Summary

The Nimishillen Creek Watershed is an area of mixed development, in which the conversion of agricultural land and open space to residential and commercial development is occurring at a constant pace. As land use changes, greater demands are placed upon the water resources, which are a vital component to the quality of life for many who live and/or work in the area.

Various potential pollution sources were identified in the watershed, and reflect the many types of land use taking place. Each of these sources was evaluated to assess their ability to impair surface and/or ground water quality. On-lot home and semi-public sewage treatment systems (HSTSs) and (SPSTSs), impervious surfaces appear to have the greatest potential impact from nonpoint source pollution (NPS) in the watershed as a whole, although individual subwatersheds may vary. The evaluation revealed that the greatest potential water quality threat from point sources of pollution is linked to off-lot HSTSs and SPSTSs. Other point sources of pollution include municipal wastewater treatment plants, several smaller semi-public sewage treatment plants (package plants) and industrial direct dischargers.

Ten waterways were evaluated for riparian habitat quality, for a total of 94 river miles, which included the following: Nimishillen Creek Mainstem, Sherrick Run, Hurford Run, West Branch Nimishillen Creek, West Branch Tributary 1, Middle Branch Nimishillen Creek, Swartz Ditch, East Branch Nimishillen Creek, and East Branch Tributaries 1 and 2. The riparian evaluation revealed that 24.8%, of the ten waterways assessed, consisted of high quality riparian habitat (i.e. forest, swamp, shrub, or old field). Three streams, Nimishillen Creek Mainstem, Sherrick Run, and East Branch Nimishillen Creek had the greatest percentage of high quality habitat with percentages of 46.8, 41.4 and 39.5, respectively. Two streams containing the lowest percentage of high quality habitat were Hurford Run (6.2%) and Swartz Ditch (4.7%).

Another purpose of this study is to summarize the water quality of the watershed. Using raw data collected by the Ohio EPA-NEDO office, NEFCO staff compiled, tabulated and summarized the water quality data for the Nimishillen Creek watershed. Stream monitoring took place at a total of 31 stations within the watershed from July to September 1998. Parameters included nutrients, heavy metals and bacteria. A portion of the samples tested exceeded water quality standards and/or suggested levels for phosphorus, total dissolved solids, iron and fecal coliform.

Introduction

The intent of the Nimishillen Creek Watershed Study is to protect and/or restore the water quality of the Nimishillen Creek Mainstem and its associated tributaries by developing a Comprehensive Watershed Management Plan (CWMP). This report represents Phase I of that study; the Diagnostic.

Understanding the problem areas that adversely affect or impair water quality of Nimishillen Creek requires a knowledge of the condition of the watershed (NEFCO, 1997, p. I 1). Insight can be gained by looking at the contributions from point sources, such as sewage treatment plants, land uses and soil characteristics. This report examines the potential pollution sources in the Nimishillen Creek Watershed, as they exist today, and attempts to prioritize the subwatersheds that appear to be most impaired. Point sources of pollution will be identified and mapped in the following pages, and a description of the various nonpoint source (NPS) pollution categories within each subwatershed will be done. It is intended that the results of this diagnostic study help guide land use decisions made by key stakeholders in order to protect/maintain the integrity of the Nimishillen Creek Watershed. This report can help these stakeholders identify and prioritize subwatersheds that are in need of remediation efforts or that are adversely affected by certain land uses.

It is also the intent of this study to raise public awareness, especially among the watershed's residents, of the pollution sources in the Nimishillen Creek Watershed. This awareness will enhance the effort to develop and implement watershed stewardship projects through volunteer citizen groups or local landowners within the watershed, and to encourage their participation in the use of Best Management Practices (BMPs), such as maintaining a riparian corridor or vegetated buffer strip/swale, which can ameliorate water quality problems associated with (NPS) pollution in the watershed.

Study Area

The study area (shown in Figure 1) is located in the northeastern portion of the Muskingum River Watershed in the Ohio River drainage basin in which Nimishillen Creek is a major subwatershed. For the purpose of this study, the Nimishillen Creek Major Subwatershed will be referred to as the Nimishillen Creek Watershed. This will enable the study to remain consistent with previous NEFCO work. Additionally, NEFCO has divided the Nimishillen Creek Watershed into four (4) major subwatersheds and thirty (30) minor subwatersheds. This will improve the accuracy of determining specific hydrologic habitat modifications and/or stream segments within the watershed that may receive a higher priority for protection and of measuring the progress of restoration efforts in the future.

The headwaters of the Nimishillen Creek Mainstem originate in three different locations. The headwaters of the West Branch Nimishillen Creek are located to the west of the Village of Hartville and just south of the Akron-Canton Airport. Flowing south, the West Branch Nimishillen Creek flows through the City of North Canton and the City of Canton to its confluence with the Nimishillen Creek Mainstem near river mile (RM) 12.1; the headwaters of the Middle Branch Nimishillen Creek are located in Marlboro Township. Flowing southwesterly, the Middle Branch Nimishillen Creek flows along the western portion of Plain Township, before entering the City of Canton where it enters the Nimishillen Creek Mainstem at RM 15.0; and the headwaters of the East Branch Nimishillen Creek are located to the north, east and south of the City of Louisville.

Flowing southwesterly, the East Branch Nimishillen Creek flows to the City of Louisville before entering the City of Canton until its confluence with the Nimishillen Creek

Mainstem near RM 15.0. Continuing to flow south, the Nimishillen Creek Mainstem flows through the City of Canton and the Village of East Sparta, prior to its confluence with Sandy Creek just south of the Stark and Tuscarawas County boundaries. For the purpose of this study the riparian habitat inventory started at approximately .55 RM upstream (Stark County Aerial Photo Index Sheet 20-27) of the Nimishillen Creek Mainstem confluence with Sandy Creek. However, NEFCO mapped only the riparian habitat scores within NEFCO's region due to the lack of Tuscarwas County GIS data sets.

Located within the NEFCO study area are, in part or in whole, the following government jurisdictions: the Village of Hartville, City of North Canton, City of Canton, City of Louisville, Village of East Canton, Village of East Sparta, Village of Hills and Dales, Village of Meyers Lake, Lake Township, Marlboro Township, Jackson Township, Plain Township, Nimishillen Township, Washington Township, Perry Township, Canton Township, Osnaburg Township, and Pike Township in Stark County; and the City of Green in Summit County (Shown in Figure 2).

Data Sources

The following information was obtained in consultation with a number of state and county agencies including the Ohio Environmental Protection Agency (Ohio EPA) Northeast District Office (NEDO), Division of Surface Water, Division of Drinking and Ground Waters, and Division of Solid and Infectious Waste Management. Other data sources include: the Stark County Regional Planning Commission, Stark County Health Department, the Stark County Sanitary Engineer, the Stark Soil and Water Conservation District (SWCD), the Department of the Interior, and United States Geological Survey. The Ohio Department of Natural Resources (ODNR) provided information from its Division of Water, Division of Ground Water Resources, Division of Soil and Water, Division of Geological Survey, Division of Oil and Gas, and Division of Real Estate and Land Management. The digital data received from these sources was then imported into NEFCO's Geographic Information System (GIS), thereby permitting NEFCO to conduct a more complex and comprehensive evaluation of the study area. Furthermore, the GIS permits NEFCO to conduct complicated spatial analyses, modeling of map features, data storage and retrieval, data manipulation and display of geographically-referenced information.

I. Land Use/Land Cover

Summary

Characterization of a watershed's land use/land cover can lend a better understanding of potential threats to water quality. A study of the Nimishillen Creek Watershed's land use/land cover was achieved by combining 1977 digital land use data with 1994 digital satellite land cover data resulting in a generalized categorization of land use/land cover types. Results of the study revealed that the watershed is comprised of various types of land use/land cover. The most substantial form of land use in the watershed is agricultural/open urban. Agricultural areas have the potential to be sources of animal waste, nutrients, and sediment; potential products of agricultural stormwater runoff from fields. Urban areas are also found in the watershed. These areas have the potential to be sources of nutrients, bacteria and other pollutants. Portions of undeveloped land remains, in the form of wooded, shrub/scrub, non forested wetland and open area. These areas may help alleviate the impacts from stormwater runoff from urbanized areas.

Introduction

Understanding land uses within the watershed can offer clues as to the types of nonpoint source pollutants, subwatersheds at high risk of NPS, and appropriate BMPS to address the problems. Land use in the Nimishillen Creek Watershed was derived from existing digital data and digital satellite data. Land use/land cover categories for the study area include: agriculture/open urban area, industrial, urban (residential/public), non forested wetlands, barren, wooded and shrub/scrub, and water. The land use/land cover for the watershed is illustrated in Figure 3. Table 1 presents the acreage and percentage of land use/land cover in the watershed.

Source Materials

The source materials include the following:

1. Stark County - 1977 Ohio Capability Analysis Program (OCAP) data; and 1994 Ohio Department of Natural Resources (ODNR), Division of Real Estate and Land Management digital satellite data.

2. Summit County - 1994 ODNR digital satellite data.

Discussion

The watershed constitutes a total area of approximately 117,826 acres (Table 1). The majority of the watershed is located in Stark County (98.5%), with a minor portion in Summit County (1.5%).

The land use/land cover categories for the study area include: 1) Agriculture (cropland, pasture, and orchards)/Open Urban Area (parks, golf courses, lawns, and open grassy areas); 2) Industrial (heavy and light industrial operations); 3) Urban (residential areas, roads, shopping centers, warehouses, office buildings, educational, religious and health care facilities, and parking lots); 4) Non Forested Wetlands (wetlands identified from the 1994 Thematic Mapper data as well as from the Ohio Wetland Inventory); 5) Barren (strip mines, quarries, sand and gravel pits, and beaches); 6) Wooded (deciduous and coniferous forest land)/Shrub/Scrub (young, sparse, woody vegetation); and 7) Water (lakes, ponds and streams).

Table 1
Land Use/Land Cover by Subwatershed - Nimishillen

	Total Area		**Subwatersheds**							
			1		**2**		**3**		**4**	
	acres	(%)	acres	(%)	acres	(%)	acres	(%)	acres	(%)
Ag/open	52,716	44.7	9,457	32.9	9,605	32.1	16,965	56.8	16,689	56.9
Industrial	2,924	2.5	1,430	5.0	416	1.4	218	0.7	860	2.9
Urban	34,852	29.6	8,751	30.4	14,018	46.9	6,086	20.4	5,997	20.5
Non-forested Wetland	1,203	1.0	97	0.3	246	0.8	805	2.7	55	0.2
Barren	42	0.0	28	0.1	2	0.0	5	0.0	7	0.0
Wooded	25,106	21.3	8,815	30.6	5,362	17.9	5,402	18.1	5,527	18.9
Shrub/scrub	556	0.5	178	0.6	87	0.3	139	0.5	152	0.5
Open Water	427	0.4	19	0.1	159	0.5	228	0.8	21	0.1
Total Area	**117,826**		**28,775**		**29,895**		**29,848**		**29,308**	

Source: Department of Natural Resources, Division of Real Estate and Land Management, 1977 and 1994.

Table 1 reveals that the predominate land use in the watershed is agricultural/open urban (44.7%). Other significant forms of land use/land cover consist of urban (29.6%) and wooded (21.3%).

As residential development continues, the demand for clean and safe water is on the rise. Residential areas have the potential to be sources of nutrients and bacteria, particularly if located on poor soils for HSDSs and if sewers are unavailable. Nutrients and bacteria can originate from failed HSDSs, while other pollutants can arise as the result of lawn fertilizers, pesticides and general household wastes. As development proceeds, the level of imperviousness and storm water drainage increases. The impacts of storm water runoff from urbanized areas can destabilize streams and ditches. Streams respond to increased flows by eroding (usually along stream banks), transporting and depositing sediment downstream. Increased sediment and attached nutrients may well exacerbate other pollutant impacts, i.e. reducing a stream's ability to assimilate pollution.

Significant portions of wooded, scrub/shrub and open areas are located throughout the watershed (Table 1). For example, vast tracts of wooded and shrub/scrub areas are located in the southern and eastern portions of Subwatershed 1, in Pike and Osnaburg Townships, along the Nimishillen mainstem and Sherrick Run; scattered in the northern portion of Subwatershed 3; and eastern section of Subwatershed 4. The presence of these natural areas probably moderates the impact of runoff from many of the land uses throughout the watershed. These natural areas act as buffers and filters to moderate water flow and reduce erosion and the transport of pollutants downstream.

Conclusion

Because of the diversity of land use/land cover present in the watershed, a wide variety of preventative and restorative measures are needed to ensure healthy water quality. The increasing pressure of development should be taken into consideration when designing activities to protect the Nimishillen Creek Watershed. Efforts to promote environmentally-sound and sustainable development; riparian protection and restoration activities; and storm water management are essential to protecting water quality.

II. Potential Pollution Sources

Summary

Potential pollution sources in the Nimishillen Creek Watershed vary widely, but generally are typical of a watershed of mixed development. Sources of pollution can include home sewage treatment systems (HSTSs), public and semi-public sewage treatment plants (package plants), agricultural runoff, construction sites, petroleum production activity, and industrial land use areas.

The following pages examine the potential pollution sources in the watershed as they exist today. Wastewater treatment plants are the primary point sources of pollution. Self-monitoring requirements were reviewed for domestic wastewater dischargers. Nonpoint sources of pollution in the watershed were identified by focusing on studying land use (human activity) within the watershed.

Unsewered urban areas, and soil characteristics were used to estimate the potential for failure of HSTSs in the watershed. The distribution of these areas, and all other sources of NPS pollution in the watershed, was evaluated at a subwatershed level for prioritization purposes.

