Total Maximum Daily Loads for Mill Creek (Scioto River Basin)

Final Report

prepared by

Ohio Environmental Protection Agency
Division of Surface Water

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The TMDL in Brief

Basin:
Mill Creek in the Scioto River Basin
Study Area:
Mill Creek headwaters to confluence with the Scioto River, selected tributaries.
Goal:
Attainment of the appropriate Aquatic Life Use
Major Causes:
Organic enrichment, low dissolved oxygen, habitat alteration.
Major Sources:
Municipal and industrial point source discharges, urban and agricultural runoff and habitat alteration.
Measure:
Dissolved oxygen, ammonia, phosphorus as well as biological and habitat indices
Restoration Options:
Point source controls, habitat protection and restoration, septic system improvements, urban runoff controls and public education.

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ACKNOWLEDGMENTS

A key aspect of the project involved public participation and coordination at the local level. Chad Meenach and Keri Hudec, the watershed coordinators for Mill and Bokes Creek, were invaluable in communicating the goals of the TMDL project to local stakeholders and in the formation of the Bokes/Mill Creek Watershed Partnership The Partnership, under the leadership of Ryan Lee, is commended for its patience and commitment and is recognized for the significant contributions the group made to this process.

Acknowledgment is also made to the property owners that allowed Ohio EPA personnel access to the Mill Creek and its tributaries.

The following Ohio EPA staff provided technical analyses for this project:

Biology and Chemical Water Quality	-	Jack Freda, Paul Vandermeer
Nonpoint Source Issues	-	Vince Mazeika
Point Source Issues	-	Mike Sapp, Jeff Bohne
Project Leader	-	Mike Gallaway
Modeling	-	Chris Selbe

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Many full- and part-time staff participated in field monitoring. Chemistry analyses were provided by the Ohio EPA Division of Environmental Services.

EXECUTIVE SUMMARY

The Mill Creek watershed encompasses 178 square miles in Logan, Union and Delaware Counties. The Mill Creek mainstem flows over 37 miles east southeast from the headwaters originating in Logan County through Union County to its confluence with the Scioto River in Delaware County. Major tributaries included in this assessment include Blues Creek, Town Run, Crosses Run and the North Branch Crosses Run.

The basis for listing portions of Mill Creek and its tributaries on the 1998 303(d) list includes detailed assessments of chemical (water column, effluent, sediment), physical (flows, habitat), and biological (fish and aquatic macroinvertebrate conditions conducted in 1990 and 1995. More recently, biological sampling was conducted along the length of Mill Creek during the summers of 2000 and 2001 following large manure spills and fish kills upstream from Marysville. Results of the 2000 and 2001 surveys are included in this assessment to evaluate the spills and the general trends in biological quality since the earlier surveys. However, greater weight is given to the 1995 data, as it is the most comprehensive evaluation of watershed conditions. Additional biological sampling was also conducted in upper Blues Creek in 2001 to assess the channel modified headwaters and to provide more recent data from the impaired middle reaches of the creek.

The Marysville WWTP (RM 18.26) is the most significant source of impact to chemical water quality and biological community performance in Mill Creek. Impairment in 1995 was primarily related to organic waste loadings and subsequent dissolved oxygen depletion downstream from the plant. Aquatic life use attainment in 1995 was partial (*i.e.*, fair to good quality) immediately upstream and downstream from the Marysville WWTP but declined to non attainment (fair to poor quality) about two miles further at RM 16.8. Nonattainment coincided with the measurement of consistently low dissolved oxygen (D.O.) concentrations and elevated levels of ammonia-N, total phosphorus, and fecal coliform bacteria. Biological communities recovered by RM 14.6 and remained in full attainment except for a slight decline to partial attainment immediately downstream from Crosses Run and The Scotts Company (Scotts) (RMs 11.6/11.7). Chemical and biological sampling in Crosses Run has revealed numerous water quality criteria exceedences and severely degraded biological communities adjacent to and downstream from Scotts. The property has been associated with an extensive fish kill (1987), numerous NPDES permit violations, storm water contamination, slug type discharges of ammonia, and contamination from pesticides and organic compounds. In Mill Creek, biological performance again improved with increased distance downstream. Very good to exceptional quality communities were found from upstream Ostrander to the mouth (RMs 4.4-1.7).

Ohio's Water Quality Standards include numerical biological criteria. These criteria form the basis of the numerical targets for the TMDLs. The success of the implementation actions resulting from the TMDLs will therefore be evaluated by observed improvements in biological scores. Intermediate nutrient targets were identified to complement the biocriteria and to help evaluate the impact of nutrient loadings. These nutrient targets were based on a recent Ohio EPA technical bulletin (OEPA, 1999). Necessary loading reductions for the Mill Creek TMDLs were estimated by comparing the instream 1998

summer concentrations to the desired targets.

The Enhanced Stream Water Quality Model (QUAL2E) was used to predict the instream chemical concentration response to various point source inputs and stream conditions in Mill Creek. QUAL2E has been used extensively for many years and is a USEPA-approved model. It is appropriate for use only with steady, non-variable stream flows. It was used in this project to predict the instream concentration of dissolved oxygen, nitrogen compounds, and phosphorus during low-flow, summer conditions. These conditions are considered very stressful to stream biota, and therefore, allocations of loads need to be protective of this critical state. QUAL2E simulates instream concentrations which can then be compared to water quality criteria to evaluate if violations of these numeric criteria have the potential to occur. Inputs such as point source loads can be adjusted until the predicted instream concentrations meet the water quality criteria. This provides a means of developing the wasteload allocation portion of the TMDL equation.

Technical Release 55 (TR-55) was used as a model to provide a reasonable and scientifically defensible estimation of the storm runoff which impacts Crosses Run and the North Branch Crosses Run from the Scotts facility. TR-55 is a simplified procedure used to calculate the storm runoff volume, peak rate of discharge, flow hydrographs and storage volumes required for storm water management structures in both urban and agricultural areas and at selected points along the stream system. Since the TR-55 model only predicts the runoff flow to the stream from a design storm the Conservative Substance Wasteload Allocation Program (CONSWLA) was used to predict the instream chemical concentration response by automating the allocation of conservative pollutants for multiple-discharger/multiple-stream systems. CONSWLA was used to predict the instream chemical response of NH_3-N, phosphorus and pesticides in the Crosses Run sub-basin.

Blues Creek is not attaining its use designation due primarily to habitat degradation. The Qualitative Habitat Evaluation Index (QHEI) was used to assess and establish habitat restoration goals in the Blues Creek subwatershed. The QHEI is a quantitative composite of six physical habitat variables used to 'score' a stream's habitat. QHEI targets supportive of the appropriate biocriteria have been developed based on statewide and ecoregional reference site data. The analysis of the QHEI provides a framework to develop habitat restoration and improvement strategies.

A stakeholder workgroup, the Bokes/Mill Creek Watershed Partnership, representing a wide variety of interests, areas, and expertise has been assisting the Ohio EPA with this project. The steering committee in conjunction with Ohio EPA will be developing an implementation plan designed to achieve the TMDLs developed in this report during the summer and fall of 2002. The implementation plan will include point source improvements, agricultural and urban runoff control strategies, septic system upgrades, and habitat restoration strategies.

Table 1. Components of the Mill Creek TMDL process	
Study Area	Mill Creek basin: headwaters to Scioto River
1998 303(d) Listed Watersheds ***(see Table 2 for segments)***	050600001 070 Mill Creek (headwaters to Otter Run) 050600001 070 Mill Creek (Otter Run to Scioto River) 050600001 070 Town Run (entire length) 050600001 070 Crosses Run (entire length) 050600001 070 North Branch Crosses Run (entire length) 050600001 070 Blues Creek (entire length) 050600001 070 BMY Tributary (entire length)
Target Identification	Organic enrichment, dissolved oxygen, sediment, and biological and habitat indices.
Applicable Water Quality Criteria	*OAC 3745-1-04* Free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. Free from nutrients entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae. *OAC 3745-1-07* Dissolved oxygen, instantaneous minimum: 4.0 (WWH) or 3.0 (MWH) mg/l 24-hour average: 5.0 (WWH) or 4.0 (MWH) mg/l Ammonia-nitrogen, outside mixing zone maximum: 9.1 (WWH and MWH) (pH 8.0/temp 24.4) 30-day average: 1.0 (WWH and MWH) (pH 8.0/temp 24.4) Ecoregion Biocriteria, refer to Appendix A
Current Deviation from Target	Violations of the 24-hour average and minimum dissolved oxygen criteria have been recorded (lowest average, 2.3 mg/l; lowest instantaneous, 1.67 mg/l). Biological communities fail to achieve biocriteria; refer to Appendix A.
Sources	Municipal treatment plants, industrial sources, urban and agriculture runoff, septic systems, channelization and lack of riparian habitat .
Load Allocation	Refer to Table 11 on page 54
Critical/Season Conditions	The critical condition for low D.O. occurs when water temperatures are high and the stream flow is low. These conditions occur in the summer.
Margin of Safety	Implicit in calculations
Implementation Plan	Will be developed in summer and fall of 2002 The implementation plan will involve point source improvements, agricultural and urban runoff control strategies, septic system upgrades, and habitat restoration strategies. 319 Grant conditions require the preparation of a watershed action plan by the watershed coordinator.
Validation	Tiered approach to validation; assessment progression includes: 1. Confirmation of completion of implementation plan activities 2. Evaluation of attainment of chemical water quality criteria 3. Evaluation of biological attainment
Public Participation	Public information sessions, public notices of report, and a stakeholder group all have contributed to the public participation for this project.

1.0 INTRODUCTION

The 1972 Clean Water Act (CWA) Section 303(d) requires States, Territories, and authorized Tribes to list and prioritize waters for which technology-based treatment limits alone do not ensure attainment of water quality standards. The 303(d) list of impaired waters is made available to the public and submitted to the U.S. Environmental Protection Agency (USEPA) in every even-numbered year (40 CFR 130.7(d) did not require a 303(d) list submittal in the year 2000). The Ohio Environmental Protection Agency (Ohio EPA) identified the Mill Creek watershed as a priority impaired water on the 1998 303(d) list. A summary of the Mill Creek watershed portion of the 1998 303(d) list is included in Table 2. A general overview of Ohio's water quality standards is included in Table 4.

The Clean Water Act and USEPA regulations require that Total Maximum Daily Loads (TMDLs) be developed for all waters on the section 303(d) lists. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards, and an allocation of that amount to the pollutant's sources. The process of formulating TMDLs for specific pollutants is therefore, a method by which impaired water body segments are identified and restoration solutions are developed. Ultimately, the goal of Ohio's TMDL process is full attainment of biological and chemical Water Quality Standards (WQS) and, subsequently, delisting of water bodies from the 303(d) list. The Ohio EPA believes that developing TMDLs on a watershed basis (as opposed to solely focusing on impaired segments within a watershed) is an effective approach towards this goal.

This report serves to document the Mill Creek TMDL process and provide for tangible actions to restore and maintain this water body. The main objectives of the report are to: describe the water quality and habitat condition of Mill Creek and to quantitatively assess the factors affecting non or partial attainment of WQS. The report is organized in sections forming the progression of the TMDL process.

The primary causes of impairment in the Mill Creek watershed are organic enrichment and low instream dissolved oxygen attributable to point source discharges and habitat degradation in some tributaries to Mill Creek. TMDLs were calculated for $CBOD_5$ and ammonia-N in order to provide for increased dissolved oxygen in Mill Creek. Habitat degradation and dissolved oxygen depletion are not load based quantities; however, the regulations provide for these types of impairing causes and 'TMDL' numbers were calculated for these as well.

Table 2. Summary of the 1998 303(d) listing included in this report

Waterbody Segment Description	303(d) status		Major causes 303(d)	Included in this report? [3]	Comments
	1998[1]	2002[1]			
050600001 070	Mill Creek (headwaters to Scioto River)				Impairment Rank[2] 8
Mill Creek (headwaters to Otter Run) [OH 35 9]			Not Listed	☺	Full attainment of water quality standards based on the 1995 Mill Creek assessment
Mill Creek (Otter Run to Scioto River) [OH 35 1]	✓	✓	Organic Enrichment/ Dissolved Oxygen	✓	Revised point source allocations for oxygen demanding substance. Renewal of Marysville WWTP permit with revised limits for ammonia, $CBOD_5$ and D.O.
	✓	✓	Metals	No	Upstream Sources in Marysville have been substantially reduced (e.g. Eljer landfill, Ray Lewis, BMY Corp.)
	✓		Priority Organics	✓	Highest concentrations generally limited to tributaries (Town Run, Crosses Run sediments). Habitat improvements and improved stormwater management to mitigate pollutant inputs.
		✓	Unknown Toxicity	✓	Marysville WWTP toxicity limits in NPDES permit will be protective for chronic toxicity
		✓	Ammonia	✓	Included in point source allocations
Town Run (Entire length) [OH 35 1]	✓	✓	Unknown Toxicity	✓	Culverted area near mouth
	✓	✓	Habitat alteration	✓	Culverted area near mouth
	✓	✓	Metals	✓	Eljer landfill site (remediated and capped)
	✓	✓	Organic Enrichment /Dissolved Oxygen	No	Failing on-site systems tied into Marysville WWTP
	✓		Oil & Grease	No	Urban culverted area near mouth. Implementation of the Phase 2 Stormwater Program to address urban non-point sources.
Crosses Run (Entire length) [35 8]	✓	✓	Organic Enrichment/ Dissolved Oxygen	✓	Not a load based parameter; allocations included. Activities implemented to meet nutrient and habitat targets will also address this cause.
		✓	Pesticides	✓	Included in point source allocations
	✓		Priority Organics	✓	Included in point source allocations
	✓		Total Toxics	✓	Included in point source allocations
		✓	Ammonia	✓	Included in point source allocations

Table 2. Summary of the 1998 303(d) listing included in this report

Waterbody Segment Description	303(d) status		Major causes 303(d)	Included in this report? [3]	Comments
	1998[1]	2002[1]			
North Branch Crosses Run (Entire length) [OH 35 8.1]		✓	Ammonia	✓	Included in point source allocations
		✓	Pesticides	✓	Included in point source allocations
		✓	Flow Alteration	✓	Not a load based parameter; activities implemented to meet nutrient targets that result in habitat improvements will also address this cause
Blues Creek (Entire length) [OH 35 2]	✓	✓	Habitat Alteration	✓	Not a load based parameter; allocations included
	✓		Organic Enrichment/ Dissolved Oxygen	✓	Activities implemented to meet habitat targets will also address this cause
		✓	Sedimentation	✓	Activities implemented to meet habitat targets will also address this cause. Implementation of BMPs in the modified section will also address this cause.
BMY Tributary* (Entire length) [OH 35 7] * - mistakenly identified as Phelps Run in 1998 list	✓		Habitat Alteration	No	The use designation of this stream has been changed to LRW to more appropriately reflect the aquatic life potential of this small drainageway. This change was subsequent to the data collection used for the 1998 listing.
	✓		Metals	✓	BMY Corp. closed, discharge eliminated

[1] The 1998 303(d) list was based on data collected in 1990; the 1995 data was not available at the time of list development. This report also includes data collected in 1995 and data from 2000 and 2001, which will be included in the 2002 and subsequent 303(d) lists.

[2] The impairment rank is Ohio EPA's prioritization of the various impaired subwatersheds; refer to Ohio EPA's 303(d) list available at: http://www.epa.state.oh.us/dsw/tmdl/303dnotc.html for more information.

[3] QUAL2E was used to calculate point source load reductions for NH_3 and $CBOD_5$ in the Mill Creek mainstem. Alternative models were used in the tributaries to account for causes of impairment stemming from urban runoff, industrial storm water pollution and habitat impairment Low D.O. and altered habitat are not load based causes of impairment. Allocations for factors affecting instream D.O. (TP, NH_3,$CBOD_5$, D.O., shading) and habitat (components of the QHEI scores) are included and are considered to be a parallel concept to a 'TMDL' for load-based parameters.

