Total Maximum Daily Loads for the Middle Cuyahoga River

Final Report

prepared by

Ohio Environmental Protection Agency
Division of Surface Water

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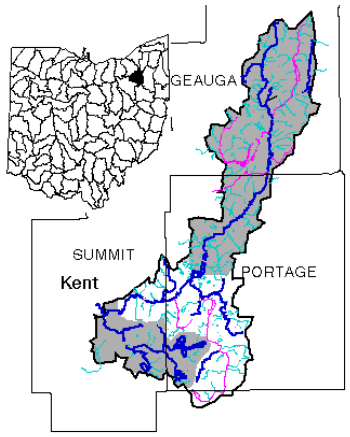

The TMDL in Brief:

Basin:	The Cuyahoga River in the Lake Erie Basin
Study Area:	Lower portion of the Upper Cuyahoga Watershed; referred to as the Middle Cuyahoga. Shown as the white portion of the watershed pictorial at left
Goal:	Attainment of the Warmwater Habitat Aquatic Life Use
Causes:	Nutrient enrichment and hydromodifications leading to low dissolved oxygen and poor habitat.
Sources:	Dams, flow alterations, and municipal discharges.
Measure:	Dissolved oxygen concentrations
Restoration Options:	Increase natural river characteristics by modification of dams and flow releases, and decrease loading of pollutants that consume dissolved oxygen.

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EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act and Chapter 40 of the Code of Federal Regulations Part 130 require states to develop total maximum daily loads (TMDLs) for waters not meeting designated uses under technology-based controls for pollution. The TMDL process quantitatively assesses the impairment factors so that states can establish water-quality based controls to reduce pollution from both point and nonpoint sources, and to restore and protect the quality of their water resources.

The middle Cuyahoga River has been identified as a priority impaired water on Ohio's 303(d) list. Biological and chemical stream surveys from 1989 through 1998 indicate that habitat alteration, excessive nutrient levels and low dissolved oxygen (D.O.) are the primary causes of impairment in this stream segment; the main sources of impairment include flow modification, impoundments and municipal discharges. The flow modification refers to the quantity of water entering the study area from Lake Rockwell, a Cuyahoga River reservoir used as a public water supply for the City of Akron. The release from Lake Rockwell provides the upstream flow to the middle Cuyahoga and is controlled by Akron. There is no minimum flow that Akron must release from Lake Rockwell; however, this situation is under litigation and a minimum release from Lake Rockwell may be required in the near future. In addition, there are two impoundments including the Kent and Munroe Falls dams which, as a result of this TMDL process, are currently under consideration for modification or removal, and six municipal plants contributing to the impairment of the river.

A TMDL calculation is a reflection of the assimilative capacity of a stream. The critical flow and the physical characteristics of a stream are important components when calculating its assimilative capacity and TMDL. In the case of the middle Cuyahoga River, both the upstream flow (the Lake Rockwell release) and the physical characteristics (the dam pools) are not well defined. In addition, these two components are major contributors to the stream impairment and lie outside of Ohio EPA's authority to regulate. Therefore, a tiered approach was used and TMDLs were calculated to reflect this. The tiers include an Ohio EPA recommended option (summarized below) based on voluntary actions involving increased release from Lake Rockwell and dam modifications. This is backed up by a second tier of actions based on the existing critical conditions (no release from Lake Rockwell and dams are unmodified) and uses regulatory authority as the main implementation tool. The components of the most viable reduction strategy to meet Ohio's WQS are:

- A minimum release from Lake Rockwell of at least 3.5 MGD unless the public water supply is at emergency levels and all other reasonable water conservation activities have been exhausted. The release should be aerated, be of reasonable water quality and not a hypolimnetic release.

- Modification or removal of the Munroe Falls Dam to reduce or eliminate the dam pool.

- Modification or removal of the Kent Dam to reduce or eliminate the dam pool.

- Summer limits of ammonia nitrogen no greater than 1.0 mg/l are recommended.
- Summer limits of phosphorus no greater than 1.0 mg/l are recommended.
- Summer total suspended solids limits no greater than 8 mg/l are recommended.
- Monitoring and, if necessary, permit limitations of Akron WTP outfalls 001 and 002 for nutrients, solids and dissolved oxygen.
- Improved method of sludge transport associated with the Akron WTP. Increased monitoring to assure these controls are sufficient and spills are minimized.
- Whole effluent toxicity testing of the Ravenna WWTPs as appropriate.
- Implementation of the TMDL for the Middle Cuyahoga River NPDES permit holders will consist of special conditions in the permits. The permits will be self-implementing and will contain two final tables - one to represent a change in assimilative capacity of the river (e.g. dams modified) and one assuming the existing stream conditions remain.

Table 1. Components of the Middle Cuyahoga River TMDL Process

Study Area	Cuyahoga River Basin from Lake Rockwell to Waterworks Park (Cuyahoga Falls)
303(d) Listed Segments	OH88 5[P], Cuyahoga River (*Breakneck Ck to Waterworks Park)* - Impairment Rank 5 OH88 6, Fish Creek (*headwaters to mouth*) - Impairment Rank 5 OH88 9.1, Tributary to Wahoo Ditch (*headwaters to mouth*) - Impairment Rank 13 OH88 11[P], Cuyahoga River *(Lake Rockwell to Breakneck Ck)* - Impairment Rank 13 Segments not on the 1998 303(d) list but predicted to be on the next 303(d) list: Breakneck Creek (OH88 8), Wahoo Ditch (OH88 9), and Potter Creek (OH88 10) [P] *denotes only a portion of the full segment was included in the study area of the TMDL; the segment boundaries used in the project are described in italics.*
Target Identification	Dissolved oxygen and biological and habitat indices (i.e., IBI, ICI, QHEI). Some site specific contributors to depleted dissolved oxygen and poor indices scores include nutrients, CBOD, ammonia, and hydromodifications.
Applicable Water Quality Standards (WQS)	*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 mg/l; 24-hour average: 5.0 mg/l Ammonia-nitrogen, outside mixing zone maximum,13 mg/l; average, 1.8 mg/l Ecoregion Biocriteria, refer to Table 2 .
Current Deviation from Target	Violations of the 24-hour average and minimum dissolved oxygen WQS have been recorded (lowest average, 1.7 mg/l; lowest instantaneous, 0.0 mg/l). Violations of the biocriteria have also been evaluated. Refer to Table 2.
Sources	Municipal treatment plants, dams and flow alterations. Nonpoint sources do not appear to be significant contributors of impairment.
Load Allocations (Recommended Option)	*(kg/d)* Point Nonpoint Background $CBOD_5$ 534 64 137 Total N 1062 14 276 NH_3-N 54 4 13
Critical/Season Conditions	The critical condition occurs when water temperatures are high and the flow is low. These conditions occur only in the summer. No D.O. violations have been recorded in the winter.
Safety Margin	Implicit in calculations
Implementation Plan	The implementation plan contains a hierarchy of actions. The recommended plan is referred to as Level 1 and is dependent on voluntary actions; the backup plan (Level 2) is based on regulatory authority and will be implemented if Level 1 is not.
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	Coordinated by OEPA; ongoing; increased involvement in implementation phase.

Section 1. Introduction

The Total Maximum Daily Load (TMDL) process, as established by the Clean Water Act (CWA), is a method for identifying and restoring impaired waterbodies. The CWA Section 303(d) and Chapter 40 of the Code of Federal Regulations Section 130.7 direct each State to identify and prioritize water quality limited segments for which pollution controls required by local, State or Federal authority are not stringent enough to achieve applicable water quality standards (WQS). Further, TMDLs for pollutants that prevent the identified segments from attaining WQS must be established. TMDLs are quantitative assessments of water quality problems contributing to the impairment of these segments.

The middle Cuyahoga River watershed has been identified as a priority impaired water on Ohio's 303(d) list. Biological and chemical stream surveys indicate that habitat and flow alteration, excessive nutrient levels and low dissolved oxygen (D.O.) are the primary causes of impairment in the watershed. The goal of the TMDL is full attainment of the biological WQS; attainment of the D.O. WQS will be used as the target to evaluate progress towards this goal. The D.O. WQS can be achieved through control of nutrient and carbonaceous biochemical oxygen demand (CBOD) inputs, and impoundment and flow modifications. These actions would address the major factors that were the basis for this section of the Cuyahoga to be on Ohio's 303(d) list.

The main objectives of this report are to: 1) describe the water quality and habitat conditions of the middle Cuyahoga River; 2) quantitatively assess the factors impacting the instream dissolved oxygen concentration; 3) identify actions to remediate the existing problems; and 4) detail monitoring activities to assess that the remediation plan has been implemented and to evaluate the efficacy of the remediation efforts.

The document is organized in sections forming the progression of the TMDL calculation and includes both the required components of a TMDL as listed in the CWA and the suggested components as listed in the Final Report of the Federal Advisory Committee on the Total Maximum Daily Load Program (NACEPT, 1998). These sections are outlined on the Table of Contents page.

Section 2. Waterbody Overview

Description of the Study Area

The middle Cuyahoga River watershed is located northeast of Akron, Ohio and covers portions of Portage, Summit and Stark Counties. The study area drains 135 square miles and extends from the Lake Rockwell reservoir located northeast of the city of Kent and flows through the urban areas of Kent and Munroe Falls. The downstream boundary is Waterworks Park in Cuyahoga Falls, a suburb of Akron. The study area is upstream of the Little Cuyahoga River and the Gorge Dam. Tributaries include Twin Lakes Outlet, Breakneck Creek (and tributaries), Plum Creek and Fish Creek. This portion of the Cuyahoga River is situated within the Erie/Ontario Lake Plain (EOLP) ecoregion and is characterized by glacial formations and in general, low gradient and velocities. Soils are mainly derived from glacial till and lacustrine deposits and tend to be light colored, acidic and moderately to highly erodible.

Land use of the watershed is dominated by urban development, followed by agriculture, forest and wetland areas. There are several municipal wastewater treatment plants both on the Cuyahoga mainstem and in the Breakneck Creek watershed, a major tributary in the study area. The hydrology of the study area is influenced by impoundments and flow modification. Lake Rockwell is an impounded section of the Cuyahoga River and is used as a public water supply reservoir for the City of Akron. When reservoir levels meet certain conditions, Akron stops the outflow from the reservoir to protect the city's water supply. There are also two low-head dam pools in the mainstem of the Cuyahoga River that act as significant sinks for dissolved oxygen. A reference map of the Cuyahoga River watershed is shown in Figure 1; the study area is pictured in Figure 2, and Figure 3 shows the land use of the watershed.

Water Quality Assessment

Assessment of water quality includes an evaluation of the available chemical and physical (water column, effluents, sediment, flows), biological (fish and macroinvertebrate assemblages), and habitat data collected by Ohio EPA pursuant to the Five-Year Basin Approach for Monitoring and NPDES Permit Reissuance. Other data may be used provided it was collected in accordance with Ohio EPA methods and protocols as specified by the Ohio Water Quality Standards and Ohio EPA guidance documents. Other information which may be evaluated includes, but is not limited to, NPDES permittee self-monitoring data and effluent and mixing zone bioassays conducted by Ohio EPA, the permittee, or U.S. EPA.