Introduction

Understanding the problem areas that adversely affect or impair the water quality of the Nimishillen Creek Watershed requires a knowledge of the condition of the watershed (NEFCO, 1997d, p. 11). Insight can be gained by looking at the contributions from point sources, nonpoint sources and land use. This section of the report examines the present potential pollution sources in the watershed, and attempts to prioritize the subwatersheds that appear to be the most impaired. Potential point sources of pollution will be discussed and particular emphasis will be given to potential nonpoint source (NPS) pollution within each subwatershed. It is intended that the results of this study help guide land use decisions made by key stakeholders in order to protect/maintain the integrity of the Nimishillen Creek Watershed. Such an analysis can help these stakeholders identify and prioritize subwatersheds that are in need of remediation efforts or that are adversely affected by certain land uses.

It is also the intent of this study to raise public awareness, especially with the watershed's residents, of the potential pollution sources in the Nimishillen Creek Watershed. It is hoped that information in this report will stimulate watershed stewardship, through government organizations, volunteer citizen groups, or land owners within the watershed, to help develop and implement best management practices (BMPs), which can ameliorate water quality problems associated with (NPS) pollution in the watershed.

Potential Point Source Pollution Inventory

A point source is defined as a source that discharges pollutants, or any effluent, from a known discharge point, such as a pipe, ditch, or sewer and into a waterbody after treatment (Miller, 1988, p. 348). Treatment generally consists of removal of solids and disinfection. The discharge often contains a high proportion of dissolved nutrients and chemicals. Point sources can be traced back to the discharger, i.e., the owner/operator of a factory, sewage treatment plant or even an off-lot home sewage treatment system (HSTS).

Approximately 56 point sources were identified discharging domestic wastewater into the watershed (Figure 4). These include wastewater treatment plants (WWTPS) which encompass both public (municipal and county) and semi-public sewage treatment plants (package plants), and are listed in Appendix A. Industrial direct dischargers were also identified in the watershed (Figure 4), these are noted in Appendix A under Active Industrial Operations. Table 2 shows the distribution of domestic wastewater dischargers by subwatershed and design flow in millions of gallons per day (mgd). This table does not include industrial dischargers, as they discharge process and storm water.

Table 2
Distribution and Design Flow for
Domestic Wastewater Treatment Plants by Subwatershed

	Design Flow (Q) in Millions of Gallons Per Day (mgd)						
Subwatershed	**Q>10.0**	**10.0>Q>1.0**	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.025**	**Q<0.0251**	**Total Maximum Designed Discharge**
1	1					14	33.0848
2			1		2	3	0.4105
3			1	1	2	12	0.8043
4		1		1		17	2.2045
Total	1	1	2	2	4	46	36.5040

Source: Stark County Sanitary Engineers, 1999; Stark County Health Department

Self-Monitoring

The Ohio EPA has the authority to regulate all wastewater treatment plants, enforce water quality regulations, and review plans or permits-to-install for any new plants (Ohio EPA and Local Health Department Work Group, 1996). However, under the provisions of House Bill 110, the Ohio EPA allows contracts with local health departments to inspect, and collect fees for, package plants with design flows of 25,000 gallon per day (gpd) or less. To protect surface and ground waters from pollutants associated with

WWTPS, the Ohio EPA requires that all sanitary dischargers monitor their effluent stream for certain parameters with a frequency based on design flow, and report the results to the agency once a month.

Table 3 lists the final effluent self-monitoring requirements for WWTP owners/operators. There is one plant with a design flow greater than 10.0 mgd: City of Canton Plant (M-1) discharges 33.0 mgd (design flow will increase to 39.0 mgd by the end of July, 1999 - Canton Water Pollution Control Center, Pers. Com., June 1999) into Subwatershed 1. There is also one plant with a design flow greater than 1.01, but less than 10.0 mgd: City of Louisville Plant (M-3) discharges 2.0 mgd into Subwatershed 4. Two WWTP with design flows of greater than 0.25 mgd and less than 1.0 mgd are found in the watershed: Village of Hartville Plant (M-2) discharges 0.45 mgd into Subwatershed 3; and Walthem Woods Plant (C-1) discharges 0.3 mgd into Subwatershed 2. These four plants mentioned above, are monitored for fifteen out of sixteen parameters listed on the table, as seen in first three columns on the left hand side. There are two WWTP with design flows greater than 0.1 mgd and less than 0.249 mgd: Diamond Estates Plant (C- 2) discharges 0.2 mgd into Subwatershed 3; and Molly Stark Plant (C-3) discharges 0.1 mgd into Subwatershed 4. These plants correspond to the middle, right column on the table, and is monitored for all parameters except nitrates, nitrates, and turbidity/odor/color. The remaining fifty package plants correspond to the two columns on the right hand side of the table. These are monitored for eleven parameters, but do not include nitrates, nitrites, phosphorous, oil and grease, metals, and free cyanide (Ohio EPA, 1994a, p. 2).

Table 3 (continued)
Final Effluent Self-Monitoring Requirements

	Design Flow (Q) in Millions of Gallons Per Day (mgd)					
Parameter	**Q>10.0**	**10.0>Q>1.01**	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.0251**	**Q<0.0251**
Flow	Daily	Daily	Daily	Daily	Daily	Daily
Temperature	Daily	Daily	Daily	Daily	Daily	1/week
Residual Chlorine	Daily	Daily	Daily	Daily	Daily	1/2 weeks
Dissolved Oxygen	Daily	Daily	Daily	Daily	1/week	1/ week
pH	Daily	Daily	Daily	Daily	1/week	1/month
Suspended Solids	Daily	3/week	2/week	2/week	1/week	1/month
Biological Oxygen Demand (BOD)	Daily	3/week	2/week	2/week	1/week	1/month
Carbonaceous BOD	Daily	3/week	2/week	2/week	1/week	1/month
Ammonia (NH_3)	Daily	1/month	2/week	1/2 weeks	1/2 weeks	1/month
Nitrites (NO_2)	1/2 weeks	1/month	1/month	Not monitored*	Not monitored*	Not monitored*
Nitrates (NO_3)	1/2 weeks	1/month	1/month	Not monitored*	Not monitored*	Not monitored*
Phosphorous (P)	2/week	1/week	1/month	1/quarter	Not monitored*	Not monitored*
Oil and Grease	1/week	1/2 weeks	1/month	1/month	Not monitored*	Not monitored*

Table 3 (continued) Final Effluent Self-Monitoring Requirements						
	Design Flow (Q) in Millions of Gallons Per Day (mgd)					
Parameter	**Q>10.0**	**10.0>Q>1.01**	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.0251**	**Q<0.0251**
Bacteria	Daily	3/week	2/week	1/week	1/month	1/month
Metals, Free Cyanide	1/2 weeks	1/month	1/quarter	2/year	Not monitored*	Not monitored*
Turbidity/Odor/ Color	Not monitored*	Not monitored*	Not monitored*	Not monitored*	Daily	Daily
*Effluent is not monitored for the corresponding listed parameter as of 1997. Source: Ohio EPA, 1994a., p.2						

Table 4 lists the Ohio EPA's influent self-monitoring requirements. It indicates that the influent for 89% of the domestic wastewater dischargers (corresponding to the two columns on the right hand side) is not monitored (due to low design flow). However, the influent of larger plants with a discharge greater than 0.25 mgd, is monitored for suspended solids, carbonaceous BOD, pH, metals and total cyanide, as shown in the three columns on the left hand side of the table. Plants discharging between 0.249 mgd and 0.1 mgd are required to monitor suspended solids and carbonaceous BOD (Ohio EPA, 1994a., p. 3).

Table 4 Influent Self-Monitoring Requirements						
	Design Flow in Millions of Gallons Per Day (mgd)					
Parameter	**Q>10.0**	**10.0>Q>1.01**	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.0251**	**Q<0.0251**
Suspended Solids	Daily	3/week	2/week	1/week	Not monitored*	Not monitored*
Carbonaceous BOD	Daily	3/week	2/week	1/week	Not monitored*	Not monitored*
pH	Daily	Daily	Daily	Not monitored*	Not monitored*	Not monitored*
Metals, Total Cyanide	1/month	1/month	1/quarter	Not monitored*	Not monitored*	Not monitored*
*Influent is not monitored for the corresponding listed parameter as of 1997. Source: Ohio EPA, 1994a., p. 3						

Table 5 lists upstream/downstream self-monitoring requirements. It indicates that the majority of all wastewater dischargers in the watershed (corresponding to the two columns on the right hand side, as mentioned) are not required to perform upstream/downstream monitoring. For comparison, the owners/operators of larger plants with a discharge greater than .25 mgd, are required to monitor upstream/downstream for pH, ammonia, temperature, bacteria, hardness, dissolved oxygen, and metals, as shown in the first three columns on the left hand side of the table. Plant discharge between 0.249 and 0.1 mgd are required to monitor for all parameters listed in Table 4, except for metals (Ohio EPA, 1994a., p. 3).

Table 5 Upstream/Downstream Self-Monitoring Requirements						
	Design Flow Millions of Gallons Per Day (mgd)					
Parameter	**Q>10.0**	**10.0>Q>1.01**	**1.0>Q>0.25**	**0.25>Q>0.1**	**0.1>Q>0.0251**	**Q<0.0251**
pH	1/month	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Ammonia (NH_3)	1/month	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Temperature	1/month	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Bacteria	1/month	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Hardness	1/month	1/month	1/quarter	1/quarter	Not monitored*	Not monitored*
Dissolved Oxygen	1/month	1/month	1/month	1/quarter	Not monitored*	Not monitored*
Metals	1/month	1/month	1/quarter	Not monitored*	Not monitored*	Not monitored*
*Upstream/downstream areas of package plant discharges are not monitored for the corresponding parameter. Source: Ohio EPA, 1994a., p. 3						

Tables 2, 3, 4 and 5 show that it is not difficult to assess the cumulative impact of these dischargers on the Nimishillen Creek Watershed. Even though six of the WWTPs, which correspond to the first four columns on the left of Tables 2-5, represent approximately 11% of the total number of plants in the watershed, they contribute 99% of the total design flow. This suggests that out of all WWTPs in the watershed, the WWTPs with flows between 0.1 mgd and 33.0 mgd account for the majority of impact from dischargers in the watershed. Plants with design flows less than 0.1 mgd represent about 89% of the total number of WWTPs and account for 1% of the design flow. These smaller plants are not required to monitor nutrients, influent, and upstream/downstream (refer to the two columns on the right hand side of Tables 5-7). Subwatershed 4 contains 34% of the package plants discharging less than 0.1 mgd in the watershed, 28% are found in both Subwatersheds 1 and 3, and Subwatershed 2 houses approximately 10% (refer to Table 4).

Watershed and Subwatershed Discharge Characterization

Figure 5 shows the approximate location of two U.S.G.S. gaging stations that have been in place and operating in the watershed. Gaging station 03118500 is located at Middle Branch Nimishillen Creek, Canton. It is situated in the southern region of Subwatershed 3, downstream from all the wastewater treatment plants in the subwatershed. The second gaging station, 03118000 is located at Nimishillen Creek Mainstem at North Industry. It is centrally situated in Subwatershed 1 downstream from the majority of all the wastewater treatment plants in the watershed.

Table 6 incorporates data (1993-1997) from the gaging stations (reported annual seven-day minimum discharges), and lists the stream discharges vs. the sum of maximum known wastewater discharges for Subwatershed 3, and for the entire watershed. From this data, a potential percentage of total stream discharge that is treated, discharged wastewater was calculated at the subwatershed level

(Subwatershed 3), and at watershed level and included in the table. It should also be noted that the annual seven-day minimum stream discharge data taken for the years 1994, '95 and '96 (from both gaging stations), were taken from two separate water years. Then the two sets of data for each water year was averaged to get the annual seven-day minimum stream discharge for that year.

Over a four-year period, gaging station 03118500, located at Nimishillen Creek Mainstem, had its lowest average discharge of, 78.5 cubic feet per second (cfs), for seven consecutive days in September 1995 (U.S.G.S., 1995, p. 62, 1996, p. 63). The sum of the package plant design flows from Table 2 is 56.28 cfs {36,469,750 gallons per day (gpd)}. This means that during this period, in a worst case scenario, over 71.69% of the water that discharged to the Nimishillen Creek had the potential to be treated wastewater.

Gaging Station 03118000, at Middle Branch Nimishillen Creek, recorded its lowest discharge of 4.6 cfs, in seven consecutive days on September 10, 1993 (U.S.G.S., 1994, p. 64). The sum of the package plant design flows to this gaging station is 1.246 cfs, or 807,500 gallons per day, therefore, over 27% of the total stream discharge of the Middle Branch could have been discharged, treated wastewater.

This is based on the assumption that all of the package plants in the watershed were running at and are still running at peak capacity and that the sum of present plant design flows remained constant over those four years. These are reasonable assumptions, however, since the purpose of this calculation is to determine the potential percentage of treated wastewater flowing in the entire watershed and subwatershed 3 during low flow or base flow conditions. The design flows were used because they are known maximum quantities of treated wastewater potentially discharged to the watershed. If the unknown quantities of treated wastewater currently discharged to the watershed from off-lot HSTSs were used, they would have only driven the percentages in Table 2 higher. Unfortunately, the number of and location of off-lot systems in the watershed is not readily available.