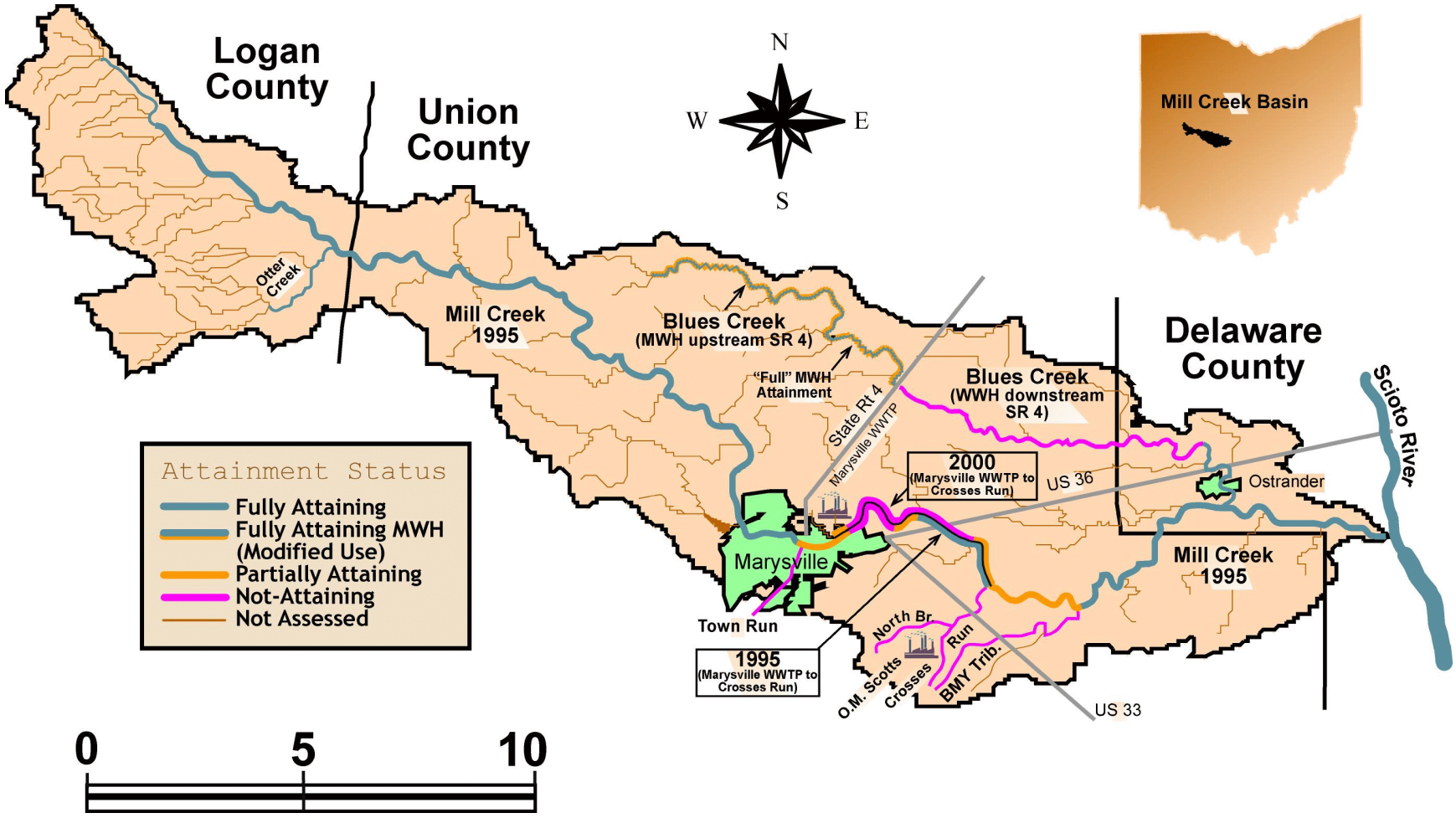


Figure 1. Use attainment map of the Mill Creek watershed

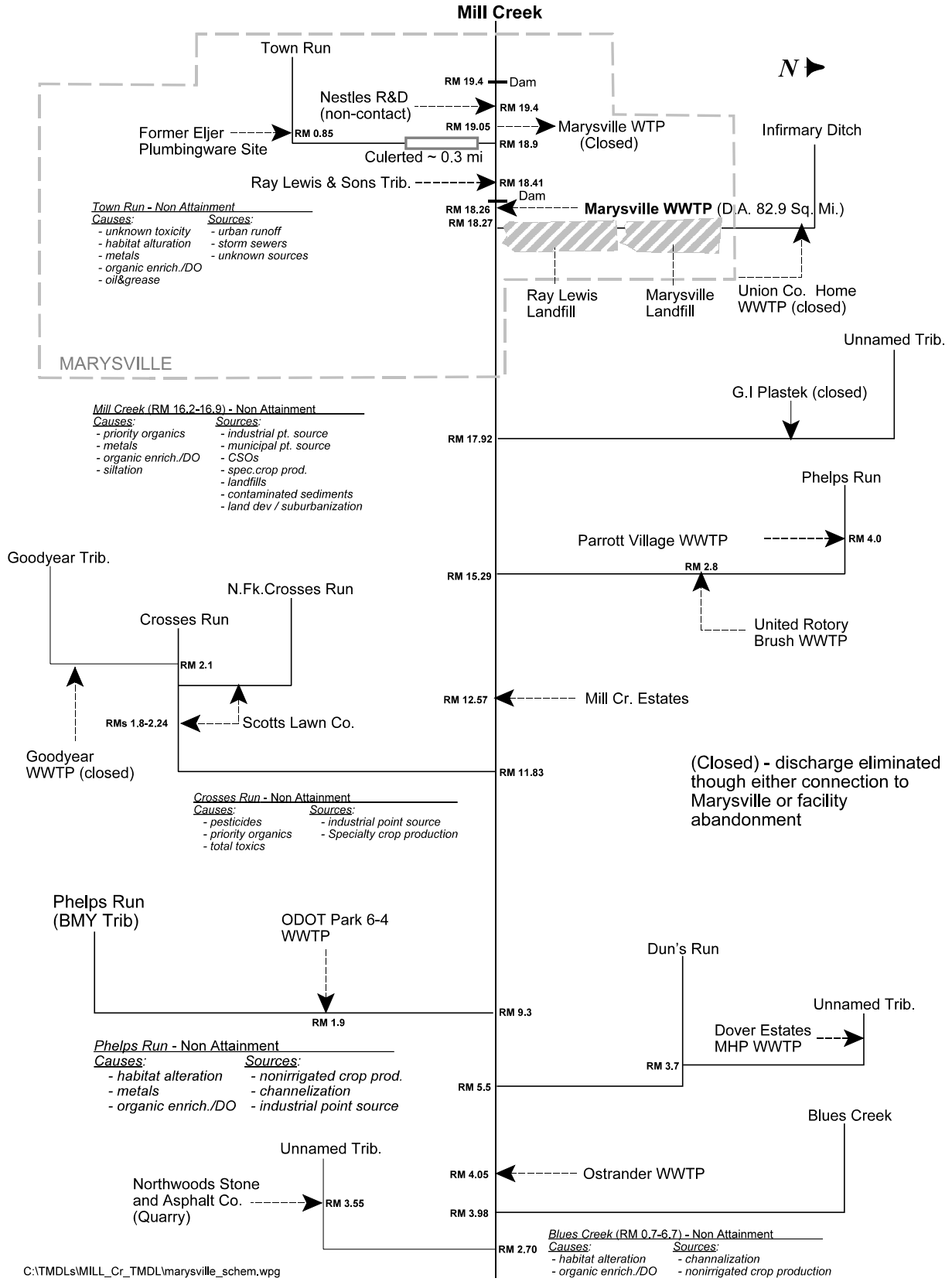


Figure 2. Schematic representation of the Mill Creek watershed

2.0 WATERBODY OVERVIEW

Various aspects of the Mill Creek watershed are described in this chapter along with the water quality condition, based on recent studies.

2.1 Description of the Study Area

The Mill Creek basin drains 178 square miles in Logan, Union and Delaware counties. The headwaters of Mill Creek rise in the Eastern Corn Belt Plains (Omernik, 1988) of West Central Ohio approximately two miles east by south east of Rushsylvania in Logan county. Just east of Walnut Grove the creek crosses the old Greenville Treaty Line (County Road 26) and moves southeast. Passing within a mile of North Greenfield it continues into Union county. Skirting Lunda, Raymond, and Peoria, Mill Creek flows through Marysville then continues east passing New Dover and Watkins. Less than a mile south of Ostrander in Delaware county, it receives Blues Creek, persists eastward then enters the Scioto River at Bellepoint, in view of the US 42 bridge.

Physical Setting

Near the headwaters at County Road 26 and the village of Walnut Creek the bench mark elevation is 1147 feet. The first sample site on Mill Creek (Logan County Road 131) is at 1090 feet. Approximately 20 miles downstream in Marysville, elevation has dropped 120 feet and falls an additional 130 feet upon reaching the mouth at Bellepoint (Table 3;ODNR 1960).

Mill Creek and its tributaries lie within the Central Lowlands physiographic region. The topography of this drainage area strongly reflects glacial deposition. Advancement of the Wisconsin glacier over the sedimentary bedrock was the predominant geologic influence. Ground moraines left nearly level or gently sloping terrain while end moraines show their presence by steeper slopes or a hilly, hummocky aspect. Glacial lake beds provided flats and the meltwater incised the present stream patterns down through the till and drift.

The source of the Mill Creek headwaters is a series of terminal moraines that arc around a "bedrock high" near Bellefontaine in southeastern Logan County. Dolomite and other limestones form the underlying bedrock in the basin. Glacial movement over this base produced calcareous tills and left igneous rocks now found in the substrates of the Mill Creek system.

A glacial lake bed (drained by Otter Creek) lies north east of the village of East Liberty. Poor drainage and channelization (ditching) characterize these flats north of SR 347.

North of Raymond, Mill Creek flows at the base of the Broadway Moraine that extends south east to Wheeler - Green Road. Many intermittent tributaries drain this glacial deposition feature. Sites subject to severe erosion on Morley and Blount soils extend from ½ to 1 mile west of SR 739 and south of Hoover-Bault Road. Union County Natural Resource Conservation Service (NRCS) staff state that a comparatively large number of acres on this moraine participate in the Conservation Reserve Program.

Blues Creek flows along the base of a recessional moraine extending east from SR 4 to Mill Creek south of Ostrander.

This watershed experiences the cold winters and moist, warm, summers of a humid continental climate. Large daily changes in temperature are common. Precipitation may vary widely from year to year but is normally abundant and widespread. Thunder storms occur about 40 times a year in Union county, usually between April and August (Union County NRCS).

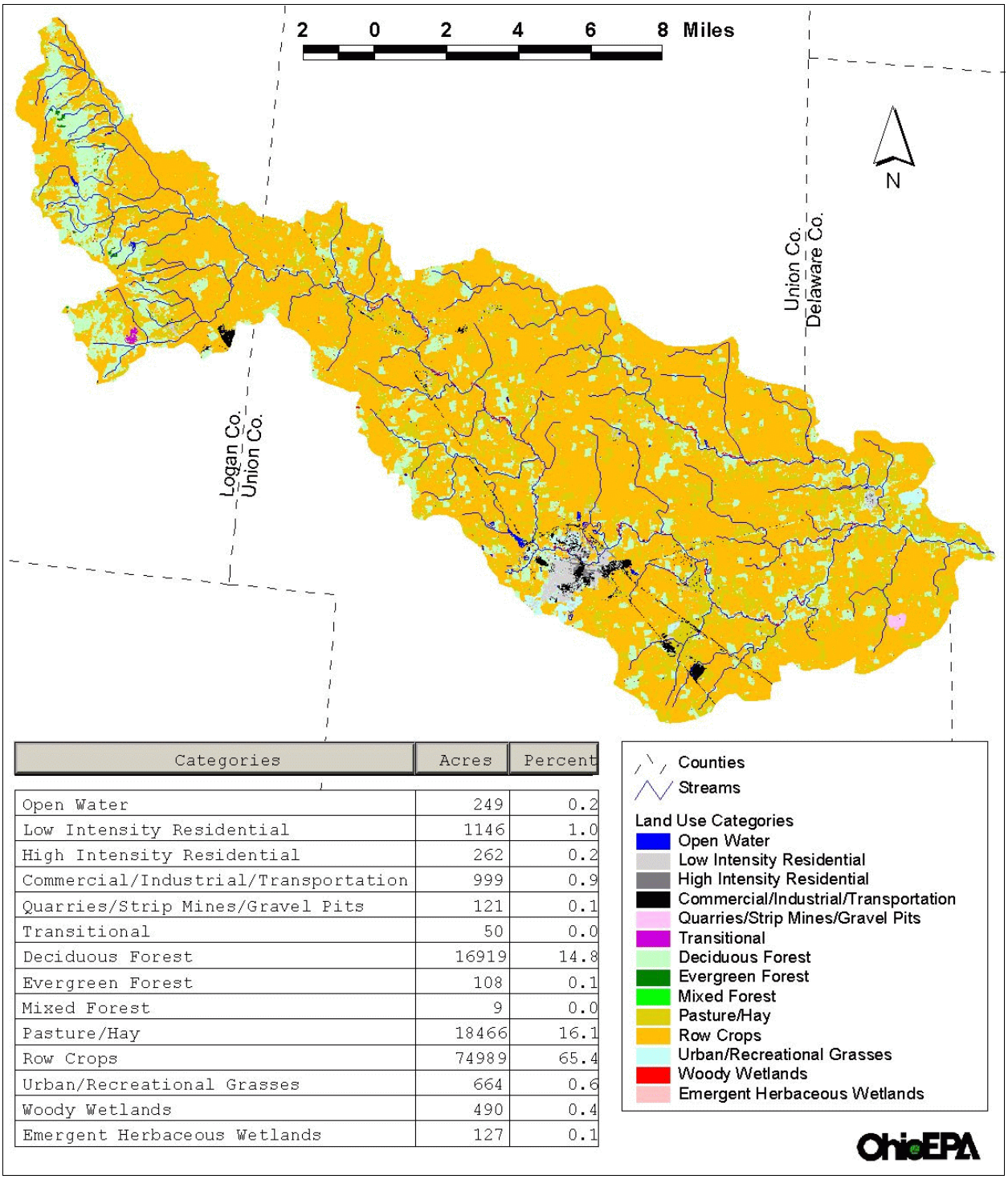
In the study area, cultivation and planting take place between mid April and mid June. This coincides with the period of historic highest average monthly precipitation. The overlap of these human and natural phenomena holds the potential for soil loss and runoff into surface waters. October has the lowest monthly average precipitation and lesser potential for surface runoff. During this period groundwater contributes a larger portion of the flow in Mill Creek system than at other times of the year (personal communication, Richard Swisshelm, U.S.G.S. - Water Resources Division, Columbus, Ohio).

The headwater area of Mill Creek shows the densest tree cover in the watershed. As one proceeds downstream, a greater concentration of forest cover is found in riparian corridors as cultivation dominates the landscape. In 1996 forest covered approximately 7% of Union county (Figure 3). Many reaches show some forested riparian corridors, though they may be narrow. In recent years there has been considerable timber buying activity. This has resulted in the removal of higher value hardwoods such as oaks, leaving lower value species to reseed (personal communication , Kathy Smith, ODNR Division of Forestry).

The dominant species found along tributaries of the watershed include: cottonwood, silver maple, red maple, sycamore, box elder, buckeye, hackberry, willow, green ash and American elm.

Soils found in the Mill Creek drainage basin are formed of high lime glacial drift, till and lake sediments. The texture and slope of the parent glacial materials strongly influence drainage, permeability and erosion potential that can vary greatly from site to site. There are soils with high erosion potential (frequently on the slopes of end moraines) and soils of very slow permeability (often in glacial lake beds) within the study area (USDA1975). These characteristics present limitations for cultivation, construction, septic treatment and other uses, which if exceeded may impact surface water.

In the upper reaches of the watershed, flooding between Walnut Grove and the intersection of SR 292 and County Road 2 is viewed by many land owners as a serious problem (personal communication , Logan County NRCS).



Categories	Acres	Percent
Open Water	249	0.2
Low Intensity Residential	1146	1.0
High Intensity Residential	262	0.2
Commercial/Industrial/Transportation	999	0.9
Quarries/Strip Mines/Gravel Pits	121	0.1
Transitional	50	0.0
Deciduous Forest	16919	14.8
Evergreen Forest	108	0.1
Mixed Forest	9	0.0
Pasture/Hay	18466	16.1
Row Crops	74989	65.4
Urban/Recreational Grasses	664	0.6
Woody Wetlands	490	0.4
Emergent Herbaceous Wetlands	127	0.1

Figure 3. Land use in the Mill Creek watershed

Land Use

The US census count for Union County in 1990 was 31,969. The National Population Assessment (NPA) data services projection for year 2000 (found in the most recent county plan), is 37,400. Local government and chamber of commerce officials believe this figure was reached or slightly exceeded in 1996 for an increase of 17% (personal communication, Union County Engineers Office). Most population increases since 1980 have occurred within Marysville and adjoining townships to the north. Nearly all of this area is within the study watershed.

Within the watershed, the period 1991-1996 saw little change in total acreage farmed, but the trend toward fewer and larger operations continued. In Logan County, the head waters and upper reaches of the watershed drain end moraines and fine textured soils. Between Walnut Grove and SR 47 (approximately RMs 46-20) there is considerable acreage in the Conservation Reserve Program (CRP). However a decline of 12% to 30% is expected as more acres return to cultivation in response to the 1996 Farm Bill. The percentage of CRP acres drops south of SR 47, due in part to the gentler topography and lessened threat of soil erosion. The number of "No Till" acres have remained essentially steady here (personal communication , Logan County NRCS).

Between North Greenfield and Walnut Grove there are several 100 head dairy herds. Beef operations of 10 to 25 head are estimated to number between 8 and 12. Poultry and swine operations are small and few in number. In Union County's share of the watershed, concentrated swine operations are increasing in number but the small number of dairy farms has changed little. Land application of manure from two of these facilities resulted in significant manure releases to and subsequent fish kills in Mill Creek upstream of Marysville in 2000 and 2001.

Estimates (1996) for field cover in the Union County portion of the watershed are: corn 30%, soybeans 60% and wheat 10%. "No till" practice continues to expand, although it is largely confined to wheat and soybean fields. Recent (1996) changes in federal agricultural policy are resulting in decreased Conservation Reserve Program acres. Local officials believe this trend will disproportionately affect the Broadway moraine that presently has a concentration of CRP acreage, thus putting more acres under cultivation (personal communication , Union County NRCS).

The building of the Honda Manufacturing plant (in the Big Darby watershed) has been a dominant stimulus for land use change within the study watershed during the last fifteen years. In Union county, single family home building permit applications more than doubled between 1991 and 1996 (197 to 403). Yet most development in the watershed has occurred in Marysville proper. Local officials expect the Marysville sewage treatment facility to expand in the next three years (personal communication , Union County Engineer's Office).

The rail and highway corridor between Marysville and the Columbus perimeter is expected to draw the major part of development in the future (only the portion north of County Road 37-Beecher Gamble road lies within the watershed). Yet the potential for land use change is increasing north and west of Marysville as well. Extended water and sewer line service

facilitates land use change as development follows the utilities.

Raymond and Peoria are expected to be sewered in the next 3 to 5 years. Should this occur, impacts on Mill Creek's unnamed tributary south of Raymond may lessen. Systemic failure of on-site systems within these two communities is a source of nutrient and organic loadings to Mill Creek upstream of Marysville. A sanitary sewer trunkline was installed along SR 4 toward County Road 132 in 2000. Besides stimulating development north of Marysville, this action enabled the County to eliminate the problematic package sewage treatment plant serving the Union County Home (personal communication , Union County Engineer's Office).

Although at a slow pace, single lot residential development is occurring and expected to continue in the upper reaches of the watershed south of Walnut Grove (along SR 292 between SR 47 and SR 540). Sewage lines do not yet serve this area. The new Ben Logan School complex, which opened in 1996, is expected to draw new residents here (personal communication , Logan County Planning Office). The Village of West Mansfield completed construction of a centralized collection and treatment system in 1997. Wastewater from the treatment system is land applied to a 47 acre spray field. The expected stimulus to development may extend over the watershed boundary south toward Mill Creek.

Table 3. Stream characteristics of Mill Creek watershed

Stream Length[ab]	Length (miles)	Average Fall (feet per mile)	Drainage Area (square miles)
Mill Creek	37.8	6.2	185.5
Blues Creek	12.5	5.9	36.62
Dun Run	3.8	11.6	8.86
Phelps Run (a.k.a., BMY Tributary)	5.0	15.0	4.32
Crosses Run	3.8[c]	1.6	5.24
Otter Run	4.4	12.3	7.00
Otter Creek	5.8	22.4	11.32
Town Run[b]	2.0	8.8	1.5

[a] ODNR 1960
[b] Ohio EPA, ECOS electronic file data.
[C] Updated from USGS 7.5 minute topographical map.

2.2 Water Quality and Biological Assessment

Under the Clean Water Act, every state must adopt water quality standards to protect, maintain and improve the quality of the nation's surface waters. These standards represent a level of water quality that will support the goal of "swimable/fishable" waters. Table 4 provides a brief description of Ohio's water quality standards. Further information is available in Chapter 3745-1 of the Ohio Administrative Code (OAC) (http://www.epa.state.oh.us/dsw/wqs/criteria.html).

In the Mill Creek study area, the aquatic life use designations that apply to various segments are Warmwater Habitat (WWH), Modified Warmwater Habitat (MWH), and Limited Resource Water (LRW). Waters designated as WWH are capable of supporting and maintaining a balanced integrated community of warmwater aquatic organisms (Note: a Coldwater Habitat is a trout stream). The headwaters of Blues Creek have been extensively channelized and are under county maintenance to prevent flooding of adjacent fields. This section of the creek is designated Modified Warmwater Habitat. Waters designated as MWH support more tolerant, lower quality aquatic communities than WWH streams and minimum standards for attainment are correspondingly lower. LRW streams are even more severely limited by physical habitat quality (or other irretrievable condition) than modified streams and criteria are even less restrictive than MWH. The small, extensively ditched BMY Tributary is designated LRW. Attainment of aquatic life uses is determined by directly measuring fish and aquatic macroinvertebrate communities to see if they are comparable to those seen in least impacted areas of the same ecological region and aquatic life use. Attainment benchmarks from these least impacted areas are established in the WQS in the form of "biocriteria", which are then compared to the measurements obtained from the study area. If measurements of a stream do not achieve the three biocriteria (fish: Index of Biotic Integrity (IBI) and modified Index of Well-being (MIwb); aquatic macroinvertebrates : Invertebrate Community Index (ICI)) the stream is considered in "nonattainment" . If the fish and aquatic macroinvertebrate communities in stream meet some of the biological criteria, but not others, the stream is said to be in "partial-attainment". A stream that is in "partial attainment" is not achieving its designated aquatic life use, whereas a stream that meets all of the biocriteria benchmarks, it is said to be in "full attainment".

Another type of beneficial use in the WQS is for recreational purposes. The recreational use for the majority of the Mill Creek study area is Primary Contact Recreation (PCR). The two criteria for the PCR designation are a water depth of at least one meter over an area of at least 100 square feet or that canoeing is a feasible activity. If a water body is too small and shallow to meet either criterion, the Secondary Contact Recreation (SCR) use applies. The attainment status of PCR and SCR is determined using bacterial indicators; the criteria for each are specified in the Ohio WQS.

Table 4. Summary and examples of Ohio's water quality standards (WQS)

WQS Components	**Examples of:**	**Description**
Beneficial Use Designation	1. Water supply • Public (drinking) • Agricultural • Industrial 2. Recreational contact • Beaches (Bathing waters) • Swimming (Primary Contact) • Wading (Secondary Contact) 3. Aquatic life habitats (partial list): • Exceptional Warmwater (EWH) • Warmwater (WWH) • Modified Warmwater (MWH) • Limited Resource Water (LRW) • State Resource Water	Designated uses reflect how the water is potentially used by humans and how well it supports a biological community. Every water in Ohio has a designated use or uses; however, not all uses apply to all waters (they are water body specific). Each use designation has an individual set of numeric criteria associated with it, which are necessary to protect the use designation. For example, a water that was designated as a drinking water supply and could support exceptional biology would have more stringent (lower) allowable concentrations of pollutants than would the average stream. Recreational uses indicate whether the water can potentially be used for swimming or if it may only be suitable for wading.
Numeric Criteria	1. Chemical	Represents the concentration of a pollutant that can be in the water and still protect the designated use of the waterbody. Laboratory studies of organism's sensitivity to concentrations of chemicals exposed over varying time periods form the basis for these.
	2. Biological *Measures of fish health:* • Index of Biotic Integrity • Modified Index of Well Being *Measure of bug (macroinvertebrate) health:* 1. Invertebrate Community Index	Indicates the health of the instream biological community by using these 3 indices (measuring sticks). The numeric biological criteria (biocriteria) were developed using a large database of reference sites. These criteria are the basis for determining use attainment.
	3. Whole Effluent Toxicity (WET)	Measures the harmful effect of an effluent on living organisms (using toxicity tests).
	4. Bacteriological	Represents the level of bacteria protective of the potential recreational use.
Narrative Criteria (Also known as 'Free Froms')	General water quality criteria that apply to all surface waters. These criteria state that all waters shall be free from sludge, floating debris, oil and scum, color and odor producing materials, substances that are harmful to human, animal or aquatic life, and nutrients in concentrations that may cause algal blooms.	
Antidegradation Policy	This policy establishes situations under which the director may allow new or increased discharges of pollutants, and requires those seeking to discharge additional pollutants to demonstrate an important social or economic need. Refer to http://www.epa.state.oh.us/dsw/wqs/wqs.html for more information.	

