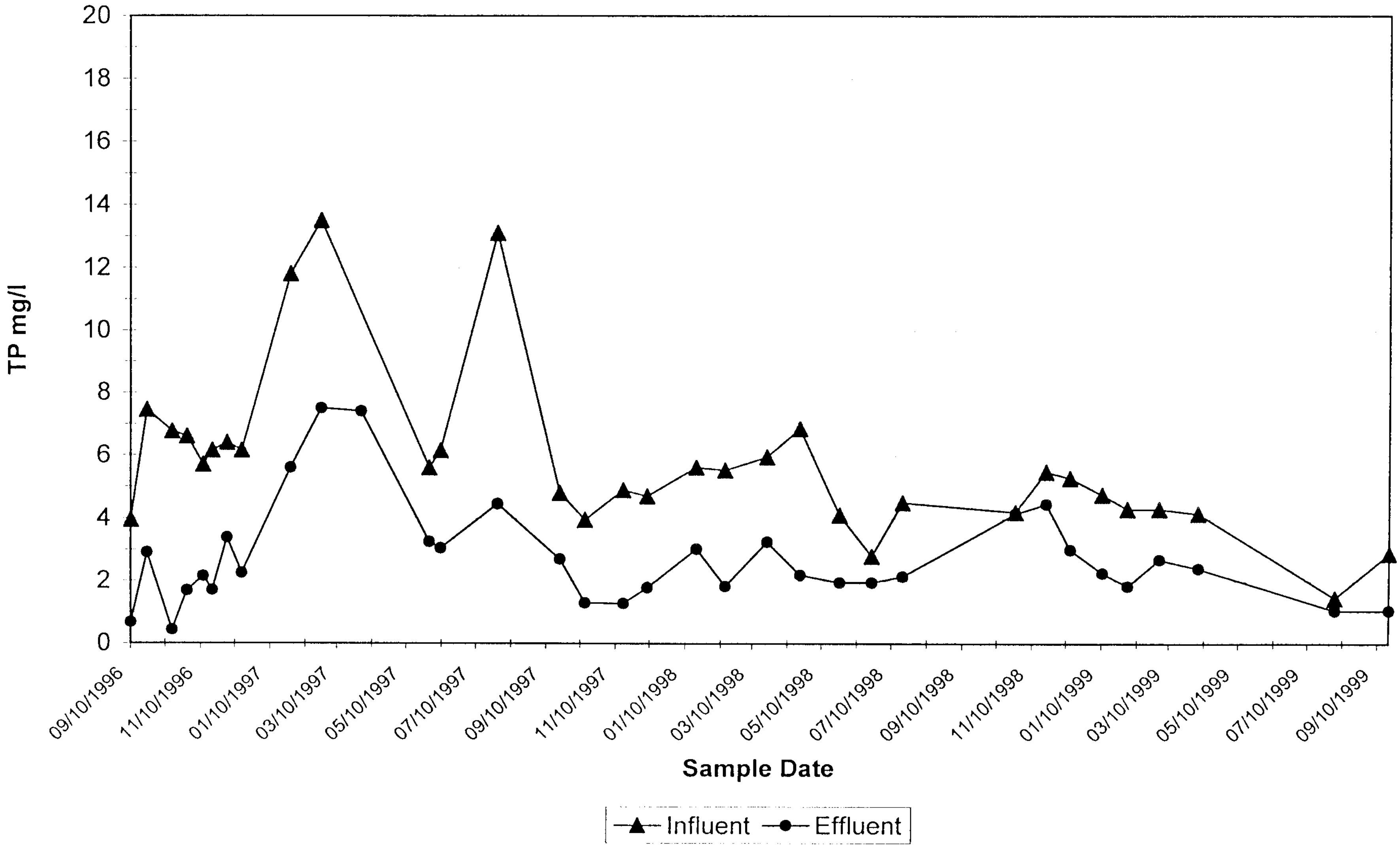


Figure 7
Concentrations of Total Phosphorus
Constructed Wetland



apparent when comparing the results from 6/9/97 and 4/5/99. When a sample was taken on 6/9/97 the level of total phosphorus dropped from 13.10 (influent) to 3.05 (effluent), but the sample taken on 4/5/99 signifies an increase from influent (1.45) to effluent (2.4) (Table 1). There is no significant decrease in suspended solids. In fact, there are occasions when the amount of suspended solids increased from influent to effluent (Figure 8). Two notable increases from influent to effluent occurred on 7/29/97 and 1/11/99, in which suspended solids increased from 26 (influent) to 70 (effluent) and 19 (influent) to 63 (effluent), respectively (Table 1). There are no consistent rates of reduction in nitrates or ammonia (Figures 9 and 10). The level of BODs dropped significantly from influent to effluent, but not at a consistent rate (Figure 11). This is evident when comparing sampling results from 12/3/96 and 12/16/96. On 12/3/96 the level of BOD lowered 326 points from 402 (influent) to 76 (effluent), then only dropped 79 points on 12/16/96, from 146 (influent) to 67 (effluent) (Table 1).

After NEFCO made its interpretations of the CW data, they asked a representative from the Ohio EPA - Northeast District Office to review the data and point out any significant trends or patterns.

The Ohio EPA representative indicated that on the positive side, the CW seemed to be functioning to reduce concentrations of all chemicals, except for nitrates. However, the quality of effluent after wetland treatment, did not meet standards set for discharge and would "exert a toxic and nutrient enrichment impact on downstream aquatic life." He explained that "ammonia-N is acutely toxic at levels near 13 mg/l", and many of our reported ammonia-N samples exceeded this level. Some of the BOD reductions were "impressive, the effluent quality even in 1999 was still well above 30 mg/l in most samples, which would be considered elevated if discharged to downstream surface waters and would likely deplete dissolved oxygen to low levels." The Ohio EPA representative went on to report that a reduction in bacteria (fecal coliform) levels was apparent in both 1998 and 1999. However, "only 4 of 15 samples were below the 1,000/100 ml primary contact recreation standard", thus levels of bacteria in some of the samples is high enough to cause illness if someone were to come in contact with the effluent water. He also found it interesting that "total suspended solids concentrations were higher at certain times in the effluent than in the influent, possibly due to increased concentrations of planktonic algae."