Table 6 Stream Discharge Characterization					
Gaging Station 03118000 - Middle Branch Nimishillen Creek at Canton, OH					
Stream Discharge vs. Maximum Wastewater Discharge	For 1993	For 1994	For 1995	For 1996	For 1997
Annual Seven-Day Minimum Stream Discharge at U.S.G.S. Gaging Station, in Cubic Feet Per Second	4.6 Oct 10	4.6 Sep 10 6.8 Oct 12 5.7 (avg.)	5.4 Sep 24 5.2 Sep 26 5.3 (avg.)	8.8 Jan 10 7.7 Dec 8 8.25	7.9 Sep 3
Sum of Present Package Plant Design Flows Upstream From Gaging Station, in Cubic Feet Per Second (Equivalent Gallons Per Day)	1.246 (807,500)	1.246 (807,500)	1.246 (807,500)	1.246 (807,500)	1.246 (807,500)
Potential Percentage of Stream Discharge That is Treated Discharged Wastewater	27.09%	21.86%	23.39%	15.10%	15.77%
Gaging Station 03118500 - Nimishillen Creek at North Industry, OH					
Stream Discharge vs. Maximum Wastewater Discharge	For 1993	For 1994	For 1995	For 1996	For 1997
Annual Seven-Day Minimum Stream Discharge at U.S.G.S. Gaging Station, in Cubic Feet Per Second	88 Oct 10	88 Oct 9 82 Oct 12 85 (avg.)	79 Sep 24 78 Sep 26 78.5 (avg.)	96 Dec 7 101 Jan 9 98.5 (avg.)	89 Sep 24
Sum of Present Package Plant Design Flows Upstream From Gaging Station, in Cubic Feet Per Second (Equivalent Gallons Per Day)	56.28 (36,469,750)	56.28 (36,469,750)	56.28 (36,469,750)	56.28 (36,469,750)	56.28 (36,469,750)
Potential Percentage of Stream Discharge That is Treated Discharged Wastewater	63.95%	66.21%	71.69%	57.14%	63.24%

Pollutant Loads

The above discussions on self-monitoring reveal the need to analyze the pollutant loads for wastewater treatment plants. Plants with design flows less than 100,000 gallons per day (gpd) lack nutrient, influent, and upstream/downstream self-monitoring requirements. The total design flow for such plants is 454,000 gpd.

The watershed approach to environmental planning requires that the watershed be viewed as one hydrologic unit--with inputs and outputs of surface and ground waters coming from hydrologic subunits within the watershed (and even from aquifers that extend beyond the watershed boundary). It has been shown in this report that as one hydrologic unit, the watershed has a combined treated wastewater design flow of 36,504,000 gpd. As mentioned earlier, this does not include the discharge of wastewater from off-lot HSTSs, as the number and location of these systems are not available.

For all of these reasons, NEFCO recognizes that in order to protect/maintain the water quality of the Nimishillen Creek Watershed, each package plant with design flows less than 100,000 gpd would need to be monitored, to the same degree that a single plant with a design flow of 454,000 gpd is monitored. Only this would allow an analysis of pollutant loads from package plants in the watershed to be accurately completed. Also, the location of each off-lot HSTS in the watershed would further identify which subwatersheds are most impacted by off-lot wastewater contributions to lakes and streams.

Potential Nonpoint Source Inventory

The term nonpoint source (NPS) refers to a water pollution that results from a variety of human land uses. Nonpoint source pollution occurs during rain or snow melt events and transports pollutants, through runoff, to a lake, stream, or ground water table. Since nonpoint source discharges are a product of weather patterns, they are more sporadic and intermittent than point source dischargers (Ohio EPA, 1997, p. 26).

Sources of potential nonpoint source pollution in the watershed include trucking activity, oil and gas drilling activity, and road salt use. The major contributors are failing home sewage treatment systems, agriculture, construction and urban runoff (NEFCO 1996, p.69). An inventory of potential NPS pollutant contributors are described below based on land use, i.e., human activity, and natural limitations such as soils.

It is difficult to pinpoint the exact source of NPS pollution, adding to the reasons why it is one of the most complex environmental problems facing Ohio today. According to the 1990 Ohio EPA State of Ohio Nonpoint Source Assessment, nonpoint sources of pollution affect over 13,000 (45%) of Ohio's 29,000 perennial stream miles (ODNR and Ohio EPA, 1993, p. 3).

Unsewered Areas

Figure 6 illustrates the extent of unsewered, urban areas with unsuitable soils for home sewage disposal in the watershed. All present unsewered areas are a potential source of NPS pollution (Ohio EPA, 1997, p. 28).

Individual home sewage treatment systems (HSTSs) are used to treat domestic wastewater before returning it to surface and ground waters. There are approximately one million of these systems in Ohio. These systems can offer a reliable method for treating wastewater, however; it is estimated that 25-50% of a county's HSTSs could be malfunctioning or failing (NEFCO, 1997c, p.4). Malfunctions or failure of these systems can be caused by poor operation and maintenance and inadequate design or construction, which can lead to a clogged leach field, overloading of the system hydraulically or organically, short circuiting in the septic tank, aerobic system, and/or leach field. All of these problems can result in insufficient treatment of wastewater or effluent. Problems also occur from installation of the systems in highly vulnerable ground water areas, e.g., thin soils over fractured or solutioned bedrock, or very sandy soils with shallow water tables (ODNR and Ohio EPA, 1993, pp. 54-55). When these systems are operating improperly they can contribute nutrients, pathogens, heavy metals, and other pollutants to the watershed (Conservation Foundation, 1987, p. 106). Untreated sewage released from many failing on-site HSTSs goes unreported. There are an estimated 8,850 on-lot systems in the Summit County portion of the watershed alone (Summit County Health Department, Pers. Com., August, 1998).

Identification of critical areas where HSTSs are likely to fail involves three elements: unsewered areas, urban areas and unsuitable soils (offer extremely high porosity and permeability) for HSTSs. Using a geographic information system, NEFCO was able to identify the critical areas for potential HSTS failure by combining the three parameters: unsewered, urban and unsuitable soils. Figure 6 illustrates the various areas within the watershed that contain these critical areas. Subwatershed 1 has the highest concentration of these critical areas, located south of the City of Canton and north of the Village of East Sparta. Subwatersheds 3 and 4 have critical areas scattered throughout each subwatershed. Subwatershed 2 is the most urbanized and therefore, has the lowest concentration of critical areas in the watershed.

Unsewered areas are considered a potential source of NPS pollution from HSTSs. Urban areas have the potential for future development which in turn is a potential source of NPS pollution from HSTSs. Soils with high porosity and permeability increases the probability for HSTS failure, and could contribute higher levels of nutrients and bacteria to the surface and ground water (NEFCO, 1996, p. 77).

There is a potential for the areas, which contain soils conducive for HSTS failure, to contaminate wells with disease causing organisms (see *Pipeline,* 1996, Vol, 7, No. 3). According to an article in a 1984 EPA Journal, "Sources of Ground Water Pollution," by David Miller, septic disposal ranked the highest in total volume of wastewater disposal and is the most frequent source of ground water contamination.

Another major concern is the inflow of nutrients to the waterway. Algal growth in response to these nutrients can upset the treatment and disinfection processes (NEFCO, 1997d, p. 27).

Semi-public sewage treatment systems, which are like HSTS, but serve operations such as convenience stores, gas stations and offices, were identified in the watershed. Appendix B lists the operation and its address, license number, township within Stark

County and receiving subwatershed. Eighty-eight of these systems have been identified in the watershed. Subwatersheds 3 and 1 contain the highest percentages of these systems with 33% and 31%, respectively. Subwatershed 4 contains roughly 23%, and there are approximately 13% in Subwatershed 2. Figure 7 illustrates the number and location of each semi-public sewage treatment system in the watershed.

Trucking Activity

Trucking companies are important factors in economic development and growth. However, the locations of trucking companies, which contain loading docks and terminal yards, and primary roads in the watershed can indicate areas for potential sources of NPS pollution. These areas encompass tracts of nearly impermeable areas. Surface water runoff can transport spilled chemical compounds from dock surfaces, terminal yards, and roads. If storm water catch basins, which have been designed to retain pollutants, are not in place down gradient from these areas, this runoff can contaminate soils, ground water and/or streams. Severe water quality impacts could be expected if BMPs to avoid, contain and clean up spills are not implemented (NEFCO 1997a, p. 29). As far as primary roads are concerned, state and interstate highways are often considered a more serious threat for NPS pollutants. This is because the Ohio Department of Transportation (ODOT) allows the transport of hazardous pollutants along these roads. (Refer to Figure 2 for the location of state and interstate highways in each subwatershed.)

Petroleum Production Activity

Figure 8 shows the distribution of all oil and gas drilling activity on record with Ohio Department of Natural Resources (ODNR), Division of Geological Survey, for the watershed. There are a total of 2,231 sites, which include: wells producing oil, plugged oil wells, plugged dry holes, wells producing oil and gas, plugged gas wells, brine injection wells, potential drilling locations for oil and gas exploration, and unknown status. Potential drilling locations include areas which are currently permitted or have been permitted for drilling activity in the past. In most cases, expired permits become re-activated.

Table 7 breaks down how many sites are in each subwatershed:

Table 7
Upper Tuscarawas Watershed Oil and Gas Drilling Activity

Subwatershed	Number of Sites
1	584
2	508
3	569
4	570
Total	2,231

Whether it's an active, plugged or dry well, every well plotted in Figure 8 and listed on Table 7 is a potential source of NPS pollution. Pollutants from these sources could affect the watershed's ground water and surface water. For example, in Medina County, ODNR and Ohio EPA (1993) stated that, "Some wells have begun to spontaneously repressure, flowing oil and brine to the surface and into creeks" (p. 70). ODNR and Ohio EPA (1993) also stated that, "Ohio is the only oil and gas producing state that continues to allow use of prepared clay to seal surface casing and plug wells."

If BMPs to avoid, contain and/or mop up spills are not implemented, active oil and gas wells in the watershed can spill crude oil in unrecovered amounts on land and directly into the watershed's streams. Combined or alone, these unrecovered amounts of crude oil could have a negative impact on the watershed. Spilled crude oil can disrupt terrestrial and aquatic ecosystems, damage fish and waterfowl populations, and negatively affect recreation and economic development and growth (Miller, 1988, p. 349). It can cause ground water, that is pumped for drinking water supplies, to have a foul taste and odor if a spill occurs near a ground water recharge zone.

In addition to oil and gas wells, oil and gas pipelines could have a negative impact on the watershed, if BMPs are not implemented to prevent rupturing these underground utilities. Oil pipelines, oil refineries and terminals, oil storage areas, oil pumping stations, gas pipelines, gas distribution points, gas storage areas and major gas control points were identified in the watershed. Figure 9 shows the approximate locations of the various oil and gas features, and their owners. It is for general reference only and should not be used to locate pipelines prior to digging or other construction activities. The pipelines were mapped by ODNR, Division of Geological Survey, over a large area using long, straight line segments. Consequently, the accuracy at the township level has been reduced.

However, the pipelines map is very useful at the watershed level. It conveys that there are 5 oil pipelines, a twelve-inch, two eight-inch and two six-inch diameter lines. Three of these are present in Subwatershed 1, two eight-inch and a twelve inch pipeline. Subwatersheds 2 and 3 each contain segments of two of the six inch lines. Subwatershed 4 does not contain any oil pipelines. There are several gas pipelines in the watershed. Subwatersheds 3 and 4 contain two lines each, whereas, Subwatersheds 1 and 2 contain several each. Subwatershed 4 has four gas distribution points; Subwatershed 2 houses two gas distribution points, a gas storage area, and a major gas control point. Subwatershed 1 has two gas distribution points, an oil refinery, an oil pumping station, and an oil storage area.

Given the steady increase of development activity in the watershed, all of these pipelines have the potential of being hit and damaged during excavations associated with such activity. If contingency plans are not implemented by decision makers and if BMPs are not implemented, by excavators, to avoid hitting and damaging one of these pipelines, the results could be catastrophic for the watershed and its occupants. Fires, explosions and engulfing smoke clouds, could be the worst-case scenario if a pipeline were to be hit and damaged by a spark-generating piece of excavating machinery. Afterward, the resulting loss of vegetation would exacerbate mass wasting in areas of the watershed with highly erodible soils and steep slopes. The increased sediment loading to the streams and burned or unburned hydrocarbons resulting from this chain of events, would greatly reduce the streams' assimilative capacity, which would likely impact water quality in the Nimishillen Creek.

Ohio's "call-before-you-dig" law helps reduce the potential of an underground utility being hit. Under this law, all excavators must call the Ohio Utilities Protection Service (O.U.P.S.), an answering service for utility locating companies, forty-eight hours before they dig or pay for all damages that result from hitting an underground utility. Natural gas transmission pipelines are given high priority by underground utility locators. These lines are marked (painted and flagged) with wider margins than smaller diameter lines, The owner of the transmission pipelines are informed of the date and location of the excavation so that they can oversee it when it takes place (NEFCO, 1997a, p. 29).

<u>Agricultural Areas</u>

Runoff from agricultural areas in the watershed is a potential source of sediment, organic wastes, nutrients, pesticides, and herbicides. The tendency for agricultural pollutants to adversely affect water quality depends on soil properties, the pollutant characteristics, weather conditions, and farming practices.

Using a GIS, the agricultural and open urban areas were combined with steep sloped soils, to delineate areas susceptible to erosion and agricultural runoff. Figure 10 illustrates such areas within the watershed. Each subwatershed contains areas of agricultural/open urban land with steep slopes. Portions of Subwatersheds 1, 3 and 4 contain the highest amount of these agricultural land use areas. However, as the watershed continues to become more urbanized, agricultural areas are being converted to single family, recreational, commercial, or industrial use. This is gradually decreasing the impacts on the watershed of agriculture and erosion.