For the Mill Creek TMDL, Ohio EPA conducted a detailed assessment of chemical (water column, effluent, sediment), physical (flows, habitat), and biological (fish and aquatic macroinvertebrate) conditions in order to determine if streams and rivers in the study area were attaining their designated uses. The basis for listing portions of Mill Creek and its tributaries on the 303(d) list is the measurements that were obtained in an assessment conducted in 1990 (OEPA, 1991). In 1995 a water quality survey assessed the lower 39.4 miles of the Mill Creek mainstem (OEPA, 1996). A total of 27 chemical, physical and biological sampling stations were placed in a reach from upstream Otter Creek in Logan County [River Miles (RMs) 39.4 - 39.1] to near the confluence with the Scioto River at Bellepoint in Delaware County (RMs 1.7 - 1.6). Similar surveys between Marysville and Bellepoint were conducted by Ohio EPA in 1978, 1986, and 1990.

More recently, biological sampling was conducted along the length of Mill Creek during the summer of 2000 following a large manure spill and fish kill upstream from Marysville. The 2000 sampling extended downstream from Marysville to include ambient trends in the lower mainstem between Marysville and the mouth. Finally, an additional manure spill in the summer of 2001 prompted resampling of biological communities in the upper mainstem in the fall. Biological sampling was also conducted in upper Blues Creek in 2001 to assess the channel modified headwaters and to provide more recent data from the impaired middle reaches of the creek.

This TMDL report addresses both the results in the 303(d) list based on 1990 data and the results of the1995 assessment. Preliminary results of the 2000 and 2001 assessments are included to evaluate the spills and the general trends in biological quality since the earlier surveys. However, greater weight is given to the 1995 data, as it is the most current and comprehensive evaluation of watershed conditions. An aquatic life use attainment table for the Mill Creek study area (Appendix A) is provided and is based on the 1995 sampling results; this data was not available for the 1998 303(d) list but will be used in the next listing cycle. Results from both 2000 and 2001 (draft) surveys are also included in Appendix B. The attainment table is arranged from upstream to downstream and includes sampling locations indicated by river mile (RM), the applicable biocriteria indices, the use attainment status (i.e. full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI) (an indicator of habitat quality), and comments for the sampling location.

2.3 Causes and Sources of Impairment

The determination of impairment in rivers and streams in Ohio is straightforward – the numeric biocriteria are the principal arbiter of aquatic life use attainment and impairment. The rationale for using biocriteria has been extensively discussed elsewhere (Karr, 1991; OEPA, 1987a,b; Yoder, 1989; Miner and Borton, 1991; Yoder, 1991).

Ohio EPA relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, effluent and land use data, biomonitoring results, and biological response to describe the causes (e.g., nutrients) and sources (e.g. agricultural runoff, municipal point sources, septic systems) associated with observed impairments. The initial assignment of the principal causes and sources of impairment that appear on the section

303(d) list do not necessarily represent a true "cause and effect" relationship. Rather they represent the association of impairments (based on response indicators) with stressor and exposure indicators whose links with the survey data are based on previous experience with similar situations and impacts. The reliability of the identification of probable causes and sources is increased where many such prior associations have been identified.

2.3.1 **Mill Creek** (Otter Run to Scioto River) [RMs 23.80 to 0.00]

The Marysville WWTP (RM 18.26) is the most significant source of impact to chemical water quality and biological community performance in Mill Creek. Impairment in 1995 was primarily related to organic waste loadings and subsequent dissolved oxygen depletion downstream from the plant.

Mill Creek is effluent dominated downstream from the City of Marysville during summer, critical low flow periods. Cumulative annual (average) effluent flow to the Mill Creek watershed from municipal wastewater treatment plants and other domestic "package" treatment plants increased from 3.14 million gallons per day (MGD) in 1995 to 3.64 MGD in 2001 (Table 5). In contrast, industrial flows decreased from a cumulative annual average daily flow of 2.56 MGD to 0.38 MGD over the same time period (Table 6).This decrease is attributable to the elimination of discharges through connection to the City of Marysville system (Goodyear, Scotts, BMY and the Marysville WTP) and the elimination of cooling water flows through the installation of cooling tower systems (Nestle and General Industries - Plastek). Significant storm water flows in the Mill Creek basin that contributed to impairment were found only in the Crosses Run basin and were attributed to Scotts. Therefore, the only storm water that is addressed in this TMDL is that from Scotts in the Crosses Run TMDL.

Aquatic life use attainment in 1995 was partial (*i.e.*, fair to good quality) immediately upstream and downstream from the Marysville WWTP but declined to non attainment (fair to poor quality) about two miles further at RM 16.8. Nonattainment coincided with the measurement of consistently low dissolved oxygen (D.O.) concentrations (Figure 4) and elevated levels of ammonia-N, total phosphorus, and fecal coliform bacteria. Biological communities recovered by RM 14.6 and remained in full attainment except for a slight decline to partial attainment immediately downstream from Crosses Run and Scotts (RMs 11.6/11.7). Chemical and biological sampling in Crosses Run has revealed numerous water quality criteria exceedences and severely degraded biological communities adjacent to and downstream from Scotts. The property has been associated with an extensive fish kill (1987), numerous NPDES permit violations, storm water contamination, slug type discharges of ammonia, and contamination from pesticides and organic compounds. In Mill Creek, biological performance again improved with increased distance downstream. Very good to exceptional quality communities were found from upstream Ostrander to the mouth (RMs 4.4-1.7).

Table 5. Municipal wastewater discharges in the Mill Creek watershed

Entity	Receiving Stream (RM of discharge)	Design Flow (MGD)	Annual 1995 Mean Flow (MGD)	Annual 2001 Mean Flow (MGD)
City of Marysville WWTP	Mill Creek (RM 18.26)	4.0	2.91	3.43
Village of Ostrander WWTP	Mill Creek (RM 4.05)	0.090	0.041	0.033
Mill Creek Estates Subdivision WWTP	Mill Creek (RM 12.57)	0.105	NA*	0.133
Parrott Village Subdivision WWTP	Phelps Run (RM 15.29/4.0)	0.020	NA*	0.015
ODOT Park No. 6-4 WWTP	Unnamed Trib. Mill Creek (RM 9.3/2.3)	0.010	0.0026	0.0028
Dover Estates Mobile Home Park WWTP	Unnamed Trib. To Dun's Run (RM 5.5/3.7)	0.025	0.018	0.027
Union County Home WWTP	Infirmary Ditch (RM 17.92/1.93)	0.024	NA*	0.0

* Entity reported design flow on monthly operating reports in lieu of measured or calculated flow

Table 6. Industrial wastewater discharges in the Mill Creek watershed

Entity	Receiving Stream (RM of discharge)	Outfall/Source of Discharge	Annual 1995 Mean Flow (MGD)	Annual 2001 Mean Flow (MGD)
City of Marysville WTP	Mill Creek (RM 19.05)	001- Lime Sludge Lagoon	0.007	0.0
Ray Lewis & Sons, Inc.	Mill Creek (RM 18.41)	002- Cooling Water	0.007	0.006
Nestle Foods Corp.	Mill Creek via storm sewer (RM 18.9)	001-Cooling Water	0.76	0.04
General Industries - Plastek	Unnamed Trib. Mill Creek (RM 13.84)	001-Cooling Water	0.648	0.0
Northwoods Stone & Asphalt Co.	Unnamed Trib. Mill Creek (RM 3.35/2.62)	001-Sediment Pond	0.29	0.29
United Rotary Brush	Phelps Run via field tile (RM 15.29/2.8)	001-Sanitary	0.0015	0.0014
Goodyear	Unnamed Trib. To Crosses Run (RM 11.83/2.05)	001-Sanitary	0.015	0.0
BMY - Wayne Wheeled Vehicles	BMY Tributary (RM 9.3/3.2)	002-Sanitary	0.03	0.0
The Scotts Company	North Branch Crosses Run (RM 0.54) Crosses via Unnamed Trib. (RM 0.00) Crosses via Unnamed Trib. (RM 0.00) Crosses Run (RM 1.80) Crosses Run (RM 1.90) Crosses via Unnamed Trib. (RM 0.00) North Branch Crosses Run (RM 0.70) North Branch Crosses Run (RM 0.30) Crosses Run (RM 1.90)	001-Sanitary 002-Sanitary 003-Sanitary 004-Sanitary 005-Sanitary 006-Cooling 007-Cooling 008-Cooling 009- Swimming Pool	0.017 0.001 0.001 0.005 0.001 0.329 0.426 0.041 0.0	0.0 0.0 0.0 0.0 0.0 0.0001 0.025 0.0 0.0

More recent biological sampling results from 2000 (Appendix B) suggest similar, if not more severe impairment downstream from the Marysville WWTP. Non and partial attainment in 2000 extended as far downstream as Crosses Run (RM 12.1), several miles further than in 1995. The area of most severe decline in biological health (RM 16.8) fit the area of historic dissolved oxygen depletion measured downstream from the Marysville WWTP. In addition to enrichment, other causes of mainstem impairment based on 1990 and 1995 survey included metals (primarily copper, lead, and zinc), ammonia, priority organics, and unknown toxicity (based on WWTP effluent bioassay testing). Besides the Marysville WWTP, suspected sources of mainstem impact included urban runoff and landfills in the Marysville area, minor point sources (*e.g.*, Mill Creek Estates WWTP), and the combination of storm runoff, pollutant spills and land-application of fertilizer products associated with Scotts via Crosses Run. Scotts' five minor sanitary WWTPs were considered significant sources of impact in Crosses Run following the 1995 survey but they have since been eliminated through connection to Marysville.

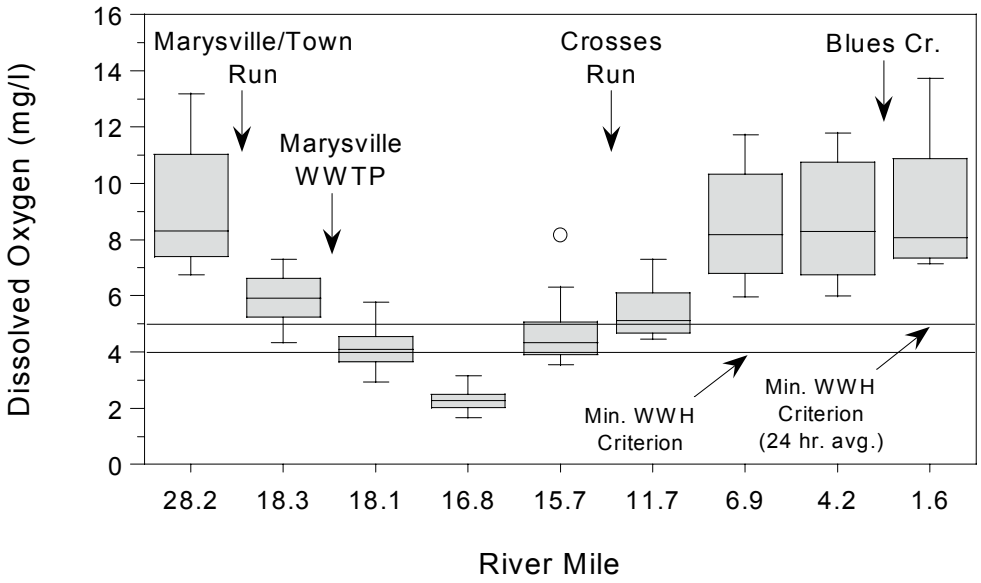


Figure 4. Dissolved oxygen monitoring plot for Mill Creek (Box and whisker plot of dissolved oxygen continuous monitor data from Mill Creek, August 29-31, 1995)

Except for the Marysville WWTP, most other causes and sources of Mill Creek impairment have diminished during the past decade, either by corrective action or additional assessment. For example, the Eljer Plumbingware property in Marysville was a major source of copper, lead, and zinc contamination in Town Run that extended into Mill Creek. The site was capped and remediated in the late 1990s. The Ray Lewis company is an electroplater that discharged toxic levels of copper and other metals to Mill Creek in the 1970s and 1980s before tying their discharge of process wastewater into the Marysville WWTP in 1989. Presently, five industrial indirect dischargers (Honda, Scotts, Nestle, Ray Lewis, and the Ohio Reformatory for Women) comprise 34.8% of the average daily flow to the WWTP. Of these, the three Honda manufacturing facilities comprise almost 23% of the total flow. Sanitary sewer overflow (SSO) repairs in Marysville between 1990 and 1995 resulted in significant biological improvement in Mill Creek upstream from the WWTP. In addition, concerns were raised over elevated organics and pesticides levels in Marysville area sediments following the 1990 survey. Subsequent intensive sampling by the Division of Emergency and Remedial Response (DERR) in 1995 and 1997 found Mill Creek contamination levels were relatively low and highest concentrations were mostly confined to small tributaries (*i.e.,* Town Run, Crosses Run). Biological performance has responded positively to these corrective actions and mainstem impairment is generally restricted to the reach between the Marysville WWTP and Crosses Run.

The 1995 Mill Creek survey found that sharp loading increases for ammonia-N, biochemical oxygen demand (BOD), suspended solids, copper, and zinc in 1994-95 were associated with the delivery of lime sludge from the water treatment plant to the Marysville WWTP. The introduction of the lime sludge resulted in solids handling and removal problems at the WWTP and negatively impacted water quality. Following the 1995 survey,

initial 1996 MORs (Monthly Operating Reports) suggested the Marysville WWTP has improved its sludge handling and effluent quality. However, additional sampling conducted since the summer of 1996 indicates the WWTP is a continued source of enrichment. The Mill Creek at Cherry Street site is monitored on a monthly basis as part of a National Ambient Water Quality Monitoring (NAWQM) program. Results from this site taken from 1997-2000 during 2nd and 3rd quarters (*i.e.,* May-October) showed a definite negative impact associated with the WWTP, located immediately upstream. Significant concentrations of nutrients and oxygen demanding substances are present in the form of ammonia, nitrates, nitrites, organic nitrogen (TKN), phosphorus, suspended solids, and BOD_5 (Table 7). Biological communities sampled in 2000 were also impaired at this site, still likely due to enrichment associated with the WWTP discharge.

Summary: Mill Creek 2000 and 2001 Survey Results

Recently, two large manure spills in upper Mill Creek prompted additional biological sampling in 2000 and 2001. Sampling results suggest at least short-term impacts in upper Mill Creek following the spills and significant, continued impairment downstream from the Marysville WWTP.

Based on the 2000 and 2001 sampling, manure spills on upper Mill Creek had pronounced, but not permanent, impacts on biological communities. Macroinvertebrate ICI scores reflected minimal impacts approximately two to three months after each spill. Fish communities were impacted during both summers, but subsequent sampling in 2001 suggests recovery was virtually complete after one year. Extensive sampling in the upper Mill Creek mainstem since the late 1970s has found consistently high quality biological communities and good water quality conditions despite the adjacent agricultural land use. Given the generally good habitat quality and the streams ability to assimilate normal background nutrient levels, recovery to Full attainment below each spill is expected. However, if the spill incidents increase and become a chronic problem in the upper basin, the additional loads could result in long term biological impacts.

Sampling downstream from Marysville in 2000 suggests similar, if not more severe impairment downstream from the Marysville WWTP. Non and partial attainment in 2000 extended as far downstream as Crosses Run (RM 12.1), several miles further than in 1995. The area of most severe decline in biological health (RM 16.8) fit the area of historic dissolved oxygen depletion measured downstream from the Marysville WWTP. A more comprehensive summary of the 2000 and 2001 surveys can be found in Appendix B.

Table 7. Nutrient and bacteria concentrations from Cherry Street ambient site, May-October, 1997-2000. Comparison is made with median values at WWH reference sites in the ECBP ecoregion

Parameter	Mean (n = 28)	Median (n = 28)	Maximum	ECBP-WWH Median Concentration
Ammonia	1.17	0.70	4.01	0.025
Nitrate-Nitrite	5.18	4.81	11.4	0.840
Nitrite [1997-2000 (n = 18)]	0.26	0.14	1.0	0.013
TKN	3.07	2.66	8.5	0.50
Phosphorus (Total)	3.80	3.66	10.4	0.07
TSS	29.1	18.0	190	14.0
BOD_5	8.2	5.6	30.0	1.4
Fecal Coliform (#/100 ml)	5574	700	60,000	340

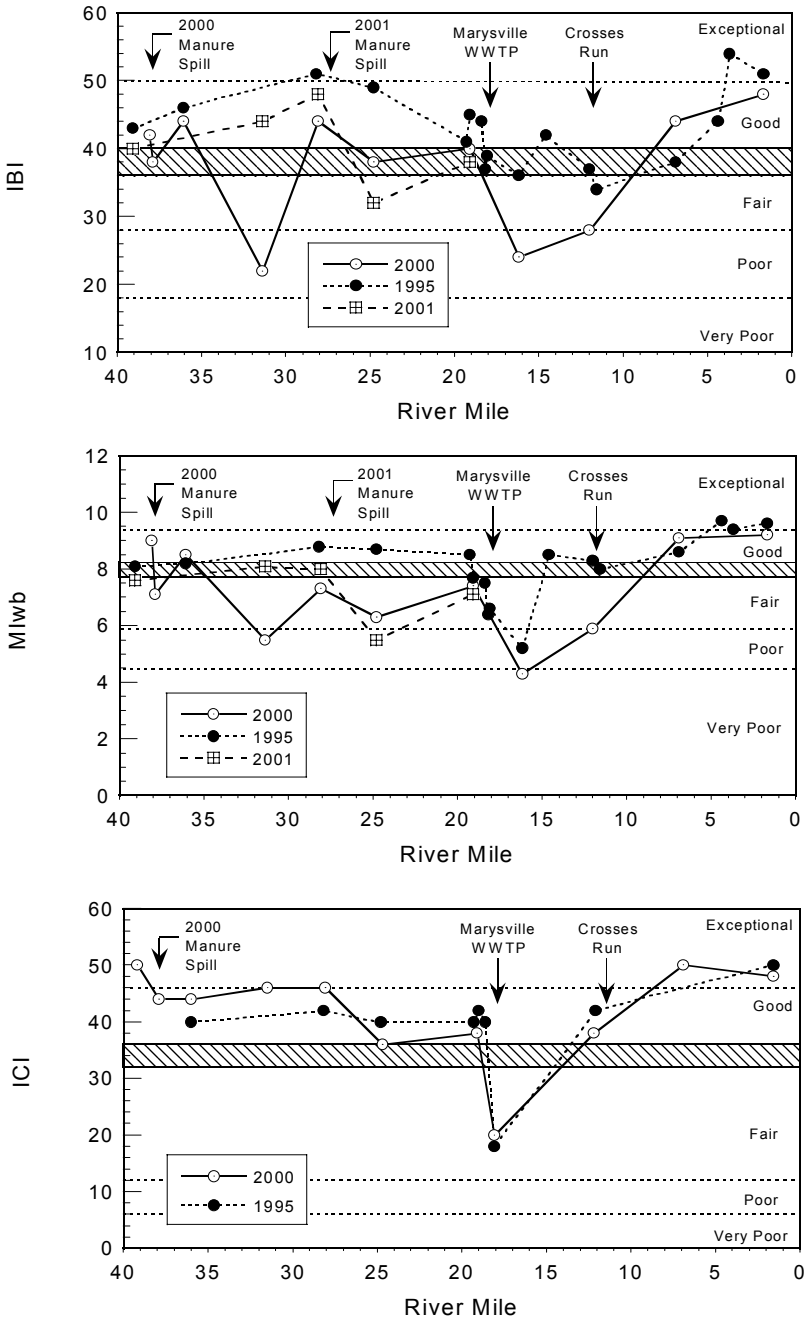


Figure 5. Longitudinal trends in the IBI, MIwb (1995-2001) **and ICI** (1995-2000) **in Mill Creek**

2.3.2 Crosses Run

Severe biological and water quality impacts in Crosses Run were primarily related to unionized ammonia, organic enrichment, low dissolved oxygen levels, and contamination from pesticides and organic compounds. The *very poor* condition of the fish and macroinvertebrates reflected acutely toxic conditions and coincided with the degraded water quality conditions. In addition, stream sediments were highly contaminated by pesticides and organics including dieldrin, chlordane, DDT metabolites, heptachlor epoxide (Kelly and Hite criteria), and numerous semivolatile compounds (mostly PAHs).

