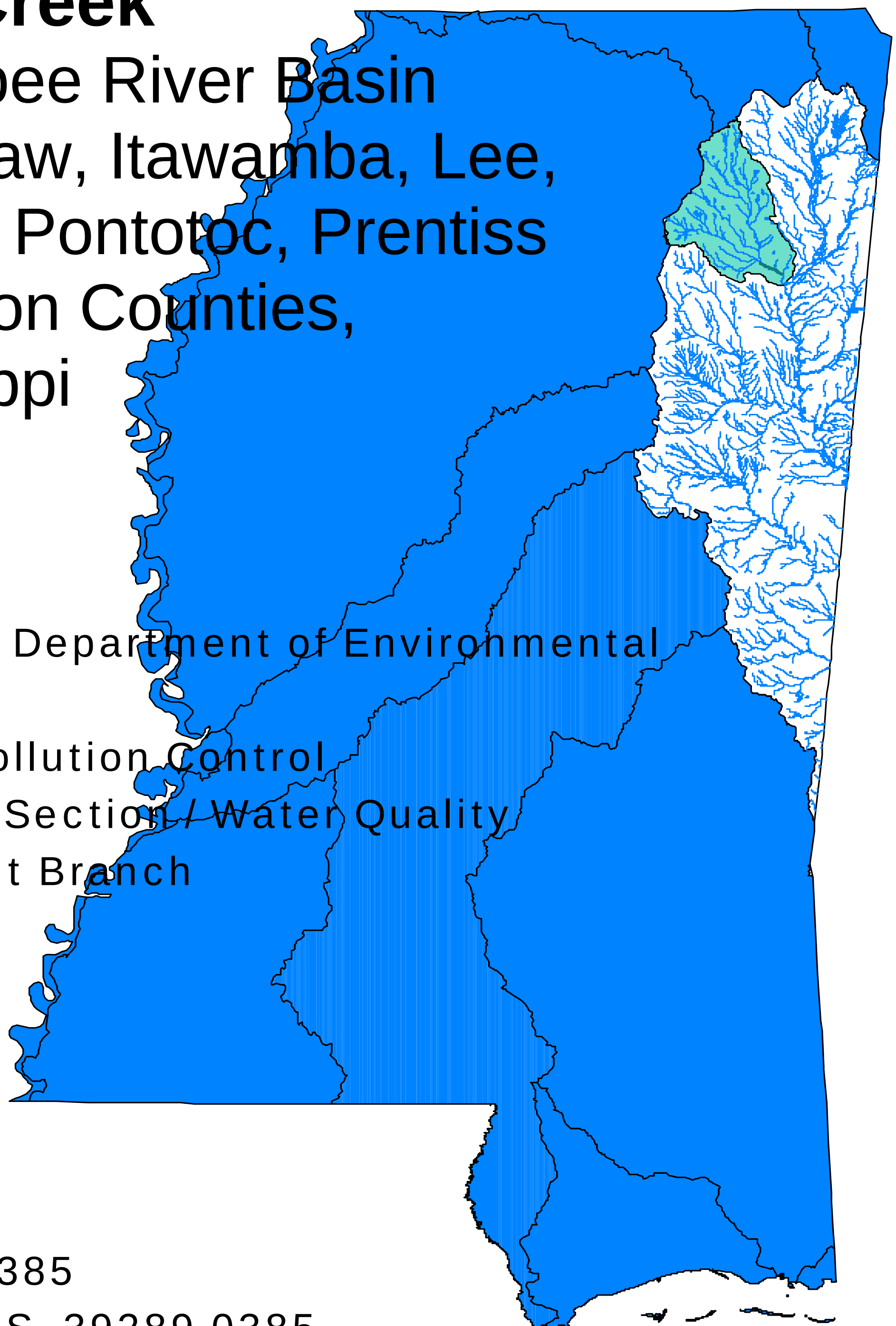
FINAL REPORT
June 2002
ID: 802062101

Fecal Coliform TMDL for **Town Creek**
Tombigbee River Basin
Chickasaw, Itawamba, Lee, Monroe, Pontotoc, Prentiss And Union Counties, Mississippi



Prepared by

Mississippi Department of Environmental Quality
Office of Pollution Control
TMDL/WLA Section / Water Quality Assessment Branch

MDEQ
PO BOX 10385
Jackson, MS 39289-0385
www.deq.state.ms.us

FOREWORD

This report has been prepared in accordance with the schedule contained within the federal consent decree dated December 22, 1998. The report contains one Total Maximum Daily Load (TMDL) for a waterbody segment found on Mississippi's 1996 Section 303(d) List of Impaired Waterbodies. Because of the accelerated schedule required by the consent decree, many of these TMDLs have been prepared out of sequence with the State's rotating basin approach. The segments addressed are comprised of monitored segments that may have data indicating impairment. The implementation of the TMDLs contained herein will be prioritized within Mississippi's rotating basin approach.

The amount and quality of the data on which this report is based are limited. As additional information becomes available, the TMDLs may be updated. Such additional information may include water quality and quantity data, changes in pollutant loadings, or changes in landuse within the watershed. In some cases, additional water quality data may indicate that no impairment exists.

Prefixes for fractions and multiples of SI units

Fraction	Prefix	Symbol	Multiple	Prefix	Symbol
10^{-1}	deci	d	10	deka	da
10^{-2}	centi	c	10^{2}	hecto	h
10^{-3}	milli	m	10^{3}	kilo	k
10^{-6}	micro	µ	10^{6}	mega	M
10^{-9}	nano	n	10^{9}	giga	G
10^{-12}	pico	p	10^{12}	tera	T
10^{-15}	femto	f	10^{15}	peta	P
10^{-18}	atto	a	10^{18}	exa	E

Conversion Factors

To convert from	To	Multiply by	To Convert from	To	Multiply by
Acres	Sq. miles	0.0015625	Days	Seconds	86400
Cubic feet	Cu. Meter	0.028316847	Feet	Meters	0.3048
Cubic feet	Gallons	7.4805195	Gallons	Cu feet	0.133680555
Cubic feet	Liters	28.316847	Hectares	Acres	2.4710538
cfs	Gal/min	448.83117	Miles	Meters	1609.344
cfs	MGD	.6463168	Mg/l	ppm	1
Cubic meters	Gallons	264.17205	µg/l * cfs	Gm/day	2.45
Cubic meters	Liters	1000	µg/l * MGD	Gm/day	3.79

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Listing Information

Name	ID	County	HUC	Cause	Mon/Eval
Town Creek	MS016TM	Monroe	03160102	Pathogens	Monitored
Location – Near Nettleton: From confluence with Chiwapa Creek to confluence with Shoaf					

Water Quality Standard

Parameter	Beneficial use	Water Quality Criteria
Fecal Coliform	Secondary Contact	**May - October**: Fecal coliform colony counts not to exceed a geometric mean of 200 per 100ml, nor shall more than 10 percent of samples examined during any month exceed a colony count of 400 per 100ml. **November – April**: Fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 4000 per 100 ml.

NPDES Facilities

NPDES ID	Facility Name	Subwatershed	Receiving Water
MS0047660	Nettleton POTW	03160102001	Town Creek
MS0035246	Oak Grove Mobile Home	03160102003	Town Creek Tributary
MS0020940	Plantersville POTW	03160102003	Town Creek
MS0033464	Tombigbee State Park	03160102003	Wolf Creek
MS0034444	Elvis Presley Park	03160102004	Middle Tulip Creek
MS0039501	Super 8 Motel	03160102005	Sand Creek
MS0048046	Tupelo Deer Park Estates	03160102005	West Tulip Creek
MS0036111	Tupelo POTW	03160102005	Town Creek
MS0046621	Crafton Warehouse	03160102006	Mud Creek
MS0023655	Guntown POTW	03160102006	Sand Creek
MS0022845	Indian Hills Subdivision	03160102006	Little Sand Creek
MS0055255	Mother Goose Landing Day Care	03160102006	Mud Creek Tributary
MS0043958	Richardson's Outlet	03160102006	South Tulip Creek
MS0021733	Saltillo POTW	03160102006	Sand Creek
MS0052647	Sand Creek Apt.	03160102006	Little Sand Creek
MS0052639	Garden Park Estates	03160102009	Yonaba Creek
MS0023302	Natchez Trace Pkwy	03160102009	Mud Creek
MS0023302	Nathez Trace Tupelo HDQRs	03160102009	Mud Creek
MS0054364	North Ridge Crossing	03160102009	Yonaba Creek Tributary
MS0042471	Tri State Mack	03160102009	Town Creek
MS0042048	Verona POTW	03160102014	Coonewah Creek
MS0037745	Bissell Center	03160102015	Little Coonewah Creek
MS0048313	Renate Rosa Trailer Park	03160102016	Coonewah Creek