Ohio EPA relies on a tiered approach in attempting to link administrative activity indicators (*i.e.*, permitting, grants, enforcement) with true environmental indicators (*i.e.*, stressor, exposure, and response indicators). Stressor indicators generally include activities that have the potential to degrade the aquatic environment such as pollutant discharges (permitted and unpermitted), land use effects, and habitat modifications. Exposure indicators include whole effluent toxicity tests, tissue residues, and biomarkers, each of which provides evidence of biological exposure to stressor or bioaccumulative agents. Response indicators include the more direct measures of community and population response and are represented here by the biological indices which comprise Ohio EPA's biological criteria. The key is in using the different types of indicators

Figure 1. Reference Map of the Middle Cuyahoga River

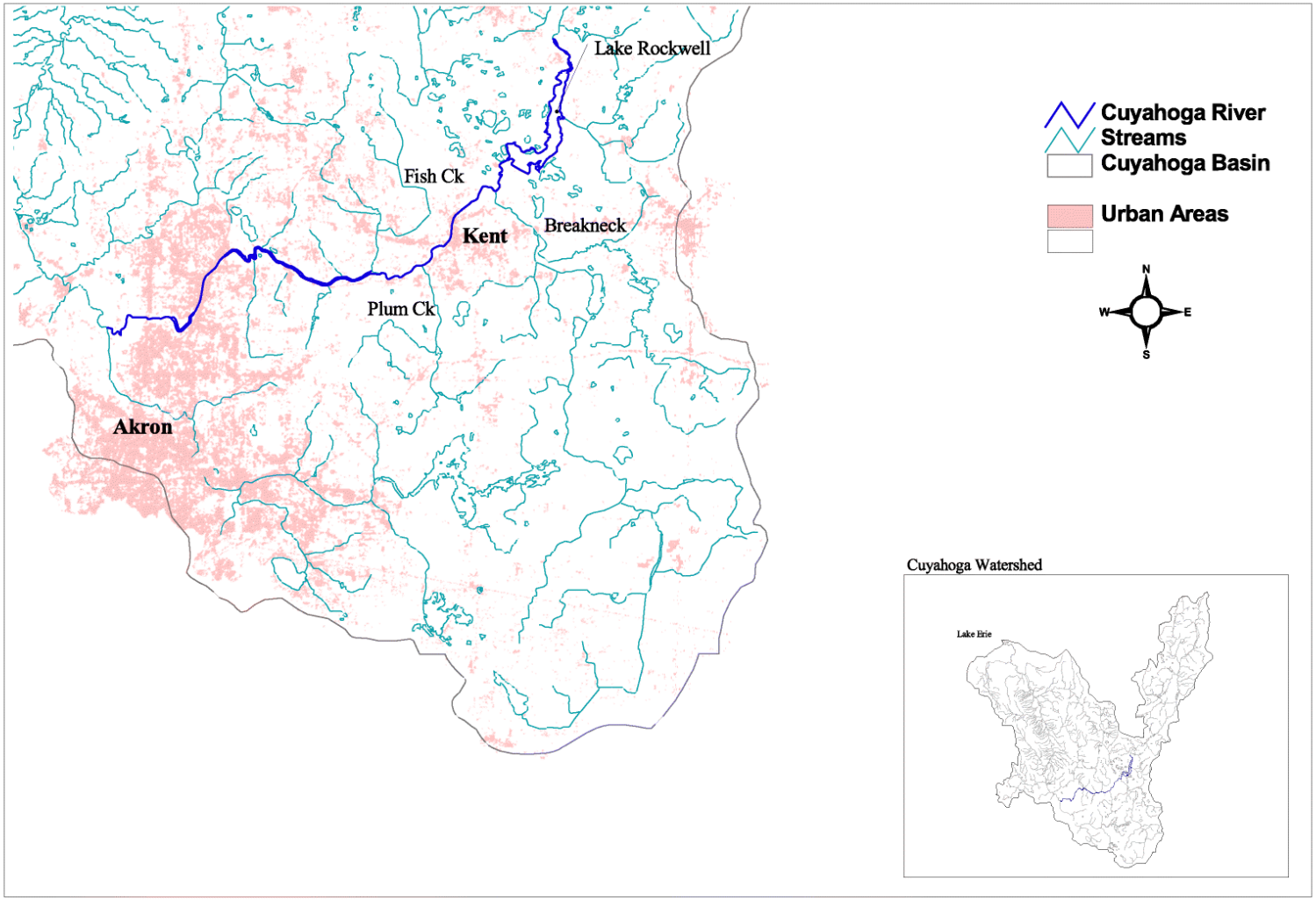

Figure 2. Schematic of the Middle Cuyahoga River

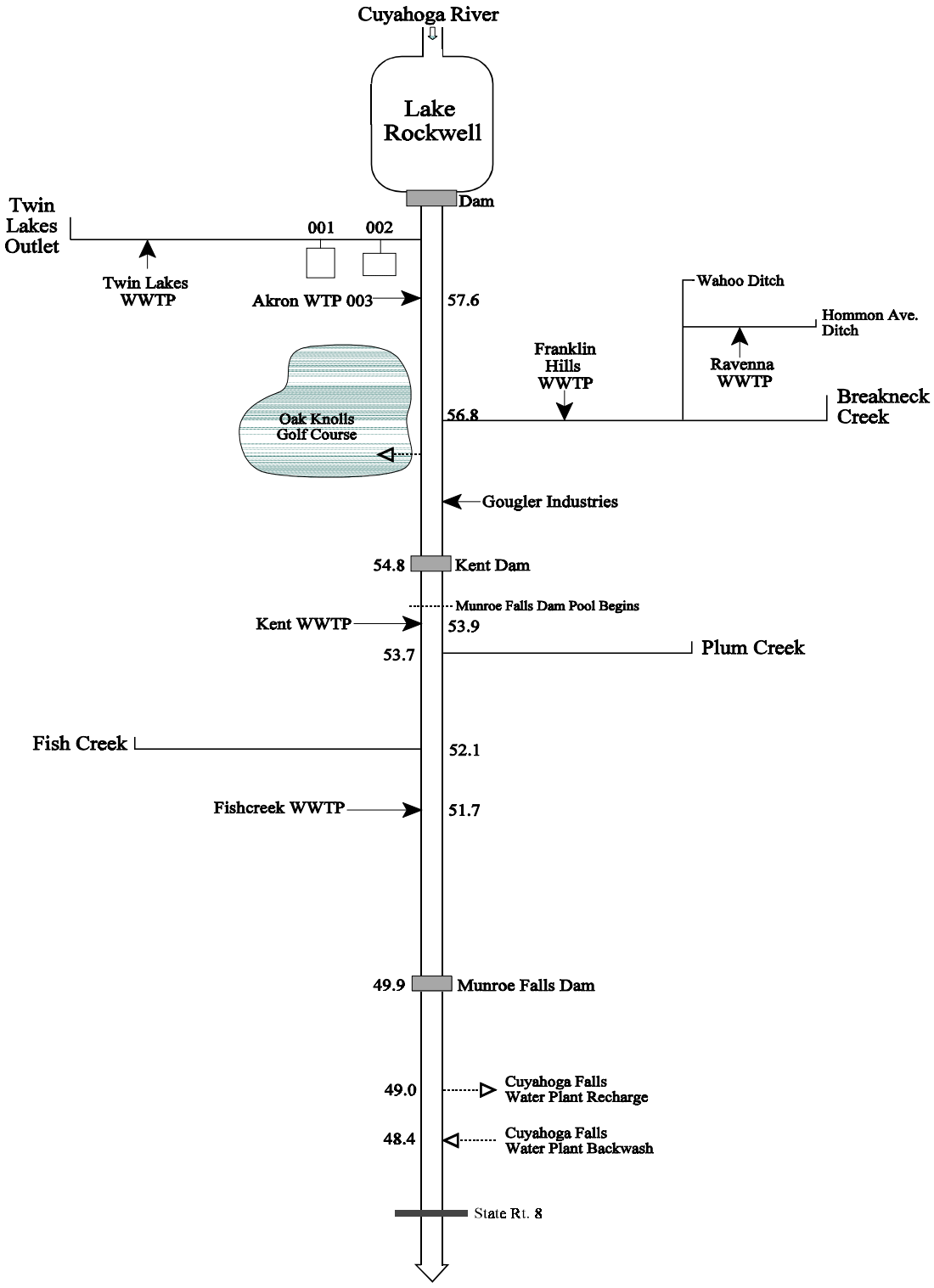

Figure 3. Land Cover Map of the Middle Cuyahoga River

within the roles most appropriate for each. Describing the causes and sources associated with observed impairments relies on an interpretation of multiple lines of evidence including water chemistry, sediment, habitat, and effluent data, biomonitoring results, land use data, and biological response signatures within the biological data itself. Thus the assignment of principal causes and sources of impairment represents the association of impairments (defined by response indicators) with stressor and exposure indicators.

Use attainment is a term describing the degree that environmental indicators are either above or below criteria specified by the Ohio Water Quality Standards (Ohio Administrative Code (OAC) 3745-1). Assessing use attainment status for aquatic life uses involves a primary reliance on the Ohio EPA biological criteria (OAC 3745-1-07; Table 7-17). These are confined to ambient assessments and apply to rivers and streams outside of mixing zones. Numerical biological criteria are based on multimetric biological indices including the Index of Biotic Integrity (IBI) and modified Index of Well-Being (MIwb), which indicate the response of the fish community, and the Invertebrate Community Index (ICI), which indicates the response of the macroinvertebrate community. Numerical endpoints are stratified by ecoregion, use designation, and stream or river size. Three attainment status results are possible at each sampling location - full, partial, or non-attainment. Full attainment means that all of the applicable indices meet the biocriteria. Partial attainment means that one or more of the applicable indices fails to meet the biocriteria. Non-attainment means that none of the applicable indices meet the biocriteria or one of the organism groups reflects poor or very poor performance. An aquatic life use attainment table (see Table 2) is constructed based on the sampling results and is arranged from upstream to downstream and includes the sampling locations indicated by river mile (RM), the applicable biological indices, the use attainment status (*i.e.*, full, partial, or non), the Qualitative Habitat Evaluation Index (QHEI), and comments and observations for each sampling location.

