PART 4—HABITAT AND DIVERSITY

4.1 Stream Assessment

4.1.1 Overview

Four parameters of an aquatic ecosystem interact with one another to shape the overall biological health and diversity of that particular ecosystem. These parameters include the ***aquatic macroinvertebrate community***, ***fish community***, ***habitat composition*** and ***chemistry*** of the surface waters. Separate assessments are conducted to examine the physical condition of each individual parameter. The assessment data from each individual parameter are then combined and analyzed to make inferences regarding the overall health and diversity of the entire ecosystem in question.

Walnut Creek and its major tributaries were evaluated using this approach. Each of these parameters were assessed during 2006 to obtain the biological, physical and chemical data needed in order to make conclusions regarding the overall health and diversity of one of the best steelhead fisheries in the Lake Erie drainage.

To adequately assess the entire Walnut Creek drainage, sampling locations were established throughout the watershed. Sampling locations were situated on the main stem of Walnut Creek and on many of its associated tributaries in order to bracket potential sources of pollution. Three "reference quality" waterways were also assessed for comparative purposes. Sampling locations are described in Table 1.

Walnut Creek sampling location 15UNT

Walnut Creek sampling location 6WC

Walnut Creek sampling location 5UNT

Walnut Creek sampling location 16WC

Walnut Creek sampling location 3UNT

Walnut Creek sampling location 24WC

4.2 Benthic Macroinvertebrate Survey

4.2.1 Introduction

Walnut Creek sampling location 21WC

One method of analyzing the condition of the water quality of a waterway is to survey the aquatic benthic macroinvertebrate community of that particular stream or river. Macroinvertebrates respond differently to the addition of various pollutants, from both point and non-point sources, and can indicate changes within the water quality of the surveyed stream.

Measurements of the macroinvertebrate diversity and abundance, with regard to the waterway's physical habitat, can help define water quality conditions and indicate if pollutants have impacted the waterway. If the macroinvertebrate community is not in balance or is not typical for that particular waterway, determined from historical survey data or when compared to a reference waterway, then the stream may not be attaining its designated aquatic life use. If the designated aquatic life use is not being met, the stream is considered impaired and a specific source and cause for the pollutants are determined. Additional in-depth investigations through stream water sampling and watershed reconnaissance can aid in determining the exact sources and causes of these impairments.

Walnut Creek sampling location 23WC

By examining the benthic macroinvertebrate community throughout an entire watershed, inferences can be made regarding the overall health of all waterways within the watershed.

During April 2006, the benthic macroinvertebrate communities of Walnut Creek and its associated tributaries were surveyed to determine the overall health of the entire watershed. Benthic macroinvertebrate communities from three reference waterways were also surveyed for comparative purposes. The reference waterways included Elk Creek, Goodban Run and Twentymile Creek. The benthic macroinvertebrate sampling was conducted between April 13, 2006 and April 28, 2006. Sampling occurred during the month of April to capture many of the insects in later life stages making identifications easier and allowing the capture of some insects before late spring emergence.

4.2.2 Benthic Macroinvertebrate Sampling Locations

Eighteen aquatic macroinvertebrate sampling locations were established within the Walnut Creek Watershed, including ten stations on the main stem and eight on tributaries (Map 1). Three sampling locations were established on Twenty Mile Creek, Elk Creek and Goodban Run, one on each stream, to serve as reference waterways (Maps 2 & 3).

The main stem of Walnut Creek is protected as a Cold Water Fishery and Migratory Fishery under Chapter 93 Water Quality Standards, Drainage List X. The ten sampling locations on the main stem of Walnut Creek were selected to bracket potential pollutant impacted stream sections. These sections included: highly developed areas, agricultural areas, major transportation routes, a permitted landfill and areas that were currently being developed.

Walnut Creek headwaters sampling location 1WC.

Two major tributaries of Walnut Creek, Thomas Run and Bear Run, were selected because they were bigger in size and could be more easily sampled. Thomas Run is protected as a High Quality - Cold Water Fishery and Migratory Fishery, for its entirety, under Chapter 93 Water Quality Standards, Drainage List X. Three stations were situated on Thomas Run to bracket newly developed areas. Bear Run is protected as a Cold Water Fishery and Migratory Fishery as listed within Chapter 93 Water Quality Standards, Drainage List X. Newly developed areas, with some areas still under construction, and agricultural areas are located in the headwaters of Bear Run. The sampling station was situated near the mouth of Bear Run.

Bear Run sampling location; 22 BR.

Two unnamed tributaries of Walnut Creek were selected because they were previously assessed during State Surface Water Assessment Program Biological Screening Protocol (2001) and found to be impaired due to siltation stemming from urban runoff, storm sewers and residential runoff. Two other unnamed tributaries of Walnut Creek were sampled to bracket newly constructed developments, a cooperative fish hatchery and a stream section that appeared to be nutrient enriched. All stream sections nearby to potential sources of stream impairment were surveyed to attain an overview of the health of the aquatic life within the Walnut Creek Watershed. All of the unnamed tributaries to Walnut Creek are protected as a Cold Water Fishery and Migratory Fishery under Chapter 93 Water Quality Standards, Drainage List X.

Three waterways outside of the Walnut Creek watershed, but still tributaries to Lake Erie, were selected for comparative purposes. These reference streams were selected because they have less development but have the same general stream characteristics and geological features when compared to the Walnut Creek watershed.

Twentymile Creek is similar in drainage area but does not have the amount of development or the number of potential pollution sources as the Walnut Creek watershed. Vineyards and transportation routes are the chief sources of potential pollutants within the Twentymile Creek watershed. Twentymile Creek is protected as a Cold Water Fishery as listed within Chapter 93 Water Quality Standards, Drainage List X.

Twentymile Creek sampling location 25TM; reference waterway.

Elk Creek has a larger drainage area than Walnut Creek. However it was sampled approximately 13.5 miles upstream from the mouth and at a point along its length that would make it comparable in size, or drainage area, to the Walnut Creek Watershed. The Elk Creek watershed has several developed and residential areas but is not as highly developed as the Walnut Creek watershed. Elk Creek is protected as a Warm Water Fishery and Migratory Fishery under Chapter 93 Water Quality Standards, Drainage List X.

Elk Creek sampling location 26EC; reference waterway

Goodban Run is a tributary of Elk Creek and is protected as a Cold Water Fishery and Migratory Fishery as listed within Chapter 93 Water Quality Standards, Drainage List X. The Goodban Run watershed is mostly forested with a low potential for any non-point sources of pollution. The drainage area of Goodban Run is smaller in size and provides an excellent comparison for the tributaries and headwater sampling stations of the Walnut Creek watershed.

Goodban Run sampling location 27GR; reference waterway

4.2.3 Benthic Macroinvertebrate Methods

Semi-quantitative benthic macroinvertebrate samples were collected at all sampling locations using the Pennsylvania Instream Comprehensive Evaluation (ICE) survey methodology. All benthic macroinvertebrate samples were collected from the best available fast and slow riffle habitat at each sampling location. The samples were collected using a D-frame net with 500-micron mesh netting. At each location, six 1-m^2 sections of substrate were thoroughly disturbed during collection and then composited into the same sampling container. The samples were properly preserved in ethanol and transported to the DEP Regional Office for sorting and identification.

The six-kick composite was sorted and all organisms removed for identification. All macroinvertebrates in each sample were identified to the lowest taxanomic level possible. A detailed analysis of the benthic macroinvertebrate community at each sampling location was computed using biometric indices. Using the metric analysis, comparisons were made between the macroinvertebrate communities of the Walnut Creek watershed and reference stream sampling locations.

Habitat conditions were scored at each sampling location according to the protocol described in the Standardized Biological Field Collection and Laboratory Methods. Habitat scoring included eight instream habitat qualities and four riparian zone conditions. Habitat conditions could potentially explain differences in the benthic community composition at sites that differed significantly from others in one or more habitat parameters.

Dissolved oxygen, pH, specific conductance and temperature were measured in the field using a hand-held YSI 556 multi-parameter meter. The meter was calibrated according to manufacturer specifications during each day of use. Total alkalinity was measured using a Hawk Run Total Alkalinity field test kit.

4.2.4 Benthic Macroinvertebrate Analysis and Results

The total numbers of individuals collected by taxonomic group are listed in Table 2. Taxa richness ranged from a low of 4 taxa at station 20UNT to 48 taxa at 1WC. Sample size, or the number of individual organisms collected at each sampling location, ranged from 4122 organisms at 27GR to 84 organisms at 24WC. Chironomidae (midges) were the most abundant taxa collected at all stations except for 22BR, where *Haploperla* (stoneflies) and 27GR, where *Epeorus* (mayflies) were the dominant taxa.