Scotts is the primary source of impacts to Crosses Run and their influence may extend downstream into Mill Creek. Plant operations and inadequate environmental controls at Scotts contributed to the degraded conditions. For example, spraying of recycle pond water on test fields during a rainfall event (observed on June 30, 1995) resulted in direct runoff and extremely high ammonia levels in the North Branch of Crosses Run. Despite tertiary treatment, the five small package plants had chronic treatment problems with a total of 189 NPDES permit violations from 1990 through 1995. The discharges were tied into the Marysville sewer system in August 1998 but before their elimination, ammonia concentrations as high as 170 mg/l (limit 10 mg/l) were recorded from the outfalls. Storm water sampling performed by Scotts in 1998 revealed ammonia and phosphorus concentrations as high as 212 mg/l and 35.4 mg/l, respectively. In August 1999, the herbicide 2,4-D was detected as high as 1300 ug/l at one storm water outfall. DERR sampling in 1994 identified pesticide and organic chemical contamination in soils and sediments associated with land filling of product and field broadcast of off-specification pesticide products. Sampling in 1995 revealed water quality standard (WQS) exceedences of aquatic life and human health criteria for pesticides downstream from the facility. Fish tissue concentrations of the pesticide chlordane exceeded FDA action limits immediately downstream from Crosses Run with Scotts a suspected source. Chemical and/or biological impacts associated with Scotts have been described in water quality surveys since 1978 (OEPA 1980, 1987d, 1991).

2.3.3 North Branch Crosses Run

The condition of biological communities and causes and sources of impact in the North Branch were very similar to Crosses Run. Most of the watershed is located on Scotts property and was severely impacted by ammonia, pesticides and organics. Biological communities were very poor and indicative of toxic influences. Scotts 001 sanitary discharge to the North Branch was eliminated in August 1998 and tied into the Marysville WWTP.

2.3.4 Town Run

Town Run is a small urban tributary in Marysville. Causes and sources of biological impairment were numerous and associated with urban runoff, habitat alteration (culverting), metals (Eljer Plumbingware hazardous waste site), organic enrichment/D.O. (septic tank drainage), and toxicity (unknown sources). The most severe biological impacts were observed at the mouth, downstream from a culverted section in downtown Marysville.

Oil sheens, foul odors, and a toxic response in the macroinvertebrates have been observed since 1990. Subsequent sediment sampling by DERR in 1997 found extremely elevated concentrations of DDT metabolites in sediments from this same area, suggesting possible illegal disposal or application of the banned pesticide.

Following the 1995 survey, remediation of the Eljer Plumbingware RCRA site was completed in December 1999. The landfill was capped and the property was converted to a city park. These actions should reduce the severity of heavy metals contamination in lower Town Run and Mill Creek in Marysville. From field observations, the culverted section of Town Run acts as a sediment sink and will likely remain a "hot spot" of sediment contamination. However, the overall trend should be one of improved sediment quality and reduced impairment both in Town Run and Mill Creek in the Marysville urban area.

2.3.5 Blues Creek

The upper reaches of Blues Creek (upstream from State Route 4 at RM 11.85) are under active channel maintenance and designated a Modified Warmwater Habitat. The remainder of the stream is not under maintenance and designated WWH. However, the combination of extensive agricultural land usage, siltation and past habitat alteration results in significant biological and chemical impacts to Blues Creek. Biological sampling in 1990 was limited to one site at RM 6.7. Communities were in Non attainment but improved to Full attainment near Ostrander (RM 0.6). The lower 2-3 stream miles are largely unmodified, with a high gradient and firm substrates of boulder, cobble and exposed bedrock. At RM 6.7, habitat alteration and organic enrichment/D.O. were considered the primary causes of impact in 1990 with channelization (old, inactive) and non-irrigated crop production the primary sources. Water quality standards violations for D.O., fecal coliform, and nitrate (water supply standard) were detected during limited chemical sampling. Field observations of unrestricted cattle access and extensive silt deposition were also noted.

Because of the limited sampling coverage in 1990, additional biological sampling was conducted in the Fall of 2001 to update attainment status in the upper and middle reaches of Blues Creek.

Five Blues Creek fish sites (RMs 19.6-4.7) and one macroinvertebrate site (RM 6.7) were sampled in 2001. Two sites were located in the modified headwaters at RMs 19.6 and 12.0, and three sites were in the WWH designated middle section at RMs 10.1, 6.7, and 4.7. Overall, Blues Creek appeared to be impaired by excessive amounts of silt within the substrates. Silt-tolerant species dominated the fish communities. Twenty five species were captured, with no sensitive species present at any site. IBI scores in the middle reaches ranged from 26 (poor) to 32 (fair), well below the WWH criterion of 40. In the channelized headwaters, fish communities were also poor to fair but within acceptable limits for the existing MWH-Channelized use designation.

Qualitative Habitat Evaluation Index (QHEI) scores were progressively lower at each site as you moved upstream through the basin. Scores ranged from 64 (good) at the Blues Creek Nature Preserve (RM 4.7), to 19.5 (very poor) at St. Rt. 31 bridge (RM 19.6) in the headwaters. Despite the general trend of improving habitat and less siltation from

upstream to downstream, fish communities remained impacted. This may point to water quality impacts in addition to siltation. Sampling at RM 6.7 indicated little change in habitat quality or the condition of fish communities since 1990.

Macroinvertebrates from RM 6.7 were considered "good" in 2001, suggesting some improvement compared to the "fair" conditions at RM 6.2 in 1990. EPT taxa richness increased from five to ten between surveys. Samples were not collected from precisely the same location but, from field observations, siltation appeared more extensive at the 1990 sampling site.

Sampling in 2001 confirms the MWH use designation is appropriate for the petitioned ditch portion of upper Blues Creek (upstream from RM 11.5). Habitat quality was very low and fish communities, while meeting modified criteria, fell well below WWH expectations. Fish communities continue to show significant impairment and no obvious improvements in the middle reaches between SR 4 and Ostrander. With the exception of increased emphasis on siltation, causes and sources of impact of impact remain largely unchanged compared to the1990 evaluation.

2.3.6 BMY Tributary (mistakenly listed as Phelps Run in 1998 303(d) Table 1)

Based on the1990 survey results, extensive channelization and small drainage size was the basis for a Limited Resource Water designation for the tributary. In addition, acute toxicity associated with heavy metals from the former BMY Corporation at RM 3.2 contributed to biological and water quality impacts in the upper reaches of the tributary. The stream was dry upstream from BMY. The BMY discharge was relatively temporary and associated with defense buildup prior to the Gulf War. Shortly after the 1990 survey, the company closed and it is doubtful that a similar discharge would occur in the future.

Table 8. Major causes and sources of impairment in the Mill Creek watershed

Waterbody Segment Description [Ident. Number]	**Causes of Impairment**[1]	**Sources of Impairment**[1]	**Aquatic Life Use**[2] **Year**	**Miles Attaining Use**			
				Full	**Partial**	**Non**	**Not Assessed**
Mill Creek - Headwaters to Otter Run RMs 48.87 to 23.80 [OH35 9]	Not Listed	Septage Disposal (land application) (T)	WWH	(RMs 39.4 - 23.8)			
			2001	11.5	2.6	1.5	9.5
			2000 A[3]	1.4	9.0	5.2	9.5
			2000 B[4]	3.3	10.4	1.9	9.5
			1995	15.6	--	--	9.5
Comments: Biological communities were in Full attainment throughout upper Mill Creek in 1995 and the segment was not listed in the TMDL. However, since 1995, two large pollutant spills and fish kills associated with runoff of chicken and livestock manure have occurred during the summers of 2000 and 2001, respectively. Biological sampling results from the affected areas suggest pronounced but temporary impacts associated with the spills. Recovery below the 2000 spill was essentially complete one year later. Similar impacts observed below the 2001 spill should follow a similar recovery pattern if additional loads are not introduced. Because of the observed recovery pattern, the segment should be considered threatened but not impaired for purposes of TMDL.								
Mill Creek - Otter Run to Scioto River RMs 23.80 to 0.00 [OH35 1]	**Organic enrichment/D.O. (H)** **Metals (M)** *Priority Organics (M)* Unknown Toxicity (M) Ammonia (M) *Siltation (T)* *Organic Enrichment/D.O. (T)*	**Municipal Point Source (H)** **Specialty Crop Production or Industrial Land Treatment (M)** **Industrial Point Sources (H/M)** **Urban Runoff (M /S)** *SSOs (sic CSOs) (M/ -)* *Landfills (M/ -)* *Contaminated. Sediments (M/-)* Spills (- /M) *Development/Suburbanization (T)*	WWH	(RMs 23.8 - 0.0)			
			2001 (RMs 23.8-19.1)	0.0	4.7	0.0	19.1
			2000 A	9.2	8.8	5.8	0.0
			2000 B	9.2	8.8	5.8	0.0
			1995	17.0	5.5	1.3	0.0
			1990	3.4	11.9	8.5	0.0
Comments: Organic enrichment and associated low dissolved oxygen levels downstream from the Marysville WWTP were the primary causes and sources of impact in the segment. Moderate impacts were also attributed to Metals and Priority Organics in the 303d listing but, excepting the WWTP, most causes and sources have been reduced or eliminated since the 1990 survey. Despite the impacts from Marysville, the overall quality of Mill Creek is improving. Attainment is virtually Full in Marysville, upstream from the WWTP, and the lower 5 miles of Mill Creek had exceptional quality. Nutrient levels remain elevated throughout the reach from Marysville to the mouth.								

Table 8. Major causes and sources of impairment in the Mill Creek watershed

Waterbody Segment Description [Ident. Number]	**Causes of Impairment**[1]	**Sources of Impairment**[1]	**Aquatic Life Use**[2] **Year**	**Miles Attaining Use**			
				Full	**Partial**	**Non**	**Not Assessed**
Town Run - Entire length RMs 2.01 to 0.00	**Unknown Toxicity (H)** **Organic enrichment/D.O. (M/H)** **Metals (M/H)**	**Urban Runoff (H,/M)** **Unknown (H)** **Other (H)** (culvert) Onsite wastewater systems (- /H)	WWH 1995	--	--	1.0	1.0
OH35 1.1	**Habitat Alteration (H)** (culvert) *Oil & Grease (M)*	Hazardous Waste (- /H)	1990	--	--	0.5	1.5
Comments: Town Run is a small urban tributary that flows through Marysville. In addition to urban runoff and septic tank drainage, heavy metals contamination from the now closed Eljer Plumbingware landfill has been problematic. Also, a short portion of the creek is culverted near the mouth; sampling downstream from this area found oily sediments and a toxic response in the macroinvertebrates. Since the 1995 survey, the Eljer landfill has been capped so metals contamination, particularly from copper, lead, and zinc, should be reduced.							
Crosses Run - Entire length RMs 2.80 to 0.00	**Organic enrichment/D.O. (M)** **Priority Organics/Pesticides (M/H)** *Total Toxics (M)*	**Specialty Crop Production or Industrial Land Treatment (M/H)** **Industrial Point Source (H)** Spills (H)	WWH 1995	--	--	2.8	0.0
OH35 8	Ammonia (- /H, M)	Feedlots (Confined Animal Feed Op.) (M)	1990	--	--	2.1	0.7
Comments: Runoff and discharges of fertilizer related chemicals (*e.g.*, ammonia, pesticides, and organic chemicals) from the Scotts facility were the primary causes and sources of impact in Crosses Run. Ohio EPA sampling has documented water column, sediment and soil contamination within and adjacent to the stream. Biological communities indicated very poor quality and toxic conditions. Upstream from Scotts, Crosses Run has poor instream conditions influenced by intermittent flow and a dairy farm. Since the 1995 survey, Scott's five minor point source discharges were eliminated and tied into the Marysville sewer system.							
North Branch Crosses Run - Entire length RMs 2.10 to 0.00	Ammonia (H) Pesticides (M) Priority Organics (M) Flow Alteration (H)	Industrial land treatment (H) Spills (H) Minor Industrial Point Source (H) Natural (H)	WWH 1995	--	--	2.1	0.0
[OH35 8.1]							
Comments: Causes and sources of impact in the North Branch were essentially the same as in Crosses Run. The small stream flows through the Scotts property and severe toxic impacts were recorded downstream at the mouth. Excessive levels of ammonia were present from point source discharges, spills and runoff from Scotts property. Pesticides and PAHs were also potential sources of impact. Non-attainment upstream was attributed to small stream size and intermittent flow conditions. As in Crosses Run, Scotts package plant (point source) discharges have been eliminated and tied into the Marysville WWTP since the 1995 survey.							

Table 8. Major causes and sources of impairment in the Mill Creek watershed

Waterbody Segment Description [Ident. Number]	**Causes of Impairment**[1]	**Sources of Impairment**[1]	**Aquatic Life Use**[2] **Year**	**Miles Attaining Use**			
				Full	**Partial**	**Non**	**Not Assessed**
Blues Creek - Entire length RMs 22.7-0.0 [OH35 2]	*Habitat alteration (H)* *Organic enrichment/D.O. (M)* Siltation (H) (2001 sampling)	Channelization (H) Non-irrigated crop production (H)	MWH (RM 22.7-11.5)				
			2001	11.2	--	--	0.0
			WWH. (RM 11.5-0.0)				
			2001	0.7	1.0	5.0	4.8
			1995	0.7	–	--	22.0
			2001	0.7	--	6.0	16.0
Comments: The upper reaches of Blues Creek (upstream from State Route 4 at RM 11.85) are under active channel maintenance and designated a Modified Warmwater Habitat. The remainder of the stream is not under maintenance and designated WWH. However, the combination of extensive agricultural land usage, siltation and past habitat alteration results in significant biological and chemical impacts to the middle reaches of Blues Creek. Habitat quality and biological communities improve near the mouth at Ostrander and exceeded WWH criteria in both 1990 and 1995. Biological and habitat assessments conducted in 2001 confirmed that the MWH use designation is appropriate in upper Blues Creek and communities remain impaired in the middle reaches.							
BMY Tributary* - Entire length RMs 5.0 -0.0 [OH35 7]	*Habitat Alteration (H)* *Metals (M)*	*Channelization (H)* *Non-irrigated crop production (H)* *Industrial Point Source (M)*	LRW				
			1990	–	–	5.0	0.0
* Mistakenly identified as Phelps Run in 303(d) Table 1							
Comments: This small stream had been extensively channelized in the 1920s and rechannelized by local landowners within ten years of the 1990 survey. In addition, heavy but limited production at BMY Corp. during the Gulf War coincided with the 1990 survey. BMY toxicity was acute and water quality exceedences were documented for copper. BMY Corp. closed after 1990. Channelization and small stream size prompted the existing LRW designation.							

[1] Causes and sources of impairment in **bold** type are listed in the 1998 303(d) list (based on 1990 field data) and were also identified during the 1997 Biological and Water Quality Study of Mill Creek (Scioto River Basin) and Selected Tributaries (1995 field data); items in *italics* are listed in the 1998 303(d) list only; items in plain type were identified during the 1995 survey only. The magnitude (i.e. relative contribution) of the cause or source of impairment is estimated as follows: H-High magnitude M-Moderate magnitude S-Slight Magnitude T-identifies a threat

[2] The Aquatic Life Use Designation and corresponding Attainment Status are given:
(a) as provided in the 1998 303(d) list (1990 field data) or the Ohio WQS, based on use designation recommendations from the 1997 Biological and Water Quality Study of Mill Creek (Scioto River Basin) and Selected Tributaries (1995 field data).

[3] Biological sampling conducted during the summer of 2000, approximately 3 weeks after July 27 manure spill.

[4] Biological sampling conducted during the summer of 2000, approximately 9 weeks after July 27 manure spill.

3.0 PROBLEM STATEMENT

The goal of the TMDL process is full attainment of chemical and biological Water Quality Standards (see Appendix A). The water quality and biological assessment of this waterbody indicates that nonattainment of the WQS is primarily due to organic enrichment and unionized ammonia which correspond to low dissolved oxygen levels, siltation caused by habitat alteration, phosphorus and pesticides which in turn leads to failure to attain biocriteria.

Poor quality habitat with reduced or debilitated riparian zones (either no riparian zone is present or runoff bypasses the zone via field tiles) and simplified channel morphology generally exacerbate the deleterious effects of siltation by reducing the availability of substrates and their related importance in providing food organisms (macroinvertebrates) to the insectivores and benthivores. Poor habitat conditions lead to increases in erosion causing greater levels of suspended sediments in the water column and creates a higher susceptibility to nonpoint pollution in the form of nutrients and pesticides that may be bound to these fine sediments (especially clays and silts) which are transported overland during rain events. The riparian cover, which is often regarded as an "impediment" to flow is often removed in association with channel modifications. The results decrease the filtering time, assimilation and retention of pollutants during overland flow events, may allow full sunlight to stimulate nuisance growths of algae and diminishes the input of woody debris to the stream channel. This instream cover is an important component of warmwater streams and may function as valuable habitat to aquatic life (Karr 1991).

The parameters selected for Total Maximum Daily Load development are ammonia, $CBOD_5$, sediment, phosphorus, habitat and the pesticides Aldrin, d-BHCB, Dieldrin, Endosulfan I, Endrin and Heptachlor. In conjunction with modeling the loads for these parameters, the instream dissolved oxygen concentration and stream habitat have also been evaluated. Although not expressed as loads per se, allocations for the factors affecting instream dissolved oxygen and stream habitat have been included analogous to the "TMDL" numbers for the above parameters.

3.1 Target Identification

The establishment of instream numeric targets is a significant component of the TMDL process. The numeric targets serve as a measure of comparison between observed instream conditions and conditions that are expected to restore the designated uses of the segment. The TMDL identifies the load reductions and other actions that are necessary to meet the target, thus resulting in the attainment of applicable water quality standards.

Numeric targets are derived directly or indirectly from state narrative or numeric water quality standards (OAC 3745-1). In Ohio, applicable biocriteria are appropriate numeric targets (see section 2.2). Determinations of current use attainment are based on a comparison of a stream's biological scores to the appropriate criteria, just as the success of any implementation actions resulting from the TMDLs will be evaluated by observed

improvements in biological scores.

Ohio's standards also include narrative criteria which limits the quantity of pollutants which may enter waters. Specifically, OAC 3745-1-04 states that all waters of the state shall be free from substances entering the waters as a result of human activity in concentrations that create nuisance growths of aquatic weeds and algae or are toxic or harmful to human, animal or aquatic life and/or are rapidly lethal in the mixing zone.

Dissolved Oxygen

The instream dissolved oxygen (D.O.) is the primary chemical specific parameter not fully attaining WQS in Mill Creek. The measurable endpoint of this TMDL process is to attain the D.O. water quality criterion at all times including summer, low flow critical conditions. The D.O. criteria for the Warmwater Habitat streams is a 5.0 mg/l average over a 24-hour period and a 4.0 mg/l minimum at all times of the year including summer, low flow conditions.

Ammonia-N

Ohio's water quality standards for ammonia nitrogen are based on the stream's designated use, pH and temperature. The standards are tabularized and can be found in OAC 3745-1-07, Tables 7-2 through 7-8 and are protective of aquatic toxicity. Table 9 of this report details the standards and existing conditions as measured in 1995 for those segments with ammonia as a cause of impairment in Ohio's1998 303(d) list and the upcoming 2002 303(d) list for this study area.