Causes and Sources of Impairment

Median total phosphorus concentrations from grab samples collected in the reach between Lake Rockwell and the Munroe Falls dam were generally between 0.08 and 0.10 mg/l. The median value for total phosphorus from small river reference sites in the Erie-Ontario Lake Plain is 0.06 mg/l, indicating that the Middle Cuyahoga River is moderately enriched with respect to phosphorus. Nitrate-nitrite nitrogen concentrations increase downstream from Breakneck Creek, demonstrating that the Ravenna and Franklin Hills WWTPs contribute nitrogen loads to the Cuyahoga mainstem. Median nitrate-nitrite nitrogen concentrations increase nearly five-fold downstream from the Kent and Fishcreek WWTPs compared to upstream, and little assimilation is evident through the reach and downstream from the Little Cuyahoga River. The lack of assimilation indicates that nitrogen is present in concentrations saturating to algal growth. High algal productivity combined with impounded conditions in the Munroe Falls dam pool results in dissolved oxygen concentrations frequently falling below levels limiting to aquatic life at night. Lake Rockwell also contributes to the enriched conditions by adding significant amounts of remineralized phosphorus and ammonia nitrogen to the Cuyahoga River. Remineralization is the process with which nutrients are converted from an organic form (such as leaf litter, detrital phytoplankton, etc) to an inorganic form. This is a cyclical process; for example, plant and animal byproducts provide a source of organic nitrogen in streams. This organic nitrogen is then mineralized to ammonia (through hydrolysis and bacterial decomposition) which in turn can be

oxidized to nitrite and nitrate. Inorganic nitrogen (ammonia, nitrite and nitrate) is the nitrogen utilized by phytoplankton for growth. The phytoplankton then provide a source of organic nitrogen and the cycle is repeated.

Median nitrate-nitrite nitrogen concentrations in Breakneck Creek increased an order of magnitude downstream from Wahoo Ditch (the Ravenna WWTP) from 0.2 mg/l to 2.0 mg/l, and peaked downstream from the Franklin Hills WWTP. Phosphorus and ammonia nitrogen concentrations were high in Wahoo Ditch with peak concentrations of 0.65 mg/l and 2.5 mg/l, respectively. However, only ammonia nitrogen concentrations were detectably higher in Breakneck Creek downstream from Wahoo Ditch, suggesting that the phosphorus was readily assimilated whereas the nitrogen was not. The high ammonia nitrogen concentrations found in Wahoo Ditch corresponds to the high 95th percentile loadings from the WWTP.

Metals are not apparently limiting to aquatic life in the Munroe Falls dam pool in relation to the magnitude of impairment associated with habitat and low dissolved oxygen. However, sediments collected in and below the Munroe Falls dam contained elevated levels of metals in concentrations likely to affect the most sensitive benthic macroinvertebrates. Metal concentrations increased sharply downstream from Breakneck Creek, possibly in response to loadings from either the Franklin Hills WWTP, the Ravenna WWTP, or both. Flows from the Ravenna WWTP frequently exceed design capacity during wet weather; consequently, poorly treated effluent is discharged. Biological communities in Breakneck Creek are negatively impacted as a result.

Index of Biotic Integrity (IBI) scores decrease downstream from Lake Rockwell relative to the free-flowing reach upstream, primarily because the river is impounded and because of low dissolved oxygen. The lower IBI scores are due to the loss of habitat sensitive round-bodied suckers and simple lithophils, and to an increase in the relative abundance of tolerant fishes. Within the study area the relative abundance of tolerant fishes was highest downstream from Breakneck Creek at Fred Fuller Park, suggesting pollutant loads associated with Breakneck Creek were influencing the Cuyahoga River mainstem. Further declines in IBI scores were measured in a short free flowing reach downstream from Munroe Falls, and may be related to nutrient enrichment and the resulting increased algal productivity from the Kent and Fishcreek WWTPs. There, relative abundance of omnivorous and tolerant fishes increased compared to the dam pool. A surface scum of what appeared to be blue-green algae was present in the Munroe Falls dam pool. Blue-green algae are favored by enriched conditions and low nitrogen to phosphorus ratios (*i.e.*, high phosphorus concentrations).

The Modified Index of well-being (MIwb) scores also decreased in the reach downstream from Lake Rockwell. Consequently, neither fish index met the respective WWH criterion. The invertebrate community sampled from the artificial substrates, being less dependant on habitat, fared better than the fish community, not meeting the WWH criterion only at the station immediately downstream from Lake Rockwell. The habitat and water quality impairments in the reach downstream from Lake Rockwell collectively resulted in biological communities that were either in Partial or NON-attainment of the WWH aquatic life use designation (Table 2). Breakneck Creek fish communities reflected significant impacts beginning downstream from the

Ravenna WWTP (RM 3.1) and further, more severe degradation downstream from the Franklin Hills WWTP (RM 1.8). The WWTPs had noticeable impacts on ammonia, nitrate, dissolved solids and D.O. concentrations downstream.. The Ravenna WWTP and the Franklin Hills WWTP significantly impacted the fish community in Breakneck Creek. Evidence for the Ravenna WWTP contributing to the impairment is given by the increased percentage of tolerant fishes at RM 3.1 relative to RM 5.2, and the low MIwb score (Table 2). The poor MIwb score paired with a good IBI score implies intermittent toxicity, which is consistent with the sporadic toxicity recorded in bioassay tests. The MIwb score continued to decline downstream from the Franklin Hills WWTP before recovering at the mouth. IBI scores clearly plummeted downstream from the Franklin Hills WWTP (RM 1.7), despite having similar habitat to the site upstream (RM 3.1). Toxic conditions were indicated by the very low numbers of individuals and few species captured while electrofishing. These results suggest that the impairment caused by the Ravenna WWTP was not merely augmented by the Franklin Hills WWTP, but severely exacerbated by it. Fish communities at three sites in Breakneck Creek near the Franklin Hills WWTP were sampled in 1999 in an attempt to locate the source of the possible toxicity observed in previous sampling. The most recent sampling revealed that the IBI scores met the ecoregion criteria while the MIwb scores did not. The improvements in IBI scores correspond to reductions in headworks bypassing at the Ravenna WWTP, which suggest the apparent in-stream toxicity in 1996 may be associated with the Ravenna bypasses. Subsequent modeling of the Breakneck Creek system indicate that the predicted D.O. sag from the Ravenna plant corresponds to the lowest fish community scores downstream from the discharge.

Macroinvertebrate communities in Wahoo Ditch, a tributary to Breakneck Creek, were very poor downstream from the Ravenna WWTP and were in non-attainment of the existing modified warmwater habitat (MWH) designation. Fish communities were not sampled in Wahoo Ditch. The potential impacts associated with the discharge were exacerbated by the severely limited, ditch-like habitat conditions present in the stream. Nitrate, phosphorus and ammonia concentrations were substantially higher in Wahoo Ditch than in Breakneck Creek and one D.O. measurement violated the MWH criteria. Loadings have declined from the Ravenna WWTP but erratic treatment performance was problematic into the 1990s.

Potter Creek, a tributary to Breakneck Creek, was in substantial compliance with Ohio's chemical WQS during the 1996 survey. In general, surface water quality in Potter Creek was better than in Breakneck Creek. However, Potter Creek was in non-attainment of the designated WWH designation due to the poor quality of the fish community. The creek is recovering from prior channelization; a narrow riparian corridor has been reestablished and the creek is regaining free flowing characteristics. The habitat remains disturbed, however, by embedding silt and poor channel development

Results of biological sampling in Fish Creek, a tributary to the Cuyahoga River, show that it is in NON attainment of the existing WWH use designation. While biological and habitat quality were not severely degraded, the data suggests stressed communities. Recent channelization immediately upstream from this site is believed to have exerted the greatest influence. Other potential sources of impact include urban runoff from the cities of Kent and Stow, the Norton CPP Corporation discharge, and nonpoint source runoff from past and present construction and

agricultural activities. Fish Creek has been completely channelized upstream from river mile 1.3. Continued maintenance of the channel modification is expected in response to localized flooding problems.

Insufficient data was available at the time of this TMDL project to develop an effective implementation plan for Potter and Fish Creeks. The beginnings of a return of the free-flowing characteristics observed in Potter Creek and the re-established riparian zone may, in time, be sufficient to address the habitat concerns in this creek. Water quality data indicate that these two streams do not contribute significant loads of nitrogenous or carbonaceous biochemical oxygen demanding substances to the Cuyahoga River. Therefore, these two streams will not be directly addressed further in this report. An evaluation of the creeks will be included as part of the monitoring plan associated with this TMDL report.

Table 2. Aquatic life use attainment status for the Warmwater Habitat (WWH) use designation in the Cuyahoga River. Attainment status is based on the biocriteria for the Erie/Ontario Lake Plain ecoregion of Ohio (OAC 3745-1-07, Table 7-17). Fish sites were sampled with boat methods unless otherwise indicated.

RIVER MILE Fish/Invert.	IBI	Modified MIwb	ICI[a]	QHEI	Attainment Status[b]	Comment
Cuyahoga River (1996)						
64.5[w]/64.2	39	7.5[ns]	52	85.5	FULL	Ust. Lake Rockwell
57.5[w]/57.6	32*	5.6*	24*	56.5	**NON**	Dst. Lake Rockwell
56.0[w]/56.1	34*	6.7*	32[ns]	67.5	PARTIAL	Dst. Breakneck Creek
54.2/54.4	28*	7.6*	44	70.0	PARTIAL	Kent urban area
53.4/53.4	31*	6.7*	38	64.0	PARTIAL	Dst Kent WWTP
52.0/ --	30*	7.5*	--	54.0	(**NON**)	Ust Fishcreek WWTP (dam pool)
51.0/ --	30*	6.2*	--	48.5	(**NON**)	Dst Fishcreek WWTP (dam pool)
48.7/49.8	26*	7.1*	42	56.0	PARTIAL	Dst Kent/Fishcreek WWTPs
48.0/48.0	24*	6.7*	44	46.5	**NON**	Dst. Waterworks Park
Cuyahoga River (1991)						
64.5/64.2	44	8.8	54	83.0	FULL	Ust. Lake Rockwell
54.6/54.4	40	8.8	G	72.5	FULL	Kent urban area
49.8/49.8	35*	8.7	32[ns]	74.0	PARTIAL	Dst Kent/Fishcreek WWTPs
Fish Creek (1991)						
0.1/0.4	32*	NA	F*	70.5	**NON**	Channelized upstream
Breakneck Creek (1999)						
2.6[w]/ --	44	7.1*	–	–	PARTIAL	Ust. Franklin Hills WWTP
2.5[w]/ --	40	6.3*	–	–	PARTIAL	Dst. Franklin Hills WWTP
1.6[w]/ --	42	7.2*	–	–	PARTIAL	Dst. Franklin Hills WWTP
Breakneck Creek (1996)						
9.5[w]/ --	46	NA	--	67.5	(FULL)	Background/Reference
6.8[w]/6.9	30*	NA	44	66.5	PARTIAL	Reference Site
5.2[w]/5.2	40	NA	46	68.0	FULL	Ust. Wahoo Ditch
3.1[w]/3.1	38	5.1*	48	56.5	**NON**	Dst. Wahoo Ditch
1.7[w]/1.8	15*	4.6*	36	56.5	**NON**	Dst. Franklin Hills WWTP
0.2[w]/0.1	44	7.2*	44	57.5	PARTIAL	Dst. abandoned landfill
Breakneck Creek (1984)						
6.8[w]/6.9	37[ns]	NA	32[ns]	67.0	FULL	Background/Reference
4.0[w]/--	41	6.0*	--	--	(PARTIAL)	Ust. Wahoo Ditch
3.1[w]/3.1	35[ns]	6.3*	44	--	PARTIAL	Dst Wahoo Ditch (Ravenna WWTP)
1.7[w]/1.8	31*	6.1*	38	--	PARTIAL	Dst. Franklin Hills WWTP
0.1/0.5	27*	6.9*	44	--	**NON**	Impact/Recovery
Potter Creek (1996)						
1.8[w]/1.5	24*	NA	34	41.0	**NON**	Reference Site
Wahoo Ditch (1996)						
–/0.4	--	--	P*	--	(**NON**)	Dst. Ravenna WWTP

Table 2. Aquatic life use attainment status for the Warmwater Habitat (WWH) - continued

Ecoregion Biocriteria: Erie-Ontario Lake Plain (EOLP)			
INDEX - Site Type	WWH	EWH	MWH[c]
IBI - Wading	38	50	24
IBI - Boat	40	48	24
Mod. Iwb - Wading	7.9	9.4	6.2
Mod. Iwb - Boat	8.7	9.6	5.8
ICI	34	46	22

* - significant departure from interim biocriteria; poor and very poor results are underlined.
[ns] - nonsignificant departure from interim biocriteria for WWH or EWH (4 IBI or ICI units; 0.5 MIwb units).
[a] - A narrative evaluation based on the qualitative sample is used in lieu of the numeric score when an ICI score is not available (F=Fair).
[b] - Attainment status based on one organism group is parenthetically expressed.
[c] - Modified Warmwater Habitat for channel modified areas.
[w] - Wading method used.