MS0047830	High Forest Subdivision	03160102018	Reeds Branch
MS0027405	Shannon POTW	03160102018	Chiwapa Creek
MS0043311	Trace State Park	03160102020	Mubby Creek
MS0021148	Pontotoc POTW #1	03160102023	Chiwapa Creek
MS0021105	Pontotoc POTW #4	03160102023	Webster Creek
MS0037346	Simmons Smoke House	03160102023	Webster Creek
MS0046400	Natchez Trace RV Camp	03160102026	Tubbalubba Creek

TMDL INFORMATION PAGE

Total Maximum Daily Load

Type	Number	Unit	MOS Type
WLA	0.00941E+15	counts/30 day critical period	
LA	2.10E+15	counts/30 day critical period	
MOS	63% Conservative Assumption	counts/30 day critical period	Implicit
TMDL	2.11E+15	counts/30 day critical period	

EXECUTIVE SUMMARY

A segment of Town Creek has been placed on the Mississippi 1998 Section 303(d) List of Waterbodies as impaired due to fecal coliform bacteria. The standard states that from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of samples examined during any month exceed a colony count of 400 per 100 ml, and from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 4000 per 100 ml.

Town Creek flows in a southerly direction from its beginning at the confluence of Euclatubba Creek and Yonaba Creek near Tupelo in Lee County to its confluence with the Tombigbee River near Amory in Monroe County. This TMDL has been developed for one listed section of Town Creek. The BASINS Nonpoint Source Model (NPSM) was selected as the modeling framework for performing the TMDL allocations for this study. The weather data used for this model were collected at Booneville, MS. The representative hydrologic period used for this TMDL was January 1984, through December 1998.

Fecal coliform loadings from nonpoint sources in the watershed were calculated based upon wildlife populations; livestock populations; information on livestock and manure management practices for the Tombigbee Basin; and urban development. The model was then calibrated against the limited fecal coliform data available. The estimated fecal coliform production and accumulation rates due to nonpoint sources for the watershed were incorporated into the model. Also represented in the model were the nonpoint sources such as failing septic systems and other direct inputs to tributaries of Town Creek. There are 30 NPDES Permitted discharges included as point sources in the model. Under existing conditions, output from the model indicates no violation of the geometric mean fecal coliform standards, summer or winter.

All permitted facilities currently have requirements in their NPDES Permits that require disinfection to meet standards, therefore, no changes are required to existing NPDES permits. Monitoring of all permitted facilities in the Town Creek Watershed should continue to ensure that compliance with permit limits is consistently attained. The model assumed there is a 40% failure rate of septic tanks in the drainage area.

The model accounted for seasonal variations in hydrology, climatic conditions, and watershed activities. The use of the continuous simulation model allowed for consideration of the seasonal aspects of rainfall and temperature patterns within the watershed. Calculation of the fecal coliform accumulation parameters and source contributions on a monthly basis accounted for seasonal variations in watershed activities such as livestock grazing and land application of manure.

1.0 INTRODUCTION

1.1 Background

The identification of waterbodies not meeting their designated use and the development of total maximum daily loads (TMDLs) for those waterbodies are required by Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR part 130). The TMDL process is designed to restore and maintain the quality of those impaired waterbodies through the establishment of pollutant specific allowable loads. The pollutant of concern for this TMDL is fecal coliform. Fecal coliform bacteria are used as indicator organisms. They are readily identifiable and indicate the possible presence of other pathogenic organisms in the waterbody. The TMDL process can be used to establish water quality based controls to reduce pollution from both point and nonpoint sources, and restore and maintain the quality of water resources.

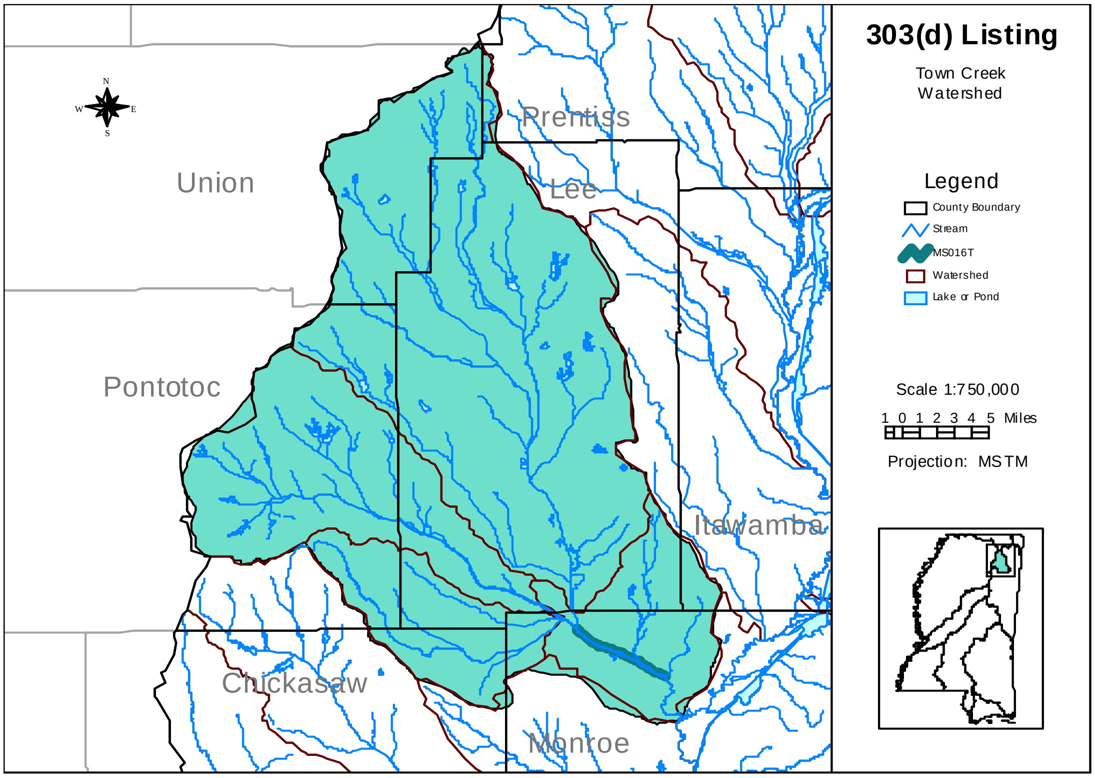
The Mississippi Department of Environmental Quality (MDEQ) has identified a segment of Town Creek as being impaired by fecal coliform bacteria for a length of 5 miles as reported in the Mississippi 1996 Section 303(d) List of Waterbodies. The listed segment is near Nettleton, from the confluence with Chiwapa Creek to the confluence with Shoaf Creek. The 303d listed section is shown in Figure 1.1a.

The listed segment of Town Creek is in the Tombigbee Basin Hydrologic Unit Code (HUC) 03160102 in northeast Mississippi. The drainage area of the segment is approximately 409,000 acres; and lies within portions of Lee, Monroe, Pontotoc, and Union Counties. The watershed is rural but includes the major urban area of Tupelo. Forest and pasture are the dominant landuses within the watershed. The land distribution is shown in Table 1.1.