The benthic macroinvertebrate communities from the main stem of Walnut Creek showed a steady decline from the headwaters to the mouth within the following analysis categories: taxa richness, abundance, diversity, the number of intolerant taxa, Hilsenhoff Biotic Index (HBI) and the number and percentage of Ephemeroptera, Plecoptera and Trichoptera (EPT) taxa. Significant and noticeable declines within the benthic macroinvertebrate communities of Walnut Creek began near station 7WC. This coincides with the point within the Walnut Creek watershed where the potential for major impacts from non-point source pollution begin. Potential sources of pollution at this point include: previously developed commercial~~ly developed~~ areas, highly traveled transportation routes, residential areas and ongoing major construction activities.

Severe impacts are evident within the benthic macroinvertebrate communities of three unnamed tributaries of Walnut Creek, 9UNT, 12UNT and 20UNT. These three UNT's were very degraded and had low overall analysis scores. The major impacts may be attributed to urban sprawl as these streams have been heavily encroached upon by anthropogenic activities.

Diverse macroinvertebrate communities with balanced trophic structures were found at all three reference sampling locations. Each of these macroinvertebrate communities consisted of a high number of taxa that are generally intolerant of pollution. Therefore, the reference stations provide excellent metric analysis data in which to compare the sampling data from the stations of the Walnut Creek watershed.

4.2.5 Metric Analysis

Five metrics were evaluated to characterize the biological condition of the Walnut Creek watershed. These metrics included: Taxa Richness, Hilsenhoff Biotic Index (modified), EPT Index (modified), Community Loss Index and the Ratio of EPT and Chironomidae Abundances (Table 3).

Taxa Richness is the number of taxa (genera) present within the sample and can characterize the overall health of the macroinvertebrate community. Taxa richness generally increases with healthier water quality.

The Hilsenhoff Biotic Index (HBI) measures organic pollution tolerance and was modified for organisms found in Pennsylvania. The index assigns a value to each taxa. Values range from zero for organisms that are very intolerant of organic pollution to ten for organisms extremely tolerant of pollution. Tolerance values are multiplied by the number of individuals for each taxa within the sample. The results are summed and the total divided by the number of organisms within the sample to calculate the overall HBI score. This produces an index value for the entire

sample. The community index values range from zero to ten and can be interpreted according to the following chart from Hilsenhoff (1987):

Hilsenhoff Biotic Index Condition Scoring Criteria

Score	*Narrative Range*	*Degree of Organic Pollution*
0.00 – 3.50	Excellent	No apparent organic pollution
3.51 – 4.50	Very Good	Possible slight organic pollution
4.51 – 5.50	Good	Some organic pollution
5.51 – 6.50	Fair	Fairly significant organic pollution
6.51 – 7.50	Fairly Poor	Significant organic pollution
7.51 – 8.50	Poor	Very significant organic pollution
8.51 – 10.00	Very Poor	Severe organic pollution

The EPT Index is the total number of taxa within the orders Ephemeroptera, Plecoptera and Trichoptera and was modified for organisms found in Pennsylvania. These orders of insects are generally sensitive to environmental stress. This metric value generally increases with healthier water quality.

The Community Loss Index measures the amount of dissimilarity between the macroinvertebrate taxa present at the reference and study sampling locations. The value of the index increases as the reference and study locations become less similar to one another with regard to their community taxa composition.

The Ratio of EPT and Chironomidae Abundances measure the evenness of distribution within these four taxonomic groups. Commonly, an increase in Chironimid abundance and a decrease in EPT abundance are noticed as water quality decreases or environmental stress is placed on the aquatic community. In turn, as the more intolerant EPT taxa are reduced in abundance, the calculated overall metric value is lower.

The functional feeding groups of the collected macroinvertebrate taxa and several other metrics were also reviewed but were not directly used in determining the biological condition of the Walnut Creek watershed. By examining the functional feeding groups of the collected macroinvertebrates, community shifts between sampling stations can be detected. Community shifts within the macroinvertebrate community can be either natural or indicative of environmental stress.

The Shannon Diversity Index depends not only on species richness but also takes relative abundance into account. The index is used to measure the evenness of individual taxa within the diversity of taxa collected. As a general rule, the higher the Index number, the more evenly distributed the taxa are within a sample, indicating better water quality. Benthic communities containing high numbers of only a few taxa with increased numbers of rare taxa generally have lower index values and poorer water quality.

4.2.6 Metric Comparison

Once a numerical value was calculated for each metric and a subsequent overall score computed for each sampling location, comparisons were made between the Walnut Creek watershed and reference waterways. A biological condition category, ranging from non-impaired to severely impaired, was given to each sampling location within the Walnut Creek watershed depending upon the percent comparison to the respective reference waterway. The 1989 EPA Rapid Bioassessment Protocols For Use In Streams And Rivers Manual, Plafkin et.al. (1989), provide scoring for the biological condition categories.

Twentymile Creek was used as a reference waterway in which to compare the main stem sampling locations of Walnut Creek (7WC, 8WC, 11WC, 13WC, 16WC, 21WC, 23WC and 24WC). Elk Creek was also used as a reference waterway in which to compare the main stem sampling locations of Walnut Creek (7WC, 8WC, 11WC, 13WC, 16WC, 21WC, 23WC and 24WC). Goodban Run was used as a reference waterway in which to compare all of the tributaries of Walnut Creek and the two-headwater sampling locations of Walnut Creek (1WC, 2WC, 9UNT, 12UNT, 14UNT, 17TR, 18TRUNT, 19TR, 20UNT and 22BR).

Walnut Creek vs. Twentymile Creek

When compared to Twentymile Creek, all of the sampling locations on the main stem of Walnut Creek were rated as “Moderately Impaired” (Table 4). The “Moderately Impaired” category is given to stations with a percent comparability between 21-50%.

The number and percent of EPT taxa present at all stations within the Walnut Creek watershed are significantly lower than the reference stream. EPT taxa composed 33.3 % of the macroinvertebrate community within Twentymile Creek. The Walnut Creek stations had EPT taxa compositions ranging from 1.5% at stations 13WC and 16WC to 11.6% at station 8WC.

HBI scores range from 5.32 at station 8 WC to 6.02 at station 16WC. These scores, with the exception of station 8WC, indicate “fairly significant organic pollution” present according to the Hilsenhoff Biotic Index Condition Scoring Criteria Chart from Hilsenhoff (1987). The score from station 8 WC indicates the presence of “some degree of organic pollution”. Twentymile Creek, with a HBI score of 4.25, falls into the category of “possible slight organic pollution”.

The Shannon Diversity of Walnut Creek ranges from 0.9 at 24WC to 1.47 at 13WC. Twentymile Creek had a score of 2.26 indicating an evenness of individual taxa within the diversity of taxa collected. The diversity index scores within Walnut Creek show a sharp drop off beginning at station 16WC and extending to the mouth.

Twenty-two intolerant taxa were present at the reference station. The number of intolerant taxa present within Walnut Creek ranged from 6 taxa at 21WC to 17 taxa at 8WC. The sampling stations closest to the mouth of Walnut Creek had the lowest number of intolerant taxa present.

Walnut Creek vs. Elk Creek

When compared to Elk Creek and using the table from Plafkin et.al. (1989), three stations, 21WC, 23WC and 24WC, rated as “Moderately Impaired”. Four stations, 7WC, 11WC, 13WC

and 16WC, were rated as "Slightly Impaired" to the reference station by having a percent comparability between 54-79%. Station 8WC rated as "Non-Impaired" by having a percent comparability greater than 83% when compared to Elk Creek (Table 5).

The number and percent of EPT taxa present at all stations within the Walnut Creek watershed were lower than the reference station. The Elk Creek station had an EPT taxa composition of 14.2%. The Walnut Creek stations had EPT taxa compositions ranging from 1.5% at stations 13WC and 16WC to 11.6% at station 8WC. The individual number of EPT taxa begins to drop off at a point downstream of station 8WC.

HBI scores range from 5.32 at station 8WC to 6.02 at station 16WC. These scores, with the exception of station 8WC, indicate "fairly significant organic pollution" present according to the Hilsenhoff Biotic Index Condition Scoring Criteria Chart from Hilsenhoff (1987). The score from station 8 WC along with the HBI score from Elk Creek, 5.37, indicate the presence of "some degree of organic pollution".

The Shannon Diversity of Walnut Creek ranges from 0.9 at 24WC to 1.47 at 13WC. Elk Creek had a score of 2.11 indicating an evenness of individual taxa within the diversity of taxa collected. The diversity index scores within Walnut Creek show a sharp drop off beginning at station 16WC and extending to the mouth.