The representative from the Ohio EPA made recommendations to increase the size of the wetland cells, that "perhaps the wetland was not sized large enough to treat the wastewater in order to attain acceptable concentrations of chemicals to protect for aquatic life and human health." It was suggested that additional studies be done using different sized wetlands for similar effluent quality, before this type of wetland treatment can be recommended for human wastewater. For example, the Ohio EPA would require "BODs of 10 mg/l, ammonia of 1.5 mg/l, and total suspended solids (TSS) of 12 mg for discharge of any new source of pollutant loadings to small streams." Effluent samples from the first cell of NEFCO's constructed wetland indicate that it is not close enough to this level of treatment. The Ohio EPA's last suggestion was to use this type of wetland system as a form of pre-treatment.

Figure 8
Concentrations of Suspended Solids
Constructed Wetland

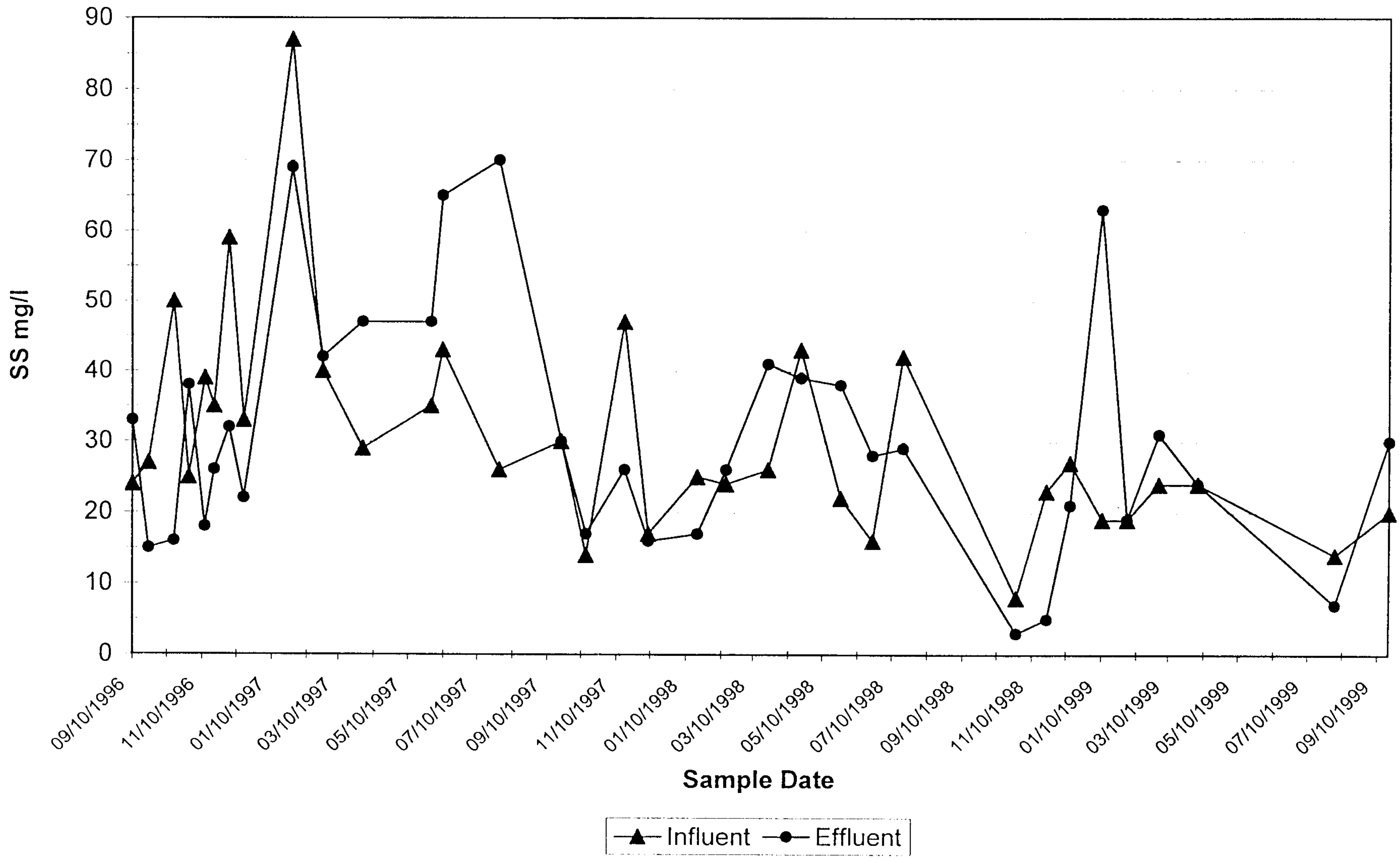


Figure 9
Concentrations of Nitrates
Constructed Wetland

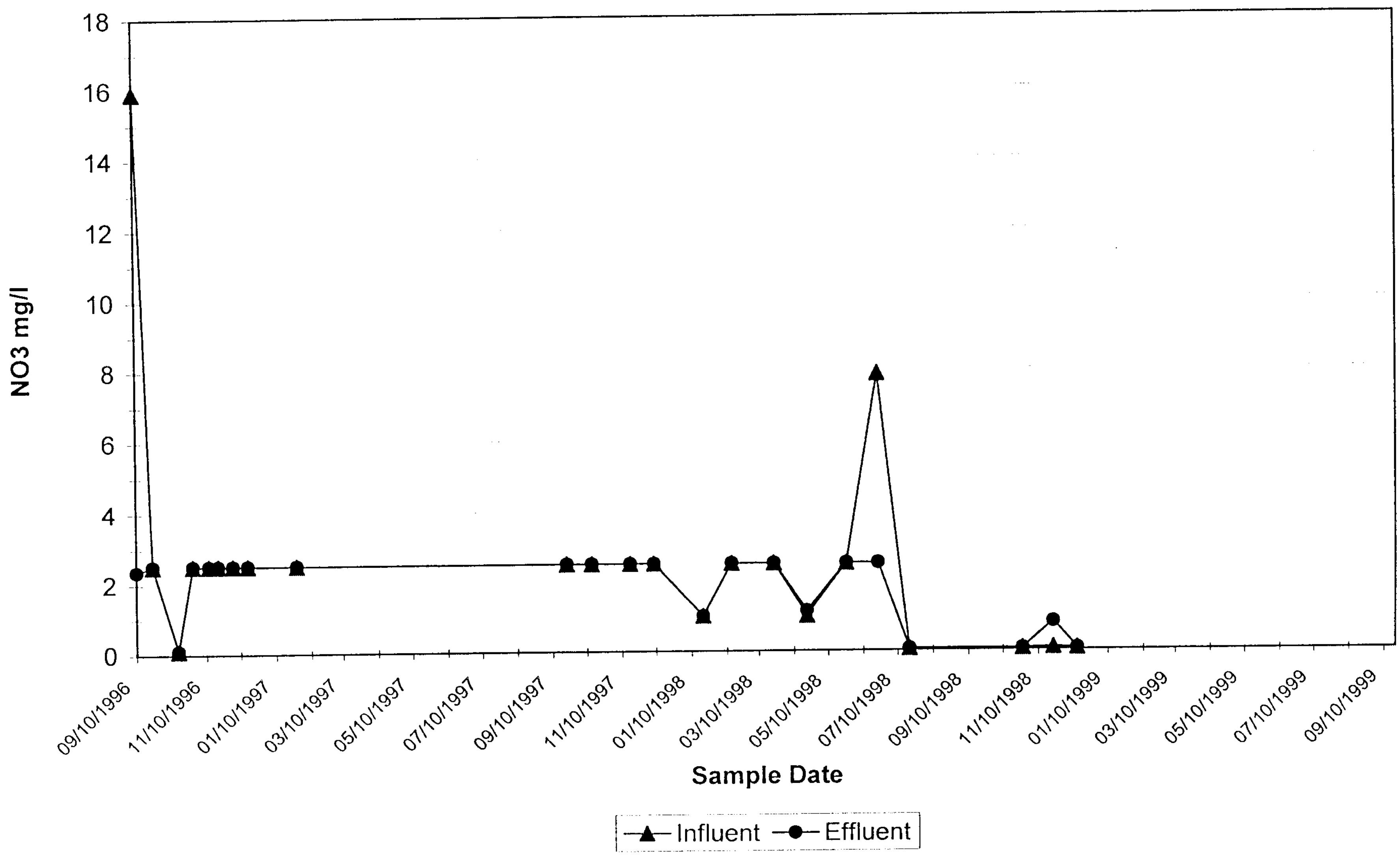


Figure 10
Concentrations of Ammonia
Constructed Wetland

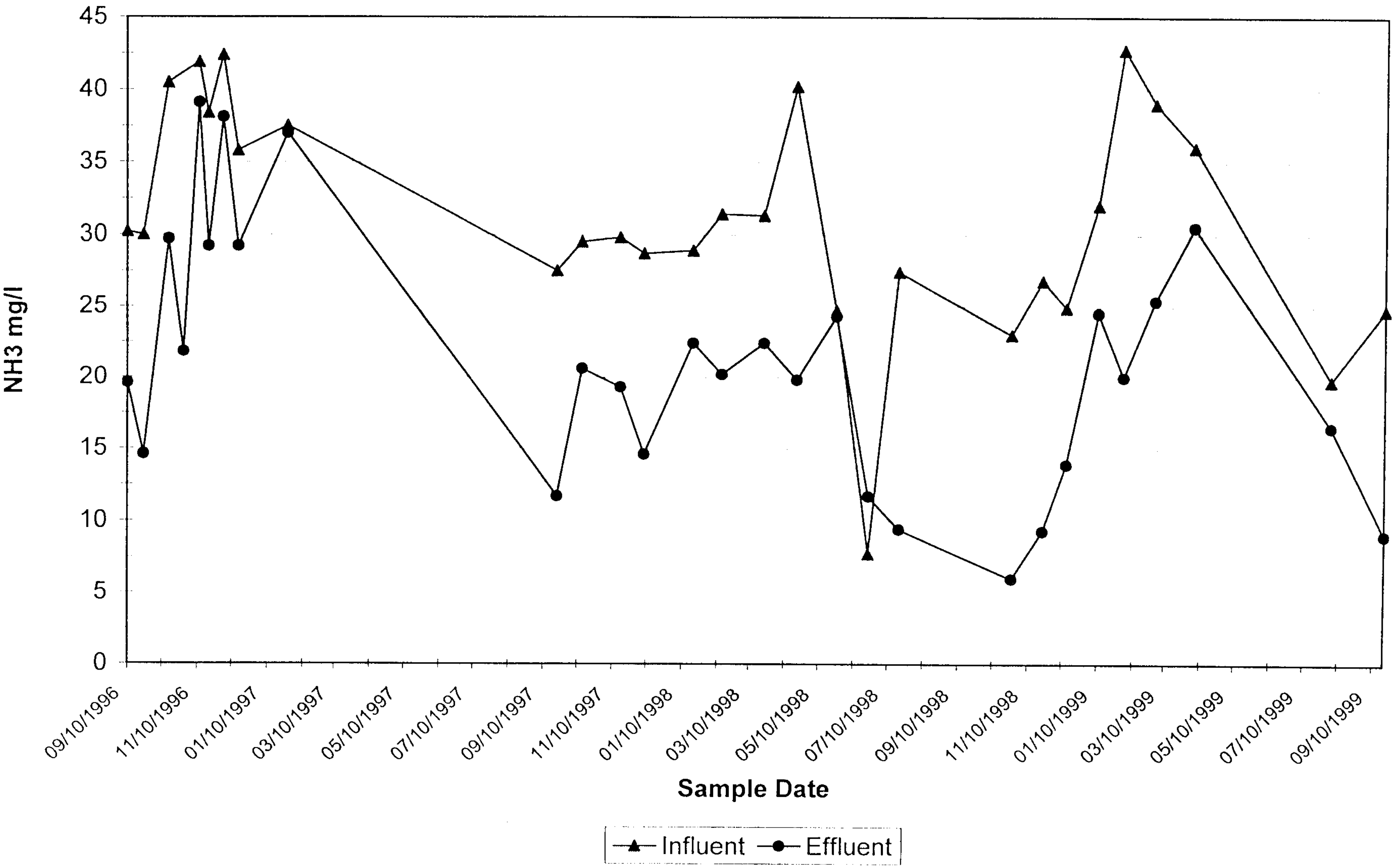
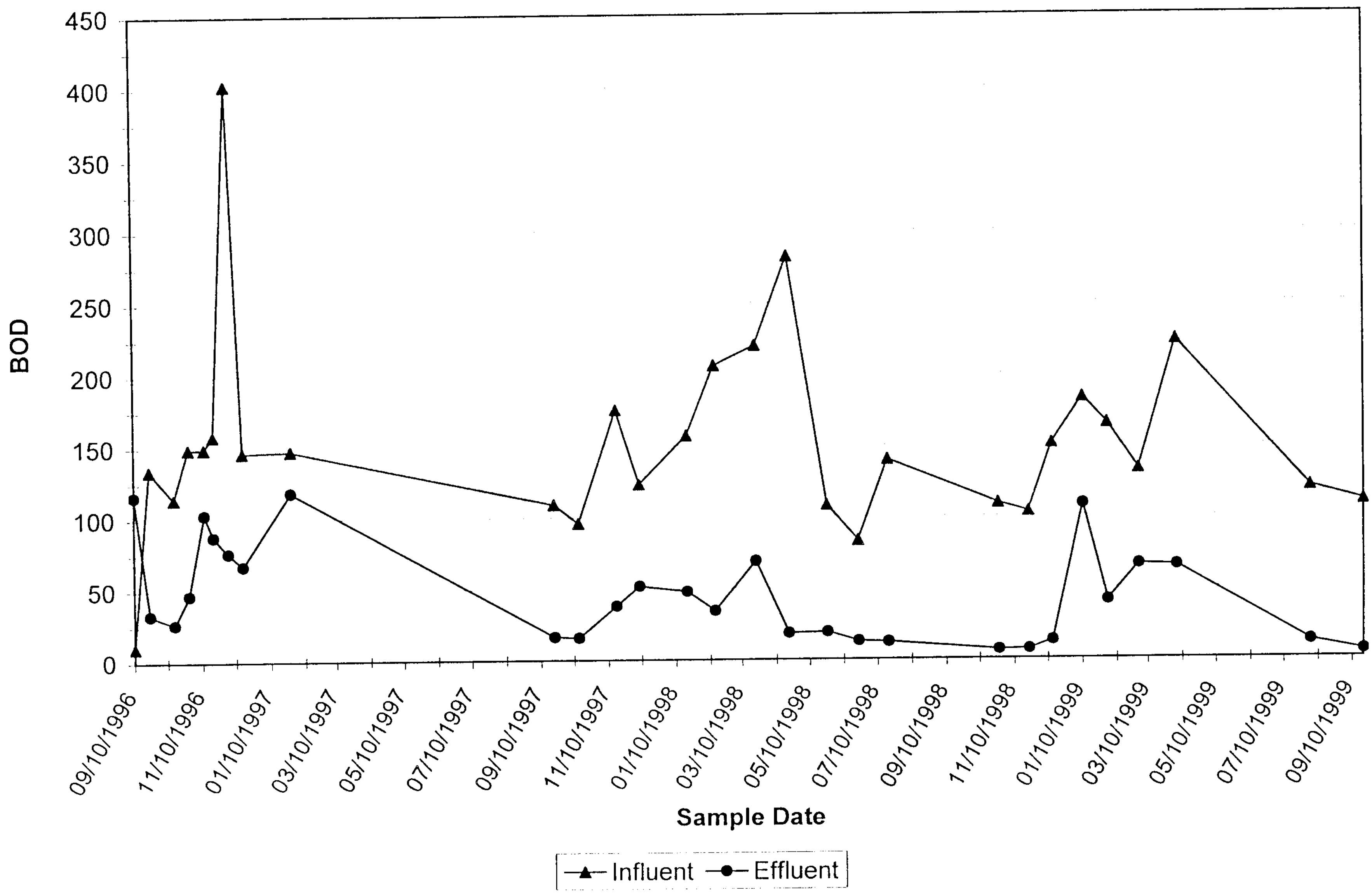


Figure 11
Concentrations of Biochemical Oxygen Demand (BOD)
Constructed Wetland



After reviewing the pump data, there appeared to be a seasonal trend (Figure 12), in which the number of gallons of effluent being pumped through the system seems to increase during the spring and summer months, and then fall as the weather gets colder. However, there is not enough data to be able to identify the reason behind the trend. It could be a result of doing more laundry or taking more showers in the warmer months. There was also a period in which the counter on the pump crock was not functioning properly. There was a reading taken on May 14, 1997, that was questionable (Table 2). It recorded 275 gallons of effluent being pumped per minute. This reading may have been altered due to debris found in the pump crock. The contractor was notified and the problem was resolved at that time.

Discussion

The two-celled submerged flow constructed wetland system was installed on City of Akron owned land in Ravenna on June 13, 1996. Construction materials and excavation costs were paid for with the grant money awarded to NEFCO from the Lake Erie Protection Fund (LEPF).

The CW was planted for the first time in September, 1996 with wetland plants purchased from J&J Tranzplant Aquatic Nursery. Some plants did not survive the first year, so a replant was necessary in the Spring of 1998.

NEFCO staff maintained the CW on a regular basis. This entailed weeding, replanting vegetation, recording the counter and timer numbers from the pump crock, and ensuring that the effluent level was below the surface of the wetland.