<u>Construction Sites</u>

Construction sites are considered potential areas for NPS pollution because of sediment runoff into waterways. Excess sediment can cause volume loss in lakes and streams, increase the turbidity of the water, and smother fish spawning beds. Soil particles can also bind to other contaminants such as heavy metals and nutrients, thus transporting them into surface water. According to a Wisconsin Department of Natural Resources study, a stream's typical suspended sediment load is composed of sediments it receives from construction sites at the rate of about 4.4 tons/acre/year, whereas, the next highest source of sediment--agricultural land in row crops without any BMPs that would ameliorate sediment yield--contributes about 1.7 tons/acre/year (ODNR and Ohio EPA, 1993, p.79). (Wisconsin and northeast Ohio have similar geomorphology.)

Since the watershed encompasses the City of Canton, North Canton and Louisville there is a high potential for growth as urban sprawl continues. Subwatersheds 1, 2 and 4 have experienced rapid rates of development during the past ten years. Present land use/land cover associated with agricultural/open urban, non forested wetland, and wooded/shrub/scrub (Figure 3) has the possibility for future development.

Active construction sites were identified through the Stark Soil and Water Conservation District (SWCD). Table 8 lists the location, name of site, and size for each subwatershed. All of these sites have Storm Water Pollution Prevention Plans (SWPPPs), in accordance with the requirements of the Clean Water Act. These plans utilize BMPs to ameliorate soil erosion, transport, and deposition. The SWCD SWPPPs', in accordance with the requirements of the Clean Water Act. These plans utilize BMPs to ameliorate soil erosion, transport, and deposition. The SWCD SWPPPs' goal is to catch 75% of the sediment, the remaining 25% goes into the watershed (NEFCO, 1998, p. 32).

Table 8 **Active Construction Sites in the Nimishillen Creek Watershed with Storm Water Pollution Prevention Plans (SWPPPs)**			
Subwatershed	**Location**	**Name of Site**	**Size (Acres)**
3	City of Canton	Southpoint	11.3
3	City of Canton	Burnham Hills Estates	78.0
2	City of North Canton	Monticello	151.0
2	City of North Canton	Sturbridge	36.0
2	City of North Canton	Washington Square	97.4
4	City of Louisville	Constitution Estates	23.26
4	City of Louisville	Buffalo Ridge Allotments	6.5
4	City of Louisville	Park Village Proper	11.0
4	City of Louisville	Beau Chemin - 5 acre Brienza Plat	17.5
4	City of Louisville	Bek-Lea Estates	6.38
4	City of Louisville	Lepard Estates	17.5
4	City of Louisville	Stonebridge Allotment	100.0
4	City of Louisville	Glenbrook	65.3
4	City of Canton	Georgeview Estates	71.0
3	Plain Township	Pendelton Commons Condos	11.79
3	Plain Township	Stonehedge Development	49.5
3	Plain Township	Martindale	7.5
3	Plain Township	Wellington Woods	34.9
3	Plain Township	Wellington Hills #3	26.799
3	Plain Township	Progress St. Site A&B	20.0
4	Plain Township	Groffre Commerce Center	29.8
2	Plain Township	Diamond Street Park	60.0
2	Lake Township	Shepherds Gate	13.7
2	Lake Township	Saint Ives	19.0
2	Lake Township	St. James Place	104.0
2	Lake Township	Vincent Hills	6.46
2	Lake Township	Asshan Allotment	6.0
1	Canton Township	Canton Industrial Park	51.7
1	Canton Township	Westwind Estates #2	7.95
1	Canton Township	WPCC Improvements	5.0
1	Canton Township	Canton Twp. Community Park	10+
1	Canton Township	Lakeshore Storage Center	5.2
4	Nimishillen Township	Shallow Creek Estates	49.0
3	Nimishillen Township	Sunscape Estates	38.9
4	Nimishillen Township	Franlon Estates	11.6
4	Nimishillen Township	Georgehaven	30.0
2	Jackson Township	The Preserve	N/A
2	Jackson Township	Wood Lawn Village II	15.9
2	Jackson Township	Canton Regency	4.3
2	Jackson Township	Kent Stark Addition	13.0
2	Jackson Township	Jackson Industrial Park	60.0
Source: Stark Soil and Water Conservation District, June 1999.			

Table 9 lists the total acres currently under construction for each subwatershed with Storm Water Pollution Prevention Programs.

Table 9 **Total Number of Acres Under Construction in the Nimishillen Creek Watershed with SWPPs**	
Subwatershed	**Total Acres Under Construction**
1	79.85
2	586.76
3	278.69
4	438.84
Source: Stark Soil and Water Conservation District, June 1999	

Subwatersheds 2 and 4 contain the most area under construction at this time, with 586.76 and 438.84 acres under construction, respectively. Subwatershed 3 has 278.69 acres under construction with the potential for future development, as it has the highest percentage of agricultural/open urban land in the watershed. Subwatershed 1 has the lowest amount of land under construction with 79.85 acres, which also contains areas desirable for future development.

Impervious Areas

Impervious areas in the watershed are those areas where vegetation has been replaced by nearly impermeable surfaces, such as roads, sidewalks, parking lots, and roof tops. As the level of impervious cover increases it prevents the infiltration of water into the soil. This can reduce ground water recharge, exacerbate runoff and streambank erosion, and impact the natural aquatic community. Research indicates that stream degradation occurs at levels of imperviousness as low as 10% (Ohio EPA, 1997, p. 27). The location of urbanized areas, as well as roads, in the watershed indicate where a high degree of impervious surfaces are found (Figure 3).

Impervious areas can also be the source of a magnitude of pollutants, since gasoline, oil, and chemical spills are likely to occur on impervious surfaces, such as: trucking docks and yards, gasoline stations, and roads.

Salt Storage and Seasonal Spreading of Salt

The heavy application of deicing salt, as well as improper storage, can contribute to surface and ground water contamination. The salts are washed off roads with snow melt and can flow into surface water or seep into ground water. Chloride levels of 1,000 to 25,000 mg/l have been documented in road runoff (Conservation Foundation, 1987, p. 162).

Nine salt storage sites were identified in the watershed (Figure 11). All of these sites are located in a covered area, such as a shed, to protect it from the elements and to minimize runoff. Table 10 lists the subwatershed, community, and street address location for each identified site, in addition to the average amount stored per month.

Table 10
Salt Storage Sites within the Watershed

Subwatershed	Community	Street Address	Average Amount Stored/Month (Tons)
3	City of Canton	2436 30th St NE, Canton	7,000
3	Marlboro Twp.	7344 Edison St., Hartville	20
1	Pike Twp.	7134 East Sparta Ave., Magnolia	140
2	City of Canton	1000 Block of Shrover Ave. SW, Canton	not available
2	Summit Co.	Airport Outpost, 8655 Frank Ave., N, Canton	600
1	Pike Twp.	Ridge Rd., She, 8400 Ridge Ave., East Sparta	700
1	City of Canton	2506 Cleveland Ave., Canton	25,000
4	City of Canton	4505 Atlantic Blvd. NE	5,800
3	Plain Twp.	6300 Heminger Ave.	2,500

Source: NEFCO, 1987

Transportation areas, e.g., roads and parking lots, are locations where large applications of road salt occurs during the winter months. High traffic roads, such as state and interstate highways, are prime targets for deicing efforts.

The application of road deicing salts can increase the salinity (dissolved solids) of surface and ground waters. High levels of dissolved solids can affect the taste and sodium content of drinking water (NEFCO, 1997a, p. 56). And, Ohio EPA (1997) states that, "High concentrations of salts can inhibit aquatic plant growth and have an adverse effect on aquatic life" (p. 33). This indicates that salt storage sites and transportation areas can be potential sources of NPS pollution to the watershed if BMPs are not implemented to minimize the release of its contents to the environment.

Conclusion

There are a wide variety of potential pollution sources in the watershed. Fifty-six wastewater treatment plants and package plants are the primary point sources. The greatest combined flow of discharged wastewater from these plants occurs in Subwatershed 1. There are also several off-site home sewage treatment systems (HSTSs) in the watershed that should be considered point sources. However, attempting to figure out how many exist and where they are located within the watershed would be difficult and time consuming if undertaken. This makes determining their wastewater quality impacts difficult.

The total pollutant loads contributed by the package plants in the watershed cannot be tabulated because adequate flow measurements are not available, and the majority of the plants have design flows less than 250,000 gallons per day (gpd). Only package plants with design flows above 250,000 gpd are monitored comprehensively. One way to get an accurate count of the pollutant loads is to require that all package plants in the watershed be monitored to the same degree that plants with design flows greater than 250,000 gpd are monitored.

Industrial dischargers are another major point source in the watershed. These twenty-nine point sources discharge storm and process water. Subwatershed 1 contains the majority of industrial dischargers in the watershed.

Major sources of potential nonpoint source (NPS) pollution in the watershed are directly related to land use (human activity). Unsewered areas; trucking activity; petroleum production activity; agricultural areas; construction sites; impervious areas; salt storage and seasonal spreading of salt are all potential sources of NPS pollution in the Nimishillen Creek Watershed.

The majority of the watershed is unsewered. There is a very high potential for unsewered areas to be a source of untreated/poorly treated sewage, which contain nutrients and disease-causing organisms, when home sewage treatment systems fail. When unsewered, urban areas are combined with unsuitable soils for home sewage treatment, we are able to identify potential areas for HSTS failure.

NPS pollution from producing and plugged oil and gas wells can have a negative impact on the entire watershed. Additionally, trucking activity can contaminate the soils, surface water and ground water.

Agricultural areas in the watershed can also be potential sources of N-P-K, pesticides, herbicides, organic wastes and associated disease-causing organisms. However, the impact of agricultural areas is gradually decreasing as agricultural areas are converted to residential, commercial, or industrial areas.

Construction sites can contribute sediment loadings to nearby lakes and streams through runoff events, and degrade water quality in streams or lakes. Heavy metals and nutrients can bind to soil particles and travel to the waterway along with sediment.

Impervious areas can facilitate the transportation of spilled pollutants and exacerbate runoff problems. All of the parking lots, roads, highways and state/interstate highways in the watershed are impervious areas. Subwatershed 2 contains the highest percentage of impervious area.

Another lesser known potential source of NPS pollution in the watershed are salt storage sheds, which can be a source of sodium (dissolved solids).

Industrial land use areas can contribute a variety of chemical wastes to the watershed. These substances pose serious threats to water quality if they are not handled or disposed of properly.

Considering all of these dispersed sources of potential pollution, it has become apparent that the entire watershed has a high potential to be affected by NPS pollution. However, Subwatershed 1 seems to be the most threatened from a variety of point and nonpoint source pollutants, although each subwatershed has one or more specific sources of pollution with a higher potential to impair surface and/or ground water quality than the other subwatersheds. Targeting efforts to maintain a riparian corridor and slow runoff in high risk areas may be an effective way to control some of the NPS pollution.

Future actions could include testing for the presence of contaminants downstream from nearby pollution sites. If a site is causing an impact on the watershed, targeting efforts to contain and clean up that site may also be an effective plan.

Pollution Potential Rating

Table 11 represents the initial attempt to rate the potential pollution sources in the Nimishillen Creek Watershed. The above identified point and potential nonpoint pollution sources (as well as some additional potential nonpoint pollution sources that were not included in this particular study) were included in the rating procedure. The Ratings were to be assigned using criteria mentioned throughout this report, in addition to ratings from Technical Advisory Committee meeting participants. Some of the criteria are summarized in Appendix C. Other criteria were to come in the form of expert opinions from local stakeholders. These expert opinions included representatives from such agencies and organizations as the Stark County Health Department, the Ohio EPA, the Stark Soil and Water Conservation District, the Stark County Regional Planning Commission, Stark County Sanitary Engineers, Stark County Park District, local governments agencies, and local citizens.

However, when confronted with this task, the local stakeholders felt that there was a lack of information needed to aid them in rating the potential pollution sources in an objective fashion. They believed that detailed documentation was essential to developing a comprehensive analysis such as this. In light of their apprehension, a group consensus was achieved in developing an initial Rating of the potential pollution sources within the watershed (Table 11). Although Table 11 represents the initial feedback of the local stakeholders, it by no means represents any conclusive findings. With this in mind, some initial observations were made.

Each Rating is a whole number value rating from 1 (virtually no potential) to 5 (very high potential to impair surface and/or ground water). Subwatershed 1 rated highest in off-lot discharging HSTSs, failing on-lot HSTSs, trucking activity, oil and gas wells, gasoline use, and industrial land use areas. Impervious areas, trucking activity and lawn and garden/household maintenance activity scored high in Subwatershed 2. Oil and gas wells were rated highest in Subwatershed 3, and Subwatershed 4 rated 5 in industrial land use areas.

As mentioned earlier, the above are merely observations made from the initial Rating of the potential pollution sources in the watershed. Future efforts in rating the potential pollution sources will hopefully involve more significant feedback from the local experts once they have documentation to back up their opinions. Future analysis will also include further rating steps, using the existing rankings that were developed under the Ohio Comparative Risk Project (OCRP).

III. Riparian Zone Analysis

Summary

The purpose of this Nimishillen Creek Riparian Habitat Inventory was to evaluate the condition of the riparian corridor along the Nimishillen Creek Mainstem, Sherrick Run, Hurford Run (Nimishillen Creek Subwatershed); West Branch Nimishillen Creek, West Branch Tributary-1 (West Branch Subwatershed); Middle Branch Nimishillen Creek, Swartz Ditch (Middle Branch Subwatershed); and East Branch Nimishillen Creek, East Branch Tributary-1 and East Branch Tributary-2, as they existed in March 1997.