Table 1.1 Land Distribution in Acres for the Town Creek Watershed

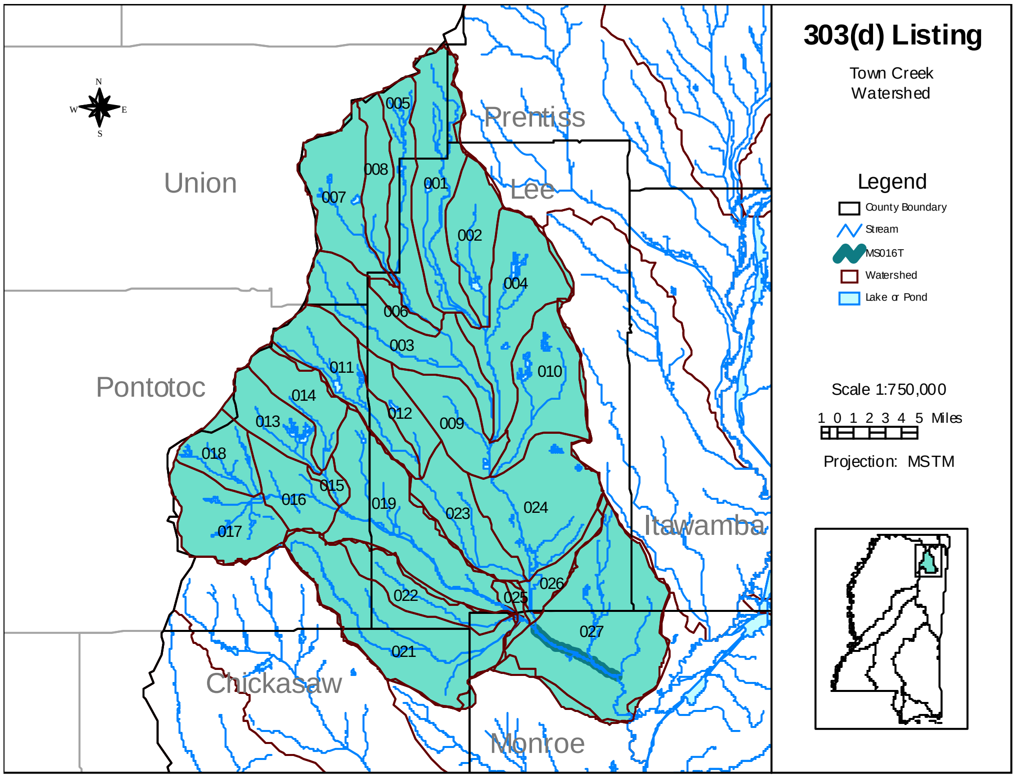
	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
Area (Acres)	13,039	93,254	72,696	176,361	203	53,288	408,843
% Area	3%	23%	18%	43%	0%	13%	100%

Figure 1.1a Town Creek Watershed 303d Listed Segment



The drainage area, or watershed, has been divided into 27 subwatersheds based on the major tributaries and topography. Figure 1.1b shows the subwatersheds with a three-digit Reach File 1 segment identification number. Each subwatershed has been assigned a corresponding identification number, which is a combination of the eight-digit HUC and the three-digit Reach File 1 segment identification number. The listed portion of the waterbody is made up of (using HUC and Reach File 1 identification numbers) segment 03160102001.

Figure 1.1b Town Creek Subwatersheds



1.2 Applicable Waterbody Segment Use

The water use classification for the listed segment of Town Creek, as established by the State of Mississippi in the *Water Quality Criteria for Intrastate, Interstate and Coastal Waters* regulation, is Fish and Wildlife Support. The designated beneficial uses for Town Creek are Secondary Contact and Aquatic Life Support.

1.3 Applicable Waterbody Segment Standard

The water quality standard applicable to the use of the waterbody and the pollutant of concern is defined in the *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. The standard states that from May through October the fecal coliform colony counts shall not exceed a geometric mean of 200 per 100 ml, nor shall more than 10 percent of samples examined during any month exceed a colony count of 400 per 100 ml, and from November through April the fecal coliform colony counts shall not exceed a geometric mean of 2000 per 100 ml, nor shall more than 10 percent of the samples examined during any month exceed a colony count of 4000 per 100 ml. This water quality standard will be used as targeted endpoints to evaluate impairments and establish this TMDL.

2.0 TMDL ENDPOINT AND WATER QUALITY ASSESSMENT

2.1 Selection of a TMDL Endpoint and Critical Condition

One of the major components of a TMDL is the establishment of instream numeric endpoints, which are used to evaluate the attainment of acceptable water quality. Instream numeric endpoints, therefore, represent the water quality goals that are to be achieved by implementing the load and waste load reductions specified in the TMDL. The endpoints allow for a comparison between observed instream conditions and conditions that are expected to restore designated uses. The instream fecal coliform target for this TMDL is normally a 30-day geometric mean of 200 colony counts per 100 ml. The standard also intends that no more than 10% of the samples used to calculate the geometric mean shall exceed 400 counts per 100 ml. Even though the data could not strictly be interpreted by the standard, MDEQ completed this TMDL because 6 out of 11 samples were greater than 400 counts per 100 ml for the summer. This exceeds the limits for the standard for this use of the waterbody. However, when this same data are used to calibrate the model and a geometric mean is calculated, the model output does not indicate impairment. Since the modeled results did not show a violation of the geometric mean, MDEQ looked at the summer-modeled results for the period in which actual samples were collected. This effort was to determine if the model showed instantaneous violations of the 400 standard 10% of the time.

Because fecal coliform may be attributed to both nonpoint and point sources, the critical condition used for the modeling and evaluation of stream response was derived within by a multi-year period. Critical conditions for waters impaired by nonpoint sources generally occur during periods of wet-weather and high surface runoff. But, critical conditions for point source dominated systems generally occur during low-flow, low-dilution conditions. The 1985-1998 period represents both low-flow conditions as well as wet-weather conditions and encompasses a range of wet and dry seasons. Therefore, the 14-year period was used to find the critical conditions associated with all potential sources of fecal coliform bacteria within the watershed.

2.2 Discussion of Instream Water Quality

There is one MDEQ ambient monitoring station and one USGS monitoring station (both being 02436500) on the listed segment. However, only MDEQ collected fecal coliform monitoring data during the 14-year modeling period. Data from MDEQ's station were used to determine the impaired status of the segment. MDEQ monitoring for flow and fecal coliform was performed on a bimonthly (six per year) basis at Town Creek near Nettleton at Highway 45. Flow data from the USGS station are listed in Appendix A.

2.2.1 Inventory of Available Water Quality Monitoring Data

The State's 1998 Section 305(b) Water Quality Assessment Report was reviewed to assess water quality conditions and data available for the watershed. According to the report, Town Creek is not supporting the use of secondary contact recreation. This conclusion was based on instantaneous data collected from MDEQ's monitoring station from January 1993 to September 1996. Data collected at the station from January 1993 to September 1996 are listed in Table 2.2a.

Table 2.2a Fecal Coliform Data reported in Town Creek, MDEQ Station 02436500, January 1993 to September 1996

Date	Flow (cfs)	Fecal Coliform (counts/100ml)
1/12/1993	1730	790
3/8/1993	531.8	110
5/3/1993	3590	**2400**
7/12/1993	48	49
9/13/1993	35	79
11/2/1993	104	230
1/10/1994	848	500
3/7/1994	670	230
5/2/1994	306	**540**
6/20/1994	259	350
8/22/1994	196	**1600**
11/7/1994	767	2400
1/11/1995	595	330
3/6/1995	7510	920
4/17/1995	194	350
7/11/1995	192	**540**
9/12/1995	37	130
11/8/1995	750	2400
1/9/1996	1020	1250
3/5/1996	501	170
5/7/1996	297	**540**
7/10/1996	328	**920**
9/10/1996	45	205

2.2.2 Analysis of Instream Water Quality Monitoring Data

Statistical summaries of the water quality data from January 1993 through September 1996 are presented in Table 2.2c and Table 2.2d. Samples are compared to the instantaneous maximum standard of 400 counts per 100 ml for the summer standard and 4000 counts per 100 ml for the winter standard. The percent exceedance was calculated by dividing the number of exceedances by the total number of samples and does not represent the amount of time that the water quality is in violation.

Table 2.2c Summer Statistical Summaries of Water Quality Data

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
02436500	11	49	2400	6	55%

Table 2.2d Winter Statistical Summaries of Water Quality Data

Station Number	Number of Samples	Minimum Value (counts/100ml)	Maximum Value (counts/100ml)	Number of Exceedances	Percent Instantaneous Exceedance
02436500	12	110	2400	0	0%

3.0 SOURCE ASSESSMENT

The TMDL evaluation summarized in this report examined all known potential fecal coliform sources in the Town Creek Watershed. The source assessment was used as the basis of development for the model and ultimate analysis of the TMDL allocation options. The sources were analyzed according to the 24 separate subwatersheds. The subwatershed delineations were based primarily on an analysis of the Reach File 3 (RF3) stream network and the digital elevation model of the watershed. In evaluation of the sources, loads were characterized by the best available information, monitoring data, literature values, and local management activities. This section documents the available information and interpretation for the analysis. The representation of the following sources in the model is discussed in Section 4.0, Modeling Procedure: Linking the Sources to the Endpoint.

3.1 Assessment of Point Sources

Point sources of fecal coliform bacteria have their greatest potential impact on water quality during periods of low flow. Thus, a careful evaluation of point sources that discharge fecal coliform bacteria was necessary in order to quantify the degree of impairment present during the low-flow, critical condition period. The 30 wastewater treatment plants in the Town Creek Watershed serve a variety of activities including residential subdivisions, schools, recreational areas, and other businesses. The majority of the 30 wastewater treatment plants serve schools or municipalities.