Summary of Point Sources

City of Kent WWTP

The City of Kent WWTP has NPDES permit number 3PD00031. The present design capacity is 5 million gallons per day (MGD). Both median and 95th percentile flows from the Kent WWTP have remained steady since 1976. Median flows average near 3 MGD, and the 95th percentile flows have remained below design capacity suggesting that treatment efficiency should be high. Ammonia-nitrogen, phosphorus and total suspended solids loadings from the plant declined subsequent to plant upgrades in 1986. Forty-eight hour acute toxicity tests on *Ceriodaphnia dubia* and fathead minnows using the City of Kent WWTP effluent were conducted by the Ohio EPA on 5 August 1996 and on 15 November 1996. The tests showed no toxicity to either organism.

Summit County Fishcreek WWTP # 25

Fishcreek WWTP has NPDES permit number 3PK00012. The present design capacity is 4 MGD; however, the plant is proposing to expand to 8 MGD. The current conditions of the Cuyahoga River (the Munroe Falls Dam pool) preclude Fishcreek WWTP from expanding to 8 MGD unless extremely tight limits are imposed. An expansion to 5 MGD with Fishcreek WWTP maintaining their current loads has been approved by Ohio EPA. Flows from outfall 001 steadily increased after the plant went online in 1982, reaching the current design capacity in 1993. Median flows leveled off averaging slightly more than 4 MGD; however, the 95th percentile flows have progressively increased. Ammonia-nitrogen loadings from the plant have declined in the past three years, suggesting that treatment efficiency has been maintained despite increases in flow. There are no other apparent loadings trends for the Fishcreek discharge. Forty-eight hour acute toxicity tests on *Ceriodaphnia dubia* and fathead minnows using Fishcreek WWTP effluent were conducted by the Ohio EPA on 4 April 1996 and 12 August 1996. The tests showed no toxicity to either organism.

Ravenna WWTP

The Ravenna WWTP has NPDES permit number 3PD00018. The present design capacity is 2.3 MGD during the summer and 2.8 MGD in the winter; however, the plant is proposing to expand to a design capacity of 4.5 MGD. Median flows average near the design capacity of 2.3 MGD, but the 95th percentile flows have increasingly exceeded the design capacity. The result is that the city has bypasses of their treatment plant which results in discharges of untreated wastewater. Median ammonia nitrogen and total Kjeldahl nitrogen loads have decreased over time, especially since 1988; however, 95th percentile loadings have increased, indicating that the plant operates well during dry weather but is unable to handle peak flows. Forty-eight hour acute toxicity tests on *Ceriodaphnia dubia* and fathead minnows using the Ravenna WWTP effluent were conducted by the Ohio EPA on 22 April 1996 and 1 October 1996, and by the Ravenna WWTP on 7 October 1997. The 22 April 1996 and 7 October 1997 tests showed no toxicity to either organism. The 1 October 1996 test however revealed acute toxicity to *C. dubia* as 60% mortality occurred in the undiluted effluent sample compared to both upstream and laboratory control water.

Other Dischargers

Other dischargers in the study area include:

- The Portage County Twin Lakes WWTP discharges to the Twin Lakes Outlet, which enters the Cuyahoga River at RM 57.82. This same tributary receives the effluent from the Akron WTP 001 outfall. Nitrogen ammonia loadings from the WWTP have decreased since 1991. There are no other apparent loading trends in the Twin Lakes discharge.

- The Akron drinking water treatment plant (WTP) has three wastewater discharges. Flows from all outfalls have been increasing since 1991. Outfall 001 is the discharge from the west backwash settling basin into the Twin Lakes Outlet at RM 57.82/0.2, Outfall 002 is the discharge from the east backwash settling basin at RM 57.82/0.1, and 003 is the discharge from the sanitary treatment system at RM 57.61. Ammonia-nitrogen loadings from 003 have been increasing since 1991.

- The Portage County Franklin Hills WWTP has NPDES permit number 3PK00015 and a design flow of 1.0 MGD. Flows have increased at the plant while ammonia-nitrogen loadings have declined. Franklin Hills has recently indicated an interest in expanding to 2.0 MGD; however, Ohio EPA has not yet received a formal request for expansion. During the 1996 survey, a toxic response by the fish community was observed in Breakneck Creek downstream from the Franklin Hills discharge. Subsequent sampling indicates that the toxic response is no longer evident.

- The Cuyahoga Falls WTP discharges backwash water from their ionization softener to the Cuyahoga River at RM 48.4. The discharge is high in total dissolved solids and the flow and subsequent loading from this discharge has increased in the last several years (loading avg 2975 kg/day @ avg flow of 0.177 MGD in 1998 vs 2085 kg/day @ 0.139 MGD avg flow in 1997.

- There are a total of 12 industrial wastewater discharges in the study area with a combined currently permitted flow of 1.76 MGD. These plants primarily discharge non-contact cooling water and, therefore, the influence of these dischargers on nutrient loads and oxygen depletion is extremely small, therefore, they will not be further addressed in this report. (Permit #s 3IV00000, 3IV00001, 3IZ00010, 3IW00014, 3IY00153, 3IR00032, 3IR00090, 3IQ00013, 3IQ00015, 3IR00055, 3IR00009, 3IG00086)

- There are 24 semi-public wastewater treatment plants in the study area with a combined currently permitted flow of 0.19 MGD. The influence of these dischargers is extremely small; therefore, they will not be further addressed in this report

Summary of Impoundments

Munroe Falls Dam

The Munroe Falls Dam is situated at river mile 49.9 and is owned and maintained by Sonoco Products Company. The purpose of the dam is to create a reservoir to supply process water for the manufacturing of paper products. The Sonoco low head dam is an arch-shaped weir constructed of stone block with stone and earth abutments. It is 350 feet long, 12 feet high, and supplies 100,000 to 130,000 gallons per day for Sonoco's paper processing needs. The dam is currently in need of several safety-related repairs with estimated costs near $500,000. Because of the high costs associated with maintaining the dam and the intake structure and due to the relatively low volume of water required for operations, Sonoco is seeking to develop a less expensive water supply. The dam pool extends approximately 4 miles upstream and significantly impacts the hydraulics of the river. During the hot, dry summer months the water becomes stagnant and results in a significant dissolved oxygen sink. In 1996, Ohio EPA documented dissolved oxygen levels as low as 2.66 mg/l. The dam pool has greatly diminished the natural assimilative capacity of the river resulting in more stringent effluent limits for the Kent and Fishcreek WWTPs. In addition, the low dissolved oxygen levels, the altered aquatic habitat conditions, and the fish barrier imposed by the dam are all major disrupters to the natural ecology of the river.

Kent Dam

The Kent Dam, located at river mile 54.8, was originally a wooden structure constructed in 1834 to supply water power for a grist mill. The dam was destroyed by a flood in 1913. The dam was rebuilt in 1925 for aesthetic reasons, and it currently does not provide water or power for any purposes. It is an arch-shaped weir approximately 12 feet high constructed of stone blocks. Sluice gates located on the east end of the dam can bottom-release water.

The dam pool extends upstream to approximately Standing Rock Cemetery. During the hot and dry summer months the water in the pool becomes stagnant and low dissolved oxygen conditions develop. In 1996, Ohio EPA measured dissolved oxygen levels as low as 1.61 mg/l. The Kent Dam greatly alters the natural reaeration properties of the river and will therefore, result in stringent effluent limits for upstream dischargers. The sluice gates were opened in 1998 and the dam pool was drained, revealing the natural river channel and several riffle areas. The river channel was relatively free of sediment deposits, and it was revealed that significantly improved aquatic habitat conditions are possible.

Lake Rockwell Dam

Located at river mile 57.97, the Lake Rockwell dam is 35 feet high and 490 feet wide with a 280 foot wide spillway. The structure was completed in 1914 and provides the primary water supply for the City of Akron. Akron currently withdraws an average of 41 MGD, which is considerably less than their peak usage in the sixties and seventies. The highest annual average intake was 51 MGD and occurred in 1969. The average annual intake could increase by 4.8 MGD over the next twenty years as a result of the Joint Economic Development Districts Akron has formed with three neighboring communities.

The City of Akron manages the Lake Rockwell reservoir and can control the outflow to the river during lower flow periods. When more water is needed in the reservoir, the dam can hold back all water except for some seepage. Historically, these conditions have occurred nearly every year with only a few exceptions. When the dam release mechanisms are closed and no water is flowing over the spillway, the flow of the Cuyahoga River in Kent is composed of Breakneck Creek and treated wastewater from upstream dischargers. During the hot, dry summer months the water becomes stagnant and results in dissolved oxygen violations. Dissolved oxygen readings as low as 0.0 mg/l have been recorded just downstream of the Lake Rockwell dam. The conditions are further aggravated by the dam pool created by the Kent dam located about 3 miles downstream. A 1998 contract between the City of Akron and the Ohio Department of Natural Resources better defines the minimum release from Lake Rockwell; the contract is included in Appendix F. Akron agreed to release a minimum of 3.5 MGD. When reservoir levels become threatened (as measured by a specific conservation index) Akron will scale back its release accordingly. This agreement will ensure that some water will flow through the Lake Rockwell dam during all but the most severe droughts and represents an improvement from historical conditions. According to the City of Akron, throughout 1999 an estimated minimum flow of 5 MGD was released from Lake Rockwell.

In April 1998, a civil law was filed against the City of Akron by five middle Cuyahoga River communities including the cities of Kent, Munroe Falls, Cuyahoga Falls, Silver Lake, and Portage County. The seven count suit alleges that the City of Akron has restricted the natural flow of the Cuyahoga River at the expense of the downstream communities. The suit seeks to have Akron operate the Lake Rockwell Dam in a manner that does not impair the use of the middle Cuyahoga River for navigation, fishing, and recreation. The law suit is included in Appendix F.