The riparian inventory report was completed by using 1997 aerial photos of the watershed to investigate riparian habitat along the Nimishillen Creek mainstem and major tributaries. The criteria used to evaluate the riparian habitat were developed from the Ohio EPA Qualitative Habitat Index (QHEI). Using a template corresponding to the aerial photos' scale, each evaluated watercourse was marked off into 600 foot long segments. The first 400 lineal feet along the length of the stream was evaluated to a width of 200 feet on each side of the stream. For a comprehensive analysis, the condition of the remaining 200 feet of stream length and width was assumed to be similar to the first 400 linear feet in each segment. Each streambank was analyzed for both riparian width and quality, then scored numerically. The scoring criteria are found under "Riparian Width" and "Floodplain Quality" in paragraph 4 of the Ohio EPA QHEI Field Sheet (EPA Form 4520).

Additionally, NEFCO summarized the riparian habitat scores in the tables and figures found in the report and produced a color map of the scored stream segments. The results of the riparian inventory indicated that much of the watershed is fragmented from either past urbanization or from agricultural activities.

Introduction

The intent of the Nimishillen Creek Comprehensive Watershed Management Plan - Phase I is to protect the water quality of the Nimishillen Creek Mainstem and its associated tributaries. This report represents component four of that study. Pursuant to protecting the water quality of the Nimishillen Creek Watershed, it is NEFCO's intent to produce an inventory of the riparian habitat through the use of 1997 aerial photos supplied by the Stark County Regional Planning Commission to identify areas with severely altered riparian corridors, as well as areas with intact habitat. The criteria with which to evaluate the riparian habitat are from the Ohio Environmental Protection Agency (Ohio EPA) Qualitative Habitat Evaluation Index (QHEI) metric for Riparian Zone and Bank Erosion. An evaluation and mapping of existing conditions within the watershed is required to characterize the watershed and prioritize low, moderate and high quality riparian habitat corridors that could be used to target stream segments in need of protection and/or restoration efforts.

It is also the intent of this report that the results of this diagnostic study will be used to raise public awareness of watershed riparian residents and landowners and help guide land use decisions by key stakeholders in order to protect the integrity of stream segments that are adversely impacted or threatened by urbanization, land use practices and a lack of implementation of Best Management Practices (BMPs), thereby protecting water quality standards within the watershed.

Riparian Habitat Inventory and Evaluation

The integrity of the riparian habitat is a key component of a Comprehensive Watershed Management Plan (CWMP) because an intact riparian corridor helps the stream resist erosion and reduces inflows of pollutants, nutrients, and sediment from over-land runoff. These factors help the stream maintain important chemical and physical characteristics needed to support biodiversity. As a result, a balanced biodiversity preserves the stream's ability to assimilate pollution and prevent development of nuisance and health threatening conditions. The riparian habitat inventory and evaluation of the Nimishillen Creek Mainstem and its associated tributaries examined current conditions of the riparian habitat quality through the use of aerial photos and Ohio EPA's Qualitative Habitat Evaluation Index (QHEI) matric for Riparian Zone and Bank Erosion. This was accomplished by delineating each evaluated waterway into a series of 600 lineal feet by 400 feet segments, which were scored according to riparian habitat width and quality. The data will then be tabulated for the purpose of prioritizing either a specific subwatershed, stream or stream segment that is of low, moderate, or high riparian habitat quality. Individual stream segments or subbasins that may be targeted for outreach efforts for either protection or restoration efforts.

The identification of impaired stream segments, stream(s), minor subwatershed(s) and/or subwatershed(s) habitat, may facilitate the development of goals for habitat restoration. High quality stream segments, stream(s) minor subwatershed(s), and/or subwatersheds may be targeted for preservation and/or protection by implementing BMPs to prevent degradation of these habitats.

Source Materials

The source materials used include the following:

1. Department of the Interior, United States Geological Survey (U.S.G.S.) 7.5 Minute Series Topographic maps at a scale of 1:24,000 as follows:

    a. 4765 IV SW, Canton West Quadrangle
    b. 4765 III NE, Waynesburg Quadrangle
    c. 4765 IV NE, Hartville Quadrangle
    d. 4765 I SW, Robertsville Quadrangle
    e. 4765 IV SE, Canton East Quadrangle
    f. 4765 I NW, Limaville Quadrangle
    g. 4765 IV NW, North Canton Quadrangle

2. One hundred fifty-nine (159) blue line aerial photos, at a scale of 1":400', produced in March 1997 were obtained from the Stark County Regional Planning Commission.

Methodology

NEFCO examined ten (10) waterways, for a total of ninety-four (94) river miles, which include the following: Nimishillen Creek Mainstem, Sherrick Run, and Hurford Run, located in the Nimishillen Creek Subwatershed, which includes N01, N02, N03, N04, N05, N06, N07, N08, and N13 minor subwatersheds; the West Branch Nimishillen Creek and West Branch Trib.-1, located in the West Branch Subwatershed, which includes N09, N10, N11, and N12 minor subwatersheds; and the Middle Branch Nimishillen Creek and Swartz Ditch, located in the Middle Branch Subwatershed, which includes N22, N23, N24, N25, N26, N27, N28, N29 and N30; and finally East Branch Nimishillen Creek and East Branch Nimishillen Creek Tribs.-1 and 2 are located in the East Branch Subwatershed, which includes N14, N15, N16, N17, N18, N19, N20, and N21 minor subwatersheds (see Figure 12). The criteria used to evaluate the habitat was developed from the Ohio EPA Qualitative Habitat Evaluation Index (QHEI), metric number 4. Using 1997 aerial photos, each major watercourse shown on the aerial photos was marked off into segments of (600) feet. Using a template corresponding to the aerial photo’s scale, the first 400 feet along the length of the stream was evaluted to a width of 200 feet on each side of the stream. Each stream bank is then analyzed for both riparian width and quality, then scored numerically. The scoring criteria are found under “Riparian Width” and “Flood Plain Quality” in metric 4 of the Ohio EPA QHEI Field Sheet (EPA Form 4520).

Flood Plain Quality could only be surmised in some areas due to inconsistencies in the blue line aerial photo copies. For example, areas that were difficult to distinguish included Conservation Tillage to Open Pasture and Forested to Residential Areas because some areas had a similar appearance on the blue line aerial photos. For a comprehensive analysis, the condition of the remaining 200 feet of the stream length is assumed to be similar to the first 400 linear feet in each segment.

Example of metric 4 of the Ohio EPA QHEI Field Sheet

Riparian Width (per bank) [total max score]	Flood Plain Quality (Most Predominant, Per Bank) [total max score]
L R	L R
__ __ Wide >50m [4pts.]	__ __ Forest, Swamp [3 pts.]
__ __ Moderate 10-50m [3 pts.]	__ __ Shrub or Old Field [2 pts.]
__ __ Narrow 5-10m [2 pts.]	__ __ Fenced Pasture [1 pt.]
__ __ Very Narrow <5m [1 pt.]	__ __ Residential, Park, New Field [1 pt.]
__ __ None	__ __ Conservation Tillage [1 pt.]
	__ __ Open Pasture, Rowcrop [0]
	__ __ Urban or Industrial [0]
	__ __ Mining/Construction [0]

Once the analysis is completed for each stream segment of selected streams in the watershed, the left and right “Riparian Width” and “Flood Plain Quality” values will be recorded on a riparian inventory sheet and the values will then be added together to give each segment a single value or score. The maximum score obtainable is 7.0, as the maximum riparian width score is 4.0 and the maximum flood plain quality score is 3.0, which indicates a High Quality riparian habitat. In an effort to prioritize segment(s), stream(s) and subwatersheds, NEFCO established three categories consisting of low, moderate and high riparian quality with score of 0.0-2.0, 2.5-4.5, and 5.0-7.0, respectively.

An example of the data is illustrated in Table 12. Stream segment number NCM-25 of the Nimishillen Creek Mainstem, exhibited a very narrow riparian width, between 0 and 5 meters (0.5 points) for the right bank and no riparian width (0.0 points) for the left bank, consequently scoring only 0.5 points of a possible 4.0 points in the “Riparian Width” category. The “Flood Plain Quality” was scored as Fenced Pasture for the left bank (0.5 points) and Urban/Industrial) (0 points) for the right bank, for a score of 0.5 of a possible 3.0 points. The total score for stream segment NCM-25 is 1.0.

In comparison, stream segment NCM-20 of the Nimishillen Creek Mainstem, had a wide riparian width of greater than 50 meters (2.0 points) for both the left and right banks, receiving the maximum score of 4.0 for “Riparian Width”. The “Flood Plain Quality” was dominated by either Forest or Swamp (1.5 points) for each bank for a maximum score of 3.0 points. Consequently, stream segment NCM-20 received the maximum score of 7.0 points.

Table 12 Nimishillen Creek Watershed Sample Riparian Habitat Data Entry From the Riparian Width and Quality							
	Riparian Width			Flood Plain Quality			Total Habitat Score
Segment #	Right Bank	Left Bank	Subtotal	Right Bank	Left Bank	Subtotal	
NCM-25	0.0	0.5	0.5	0.0	0.5	0.5	1.0
NCM-20	2.0	2.0	4.0	1.5	1.5	3.0	7.0

Results

A total of 827 stream segments were evaluated for riparian width and flood plain quality. This represents approximately 496,200 feet, or 93.98 miles of stream length, about two thirds of which, 320,800, or 62.65 miles, were actually evaluated. However, Figure 17 shows the distribution of only those riparian habitat scores of the Nimishillen Creek Watershed that are located within the NEFCO region. Figure 17 is based on the (Total Riparian Score) of Ohio EPA QHEI; stream segments of low, moderate, and high quality were mapped with a 200 feet buffer zone representing the stream segments in their respective subwatersheds and minor subwatersheds. Consequently, the number of evaluated stream segments located in the NEFCO region is actually 816. This represents 489,600 feet, or 92.73 miles of stream length, of which 2/3 or 326,400 feet or 61.82 miles were actually evaluated. A sample of the results of the Nimishillen Creek Watershed riparian evaluation can be found in Appendix D. The remaining riparian evaluation results are available upon request. The data include the stream name, stream segment number, aerial photo number, county, riparian width and flood plain quality, score for both left and right banks, subtotal score, and total score.

Table 13 provides a summary of the frequency of the total scores for the Nimishillen Creek Mainstem and its associated tributaries that were included in this study. Table 13 also characterizes the evaluated streams by providing a percentage breakdown of each habitat score, the total segments evaluated, total points, and the average score for the evaluated portion for each selected stream.

In an effort to prioritize and rank streams and subwatersheds in the watershed, Table 14 shows the name of each evaluated stream and the subwatershed in which it is located . The average percentage score for each stream was calculated by dividing the Frequency by Total Segments, then adding the sums for each riparian habitat score category of Low (0.0-2.0), Moderate (2.5-4.5) and High (5.0-7.0) (see Table 13). The average riparian habitat score for the entire evaluated length of each stream was calculated by dividing the total points by the total number of stream segments (see Table 13). The subwatershed average riparian habitat score was calculated by adding the average riparian habitat score of each stream within its respective subwatershed and dividing it by the number of streams. Additionally, the ranking of streams and subwatersheds is based on average riparian and subwatershed habitat scores from highest to lowest.

Table 15 provides estimates of acreage determined to be of high quality habitat (i.e. forest/swamp and shrub/old field) for the left and right stream bank for only the 400' L x 200' W of the evaluated area of the stream corridor. The maximum acres evaluated is the total acres evaluated (400' L x 400' W) along the riparian corridor times the total number of evaluated segments, while the total stream corridor area is the equivalent to the total segment length (600 feet) and its width (400 feet) times the total number of segments. Finally, the estimated percentage of stream corridor as high quality habitat represents the amount of acreage relative to maximum obtainable, then extrapolated out to the total riparian area segment.

Stream Gradient and Riparian Corridor Description

The stream gradient Figures 14, 15, 16 and 17 help to characterize streams by offering a cross-sectional representation of stream fall from its source to its confluence for each evaluated stream in the Nimishillen Creek Watershed. Typically, streams with a steep gradient have more energy available for stream flow, which increases its capacity to headwardly erode transporting sediment loads and debris downstream, depositing its stream load as the stream gradient diminishes as it approaches the convergence with the mainstem or higher order stream.

The description of each evaluated watercourse is based on aerial photo interpretations of the Nimishillen Creek Watershed, and is provided so the reader will have a better understanding of the existing conditions of the riparian corridor within the watershed.

The beginning of the Nimishillen Creek Mainstem flows southwesterly through a mix of residential, park, commercial, and industrial land uses. The aerial photos show that the mainstem's riparian habitat has been modified and has a diminished riparian width and cover, this pattern continues until the mainstem is south of Interstate 77. South of I-77, the riparian corridor becomes stable maintaining a moderate to wide riparian habitat, which is bounded by residential areas and the City of Canton WWTP, until the mainstem flows south of North Industry. Once south of North Industry, the mainstem's riparian quality and width noticeably improve flowing through a mix of forest/swamp and shrub/old field flood plain quality with moderate to wide riparian width to the Stark/Tuscarawas County Line. Its average stream gradient is approximately 7.93 ft/mile (Figure 14) with a percent slope of .15 (Table 16).

Sherrick Run enters the Nimishillen Creek Mainstem at approximately River Mile (RM) 11.3. Its average stream gradient is approximately 24.74 ft/mile (Figure 14) with a percent slope of .47 (Table 16). Sherrick Run begins in Osnaburg Township (aerial photos 14-31) flows northwest through an area dominated by agricultural land use to stream segment 41. From stream segment 41 to its confluence, the riparian corridor flows through a mix of forest/swamp and shrub/old field with a riparian width of wide and moderate, fragmented only a few urban/industrial areas in stream segments 24, 23, 22 and 2.