Seventeen intolerant taxa were present at the reference station. The number of intolerant taxa present within Walnut Creek ranged from 6 taxa at 21WC to 17 taxa at 8WC. The sampling stations closest to the mouth of Walnut Creek had the lowest number of intolerant taxa present.

Similar taxa richness was noted in the reference stream and the upper stations of Walnut Creek. The macroinvertebrate community of Elk Creek consists of 25 taxa. The taxa richness of Walnut Creek ranged from 10 taxa at 24WC to 26 taxa at 8WC.

Walnut Creek Tributaries vs. Goodban Run

When compared to Goodban Run and using the table from Plafkin et.al. (1989), three stations, 9UNT, 12UNT and 20UNT, rated as "Severely Impaired" by having a percent comparability less than 17% (Table 6). Five stations, 2WC, 14UNT, 17TR, 18TRUNT and 19TR, were rated as "Moderately Impaired" to the reference station by having a percent comparability between 21-50%. Two stations, 1WC and 22BR, were rated as "Slightly Impaired" by having a percent comparability between 54-79%.

The Goodban Run sampling station had an EPT taxa composition of 72.4%. The Walnut Creek tributaries and headwater stations had EPT taxa compositions ranging from 0% at stations 12UNT and 20UNT to 67.4% at station 22BR. The individual number of EPT taxa range from 0 taxa at stations 12UNT and 20UNT to 20 taxa at station 1WC. Goodban Run had 20 individual EPT taxa present.

The mayfly, *Epeorus*, dominated the macroinvertebrate community of Goodban Run. The low overall HBI score for Goodban Run is a reflection of the lower individual HBI score of this mayfly genus. The percent composition of EPT taxa at the reference station is also a reflection of the high number of *Epeorus* taxa present.

HBI scores range from 2.18 at station 22BR to 7.49 at station 20UNT. The HBI score of Goodban Run is 1.74. According to the Hilsenhoff Biotic Index Condition Scoring Criteria Chart from Hilsenhoff (1987), stations 12UNT and 20UNT indicate the presence of "significant organic pollution". Stations 9UNT and 18TRUNT fall into the "fairly significant organic pollution" category. The scores of 2WC, 14UNT, 17TR and 19TR point toward a presence of "some organic pollution". Along with the reference station, 1 WC and 22BR show "no apparent organic pollution" when the Hilsenhoff chart is utilized.

The Shannon Diversity scores range from 0.81 at 20UNT to 2.28 at 2WC. Three tributaries and the two-headwater stations of Walnut Creek had diversity index scores higher than the reference station score of 1.57.

Twenty-five intolerant taxa were present at the reference station. The number of intolerant taxa present within the tributaries and headwater stations of Walnut Creek ranged from a single taxa at 20UNT to 33 taxa at 1WC. Stations 9UNT, 12UNT and 20UNT had the lowest number of intolerant taxa present, 2, 4 and 1, respectively.

Taxa richness varied among all sampling locations. The reference station yielded 36 individual taxa collected. The taxa richness from the Walnut Creek watershed ranged from 4 taxa collected at 20UNT to 48 taxa at 1WC.

4.2.7 Benthic Macroinvertebrate Overview

The aquatic macroinvertebrate health within the Walnut Creek watershed appears to become more depressed as you move downstream towards the mouth. The macroinvertebrate diversity, the number and percentage of EPT taxa and the number of intolerant taxa decrease as you move downstream. The HBI scores are higher near the mouth of Walnut Creek than they are at the headwater sampling stations (Table 7).

When looking at the Walnut Creek watershed, without comparison to a reference waterway, the greatest change within the benthic communities begin between stations 2WC and 7WC.

Walnut Creek sampling location 2WC

Walnut Creek sampling location 7WC

This correlates well with the slight changes within the habitat quality, change in bottom substrate composition and an increase in anthropogenic activities that begin to occur between these sampling stations.

Macroinvertebrate communities are influenced by changes within the bottom substrate and physical habitat composition. Cobble/ gravel sections dominate the headwater sampling locations of Walnut Creek. Bedrock begins to dominate the bottom substrate at sampling locations beginning near station 8WC. Physical habitat scores, which take into account both instream and riparian parameters, also begin to decrease in overall scores between sampling stations 2WC and 7WC. The headwater sections of Walnut Creek are mostly forested/ residential areas. Beginning at a point between sampling stations 2WC and 7WC, anthropogenic activities begin to increase. These activities include major transportation routes, a permitted landfill, highly concentrated commercial areas, residential areas and ongoing major construction activities.

Another distinct change within the macroinvertebrate communities of the Walnut Creek watershed appear between sampling stations 8WC and 11WC.

Walnut Creek sampling location 8WC

Failing silt fence

Stormwater runoff from an active development site along Interchange Road

This change correlates well with the influx of potential non-point source pollutants stemming from the highly developed Peach Street area. The vast amount of impervious areas present along Peach Street raises the potential for non-point source pollutant introduction and an immense increase in stormwater runoff during rain events. Coupled together, they can have detrimental impacts to the aquatic life from the point of entry downstream to the mouth of Walnut Creek and subsequently to the waters of Lake Erie.

The health of the macroinvertebrate community within the Walnut Creek watershed appears to decrease from the headwaters downstream to the confluence with Lake Erie. This decrease can be attributed to the cumulative impacts from the influx of various non-point source pollutants throughout the entire watershed.

4.3 Fish Survey

4.3.1 Introduction

The tributary streams that flow into Lake Erie provide an exceptional potamodromous (freshwater fish migration between lake and stream) fishery for thousands of anglers each year. Because of its popularity, the steelhead (rainbow trout) fishery provides a seasonal boost to the local economy in northwestern Pennsylvania (Murray and Shields 2004). The Lake Erie steelhead fishery is mainly supported by plantings of yearling steelhead, or smolts. Smolt stockings occur in the tributary streams in late winter and spring. These small trout (generally 4-9" in length) typically remain in the tributaries until warmer spring rains trigger their migration into Lake Erie. The majority of steelhead smolts and adults spend their summer in the deeper, colder waters of Lake Erie. Cooler, fall rains in late summer and early fall prompt their migration into area tributaries. Adult steelhead (3-5 year old fish) and jacks (2+ year old fish) can remain in tributary streams from fall until spring.

Natural steelhead spawning does occur in tributary streams and Pennsylvania Fish and Boat Commission Fisheries Biologists have documented some egg hatching. However, survivorship of wild steelhead populations is believed to be low. Possible reasons for the low survivorship of eggs and young-of-year steelhead are related to the lack of suitable spawning and rearing habitat and the high summer temperatures in the Lake Erie tributaries. Therefore, the Lake Erie steelhead fishery has been regarded as a put, grow, and take fishery.

The Pennsylvania Fish and Boat Commission (PFBC) has been planting steelhead into tributary streams since the 1960's. Additional potamodromous fish traditionally stocked and managed by the PFBC since then have included Coho and Chinook salmon. Stockings of brown and brook trout have also occurred. Pink salmon inadvertently run up Pennsylvania's Lake Erie tributaries and are occasionally caught by anglers. Pink salmon have apparently naturalized in Lake Erie from an accidental release in Lake Superior in 1956 (Murray and Shields 2004). In 2005, the PFBC released approximately 1,056,946 yearling steelhead into Lake Erie, tributaries streams to Lake Erie and Presque Isle Bay (http://www.fish.state.pa.us./).

Cooperative nurseries released an additional 126,300 yearling steelhead in 2005. Prior to 2003, the PFBC also conducted annual plantings of yearling Coho and Chinook salmon. However, that program has been discontinued due to poor return rates and concerns over predation from adult salmon on fragile rainbow smelt populations.

Walnut Creek is the second largest and arguably the second most popular tributary for steelhead fishing in the Pennsylvania portion of the Lake Erie drainage (Nagy 2003). In 2005, the PFBC and cooperative nurseries released approximately 219,070 smolts into Section 2 of Walnut Creek. The upstream limit of Section 2 occurs at SR99 near the Millcreek Mall and the downstream limit occurs at the mouth at Lake Erie. Walnut Creek does not receive any adult stockings of brown or rainbow trout so it is not considered an Approved Trout Water. Walnut Creek currently holds two Pennsylvania state fish records. On July 4, 2000, a 19 lb. 10 oz. brown trout was caught at the mouth of Walnut Creek along the area called "The Wall". On April 1, 2001, a 15 lb. 6.25 oz. steelhead has caught in the "Chutes" area of Walnut Creek.