Sampling was done by the City of Akron monthly or bi-monthly. The samples were taken from the influent and effluent of the first cell of the CW. The parameters tested were fecal coliform, total phosphorus, suspended solids, nitrates, ammonia, and Biochemical Oxygen Demand (BOD). According to the Ohio EPA, the wetland does function to reduce the concentrations of all chemicals except for nitrates. The overall quality of effluent water after treatment could exert a toxic and nutrient enrichment impact on downstream aquatic life if it were discharged.

NEFCO relayed the comments that the Ohio EPA made to the collaborating agencies for their response. Chip Porter, Director of Environmental Health, from the Portage County Health Department (PCHD) agreed with the Ohio EPA's comments as far as effluent quality was concerned. However, he felt that it was important to note that the sampling for the demonstration CW was only done after one wetland cell of treatment. Most constructed wetlands that treat wastewater, have two treatment cells, and samples are taken after the second cell. Due to the permeable soils of the demonstration wetland in Portage County, NEFCO only used one cell for treatment; the second cell was used as an absorption field. Perhaps if the second cell was also lined and planted and used for treatment, the monitoring results may have met Ohio EPA standards for direct discharge.

Figure 12
Gallons of Effluent Pumped Per Day
Constructed Wetland

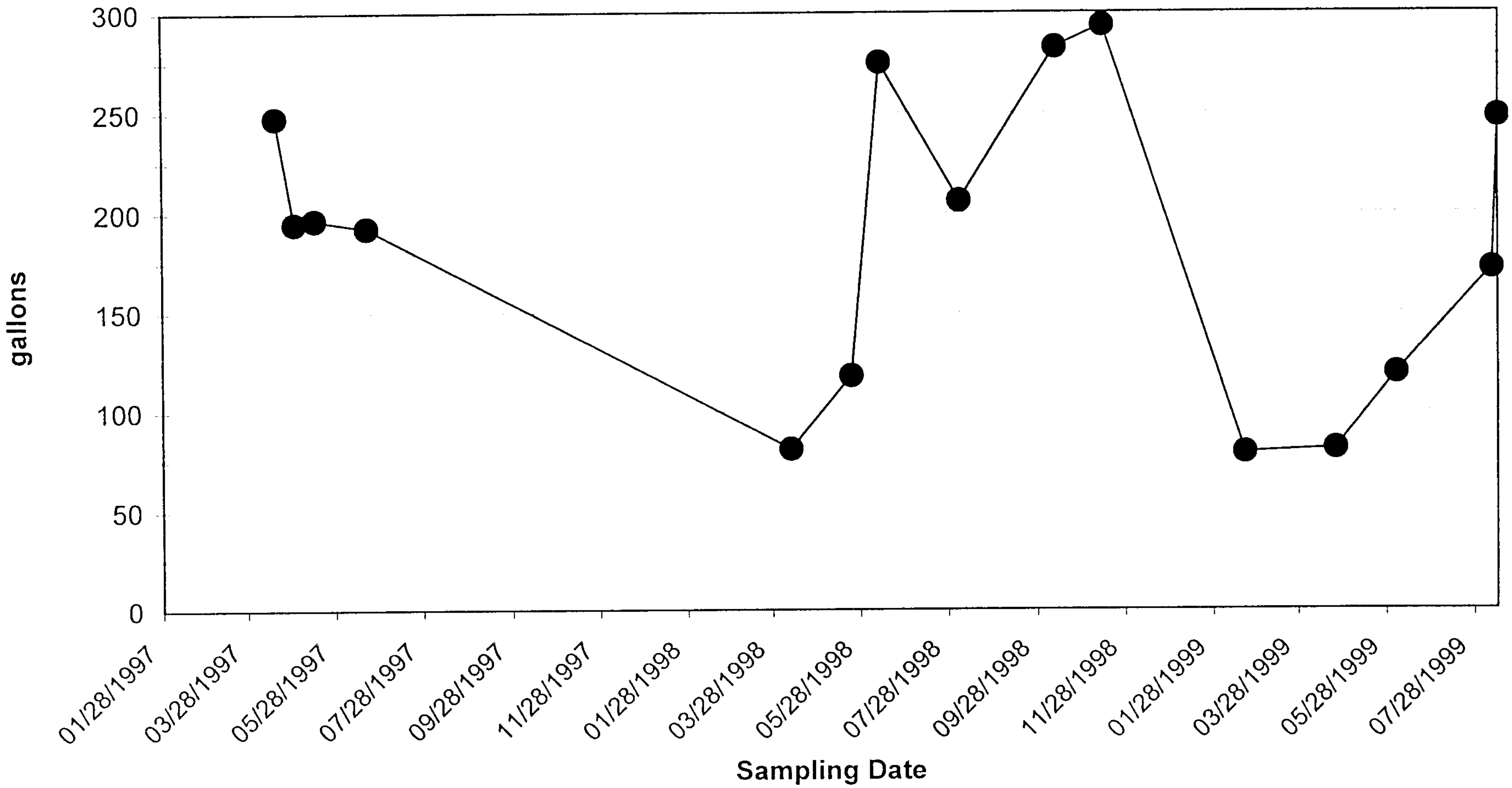


Table 2
Pump Data Results

Date	Counter	Timer	Number of Days	Number of Minutes	Min/Day	Number of Counts	Counts/Day	Gal/Min	Gal/Day	Total Gallons
01/28/1997		487								
02/21/1997		695	24	208	8.67					
03/13/1997		853	20	158	7.90					
04/09/1997	70415	1078	27	225	8.33					
04/17/1997	70451	1153	8	75	9.38	36	4.5	26	248	1980
04/30/1997	70497	1189	13	36	2.77	46	3.5	70	195	2530
05/14/1997	70547	1199	14	10	0.71	50	3.6	275	196	2750
06/19/1997	70673	1320.8	36	121.8	3.38	126	3.5	57	193	6930
04/10/1998	71108	2238.7	295	917.9	3.11	435	1.5	26	81	23925
05/22/1998	71211	2441.4	48	202.7	4.22	103	2.1	28	118	5665
06/11/1998	71286	2589.3	15	147.9	9.86	75	5.0	28	275	4125
08/05/1998	71492	2994	55	404.7	7.36	206	3.7	28	206	11330
10/11/1998	71682	3360.2	37	366.2	9.90	190	5.1	29	282	10450
11/13/1998	71858	3714.3	33	354.1	10.73	176	5.3	27	293	9680
02/19/1999	71999	4117.6	98	403.3	4.12	141	1.4	19	79	7755
04/23/1999	72092	4343.7	63	226.1	3.59	93	1.5	23	81	5115
06/04/1999	72183	4529.7	42	186	4.43	91	2.2	27	119	5005
08/09/1999	72389	4947.3	66	417.6	6.33	206	3.1	27	172	11330
08/13/1999	72407	4984.2	4	36.9	9.22	18	4.5	27	248	990

Kim Coy, Watershed Superintendent, from the City of Akron agreed with the Ohio EPA's assessment of the CW. He believes that the CW has potential, but this demonstration project did not prove its maximal efficacy. Mr. Coy went on to suggest that perhaps a different design or better vegetation may improve results. He went on to comment, "We do know that it is an improvement over the system which it replaced. I do hope that others pick up on this idea and implement it as an alternative to conventional systems which do not adequately function in the large areas of poorly drained soils of the Upper Cuyahoga River Watershed."

The sampling results tell us that the treated effluent is not meeting standards set for discharge. The CW was designed as a two-celled wastewater treatment system, in which the effluent is treated by both cells. However, this two-celled demonstration wetland is only treating effluent in the first cell and then absorbing it in the second cell, leaving no discharge to test after the second cell. Thus, the wetland is actually treating at half of its capacity. The second cell could have been used for additional effluent treatment, however, due to the porous soil types of the CW site, NEFCO chose to use the second cell for percolation.

NEFCO asked the collaborating agencies for their input on the overall performance of the CW for home wastewater treatment. Chip Porter from the Portage County Health Department commented that there is no conclusive evidence that supports that the effluent coming from the CW would meet Ohio EPA standards at this time. There are no plans to use this type of system as an alternative system for HSDSs. The comments of Kim Coy and Dick Wetzel, District Coordinator, from the Portage SWCD can be found in Appendix E.

<u>Recommendations</u>