Hurford Run enters the Nimishillen Creek Mainstem at approximately R.M. 11.8. Its average stream gradient is approximately 15.43 ft/mile (Figure 14) with a percent slope of .29 (Table 16). Hurford Run begins in Perry Township on the east side of Perry Drive and flows east through urban/industrial areas of which the stream has been directly affected by riparian habitat modifications such as channelization, removal of riparian cover as well as sections that have been culverted or piped.

West Branch Nimishillen Creek enters the Nimishillen Creek Mainstem to approximately RM 12.1. Its average stream gradient is approximately 10.51 ft./mile (Figure 15) with a percent slope of .20 (Table 16). The West Branch Nimishillen Creek begins in Lake Township (aerial photo 3-5) flowing south through a mix of large lot residential and agricultural areas. The aerial photos show that the West Branch riparian habitat is fragmented with diminished riparian width and cover, it also appears that it is being pressured from increasing urbanization. However, even though the West Branch is pressured by development and flows through urbanized areas within the City of Canton, there is one area (stream segments 43, 44, 45 and 46) of high quality riparian habitat.

West Branch Tributary-1 enters the West Branch Nimishillen Creek at approximately RM 4.6. Its average stream gradient is approximately 18.51 ft./mile (Figure 14) with a percent slope of .35 (Table 16). The West Branch Tributary - 1 begins in Jackson Township, just south of the Akron-Canton Airport (aerial photo 6-19) and flows southeasterly. The aerial photos show that the West Branch Tributary-1 initially flows through a fragmented riparian habitat of wooded and agricultural land uses. As the West Branch Tributary-1 approaches I-77 to its confluence, the stream flows through an increasingly dense mixture of commercial and residential areas interspersed with stream segments of shrub/old field and wooded areas. Many areas along the corridor appear to have had hydrologic and/or habitat modifications such as channelization, stream bank modifications, stream buried and removal of riparian vegetation.

Middle Branch Nimishillen Creek enters the Nimishillen Creek Mainstem at approximately RM 15.0. Its average stream gradient is approximately 11.91 ft/mile (Figure 16) with a percent slope of .22 (Table 16). The Middle Branch begins in Nimishillen Township, south of the State Street and Columbus Road intersection (aerial photo 6-39). The stream flows north for the first twelve stream segments which are of very low riparian habitat quality before turning east flowing through an area that remains dominated by agricultural land use. This area generally appears to contain poor riparian habitat conditions as it is heavily influenced by agricultural practices. The stream then turns south at stream segment 91 where the corridor becomes fragmented flowing through agricultural, natural and residential areas containing wide to narrow riparian wide with a flood plain quality of either forest/swamp, shrub/old field and residential/park/new field. Once the stream reaches Easton Street, housing noticeably increases on the west side of the riparian corridor before entering a high density urbanized area until its confluence with the Nimishillen Creek Mainstem.

Swartz Ditch enters the Middle Branch Nimishillen Creek at approximately RM 10.8. Its average stream gradient is approximately 3.60 ft/mile (Figure 16) with a percent slope of .07 (Table 16). The Swartz Ditch begins in the Village of Hartville south of the Prospect (State Route 43) and Maple (State Route 619) intersection (aerial photo 3-11). Swartz Ditch flows primarily through agricultural areas, fragmented by only a handful of high quality riparian habitat stream segments. As its name indicates, numerous areas have been channelized, and/or modified with limited to no riparian cover nor riparian width.

East Branch Nimishillen Creek enters the Nimishillen Creek Mainstem at approximately RM 15.0. Its average stream gradient is approximately 13.19 ft./mile (Figure 17) with a percent slope of .25 (Table 16). The East Branch Nimishillen Creek begins in Washington Township southeast of the Parks Avenue and State Route 153 intersection (aerial photo 8-47). Flowing west, the first 18 stream segments of the headwaters portion flow through an agricultural area with very little to no riparian cover with the appearance of being channelized. The remaining stream segments enter a forested/swamp and shrub/old field flood plain that is of moderate to wide riparian width with minimal fragmentation as it flows through the City of Louisville. This pattern continues until the East Branch flows through an industrial/urbanized areas for its last 13 segments before it confluence with the mainstem and Middle Branch.

East Branch Nimishillen Creek Tributary-1 enters the East Branch Nimishillen Creek at approximately RM 4.8. Its average stream gradient is approximately 27.10 ft./mile (Figure 17) with a percent slope of .51 (Table 16). The East Branch Tributary-1 begins in Washington Township (aerial photo 11-39), as the aerial photos show that the East Branch Tributary-1 habitat is fragmented through out its entire length, containing areas of high quality riparian habitat with forest/swamp, shrub/old field, and residential/park/new field with a mixture of riparian widths.

East Branch Nimishillen Creek Tributary-2 enters the East Branch Nimishillen Creek at approximately RM 7.8. Its average stream gradient is approximately 31.69 ft./mile (Figure 17) with a percent slope of .60 (Table 16). The East Branch Tributary-2 begins in Nimishillen Township just northeast of Harrisburg (aerial photo 6-39). Flowing south, the East Branch Tributary-2 also contains fragmented riparian habitat and is very similar to East Branch Tributary-1.

Table 16 Nimishillen Creek Watershed Average Stream Gradient and Percent of Slope		
Stream Name	Average Stream Gradient	Percent of Slope
	height/length = avg. stream gradient	vertical distance/horizontal distance x 100 = % of slope
Nimishillen Creek Mainstem*	107'/13.5 mi = 7.93 ft/mi	107'/72,280' x 100 = .15%
Sherrick Run	141'/5.70 mi = 24.74 ft/mi	141'/30,096' x 100 = .47%
Hurford Run	54'/3.50 mi = 15.43 ft/mi	54'/18,480' x 100 = .29%
West Branch Nimishillen Creek	148'/14.10 mi = 10.5 ft/mi	148'/74,448' x 100 = .20%
West Branch Trib. -1	124'/6.70 mi = 18.51 ft/mi	124'/35,376' x 100 = .35%
Middle Branch Nimishillen Creek	212'/17.80 mi = 11.91 ft/mi	212'/93,984' x 100 = .22%
Swartz Ditch	38'/8.9 mi = 4.27 ft/mi	38'/47,400' x 100 = .08%
East Branch Nimishillen Creek	178'/13.50 mi = 13.19 ft/mi	178'/71,280' x 100 = .25%
East Branch Trib. -1	168'/6.20 mi = 27.10 ft/mi	168'/32,736' x 100 = .51%
East Branch Trib. -2	141'/4.45 mi = 31.69 ft/mi	141'/23,496' x 100 = .60%
*Any Stream Gradient to the Stark/Tuscarawas County Line		

Figures 18 through 27 are graphs that reflect the total score of the riparian width and flood plain quality scores. Again, a stream segment score between 0 - 2.0 is of low quality, a score of 2.5 - 4.5 is considered to be moderate, and a score of 5.0 - 7.0 is recognized as a segment that is of high quality. The graphs also indicate that, currently, much of the watershed is fragmented. Finally, these graphs could be used in a future Nimishillen Creek Watershed study to determine trends with regard to further fragmentation or improvement of the riparian habitat quality.

Conclusion

NEFCO believes that riparian corridors are important components of the environment, and that such natural areas are subject to adverse impacts caused by commercial and residential development, which is exacerbated by habitat and hydraulic modifications. The integrity of the riparian corridor habitat is a key component of a watershed because an intact corridor helps the stream resist erosion and protects water quality from influxes of pollutants, sediment and overland runoff.

Based on the results of the riparian habitat evaluation for the watershed, NEFCO has been able to conclude that residential and commercial development as well as agricultural practices have fragmented much of the riparian habitat. Numerous segments indicate a loss of riparian habitat through habitat modification caused by channelization, streambank alteration, stream burial, removal of riparian vegetation and an increase in impervious surface areas. Such impacts contribute to the instability of riparian corridor ecosystems and raise serious concerns regarding water quality issues by increasing the amount of storm water runoff, streambank erosion, sedimentation, loss of shading, and the inability to serve as filter areas to trap sediment.

The riparian habitat evaluation revealed that the overall average of the “Estimated Percentage of Stream Corridor as High Quality Habitat” for the ten waterways is 24.81 percent. Three streams, Nimishillen Creek Mainstem, Sherrick Run, and East Branch Nimishillen Creek, had the longest percentages of high quality habitat with percentages of 46.82, 41.39 and 39.50, respectively. Two streams with the lowest percentage of high quality habitat were Hurford Run (6.18 percent) and Swartz Ditch (4.74 percent) (Table 15).

Table 14 indicates that the following streams received average riparian habitat scores from highest to lowest: The “High” category - no average stream scores were above 5.0; “Moderate”; Nimishillen Creek Mainstem - 4.76; Sherrick Run - 4.54; East Branch Nimishillen Creek - 3.09, East Branch Tributary 2 - 2.98, West Branch Tributary 1 - 2.86, West Branch Nimishillen Creek - 2.85, “Low” category; Swartz Ditch - 1.87 and Hurford Run - 1.58. Additionally, each subwatershed received an average riparian habitat score, of which the East Branch Subwatershed received the highest score of 3.80, follow by the Nimishillen Creek Mainstem Subwatershed, West Branch Subwatershed and the Middle Branch Subwatershed with scores of 3.63, 2.86 and 2.48 respectively.

Tables 13, 14, and 15, used in conjunction with the distribution of riparian scores figure, could be used to target severely altered riparian segments, stream or subwatersheds for remediation activities or target areas with intact riparian habitat for protection/preservation efforts.

IV. Water Quality Data

Introduction

The Ohio Environmental Protection Agency-Northeast District Office (Ohio EPA-NEDO) has conducted chemical and bacterial monitoring on selected stream areas within the Nimishillen Watershed. As of June, 1999 this data is unpublished by the Ohio EPA. The purpose of this report is to present a preliminary overview of recent stream monitoring data from the Ohio EPA files. This overview is intended to raise water quality awareness and begin to characterize nutrient inputs into the watershed.

Chemical and bacterial sampling can offer clues as to possible sources of pollution and their severity. The focus of the Ohio EPA's watershed monitoring study was to evaluate water quality in close proximity to known point source dischargers, such as wastewater treatment plants (WWTPs) and industrial operations. Monitoring stations were also chosen to provide background data for comparison with other stations in the watershed (pers. com., June 1999).

The Ohio EPA-NEDO selected a total of thirty-one sampling sites. These stations are located throughout the Nimishillen Watershed (Figure 28). Table 17 lists each monitoring station and a description of its location.

Summary and Conclusions

This report presents water quality data of samples taken by Ohio EPA from selected sites, which include the mainstem and tributaries of the Nimishillen Creek. Chemical and bacterial samples were collected from July to September, 1998 at a total of thirty-one locations. Samples were collected on thirteen different dates, with each station sampled from three to nine times. Water samples were analyzed for several parameters, including: phosphorus, ammonia, nitrate + nitrite, nitrite, total suspended solids, total dissolved solids, arsenic, copper, iron, mercury, fecal coliform, pH and stream temperature.

Table 17
Monitoring Stations Selected Within the Nimishillen Creek Watershed for Stream Monitoring by the Ohio EPA-NEDO
(Please refer to Figure 28 for a map of the stations)

Station Number	Access Point/Location	Stream Name	Subwatershed
1	Tyro Road	Swartz Ditch	3
2	Immel Road	Middle Branch	3
3	Easton Road	Middle Branch	3
4	Cook Park	Middle Branch	3
5	Upstream of Meese Road	East Branch	4
6	State Route 153	East Branch	4
7	Upstream of Louiseville WWTP	East Branch	4
8	Beck Road	East Branch	4
9	Trump Road	East Branch	4
10	Cook Park	East Branch	4
11	Upstream from Gregory Galvinizing	West Branch	2
12	Downstream from Gregory Galvinizing	West Branch	2
13	8th Street	Nimishillen Creek	1
14	Upstream of Canton WWTP	Nimishillen Creek	1
15	Canton WWTP Effluent	Nimishillen Creek	1
16	Downstream of West Branch	Nimishillen Creek	1
17	Upstream of Ashland Oil	Hurford Run	1
18	Ashland Oil 001 Outfall	Hurford Run	1
19	Downstream of Ashland Oil	Hurford Run	1
20	Timken WWTP	Hurford Run	1
21	Timken WWTP Effluent	Hurford Run	1
22	Downstream of Domer Ditch	Hurford Run	1
23	Faircrest Avenue	Hurford Run	1
24	Upstream of Timken WWTP	Domer Ditch	1
25	Downstream of Timken WWTP	Domer Ditch	1
26	At Mouth of Stream	Hurford Run	1
27	Upstream of Sherrick Run	Nimishillen Creek	1
28	Allen Avenue	Sherrick Run	1
29	Faircrest Avenue	Nimishillen Creek	1
30	Howenstine Drive	Nimishillen Creek	1
31	East Sparta	Nimishillen Creek	1

Source: Ohio EPA-NEDO, unpublished data.

Phosphorus levels indicated the potential for plant growth to surpass normal rates of eutrophication, with all concentrations recorded higher than 0.03 mg/l (milligrams per liter). It is difficult to ascertain acceptable levels for ammonia due to the lack of stream temperature and pH data as of this date; however, eighteen percent of the stream samples contained over 0.2 mg/l of ammonia, which could be toxic to specific aquatic organisms. The majority of nitrate + nitrite levels were below the standard for drinking water and all of the samples were below the standard for agricultural uses. Total suspended solids (TSS) levels were low, with only a few samples above 10 mg/l. The highest result for TSS was 30 mg/l. Total dissolved solids (TDS) levels were above 500 mg/l for 90 percent of the samples tested. Streams may naturally contain between 100 and 2,000 mg/l of dissolved material. Levels of arsenic, copper and mercury were all below acceptable limits. The majority (approximately 97 percent) of Iron levels were below 1,000 µg/l (micrograms per liter). Due to the geology of the region, elevated levels of iron are not unusual (Ohio EPA-NEDO, pers. com., March, 1999). Fecal coliform counts were high (greater than 1,000 counts per 100 ml) at about 35 percent of the samples taken.