Once the permitted dischargers were located, the effluent from each source was characterized based on all available monitoring data including permit limits, discharge monitoring reports, and information on treatment types. Discharge monitoring reports (DMRs) were the best data source for characterizing effluent because they report measurements of flow and fecal coliform present in effluent samples. Of the facilities for which they were available, the DMRs for the past five years, 1993 through 1998, were analyzed. When data were available, the fecal coliform concentrations used in the model were calculated by taking an average of fecal coliform concentrations reported in the discharge monitoring reports. If evidence of insufficient treatment existed or when data were not available, professional judgement was used to estimate a fecal coliform loading rate in the model. Every facility included in the model is listed in Table 3.1.

Table 3.1 Inventory of Point Source Dischargers

Facility Name	Subwatershed	NPDES Permit	Receiving Waterbody
Nettleton POTW	03160102001	MS0047660	Town Creek
Oak Grove Mobile Home	03160102003	MS0035246	Town Creek Tributary
Plantersville POTW	03160102003	MS0020940	Town Creek
Tombigbee State Park	03160102003	MS0033464	Wolf Creek
Elvis Presley Park	03160102004	MS0034444	Middle Tulip Creek
Super 8 Motel	03160102005	MS0039501	Sand Creek
Tupelo Deer Park Estates	03160102005	MS0048046	West Tulip Creek
Tupelo POTW	03160102005	MS0036111	Town Creek
Crafton Warehouse	03160102006	MS0046621	Mud Creek
Guntown POTW	03160102006	MS0023655	Sand Creek
Indian Hills Subdivision	03160102006	MS0022845	Little Sand Creek
Mother Goose Landing Day Care	03160102006	MS0055255	Mud Creek Tributary
Richardson's Outlet	03160102006	MS0043958	South Tulip Creek
Saltillo POTW	03160102006	MS0021733	Sand Creek
Sand Creek Apt.	03160102006	MS0052647	Little Sand Creek
Garden Park Estates	03160102009	MS0052639	Yonaba Creek
Natchez Trace Pkwy	03160102009	MS0023302	Mud Creek
Nathez Trace Tupelo HDQRs	03160102009	MS0023302	Mud Creek
North Ridge Crossing	03160102009	MS0054364	Yonaba Creek Tributary
Tri State Mack	03160102009	MS0042471	Town Creek
Verona POTW	03160102014	MS0042048	Coonewah Creek
Bissell Center	03160102015	MS0037745	Little Coonewah Creek
Renate Rosa Trailer Park	03160102016	MS0048313	Coonewah Creek
High Forest Subdivision	03160102018	MS0047830	Reeds Branch
Shannon POTW	03160102018	MS0027405	Chiwapa Creek
Trace State Park	03160102020	MS0043311	Mubby Creek
Pontotoc POTW #1	03160102023	MS0021148	Chiwapa Creek
Pontotoc POTW #4	03160102023	MS0021105	Webster Creek
Simmons Smoke House	03160102023	MS0037346	Webster Creek
Natchez Trace RV Camp	03160102026	MS0046400	Tubbalubba Creek

3.2 Assessment of Nonpoint Sources

There are many potential nonpoint sources of fecal coliform bacteria for Town Creek, including:

- Failing septic systems
- Wildlife
- Land application of hog and cattle manure
- Grazing animals
- Land application of poultry litter
- Other Direct Inputs
- Urban development

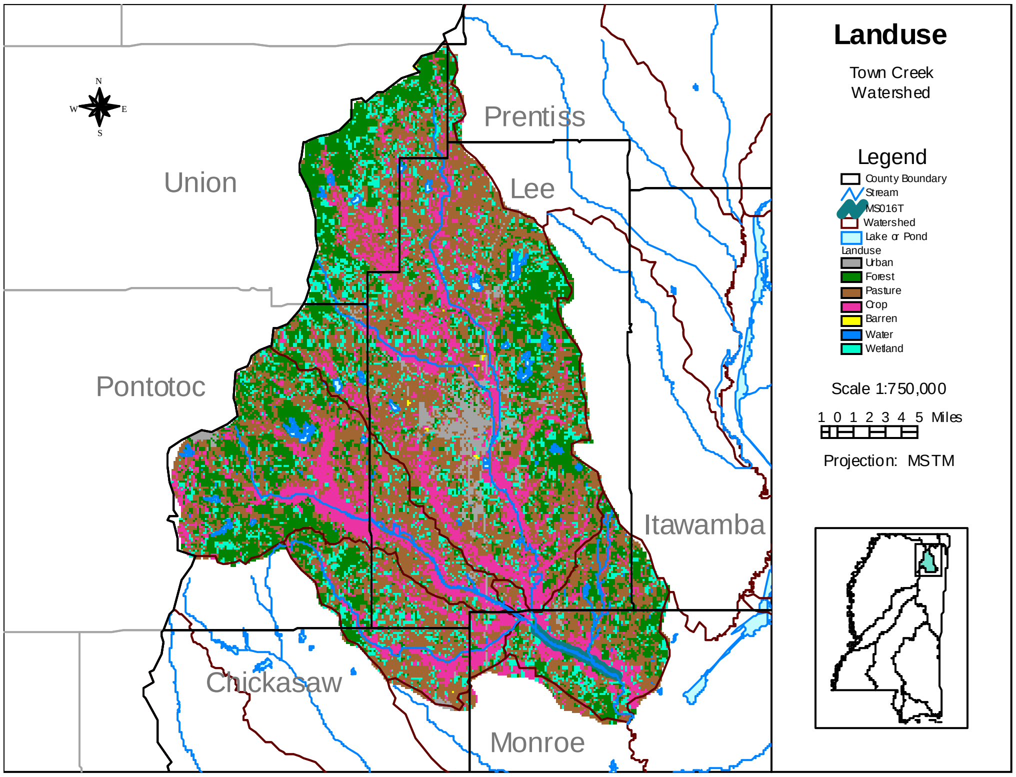
The 409,000 acre drainage area of Town Creek contains many different landuse types, including urban, forest, cropland, pasture, barren, and wetlands. The modeled landuse information for the entire watershed is based on the State of Mississippi's Automated Resource Information System (MARIS), 1997. This data set is based on Landsat Thematic Mapper digital images taken between 1992 and 1993. The MARIS data are classified on a modified Anderson level one and two system with additional level two wetland classifications. For modeling purposes the landuse categories were grouped into the landuses of urban, forest, cropland, pasture, barren, and wetlands. The contributions of each of these land types to the fecal coliform loading of Town Creek was considered on a subwatershed basis. Table 3.2 and Figure 3.2 show the landuse distribution for the watershed.

The nonpoint fecal coliform contribution from each landuse was estimated using the latest information available. The MARIS landuse data for Mississippi was utilized by the BASINS model to extract landuse sizes, populations, and agriculture census data. MDEQ contacted several agencies to refine the assumptions made in determining the fecal coliform loading. The Mississippi Department of Wildlife, Fisheries, and Parks provided information of wildlife density in the Town Creek Watershed. The Mississippi State Department of Health was contacted regarding the failure rate of septic tank systems in this portion of the state. Mississippi State University researchers provided information on manure application practices and loading rates for farms. The Natural Resources Conservation Service also gave MDEQ information on manure treatment practices and land application of manure.