Siltation and Habitat

Siltation was identified as a major cause of impairment in the Blues Creek sub-watershed. OAC 3745-1-04 states that all waters of the state shall be free from suspended solids and other substances that enter the waters as a result of human activity and that will settle to form objectionable sludge deposits, or that will adversely effect aquatic life. However, no statewide numeric criteria have been developed specifically for siltation or TSS. Instead, target Qualitative Habitat Evaluation Index (QHEI) scores, based on reference data sites for some of the aquatic life use designations, can be used as surrogates. The QHEI is a quantitative composite of six physical habitat variables used to 'score' a stream's habitat. The variables are: substrate, instream cover, riparian characteristics, channel characteristics, pool/riffle quality, and gradient and drainage area. It can be used to assess and evaluate a stream's aquatic habitat, and determine which of the six habitat components need to be improved to reach the QHEI target score. The substrate variable incorporates substrate quality and quantity and therefore, provides a numeric target for siltation. The Warmwater Habitat use designation QHEI target is 60. In addition, since habitat is strongly correlated with the IBI biocriterion, the QHEI provides a target and format to evaluate how habitat issues and impairments effect attainment of the aquatic use designations.

Pesticides

Pesticides are a major concern in the Crosses Run sub-basin. The standards are tabularized and can be found in OAC 3745-1-07 and are protective of aquatic toxicity. Table 9 of this report details the standards and existing conditions as measured in 1995

for those segments with pesticides as a cause of impairment in Ohio's 1998 303(d) list for this study area.

Biocriteria
The biocriteria are the final arbiter of attainment of a use designation. After the control strategies have been implemented, biological measures including the IBI, ICI, QHEI and MIwb will be used to validate biological improvement and biocriteria attainment. The current attainment of the biocriteria along with the applicable standards is listed in Section 2.0, Table 4.

3.2 Current Deviation from Target

Dissolved Oxygen
Dissolved oxygen data were collected under various flow and loading conditions in 1986 and 1995. Continuous monitors detected a well-defined D.O. sag over an approximate six-mile stretch between the Marysville WWTP and Crosses Run (RMs 18.14 -11.7). The lowest concentrations were recorded at RM 17.4 (adjacent Waldo Road) where most of the measurements were well below the minimum warmwater habitat (WWH) criterion of 4.0 mg/l.

Ammonia-N
Table 8 suggests that ammonia nitrogen is not a specific cause of impairment in those segments cited in the 1998 303(d) list as impaired. However, ammonia nitrogen is a component of the dissolved oxygen depletion and as such will still be indirectly included in this TMDL report for the Mill Creek mainstem. Data collected subsequent to that used for the 1998 listing indicates that Crosses Run is impaired due to high levels of ammonia. Table 9.3 shows that ammonia levels measured in Crosses Run substantially exceed the applicable water quality criteria.

Siltation, Habitat, & Biocriteria
As previously noted, the deviation or the attainment of the IBI, ICI, MIwb and QHEI is detailed in Appendix A and Figures 5, 7 and 8 in the following chapter.

Table 9. Median values and water quality standards for dissolved oxygen in Mill Creek (1995 survey)

Stream Segment \ Water Body ID# [Upper River Mile / Lower River Mile]	**Median** - mg/l (# samples)[A]	**WQS** - mg/l	**Deviation** - mg/l (% reduction)
Mill Creek \ OH35 9 Headwaters to Otter Run [48.87/23.80]	6.76 (93)	**5.0**	NA
Mill Creek \ OH35 1 Otter Run to Scioto River [23.80/0.00]	4.61 (468)	**5.0**	0.39 (8%)

[A] Samples from hourly measurements taken over a 3-day period.

Table 9.1 Median and target values for phosphorus in the Mill Creek watershed (1995 survey)[2]

Stream Segment \ Water Body ID# [Upper River Mile / Lower River Mile]	**Median** - mg/l (# samples)	**Target** [1] - mg/l	**Deviation** - mg/l (% reduction)
Crosses Run \ OH35 8 [2.8/0.00]	0.44 (16)	**0.11**[2]	0.33 (75%)
North Branch Crosses Run OH35 8.1 RMs 2.10 to 0.00	1.2 (9)	**0.11**[2]	1.1 (91%)

[1] Source: Association Between Nutrients, Habitat, and the Aquatic Biota in Ohio Rivers and Streams (Ohio EPA Technical Bulletin MAS/1999-1-1): ECBP (Eastern Corn Belt Plains) Ecoregion Criteria -- Table 2 - TP

[2] The biocriteria and chemical criteria determine the impairment not the total phosphorus target. Therefore, the target may be exceeded yet the segment be in attainment if the biocriteria attains; or, the target may be met but the biocriteria does not so the segment is considered impaired. The target is a guideline to meet biocriteria, not an absolute reference.

Table 9.2 Median values and water quality standards for pesticides in Crosses Run (1995 survey)

Stream Segment \ Water Body ID# [Upper River Mile / Lower River Mile]	**Exceedance**[3] ug/l	**WQS** ug/l	**Deviation** - ug/l (% reduction)
Crosses Run \ OH35 8 [2.8/0.00]			
Aldrin	0.023	**0.0008**	0.022 (97%)
d-BHC	0.128	**0.01**	0.12 (94%)
Dieldrin	0.16	**0.0008**	0.15 (95%)
Endosulfan I	0.009	**0.003**	0.006 (66%)
Endrin	0.011	**0.002**	0.009 (82%)
Heptachlor	0.003	**0.0028**	0.0002 (7%)

[3] Exceedences of aquatic life Water Quality Standards based on water column samples collected in Crosses Run and North Branch Crosses Run in 1995.

Table 9.3 Ammonia-N targets and existing conditions

Stream Segment \ Water Body ID# [Upper River Mile/ Lower River Mile]	**Aquatic Life Use Designation**[1] 303 (d) list	**Ammonia-N Criteria** (mg/l)		**Instream Ammonia-N** (mg/l)[3]	
		Outside Mixing Zone Maximum [pH/temp]	Outside Mixing Zone Average [pH/temp]	Maximum (# samples)	Mean (# samples)
Mill Creek \ OH35 9 Headwaters to Otter Run [48.87/23.80]	WWH	9.1 [8.0/24.4]	1.0 [8.0/24.4]	0.30 (24)	0.12 (24)
Mill Creek \ OH50 4 (Otter Run to Scioto River) [72.70/63.70]	WWH	9.1 [7.8/24.6]	1.0 [7.8/24.6]	5.46 (76)	0.17 (76)
Crosses Run \ OH35 8 [2.80/0.00]	WWH	4.7 [8.0/22.0][3]	0.6 [8.0/22.0][3]	39.7 (16)	3.73 (16)
North Branch Crosses Run \ OH35 8.1 [2.10/0.00]	WWH	13 [7.6/16.0][4]	0.6 [8.3/22.0][2,3]	51.7 (9)	7.86[5] (9)

[1] Aquatic Life Use Designations are based on the proposed/recommended use designations as determined by the 1995 biological and water quality survey of the Mill Creek Basin.

[2] For the chronic condition, the pH and temp. were from Crosses Run downstream of North Branch Crosses Run.

[3] From 1995 Mill Creek water quality survey (STORET data).

[4] Datasonde data, 2000.

[5] Mean value used as required by OAC 3745-2-05 (3)(a) for allocation purposes when less than 10 observations.

3.3 Source Identification

The major source of oxygen demanding substances and nutrients in the Mill Creek mainstem during the critical low flow periods is the Marysville municipal wastewater treatment plant. No significant non-point sources are suspected. The predominant source of impairment in the North Fork Crosses Run and Crosses Run comes from nutrient and pesticide loading from the Scotts operation. In the Blues Creek sub-basin, the largest cause of non-attainment on a yearly basis is sediment loading resulting in siltation. Lack of riparian cover and channelization, particularly in the upper reaches of Blues Creek, contributes to this non-attainment. Source identification is covered in more detail in Section 2. Allocation of loads follows in Section 4.

4.0 TOTAL MAXIMUM DAILY LOADS

A TMDL is a means for recommending controls needed to meet water quality standards (WQS) (USEPA, 1991). 40 CFR 130.2(i) states that a TMDL calculation is the sum of the individual wasteload allocations for point sources and the load allocations for nonpoint sources and natural background in a given watershed, and that TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.

The attainment of WQS in Ohio requires meeting criteria based on the health of the aquatic biological community (biocriteria). Chemical water quality criteria are established as a surrogate for direct measurement of the aquatic biological community to allow a determination if a particular pollutant is present in amounts that are projected to cause impairment in an aquatic biological community. By limiting the loads of critical pollutants, a TMDL establishes a level of the pollutant(s) whereby an impairment to the aquatic biological community is projected to be eliminated. In Ohio, this approach will be judged to be successful when direct measurement of the aquatic biological community results in the attainment of biocriteria.

Some pollutants which affect aquatic organisms may be most appropriately measured with indirect, or surrogate, measurements. For example, the chemical measurement $CBOD_5$ is a surrogate measurement for the amount of carbonaceous material in the water column that ultimately results in the water quality condition of low dissolved oxygen. Establishing loads for the surrogate pollutant $CBOD_5$ has long been recognized as an appropriate and effective method for dealing with an observed environmental condition (low D.O.) that results in impairment of the aquatic biological community.

Based on an extensive database of synoptic measures of the aquatic communities and habitat quality, Ohio EPA has established a direct association between poor habitat quality (as measured by the QHEI) and impaired biological communities. The condition of human-induced physical and hydrologic habitat modification has the obvious effect of physical removal of dwelling places for aquatic life. Where habitat quality is poor, there is a complex interaction between the remaining biota, and the pollutants heat, sediment, nitrate and phosphorus. This biologically mediated interaction can result in the water quality condition of low dissolved oxygen, particularly during the night. Ohio has designed a functional measure of habitat, the QHEI, that can be used as a surrogate to establish a target by which reduction in the loading of the pollutants heat, sediment, nitrate and phosphorus can occur. Reducing the pollutant loads and improving the habitat quality will limit the aforementioned negative interactions. As in the case where achieving target loads for the surrogate pollutant $CBOD_5$ is expected to result in an improved dissolved oxygen regime in a stream, achieving habitat targets based on the QHEI are expected to have a similar result.

Degraded or poor habitat results in impairment in the Mill Creek watershed particularly in Blues Creek. Identification of which aspects of the habitat are degraded at particular points in the watershed is provided in this report as are benchmarks which can be used to set habitat goals. This is analogous to allocations of loads for pollutants. These recommended habitat 'allocations' are a necessary means to meet biocriteria (in

combination with the other TMDLs described above) and as such are a habitat 'TMDL'.

Phosphorus and pesticides, two impairing causes in the Crosses Run watershed, are load based parameters and TMDLs are calculated for them (see Table 11). Dissolved oxygen is a condition of the water column and is not a load based parameter; however, a low level of dissolved oxygen is an impairing cause particularly during the low flow, high temperature summer months. Reductions in oxygen-demanding substances in the Mill Creek mainstem are needed, specifically for those loads that are consistently discharged to the streams during low-flow conditions. Namely, ammonia nitrogen (NH_3-N) and carbonaceous material which exerts a biochemical oxygen demand (CBOD). TMDLs for these parameters are included in Table 11 of this report.

The TMDL calculation must also include either an implicit or explicit margin of safety that accounts for the uncertainty concerning the relationship between pollutant load or the pollution (the non-load causes of impairment) and water quality. The calculations, then, provide a numeric basis for addressing the impairing causes.

4.1 Method of Calculation

Different analysis techniques were selected to address the various problems in the Mill Creek watershed, these methods are summarized in Table 10. These are:

1. The Mill Creek mainstem is impaired from river mile 23.8 to its mouth by inadequate D.O. concentrations during the summer, low flow months. The QUAL2E model is capable of simulating instream D.O. under these conditions and was used to determine the TMDL's of pollutants which contribute to the low D.O.

2. The Crosses Run sub-watershed is impaired by high levels of nutrients from storm water runoff and by legacy pesticides in the sediments. The quantity of runoff under a design storm condition was estimated using the TR-55 runoff model. The nutrient quality of the runoff was then allocated by using the mass balance model CONSWLA (OEPA 1987c) The pesticides in Crosses run were allocated only to non-point sources. The load was derived using summer low flow stream data and concentration data collected instream.

3. The Blues Creek sub-watershed is impaired due to poor habitat. The Qualitative Habitat Evaluation Index (QHEI) was used to establish current habitat conditions and quantifies desired habitat goals.

4.1.1 Mill Creek

The Marysville WWTP contributes the majority of the loads to the Mill Creek mainstem Figure 6 . A means to predict the chemical response that occurs within the stream to such input loads was required. The Enhanced Stream Water Quality Model (QUAL2E) predicts the instream chemical concentration response to various inputs and stream conditions.

QUAL2E represents the stream as a series of computational elements grouped together within a specified stream reach. A reach is defined as a length of stream that has similar physical properties (gradient, cross section, etc.) and rate constants (decay, settling, source). QUAL2E conceptualizes the stream as a sequential series of completely mixed reactors (the computational elements) (Brown and Barnwell, 1987). It calculates the output from each computational element based on the input from the previous element and on reactions that occur within the element itself.

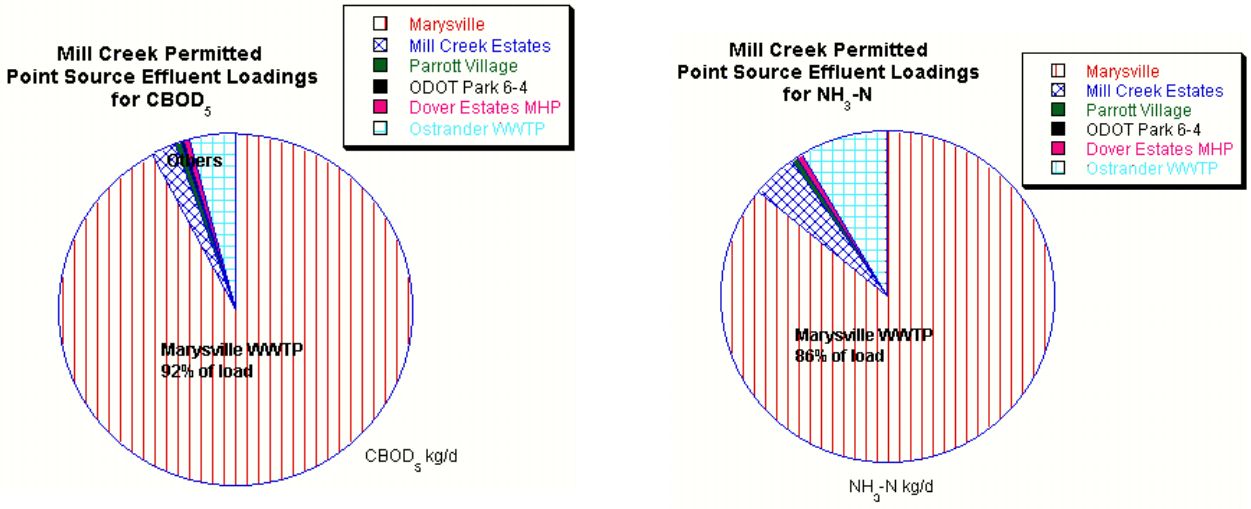


Figure 6. Permitted $CBOD_5$ and Ammonia Loadings for Point Source Discharges in Mill Creek

QUAL2E has been used extensively for many years and is a USEPA-approved model. It is appropriate for use only with steady, non-variable stream flows. It was used in this project to predict the instream concentration of CBOD, dissolved oxygen, nitrogen compounds, and phosphorus during low-flow, summer conditions within Mill Creek. These conditions are considered very stressful to stream biota, and therefore, allocations of loads need to be protective of this critical state. QUAL2E simulates instream concentrations which can then be compared to WQS to evaluate if violations of these numeric criteria have the potential to occur. Inputs such as point source loads can be adjusted until the predicted instream concentrations meet the WQS. This provides a means of developing the wasteload allocation portion of the TMDL equation.

The model was calibrated using data sets collected in 1986. Hydraulic variables were calibrated first followed by the chemical parameters (biochemical oxygen demand, the nitrogen compounds, and phosphorus) and lastly by dissolved oxygen. The model accuracy (how well the model results compare with observed data) was good; the median relative error in dissolved oxygen was 3% for the 1986 data set. This compares favorably to the results of a study of the median dissolved oxygen relative error of approved models for various rivers around the country (Thomann, 1980) which showed that fifty percent of the models had median relative error in D.O. of greater than 10%. Refer to Appendix C for more details on the QUAL2E modeling.

4.1.2 Crosses Run

Scotts is a major source of biological and chemical impacts to the Crosses Run sub-watershed that may extend downstream into Mill Creek. The extremely high NH_3-N levels in Crosses Run and the North Branch of Crosses Run result primarily from direct runoff from the facility via six storm water outfalls. Ohio EPA sampling identified pesticide and organic chemical contamination in soils and sediments associated with landfilling of product and field broadcast of off-specification pesticide products. Sampling in 1995 revealed exceedences of aquatic life and human health water quality criteria for pesticides downstream from the facility.

In order to calculate a TMDL for these pollutants, two items were required: a critical condition flow value from the source of the pollutant and an allowable concentration of the pollutant in that flow. In the case of Scotts, NH_3-N and phosphorus in the form of fertilizer and/or raw materials have the potential to reach the stream during rain events. Stormwater sampling data submitted by Scotts showed concentration of ammonia and phosphorus as hig as 304 mg/l and 20 mg/l, respectively. A specific critical flow value is difficult to determine for these outfalls due to the infinite variety and magnitude of possible storms occurring over varying periods of time.

To provide a reasonable and scientifically defensible estimation of the storm runoff which occurs at the Scotts facility, the Technical Release 55 (TR-55) method from the United States Department of Agriculture, Natural Resources Conservation Service (NRCS - formerly the Soil Conservation Service) was used as a model for this scenario. TR-55 is a simplified procedure to calculate the storm runoff volume, peak rate of discharge, hydrographs and storage volumes required for storm water management structures in both urban and agricultural areas and at selected points along the stream system (USDA 2002). Hydrographs are routed downstream through channels and/or reservoirs and multiple sub-areas can be modeled within the watershed.

The TR-55 model only predicts the runoff flow to the stream from a design storm; it does not predict the chemical response that occurs within the stream to such loads. To address this, the Conservative Substance Wasteload Allocation Program (CONSWLA) was used to determine the NH_3-N toxicity allocation. The CONSWLA model predicts the instream chemical concentration response within Crosses Run by automating the allocation of conservative pollutants for multiple-discharger/multiple-stream systems. CONSWLA allocates initially by distributing the available assimilative capacity for each conservative among the discharge points (outfalls) along the stream according to flow based proportioning factors. When allocations are reduced to meet the water quality criteria, the relinquished capacity is distributed among the other outfalls. Though NH_3-N is not usually considered a conservative parameter, the large loading rates from storm runoff results in a conservative toxic effect on the aquatic life in Crosses Run. The short instream travel times also provide little opportunity for NH_3-N to be removed though natural processes; it is therefore assumed to be affected only by dilution.

4.1.3 Blues Creek

Blues Creek, in the Mill Creek watershed, is not attaining its use designation due primarily to habitat degradation and sedimentation as a result of habitat degradation. The habitat quality was evaluated using the Qualitative Habitat Evaluation Index (QHEI) developed by the Ohio EPA for streams and rivers in Ohio (Rankin, 1989, 1995). Various attributes of the habitat are scored based on the overall importance of each to the maintenance of viable, diverse, and functional aquatic faunas. The type(s) and quality of substrates, amount and quality of instream cover, channel morphology, extent and quality of riparian vegetation, pool, run, and riffle development and quality, and gradient are some of the habitat characteristics used to determine a QHEI score from 20 to less than 100. The QHEI is used to evaluate the characteristics of a stream segment, as opposed to the characteristics of a single sampling site. As such, individual sites may have poorer physical habitat due to a localized disturbance yet still support aquatic communities closely resembling those sampled at adjacent sites with better habitat, provided water quality conditions are similar. QHEI scores from hundreds of segments around the state have indicated that values greater than 60 are *generally* conducive to the existence of warmwater aquatic faunas whereas scores less than 45 generally cannot support an aquatic assemblage consistent with the warm water habitat biological criteria. Scores greater than 75 frequently typify habitat conditions having the ability to support exceptional warmwater aquatic faunas. The QHEI can be used as a guide to direct restoration efforts for habitat and provides a monitoring tool to measure progress towards habitat goals.

4.2 Critical Conditions and Seasonality

TMDL development should specify the environmental conditions assumed to define allowable loads. Determinations of TMDLs must take into account critical conditions for stream flow, loading, and water quality parameters (40 CFR 130.7(c)(1)). The critical condition is defined as the set of environmental conditions that, if controls are designed to be protective of them, will ensure attainment of objectives for all other conditions. Seasonality is defined as a description of the method chosen which considers seasonal and inter-annual variation. Seasonality is addressed in this TMDL by taking into account the various conditions which exist that influence the source of the loads and their instream reaction through out the year.