This study can fuel efforts to gather baseline data for future comparison of monitoring studies involving the watershed. Chemical and bacterial sampling should continue at the stream areas selected for this study, in addition to other monitoring stations, as resources allow.

The protection of the water quality for the Nimishillen Creek Watershed relies on an understanding of contaminants in the streams and tributaries. Continuation of stream monitoring will assist in providing sufficient information to facilitate management decisions. This study initiates the effort toward that understanding.

NEFCO encourages monitoring in the upper reaches of the watershed to characterize smaller drainage basins as to their impact and contribution. NEFCO also encourages Ohio EPA to summarize the data and findings into a Technical Services Document (TSD) to assist with future CWMP work.

Methods, Results and Discussions

This portion of the report discusses the results of three months of chemical and bacterial sampling performed in the watershed. A total of thirty-one stations were sampled. The dates of the grab samples were July 16, 28, 30, 31; August 4, 5, 6, 9, 19, 20, 21; and September 1 and 2, 1998. The numerical laboratory results and sample dates are presented in Appendix E.

Water samples were collected and analyzed for several parameters including: phosphorus, ammonia, nitrate + nitrite, nitrite, total suspended solids, total dissolved solids, arsenic, copper, iron, mercury, fecal coliform, pH and stream temperature.

The Nimishillen Creek and its tributaries within the Nimishillen Creek Watershed are located in the Muskingum River Basin which is part of the Ohio River Drainage Basin. The Ohio Environmental Protection Agency (Ohio EPA) Division of Surface Water has developed water quality standards for the state of Ohio, according to drainage basin and designated uses, under Chapter 3745-1 of the Administrative Code. The purpose of these water quality standards is: "to establish minimum water quality requirements for all surface waters of the state, thereby protecting public health and welfare; and to enhance, improve and maintain water quality as provided under the laws of the state of Ohio, section 6111.041 of the Revised Code, the federal Clean Water Act, 33 U.S.C. section 1251 et seq., and rules adopted thereunder".

Water quality standards contain two distinct elements: designated uses; and numerical or narrative criteria designed to protect and measure attainment of the uses. The Ohio EPA designated uses for streams within the Nimishillen Creek Watershed are as follows:

Aquatic life habitat:

"Warmwater" - These are identified by the Ohio EPA as waters capable of supporting and maintaining a balanced, integrated, adaptive community of warmwater aquatic organisms having a species composition, diversity, and functional organization comparable to the twenty-fifth percentile of the identified referenced sites within specific ecoregions.

Water supply:

"Agricultural" - These are waters suitable for irrigation and livestock watering without treatment.

"Industrial" - These are waters suitable for commercial and industrial uses, with or without treatment. Criteria for the support of the industrial water supply use designation will vary with the type of industry involved.

____**Recreation:**

"Primary Contact" - These are waters that, during the recreation season, are suitable for full-body contact recreation such as, but not limited to, swimming, canoeing, and scuba diving with minimal threat to public health as a result of water quality. In addition to those water body segments designated in rules 3745-1-08 to 3745-1-32 of the Administrative Code, all lakes and reservoirs, except underground storage reservoirs and those lakes and reservoirs meeting the definition of bathing waters, are designated as primary contact recreation.

Whenever two or more use designation apply to the same surface water, the more stringent criteria of each use designation is applied by the Ohio EPA. If numerical or narrative criteria from the State of Ohio water quality standards is available, the Outside Mixing Zone (OMZ) criteria will be reported for the parameters below. The OMZ refers to the water after any effluent and the receiving water are reasonably well mixed. Water quality standards do not apply to water bodies when the flow is less than the critical low-flow values determined in rule 3745-2-05 of the Administrative Code.

The following table presents each parameter tested in addition to possible sources and adverse effects.

Table 18 (continued)
Chemical and Bacterial Parameters Tested During Stream Monitoring

Parameter	Possible Sources/Causes	Possible Adverse Effects
Phosphorus	• Human and animal waste • Decomposing organic matter • Fertilizer runoff • Industrial effluent • Detergent wastewater • Natural deposits	• Increasing rates of eutrophication - High levels of algae - Oxygen depletion - Fish kills • Taste and odor problems
Nitrogen - Ammonia - Nitrates + Nitrites - Nitrites	• Human and animal waste • Decomposing organic matter • Fertilizer runoff • Industrial effluent	• Increasing rates of eutrophication High levels of algae - Oxygen depletion - Fish kills
Total Suspended solids	• Runoff from: - Agriculture - Construction - Mining - Forestry - Natural erosion processes • Microscopic plankton	• Reducing light available - Decreasing photosynthesis • Smothering of aquatic habitat • Decreasing visibility and aesthetics • Binding to other contaminants and transporting them into the waterway
Total Dissolved Solids	• Human Use - Wastewater treatment - Stormwater runoff - Industrial effluent - Household effluent • Natural dissolution of rocks and soils	• Physiological impairments • Taste problems • Decreasing visibility and aesthetics • Increasing corrosion
Arsenic	• Mineral dissolution • Industrial effluent • Insecticides	• Toxic and carcinogenic at higher levels

Table 18 (continued) Chemical and Bacterial Parameters Tested During Stream Monitoring		
Parameter	**Possible Sources/Causes**	**Possible Adverse Effects**
Copper	• Industrial wastes • Water supply systems • Corrosion • Natural	• Taste and odor problems • Toxic at higher levels
Mercury	• Fly ash from burning coal • Commercial, industrial, medical and consumer wastes • Natural	• Toxic at higher levels
Iron	• Industrial wastes • Acid mine drainage • Natural deposits • Corrosion	• Toxic at higher levels
Fecal coliform	• Human or animal waste	• Indicator of risk of illness and disease

The paragraphs below give a brief description of each parameter tested including possible sources, significant levels and impacts associated with high levels. Figures 29-32 contain graphs to illustrate levels recorded for four of the nine parameters tested. Graphs for the remaining parameters are available upon request.

Phosphorus

Chemical analysis to determine phosphorus concentration is important to assess stream health. Phosphorus can enter the water from human and animal waste, decomposing organic matter and fertilizer runoff. Industrial effluent and detergent wastewater also contribute phosphates, in addition to leaching from natural deposits. Figure 29 depicts phosphorus concentrations for the monitoring stations.

Total phosphorus levels higher than 0.03 mg/l contribute to increased eutrophication and levels above 0.1 mg/l may stimulate plant growth sufficiently to surpass normal eutrophication rates (Campbell and Wildberger, 1992, p. 42). Elevated levels of phosphorus may stimulate plant growth beyond natural limits causing excessive algal production, fish kills, and taste and odor problems. The OEPA's water quality standards limit phosphorous to the extent necessary to prevent nuisance growths of algae, weeds and slimes that result in violation of water quality criteria or, for public water supplies, results in taste or odor problems (3745-1-07, 1997, p. 20).

All samples analyzed has phosphorus levels above 0.03 mg/l, with approximately 36 percent between 0.03 and 0.1 mg/l. Roughly 64 percent of the samples measured had over 0.1 mg/l of phosphorus.

Ammonia

Ammonia is a naturally occurring compound of nitrogen and hydrogen highly soluble in water. It can reach waterways through discharge of industrial wastes containing ammonia as a byproduct or wastes from industrial processes using “ammonia water”. Ammonia is a normal product of biological degradation of nitrogenous organic material. Sources of nitrogen can enter water from human and animal waste, decomposing organic matter and fertilizer runoff. The toxicity of aqueous solutions of ammonia is attributed to the NH_3 species. Factors which affect the concentration of NH_3 in water solutions include pH and water temperature (U.S. EPA, 1976, pp. 10-11).

Many laboratory experiments of relatively short duration have demonstrated that the lethal concentrations for a variety of fish species are in the range of 0.2 to 2.0 mg/l NH_3, with trout being the most sensitive and carp the most resistant (U.S. EPA, 1976, p.11). Less than 20 percent of the stream samples contained more than 0.2 mg/l of ammonia.

Nitrate + Nitrite

Nitrate is a natural form of nitrogen found in water. Nitrite occurs as an intermediate stage in the biological decomposition of compounds containing nitrogen. Since nitrites readily oxidize to nitrates, they are not often found in surface water (HACH Co.). Nitrogen is similar to phosphorus, in that it can also enter water from human and animal waste, decomposing organic matter and fertilizer runoff.

State water quality criteria for the protection of agricultural uses limits total nitrates + nitrites to levels of 100 mg/l or less. The limit of nitrates for drinking water is 10 mg/l or less (Ohio EPA, 1997, 3745-1-07, pp. 19- 21). Approximately 10 percent of the samples had nitrate + nitrite concentrations above 10 mg/l, with the majority of these occurrences located on the East Branch (Stations 7,8,9 and 10). The highest level recorded was 77.4 mg/l.

Due to the rapid oxidation of nitrites into nitrates, high levels of nitrites may indicate recent nutrient inputs into surface water from pollution sources. The highest concentrations of nitrites were present at Stations 7 and 8, which are located on the East Branch.

Nitrogen is an essential nutrient for plant growth. Excessive amounts of nitrates and nitrites may result in plant growth past normal eutrophication rates, leading to high levels of algae, oxygen depletion, and fish kills (Campbell and Wildberger, 1992, pp. 46-7).

Total Suspended Solids

Sources of elevated levels of suspended solids and low water clarity include sedimentation from agricultural and construction site runoff, mining, forestry, natural erosion processes and increased growth of microscopic plankton.

There are no formal water quality criteria for suspended solids relating to either human health or aquatic life (U.S. EPA, 1983, p. 6). Moderately low levels of turbidity may indicate a healthy, well functioning ecosystem without excessive plankton growth. High levels of turbidity may be an indication of runoff or blooms of microscopic organisms as a result of high nutrient inputs (Campbell and Wildberger, 1992, p. 32). A document referred to as the Ohio Reference Site Data (Brown, 1988) has developed a water quality scale based on total suspended solids values:

Table 19
Water Quality Based on Total Suspended Solids Values

Total Suspended Solids (mg/l)	Water Quality
Less than 10	Excellent water quality
10 to 30	Normal
31 to 133	Impaired stream
More than 133	Severely impaired stream

Over 90 percent of the samples taken had less than 10 mg/l of suspended solids. The highest level recorded for TSS was equal to 30 mg/l.

Suspended materials reduce light penetration, therefore limiting the amount of photosynthetic organisms which decompose organic matter and are an important link in the food chain (Miller, 1998, pp. 348-9). Some examples of how fish populations are adversely affected by suspended solids include: preventing successful development of eggs and larvae, modifying natural movements and migration, and reducing food sources (U.S. EPA, 1976, p. 211). Soil particles can also bind to contaminants such as heavy metals and nutrients, thus transporting them into the waterway (Mayer et. al. 1995).

Total Dissolved Solids

Sources of total dissolved solids (TDS) include various human consumptive uses such as treating wastewater to balance pH and stormwater runoff. The natural dissolution of rocks and soils can also raise TDS values. The term TDS is usually associated with freshwater systems and consists of inorganic salts, small amounts of organic matter and dissolved materials. TDS is defined as the material left behind after a water sample is filtered and evaporated. The quantity of dissolved material in the sample is affected by the solubility of rocks and soils the water contacts. Each waterbody contains a unique mixture of dissolved material. For example, water flowing through limestone and gypsum dissolves calcium, carbonate and sulfate which results in high TDS levels. Rivers may contain between 100 and 2,000 mg/l of dissolved material. For use in municipal water systems, less than 500 mg/l of TDS is desired (Campbell and Wildberger, 1992, p. 51).

The Ohio EPA has determined levels of TDS from 500-750 mg/l or less as acceptable for the protection of human health. TDS levels over 1,500 mg/l are considered unsafe for aquatic life (Ohio EPA, 3745-1-07, 1997, pp. 11 and 19).

Figure 30 illustrates levels of TDS. Nearly 90 percent of samples analyzed had TDS levels above 500 mg/l, with over 70 percent of these over 750 mg/l. Eight percent of the stream samples contained over 1,500 mg/l or TDS. The majority of these samples came from Stations 18 and 19 (Hurford Run).

Arsenic

Arsenic [expressed in µg/l (micrograms per liter)] may be present in water as a result of mineral dissolution, industrial dischargers, or the application of insecticides. Severe poisoning can result from the ingestion of as little as 100 mg of arsenic and chronic effects can appear from its accumulation in the body at low intake levels. Carcinogenic properties have also been related to arsenic (APHA, 1981, p.173).

The arsenic concentration of most potable water seldom exceeds 10 µg/l, although values as high as 100 µg/l have been reported. Statewide water quality criteria limits arsenic to 50 µg/l for the protection of human health and 100 µg/l for the protection of agricultural uses (Ohio EPA, 3745-1-07, pp. 19-21). There were no levels of arsenic in excess 5 µg/l.

Copper

Copper is used in industrial applications and water supply systems. Copper salts are used to control biological growths in water supply systems such as reservoirs and distribution pipes and to catalyze the oxidation of manganese. Corrosion of copper-containing alloys in pipe fittings may introduce significant amounts of copper into the water in a pipe system. Copper is an essential element for humans and the adult daily requirement has been estimated at 2 mg/l (APHA, 1981, p.190).

Statewide water quality criteria for the protection of agricultural uses limits copper to 1,000 µg/l (Ohio EPA, 3745-07-01, p. 21). This limit is also for protection against undesirable taste and odor quality (U.S. EPA, 1986). The majority of copper levels were less than 10 µg/l. The highest concentration was 23 µg/l (Station 22).