Table 3.2 Landuse Distribution in Number of Acres

Subwatershed	Urban	Forest	Cropland	Pasture	Barren	Wetland	Total
03160102001	276	14,251	8,033	20,597	0	6,499	49,657
03160102002	0	979	2,394	1,993	0	363	5,728
03160102003	572	7,303	5,460	10,960	6	3,366	27,667
03160102004	520	7,357	1,881	7,621	0	3,108	20,487
03160102005	5,064	628	1,366	5,385	31	1,331	13,805
03160102006	1,176	9,509	1,930	8,496	42	3,943	25,096
03160102007	251	846	1,651	9,508	7	1,667	13,929
03160102008	41	4,621	4,763	12,760	18	3,868	26,071
03160102009	1,563	3,966	4,264	10,268	34	4,354	24,449
03160102010	17	2,740	3,341	7,338	5	2,358	15,800
03160102014	1,291	1,059	4,239	6,436	6	1,655	14,686
03160102015	614	876	873	4,771	39	886	8,059
03160102016	37	4,056	2,530	7,969	0	2,476	17,067
03160102017	4	136	736	713	0	256	1,844
03160102018	408	2,832	9,758	16,862	0	2,997	32,858
03160102019	0	111	1,151	731	0	96	2,089
03160102020	0	3,909	1,801	5,018	0	1,219	11,947
03160102021	0	4,832	1,119	3,806	0	738	10,494
03160102022	0	4,280	2,984	3,350	0	743	11,357
03160102023	666	3,637	1,182	3,682	0	703	9,870
03160102024	0	7,955	1,993	5,620	0	2,368	17,936
03160102025	0	0	56	6	0	6	68
03160102026	113	1,221	2,658	5,819	0	1,654	11,465
03160102027	425	6,150	6,533	16,652	15	6,635	36,410
Total	**13,039**	**93,254**	**72,696**	**176,361**	**203**	**53,288**	**408,843**

Figure 3.2 Landuse Distribution



3.2.1 Failing Septic Systems

Septic systems have a potential to deliver fecal coliform bacteria loads to surface waters due to malfunctions, failures, and direct pipe discharges. Properly operating septic systems treat wastewater and dispose of the water through a series of underground field lines. The water is applied through these lines into a rock substrate, thence into underground absorption. The systems can fail when the field lines are broken, or when the underground substrate is clogged or flooded. A failing septic system's discharge can reach the surface, where it becomes available for wash-off into the stream. Another potential problem is a direct bypass from the system to a stream. In an effort to keep the water off the land, pipes are occasionally placed from the septic tank or the field lines directly to the creek.

Another consideration is the use of individual onsite wastewater treatment plants. These treatment systems are in wide use in Mississippi. They can adequately treat wastewater when properly maintained. However, these systems may not receive the maintenance needed for proper, long-term operation. These systems require some sort of disinfection to properly operate. When this expense is ignored, the water does not receive adequate disinfection prior to release.

3.2.2 Wildlife

Wildlife present in the Town Creek Watershed contributes to fecal coliform bacteria on the land surface. In the Town Creek model, all wildlife were accounted for by considering contributions from deer. Estimates of deer population were designed to account for the deer combined with all of the other wildlife contributing to the area. An upper limit of 60 deer per square mile was used as the estimate. It was assumed that the wildlife population remained constant throughout the year, and that wildlife were present on all land classified as pastureland, cropland, and forest. It was also assumed that the wildlife and the manure produced by the wildlife were evenly distributed throughout these land types.

3.2.3 Land Application of Manure

In the Tombigbee Basin processed manure from confined hog and dairy cattle operations is collected in lagoons and routinely applied to pastureland during April through October. This manure is a potential contributor of bacteria to receiving waterbodies due to runoff produced during a rain event. Hog farms in the Tombigbee Basin operate by either keeping the animals confined or by allowing hogs to graze in a small pasture or pen. For this model, it was assumed that all of the hog manure produced by either farming method was applied evenly to the available pastureland. Application rates of hog manure to pastureland from confined operations varied monthly according to management practices currently used in this area.

The dairy farms that are currently operating in the Town Creek Watershed only confine the animals for a limited time during the day. The model assumed a confinement time of four hours per day, during which time the cattle are milked and fed. The manure collected during confinement is applied to the available pastureland in the watershed. Like the hog farms, application rates of dairy cow manure to pastureland vary monthly according to management practices currently used in this area.

3.2.4 Grazing Beef and Dairy Cattle

Grazing cattle deposit manure on pastureland where it is available for wash-off and delivery to receiving waterbodies. The dairy farms that are currently operating in the Town Creek Watershed only confine the animals for a limited time during the day. The model assumed a confinement time of four hours per day. During all other times, dairy cattle are assumed to graze on pasturelands. Beef cattle have access to pastureland for grazing all of the time. Manure produced by grazing beef and dairy cows is directly deposited onto pastureland.

3.2.5 Land Application of Poultry Litter

There are a considerable number of chickens produced in the Town Creek Watershed each year. In this area, poultry farming operations use houses in which chickens are confined all of the time. The litter produced by the chickens is collected and is routinely applied as a fertilizer to pastureland in the watershed. Application rates of the litter vary monthly.

Predominantly, two kinds of chickens are raised on farms in the Tombigbee Basin, broilers and layers. For the broiler chickens, the amount of growth time from when the chicken is born to when it is sold off the farm is approximately 48 days or 1.6 months. Layer chickens remain on farms for ten months or longer. The majority of the chickens raised in this area are broilers. For the model, a weighted average of growth time was determined to account for both types of chickens. An average growth time of 52 days, or 1/7 of a year, was used. To determine the number of chickens on farms on any given day, the yearly population of chickens sold was divided by seven.

3.2.6 Other Direct Inputs

Due to the general topography in the Town Creek Watershed, it was assumed that all land slopes in the watershed are such that unconfined animals are able to access the intermittent streams in all pastures. Feces deposited in streams by grazing animals are included in the water quality model as a point source having constant flow and concentration. To calculate the amount of bacteria introduced into streams by animals, it is assumed that cattle populations have access to the streams and spend 0.026 % (winter) and 0.052 % (summer) of their time subwatershed standing in a stream at any given time. This direct input of constant flow and concentration represents all animal access to streams (domestic and wild), illicit discharges of fecal coliform bacteria, and leaking sewer collection lines.

3.2.7 Urban Development

Urban areas include land classified as urban and barren. Even though only a small percentage of the watershed is classified as urban, the contribution of the urban areas to fecal coliform loading in Town Creek was considered. The largest municipality within the Town Creek Watershed for this model is Tupelo. Fecal coliform contributions from urban areas may come from storm water runoff, runoff from construction sites, and runoff contribution from improper disposal of materials such as litter.

4.0 MODELING PROCEDURE: LINKING THE SOURCES TO THE ENDPOINT

Establishing the relationship between the instream water quality target and the source loading is a critical component of TMDL development. It allows for the evaluation of management options that will achieve the desired source load reductions. Ideally, the linkage will be supported by monitoring data that allow the TMDL developer to associate certain waterbody responses to flow and loading conditions. In this section, the selection of the modeling tools, setup, and model application are discussed.

4.1 Modeling Framework Selection

The BASINS model platform and the NPSM model were used to predict the significance of fecal coliform sources to fecal coliform levels in the Town Creek Watershed. BASINS is a multipurpose environmental analysis system for use in performing watershed and water quality-based studies. A geographic information system (GIS) provides the integrating framework for BASINS and allows for the display and analysis of a wide variety of landscape information such as landuses, monitoring stations, point source discharges, and stream descriptions. The NPSM model simulates nonpoint source runoff from selected watersheds, as well as the transport and flow of the pollutants through stream reaches. A key reason for using BASINS as the modeling framework is its ability to integrate both point and nonpoint sources in the simulation, as well as its ability to assess instream water quality response.

4.2 Model Setup

The Town Creek TMDL model includes the listed section of the creek. Yonaba Creek, located in HUC 03160102, was modeled separately and the results of the model were added to this Town Creek TMDL model. This source input allows the model to assess the contribution of Yonaba Creek, to the hydrology and fecal coliform loading in Town Creek. Thus, all upstream contributors of bacteria are accounted for in the model. The remaining watershed was divided into 24 subwatersheds in an effort to isolate the major stream reaches in the Town Creek Watershed. This division allowed the relative contribution of point and nonpoint sources to be addressed within each subwatershed.

4.3 Source Representation

Both point and nonpoint sources were represented in the model. A spreadsheet was developed for quantifying point and nonpoint sources of bacteria for the Town Creek model. This spreadsheet calculates the model inputs for fecal coliform loading due to point and nonpoint sources using assumptions about land management, septic systems, farming practices, and permitted point source contributions.

The discharge from point sources was added as a direct input into the appropriate reach of the waterbody. There are 30 NPDES permitted facilities in the watershed which discharge fecal coliform bacteria. Fecal coliform loading rates for point sources are input to the model as flow in cubic feet per second and fecal coliform contribution in counts per hour. The nonpoint sources are represented in the model with two different methods. The first method is a direct fecal coliform loading to Town Creek. Other sources are represented with application rate to the land in the Town

Creek Watershed. For these sources, fecal coliform accumulation rates in counts per acre per day were calculated for each subwatershed on a monthly basis and input to the model for each landuse. Fecal coliform contributions from forests and wetlands were considered to be equal. Urban and barren areas were also considered to produce equal loads. The fecal coliform accumulation rate for pastureland is the sum of accumulation rates due to litter application, wildlife, processed manure, and grazing animals. For cropland, the accumulation rate is only due to wildlife.