NEFCO and the local agencies, including the Portage County Health Department, the City of Akron and the Portage SWCD have learned a great deal from this demonstration wetland project: 1) it is relatively inexpensive to install a CW; 2) wetland plants can thrive in the cells; 3) if properly monitored, there is no odor; 4) maintenance is required as invasive plants quickly take advantage of the moisture and nutrients; 5) the sizing criteria of the cells may have to be revised to achieve optimum treatment; and 6) long term studies need to be undertaken on a greater number of CWs to determine performance criteria.

Reflecting back on the past three years we have discovered that making a number of changes could improve the performance of the present study. For instance, if a second phase of "A Demonstration of a Constructed Wetland for Home Wastewater Treatment" were undertaken, there would be a variety of CW system design modifications. First, the contents of the second cell would be extracted, the cell would be lined with impermeable material, filled with pea gravel and planted in order to act as a secondary treatment cell. Samples would be taken from the distributor box at the end of the second cell to test for quality. The second cell would also be followed with a tile field to prevent discharge to a waterbody, in case the quality of the effluent coming out of the second cell is substandard. In making such modifications the performance of the CW could improve as the plants mature, and later it could be used as an off-lot system if needed.

Another change to consider, as suggested by the Ohio EPA, would be to make the cells larger. The existing system could be modified by extracting all materials from the two cells; resizing the cells to make them larger; lining and planting both cells; and following the second cell with a tile field. As the effluent flows into the larger cells, it has a larger surface area to cover, spending more time in each cell, and therefore, spending more time among the roots of the wetland plants. This would allow for a longer detention period, more plant rhizosphere contact time, and improved performance of the CW.

Maintenance is essential to the performance of the constructed wetland. The biggest problem encountered by NEFCO staff when maintaining the wetland was invasive vegetation. It is important not to allow weeds to overrun the desired wetland vegetation as it may affect the growth of the wetland plants, and result in poor performance of the system as a whole. Replanting vegetation and checking the effluent water level in the cells is also important. The Lorain County Health Department faces this problem with their twelve constructed wetlands. Each CW was installed on privately owned land, leaving the maintenance of the constructed wetland system to the homeowner. It may not pose a problem if the homeowner maintains the CW on a regular basis, but if the present homeowner were to move, the new homeowners may not give the system the attention it needs in order to perform properly. This is why educating the public on alternative wastewater treatment systems such as the CW is so important.

An early concern by the Portage County Health Department was the amount of maintenance needed by homeowners to keep the CW operating optimally. The CW required at least two visits (8 hours each) by NEFCO to weed out the invasive vegetation. The water level needed to be monitored to avoid surface ponding but maintain coverage of the plant roots. Surface ponding created considerable nuisance odors. The constantly damp and nutrient rich environment is highly conducive to invasive plant establishment.

An additional recommendation would be to do another project in which the constructed wetland is installed in impermeable soils i.e. more realistic situation. Since impermeable soils are the leading cause of most failing septic systems, it makes sense to test this particular system in soils that do not allow a traditional septic system to run properly.

Conclusion

As stated at the beginning of the report, the goal of using a constructed wetland project to demonstrate the use of constructed wetlands as a feasible alternative to treat residential wastewater when conventional treatment systems present an environmental risk or economic liability. Cost effective alternatives are needed to provide citizens' options. While overall effectiveness of a CW has been shown to substantially reduce pollution, but a single cell is only partially adequate. For the past three years, NEFCO and collaborating agencies, the City of Akron, the Portage County Health Department, and the Portage Soil and Water Conservation District have invested a great deal of time and effort into reaching this goal.