Research has shown that excess copper can have acute and chronic toxic effects on plant and animal populations (Ohio EPA-NEDO, pers. com., June 1999).

Iron

Figure 31 illustrates iron concentrations in µg/l (micrograms per liter) for the three months of sampling. Iron is common in many rocks and soils, especially clay soils where it is often a major component. Iron may be present in water in varying quantities, dependent upon the geology of the area and the remaining chemical composition of the waterway. Both plants and animals require iron, making it an essential trace element.

Prime iron pollution sources include industrial wastes, acid mine drainage and iron-bearing groundwaters. In the presence of dissolved oxygen, iron in water from mine drainage is precipitated as a hydroxide, $Fe(OH)_3$. These yellowish precipitates produce "yellow boy" deposits.

Levels of iron above 1.0 mg/l or 1000 µg/l can be toxic to aquatic life. Iron at exceedingly high concentrations has been reported to be toxic to livestock and to interfere with the metabolism of phosphorus (U.S. EPA, 1976, pp. 79-80). Ohio EPA water quality criteria for the protection of agricultural uses is 5,000 µg/l or below (Ohio EPA, 1997, 3745-1-07 p. 21).

Approximately 3 percent of the samples analyzed had iron levels above 1000 µg/l. The highest iron level recorded was 1,950 µg/l at Station 20.

Mercury

Mercury is used in a variety of commercial, industrial, medical and consumer applications. High concentrations of mercury can have a detrimental impact on human and ecosystem health. Broken thermometers, flyash from coal plants and natural deposits are all sources of mercury.

The Ohio EPA limits mercury concentrations to 100 µg/l for the protection of agricultural uses (3745-07-01, p. 21). Data available on the acute toxicity of mercury to 28 genera of freshwater animals ranges from 2.2 to 1,000 µg/l (U.S. EPA, 1986). Only one sample had a reading for mercury greater than 0.2 µg/l - this occurred at Station 11, with .248 µg/l.

Fecal Coliform

Fecal coliform are a type of bacteria naturally abundant in the lower intestine of humans and other warm blooded animals but are rare or absent in unpolluted waters. Because of this, their presence is a reliable indication of sewage or fecal contamination in water. Other coliform bacteria are also present in human and animal feces, but the fecal coliform measurement is more specific, by indicating coliform strains of which 95 percent have a fecal origin (Campbell and Wildberger, 1992 p. 49). Fecal coliform counts are typically higher during the summer months and during or immediately after storm events (U.S. EPA, 1983, p. 5). Figure 32 illustrates fecal coliform at the monitoring locations.

Fecal coliform counts of less than 200 per 100 ml of water is desirable for primary contact waters (swimming) and less than 1,000 per 100 ml for secondary contact waters (boating and fishing). Generally, less than 1,000 colony forming units per 100 ml is permissible for primary contact waters and less than 5,000 per 100 ml for secondary contact waters (Campbell and Wildberger, 1992, p. 10).

The Ohio EPA has developed specific acceptable levels of bacteria for surface waters within Ohio. Statewide criteria for recreational use designations are included below. For each designation at least one of the two bacteriological standards (fecal coliform or *E. coli*) must be met.

Primary Contact

Fecal Coliform - geometric mean fecal coliform content, either most probable number (MPN) or membrane filter (MF), based on not less than five samples within a 30-day period, shall not exceed 1,000 per 100 ml and fecal coliform content (either MPN or MF) shall not exceed 2,000 per 100 ml in more than 10 percent of the samples taken during any 30-day period.

E. coli - geometric mean *E. coli* content (either MPN or MF), based on not less than five samples within a 30-day period, shall not exceed 126 per 100 ml and *E. coli* content (either MPN or MF) shall not exceed 298 per 100 ml in more than 10 percent of the samples taken during any 30-day period.

High levels (above 1,000/100 ml) of fecal coliform were present in approximately 35 percent of the samples tested. Elevated levels (between 200 and 1,000 per 100 ml) of fecal coliform were recorded for approximately 58 percent of the samples taken.

pH

The Ohio EPA defines pH as "the negative logarithm of the hydrogen ion activity concentrations when expressed as moles per liter or pH = -log (H+)" (1997, pp. 2-4). The pH test is one of the most common analyses in water testing. Rapidly growing algae remove carbon dioxide from the water during photosynthesis, which can elevate pH levels (Campbell and Wildberger, 1992, p. 33). A range of pH 6.5 to 8.2 is optimal for most organisms. Rapidly growing algae or submerged aquatic vegetation (SAV) remove CO_2 from the water during photosynthesis and can result in significant increases in pH levels. Ohio EPA statewide water quality criteria for the protection of aquatic life in warmwater habitats lists pH levels between 6.5 - 9.0 as acceptable.

Changes in the water's pH can affect aquatic life indirectly by changing other aspects of the water chemistry. For example, toxic metals trapped in sediment are released into the water at lower pH levels and the toxicity of ammonia to fish varies with changes in pH.

Stream Temperature

Water temperature may be increased as a result of discharges of water used for cooling by industrial or utility plants, runoff from impervious surfaces, and loss of riparian cover. Increased stream temperature enhances oxygen retention in the water and facilitates the streams assimilative capacity. Underground water sources, snow melt and shade can lower water temperature (Campbell and Wildberger, 1992, p. 30).

Stream temperature affects feeding, reproduction and the metabolism of aquatic animals. Temperature preferences among species vary, but all species can tolerate slow, seasonal changes better than rapid changes.

Please Note: Data regarding pH and stream temperature was not available in time for the writing of this report. This data is expected to be included in the final draft.

V. Technical Advisory Committee Meeting Summaries

Summary

This section of the report briefly summarizes the results of two planning meetings held in the Nimishillen Creek Watershed. The purpose of the first meeting on December 10, 1998, was for NEFCO to provide an explanation of the Nimishillen Creek Comprehensive Watershed Management Plan (CWMP) - Phase 1; to give the public a chance to voice its concerns regarding the present and future health of the Nimishillen Creek Watershed; and to give the Ohio EPA an opportunity to describe the types of sampling they recently conducted within the watershed. NEFCO held a second meeting on May 6, 1999, to report on the progress of the project, and review the potential pollution sources within the watershed.

Introduction

The goal of this project is to conduct a diagnostic study of the Nimishillen Creek Watershed, to gain insight into the existing conditions and to identify threats or problems in maintaining the character of the streams within the watershed. The steps that follow involve gaining feedback from local government agencies and citizens as to the extent and impact of the water quality problems.

Results

The Nimishillen Creek Watershed planning meetings were held December 10, 1998 and May 6, 1999. The first meeting began with an introduction of the Nimishillen Creek Watershed. The next hour of the meeting was spent discussing Phase I of the Nimishillen Creek CWMP, and outlining the goals that NEFCO intended to achieve by the end of the project. This included discussing the compilation of existing water quality data; identification of potential point and nonpoint pollution sources; and conducting an inventory of riparian habitat. Ken Frase from the Ohio EPA-NEDO spent the following portion of the meeting explaining the types of sampling being conducted in the Nimishillen Creek Watershed; the approximate sampling locations; and explaining the qualitative habitat evaluation index. The latter part of the meeting was left open for the attendees to bring forth any issues or concerns regarding the water quality of the watershed. The meeting concluded with a tentative date of when a second meeting would be held.

A review of the progress of Phase I of the Nimishillen Creek CWMP was the opening topic of the second planning meeting. This review included a discussion on the status of following: the riparian habitat inventory; the potential point and nonpoint sources; water quality data; and project base maps. The next part of the meeting involved a description of potential pollution sources in the watershed, and their impact on the watershed. The rating of potential pollution sources within the watershed was the next subject of the meeting (the attendees were shown a copy of the potential pollution source ratings list that was completed by NEFCO staff before the meeting). The meeting attendees were then asked to provide any input regarding the assigned ratings. The meeting ended by discussing the completion of Phase I of the Nimishillen Creek CWMP by June 30, 1999, and NEFCO's thoughts on any future phases of the Nimishillen Creek CWMP.

Discussion

December 10, 1998:
The planning meetings have generated a variety of concerns and issues regarding the Nimishillen Creek watershed. During the first planning meeting NEFCO sensed that the citizens of the watershed do not consider the Nimishillen Creek watershed an issue of urgency. Some of the stakeholders brought up past efforts in the Nimishillen Creek watershed that turned out to be unsuccessful. Ed Moody, a concerned citizen, commented that although a similar study was conducted fifteen years ago, many wetlands and pristine wildlife areas were destroyed. He believed that these studies are just excuses to spend money and that this study would probably end up sitting on a shelf. Mr. Moody went on to say that NEFCO’s intentions were good, but nothing worthwhile ever comes out of these studies.

One attendee asked NEFCO to clarify the goal of the project. He also wanted to know what the present quality of the water discharging from the watershed (from mainstem of the Nimishillen Creek) was. Ken Frase of the Ohio EPA-NEDO responded to this question by stating that the water quality was meeting Clean Water Act standards (surprisingly, even downstream from WWTPS).

Phillip Roush from the City of North Canton brought up the issue of flooding at the headwaters of McDowell - Zimber Ditch. He brought up a study done by Stark County and suggested that we contact Gary Conner, a hydraulics engineer, who has studies available on the hydrology of that area.

Mr. Roush also asked NEFCO how specific nonpoint sources of pollution were linked to water quality impact (i.e. phosphorus is shown to be a main pollutant, how would the sources of phosphorus be identified?). NEFCO responded to this question by stating that areas of high soil loss, high construction and agriculture were targeted areas of high phosphorus. NEFCO's response triggered a question from Jim Pastore, a chicken farmer. Mr. Pastore asked whether agricultural land is considered potential nonpoint sources of pollution. Ken Frase, from the Ohio EPA-NEDO, responded to this question by stating that agricultural land was indeed a potential nonpoint source of pollution, and explained why.

Bob Fonte of Stark County Park District stressed habitat preservation and conservation as being an important issue in the watershed. He described a county-wide plan, that the Park District is developing in Stark County, for a trail system along the stream corridor. Mr. Fonte gave NEFCO a map of the plan and offered a copy of more detailed plans if needed. He also was interested in whether or not there was 319 money available to buy conservation easements to protect habitat from future development.

May 6, 1999:
The second planning meeting did not generate many comments until NEFCO discussed the water quality of the watershed. Conrad Moeller, Stark County Sanitary Engineers Office, requested a map of the Ohio EPA sampling sites for water quality. Many attendees asked when a final report of the water quality data would be available (OEPA document). Ken Frase from Ohio EPA-NEDO responded by stating that there was a good chance that it would not be written. Bruce Bernhard, City of North Canton, asked if copies of the raw water quality data would be available.

Most comments started during the Potential Pollution Ratings segment of the meeting. After all the potential pollution sources were explained, NEFCO asked the meeting attendees to participate in ranking each potential source of pollution in each subwatershed. Andy Bayham from USDA-NRCS began questioning NEFCO's ranking method. He thought that using the ranking system made the study too subjective, and was disappointed because he expected a study that would generate more hard data, and be more conclusive. Mr. Bayham felt that there wasn't sufficient data to rate all the potential pollution sources. Others agreed and stated that they didn't feel comfortable rating for all subwatersheds because they were only familiar with particular subwatersheds.

Bob Fonte of Stark County Park District agreed with Mr. Bayham that the study was too subjective, as there was not enough information to back up ratings. He felt that this method of rating did not reflect the true conditions in the watershed and that the study doesn't seem valid without sufficient data. Mr. Fonte also asked if NEFCO took the size of the subwatersheds into consideration when doing the rating, and went on to suggest that the meeting be reconvened when more data was available.

NEFCO assured the stakeholders that it was not basing any conclusions on potential pollution sources within the watershed. NEFCO was only asking for attendees opinions as citizens of the watershed. NEFCO staff also stated that they understood the attendees' apprehension and that if they weren't comfortable with the ranking method that they were not obligated to participate. NEFCO also stated that the group could rank the potential pollution sources again at a later date, after the report was written. This would give the stakeholders sufficient information to back up their opinions.

Andy Bayham asked if the Ohio EPA had been doing studies on the Nimishillen, and if so, why was NEFCO doing this report? He wanted to know what the basis of asking for grants to work on this study if it had already been done. Ken Frase from Ohio EPA-NEDO replied by stating that a study has not been done on the Nimishillen in years and that it does need to be done.

Mary Gibson, a concerned citizen, asked about a Nimishillen book (report) that was supposed to come out in January of 1999 by the Ohio EPA.

After the meeting Andy Bayham suggested that NEFCO have smaller focus sessions or meetings throughout the effort. Once the individual areas have been discussed in more detail, then hold a larger planning meeting.

NEFCO staff followed up by phone with Messrs. Bayham and Fonte to discuss and answer their concerns in detail.

Conclusion

NEFCO recognizes the importance of the planning meetings. It gives local government agencies, organizations, businesses and citizens an opportunity to lean about the health of their local watershed, and gives them a chance to voice their concerns and opinions regarding the watershed. The two planning meetings hosted by NEFCO in the last six months have given it a chance to gain insight into many of the concerns held by the citizens of the Nimishillen Creek watershed. With this is mind NEFCO recognizes the importance of future meetings in order to maintain a relationship with local stakeholders, that will enable the organization to continue its efforts in maintaining the character of the streams in the Nimishillen Creek watershed. NEFCO believes that with sufficient diagnostic materials about the watershed, the local stakeholders will be more willing to contribute their perceptions in identifying the potential sources of pollution within the watershed. This information will enable NEFCO to determine (with input from the stakeholders) which sources should be targeted as a priority and which areas should be targeted as areas of concern.