No specific minimum release value is requested in the suit, therefore, a single TMDL value cannot be calculated to predict how the river would respond if the plaintiffs prevail. However, the Ohio EPA model calculates that a release of 32 MGD from Lake Rockwell would be required to maintain dissolved oxygen levels at or above the 5 mg/l standard if no modifications are made to the Kent or Munroe Falls dams and to the discharger permits. It should be noted that 32 MGD would be considerably higher than the estimated natural critical low flow conditions for the middle Cuyahoga with no hydraulic controls. Also, the release of more water alone, would not address habitat impairments or fish migrations; full attainment of the WQS would be unlikely.

Section 3. Problem Statement

Target Identification

The goal of the TMDL process is full attainment of the WQS. The water quality and biological assessment of this waterbody indicates that the impairment of the WQS is primarily due to nutrient enrichment and hydromodifications leading to low dissolved oxygen levels and poor habitat conditions. The instream dissolved oxygen is the indicator parameter, and the measurable endpoint of the TMDL process is to attain the D.O. water quality criterion of a 5.0 mg/l average over a 24-hour period at all times of year including summer, low flow critical conditions. In addition, after the control strategies have been implemented, biological measures including the IBI, ICI, QHEI and modified MIwb will be used to validate biological improvement and biocriteria attainment.

Identification of Current Deviation from Target

Dissolved oxygen data were collected under various flow and loading conditions in 1989, 1991, 1996 and 1998. The 1991 and 1998 surveys collected data for the portion of the study area from Lake Rockwell to the Kent Dam. All data collection sites in this reach had 24 hour average instream D.O. concentrations at or below 4 mg/l (criterion is 5 mg/l) and minimum readings ranging from 3 mg/l to 0 mg/l (criterion is 4 mg/l). Surveys in 1989, 1991 and 1996 collected data from Kent to Cuyahoga Falls. The 1996 surveys were the closest to the critical condition and documented many minimum D.O. violations in the Munroe Falls Dam pool. These violations ranged from 2.66 to 4.0 mg/l. The 24-hour average instream D.O. concentrations were all at or above the 5 mg/l average criterion. It is important to note that none of the data collection surveys were conducted under critical conditions; therefore, it is difficult to calculate a firm current deviation from the target as current critical condition instream D.O. concentrations have not been measured. The existing data, however, does give an estimate of the current deviation. In addition, Table 2 shows the current deviation from the biocriteria. All sampling points on the Cuyahoga River in the study area were either in Partial or Non attainment of the biocriteria in 1996.

Source Identification

The major sources of oxygen demanding substances and nutrients are the municipal waste water treatment plants located throughout the study area. No major nonpoint sources are suspected. The background water from Lake Rockwell also contributes nutrients which promote aquatic plant growth in the upper section of the study area. In addition, the impoundments and flow modifications alter the stream hydraulics, thereby decreasing the assimilative capacity of the stream and lowering the natural stream aeration. Source identification is covered in more detail in section 2.

Section 4. Total Maximum Daily Loads

A TMDL is a means for recommending controls needed to meet WQS. U.S. EPA guidance (Office of Water, 1991) suggests that a TMDL calculation should be the sum of the individual wasteload allocations for point sources and the load allocations for both natural background inputs and nonpoint sources in a given watershed. 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 and water quality.

The target of this TMDL is to recommend controls needed to meet the dissolved oxygen water quality criteria (in order to contribute to the goal of full biological attainment). However, dissolved oxygen is not a pollutant and cannot be appropriately expressed as a load. Nitrogenous (NBOD) and carbonaceous biochemical oxygen demand (CBOD) influence instream D.O. in the middle Cuyahoga River and can be expressed as loads. Total nitrogen is composed of four forms of nitrogen: the organic, ammonia, nitrite and nitrate. All of these forms influence D.O., but the latter three comprise the inorganic component and are the portion of the total nitrogen utilized by phytoplankton for growth (Thomann and Mueller, 1987). Accordingly, CBOD and total nitrogen will be used as surrogate measures to express source contributions in this report. The TMDL for total nitrogen includes all four of the nitrogenous components; however, a TMDL for just ammonia nitrogen will also be presented to assist in allocation of loads to municipal treatment works for which ammonia nitrogen is a design parameter. In addition, the impoundments in the study area play a significant role in the water quality impairment. A water quality management option in the TMDL process will be modification to these structures and the TMDL calculation will vary depending on the management option selected.

Method of Calculation

Dissolved oxygen was modeled using QUAL2E-UNCAS (Brown and Barnwell, 1987). This model was selected based on the attributes of the study area and of the sources and causes of impairment. It is a steady-state, one-dimensional model capable of simulating D.O., CBOD, and the nitrogen series. The steady-state assumption of the model is applicable to this TMDL calculation as the modeling conditions reflect a low flow scenario where the model inputs can be assumed to remain constant and the desired product is a spatial concentration profile representing an average of the actual concentrations during this period. The single dimensionality of the model is appropriate as the dissolved oxygen gradient in streams has been found to be most significant in the longitudinal direction (Office of Water, 1997).

This modeling approach relies on developing a model based on an initial set of field data and tuning it based on how well the predicted results compare to the observed data. Successive iterations and adjustments of estimated model coefficients within a predefined range are performed to obtain a reasonable fit of the model predictions and measured data. Once the model performs well under the initial field data set, it is run with inputs from another data set collected under different conditions. The process is repeated until the model predictions agree reasonably well with the observed data of both data sets. The model is then considered calibrated and verified and can be used with confidence to simulate the stream response under conditions for which data has not been collected.

Calibration and verification of the middle Cuyahoga River D.O. model was conducted using data from six stream surveys conducted by the Ohio EPA during the summers of 1989, 1996 and 1998. The study area was divided into three segments so that an individual field survey would have a manageable data collection work load; each field survey targeted one of these three sections. The three sections include the upper portion of the study area (Rockwell to Kent), the lower portion (Kent to Cuyahoga Falls) and Breakneck Creek. A QUAL2E model was constructed for each section and calibrated and verified with the appropriate field data. The two mainstem models were then merged and the results of the Breakneck model were input to the mainstem model as required. Refer to Appendix A for a more detailed discussion of the modeling process.

Critical Conditions and Seasonality

The conditions that are the most critical to the instream D.O. concentrations of the middle Cuyahoga occur when water temperatures are high and stream flow is low. This would include a drought condition (a 7Q10 stream flow situation) during the summer when the water temperature is at its highest and the Lake Rockwell dam is not releasing. A truly critical situation would arise if the dischargers in the area were also operating at above normal loading rates (for example, if they were operating at their design capacity). These critical circumstances formed the input data set to the model for the TMDL calculation.

During the winter, 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 middle Cuyahoga River 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 any D.O. violations in the study area. Accordingly, winter TMDL calculations are not necessary and will not be presented in this report.

Margin of Safety

A margin of safety that accounts for the uncertainty concerning the ability of the TMDL to reflect the actual assimilative capacity of the stream is a required component of the TMDL calculation. The middle Cuyahoga TMDL calculations incorporated conservative assumptions to implicitly include a margin of safety. Some of these conservative assumptions include: 1) setting the point source inputs at the full design or permit value per entity; 2) including an incremental flow component per reach at a water quality reflective of high-end background values to represent potential nonpoint source inputs; 3) assuming the water intakes within the study area are withdrawing at their maximum potential; 4) using moderately high instream temperatures; and 5) calculating the low flow value using a yield derived from subtracting 100% of the total effluent design flow from the 7Q10 at a downstream USGS gage. These circumstances are extremely unlikely to occur concurrently during the low flow condition these TMDLs are calculated for, and they provide a buffer to account for any incertitude in the modeling process.

TMDL Calculations

Currently, the water management of the middle Cuyahoga is under litigation; until a final agreement or court decision is reached, a particular flow regime cannot be reasonably assured.

The outcome of this litigation may effect either the quantity of flow released from Lake Rockwell or the frequency of when the flow from the reservoir is shut off. Therefore, the litigation could have an extreme impact on the instream D.O. levels and on the TMDLs calculated and the remediation options selected. For example, if the flow from Lake Rockwell is shut off during critical low flow events as has been the case historically, the D.O. will continue to violate the WQS upstream from the Breakneck Creek confluence even if all the upstream discharges (Akron WTP and Twin Lakes WWTP) discharge no BOD and no total nitrogen.

The issues that need to be resolved before a single TMDL number can be finalized include:

- The minimum release from Lake Rockwell. The City of Akron has agreed to a release of 3.5 MGD unless the Akron water supply is threatened; however, the water release from Lake Rockwell is currently under litigation and the flow value will not be final until the litigation is completed or a final agreement is reached.

- The structure of the Kent Dam. The Kent Dam has been proposed to be modified or removed so that the Kent dam pool will be reduced or eliminated. The Kent City Council is currently considering this issue.

- The structure of the Munroe Falls Dam. The Munroe Falls Dam has been proposed to be modified or removed so that the Munroe Falls dam pool will be reduced or eliminated. The Munroe Falls City Council is currently considering this issue and Summit County (the operator of Fishcreek WWTP) has hired a consultant to study the dam and dam pool.

Since many of the issues effecting the assimilative capacity of the river are not currently resolved and are outside of Ohio EPA authority to regulate, a hierarchical approach will be used to account for these unresolved issues. The first tier of the hierarchy includes the following actions:

Level 1: Lake Rockwell releases a minimum of 3.5 MGD of high quality water (high D.O., reasonable total nitrogen concentrations). In the interests of protecting public water supply, this flow could be reduced under some pre-defined emergency conditions such as when the drinking water supply of the communities served by Akron was severely limited and all other reasonable water conservation actions were exhausted. In addition, the Munroe Falls and Kent Dams are removed or modified so that the dam pools are reduced to more natural riverine characteristics and fish passage is possible. The allocations and graph presented in this report for Level 1 are based on the Kent Dam modified to route the water around the existing dam structure and the Munroe Falls Dam to be lowered 7 feet (i.e., 5 feet high). These were selected as "average" modifications and were intended as reference points for Level 1 actions.

The recommended actions are, in general, voluntary; should these steps not be initiated within the specified time frame then the next level of actions (regulatory in nature) will be enforced. If other actions, significantly different from those listed in this report, are implemented by the stakeholders and communities, then the TMDL will be recalculated and appropriate actions taken at that time. The conditions used to calculate the TMDL associated with the second level of actions include:

Level 2: Lake Rockwell does not release flow during critical conditions and the Kent and Munroe Falls Dams remain intact and unmodified. This option reflects the current hydromodification situation on the middle Cuyahoga River.