A constructed wetland was built at a home site to replace the existing failed septic system. The performance of the CW was monitored over a three year period. The results reveal that the treated effluent is not meeting standards set for discharge. Consequently, NEFCO reviewed the project and made a number of recommendations to improve the performance of the study. The recommendations are as follows: **1) lining the second cell with an impermeable membrane and using both cells for wastewater treatment instead of one; 2) making the cells larger to promote longer detention times; 3) keeping up with the maintenance, as it is fundamental to the performance of the CW; 4) allowing enough time in the project for vegetation maturation; and 5) conducting another CW project to test its performance in impermeable soils.**

Constructed wetland projects designed for treating wastewater have the potential to assist in dealing with the critical water quality problem in the Cuyahoga River Watershed. The Cuyahoga River Remedial Action Plan (RAP) has targeted home septic systems as a major source of nutrients. Although this alternative system has not yet met water quality standards set for discharge, it holds a lot of promise for the future. With subsequent projects and additional research, the constructed wetland could contribute to nutrient reduction to the Cuyahoga River.

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A Demonstration of a Constructed Wetland for Home Wastewater Treatment

Executive Summary

Background

- concern exists for health risks and water quality impacts from failed on-site residential wastewater treatment systems
- reduction of federal funds for municipal pollution control and the increasing concern for water quality introduced the necessity for an effective, yet inexpensive treatment system
- constructed wetlands are an environmentally-friendly, efficient, safe and cost-effective alternative solution to conventional wastewater treatment

What is a Constructed Wetland?

- a constructed wetland (CW) is a wastewater treatment system designed to optimize physical, chemical and biological processes of natural ecosystems

Why Use Constructed Wetlands for Wastewater Treatment?

- to provide an easy and effective solution for treating waste water
- as an alternative technology that can be used to replace failing septic systems, especially in unsewered areas with severe soil limitations
- they can be used to accommodate flows from individual homes to small businesses and schools
- to lower the wastewater costs to the homeowner

Additional Things to Consider ....

- local regulations need to be followed as the system may still be considered experimental
- maintenance and regular observation of the system is required to keep the system operating optimally
- planning for a back up system may be needed if the constructed wetland fails
- compounds such as paints, solvents, herbicides, and drain cleaners cannot be discharged to a constructed wetland as they will kill the vegetation

NEFCO's Constructed Wetland

Background

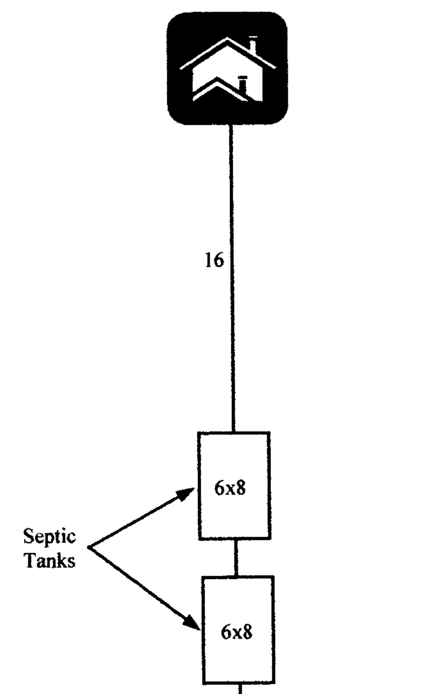
- the constructed wetland was developed in response to the need for an alternative wastewater treatment system when conventional treatment systems fail in areas with poor soil conditions
- in coordination with the City of Akron, Portage County Health Department and Portage Soil and Water District, Northeast Ohio Four County Regional Planning and Development Organization (NEFCO) started a demonstration project of a constructed wetland for wastewater treatment by installing a constructed wetland on a residential property
- construction commenced on June 13th, 1996 and was funded by the Lake Erie Protection Fund
- water quality is monitored to evaluate the effectiveness of the constructed wetland as it matures

What Does the Subsurface System Consist of?

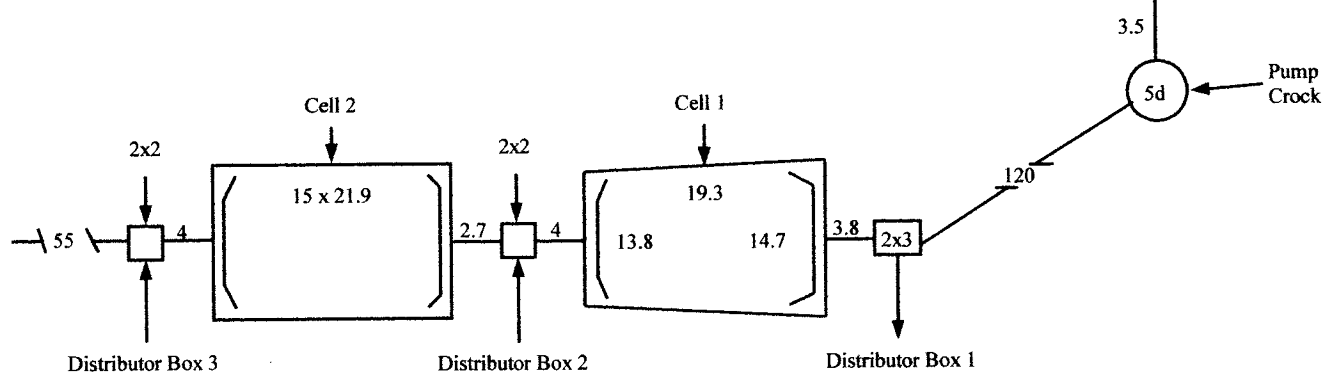
Pre-Treatment System:

Septic Tanks
- two 1,000 gallon septic tanks are used to separate the solids from the wastewater
- using a dual septic tank system ensures the maximum separation of solids from the wastewater before it enters the wetland

Pump Crock
- a cylindrical tank that collects outflow from the septic tanks and pumps it to the wetland