4.2.1 Mill Creek

The critical condition for instream dissolved oxygen concentrations in Mill Creek is expected to be the summer low-flow period. This sensitive period is the most conducive to algal growth, high instream temperatures, and low stream flows. Further, Mill Creek is effluent dominated during lower flow conditions typical of the summer. Therefore, the observed summer concentrations were compared to the water quality criteria and used to estimate the necessary loading reductions. Seasonality in Mill Creek was considered for the winter condition as well. During this period, water temperatures are lower, D.O. saturation levels are higher, stream flows are typically higher and the aquatic vegetation is reduced. Therefore, the majority of the factors causing low D.O. concentrations in the

Mill Creek do not exist in the winter months, and there is no reason to believe that low dissolved oxygen levels occur during the cold season. In addition, model runs under estimated winter conditions do not predict D.O. violations in the study area. Accordingly, winter TMDL calculations are not necessary and will not be presented in this report.

4.2.2 Crosses Run

The critical condition for Crosses Run occurs during a rainfall event. A 2 year, 24 hour storm was selected as the design storm because of its wide use in storm water modeling and because of the general availability of daily rainfall data that's used to estimate 24-hour rainfall amounts. This design storm spans most of the applications of TR-55 and is recommended by NRCS. It is protective of critical conditions because it represents a low frequency high volume rain event. When compared to local weather data, a storm of this type occurs less then one percent of the time. By protecting for this higher than normal runoff condition, more frequent runoff situations should maintain the water quality criteria.

Seasonality is addressed for ammonia (NH_3-N) by the selection of summer season ammonia criteria, which is the critical condition for ammonia toxicity, and thus protective for other seasons. The selection of a storm event with a recurrence interval determined on an annual basis as opposed to a seasonal basis ensures that allocations are adequate to protect in all seasons. Total phosphorus criteria is applicable only during the summer. Therefore, flows were derived using ten years of rain data over the summer period for Crosses Run.

4.2.3 Blues Creek

Poor habitat is the limiting factor in this sub-watershed. It was evaluated under the most critical yearly condition which is the summer, low flow period. The QHEI results presented in Appendix C apply year around.

Table 10. Modeling approach summary

Model or Method	Parameters Analyzed	Goals	How was it used?
Enhanced Stream Water Quality Model (QUAL2E)	• D.O. • CBOD • NH_3-N • Nitrite • Nitrate • Phosphate • Organic phosphorus	Evaluate the instream water quality under non-varying flow conditions. Determine the loading level that the impaired streams can receive and still achieve Water quality criteria under low flow, critical conditions.	• Developed Mill Creek Mainstem TMDL. • Set Marysville WWTP permit limits to meet D.O. WQC.
Technical Release 55 (TR-55)	• Stormwater Runoff Flow	Determine amount of storm sewer discharge from a rain event on predominantly impervious surfaces.	• Estimated the flows for each stormwater outlet for Scotts and for the upstream flow based on a 2 year, 24 hour design storm.
Mass Balance Approach (CONSWLA)	• NH_3-N • Phosphorus • Pesticides	Determine the loading level that the impaired streams can receive and still achieve Water quality criteria under low flow, critical conditions.	• In conjunction with TR-55 (NH_3-N), determined loading to Crosses Run resulting from storm related runoff.
Ecological Assessment Techniques and Models	• TSS • IBI • ICI • QHEI 1. Substrate 2. Instream cover 3. Riparian quality	Establish targets for parameters with no criteria. Evaluate parameters which are not directly incorporated in the other models. **Directly address the biocriteria impairment issues.**	• Determine numeric targets for phosphorus and habitat where no criteria exists 2.Compare attaining reference sub-watersheds to impaired sub-watersheds in the Mill Creek watershed. Assist in determining needed changes in Blues Creek. 3.Determine effects of habitat characteristics on instream concentrations of nutrients, and dissolved oxygen.

4.3 Margin of Safety

The statute and regulations require that a TMDL include a margin of safety to account for any lack of knowledge concerning the relationship between load and wasteload allocations and water quality (CWA § 303(d)(1)(C), 40 C.F.R. § 130.7(c)(1)). EPA guidance explains that the margin of safety (MOS) may be implicit, i.e., incorporated into the TMDL through conservative assumptions in the analysis, or explicit, i.e., expressed in the TMDL as loadings set aside for the MOS. If the MOS is implicit, the conservative assumptions in the analysis that account for the MOS must be described. If the MOS is explicit, the loading

set aside for the MOS must be identified.

A margin of safety is incorporated implicitly into these TMDLs. There are several areas where an implicit margin of safety is incorporated including: the 303(d) listing process, the target development, the model inputs and application. An explanation for each of these areas is provided below.

4.3.1 TMDL Priority 303(d) Listing

It is important to keep in mind during the evaluation of the TMDL a major difference in Ohio's program from other state programs. In Ohio, a stream segment is listed on the 303(d) list is for failure to attain the appropriate aquatic life use as determined by direct measurement of the aquatic biological community. Many other regional or state programs rely solely on chemical samples in comparison to chemical criteria to determine water quality and designated use attainment. However, relying solely on chemical data does not take into account any of the parameters or other factors for which no criteria exist but that affect stream biology nor does it account for multiple stressor situations. Therefore, the chemical specific approach misses many biologically impaired streams and may not detect a problem until it is severe. Ohio's approach incorporates an increased level of assurance that Ohio's water quality problems are being identified. Likewise, de-listing requires attainment of the aquatic life use determined by the direct measurement of the aquatic biological community. This provides a high level of assurance (and an implicit margin of safety) that if the TMDL allocations do not lead to sufficiently improved water quality then the stream remains on the list until true attainment is achieved.

4.3.2 Target Development

The use of nutrient targets that are based on data from relatively unimpacted reference sites provides an additional implicit safety factor. These data constitute a background concentration of nutrients in a stream; unimpacted streams generally have nutrient levels well below those needed to meet biological WQS. As the stream becomes impacted, nutrient levels can rise, but the stream can still meet WQS based on other factors such as the presence of good habitat. Once the nutrient levels rise high enough or other factors change which no longer mitigate the affects of nutrients then the biological community is impacted, and the stream is impaired. By using nutrient targets based on data from relatively unimpacted sites (or sites that are conservatively in attainment of biological water quality criteria) the targets themselves are set at a conservative level. In other words, water quality attainment is likely to occur at levels higher than these targets and the difference between this actual level where attainment can be achieved and the selected target is an implicit margin of safety.

A further conservative assumption implicit in the target development lies in the selection of the statistic used to represent the phosphorous target which corresponds to an unimpaired biological community. Since Ohio EPA's evaluation of phosphorus data for generating target values is based on measured performance of aquatic life and since full attainment can be observed at concentrations above this target (reinforcing the concept that habitat and other factors play an important role in supporting fully functioning biological

communities), it would be valid to argue that a 95th percentile of these values (to exclude outliers) would be protective of the respective aquatic life use. Instead, Ohio EPA selected the median value associated with measured aquatic life performance. The selection of this statistic is an implicit margin of safety in these TMDLs.

The habitat targets were selected using a method analogous to the nutrients method. The habitat targets and the specific aspects of the habitat that are degraded as provided with the QHEI model combine to add another layer of potential protection to achieving the WQS by providing additional guidance on an alternate means to reduce the nutrient load to the stream, mitigate the impacts of the nutrients in the stream, and directly improve an aspect of stream ecology vital to the biological community. Ohio EPA's ability to add habitat targets, and provide guidance on the improvement of the habitat is an implicit margin of safety made possible through extensive ecosystem monitoring and analysis, and should be recognized as a margin of safety in these TMDLs.

4.3.3 Model Inputs and Application

Conservative modeling assumptions also implicitly incorporate a margin of safety into the project especially for the dissolved oxygen "TMDL". Some of these conservative assumptions include, for the Mill Creek mainstem,

- Including an incremental inflow component per reach at water quality concentrations representative of elevated background levels. Assigning higher loads to this source incorporates potential nonpoint source inputs such as higher levels of nitrate in the groundwater due to current agricultural or urban fertilization practices (which are expected to decrease as part of the watershed action/implementation plan actions);

- Assuming a low flow condition (7Q10) which has a very small recurrence interval (water quality criteria generally do not apply to flow conditions that have a statistical recurrence interval lower than the lowest 7 day consecutive flow in any 10 year period (the 7Q10); and,

- Using moderately high instream temperatures.

For Crosses Run, some of conservative assumptions include

- Choosing a design storm with a low frequency of occurrence in the Crosses Run sub-watershed. Since wet weather is the critical condition, selecting an infrequent design storm increases the probability that the water quality criteria (WQC) will be protected during the majority of actual storms.

- The TR-55 model over-estimates runoff from what is typically observed in this region during the summer period. The calculated flows from the TR-55 model were higher then expected from the USGS gage readings in the area.

- The amount of rain produced by a 2 year, 24 hour storm is 2.6 inches. This amount of rain is received in the area less then 1% of the time.

4.4 TMDL Calculations

The TMDL calculations for each of the three impaired streams in the Mill Creek watershed are presented below.

4.4.1 Mill Creek Mainstem

Results of field surveys in 1986 and 1995 revealed the presence of a D.O. sag downstream of the Marysville WWTP. The necessary loading reductions needed to meet the criteria were estimated with the QUAL2E water quality model. This model simulates the instream response of D.O. to varying levels of point source discharges of $CBOD_5$, NH_3-N, and D.O. This model was calibrated to the 1986 Data set and the results confirmed this violation of instream dissolved oxygen downstream of Marysville. In order to meet the minimum 24-hour average D.O. standard of 5.0 mg/l in Mill Creek, the effluent quality of the Marysville WWTP would need to improve. The current permit limits for NH_3-N and $CBOD_5$ are inadequate to meet this standard. See Table 11 for the results of the modeling and Appendix C for further discussion of the QUAL2E model.

4.4.2 Crosses Run

TMDLs for Crosses Run were calculated for pesticides, total phosphorus, habitat and ammonia nitrogen (NH_3-N). Discussion of each of these follows.

4.4.2.1 Pesticides

The TMDL for pesticides was calculated with a mass balance approach using the median instream 1995 summer concentrations at the most downstream sampling location in the study area and the appropriate summer low flow assumptions. The 7Q10 stream flow was applied for the aquatic life criteria and the harmonic mean flow for the human health criteria. The most stringent criteria was then chosen for the load calculation. The pesticide loads were allocated only to the non-point source because the source of in-stream pesticide concentrations are from the sediment which is attributed to legacy non-point activity. See Table 11 for the TMDL values.

4.4.2.2 Total Phosphorus

Ohio currently does not have WQC for total phosphorus (TP). However, the Ohio EPA has developed TP targets applicable to an average or cumulative condition. The concentration used for the TP load was from the “Associations Report” (OEPA1999) and is based on an association between nutrient, habitat, and the aquatic biota in riverine ecosystems within specific ecoregions (see also Appendix G). This suggested phosphorus target is considered protective of aquatic life in the Crosses Run sub-watershed. The point source concentration was a set value due to administrative limitations. The non-point source and the natural load concentrations were set at an empirical value which represents the unimpacted stream data collected in the Scioto River Watershed (OEPA,1988). Since the source of TP is wet weather runoff, which is not reflective of the typical summer condition, a cumulative mass balance approach was used. Accordingly, a total maximum load for the

four month summer period was developed (a TMSL).

The general approach in determining the TMSL was to calculate the total volume of water from Crosses Run over a four month summer period (June to September) and multiply this by the TP target to get the total allowable summer load. This load was allocated by determining the total summer flows applicable from Scott's runoff (for the WLA), from base flow (for the background allocation), and from the rest of the sub-watershed runoff minus Scott's the background allocation, a 1 mg/l concentration was assumed for the WLA and the mass balance equation was solved for the allowable concentration from the non-point source.

The total summer flow volume was calculated by adjusting ten years of data from the Mill Creek USGS gage at Bellepoint to estimate the flow at the mouth of Crosses Run using a drainage area yield relationship. The mean daily flow in cubic feet per second was converted to cubic feet per day and these total daily flow volumes were summed to get the total summer flow volume per year from 1990 to 2000. These values were then averaged to get the average total summer flow volume.

To determine the point and non-point load allocation, the runoff value from the TR-55 model needed to be adjusted to estimate the typical total summer runoff. To do this, the total average precipitation recorded over the same ten year period at the Mill Creek gage was examined and all precipitation amounts less then 0.25 inches were deleted from the data set because rainfall of this amount or less produces little if any runoff due to evapotranspiration (Kawa Stream TMDL2002). This adjusted precipitation data was then divided by the predicted precipitation from the TR-55 design storm hydrograph. This ratio was multiplied by the total volume of runoff from Scotts for the point source and the predicted runoff to Crosses Run at the mouth for the non-point fraction to estimate the cumulative storm runoff from each source.

4.4.2.3 Ammonia-nitrogen

To determine the acute condition point source allocations, TR-55 in conjunction with the instream wasteload allocation model CONSWLA was used to determine discharge limits for NH_3-N in the Crosses Run sub-watershed. North Branch Crosses Run contains six interactive storm sewers for the Scotts facility. TR-55 estimates the individual peak runoff rates from all six sub-catchment of the facility and the upstream flow to a program specified storm duration and frequency. This "design storm" imposes a specific time distribution of rainfall uniformly in space over the watershed. The time distribution for this watershed is a type II distribution with a 24 hour duration and a reoccurrence interval of two years. The 24-hour time period was chosen because of the availability of data and the suitability of the time span to the applications of TR-55. The rainfall is converted to runoff with the Runoff Curve Number method supplied by the program. A unit hydrograph is obtained from a table based on subarea and rain event specific variables. TR-55 predicted a rain depth over the catchment area of 2.6 inches and is assumed to be distributed uniformly across the sub-watershed.

The predicted flows were then used in the CONSWLA model which distributes the loading capacity of the stream among the six storm water outfalls by calculating the maximum

concentration (based on the applicable acute water quality criteria of the specified pollutant that can be safely released to the stream and still maintain the WQC. No outfall interactivity exists on the Crosses Run mainstem as it receives only one storm water discharge, therefore its wasteload allocation is simplified. Refer to Table 11 for the results of the modeling.

The conditions which exist for the chronic NH_3-N water quality criteria facilitated the need to apply a similar method outlined in section 4.4.2.2 to derive the flows needed to calculate the NH_3-N loads for this criteria. As with the conditions mentioned above with phosphorus, the chronic, 30-day average criteria requires a specific flow regime which doesn't apply to the runoff flows of a single storm event. Therefore, a Total Monthly Maximum Load (TMML) was developed. With this approach, the typical monthly runoff conditions during the summer were estimated using the yield adjusted summer flow data along with rain depth recorded at the Mill Creek gage. The NH_3-N concentration for the TMML relied on the applicable water quality criteria for a warmwater habitat under summer conditions and is based on downstream pH and temperature data collected in Crosses Run. The non-point concentration was calculated and the natural load concentration was based on unimpacted site data. See Appendix C for more details.

Table 11. TMDLs and Allocations

Sub-watershed (Identification #)	TMDL[2]	TMDL Allocations		
		Background[1]	WLA [1]	LA [1]
Ammonia-nitrogen				
Mill Creek (kg/d)	**15**	0.03	15	0.1
Crosses Run - Acute Condition (kg/hr)	**160**	0.046	145	15
Crosses Run - Chronic Condition (kg/mo, cumulative)	**736**	0.46	167	569
$CBOD_5$				
Mill Creek (kg/day)	**110**	1.2	106	3
Phosphorus				
Crosses Run - Chronic Conditions (kg/summer, cumulative)	**143**	2.9	77	63
Pesticides				
Crosses Run (mg/day)				
Aldrin	**0.48**	0	0	0.48
d-BHC	**1.39**	0	0	1.39
Dieldrin	**0.46**	0	0	0.46
Endosulfan I	**1223**	0	0	1223
Endrin	**0.88**	0	0	0.88
heptachlor	**1.71**	0	0	1.71

[1] TMDL = Total Maximum Daily Load; WLA = Wasteload Allocation (i.e., point source allocation); LA = Load Allocation (nonpoint source allocation less the natural background); Background = Natural.

[2] TMDL = Background + WLA + LA

4.4.3 Habitat Calculations for Blues Creek

The detailed QHEI results are presented in Appendix D, and the QHEI scores per river mile are shown graphically below in Figures 7 and 8. Figure 7 shows the longitudinal QHEI score and Figure 8 the deviation of the QHEI score from the target per sampling site. These figures highlight where the habitat is degraded and to what extent. The potential to achieve WWH in the impaired section (RM 11.9 to the mouth) is limited by the number of modified habitat attributes (mean QHEI = 55). High influence modified habitat attributes (i.e., those strongly associated with impaired biological performance (Rankin, 1995) encountered in the reach upstream from Ostrander (river mile 0.6) included silt substrates, sparse cover, no sinuosity, and channelization. An accumulation of two high influence attributes is likely to preclude fish communities from meeting WWH. Moderate influence

attributes have less effect on the fish community, such that five to six moderate influence attributes can sometimes be present without precluding a WWH fish community, especially when the influence extends to only a small reach. The five sites sampled upstream from Ostrander each had one to seven moderate influence attributes, with low sinuosity and current and fair to poor channel development being common to nearly all of the sites.

The other pattern evident in the QHEI matrix is that all the riffles are at least moderately embedded with fine gravel, sand and silt and this becomes progressively worse further upstream. These two patterns are related as the practices resulting in modified habitat attributes in the headwaters and tributaries result in the bedload of sediment that infiltrates the riffles throughout the mainstem particularly in the upper reaches. Other pervasive sources of sediment loads affecting the mainstem are eroding banks, especially where the riparian buffers have been removed. In the impaired section downstream from SR 4, the habitat is otherwise capable of supporting WWH communities, with the habitat characterized by natural features derived from a free flowing channel interacting with glacial till and a fairly mature riparian corridor. A free flowing river allows for channel development *(i.e.*, riffle-pool-run sequences and sinuosity), glacial till provides a variety of substrate sizes, and woody debris augment structural complexity and cover. These characteristics generally exist downstream from SR 4 (in the impaired reach).

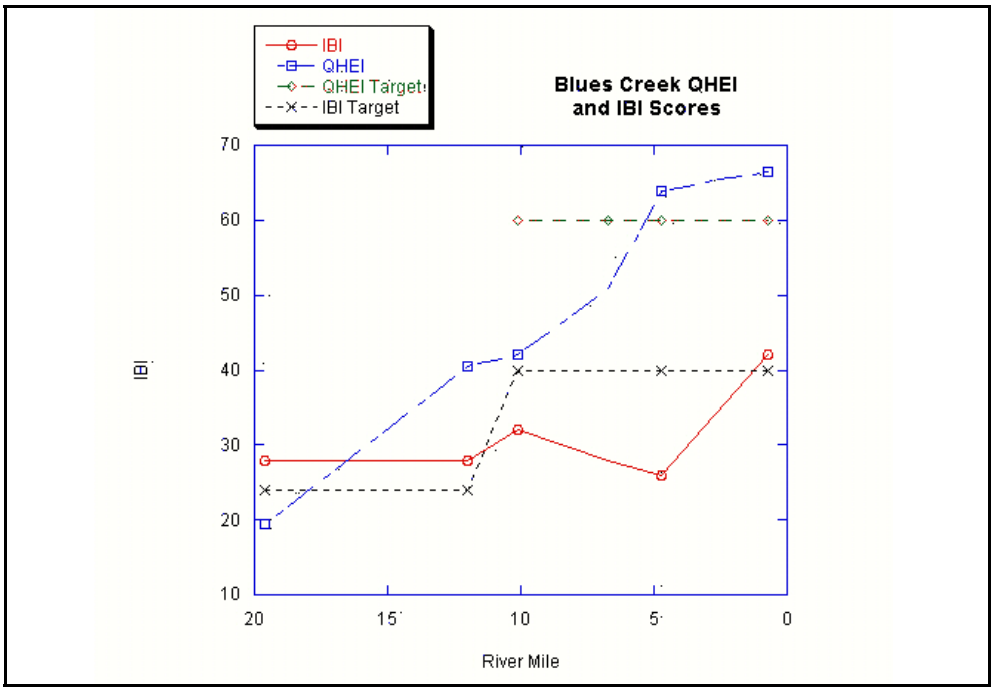


Figure 7. Longitudinal trends in IBI and QHEI scores in Blues Creek (2001), relative to target values

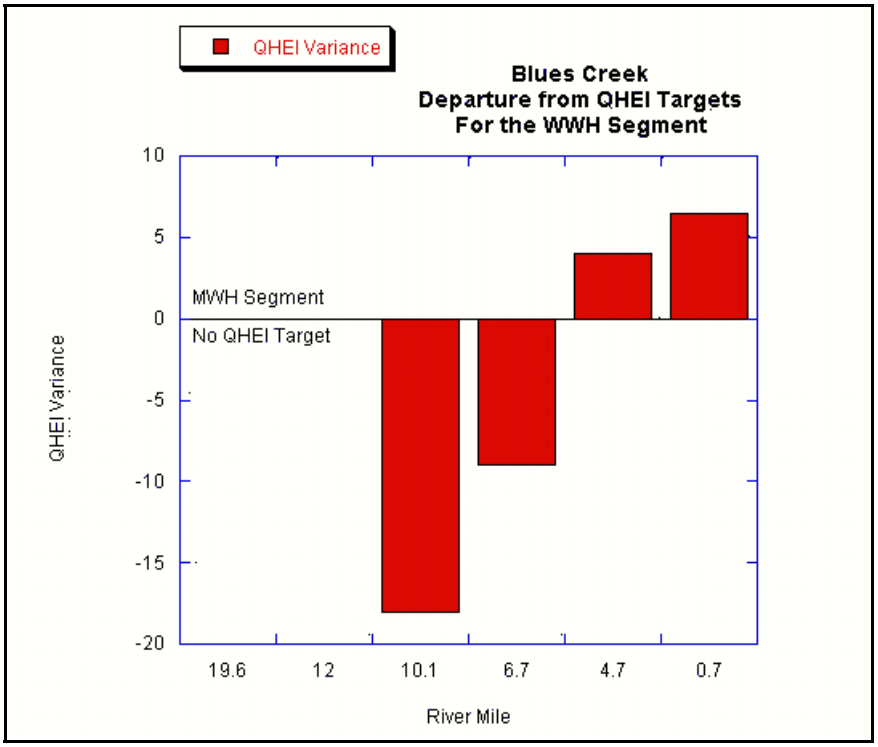


Figure 8. QHEI scores and deviation from target values in Blues Creek (2001)

5.0 PUBLIC PARTICIPATION

The Ohio EPA convened an external advisory group (EAG) in 1998 to assist the Agency with the development of the TMDL program in Ohio. The EAG met multiple times over eighteen months and in July, 2000, issued a report to the Director of Ohio EPA on its findings and recommendations.