4.3.2 Methods

Fish communities were assessed using a Coffelt backpack electrofishing unit with alternating current (AC). At each station, a 100-meter section of stream was sampled. Starting at a downstream point and maneuvering in a zigzag pattern upstream, a single pass was made. Station locations were chosen to cover a variety of habitats (i.e. riffles, runs, pools, depositional areas) that best characterized the stream reach. Fish species were collected and identified when the electrofishing reach was completed or visually identified immediately and not collected. General abundances were determined in the field for all non-game fish species. Game fish species were collected and additionally weighed, measured and returned to the stream. Abundances were tabulated as follows: rare (< 3 individuals), present (3-9 individuals), common (10-24 individuals), abundant (25-100 individuals) and very abundant (> 100 individuals). General observations were made for habitat complexity and quality and flow. Sampling duration and average stream width was also tabulated at each sampling reach.

A total of 22 stations were examined from June 22, 2006 to July 17, 2006 (Maps 2, 3 & 4). The time of year for sampling was chosen to not coincide with annual fall, winter and spring adult steelhead runs. Additionally, electrofishing during the late spring steelhead smolt stocking by the Pennsylvania Fish and Boat Commission (PFBC) and 3-C-U Cooperative Nurseries were also avoided. Ten sampling locations were chosen on the main stem of Walnut Creek and five stations on unnamed tributaries to Walnut Creek. In addition, two stations were chosen on Thomas Run and one station each on Bear Run and an unnamed tributary to Thomas Run. Reference stations were selected on Twenty-Mile Creek, Elk Creek and Goodban Run to compare fish populations. Fish station locations mimicked the macroinvertebrate stations with the exception of 15UNT, where no benthic insects were collected. Bear Run (22BR) was re-sampled on December 13, 2006 to further examine the brown trout fishery.

4.3.3 Results and Discussion

A total of 24 fish species were collected at the 19 Walnut Creek watershed stations and three reference stations on Elk Creek, Twenty-Mile Creek and Goodban Run (Table 8). Fish diversity ranged from 0 to 20 species per station. Station 24WC at the mouth of Walnut Creek had the highest diversity with 20 species collected while no fish were collected at station 9UNT. In addition, only stocked steelhead smolts were collected at station 20UNT. These individuals probably escaped from a cooperative nursery upstream.

Central Stoneroller (*Campostoma anomalum*)

The central stoneroller (*Campostoma anomalum*) was the most common fish collected during the survey. Stonerollers were found at 18 of the 22 fish sampling stations and were at least abundant at 11 stations. This small fish inhabited most of the drainage except in the headwater reaches and a few severely degraded tributaries of Walnut Creek. Central stonerollers consume principally plant material such as periphyton and filamentous algae. The habitat of stonerollers is highly variable but prefer medium sized creeks with pool and riffle habitat that contain sand and gravel bottoms. Because of their herbaceous diet, stonerollers can reach high densities in clean, eutrophic streams (Cooper 1981).

Blacknose Dace (*Rhinichthyes atratulus*)

Three species of dace were found in the Walnut Creek basin. The blacknose dace, *Rhinichthyes atratulus* was common to abundant at 17 of 19 stations on Walnut Creek and all reference stations. This dace is tolerable of a wide variety of environmental conditions and occur in moderately flowing waters of slower current. Blacknose dace occurred sympatrically in streams with longnose dace, *Rhinichthyes cataractae*. However, the two species occupied different habitats.

Longnose dace were found in 11 of 19 stations and two reference stations, Twenty-Mile Creek and Elk Creek. This species was present to common at most stations where it occurred. Unlike blacknose dace, longnose dace were found in the swifter flowing sections of Walnut Creek over gravelly bottoms.

Longnose Dace (*Rhinichthyes cataractae*)

Redside dace (*Clinostomus elongates)*

The redside dace, *Clinostomus elongatus*, occurred from station 2WC downstream to station 11WC. It was also found at station 7WC and 12UNT. This dace was common at all four stations where it was collected. The habitat of redside dace normally includes small creeks with a variety of pool and riffle areas over sand and gravel substrate.

Rainbow Darter (*Etheostoma caeruleum*)

Five species of darters were found in the Walnut Creek basin, four of which occur in the genus *Etheostoma*. The rainbow darter, *Etheostoma caeruleum*, occurred at 17 stations and was abundant to very abundant at seven stations. This small darter was found in the faster, shallow riffle habitats. Although they occupy different niches, rainbow darters are common associates with fantail and Johnny darters in northwestern Pennsylvania.

The Johnny darter, *Etheostoma nigrum*, was rare to present at only two stations on Walnut Creek, 2WC and 7WC. The species was found in the slower areas in pools or edges of Walnut Creek over fine gravel and sand. The fantail darter, *Etheostoma flabellare*, was collected at 14 stations where it was rare to common.

Johnny Darter (*Etheostoma nigrium*)

Fantail Darter (*Etheostoma flabellare*)

Fantail darters occurred in a variety of habitats during this survey but were most readily found in run areas where cobble or broken bedrock provided cover. The banded darter, *Etheostoma zonale*, was found at only one station, 23WC, where it was present. Banded darters are a widespread and common fish in northwestern Pennsylvania, where they occur in fast, shallow riffles. It is normally a common associate with greenside and variegate darters, neither of which was collected during this survey.

Log perch, *Percina caprodes*, was present at one station, 24WC. This large darter can tolerate silty water and occurs in a variety of habitats. Log perch run up tributary streams to spawn in late spring and early summer and may be locally abundant in the lower reaches of Walnut Creek and probably Twenty-Mile and Elk Creeks during that time period.

Log Perch (*Percina caprodes*)

River Chub (*Nocomis micropogon*)

Creek chubs, *Semotilus atromaculatus*, were collected at 20 stations where they were present to very abundant. This species did not occur at 9UNT and 20UNT. A hardy fish, this species occurred in a variety of habitats but usually were most common in moderate current over bedrock or gravel. Creek chubs are labeled as a transitional species, preferring coolwater conditions as opposed to warmwater or coldwater streams. They often occur sympatrically with blacknose dace and white suckers. River chubs were collected at the downstream stations on Walnut Creek and the reference stations on Elk and Twenty-Mile Creeks where they were present to common. River chub habitat includes medium sized streams with cool water in bedrock bottoms and gravelly riffles (Steiner 2002).

Creek Chub (*Semotilus atromaculatus*)

Northern hog suckers, *Hypentilium nigricans*, and white suckers, *Catostomus commersoni*, were collected at 13 and 16 stations, respectively. Depending on the station, northern hog sucker abundance was varied while white suckers were present to common. Northern hog suckers usually occur in small to medium size creeks where clean gravel and cobble are common. White suckers are usually tolerable of a variety of different habitats. White suckers migrate into Walnut Creek in large numbers in early spring to spawn in fast flowing riffles. Most white suckers collected during this survey were young-of-year fish.

Northern Hog Sucker (*Hypentilium nigricans*)

Common Shiner (*Notropis cornutus*)

Common shiners, *Notropis cornutus*, were collected at 13 stations where population abundance was varied and ranged from present to abundant. Common shiners prefer medium size creeks with cool water.

Mottled sculpin, *Cottus bairdi*, were collected at 14 stations where they were rare to common. Sculpin usually inhabit small, cold headwaters streams and are normally associated with brook and brown trout. However, this species is

Mottled Sculpin (*Cottus bairdi*)

somewhat variable and does occur in streams where wild, reproducing populations of trout do not exist. During this survey, sculpin were normally found at the headwater areas of the watershed and in tributaries with good water quality and were much less abundant downstream. Mottled sculpin typically have a small home range.

Bluegill, *Lepomis macrochirus*, and pumpkinseed, *Lepomis gibbosus*, were collected at 11 and six stations, respectively. Abundance of these panfish was rare to present at each station. Bluegill and pumpkinseeds were collected from backwater depositional and erosional habitats and deeper pools. Most fish collected were small (< 4 inches in total length). Young-of-year Yellow perch, *Perca flavescens*, were found in low numbers in Elk Creek and Goodban Run.

Stonecat (*Notorus flavus*)

The stonecat, *Notorus flavus*, occurred at five stations and was restricted to the lower reaches of Walnut, Elk and Twenty-Mile Creeks. Stonecats were found in low numbers but population abundance might have been misleading due to the secretive nature of this small member of the catfish family. Stonecats were collected in deeper runs where shelves of bedrock provided ample daytime cover.

Largemouth Bass *(Micropterus salmoides*) (young-of-year)

Young-of-year smallmouth bass, *Micropterus dolomieu*, and largemouth bass, *Micropterus salmoides*, were each collected at three stations. Smallmouth bass were collected at the mouths of Walnut and Twenty-Mile Creeks and at station 26EC on Elk Creek. Good populations of adult smallmouth bass migrate into Walnut Creek in late spring each year to spawn. Young-of-year bass probably use tributary streams of Lake Erie as summer refuge areas.