4.3.1 Failing Septic Systems

The number of failing septic systems used in the model was derived from the watershed area normalized county populations. The percentage of the population on septic systems was determined from 1990 United States Census Data. Based on the best available information, a failure rate of 40% was assumed. This information was used to calculate the estimated number of failing septic tanks per watershed. The number of failing septic tanks also incorporates an estimate for the failing individual onsite wastewater treatment systems in the area. In reality, septic tank failures are both point and nonpoint sources. Therefore, the load from failing septic tanks has been considered to contribute equally to the wasteload allocation component and load allocation component of the TMDL calculation

Discharges from failing septic systems were quantified based on several factors including the estimated population served by the septic systems, an average daily discharge of 70 gallons per person per day, and a septic system effluent fecal coliform concentration of 10^4 counts per 100 ml.

4.3.2 Wildlife

Based on information provided by the Mississippi Department of Wildlife, Fisheries, and Parks, the deer population throughout the Town Creek Watershed was estimated to be greater than 45 animals per square mile. For the model, an upper limit of 60 deer per square mile was used to account for the deer and all other wildlife contributing to fecal coliform accumulation in the area. The wildlife contribution in counts per acre per day is calculated by multiplying a loading rate by the number of animals. The loading rate used in the model was estimated to be 5.00E+08 counts/day/animal. The per acre loading rate applied to the landuses is 4.69E+07 counts/acre/day.

4.3.3 Land Application of Manure

The spreadsheet was used to estimate the amount of waste and the concentration of fecal coliform bacteria contained in hog and dairy cattle manure produced by confined animal feeding operations. The livestock count per county is based upon the 1997 Census of Agriculture data. The county livestock count is used to estimate the number of livestock in a subwatershed. This is calculated by multiplying the county livestock figures with the area of the county within the subwatershed boundaries. This estimate is made with the assumption that the livestock are uniformly distributed throughout the county. A fecal coliform production rate in counts per day per animal was multiplied by the number of confined animals to quantify the amount of bacteria produced. The manure produced by these operations is collected in lagoons and applied evenly to all pastureland. Manure application rates to pastureland vary on a monthly basis. This monthly variation is incorporated into the model by using monthly loading rates.

4.3.4 Grazing Beef and Dairy Cattle

The model assumes that the manure produced by grazing beef and dairy cattle is evenly spread on pastureland throughout the year. The fecal coliform content of manure produced by grazing cattle is estimated by multiplying the number of grazing cattle by a fecal coliform production of 1.06E+11 counts per day per animal (NCSU, 1994). The resulting fecal coliform loads are in the units of counts per acre per day.

4.3.5 Land Application of Poultry Litter

The concentration of bacteria, which accumulates in the dry litter where poultry waste is collected, is estimated with the spreadsheet. This is done by multiplying the daily number of chickens by a fecal coliform production rate in counts per day per animal given in Metcalf & Eddy, 1991. The model assumed a watershed area normalized chicken population. The chicken population was determined from the 1997 Census of Agriculture Data for the number of chickens sold from each county per year. Litter application to pastureland varies monthly, and is modeled with a monthly loading rate.

4.3.6 Other Direct Inputs

In the water quality model, a point source of constant flow and concentration was added in each subwatershed. This direct input represented animals having direct access to the stream, illicit discharges of fecal coliform bacteria, and leaking sewer collection lines. The point source loading produced by the other direct inputs is represented by 0.026 % (winter) and 0.052 % (summer) of the number of grazing cattle in each subwatershed standing in a stream at any given time. The fecal coliform concentration is calculated using the number of cows in the stream and a bacteria production rate of 1.06E+11 counts per animal per day (NCSU, 1994).

4.3.7 Urban Development

The MARIS landuse data divide urban land into several categories. For the Town Creek Watershed, the urban land is divided into four different categories: high density, low density, nothing, and transportation. For the model, fecal coliform buildup rates for each category were determined by using literature values from Horner, 1992. The literature value accounts for all of the potential fecal coliform sources in each urban category. Table 4.3 shows the break up of urban land into high density, low density, nothing, and transportation on a subwatershed basis. The fecal coliform production rate for each of these subdivisions of urban land is 1.54E+07 for high density, 1.03E+07 for low density, 1.13E+07 for barren, and 2.00E+05 for transportation. In the model, fecal coliform loading rates on urban land are input as counts per acre per day.

Table 4.3 Urban Landuse Distribution in Acres

Subwatershed	High Density Urban	Low Density Urban	Barren	Transportation	Total
03160102001	136	139	0	0	**275**
03160102002	0	0	0	0	**0**
03160102003	44	371	6	158	**579**
03160102004	30	263	0	230	**523**
03160102005	2,324	2,012	31	727	**5,094**
03160102006	191	536	42	448	**1,217**
03160102007	0	15	7	237	**259**
03160102008	10	41	18	0	**69**
03160102009	354	220	34	987	**1,595**
03160102010	0	17	5	0	**22**
03160102014	343	761	6	186	**1,296**
03160102015	106	226	3	282	**617**
03160102016	0	37	0	0	**37**
03160102017	4	0	0	0	**4**
03160102018	130	175	0	102	**407**
03160102019	0	0	0	0	**0**
03160102020	0	0	0	0	**0**
03160102021	0	0	0	0	**0**
03160102022	0	0	0	0	**0**
03160102023	25	640	0	0	**665**
03160102024	0	0	0	0	**0**
03160102025	0	0	0	0	**0**
03160102026	18	44	0	68	**130**
03160102027	65	247	0	112	**424**
All Watersheds	**3,780**	**5,744**	**152**	**3,537**	**13,213**

4.4 Stream Characteristics

The stream characteristics given below describe the listed section of Town Creek. This section begins at the confluence with Chiwapa Creek and ends at the confluence with Shoaf Creek. The channel geometry and lengths for Town Creek are based on data available within the BASINS modeling system. The characteristics of the modeled section of Town Creek are as follows.

- Length 5 miles
- Average Depth 0.76 ft
- Average Width 89.84 ft
- Mean Flow 984.4 cubic ft per second
- Mean Velocity 1.25 ft per second
- 7Q10 Flow 6.78 cubic ft per second
- Slope 0.00011 ft per ft

4.5 Selection of Representative Modeling Period

The model was run for a 15-year time period, from January 1, 1984, through December 31, 1998. Results from the model were evaluated for the time period from January 1, 1985, until December 31,

1998. Seasonality and critical conditions are accounted for during the extended time frame of the simulation.

The critical condition for fecal coliform impairment from nonpoint source contributors occurs after a heavy rainfall that is preceded by several days of dry weather. The dry weather allows a build up of fecal coliform bacteria, which is then washed off the ground by a heavy rainfall. By using the 14-year time period, many such occurrences are captured in the model results. Critical conditions for point sources, which occur during low flow and low dilution conditions, are simulated as well.

4.6 Model Calibration Process

For the model time period, flow values were compared to data taken from MDEQ's and USGS's monitoring program. Flow data for MDEQ were collected on a bimonthly basis from January 1993 to September 1996. Flow data for USGS were collected approximately daily from January 1989 through December 1996. In Appendix A, Graph A-1 shows the modeled flow versus the USGS data, and A-2 shows the modeled flow versus the MDEQ data.

Water quality was calibrated by comparing the limited ambient monitoring program data to the output from the model. A computer spreadsheet was developed to compare the daily fecal coliform load calculated in the model with the actual fecal coliform samples taken in monitoring. The monitoring values are instantaneous values of individual samples. The model values and field data values are plotted together with rainfall data to evaluate the relationship between the model and recorded events. This allows the model parameters to be modified as appropriate to calibrate the model. In Appendix A, Graph A-3 shows the calibrated model output, ambient fecal coliform data, and the rainfall data.

4.7 Existing Loading

Appendix A includes graphs of the model results showing the instream fecal coliform concentrations for reach 03160102001 of Town Creek. Graph A-4 shows the existing fecal coliform levels in the most downstream impaired reach (03160102001) during the 14-year modeling period using the geometric mean method. The data available for study on this segment indicated an impairment of the waterbody because 6 out of 11 samples were greater than 400 counts per 100 ml for the summer. This exceeds the limits for the standard for this use of the waterbody. However, when this same data are used to calibrate the model and a geometric mean is calculated, the model output does not indicate impairment. Since the modeled results did not show a violation of the geometric mean, MDEQ looked at the summer modeled results for the period in which actual samples were collected. This effort was to determine if the model showed instantaneous violations of the 400 standard 10% of the time. Appendix B shows the results of this method. Graphs B-1, B-3, B-5, and B-7 show the fecal coliform values collected by MDEQ as well as the existing fecal values from the model. Graphs B-2, B-4, B-6, and B-8 show the existing percent violation in reach 03160102001 of Town Creek.