Public participation associated with the Mill Creek TMDL project began with the hiring of a local watershed coordinator funded in part by a 319 grant. The grant was awarded in August 2000, and the watershed coordinator started soon thereafter, under the sponsorship of the Union County Soil and Water Conservation District Board of Supervisors. The watershed coordinator will develop a comprehensive, community-based watershed action plan by December 2002. Through the development of a watershed action plan, the watershed coordinator will identify strategies and set goals, coordinate implementation and develop a monitoring program to ensure local efforts are sustained to improve water quality. The watershed coordinator position has served as an essential local link between Ohio EPA and local government and citizens throughout the TMDL project, and will continue to serve in that capacity through implementation of the TMDL. Table 12 gives a summary of meetings that have been held concerning the watershed action plan and the TMDL project.

Consistent with Ohio's current Continuing Planning Process (CPP), Ohio EPA involved the public in the Mill Creek TMDL project by soliciting input and recommendations for action from many local parties. Although there was no organized watershed advocacy group existing in the Mill Creek watershed, after holding some initial meetings to solicit public involvement, the Bokes/Mill Creek Watershed Partnership was formed. The partnership is comprised of private citizens/landowners, agricultural community (farmers), municipal officials, government entities, environmental interest/advocacy groups and the industrial community. The partnership is serving the purpose of providing a body representative of local interests that could interact with Ohio EPA during the TMDL project and on other watershed issues. This group will continue to serve as a focal point for local citizen and government input to the TMDL project as the implementation process goes forward.

To better identify stakeholder concerns and problems affecting the watershed, the Bokes/Mill Creek Watershed Partnership originally developed five subcommittees (Administrative, Nonpoint Source Pollution, Point Source Pollution, Stream Flow/Habitat and Water Supply). Through these subcommittees, water quality/watershed concerns have been documented, including high levels of atrazine, high nutrient levels and the presence of logjams. The Nonpoint Source Pollution and the Stream Flow/Habitat subcommittees list logjams as a high priority concern, so the decision was made to merge the two subcommittees.

Public outreach activities also include a public comment period associated with the review of the draft TMDL report prior to its submittal to U.S. EPA Region 5. The draft TMDL report was public noticed on October 21, 2002, and a copy of the report was posted on Ohio EPA's web page (http://www.epa.state.oh.us/dsw/tmdl/index.html). In addition, copies of the report were distributed to local libraries. A summary of the comments received and

the associated responses is included in Appendix E. The Union Soil and Water Conservation District, Bokes/Mill Creek Steering Committee and watershed coordinator also facilitated the public notification and review of the draft TMDL report.

The 1998 303(d) list public comment period, and the selection of Mill Creek as a priority watershed for TMDL development, provided an additional opportunity for public input concerning information contained in the list (e.g., causes and sources of impairment, priority, restorability, etc.).

Public involvement is the keystone to the success of this TMDL project. Ohio EPA will continue to support the implementation process and will facilitate to the fullest extent possible an agreement acceptable to the communities and stakeholders in the study area and Ohio EPA. Ohio EPA is reluctant to rely solely on regulatory actions and strongly upholds the need for voluntary actions to bring this section of the Mill Creek watershed into attainment. The local leadership provided by the Bokes/Mill Creek Steering Committee and subcommittees will be instrumental in promoting further public involvement and implementation.

Table 12. Bokes/Mill Creek Watershed Partnership and other public participation

Date	Time	Subject(s)
11/8/00	9:30 a.m.	TMDL Project kick-off meeting, attended by local watershed coordinator
2/16/01	8:00 a.m.	Tour of the Mill Creek watershed.
2/21/01	2:00 p.m.	Initial public meeting concerning TMDL project; solicitation of items important to the public in terms of water quality.
6/5/01	9:30 a.m.	Second public meeting concerning TMDL project; solicit public's ideas for possible watershed group structure.
9/5/01	3:00 p.m.	Third public meeting concerning TMDL project; establish structure and membership of steering group.
9/12/01	3:00 p.m.	Initial meeting of Bokes/Mill Creek Watershed Partnership.
10/10/01	9:00 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Organization; establish subcommittee structure and draft mission statement.
11/14/01	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Subcommittee reports, TMDL issues on Bokes, Mill, and Blues Creeks.
11/28/01	4:15 p.m.	Administrative (Education) subcommittee meeting
12/4/01	7:30 p.m.	Nonpoint Source subcommittee meeting.
12/11/01	7:00 p.m.	Stream Flow/habitat subcommittee meeting.
12/12/01	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Subcommittee reports, TMDL issues on Bokes, Mill and Blues Creeks.
12/19/01	4:15 p.m.	Administrative subcommittee meeting
1/3/02	7:30 p.m.	Nonpoint Source subcommittee meeting.
1/7/02	1:00 p.m.	Water Supply subcommittee meeting

Date	Time	Subject(s)
1/9/02	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Subcommittee reports and discussion, review of TMDL report structure and timing.
1/21/02	7:00 p.m.	Stream Flow/Habitat subcommittee meeting
1/23/02	1:30 p.m.	Initial Point Source subcommittee meeting.
1/24/02	3:45 p.m.	Administrative subcommittee meeting
2/5/02	7:30 p.m.	Nonpoint Source subcommittee meeting.
2/7/02	1:00 p.m.	Water Supply subcommittee meeting
2/13/02	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Discussion of pollutants to be handled in the TMDL.
3/5/02	7:30 p.m.	First meeting of the combined Nonpoint Source and Stream Flow/Habitat subcommittee.
3/13/02	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Discussion of results of TMDLs, and by-laws.
3/27/02	9:15 a.m.	Farmers breakfast. Presentations on TMDLs, results of TMDLs, and natural channel design.
4/10/02	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Update on TMDL status and by-laws.
4/24/02	2:00 p.m.	Point Source subcommittee meeting.
6/12/02	9:00 a.m.	Bokes Creek/Mill Creek Watershed Tour
7/10/01	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Update on TMDL status and by-laws.
9/11/02	9:15 a.m.	Bokes/Mill Creek Watershed Partnership meeting. Discuss implementation and learn about QHEI.
The Bokes/Mill Creek Watershed Partnership continues to meet the 2nd Wednesday of each month		

6.0 IMPLEMENTATION AND MONITORING RECOMMENDATIONS

6.1 Implementation Strategies

Restoration methods to bring an impaired waterbody into attainment with water quality standards generally involve an increase in the waterbody's capacity to assimilate pollutants, a reduction of pollutant loads to the waterbody, or some combination of both. As described in Section 2.0, the causes of impairment in the Mill Creek basin are low dissolved oxygen attributable to organic enrichment, ammonia-N, nutrients, pesticides, sedimentation, and stream habitat degradation. Therefore, an effective restoration strategy for this TMDL will address point source load reductions and habitat improvements, in some areas, combined with some additional means of increasing the assimilative capacity of the stream.

The major source of oxygen demanding substances and nutrients in the Mill Creek mainstem during the critical low flow periods is the Marysville municipal wastewater treatment plant. No significant non-point sources are suspected. The predominant source of impairment in the North Fork Crosses Run and Crosses Run comes from nutrient and pesticide loadings from Scotts operation. In the Blues Creek sub-basin, the primary cause of non-attainment is the lack of riparian cover and poor stream habitat. Sediment loading, siltation and channelization, particularly in the upper reaches of Blues Creek, contribute to this non-attainment.

Sections 3 and 4 of this report identify pollutant reduction and other targets that are expected to allow restoration of the aquatic life uses of the Mill Creek basin. The watershed action plan will identify the specific strategies to be used to achieve those targets, the NPDES permit process, future 319 Grants and other local projects will identify the specific actions that will support those strategies. The six listed segments are itemized below, showing segment specific load reductions and habitat improvement recommendations for the watershed action plan.

6.1.1 **Mill Creek** (Otter Run to Scioto River)

Point source controls have been discussed in Workgroup meetings and at other subcommittee meetings between Ohio EPA and NPDES permit holders. Reissuance of the NPDES discharge permit for the Marysville WWTP (4PC00002/OH0020630) with revised effluent limits for $CBOD_5$, dissolved oxygen and ammonia will comprise the primary component of the implementation plan for this segment. The existing permit for the plant is presently up for renewal and it is anticipated that a schedule of compliance will be provided to meet the revised limits. Marysville is planning an expansion to the wastewater treatment facility within the next 3-5 years. A plant expansion will necessitate a re-evaluation of the proposed limits for ammonia, $CBOD_5$ and dissolved oxygen and well as an evaluation for nutrient limits. Although nutrient loadings were not identified as a cause of impairment in this study it is possible that the existence of a nutrient enrichment component to the observed impairment will become more apparent once the problems of

ammonia and organic enrichment are addressed. Nutrient reduction strategies proposed for point source discharges will provide consistency will nutrient reduction targets proposed for the remainder of the basin.

Load reduction and habitat improvement options recommended for this reach are:

- Revised effluent limits for the Marysville WWTP to reduce loadings of ammonia and oxygen demanding substances. Revised effluent limits (30-day average) are proposed below:

  Dissolved Oxygen - 7.0 mg/l
  $CBOD_5$ - 7.0 mg/l
  Ammonia - 1.0 mg/l
  Suspended Solids - 12.0 mg/l

- Re-evaluation of limits for ammonia, oxygen demanding substances and nutrients based on a plant expansion.

- Reduction of nutrient and organic loadings from upstream sources by the elimination of failed septic and leaching systems in the Villages of Raymond and Peoria,

- Improved management of concentrated animal feeding operations and land application practices to prevent spills and fish kills in Mill Creek. Funding resources available through the Environmental Quality Incentives Program (EQIP) to provide cost share and incentive payments and technical assistance to agricultural producers in the Mill Creek watershed for implementing specific conservation practices.

- Evaluation of local industrial limits for Marysville industries to effect nutrient loading reductions from the Marysville WWTP

- Implementation of the Phase 2 Stormwater Program to control urban non-point source impacts from the City of Marysville

- Habitat improvements downstream of Marysville (RM 16.2-12.0) to improve marginal QHEI scores in non-attaining segment

- Evaluate the removal of low-head dam upstream of the Marysville WWTP (RM 18.26) in order to facilitate re-aeration and natural channel flow though the impacted segment

6.1.2 **Town Run** (Entire Length)

Town Run is a small urban stream that flows through Marysville. The primary sources of impairment in the 1995 study were urban runoff, discharges from failing septic systems and heavy metals contamination from the now closed Eljer Plumbingware landfill. A small

section of stream, near the mouth, is culverted.

Point and non-point source control measures and habitat improvement options recommended for this reach are:

- RCRA closure of the Eljer Plumbing site and limited sediment removal and stream remediation in Town Run was completed in 1999. It is anticipated that historical causes of impairment attributable to metals, most notably lead and zinc have been adequately addressed through this closure. Sampling performed by the Division of Emergency and Remedial Response in 2002 verified this conclusion. Metals concentrations in the 2002 sediment samples were generally lower than sample results obtained prior to remediation. Surface water samples collected from five locations showed no exceedences of water quality criteria (OEPA 2002).

- The source of organic enrichment/low dissolved oxygen was attributed to failing on-site septic systems in the upper portions of Town Run. The City of Marysville acquired funding through the State Issue 2 program in order to provide sewer service to this area thus eliminating the discharges.

- Implementation of the Phase 2 Storm water Program to control urban non-point source impacts from the City of Marysville

- Bring habitat (QHEI) scores up to an average of 60 through riparian improvements and appropriate sediment reduction measures.

6.1.3 **Crosses Run** (Entire Length)

The predominant source of impairment in Crosses Run comes from nutrient and pesticide loadings from Scotts. Scotts entered into a Consent Agreement (Appendix F) with the state to address many of the issues which were identified as a cause of impairment in this segment. The Consent Agreement will address impairment attributable to historical practices such as the disposal of waste products and off specification material in on-site landfills or on field broadcast areas through a RCRA Corrective Action in addition to on-going sources of impairment such as Storm water run-off from the active manufacturing facilities. The implementation strategy will focus on the conditions in the Consent Agreement as well as the re-issuance of the NPDES permit for Scotts (4IF00000/OH0005193) with pesticide, herbicide and nutrient limits for storm water outfalls as necessary. Non-attainment in the segment of Crosses Run upstream from Scotts was attributable to intermittent flow and a small dairy operation.

Point and non-point source control measures and habitat improvement options recommended for this reach are:

- Reissuance of the NPDES permit for Scotts with permit limits for storm water consistent with the load reduction targets outlined in Chapter 4. The NPDES permit implementing the TMDL allocations for the Scotts Company may

provide for the collection of additional information regarding the ambient conditions in Crosses Run during storm events. In the event that data collected demonstrates that different boundary conditions (as defined in OAC 3745-2-04(E)(3)) should be applied in the WLA, The NPDES permit will contain a re-opener clause that will allow for the modification of the permit to implement a revised WLA. The revised WLA shall be considered to be consistent with the revised TMDL.

- Closure of on-site landfills and field broadcast areas consistent with the RCRA Corrective Action provisions provided in the Consent Agreement.

- Sediment remediation in those areas of Crosses Run that fail a RCRA risk assessment. In areas where sediment is removed or remediated, in-stream habitat restoration/naturalization practices will be employed consistent with the Consent Agreement.

- Re-submittal of the Storm Water Pollution Prevention Plan developed for the Scotts facility consistent with the Consent Agreement. The revised plan will provide for comprehensive monitoring, source identification and quantification of wet weather loadings of ammonia, phosphorus, pesticides and herbicides present in storm water runoff. Agency review and approval of the revised plan followed by implementation of control strategies and best management practices.

- Due to the overwhelming nature of the chemical water quality problems in Crosses Run, habitat has not emerged as a specific impairment. However, as progress is made on resolving the chemical impairments, inadequacy of the habitat may emerge as a future impairment. Scotts and other Crosses Run landowners should evaluate activities that could contribute to bringing habitat (QHEI) scores up to an average of 60 through riparian improvements and appropriate sediment remediation measures. The value of 60 for the QHEI provides a means for evaluating the potential for success of any activities performed in terms of how likely it is for the aquatic life use to be restored. When QHEI values begin to exceed 60, the likelihood that a warmwater aquatic fauna will be supported is greater than when the scores are less than 60, in the absence of otherwise limiting pollutant loads. At present, Ohio EPA is stopping short of assigning a TMDL target value for the QHEI, however, this does not limit the efficacy of the tool in evaluating implementation of habitat improvement activities.

- Improve manure management practices in livestock holding facilities in order to reduce phosphorus loadings from upstream sources.

- Restrict livestock access from stream.

6.1.4 **North Branch Crosses Run** (Entire Length)

Much like the Crosses Run mainstem, the predominant source of impairment in the North Branch Crosses Run comes from nutrient and pesticide loadings from Scotts. The Consent Agreement (Appendix F) will be the primary means of addressing sources of impairment in the North Branch of Crosses Run. The implementation strategy will focus on the conditions in the Consent Agreement as well as the re-issuance of the NPDES permit for Scotts with pesticide, herbicide and nutrient limits for Storm water outfalls.

Point and non-point source control measures and habitat improvement options recommended for this reach are:

- Reissuance of the NPDES permit for Scotts with permit limits for storm water consistent with the load reduction targets outlined in Chapter 4. The NPDES permit implementing the TMDL allocations for the Scotts Company may provide for the collection of additional information regarding the ambient conditions in Crosses Run during storm events. In the event that data collected demonstrates that different boundary conditions (as defined in OAC 3745-2-04(E)(3)) should be applied in the WLA, The NPDES permit will contain a re-opener clause that will allow for the modification of the permit to implement a revised WLA. The revised WLA shall be considered to be consistent with the revised TMDL.

- Closure of on-site landfills and field broadcast areas consistent with the RCRA corrective actions provisions provided in the Consent Agreement.

- Sediment remediation in those areas of Crosses Run that fail a RCRA risk assessment. In areas where sediment is removed or remediated, in-stream habitat restoration/naturalization practices will be employed consistent with the Consent Agreement.

- Re-submittal of the Storm water Pollution Prevention Plan developed for the Scotts facility consistent with the Consent Agreement. The revised plan will provide for comprehensive monitoring, source identification and quantification of wet weather loadings of ammonia, phosphorus, pesticides and herbicides present in storm water runoff. Agency review and approval of the revised plan followed by implementation of control strategies and best management practices.

- Due to the overwhelming nature of the chemical water quality problems in North Branch Crosses Run, habitat has not emerged as a specific impairment. However, as progress is made on resolving the chemical impairments, inadequacy of the habitat may emerge as a future impairment. Scotts and other North Branch Crosses Run landowners should evaluate activities that could contribute to bringing habitat (QHEI) scores up to an average of 60 through riparian improvements and appropriate sediment remediation measures. The value of 60 for the QHEI provides a means for evaluating the potential for success of any activities performed in terms of how likely it is for the aquatic life use to be restored. When QHEI values

begin to exceed 60, the likelihood that a warmwater aquatic fauna will be supported is greater than when the scores are less than 60, in the absence of otherwise limiting pollutant loads. At present, Ohio EPA is stopping short of assigning a TMDL target value for the QHEI, however, this does not limit the efficacy of the tool in evaluating implementation of habitat improvement activities.

6.1.5 Blues Creek (Entire Length)

The community-based watershed action plan being developed by the Mill Creek watershed coordinator and the Bokes/Mill Creek Watershed Partnership is expected to address many of the non-point source problems affecting this segment. Through the development of the watershed action plan, the watershed coordinator and partnership will identify strategies and set goals, coordinate implementation, and develop a monitoring program to ensure local efforts are sustained to improve water quality. Ohio EPA has provided technical assistance and information about funding sources to assist this group with its efforts. Ohio EPA will expect to dedicate future 319 grant funding to applications for projects to accomplish the water quality goals outlined by the watershed action plan.

Non-point source control measures and habitat improvement options recommended for this reach are:

- Habitat improvements and non-point source controls in the upstream segment (headwaters - RM 11.5), currently in attainment of modified warmwater habitat criteria, in order to affect improvement in the non-attaining warmwater habitat downstream segment. The majority of this segment is maintained under the Union County Ditch Maintenance Program which maintains a 15-foot easement on both sides of the stream. The county implemented a program to provide for switch grass plantings along the maintained segment in 2000. The switch grass, once established, should provide for reductions in nutrient and sediment loadings to Blues Creek. This program, and other BMPs implemented to reduce sediment loading to Blues Creek in this section will help to achieve attainment in the warmwater habitat section, and should be encouraged and supported.