The TMDLs were calculated by inputting the applicable defining conditions into the QUAL2E model and adjusting loadings until the predicted D.O. profile attained the criterion. With the margin of safety incorporated within the modeling process, the TMDL equation is:

TMDL = WLA + LA + BA

Where:

TMDL = Loading capacity of the stream
WLA = Wasteload allocation for point source loads
LA = Load allocation for nonpoint loads
BA = Background allocation for headwater and tributary loads

The TMDLs for total nitrogen, CBOD and ammonia are presented in Table 3. Each of the TMDL components per level and per parameter are shown in Table 4. The predicted D.O. profile for each of the levels are shown in Figures 4a and 4b. The D.O. profiles are predicted using the permit limitations per level and not the wasteload allocations. The wasteload allocations are not technologically feasible; therefore, the permit limitations and the wasteload allocations differ. The D.O. profiles (see Figures 4a and 4b) using the permitted concentrations show that D.O. violations are predicted. The profile for the Level 2 actions demonstrates that the stream will not attain WQS based solely on point source control; other control measures are necessary. The profile for the Level 1 actions is based on a condition for which no data is possible (as the dams currently exist); therefore, it is an estimate and a range of results are presented. The lower boundary represents a 'worst case' condition where the Kent dam pool although shallower, retains its pool attributes; the upper bound represents reaeration rates in keeping with free flowing rivers. This upper bound is the expected result based on the physical characteristics of the river when the Kent Dam pool has been drained (many riffles were uncovered). Full attainment of the D.O. criterion is predicted under Level 1 conditions and using the worst case assumptions (the lower boundary) if the Lake Rockwell release is increased from 3.5 to 8.5 MGD; however, since the model inputs were estimated and due to factors associated with the City of Akron, a release of 3.5 MGD is acceptable at this time. This can be re-evaluated in the future if Level 1 actions are implemented.

Table 3. Total Maximum Daily Load

	Level 1	**Level 2**
(kg/d)		
$CBOD_5$	735	411
Total N	1352	953
NH_3	71	45

Table 4. Components of the TMDL Calculations

(kg/d)	Point Sources (WLA)	Nonpoint Sources (LA)	Tributary & Headwater (BA)
Level 1			
$CBOD_5$	534	64	137
Total Nitrogen	1062	14	276
Ammonia	54	4	13
Level 2			
$CBOD_5$	273	64	74
Total Nitrogen	693	14	246
Ammonia	35	4	6

Wasteload Allocations

The following table (Table 5) presents the average wasteload allocations needed in order to maintain the D.O. average criterion per implementation level. It is important to note that as the river is allowed to return to a more natural system hydraulically, its assimilative capacity increases. Also, some of the allocations required are not technologically feasible for a plant to maintain indicating that the assimilative capacity of the stream will need to be increased in order to maintain the WQS.

Table 5. Water Quality-Based Wasteload Allocations per Implementation Level[1]

Level 1

	Flow MGD	DO mg/l	$CBOD_5$ mg/l	NH_3 mg/l
Twin Lakes WWTP	0.5	8	3	0.5
Akron WTP	0.624[A]	8	3	0.5
Ravenna WWTP	4.5	8	5	0.5
Franklin Hills WWTP	1	8	5	0.5
Kent WWTP	5	8	10	1.0
Fishcreek WWTP	8	8	10	1.0

[A] This flow is the sum of: 0.2 MGD from 001 (50^{th}% effluent data), 0.42 MGD from 002 (50^{th}% effluent data), and 0.004 MGD from 003 (design flow).

Level 2*

	Flow MGD	DO mg/l	$CBOD_5$ mg/l	NH_3 mg/l
Twin Lakes WWTP	0.5	8	0	0
Akron WTP	0.624	8	0	0
Ravenna WWTP	4.5	8	0	0
Franklin Hills WWTP	1	8	0	0
Kent WWTP	5	8	3	0.5
Fishcreek WWTP	4	8	8	1

* The zero load requirements still result in small predicted D.O. violations in the upper portion of the study area.

[1] **This table does not show permit limits, refer to tables 7a and 7b for a summary of permit limits.**

Section 5. Public Participation

The public participation associated with this TMDL began when public comment was solicited for the 1996 303(d) list and for selection of the Cuyahoga River as a priority watershed for TMDL development. The 1998 303(d) list public comment period provided an additional opportunity for public input concerning the information contained in the list (i.e., causes and source of impairment, priority, restorability, etc.). Informal public comments were received and incorporated into the modeling decisions through talking with landowners and recreational enthusiasts met on the 1996 and 1998 field surveys conducted in the area. The experiences and concerns of these citizens complimented the data Ohio EPA collected.

The Ohio EPA, Northeast District Office (NEDO), continued the public outreach by working closely with the Northeast Ohio Four County Regional Planning and Development Organization (NEFCO) to establish the Middle Cuyahoga River Watershed Stakeholders Forum. A series of meetings were held (see Table 6a) to provide a forum where water quality issues could be discussed openly. The water quality concerns of the middle Cuyahoga River became a hot topic when the City of Akron proposed to divert an additional 4.8 MGD of water from Lake Rockwell to sell to neighboring communities.

The meetings were structured to strive for understanding and cooperation among the stakeholders. The primary purpose was to share the knowledge of existing water quality conditions and discuss and analyze the sources and causes of the water quality impairments, and look for implementable solutions. A mailing list of key stakeholders is contained in Appendix E along with meeting agendas and sign-in sheets of the attendees. All of the meetings were "open" and some were attended by private citizens and local media. The Middle Cuyahoga Stakeholders Forum will continue to play a key role by providing critical input and feed back on the TMDL implementation plan.

Ohio EPA met with several groups individually to present the results of the TMDL study and to discuss each group's concerns. These groups are listed in Table 6b.

The public outreach activities also included a public comment period associated with the review of the preliminary TMDL prior to its submittal to U.S. EPA Region 5. The preliminary TMDL was public noticed on June 7, 1999, and a copy of the report was posted on Ohio EPA's web page. In addition, copies of the report were distributed to local libraries. Few written comments were received during the comment period; these are included in Appendix E..

A public meeting was held July 7, 1999, at Kent State University. Approximately 120 people attended. Ohio EPA gave a brief overview of the project and the study area, touching on the decision making process, the water quality issues, and the position of the Agency. A question and answer and general comment session followed. The majority of the comments supported an increased release from Lake Rockwell. Support was also strong for modification or removal of the dams; many of the supporting comments were based on increased recreational opportunities, improved aesthetics, and improved aquatic life. There were historical concerns expressed for removal of the Kent Dam structure as it is part of Kent's Historic District. In addition, concerns

were expressed as to the aesthetic appearance of the drained dam pools should the dams be modified or removed, and to the fate of the waterfowl which use the Munroe Falls dam pool as habitat. A suggestion was made that the volume of the Lake Rockwell Reservoir could have decreased with time and that the capacity of Lake Rockwell could be increased by dredging, thereby providing enough water so that an increased minimum release could be a feasible option. Other comments included concern about contaminants in the sediment behind the dam pools and revegetation and restoration of the riparian zones if the dam pools are reduced (these concerns are to be addressed in the Summit County study). Concern was expressed that the Middle Cuyahoga River was singled out for some reason and that the entire Cuyahoga River watershed should have been addressed in this TMDL. Another comment was made about the loss of the spillways as an aesthetic focal point and identity for the communities.

The majority of the comments received and the responses given by Ohio EPA in regards to the Middle Cuyahoga TMDL (not including those received for the 1998 303(d) list) have been verbal. Three written comments were received and are included in Appendix E. In general, the comments have been received during a meeting and responses given either at the time of the comment or shortly thereafter with a follow-up conversation.

In addition to meetings, the public has been kept appraised of the situation via a strong media interest in the issues surrounding the Middle Cuyahoga TMDL. Numerous newspaper articles in various periodicals with distributions in Cleveland, Akron, Columbus, the local communities, and statewide have been written, often with input from local stakeholders, political figures and Ohio EPA. National Public Radio also aired a story concerning the Munroe Falls Dam and the water quality in the Middle Cuyahoga River and included interviews of the citizens and mayor of Munroe Falls and an Ohio EPA spokesperson.

Public involvement is the linchpin 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 Cuyahoga River into attainment.

TABLE 6a. Middle Cuyahoga River Watershed Stakeholders Forum

Date	Time	Subject(s)
11/21/97	10:00 a.m.	OEPA & ODNR updates; Community concerns
12/16/97	2:00 p.m.	Diversion approval status; Akron releases USGS gaging
01/20/98	2:00 p.m.	Diversion approval status; Akron releases and water conservation plan
1/28/98	10:00 a.m.	ODNR, Akron, and OEPA presentations; Community concerns
2/24/98	9:30 a.m.	Water quality overview; Watershed plan
3/31/98	9:30 a.m.	Water quality update, river video, watershed pressures
5/19/98	9:30 a.m.	Habitat evaluation, fisheries, riparian protection
9/29/98	9:00 a.m.	NEFCO comprehensive watershed management plan; American heritage river program
6/16/99	1:00 p.m.	TMDL process; OEPA recommended options

TABLE 6b. Meetings with Ohio EPA Concerning the Middle Cuyahoga River

Date	Time	Organization
5/25/99	10:00 a.m.	NPDES officials from cities of Akron & Kent and Summit County
5/25/99	1:00 p.m.	NPDES officials from cities of Ravenna & Kent and Portage County
6/02/99	9:00 a.m.	NEFCO Environmental Resources Technical Advisory Committee
6/09/99	7:45 p.m.	Kent City Council
6/15/99	7:00 p.m.	Munroe Falls City Council
6/16/99	8:30 a.m.	NEFCO General Policy Board
7/07/99	7:00 p.m.	Public Meeting of the Middle Cuyahoga TMDL (sponsored by OEPA)
8/04/99	7:30 p.m.	Kent City Council
8/28/99	10:00 a.m.	League of Women Voters/ Kent Environmental Council tour of Kent Dam and Munroe Falls Dam
9/28/99	7:30 p.m.	League of Women Voters/ Kent Environmental Council public meeting

Section 6. Implementation and Monitoring Recommendations

Remediation methods to bring an impaired waterbody into attainment generally involve either reduction of pollutant loads, increase in the waterbody's assimilative capacity or some combination of both. Figures 4a and 4b show the predicted D.O. profile per level under the critical conditions described in section 4. The profile representing level 2 (existing hydraulic conditions; only loadings reduced) shows that the middle Cuyahoga River is so hydromodified that the D.O. criteria cannot fully be attained by only reducing loadings to the river; a change to the existing flow management is needed. However, the flow management of Lake Rockwell is currently being litigated and an assured outflow from Lake Rockwell probably cannot be guaranteed until the lawsuit is settled. The implementation approach will therefore need to occur in phases; controls and improvements that lie outside of the lawsuit's purview will need to be enacted and modified as the Lake Rockwell release is resolved.

Based on the 1998 field survey, the nutrient concentrations from Twin Lakes Outlet and from the Lake Rockwell release were relatively high (Appendix A, Table 11). Suggested control measures include monitoring and permitting of phosphorus, ammonia, dissolved oxygen and CBOD for all outfalls to the Twin Lakes outlet including Akron WTP outfalls 001 and 002 and Twin Lakes WWTP. Further, there have been unsubstantiated reports of frequent sludge spills due to ruptured transport piping associated with the Akron WTP lagoons. The 1998 field survey did observe extensive sludge deposits in the Cuyahoga River just downstream of the Twin Lakes Outlet. The Akron WTP has since improved upon their pumping schedule which maintains lower levels of accumulated sludge in the lagoons. In addition a backup pump has been installed. Since these changes have been implemented, the Akron WTP has not reported any sludge spills to the Cuyahoga. Further monitoring of the Twin Lakes Outlet watershed may be needed to identify other sources of nutrient enrichment. Lake Rockwell acts as a nutrient sink from upstream watershed sources. Ohio EPA has worked with the City of Akron to limit upstream point sources of phosphorus. However, Lake Rockwell remains a highly eutrophic lake and discharges from the reservoir (especially from the hypolimnion or bottom waters) contribute nutrients to the river downstream of the dam.