5.0 ALLOCATION

The allocation for this TMDL involves a wasteload allocation for point sources, a load allocation for nonpoint sources, and a margin of safety. Point source contributions enter the stream directly in the appropriate reach. The nonpoint fecal coliform sources used in the model have two different transportation methods. Failing septic tanks and other direct inputs were modeled as direct inputs to the stream. The other nonpoint source contributions were applied to land area on a counts per day per acre basis. The fecal coliform bacteria applied to land are subject to a die-off rate and an absorption rate before entering the stream.

5.1 Wasteload Allocations

The contribution of point sources was considered on a subwatershed basis for the model. Within each subwatershed, the modeled contribution of each discharger was based on the facility's discharge monitoring data and other records of past performance. Table 5.1 lists the point source contributions, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. The final wasteload allocation on the summary page also accounts for the load from 50% of the failing septic tanks.

Table 5.1 Wasteload Allocations

Subwatershed	Existing Load (counts/hr)	Allocated Load (counts/hr)	Percent Reduction
03160102001	3.15E+08	3.15E+08	0%
03160102003	1.95E+08	1.95E+08	0%
03160102004	9.45E+06	9.45E+06	0%
03160102005	6.63E+09	6.63E+09	0%
03160102006	3.90E+08	3.90E+08	0%
03160102009	6.55E+07	6.55E+07	0%
03160102012	9.45E+06	9.45E+06	0%
03160102014	6.61E+08	6.61E+08	0%
03160102015	3.15E+05	3.15E+05	0%
03160102016	9.45E+05	9.45E+05	0%
03160102018	9.76E+07	9.76E+07	0%
03160102020	9.45E+05	9.45E+05	0%
03160102023	3.21E+08	3.21E+08	0%
03160102026	3.15E+05	3.15E+05	0%
Total	**8.69E+09**	**8.69E+09**	**0%**

5.2 Load Allocations

The TMDL scenario for the load allocation for this TMDL involves two different types of nonpoint sources: septic tanks and other direct inputs. Contributions from both of these sources are input into the model in a manner similar to point source input, with a flow and fecal coliform concentration in counts per hour. Table 5.2a lists the nonpoint source contributions due to other direct inputs, on a subwatershed basis, along with their existing load, allocated load, and percent reduction. Table 5.2b gives the same parameters for contributions due to septic tank failure. Septic tank failures in reality are both point and nonpoint contributions and have been calculated as equal contributors to the wasteload allocation component and load allocation component of the TMDL calculation.

Nonpoint fecal coliform loading due to cattle grazing; land application of manure produced by confined dairy cattle, hogs, and poultry; wildlife; and urban development are also included in the load allocation.

Table 5.2a Fecal Coliform Loading Rates for Nonpoint Source Contribution of Other Direct Inputs

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03160102001	4.08E-06	2.10E+09	2.25E-06	1.18E+09	45%
03160102002	4.28E-07	2.20E+08	2.35E-07	1.21E+08	45%
03160102003	2.36E-06	1.21E+09	1.30E-06	6.68E+08	45%
03160102004	1.64E-06	8.43E+08	9.01E-07	4.64E+08	45%
03160102005	1.16E-06	5.97E+08	6.38E-07	3.28E+08	45%
03160102006	1.83E-06	9.41E+08	1.01E-06	5.18E+08	45%
03160102007	2.04E-06	1.05E+09	1.12E-06	5.79E+08	45%
03160102008	2.93E-06	1.51E+09	1.61E-06	8.29E+08	45%
03160102009	2.29E-06	1.18E+09	1.26E-06	6.47E+08	45%
03160102010	1.77E-06	9.09E+08	9.71E-07	5.00E+08	45%
03160102011	2.79E-07	1.44E+08	1.53E-07	7.90E+07	45%
03160102012	9.03E-07	4.65E+08	5.81E-07	2.99E+08	45%
03160102013	1.06E-06	5.43E+08	5.81E-07	2.99E+08	45%
03160102014	1.39E-06	7.13E+08	7.62E-07	3.92E+08	45%
03160102015	1.03E-06	5.29E+08	5.65E-07	2.91E+08	45%
03160102016	1.72E-06	8.84E+08	9.45E-07	4.86E+08	45%
03160102017	1.49E-07	7.67E+07	8.19E-08	4.22E+07	45%
03160102018	3.63E-06	1.87E+09	2.00E-06	1.03E+09	45%
03160102019	1.59E-07	8.16E+07	8.72E-08	4.49E+07	45%
03160102020	1.08E-06	5.58E+08	5.96E-07	3.07E+08	45%
03160102021	8.21E-07	4.23E+08	4.52E-07	2.32E+08	45%
03160102022	7.23E-07	3.72E+08	3.98E-07	2.05E+08	45%
03160102023	7.96E-07	4.09E+08	4.38E-07	2.25E+08	45%
03160102024	1.21E-06	6.25E+08	6.68E-07	3.44E+08	45%
03160102025	0	0	0	0	0%
03160102026	1.25E-06	6.43E+08	6.87E-07	3.54E+08	45%
03160102027	4.16E-06	2.14E+09	2.29E-06	1.18E+09	45%
Total	**4.09E-05**	**2.10E+10**	**2.26E-05**	**1.16E+10**	**45%**

Table 5.2b Fecal Coliform Loading Rates for the Contribution of Failing Septic Tanks (50% WLA and 50% LA)

Subwatershed	Existing Flow (cfs)	Existing Load (counts/hr)	Allocated Flow (cfs)	Allocated Load (counts/hr)	Percent Reduction
03160102001	1.31e-01	9.80E+08	7.21E-02	5.30E+08	45%
03160102002	2.40E-02	1.23E+08	1.32E-02	6.75E+07	45%
03160102003	1.26E-01	8.35E+08	6.93E-02	4.55E+08	45%
03160102004	8.98E-02	4.66E+08	4.94E-02	2.56E+08	45%
03160102005	4.61E-02	6.86E+09	2.53E-02	3.80E+09	45%
03160102006	1.09E-01	9.40E+08	5.97E-02	5.12E+08	45%
03160102007	6.15E-02	3.13E+08	3.38E-02	1.72E+08	45%
03160102008	9.16E-02	4.66E+08	5.04E-02	2.56E+08	45%
03160102009	8.71E-02	5.09E+08	4.79E-02	2.76E+08	45%
03160102010	4.88E-02	2.49E+08	2.69E-02	1.37E+08	45%
03160102011	1.25E-02	6.35E+07	6.85E-03	3.49E+07	45%
03160102012	2.37E-02	1.30E+08	1.30E-02	7.18E+07	45%
03160102013	4.63E-02	2.36E+08	2.54E-02	1.30E+08	45%
03160102014	6.25E-02	9.79E+08	3.43E-02	5.29E+08	45%
03160102015	2.81E-02	2.41E+08	1.54E-02	1.30E+08	45%
03160102016	4.61E-02	2.35E+08	2.53E-02	1.30E+08	45%
03160102017	4.90E-03	2.50E+07	2.70E-03	1.37E+07	45%
03160102018	1.17E-01	6.93E+08	6.44E-02	3.78E+08	45%
03160102019	4.69E-03	2.39E+07	2.58E-03	1.31E+07	45%
03160102020	2.70E-02	1.38E+08	1.48E-02	7.64E+07	45%
03160102021	2.47E-02	1.26E+08	1.36E-02	6.90E+07	45%
03160102022	2.56E-02	1.31E+08	1.41E-02	7.20E+07	45%
03160102023	2.52E-02	4.49E+08	1.38E-02	2.45E+08	45%
03160102024	4.50E-02	2.29E+08	2.48E-02	1.26E+08	45%
03160102025	1.30E-04	6.60E+05	7.16E-05	3.65E+05	45%
03160102026	4.10E-02	2.09E+08	2.26E-02	1.15E+08	45%
03160102027	6.83E-02	3.48E+08	3.76E-02	1.91E+08	45%
Total	**1.42E+00**	**1.60E+10**	**7.79E-01**	**8.79E+09**	**45%**

The model estimated the fecal coliform bacteria count per 30 days entering Town Creek for each listed segment due to runoff during the 30-day critical period. These values are given in section 5.4 Calculation of the TMDL.