Smallmouth Bass (*Micropterus dolomieu*) (young-of-year)

The round goby, *Neogobius melanostomus*, was collected at the mouth of Walnut and Twenty-Mile Creeks where they were present to common. An exotic species that was introduced into the Great Lakes around 1990, gobies can be easily identified by their fused pelvic fins, which form a suction disk (Marsden and Jude, 1995). Migration of gobies upstream into the Lake Erie tributaries appears to be limited and may be a result of their inability to traverse natural barriers such as bedrock waterfalls.

Round Goby (*Neogobius melanostomus*)

Fused pelvic fin of Round Goby

Brown trout, *Salmo trutta*, occurred at three stations: 24WC, 25TM, and 22BR. This species was rare to present below the SR5 bridges on Walnut Creek and Twenty-Mile Creek. Individual trout ranged from 10-18 inches in total length. Brown trout collected had a silvery appearance and lacked the red spots normally exhibited in wild-reproducing trout inhabiting mountainous freestone streams and limestone streams in Pennsylvania. We surmise these individuals collected were from a small summer lake run brown trout migration that occurs in the Lake Erie tributaries. As mentioned earlier, the state record brown trout in Pennsylvania was caught in July at the mouth of Walnut Creek.

Lake Run Brown Trout collected from Walnut Creek

A resident wild-reproducing brown trout fishery, however, does exist in Bear Run. Bear Run was sampled at station 22BR on June 23 and December 12, 2006. No brown trout were collected during the June 23rd survey. However, the Pennsylvania Fish and Boat Commission have documented that wild-reproducing brown trout populations traditionally occurred in Bear Run (Johns, personal communications, July 20, 2006). Therefore, a re-survey of the brown trout fishery was conducted on December 12, 2006. A total of seven brown trout were collected in a 300-meter section. Brown trout ranged from 84 to 267 millimeters (3.3-10.5 inches) in length, indicating at least two different age classes and a naturally reproducing population.

Wild-Reproducing Brown Trout collected from Bear Run (267 millimeters).

Naturally reproducing (wild) steelhead trout were collected at six of the 19 Walnut Creek watershed stations and all three-reference stations. Stream-bred steelhead were defined as an individual less than 100-millimeters (4-inches) in length. Stations where naturally occurring populations existed include: 14UNT, 15UNT, 19TR, 22BR, 23WC, 24WC, 25TM, 26EC and 27GR. The number of individuals collected per station reach ranged from two at 15UNT to 138 at 25TM. Wild steelhead ranged in size from 35 to 80 millimeters (1.4-3.1 inches) in length.

Wild-Reproducing Rainbow Trout collected from Thomas Run (51 millimeters).

Steelhead smolts stocked by the PFBC were collected at 12 stations, including all reference stations. Smolts ranged in size from 111 to 282 millimeters (4.4-11.1 inches) in length. A breakdown of the length-frequency distribution of wild steelhead in percentages can be found in Chart 1. Length-weight regressions are tabulated in Chart 2.

Rainbow trout (steelhead) smolt collected from Walnut Creek (158 millimeters).

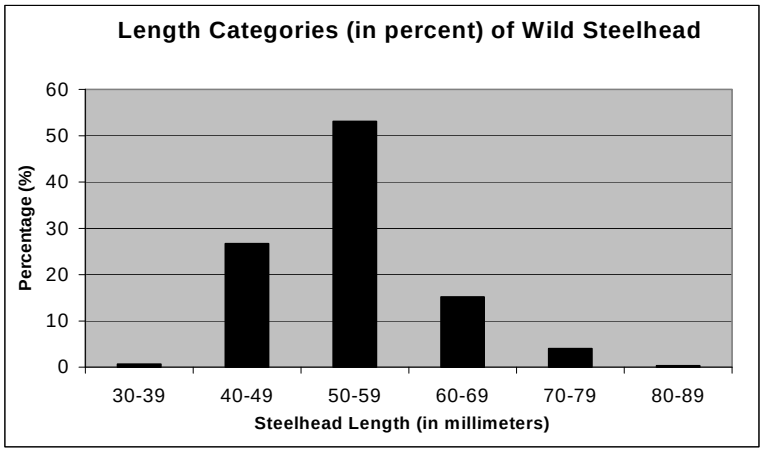


Chart 1. Length categories in percent (%) of wild steelhead collected in the Walnut Creek Watershed in 2006.

From the regression table, it is evident that there are two distinct size classes of fish. Steelhead less than 80 millimeters in length were considered stream bred while those greater than 111 millimeters were considered stocked fish. However, during the re-sampling of Bear Run (22BR) on December 12, 2006, a total of 26 steelhead were collected. The size of these individuals ranged from 85 to 168 millimeters (3.3-6.6 inches) in length. Because of their appearance, size and date of collection, these fish are believed to have occurred from natural reproduction.

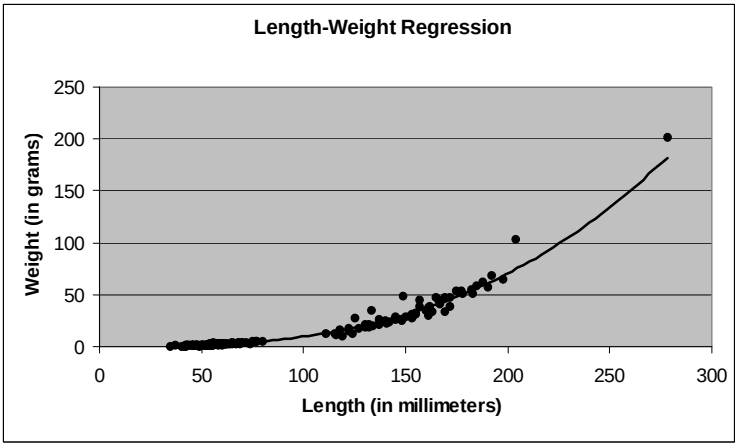


Chart 2. Length-weight regression in wild steelhead and hatchery raised smolts collected in the Walnut Creek Watershed in 2006.

Wild-Reproducing Rainbow Trout (steelhead) collected from Bear Run (130 millimeters).

In general, fish diversity and abundance of Walnut Creek was comparable to Elk and Twenty-Mile Creeks. Some differences exist when comparing Goodban Run to tributary streams of Walnut Creek. Headwater stations contained significantly lower number of fish species than downstream stations. No fish were collected at two stations, 9UNT and 20UNT.

4.4 Physical Habitat Evaluation

4.4.1 Introduction

Physical habitat assessments were conducted at all stations where macroinvertebrate collections were performed. Stations 1WC, 2WC, 7WC, 9UNT, 12UNT, 14UNT, 17TR, 18TRUNT, 19TR, 20UNT and 22BR were compared to the reference station 27GR (Table 9). Stations 8WC, 11WC, 13WC, 16WC, 21WC, 23WC and 24WC were compared to reference stations 25TM and 26EC (Table 10).

The habitat assessment is a visual rating of twelve parameters. Each parameter is scored as excellent (20-16), good (15-11), fair (10-6) or poor (5-0) by receiving a numeric value ranging from 20-0 for a total possible score of 240. Ratings are based on descriptive language of each parameter presented in Barbour et.al. (1999). Total habitat scores were evaluated and compared for each station. Habitat parameters used for riffle/run prevalent streams include: instream cover, epifaunal substrate, embeddedness, velocity/depth regimes, channel alterations, sediment deposits, frequency of riffles, channel flow status, condition of banks, bank vegetative protection, vegetative disruptive pressure, and riparian vegetative zone width.

After all parameters are evaluated, the twelve scores are summed and a total habitat score is derived for each station. Total scores in the "optimal" category range from 240-192, "sub-optimal" 180-132, "marginal" 120-72 and "poor" is 60 or less. The decision gaps between these categories are left to the discretion of the field investigator as to which generic category they would fall into. In addition, a percent comparability evaluation for each station was compared to the appropriate reference station by using the following table taken from Plafkin et.al (1989):

Assessment Category	**Percent of Comparability**
Comparable to Reference	>90%
Supporting	75-88%
Partially Supporting	60-73%
Non-Supporting	<58%

Substrate type was visually evaluated at each station and percentages of bedrock, boulder, cobble, gravel, sand and silt were tabulated (Table 11).

4.4.2 Physical Habitat Results and Discussion

Overall habitat scores for the three reference stations 27GR, 26EC and 25TM were 175, 164 and 162, respectively. Reference station habitat ratings all scored in the "sub-optimal" category. Total habitat scores in the Walnut Creek watershed ranged from a high of 193 at station 14UNT (optimal rating) to a low of 66 at station 12UNT (poor rating). A total of fourteen stations had overall habitat ratings in the "sub-optimal" category, one station in the "optimal" category, two in the "marginal" category and one in the "poor" category. When compared to the appropriate reference station and using the table from Plafkin et.al. (1989), twelve stations rated "comparable" to the reference station by having a percent comparability of over 90%. Four stations were rated as "supporting" by having a percent comparability between 75-88%. One station each was rated as "partially supporting" and "non-supporting" having a percent comparability between 60-73% and less than 58%, respectively. Four stations, 14UNT,

18TRUNT, 22BR and 16WC, had percent comparability scores greater than 100% and total habitat scores higher than their respective reference station.