The wasteload allocations for the Kent and Fishcreek WWTPs depend on the situation of the Munroe Falls Dam. Currently, the dam is owned by Sonoco Products Company which uses the dam pool as a source of process water; however, the company is looking for cheaper water supply alternatives. The dam is in need of repairs and Sonoco is willing to work with the community in whatever decision is made concerning the fate of the dam. Removal of the dam is the best remediation technique to address the D.O. violations occurring in the reach upstream from it and to improve the impaired habitat of this reach. Modification of the dam to reduce the upstream dam pool and to allow fish passage while still maintaining a 'falls' is a viable option. Preserving a water cascade is an important local aesthetic concern and a point of community pride. The assimilative capacity of the upper portion of the study area could also be increased by modifying the Kent dam to eliminate or reduce the dam pool. Elimination or modification of the dams would greatly improve habitat conditions and dissolved oxygen concentrations and would allow fish to migrate.

The final implementation plan hinges on the Lake Rockwell release the City of Akron agrees to and the modification or elimination of the Kent and Munroe Falls dams. A minimum release of at least 3.5 MGD, coupled with reasonable load reductions and modification of the Kent and Munroe Falls dams would be an excellent plan to address the water quality impairment in the middle Cuyahoga River. It would decrease the excessive plant growth in the upper portion of the study area, increase the instream D.O., and improve the habitat of the river.

Reasonable Assurances

The Ohio Department of Natural Resources and the City of Akron have worked out a Lake Rockwell release of at least 3.5 MGD unless certain water supply indicators are attained and then the release is reduced accordingly. This agreement took place before the litigation was brought forth and the outcome cannot be assured at this point. This initial agreement shows a willingness on the part of Akron to maintain a release from Lake Rockwell and opened the door for further negotiation concerning other water conservation activities Akron could implement before reducing flow from Lake Rockwell. In the event that no minimum flow is guaranteed under conditions comparable to the lowest seven-consecutive-day average flow expected to occur once every 10 years (the 7Q10 flow), then the worst case condition of no flow from Lake Rockwell will need to be assumed and other remediation methods (targeted to increased load reductions) will be necessary.

The Munroe Falls Dam is in need of costly repairs and severely impacts the attainment of water quality standards in the dam pool. Expensive improvements to both the Kent and Fishcreek WWTP will be necessary if the dam pool is not reduced. The City of Munroe Falls is seriously considering modifying the Munroe Falls dam and is currently discussing this with representatives of the community, the Ohio EPA, Kent, and Summit County. Summit County recently hired an engineering firm to study the modification of the Munroe Falls Dam and up to $150,000 has been allocated to fund such a study. The City of Kent and Sonoco Products have verbally agreed to participate in the financial cost of the study in the amount of $25,000 each. Appendix F includes documentation of the Summit County study. In addition, the Kent City council has had numerous discussions concerning modifications to the Kent Dam and Kent is considering initiating a proposal to study the Kent Dam.

Regardless of the final modifications to the flow regime of the river, some reduction to loadings is necessary. The primary source of nutrient and CBOD loadings to the river are municipal treatment works which fall under the authority of the Ohio EPA. Any necessary pollutant reductions will be handled via the NPDES program. The permit limitations per implementation level are included in Tables 7a and 7b. The permit limits are based on the allocations but are tempered by the ability of the current technology to achieve such limits. The limitations presented for Level 1 are based on the dam modifications described in Section 4; if other modifications occur, these limits would not be applicable. In addition, the Level 1 permit limitations are included for comparison purposes only. If the dams are modified, the limitations will be best available technology numbers for CBOD, TSS, and ammonia until the river is reassessed and accurate allocations can be calculated.

Implementation of the TMDL for the Middle Cuyahoga River NPDES permit holders will consist of special conditions in the permits. The permits will be self-implementing and will contain two final tables - one to represent a change in assimilative capacity of the river (dams modified) and one assuming the existing stream conditions remain.

The implementation strategy would consist of the following steps:

1. Issue NPDES permits effective for five years. Modify, or if necessary, revoke and reissue permits that aren't expired and do not expire soon.

2. In the NPDES permit renewals, include an interim table with existing permit limits. A second interim table will be required for Franklin Hills, Twin Lakes, and Ravenna because existing ammonia and/or dissolved oxygen permit limits are not adequate. It is expected that operational improvements, rather than construction, will be used to meet the second interim limits.

3. The permits will contain a compliance schedule that results in one of two final set of limits being triggered. The schedule will result in plant improvements to meet the 5/6/0.5/8.0 limits if the dams remain, or another set of limits applicable if dam modifications are implemented. The compliance schedule will also contain a date for entities to indicate which track is pursued.

4. The permits will contain two final tables, both with the same effective date late in the permit life. A compliance schedule in the permit would trigger which final table will apply based on whether changes are made to increase the assimilative capacity of the river (e.g., modify the dams).

    A. One final table will reflect existing stream conditions and will require the following effluent limits: a) 5 mg/l $CBOD_5$, 6 mg/l TSS, 0.5 mg/l Ammonia, and 8.0 mg/l D.O. limits for entities not increasing flow above existing NPDES-permitted design capacity, or b) no increase in loads for entities that are expanding (effective when expansion is completed) or 5/6/0.5/8.0, whichever is more stringent.

    B. The second final table will become effective if actions that increase the assimilative capacity of the river are implemented, including dam modifications which significantly reduce or eliminate the dam pools. However, this language will apply only to those dischargers affected by the increased capacity (e.g., if only one dam is modified) and who have participated in actions which resulted in the increased capacity. For entities not increasing flow above existing NPDES-permitted design capacity, this final table will contain best available demonstrated control technology-based (BADCT) limits of 10 mg/l $CBOD_5$, 12 mg/l TSS, and

        1.0 mg/l Ammonia. In addition the D.O. limit will be 8.0 mg/l. For expanding facilities, the limits will be 8 mg/l $CBOD_5$, 8 mg/l TSS, 1.0 mg/l Ammonia, and 8.0 mg/l DO.

5. Part II of the NPDES permits will clarify that this TMDL report projects that effluent limits of 5.0 mg/l $CBOD_5$, 6.0 mg/l TSS, 0.5 mg/l Ammonia, and 8.0 mg/l D.O. are not sufficient to achieve full attainment with water quality standards under the conditions existing as of the date of the report. Additional measures to achieve full attainment will be required after these limits are implemented if no changes occur to the stream conditions existing as of 9/30/99. These measures may include prohibition of new or increased loadings, aeration of Lake Rockwell release water, investigation into the Twin Lakes outlet, physical removal of excessive algae or other algal controls, local ordinances designed to control nutrient loads to the stream and/or investigation of the capacity of Lake Rockwell with the intent for increased Lake Rockwell release. These issues will be addressed after reassessment of the middle Cuyahoga River conditions.

6. Language will be added to Part II of the NPDES permit to address the fact that the 10/12/1.0/8.0 limits are based on BADCT since we don't have accurate modeling and channel morphology data for conditions after the modifications to the stream. This language will include the following points:

> If the dams are significantly modified to mitigate the impact of the dam pools there will be changes in the assimilative capacity of the middle Cuyahoga River. A determination of the appropriate final effluent values will be addressed after reassessment of the middle Cuyahoga River conditions. This reassessment will include an examination of the new river channel morphology, modeling data, and an assessment of the entity's participation in watershed improvement and protection activities such as dam modification, riparian corridor protection, and storm water management. The final limits proposed for the "dam modified" option (10/12/1.0/8.0) are accepted BADCT technology levels that will be implemented until the Ohio EPA has better information regarding the condition of the river once the dams are modified.

Process for Monitoring and Revision

Ohio EPA rotates watershed monitoring on a five year schedule. The Cuyahoga River could be revisited in 2001 if significant changes have occurred to ascertain its attainment status and evaluate the success of the TMDL to date. If no significant changes have occurred then the biological re-assessment should be postponed until significant changes have been instituted. Regardless of what implementation actions have been initiated, the Fish Creek watershed should be assessed in 2001. Based on this assessment, appropriate control actions will be included in this report to address attainment issues in Fish Creek.

Interim measures of in stream dissolved oxygen concentrations will be measured to monitor progress towards attainment. Additional interim measures include monitoring through the NPDES program and through the open lines of communication the NEDO currently has with the stakeholders. In addition, the Cuyahoga Falls WTP NPDES permit should be modified to

include monitoring of their backwash discharge.

The finalization of the flow management of the river will result in a final implementation plan. If the Lake Rockwell release is not increased and the Kent and Munroe Falls Dam are not modified or removed, more stringent controls will be required of the municipal treatment works in the region. Most permits will need to be renewed by 2003 and if the situation requires increased point source control, these or prior NPDES permits will reflect this. The reasonable assurances section discusses Ohio EPA's current strategy for issuing NPDES permits in the study area.

All remediation measures should be implemented and the system acclimatized to the changes by 2006. The watershed could again be monitored for attainment. If the water quality is not impaired, then the middle Cuyahoga will be removed from the 303(d) list. However, monitoring activities will continue to assure that the attainment status remains. If the waterbody remains impaired, then the remediation controls will be evaluated to assure that the agreed upon measures were implemented, and if they were not, the situation will be rectified. If all measures are in place and the waterbody still does not attain WQS, then the Cuyahoga will re-enter a new TMDL process.

Summary of an Appropriate Implementation Plan

The components of the most viable implementation plan to meet the TMDL are:

- A minimum release from Lake Rockwell of at least 3.5 MGD unless the public water supply is at emergency levels and all other reasonable water conservation activities have been exhausted. The release should be aerated, be of reasonable water quality and not a hypolimnetic release.
- Modification or removal of the Munroe Falls Dam to reduce or eliminate the dam pool.
- Modification or removal of the Kent Dam to reduce or eliminate the dam pool.
- Summer limits of ammonia nitrogen no greater than 1.0 mg/l are recommended.
- Summer limits of phosphorus no greater than 1.0 mg/l are recommended.
- Summer total suspended solids limits no greater than 8 mg/l are recommended.
- Monitoring and, if necessary, permit limitations of Akron WTP outfalls 001 and 002 for nutrients, solids and dissolved oxygen.
- Improved method of sludge transport associated with the Akron WTP. Increased monitoring to assure these controls are sufficient and spills are minimized.
- Whole effluent toxicity testing of the Ravenna WWTPs as appropriate.
- Implementation of the TMDL for the Middle Cuyahoga River NPDES permit holders will consist of special conditions in the permits. The permits will be self-implementing and will contain two final tables - one to represent a change in assimilative capacity of the river (e.g. dams modified) and one assuming the existing stream conditions remain.