- Bring habitat (QHEI) scores up to an average of 60 in the warmwater habitat segments (RM 11.5 - mouth) through riparian improvements and appropriate sediment remediation measures. The target for the QHEI provides a means for evaluating the likelihood of success for any activities performed in terms of how likely it is for the aquatic life use to be restored. When QHEI values begin to exceed 60, the likelihood that a warmwater aquatic fauna will be supported is greater than when the scores are less than 60.

6.1.6 BMY Tributary (Entire Length)

This stream has been intensively channelized for agricultural drainage since the 1920's and rechannelized by local landowners within 10 years of the 1990 survey. While in

production the BMY facility was identified as a source of impairment attributable to metals, most notably copper. The BMY facility closed after 1990. It is anticipated that historical causes of impairment attributable to metals have been adequately addressed through this closure. Subsequent to the 1990 data collection, which was the basis for the 1998 303(d) listing for this stream, the aquatic life use designation was changed to Limited Resource Water (LRW) reflecting the limited habitat conditions for aquatic life in this small stream and its ultimate potential to support aquatic life. The habitat alteration cause of impairment is no longer applicable to this stream. Please note that this tributary was mistakenly identified as Phelps Run in the 1998 303(d) list.

6.1.7 Watershed Action Plan

Through a FY 2000 319 grant (#EPA-00(h)-04), a watershed coordinator has been hired to complete a community-based watershed action plan (WAP) for the entire Mill Creek watershed by December 2002. The WAP will link local and state priorities for action in the watershed with the identified water quality targets outlined in the TMDLs. A key component of the WAP will be an estimate of the loading reductions and habitat improvements that can be expected as a result of implementing the recommended restoration actions.

Through the development of the WAP, the watershed coordinator will assist the watershed partnership with identification of strategies and setting of goals, coordinate implementation, and develop a monitoring program to ensure local efforts are sustained to improve water quality. The WAP will identify local project sponsors for recommended restoration actions and will provide the road map for future project applications to the two major funding sources for implementation ----- the 319 grant program and the Water Pollution Control Loan Fund (WPCLF). Both sources of funding provide for voluntary implementation of agricultural best management practices, upgrades/replacements of failing home sewage treatment systems (HSTSs), and stream restoration. However, the amount of funding available through the 319 grant program is far smaller (approximately $7M annually for the entire program), is available only once per year on a competitive basis, and is subject to funding caps per project ($500,000 in FY 2002). In contrast, approximately $200M of low interest loan funding is available annually through the WPCLF. WPCLF funding is available throughout the year and there are no funding caps per project. In addition, WPCLF funding is available to solve both point and nonpoint source pollution problems.

6.2 Reasonable Assurances

U.S. EPA guidance calls for reasonable assurances when TMDLs are developed for waters impaired by both point and nonpoint sources and for waters impaired solely by nonpoint sources. The purpose of the reasonable assurances requirement is for U.S. EPA to be comfortable that the identified activities will in fact be implemented. Reasonable assurances for reductions in nonpoint source loadings may be non-regulatory, regulatory, or incentive based, and should be consistent with applicable laws and programs. Because Ohio EPA does not have direct authority/jurisdiction over many of the identified nonpoint

sources, it will be important to coordinate activities with those governmental agencies that do (e.g. county health departments, municipalities, county soil and water conservation districts, local NRCS offices).

Existing federal regulations do not require implementation planning for an approvable TMDL, however implementation of the TMDL project is important to affect change in water quality. As mentioned in the previous section, a mechanism to ensure implementation planning for the Mill Creek TMDL is in place. Local leadership provided by the Mill Creek watershed coordinator coupled with grant requirements for the completion of a watershed action plan will ensure that implementation planning is performed. Once implementation planning has been completed, projects can be developed based on that plan that will accomplish the needed load reductions and habitat improvements identified in this TMDL project.

6.3 Process for Monitoring and Revision

Monitoring of the Mill Creek watershed will be necessary to ensure that the pollutant reduction targets and habitat improvements are accomplished so as to ultimately result in attainment of the Biological Criteria, which will result in restoration of the aquatic life uses in this basin. A tiered approach to monitoring progress and validating the TMDL will be followed; the tiered progression includes:

1. Confirmation of completion of implementation plan activities;
2. Evaluation of attainment of chemical water quality criteria;
3. Evaluation of biological attainment.

A TMDL revision will be triggered if any one of these three broad validation steps is not being completed or if the WQS are not being attained after an appropriate time interval. Following development of the implementation plan, if the planned activities are not being carried forth within a reasonable time frame as specified in the implementation plan then an intercession by the Bokes/Mill Creek Steering Committee or other appropriate parties would be needed to keep the implementation activities on schedule. Once the majority of or the major implementation plan items have been carried out and/or the chemical water quality has shown consistent and stable improvements then a full scale biological and chemical watershed assessment would be completed to evaluate attainment of the use designations. If chemical water quality does not show improvement and/or waterbodies are still not attaining water quality standards after the implementation plan has been carried out, then a TMDL revision would be initiated. The Ohio EPA would initiate the revision if no other parties wish to do so.

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APPENDIX A

Aquatic Life Use Attainment Table

Table A-1. Aquatic life use attainment status for stations sampled in the Mill Creek basin based on data collected July-September, 1990-2001. The Index of Biotic Integrity (IBI), Modified Index of well being (MIwb), and Invertebrate Community Index (ICI) scores are based on the performance of fish and macroinvertebrate communities. The Qualitative Habitat Evaluation Index (QHEI) is a measure of the ability of the physical habitat to support biological communities. All sites were evaluated using the "wading method" IBI metrics unless indicated otherwise.

River Mile Fish/Invert.	IBI	Mod. Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Mill Creek (2001) *Draft Results*						
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
39.1/39.4	40	7.6*	VG	TBD	PARTIAL	Ust. 2000 manure spill
31.4/31.5	44	8.1[ns]	VG	75.5	FULL	SR 739; dst spill - 2000 Fish Poor
28.1/28.2	48	8.0[ns]	VG	65.0	FULL	Wheeler-Green Rd; 2000 Fish Fair-Good
24.8/24.7	32*	5.5*	VG	74.0	**NON**	Cotton Slash Rd., Dst 2001 spill
19.1/19.1	38[ns]	7.1*	MG	69.0	PARTIAL	Main Street in Marysville
Mill Creek 2000 *[A-August Qual. Sampling; B-September Quant. Sampling (Macroinvertebrates)]*						
			Aug./Sept.		Aug./Sept.	
38.1/39.4	42	9.0	VG/50	58.5	FULL/FULL	Ust. manure spill
37.9/37.9	38[ns]	7.1*	F*/44	60.5	PART./PART.	Dst. manure spill
36.1/36.0	44	8.5	F*/44	73.0	PART./FULL	Dst. Otter Creek
31.4/31.5	22*	5.5*	F*/46	70.0	**NON/NON**	SR 739
28.1/28.2	44	7.3*	MG/46	61.5	PART./PART.	Wheeler-Green Rd.
24.8/24.7	38[ns]	6.3*	G/36	76.5	PART./PART.	Cotton Slash Rd.
19.1/19.1	40	7.4*	G/38	71.0	PART./PART.	Main Street in Marysville
-- /18.1	--	--	F*/20*	--	(**NON/NON**)	Dst. Marysville WWTP

River Mile Fish/Invert.	IBI	Mod. Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
16.2/ --	24*	4.3*	--	61.0	(**NON**)	Waldo Rd. - Historic D.O. sag
12.0/12.1	28*	5.9*	MG/38	75.5	PART./PART.	Ust. Crosses Run
6.9/6.9	44	9.1	VG/50	79.5	FULL/FULL	Bellepoint/Hinton Mill Rd.
1.7/1.6	48	9.2	VG/48	89.0	FULL/FULL	Near mouth
Mill Creek (1995)						
39.1/39.4	43	8.1[ns]	MG[d]	61.5	FULL	Ust. Otter Creek
36.1/36.0	46	8.2[ns]	40	64.0	FULL	Dst. Otter Creek
28.2/28.2	51	8.8	42	71.0	FULL	Wheeler-Green Rd.
24.8/24.8	49	8.7	40	73.0	FULL	Cotton Slash Rd.
19.3/19.3	41	8.5	40	74.5	FULL	Maple St. - Dst lowhead dam
19.1/19.0	45	7.7*	42	70.5	PARTIAL	Main St. in Marysville
18.4/18.6	44	7.5*	40	77.0	PARTIAL	Dst. Town Run
18.2/18.2	*37*	*6.4*	*16*	*NA*	*NA*	*Marysville WWTP Mix Zone*
18.1/18.1	39[ns]	6.6*	18*	71.0	PARTIAL	Dst. Marysville WWTP
16.2/16.9	36[ns]	5.2*	20*	63.0	**NON**	Waldo Rd. - Historic D.O. sag
14.6/14.6	42	8.5	44	68.0	FULL	U.S. 36
12.0/12.1	37	8.3	42	78.5	FULL	Ust. Crosses Run
11.6/11.7	34*	8.0[ns]	40	74.5	PARTIAL	Dst. Crosses Run
6.9/6.9	38[ns]	8.6	G	74.5	FULL	Bellepoint/Hinton Mill Rd.
4.4/4.4	49	9.7	44	88.5	FULL	Ust. Ostrander WTP
3.7/3.7	54	9.4	44	81.0	FULL	Dst. WWTP & Blues Cr.
1.7/1.6	51	9.6	50	91.0	FULL	Near mouth
Otter Creek (1995)						
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
0.7[H]/0.7	45	na	G	70.5	FULL	Dst. U.S. 33 Construction

River Mile Fish/Invert.	IBI	Mod. Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Town Run (1995)						
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
0.9[H]/0.8	26*	na	F*	45.5	**NON**	Ust. Eljer Plumbingware
0.7[H]/0.7	30*	na	F*	53.5	**NON**	Dst. Eljer Plumbingware
0.1[H]/0.1	28*	na	P*	60.5	**NON**	Dst. Marysville urban
Crosses Run (1995)						
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
2.8[H]/2.8	12*	na	P*	28.0	**NON**	@ Dairy Farm
-- /2.4	--	--	4*	--	(**NON**)	Ust. Trib./Water Dam
2.1[H]/2.0	12*	na	0*	42.5	**NON**	Dst. Scotts Company
0.9[H]/0.6	12*	na	6*	73.5	**NON**	Dst. N. Fk. Crosses Run
North Branch Crosses Run (1995)						
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
1.0[H]/1.0	12*	na	P*	45.0	**NON**	Ust. Scotts Company
0.2[H]/0.1	14*	na	0*	30.5	**NON**	Dst. Scotts Company
Blues Creek (2001) *Draft Results*						
Eastern Corn Belt Plains - MWH Use Designation (Existing)						
19.6[H]/ --	28	na	--	19.5	(FULL)	SR 31
12.0[H]/ --	28	na	--	40.5	(FULL)	SR 4
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
10.1[H]/ --	32*	na	--	42	(**NON**)	Leeper Perkins Road
6.7/6.6	28*	5.3*	G	51	**NON**	Springdale Road
4.7/ --	26*	6.6*	--	64	(**NON**)	Blues Creek Nature Preserve

River Mile Fish/Invert.	IBI	Mod. Iwb	ICI[a]	QHEI[b]	Attainment Status[c]	Comments
Blues Creek (1995)						
0.7/0.6	42	8.1[ns]	G	71.5	FULL	Near mouth
Blues Creek (1990)						
6.7/6.2	30*	6.2*	F*	49.5	**NON**	Springdale Road
0.7/0.6	42	8.4	G	66.5	FULL	Near mouth
BMY Tributary (1990)						
Eastern Corn Belt Plains - LRW Use Designation (Existing)						
3.4/ –	12*	na	--	–	**NON**	Ust. BMY Corp.
3.3/3.3	16*	na	VP*	--	**NON**	Dst. BMY Corp.
3.3/3.3	12*	na	VP*	27	**NON**	@ U.S. 33 Rest Area

- Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from ecoregion biocriterion (<4 IBI or ICI units; <0.5 MIwb units).

a A narrative evaluation based on the qualitative sample (E-exceptional,VG-very good, G-good, MG-marginally good, F-fair, P-poor, VP-very poor) is used in lieu of the ICI when artificial substrate data are not available.

b All Qualitative Habitat Evaluation Index (QHEI) values are based on the most recent version (Rankin 1989).

c Use attainment status based on one organism group is parenthetically expressed.

d The quantitative (artificial substrate) sample was affected by nondetectable current speed; a marginally good narrative evaluation was substituted after further analysis of the data.

H Headwater site type.

Biocriteria: Eastern Corn Belt Plains (ECBP)
(OAC Chapter 3745-1-07, Table 7-17)

INDEX -	Site Type	WWH	EWH	MWH[e]
IBI -	Headwater/Wading	40	50	24
Mod. Iwb	Wading	8.3	9.4	5.8
ICI	All Quantitative	36	46	22

[e] - Modified Warmwater Habitat for channelized habitats

APPENDIX B

Mill Creek 2000 and 2001 Survey Results

Chicken manure and livestock manure spills occurred in the upper Mill Creek basin during the summers of 2000 and 2001, respectively. As a result, biological sampling was conducted in both years to evaluate impact and recovery patterns in Mill Creek following the spills. A summary of the results is as follows:

Upstream Marysville: 2000 Survey

During the summer of 2000, a large fish kill occurred in upper Mill Creek when chicken manure applied to a farm field was washed into the creek by heavy rains. On July 13, approximately 1032 wet tons of non-composted manure from the Day Lay Egg Farm was spread on an 86 acre field near the Logan and Union County border (RM 38.0). The field is located about 20 miles upstream from Marysville. The next evening, 2-5 inches of rain fell in the area and washed an undetermined amount of the manure into the creek. The resultant fish kill extended for approximately 15 miles downstream. When ammonia concentrations of 3 mg/l were measured at the Marysville water plant, the city closed their surface water intakes and temporarily switched to ground water supply wells. While the most severe impacts were limited to the reach upstream from Marysville, elevated ammonia concentrations were detected for nearly the length of Mill Creek following the spill (DERR file data).

Fish and macroinvertebrate communities were evaluated at 11 stations along the length of Mill Creek to evaluate impacts to stream communities (Appendix A). Most fish sites were sampled in late July, about two weeks after the spill, while sites immediately upstream and downstream from the field were sampled in mid August. Artificial substrate samplers were deployed for macroinvertebrate sampling during the first week in August and retrieved six weeks later. Due to time constraints, fish sampling was limited to the single sampling pass during 2000.

Fish communities within 1-2 miles of the spill were in the good or fair-good ranges and appeared relatively unimpacted. However, communities further downstream were noticeably affected. Fish indices dropped into the poor range by RM 31.4 (about 7 miles downstream) before improving to the fair-good ranges at additional sites between Wheeler Green Road and Marysville (RMs 28.1-19.1). The marked decline well downstream from the spill was characteristic of a dissolved oxygen sag and suggested impacts from oxygen-demanding wastes. Numbers of fish in the impacted reach were also much lower than found in previous surveys. Further downstream in Marysville, fish communities at RM 19.1 appeared fairly typical of an urban stream and results were similar to other recent sampling efforts in the 1990s.

Immediately following the spill macroinvertebrates were impacted for about ten miles downstream based on qualitative collections and EPT taxa richness (Table B-1). However, ICI scores and additional qualitative sampling indicated nearly complete recovery six weeks later (Appendix A, Table B-1). ICI scores declined from the exceptional range (50) upstream from the spill, to the very good range (44) immediately

downstream but remained well above the WWH criterion (36). Further downstream, communities reflected good to exceptional quality in the 20 mile reach downstream to Marysville. ICI scores were comparable to results from previous surveys in 1995 and 1986, even exceeding past scores in some instances.

Table B-1.
Qual EPT taxa richness metric scores from Mill Creek based on natural substrate samples at similar sites in Mill Creek during 1995, 2000, and 2001. Higher metric scores are associated with a greater diversity of mayflies, caddisflies, and stoneflies and tend to reflect performance closer to reference condition.

	Qual. EPT Taxa Richness Metric Scores (0, 2, 4, or 6)			
Year	1995	2000-A	2000-B	2001
Mill Creek / River Mile		3 weeks after spill	9 weeks after spill	11 weeks after spill
39.4-.2 (Ust. Control)	4	6	4	6
>> Year 2000 Manure Spill at RM 38.0				
37.9	--	2	2	--
36.0	6	2	6	--
31.5-.4	--	2	4	6
28.2-.1	6	2	6	6
>> Year 2001 Manure Spill at RM 27.2				
24.8-.7	4	4	4	6
19.3-.0	4-6	4	4	2
>> Marysville WWTP at RM 18.2				
18.1	2	2	2	--
12.2-.1	4	2	4	--
6.9	4	4	4	--
1.6	6	4	4	--

Downstream Marysville: 2000 Survey

Downstream from Marysville and the Marysville WWTP, biological communities continued to experience significant declines in 2000. Fish were in the poor range for about six miles downstream from the plant and the river had a noticeable sewage odor throughout the reach. Poorest communities were found about two miles downstream (RM 16.2), matching the location of a significant dissolved oxygen sag documented in

the reach during past surveys. Macroinvertebrates were not as severely degraded as the fish, but impact and recovery patterns were similar to other surveys in the 1990s.

Further downstream, biological communities from the lower seven miles reached a very good to exceptional quality and improved significantly compared to upstream. Conditions in the lower reaches of the mainstem were generally similar to previous studies conducted since 1990.

Impacts downstream from the Marysville WWTP in 2000 may have been exacerbated by the manure spill upstream. However, the WWTP was still considered the primary impact source for several reasons. First, the 4 million gallon per day (MGD) discharge dominates the flow and chemical composition of Mill Creek downstream from Marysville, particularly during summer low flows (see Report, Table 7). In contrast, the 2000 spill was a significant but only temporary discharge. Second, fish and macroinvertebrates demonstrated near complete recovery downstream from the spill and upstream from the Marysville WWTP in Marysville (RM 19.1). However, both organism groups experienced additional, severe declines downstream from the WWTP. If the spill was the primary impact source, such extreme differences in upstream to downstream health would be unexpected. Also, impact and recovery patterns were similar to previous surveys conducted downstream from Marysville in 1990 and 1995.

Upstream Marysville: 2001 Survey

Since the 2000 spill, an additional livestock manure spill occurred in July 2001 on a small tributary that enters upper Mill Creek between Wheeler Green and Cotton Slash Roads (RM 27.2). Biological communities were resampled at five upper mainstem sites between RM 39.4 and RM 19.1 to assess impacts from the most recent spill, and track recovery trends following the 2000 spill.

Upstream from all spills at RMs 39.1/39.4, fish and macroinvertebrate community health was similar to previous surveys and indicated no significant water quality problems. The MIwb score of 7.6 fell slightly below the minimum WWH criterion, resulting in Partial attainment, but community health and composition was basically the same as in 1995 and 2000. Seven miles downstream from the 2000 spill at RM 31.4, fish comminutes showed substantial improvement in 2001. IBI and MIwb scores increased from the poor range in 2000 to the good and marginally good ranges in 2001. The scores reflected broad based improvement in both the quantity and quality of fish populations and near complete recovery one year after the spill. Additional improvement in the fish was observed three miles downstream at Wheeler-Green Road (RM 28.1).

The improving trend downstream from the 2000 spill was reversed downstream from the 2001 spill. Fish communities were in the fair to poor ranges at Cotton Slash Road (RM 24.8). The MIwb score of 5.5 reflected poor quality and low numbers and biomass among fish populations. Fish communities recovered to historic levels further downstream in Marysville at RM 19.1.

Macroinvertebrates showed no obvious impacts downstream from the 2001 spill.

Numbers of EPT taxa (mayfly, caddisfly, and stonefly taxa) actually increased compared to sites further upstream. Community health was considered very good at all stations upstream from Marysville. A decline in community health to the marginally good range was noted at RM 19.1 but the results were in line with previous survey results from Marysville in 1995 and 2000 (OEPA 1996). EPT taxa richness dropped from 19 at RM 24.8 to 9 at RM 19.1 and populations suggested increased enrichment. However, potential impacts from the spill could not be separated from localized urban influences or enrichment effects immediately downstream from the Marysville water supply dam at RM 19.3.