Walnut Creek sampling location 14UNT

Walnut Creek sampling location 16WC

Individual habitat parameters show that eleven out of eighteen stations in the Walnut Creek watershed scored in the "marginal" and "poor" categories for condition of banks. Six stations each scored in the "marginal" and "poor" categories for epifaunal substrate and riparian vegetative zone width.

Substrate types in the headwaters of Walnut Creek are dominated by cobble/gravel habitats (45-65%). However, as you move downstream, the stream channel changes and is comprised mainly of bedrock (25-50%) and more characteristic of aquatic systems that drain into Lake Erie. Sand and silt also account for a large percentage of substrate type and ranged from 20-40% of the visual substrate. Lesser amounts of sand and silt were found as you moved downstream and visual observations indicate extensive deposits found among the interstitial spaces of larger particles. This caused a high degree of embeddedness of the available cobble and gravel at many stations. Visual observations also indicate large-scale substrate movement and stream channel alterations during peak flow events. The references stations, 25TM and 27GR, had the lowest amounts of combined sand and silt and were only 15% and 17% of the visible substrate, respectively.

In addition to the physical habitat assessment, the study included a Stream Corridor Assessment, whereby the stream was literally walked and potential environmental problems were documented. Noted were stream encroachments, hydromodifcations, accelerated erosion, sedimentation and lack of riparian buffer. The results of the Stream Corridor Assessment are incorporated in this report as a separate section.

The observations collected during the Stream Corridor Assessment add to, and support, the conclusions of the Physical Habitat Evaluation**.**

4.5 Surface Water Monitoring

4.5.1 Introduction

The quality of surface waters play an important role in defining the types of aquatic life, including bugs and fish, that are present in waterways. Water quality can be affected by both point-source and non-point sources of pollution. Point-sources of pollution can usually be detected through surface water sampling and typically have distinct differences within the water quality above and below the actual discharge point. The origins of non-point sources of pollution are harder to determine and can sometimes be tough to detect through water sampling alone. Surface water sampling, therefore, is used in conjunction with biological surveys to assess the overall health and diversity of a watershed. Water sampling can also aid in identifying the sources and causes of aquatic life use impairment or degradation if they are still unknown after the biological sampling data has been analyzed.

Throughout the entire watershed, many potential non-point sources of pollution are present which pose a threat to its associated aquatic life. In support of the biological surveys conducted within the watershed, surface water sampling locations were established at every macroinvertebrate collection station and various other locations to bracket potential pollution sources.

Twenty-four water sampling locations were established within the Walnut Creek Watershed, including eleven locations on the main stem and thirteen locations on tributaries (Map 5). Three reference waterways, Twenty Mile Creek, Elk Creek and Goodban Run, were sampled for comparative purposes (Maps 2 & 3). Surface water samples were collected during both a warm-water and cold-water time period. Within these respective temperature regimes, samples were collected at a point during a low flow and high flow period. The low flow samples were collected after extended periods of dry weather and the high flow samples were collected shortly after heavy rain events to capture the “first-flush” and/ or while the water levels were rising.

Walnut Creek (24WC) during low-flow period

Walnut Creek (24WC) during high flow period

The low-flow, cold samples were collected on May 2, 2006. The high-flow, cold samples were collected on May 11th and May 18th 2006. Two of the high-flow cold samples were collected on a different day due to time restraints and obtaining the samples while the stream flow was rising. The total rainfall amounts for May 11th and May 18th were 0.74 inches and 1.03 inches, respectively.

The reference low-flow, warm samples were collected on August 14, 2006. The Walnut Creek watershed low-flow, warm samples were collected on September 11th, 2006. High-flow, warm samples, from all waterways, were collected on August 29, 2006. The total rainfall amount for August 29th was 1.23 inches of rain.

4.5.2 Surface Water Monitoring Methods

Surface water samples were collected for laboratory analysis from mid-stream and mid-depth at each sampling location. The samples were collected in accordance with standard sampling protocols, fixed as needed and shipped on ice via overnight courier to the PA DEP Bureau of Laboratories in Harrisburg for analysis. Each sample was analyzed using the Standard Analysis Code (SAC) 035. In addition to the 29 individual parameters specified by SAC 035, the following parameters were also collected for each sample: pH, specific conductance and fecal coliform counts. Oil & grease samples were collected from nine sampling locations.

Water chemistry parameters, pH, dissolved oxygen, temperature, and conductivity, were also evaluated in the field using a YSI 556 multi-parameter meter. The meter was calibrated according to manufacturer specifications before each use. Due to the rising stream flows and inherent hazardous conditions during high flow events, field water chemistry readings were collected during the low-flow sampling events only.

4.5.3 Surface Water Monitoring Results

Low-Flow, Cold Water Sampling

The dissolved oxygen concentrations collected during field chemistry sampling were all within expected ranges. The water clarity at all sampling locations was clear at the time of sample collection. The water samples collected for laboratory analysis during this low-flow, cold-water sampling event indicated the following (Table 12):

- Fecal coliform levels were elevated above 200 colonies/ 100 ml at 14UNT and 17TR;
- pH values were fairly consistent throughout the watershed and ranged from 7.5 units at 27GR to 8.5 units at 17TR, 18TRUNT and 19TR;
- Alkalinity values ranged from 34 mg/L at 27GR to 271 mg/L at 10UNT;
- Sulfate levels were elevated above 90 mg/L at sampling locations 3UNT and 9UNT;
- Total Suspended Solids at sampling locations 4UNT and 6WC were elevated above 25 mg/L;
- Total nitrogen concentrations were elevated above 1 mg/L at 10UNT and 20UNT;
- Specific conductance levels were elevated above 900 umhos/cm at 4UNT, 9UNT, 10UNT, 12UNT and 20UNT;
- Chloride concentrations were above 200 mg/L at 4UNT, 9UNT and 10UNT;
- The turbidity level was above 15 NTU at 6WC;

- Total iron concentrations ranged from 22 ug/L at 25TM to 1413 ug/L at 10UNT;
- Total aluminum concentrations ranged from non-detect levels at 23 stations to 380 ug/L at 10UNT;
- Total manganese concentrations ranged from non-detect levels at 9 stations to 273 ug/L at 10UNT;
- The only measurable total lead readings were collected from 4UNT and 10UNT, 1.1 ug/L and 2.5 ug/L, respectively;
- The only measurable total zinc reading, 29 ug/L, was collected from 10UNT;
- Oil & grease samples, taken at nine sampling locations only, indicated two detectable readings at 9UNT and 11WC, 7.2 and 5.1, respectively

High-Flow, Cold Water Sampling

During the high water sampling event, visual observations of water clarity showed discolored to turbid / muddy water conditions at 20 sampling locations. The water clarity at two sampling locations, 9UNT and 10UNT, was a silver-grayish color. Two locations, 22BR and 25TM, were clear and three locations, 8WC, 17TR and 27GR, were off-color but were not muddy even after heavy rainfall blanketed the Erie County area.

The high flow water sampling data indicate dramatic fluctuations within parameter concentrations when compared to the low flow water sampling data (Table 12): These fluctuations along with other data analysis collected during the high-flow, cold water sampling event are as follows:

- Fecal coliform levels increased at all locations, including the reference locations, and range from 180 colonies/ 100mL at 25TM to 43000 colonies/ 100 mL at 4UNT;
- pH values were still fairly consistent throughout the watershed and ranged from 7.1 units at 10UNT to 8.2 units at 22BR, 24WC and 25TM;
- Sulfate concentrations were elevated at 3UNT;
- Suspended solids increase at all sampling locations except for two of the reference locations, 25TM and 27GR;
- The total nitrogen, total organic carbon and ammonia concentrations increased at all sampling locations, including the reference locations;
- The specific conductance and chloride concentration decrease significantly at 9UNT and 10UNT;
- The biological oxygen demand levels increase at all sampling locations, including the reference locations;
- Turbidity levels increased considerably at all sampling locations except for the reference location 25TM;
- Total iron concentrations increased at all locations and ranged from 48 ug/L at 25TM to 58600 ug/L at 20UNT;
- Total aluminum increased at all locations except for 22BR and 25TM, where the concentrations remained non-detectable. The highest level of total aluminum, 26400 ug/L, was found at 18TRUNT;
- Total manganese increased at all locations except for 25TM where it remained non-detectable and 10UNT where the concentration lowered. The highest concentration of 1059 ug/L was found at 18TRUNT;

- Total lead readings increased at all locations except 22BR, 24WC, 25TM and 27GR where it remained non-detectable. The highest level of 93.2 ug/L was found at 18TRUNT;
- Total zinc readings increased at all locations except 22BR, 23WC, 24WC, 25TM, 26EC and 27GR where it remained at non-detectable levels. The highest level of 186 ug/L was found at 20UNT;
- No detectable Oil & Grease readings were found at any of the nine sampling locations where this parameter was analyzed.