NEFCO's Constructed Wetland



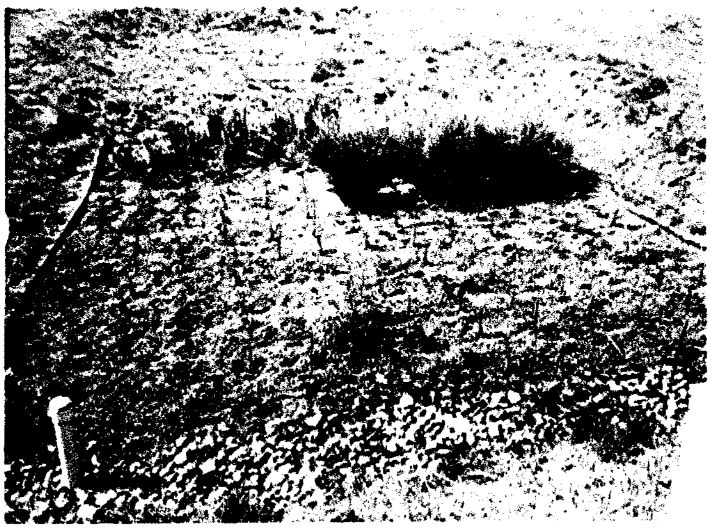
*This diagram is not drawn to scale; all measurments are expressed in feet

Wetland System:

Size
- the wetland consists of two wetland cells
- the first cell is 19.3 ft x 14.7 ft (at the inlet) and 13.8 ft (at the outlet)
- the second cell is 15 ft x 21.9 ft

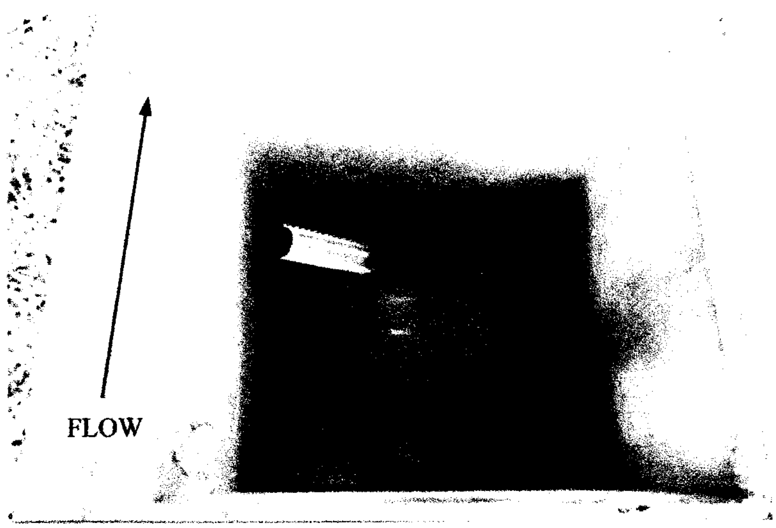
Liner
- cell 1 is lined with a heavy duty synthetic 30mm liner

Substrate
- both cells contain a layer of washed gravel
- larger sized gravel is found at the inlet and outlet of the two cells (to distribute the flow evenly in the cell and collect the outflow)



Vegetation
- the first cell was originally planted with narrow leaf cattail, soft-stemmed bulrush, soft rush, dark green bulrush, flowering rush, arrowhead, red cardinal flower, yellow and blue iris, sweet flag, duck potato, yellow water arum and pickeral weed
- after the first growing season the predominant plants that remain are the narrow leaf cattail, soft rush, soft-stemmed bulrush and yellow and blue iris. Vacant spaces in the constructed wetland were replanted with soft rush and narrow leaf cattail
- Cell 2 is used as an absorption field, consequently it was mulched instead of planted

Distributor Boxes
- the wetland structure includes three distributor boxes: one at the inlet of Cell 1; one between Cell 1 and Cell 2; and one at the outlet of Cell 2
- control water level of each wetland cell
- distribute effluent throughout the wetland cells



How Does the Constructed Wetland Work?

- sewage flows from the residence to the septic tanks where pretreatment (settling of solid material) occurs
- from the septic tanks, the wastewater flows into the pump crock
- once the pump crock collects approximately 55 gallons of wastewater, a sump pump is activated, pumping the effluent out to the first distributor box
- from the first distributor box, the effluent flows through a pipe into a distributor pipe
- the distributor pipe contains drain holes that enable the flow to spread evenly throughout the cell
- bacteria on the roots of the plants in Cell 1 process the wastewater and its nutrients
- the nutrients are then transported to the leaves and stems and incorporated into the biomass; some water is released as water vapor through evapotranspiration
- the water that remains flows into the second distributor box
- the second distributor box contains a swiveling standpipe which controls the water level within the wetland
- from the second distributor box, the treated wastewater enters another distributor pipe in the second cell
- once the wastewater is distributed throughout Cell 2, it percolates into the ground
- due to the high permeability of this specific site, the second cell was mulched. It could be planted with wetland plants to facilitate the evaporation of water
- in case of overflow, the effluent would enter a third distributor box, where it would be channeled through an outflow pipe; no discharge has occurred from the wetland thus far (as of August '98)

What Does it Cost to Build a Constructed Wetland?

- NEFCO paid $5,600 for materials and labor to install this constructed wetland system

Performance

- the preliminary results reveal that the constructed wetland is reducing the level of biological oxygen demand (BOD) and fecal coliform at a high rate, an average of 82% and 94% respectively
- the levels of total phosphorous, nitrates and ammonia being extracted are 49%, 13.5% and 7.2% respectively
- results for suspended solids are not favorable at this time. The results may be related to immature plant growth

Acknowledgements

NEFCO thanks the City of Akron for providing the site for the constructed wetland; the Portage County Health Department for providing assistance with the construction of the wetland and in obtaining permits; the Portage Soil and Water District for assistance during construction and in plant selection; and the **Lake Erie Protection Fund** for funding the project.

We also express our gratitude to the Upper Cuyahoga River Task Force for their instrumental role in bringing the partners together and brainstorming ideas for protecting and restoring water quality of the Upper Cuyahoga River.

August 20, 1998