Figure 4a. Predicted D.O. Profile for Level 1

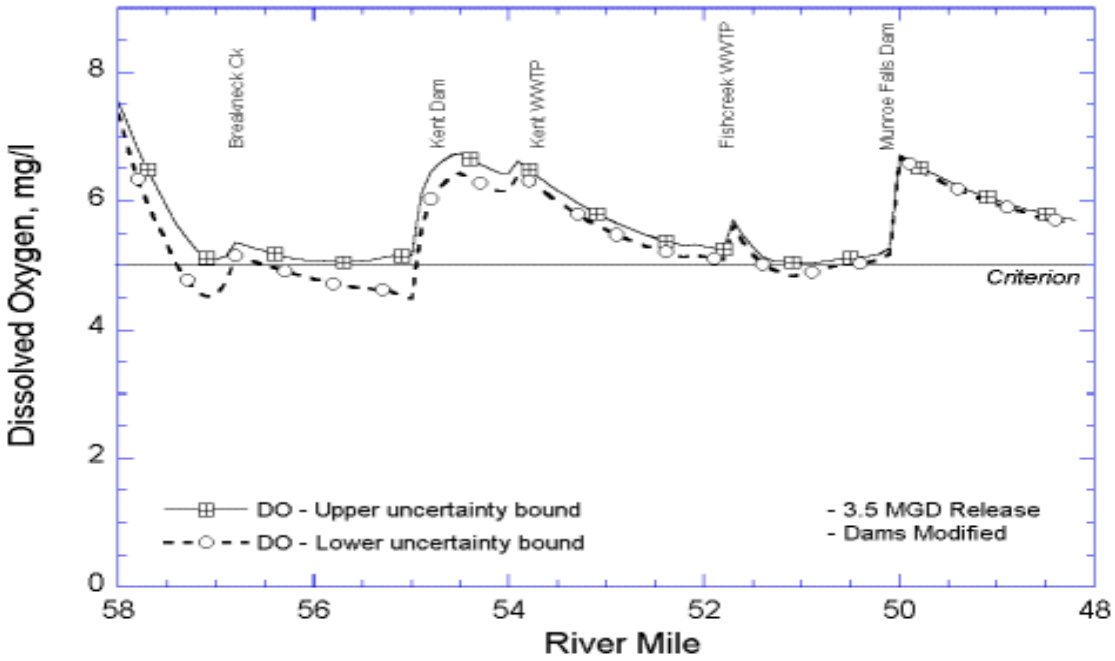

Table 7a. Summer NPDES Limits for Implementation Level 1

			Existing Permit				Projected Limits: Level 1			
			Conc.[1]		Load[2]		Conc.[1]		Load[2]	
Facility	**General**	**Parameter**	30 Day	7 Day	30 Day	7 Day	30 Day	7 Day	30 Day	7 Day
Fishcreek	Exp. Date 10/31/98	TSS	12	18	181.7	272.5	8	12	242.2	363.4
WWTP[3]	Effluent flow:	$CBOD_5$	10	15	151.4	227.1	10	13.5	302.9	408.9
Permit #:	4.0 MGD existing	NH_3	1.5	2.25	22.7	34.1	1	1.5	30.3	45.4
3PK00012	8.0 MGD projected	DO	7.0 minimum				8.0 minimum			
Kent WWTP	Exp. Date 4/1/98	TSS	12	18	227.1	340.7	8	12	151.4	227.1
	Effluent flow:	$CBOD_5$	10	15	189.3	283.9	10	15	189.3	283.9
Permit #:	5.0 MGD	NH_3	1.5	2.25	28.4	42.6	1	1.5	18.9	28.4
3PD00031		DO	7.0 minimum				8.0 minimum			
Ravenna	Exp. Date 4/1/98	TSS	12	18	104.5	156.7	8	12	136.3	204.4
WWTP	Effluent flow:	$CBOD_5$	10	15	87.1	130.6	8	12	136.3	204.4
Permit #:	2.3/2.8 MGD exist.	NH_3	1.5	2.25	13.1	19.6	1	1.5	17.0	25.5
3PD00018	4.5 MGD projected	DO	7.0 minimum				8.0 minimum			
Franklin	Exp. Date 6/27/00	TSS	12	18	45.4	68.1	8	12	30.3	45.4
Hills WWTP	Effluent flow:	$CBOD_5$	10	15	37.9	56.8	8	12	30.3	45.4
Permit #:	1.0 MGD	NH_3	6	9	22.7	34.1	1	1.5	3.8	5.7
3PK00015		DO	5.0 minimum				8.0 minimum			
Akron WTP	Exp. Date 10/28/01	TSS	12	18	0.2	0.3	8	12	0.1	0.2
	Outfall 003	$CBOD_5$	10	15	0.2	0.2	8	12	0.1	0.2
Permit #:	Sanitary Package	NH_3	--	--	--	--	1	1.5	0.015	0.023
3IV00000	0.004 MGD	DO	--	--			8.0 minimum			
Twin Lakes	Exp. Date 12/28/99	TSS	12	18	20.7	31.1	8	12	13.8	20.7
WWTP	Effluent flow:	$CBOD_5$	10	15	17.3	25.9	8	12	13.8	20.7
Permit #:	0.456 MGD	NH_3	2	3	3.5	5.2	1	1.5	1.7	2.6
3PH00038		DO	5.0 minimum				8.0 minimum			

[1] All concentrations are in mg/l [2] All loads are in kg/d [3] Fishcreek can expand to 5 MGD by maintaining load of existing permit.

Figure 4b. Predicted D.O. Profile for Level 2

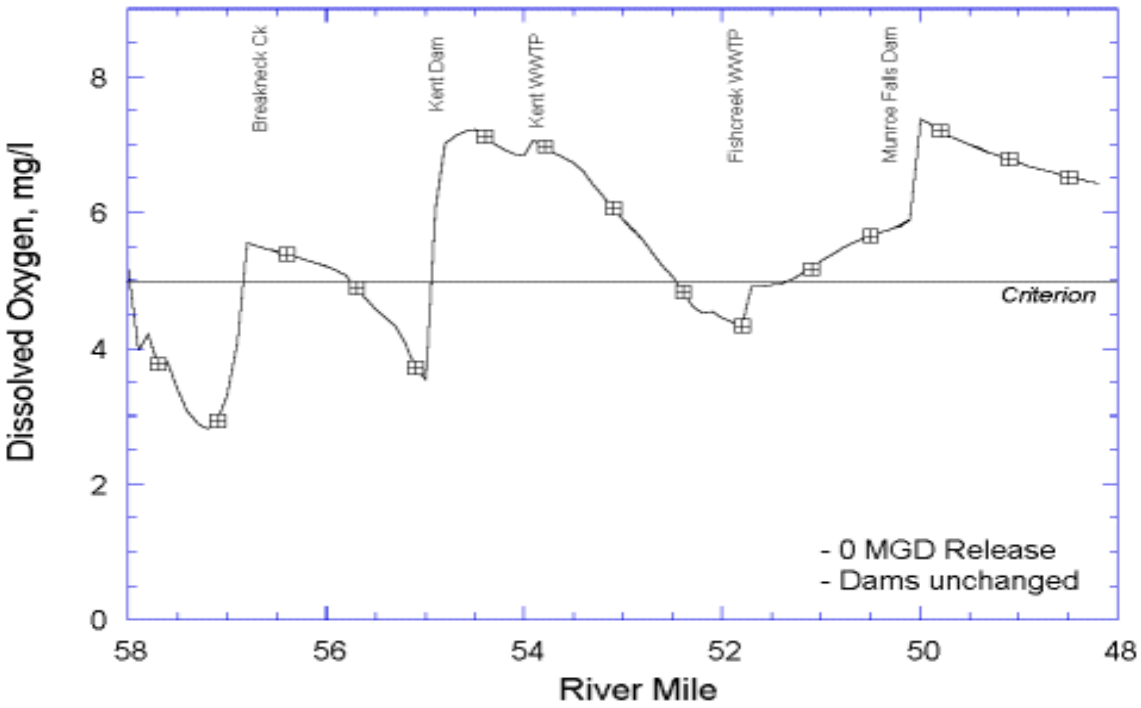

Table 7b. Summer NPDES Limits for Implementation Level 2

			Existing Permit				Projected Limits: Level 2			
			Concentration[1]		Load[2]		Concentration[1]		Load[2]	
Facility	**General**	**Parameter**	30 Day	7 Day	30 Day	7 Day	30 Day	7 Day	30 Day	7 Day
Fishcreek	Exp. Date 10/31/98	TSS	12	18	181.7	272.5	6	9	181.7	272.5
WWTP[3]	Effluent flow:	$CBOD_5$	10	15	151.4	227.1	5	7.5	151.4	227.1
Permit #:	4.0 MGD existing	NH_3	1.5	2.25	22.7	34.1	0.5	0.75	15.1	22.7
3PK00012	8.0 MGD projected	DO	7.0 minimum				8.0 minimum			
Kent WWTP	Exp. Date 4/1/98	TSS	12	18	227.1	340.7	6	9	113.6	170.3
	Effluent flow:	$CBOD_5$	10	15	189.3	283.9	5	7.5	94.6	141.9
Permit #:	5.0 MGD	NH_3	1.5	2.25	28.4	42.6	0.5	0.75	9.5	14.2
3PD00031		DO	7.0 minimum				8.0 minimum			
Ravenna	Exp. Date 4/1/98	TSS	12	18	104.5	156.7	6	9	102.2	153.3
WWTP	Effluent flow:	$CBOD_5$	10	15	87.1	130.6	5	7.5	85.2	127.7
Permit #:	2.3/2.8 MGD exist.	NH_3	1.5	2.25	13.1	19.6	0.5	0.75	8.5	12.8
3PD00018	4.5 MGD projected	DO	7.0 minimum				8.0 minimum			
Franklin	Exp. Date 6/27/00	TSS	12	18	45.4	68.1	6	9	22.7	34.1
Hills WWTP	Effluent flow:	$CBOD_5$	10	15	37.9	56.8	5	7.5	18.9	28.4
Permit #:	1.0 MGD	NH_3	6	9	22.7	34.1	0.5	0.75	1.9	2.8
3PK00015		DO	5.0 minimum				8.0 minimum			
Akron WTP	Exp. Date 10/28/01	TSS	12	18	0.2	0.3	6	9	0.1	0.1
	Outfall 003	$CBOD_5$	10	15	0.2	0.2	5	7.5	0.1	0.1
Permit #:	Sanitary Package	NH_3	--	--	--	--	0.5	0.75	0.008	0.011
3IV00000	0.004 MGD	DO	--	--			8.0 minimum			
Twin Lakes	Exp. Date 12/28/99	TSS	12	18	20.7	31.1	6	9	10.4	15.5
WWTP	Effluent flow:	$CBOD_5$	10	15	17.3	25.9	5	7.5	8.6	12.9
Permit #:	0.456 MGD	NH_3	2	3	3.5	5.2	0.5	0.75	0.9	1.3
3PH00038		DO	5.0 minimum				8.0 minimum			

[1] All concentrations are in mg/l [2] All loads are in kg/d [3] Fishcreek can expand to 5 MGD by maintaining load of existing permit.