Low-Flow, Warm Water Sampling

The dissolved oxygen concentrations collected during field chemistry sampling were all within expected ranges except for sampling location 5UNT. The dissolved oxygen concentration at 5UNT was 3.59 mg/L or 66.7%. The water clarity at all sampling locations was clear at the time of sample collection. The water samples collected for laboratory analysis during this low-flow, warm water sampling event indicated the following (Table 13):

- Measurable levels of fecal coliforms were detected at all locations except for 25TM where it was non-detectable. Fifteen locations had levels above 200 colonies/100 mL;
- pH values ranged from 7.4 units at 5UNT to 8.7 units at 8WC;
- Alkalinity concentrations ranged from 57 mg/L at 27GR to 251 mg/L at 15UNT;
- Sulfate levels were elevated at 3UNT and 10UNT, 105 mg/L and 155 mg/L, respectively;
- Total suspended solids were slightly elevated at 27GR, 22 mg/L, and relatively low at all other sampling locations;
- Total nitrogen concentrations were elevated above 1 mg/L at 9UNT, 20UNT and 27GR
- Specific conductance levels were elevated above 900 umhos/cm at 9UNT, 10UNT, 12UNT and 20UNT;
- Chloride levels were above 200 mg/L at 9UNT, 10UNT and 12UNT;
- The highest turbidity value, 11.23 NTU, was found at 6WC;
- Total iron concentrations ranged from non-detectable levels at 11WC and 25TM to 2680 ug/L at 4UNT;
- The highest total aluminum concentration was found at 4UNT and had a concentration of 1320 ug/L;
- Total manganese concentrations ranged from non-detectable levels at 11 stations to 505 ug/L at 5UNT;
- The only measurable lead readings, 3 ug/L and 1.2 ug/L, were found at 4UNT and 6WC, respectively;
- Seven measurable zinc readings were noted with the highest concentration of 25 ug/L found at 17TR;
- Nine oil & grease samples were submitted for analysis with no detectable readings found at any sampling location.

High-Flow, Warm Water Sampling

Once again, the high flow water sampling data indicate dramatic fluctuations within parameter concentrations when compared to the low flow water sampling data (Table 13): These fluctuations along with other data analysis collected during the high-flow, warm water sampling event are as follows:

- Fecal coliform levels increased dramatically at all locations and ranged from 500 colonies/ 100 mL at 10UNT to 54000 colonies/ 100 mL at 26EC;
- As with the other sampling events, pH remained fairly consistent throughout all sampling stations;
- Sulfate concentrations were elevated at 3UNT and 10UNT;
- Total suspended solids varied among all sampling locations. Twenty-two sampling locations had an increase in concentration and five sampling locations remained near low-flow sampling concentrations;
- Total nitrogen and total organic carbon levels increased at all sampling locations, except for 4UNT, 9UNT and 20UNT where levels remain constant;
- Specific conductance values decreased at all sampling locations;
- Chloride concentrations decreased at all locations except for 1WC and 26EC, where they increased slightly;
- The biological oxygen demand levels increase at all sampling locations except 15UNT and 16WC;
- Turbidity values increases drastically at all locations except for 10UNT;
- Total iron concentrations increased at all locations and ranged from 230 ug/L at 2WC to 14100 ug/L at 23WC;
- Total aluminum concentrations increased at all locations except for 2WC, 9UNT and 10UNT where it remained at non-detectable levels; The highest concentration, 6912 ug/L, was found at 24WC;
- Four locations, 3UNT, 4UNT, 7WC and 8WC, had detectable total chromium concentrations with levels of 5.2 ug/L, 8.1 ug/L, 4.9 ug/L, and 4.4 ug/L, respectively;
- Total manganese concentrations increased at 19 sampling locations with the highest level, 494 ug/L, found at 23WC;
- Total lead concentrations increased at 21 locations with the highest level of 12.8 ug/L found at 24WC;
- Total zinc concentrations increased at 23 locations with the highest level, 69 ug/L, found at 23WC;
- Nine oil & grease samples were submitted for analysis with no detectable readings found at any sampling location.

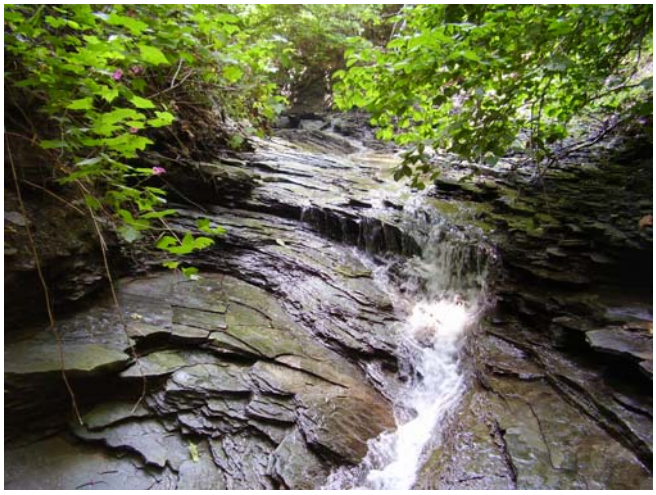
4.5.4 Surface Water Monitoring Discussion

The surface water quality within the Walnut Creek watershed appears to be negatively impacted by stormwater runoff. After rain events and as stream flows begin to increase, the concentration of pollutants entering the surface waters of the Walnut Creek watershed also begin to increase. Metals and fecal coliform concentrations and turbidity values increased significantly after rain events at most water sampling locations. Only two detectable oil & grease concentrations were found during water sampling. These were found during the low-flow, cold sampling event. Impacts stemming from point sources of pollution, however, were not as apparent.

Sampling data from stations 4UNT, 6WC, 9UNT, 10UNT and 20UNT indicate elevated pollutant concentrations during both the low-flow and high-flow sampling events. Possible non-point source contributors of pollutants are encompassed within or adjacent to these sampling locations.

Walnut Creek sampling location 4 UNT

Erosion and Sedimentation / active development upstream of 6WC.



Tributary 9UNT during low flow period

9UNT during high flow period

Potential non-point sources of pollution include, but are not limited to the following: urban and residential runoff, a permitted landfill, transportation routes, agricultural areas and other completed or ongoing commercial development. All of these sources contain enormous amounts of impervious area that create the potential for stormwater runoff, and subsequently, the capacity to impact nearby surface water quality.

The reference water sampling locations experience the same water quality trends and fluctuations as the sampling locations within the Walnut Creek watershed. Because of this, direct comparisons could not be made between the trends within the reference waterways and the Walnut Creek watershed. With this in mind, the chemical sampling within the watershed should be used in conjunction with the biological and physical assessments to make a determination of the overall health and diversity of the watershed.

Due to the cumulative impacts from non-point sources, stream use attainment is in question within numerous sections of the Walnut Creek main stem and several of its associated tributaries. Previous stream assessments conducted during 2001 documented stream use impairments within three tributaries of Walnut Creek, as noted previously in the report. These cursory assessments used a rapid biological assessment procedure and only identified the most severe impairments. These impairments are listed in the 2006 Pennsylvania Integrated Water Quality Monitoring and Assessment Report with the specific cause for impairment as siltation.

Stormwater basin discharge (10UNT)

Because of the more intensive sampling protocols that were used during this particular watershed assessment, it is expected that additional stream use impairments will be documented. Stream use attainment could not be determined because the data analysis / stream use attainment portion of the sampling protocol had not been finalized. Once this portion of the protocol has been finalized, the assessment data will be analyzed and any additional stream use impairments will be documented and included within the next Pennsylvania Integrated Water Quality Monitoring and Assessment Report.

4.6 Stream Assessment Summary

In general, Walnut Creek can be characterized as a medium-sized stream with substrate typically dominated by bedrock. The stream corridor is generally forested and adequately buffered from human encroachment; however, anthropogenic activity throughout the watershed is extensive. Land-use surveys provided by Pennsylvania SeaGrant--Lake Erie Office, based on information from the Erie County Department of Planning, indicates the watershed is approximately 38.04 square miles or 24,352 acres, is 11.28% agricultural, 3.73% commercial, 2.42% industrial, 21.47% low-density residential, 1.18% medium-density residential, 56.69% open-wooded and 3.23% public/institutional. From these percentages, it can be assumed that greater than 10% of the Walnut Creek drainage is currently covered by impervious areas.

Impervious surfaces are mostly impenetrable by water, thereby limiting normal infiltration and retention properties. This creates stormwater run-off during rain events at accelerated rates. Examples of impervious surfaces include roads, parking lots and rooftops. Research has suggested that the amount of impervious surface has been regarded as an important indicator in assessing assumed environmental degradation (Arnold and Gibbons, 1996). The Stormwater Managers Resource Center, or SMRC, (http://www.stormwatercenter.net) reviewed key findings of several studies correlating the relationship of urbanization to aquatic ecosystem impacts. This summary of stream research generally indicates that at small percentages of impervious cover within a watershed, declines in macroinvertebrate diversity start to become significant. In fact, many studies indicate that watersheds with greater than 10% impervious area, stream habitat and macroinvertebrate communities can decline significantly (Booth and Jackson, 1997; Fitzpatrick

et.al., 2004). When the amount of imperviousness in a watershed increases to over 25%, stream impacts become severe.

Walnut Creek is currently experiencing many of the hydrologic effects of urbanization. During rain events, stormwater from impervious areas create peak flows that appear to be abnormally accelerated. Peak flows during this "first flush" wash many pollutants, including nitrogen, phosphorus, zinc, lead, aluminum, iron and many others into drains, ditches, tributaries and eventually the main stem of Walnut Creek and Lake Erie. Increased and accelerated peak flows during stormwater events decrease bank stability leading to increased erosion, sedimentation and substrate scouring.

Figure 60. Development – located at the headwaters of 15UNT

Sediment from exposed surfaces during development are also picked up from stormwater and carried downstream, causing an increase in suspended solids and embeddedness of stream substrate. As stream flows subside quickly, silt and clay are deposited into the interstitial spaces in the streambed, decreasing habitat for macroinvertebrates and fish. Lack of stream bank cover from loss of riparian habitat causes an increase in ambient water temperatures Nitrogen and phosphorus inputs accelerated by increased stream temperatures create an increase in algal production.

Active development at the headwaters of 20UNT

Stormwater Runoff from development upstream of 6WC

Sedimentation causing substrate embeddedness (21WC)

Nutrient Enrichment (20UNT)

The Urban Streams Classification Model (www.stormwatercenter.net) divides the percent impervious cover into three categories: sensitive (<10%), impacted (10-25%) and non-supporting (>25%). Currently, the Walnut Creek watershed is assumed to be above the 10% threshold and further future development is projected. During this survey, the aquatic macroinvertebrate community, fish community, habitat composition and chemistry of the surface waters of Walnut Creek and its tributaries were examined extensively. When combined, analyzed as a whole and compared to other watersheds in the Lake Erie drainage, the Walnut Creek drainage did not compare favorably. Walnut Creek has been regarded as having one of the better steelhead runs of any Lake Erie tributary. Future impacts in the watershed, as the percent impervious area inches closer to the 25% threshold, will undoubtedly cause further degradation of the fishery and aquatic macroinvertebrate communities. A serious commitment by county, township and municipal entities in the Walnut Creek basin are needed to better manage further development and provide for control of the quantity and quality of stormwater runoff in the watershed.

4.7 Natural Diversity

A search under the Pennsylvania Natural Diversity Inventory (PNDI) systems reveals that sensitive species under the jurisdictions of the Pennsylvania Department of Conservation and Natural Resources, the Pennsylvania Fish and Boat Commission and the Pennsylvania Game Commission exist within the Walnut Creek watershed. These species may include plants, fish, amphibians, reptiles and/or mammals. There are multiple areas within the watershed where rare, threatened or endangered species exist. Because of the sensitive nature, neither the species names nor the locations are disclosed in this report.

4.8 Wetlands Inventory

The Walnut Creek watershed contains numerous wetlands. Although there is no data source that lists every wetland within the watershed, a review of permitted projects in conjunction with data obtained from the U.S. Fish and Wildlife Service's National Wetland Inventory maps can provide an idea of the acreage and types of wetlands in the watershed.

Wetlands are located throughout the Walnut Creek watershed and are typically one of three types of wetlands. Emergent wetlands, also known as wet meadows, are characterized by grassy vegetation, flowers and ferns. Scrub-shrub wetlands contain smaller woody plants such as dogwood and willow. Forested wetlands are characterized by a majority of trees that may include oaks, maples and willows.

Emergent wetland.
Photo courtesy of USDA Natural Resources Conservation Service

Forested wetland

Wetlands provide important ecological functions. Numerous organisms including many threatened and endangered species utilize wetlands as their habitat. Wetlands also act as filters by removing pollutants and sediments from the watershed. Acting like giant sponges, wetlands retain large amounts of stormwater and help to prevent flooding. They also provide groundwater recharge.
Projects involving wetland (and stream) impacts require state and federal permits. DEP is the issuing agency for state permits under the authority of Chapter 105 Dam Safety and Waterway Management regulations.

Multiple permits have been issued in the Walnut Creek watershed that contain both wetland and stream impacts. A review of the state Chapter 105 permits reveals that approximately 30 acres of wetlands in the Walnut Creek watershed have been impacted by development. Impacts to wetland and streams require mitigation and the typical wetland mitigation plan consists of the creation of replacement wetlands. Of the 30 acres of wetland impacts in the Walnut Creek watershed, 20 acres were replaced within the watershed. One of the largest projects, the Millcreek Mall, was permitted to replace wetlands in another watershed (Conneaut Creek) accounting for a significant loss of wetlands in the Walnut Creek watershed. Some permits also included stream impacts totaling 25,000 linear feet. A summary of the wetland impacts, wetland replacements, stream impacts, and (where known) total wetlands on the project site is as follows:

Great Blue Heron.
Photo by Tim McCabe, USDA Natural Resources Conservation Service.

Permit E25-470 Millcreek Mall and E25-562 Millcreek Mall Pavilion, Millcreek Township

Wetland impacts: 14.49 acres
Wetland replacement: 16.01 acres replaced within Conneaut Creek watershed

Permit E25-517, Lakeview Landfill Expansion, Summit Township

Wetland impacts: 1.39 acres
Wetland replacement: 1.60 acres

Permit E25-527 Bush Industries, Summit Township

Wetland impacts: 2.1 acres
Wetland replacement: 3.8 acres

Permit E25-538 Wegmans, Millcreek Township

Wetland impacts: 0.37 acres
Wetland replacement: 0.4 acres
Total wetlands on site: 3.55 acres
Stream relocation: 1,940 linear feet UNT Walnut Creek
Channel loss: 1,250 linear feet UNT Walnut Creek

Permit E25-544 Niagara Village Subdivision, Millcreek Township

Wetland impacts: 1.22 acres
Wetland replacement: 1.84 acres
Total wetlands on site: 3.19 acres

Permit E25-666 Presque Isle Downs, Summit Township

Wetland impacts: 8.61 acres
Wetland replacement: 10.56 acres
Stream impacts: 11,808 linear feet UNT Walnut Creek
Stream relocation: 1,576 linear feet UNT Walnut Creek

Permit E25-668 Lakeview Landfill, Greene and Summit Townships

Wetland impacts: 2.61 acres
Wetland replacement: 3.47 acres
Stream impacts: 4,941 linear feet UNT Walnut Creek
Stream relocation: 3,390 linear feet UNT Walnut Creek

Permit E25-681 Whispering Woods Estates, Millcreek Township

Wetland impacts: 0.049 acres (deminimus impact, so no replacement required)
Wetland replacement: 0 acres
Total wetlands on site: 8.07 acres
Stream length on site: 32,452 linear feet
Stream impacts: 6,885 linear feet

Permit E25-699: Limited Express Hotel, Summit Township

Wetland impacts: 0.042 acres (deminimus impact, so no replacement required)

It is probable that other wetland impacts have occurred in the Walnut Creek watershed through unpermitted activities, so this summary in no way characterizes all of the wetland impacts in the

watershed. General permits, which are usually issued by the Erie County Conservation District, were not reviewed in this summary.

Compliance with 105 permits is typically handled on a complaint basis. Complaint response involves technical advise by the conservation district, any further enforcement is handled by the Department.

The loss of wetlands from the Walnut Creek watershed has most likely had a detrimental impact. In a watershed where stormwater runoff is a significant problem, the loss of wetlands, which function in stormwater retention, only amplifies the problem. Future impacts to wetlands in the watershed should be avoided as much as possible and if impacts are permitted, then it is recommended that mitigation remain within the watershed to prevent any further wetland loss.