The scenario used in this analysis for the load allocation in the Town Creek Watershed assumes a 45% reduction in contributions from failing septic tanks and from other direct inputs. Graph A-5 shows the allocated fecal coliform levels in the most downstream-impaired reach (03160102001) during the 14-year modeling period using the geometric mean method. Graphs B-1, B-3, B-5, and B-7 show the fecal coliform values collected by MDEQ as well as the allocated fecal values from the model. Graphs B-2, B-4, B-6, and B-8 show the allocated percent violation in reach 03160102001 of Town Creek.

5.3 Incorporation of a Margin of Safety (MOS)

The two types of MOS development are to implicitly incorporate the MOS using conservative model assumptions or to explicitly specify a portion of the total TMDL as the MOS. For this study, the MOS is incorporated into the modeling process by utilizing a conservative fecal coliform decay rate, conservative loading and environmental conditions, and running a dynamic simulation for a period of 14 years.

The average 30-day geometric mean value during the 14-year model period is 69 counts per 100 ml. By setting the reduction needed in the TMDL on the maximum critical instance of 186 counts per 100 ml. instead of the average of 69 counts per 100 ml., the implicit MOS can be quantified as a 63% conservative assumption. Another conservative assumption contained in the implicit MOS is modeling the flow from septic tanks directly into the stream. While it is likely that some septic tanks reach the stream directly, the majority of failures only discharge a portion of the bacteria load due to filtration and die off during transport to the stream.

5.4 Calculation of the TMDL

This TMDL is calculated based on the following equation:

TMDL = WLA + LA + MOS

where WLA is the Waste Load Allocation, LA is the Load Allocation, and MOS is the Margin of Safety.

WLA = NPDES Permitted Facilites + ½ of the Septic Tank Failures

LA = Surface Runoff + Other Direct Inputs + ½ of the Septic Tank Failures

MOS = implicit

The TMDL was calculated based on the 30-day critical period for the Town Creek Watershed according to the model. Each of the loading rates has been converted to the 30-day equivalent. The wasteload allocation incorporates the fecal coliform contribution from identified NPDES Permitted facilities and 50% of the contribution from failing septic tanks. The load allocation includes the fecal coliform contributions from surface runoff, other direct inputs, and 50% of the contribution from failing septic tanks. The margin of safety for this TMDL is derived from the conservative loading assumptions used in setting up the model and is implicit. Table 5.4 gives the TMDL for the listed segment.

Table 5.4 TMDL Summary for Monitored Segment (counts/30 days)

	MS016TM
NPDES Permits	6.25E+12
½ Failing Septic Tanks	3.16E+12
WLA	**.00941E+15**
Surface Runoff	2.09E+15
Other Direct Inputs	8.35E+12
½ Failing Septic Tanks	3.16E+12
LA	**2.10E+15**
TMDL = WLA + LA +MOS	**2.11E+15**

5.5 Seasonality

For many streams in the state, fecal coliform limits vary according to the seasons. This stream is designated for the use of secondary contact recreation. For this use, the pollutant standard is seasonal.

Because the model was established for a 14-year time span, it took into account all of the seasons within the calendar years from 1985 to 1998. The extended time period allowed the simulation of many different atmospheric conditions such as rainy and dry periods and high and low temperatures. It also allowed seasonal critical conditions to be simulated.

6.0 CONCLUSION

The fecal coliform scenario used in this TMDL included requiring all NPDES Permitted dischargers to maintain current permit limits. Modeling indicates that a 45% reduction in other direct inputs and septics is needed in order for this water body to meet water quality standards.

The TMDL will not impact existing or future NPDES Permits as long as the effluent is disinfected to meet water quality standards for fecal coliform bacteria. MDEQ will not approve any NPDES Permit application that does not plan to meet water quality standards for disinfection. Education projects that teach best management practices should be used as a tool for reducing nonpoint source contributions. These projects may be funded by CWA Section 319 Nonpoint Source (NPS) Grants.

6.1 Future Monitoring

MDEQ has adopted the Basin Approach to Water Quality Management, a plan that divides Mississippi's major drainage basins into five groups. During each yearlong cycle, MDEQ resources for water quality monitoring will be focused on one of the basin groups. During the next monitoring phase in the Town Creek Basin, Town Creek may receive additional monitoring to identify any change in water quality. MDEQ produced guidance for future Section 319 project funding will encourage NPS restoration projects that attempt to address TMDL related issues within Section 303(d)/TMDL watersheds in Mississippi.

6.2 Public Participation

This TMDL will be published for a 30-day public notice. During this time, the public will be notified by publication in the statewide newspaper and a newspaper in the area of the watershed. The public will be given an opportunity to review the TMDL and submit comments. At the end of the 30-day period, MDEQ will determine the level of interest in the TMDL and make a decision on the necessity of holding a public hearing.

All comments received during the public notice period and at any public hearings become a part of the record of this TMDL. All comments will be considered in the ultimate approval of this TMDL by the Commission on Environmental Quality and for submission of this TMDL to EPA Region IV for final approval.

DEFINITIONS

Allocated Load: instream fecal coliform concentrations after reductions have been applied.

Ambient stations: a network of fixed monitoring stations established for systematic water quality sampling at regular intervals, and for uniform parametric coverage over a long-term period.

Assimilative capacity: the capacity of a body of water or soil-plant system to receive wastewater effluents or sludge without violating the provisions of the State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters and Water Quality regulations.

Background: the condition of waters in the absence of man-induced alterations based on the best scientific information available to MDEQ. The establishment of natural background for an altered waterbody may be based upon a similar, unaltered or least impaired, waterbody or on historical pre-alteration data.

Calibrated model: a model in which reaction rates and inputs are significantly based on actual measurements using data from surveys on the receiving waterbody.

Critical Condition: hydrologic and atmospheric conditions in which the pollutants causing impairment of a waterbody have their greatest potential for adverse effects.

Daily discharge: the "discharge of a pollutant" measured during a calendar day or any 24-hour period that reasonably represents the calendar day for purposes of sampling. For pollutants with limitations expressed in units of mass, the "daily discharge" is calculated as the total mass of the pollutant discharged over the day. For pollutants with limitations expressed in other units of measurement, the "daily average" is calculated as the average.

Designated Use: use specified in water quality standards for each waterbody or segment regardless of actual attainment.

Discharge monitoring report: report of effluent characteristics submitted by a NPDES Permitted facility.

Effluent standards and limitations: all State or Federal effluent standards and limitations on quantities, rates, and concentrations of chemical, physical, biological, and other constituents to which a waste or wastewater discharge may be subject under the Federal Act or the State law. This includes, but is not limited to, effluent limitations, standards of performance, toxic effluent standards and prohibitions, pretreatment standards, and schedules of compliance.

Effluent: treated wastewater flowing out of the treatment facilities.

Existing Load: instream fecal coliform concentrations at existing conditions.

Fecal coliform bacteria: a group of bacteria that normally live within the intestines of mammals, including humans. Fecal coliform bacteria are used as an indicator of the presence of pathogenic organisms in natural water.

Geometric mean: the *n*th root of the product of *n* numbers. A 30-day geometric mean is the 30^{th} root of the product of 30 numbers.

Impaired Waterbody: any waterbody that does not attain water quality standards due to an individual pollutant, multiple pollutants, pollution, or an unknown cause of impairment.

Land Surface Runoff: water that flows into the receiving stream after application by rainfall or irrigation. It is a transport method for nonpoint source pollution from the land surface to the receiving stream.

Load allocation (LA): the portion of a receiving water's loading capacity attributed to or assigned to nonpoint sources (NPS) or background sources of a pollutant. The load allocation is the value assigned to the summation of all direct sources and land applied fecal coliform that enter a receiving waterbody. It also contains a portion of the contribution from septic tanks.

Loading: the total amount of pollutants entering a stream from one or multiple sources.

Nonpoint Source: pollution that is in runoff from the land. Rainfall, snowmelt, and other water that does not evaporate become surface runoff and either drains into surface waters or soaks into the soil and finds its way into groundwater. This surface water may contain pollutants that come from land use activities such as agriculture; construction; silviculture; surface mining; disposal of wastewater; hydrologic modifications; and urban development.

NPDES permit: an individual or general permit issued by the Mississippi Environmental Quality Permit Board pursuant to regulations adopted by the Mississippi Commission on Environmental Quality under Mississippi Code Annotated (as amended) §§ 49-17-17 and 49-17-29 for discharges into State waters.

Point Source: pollution loads discharged at a specific location from pipes, outfalls, and conveyance channels from either wastewater treatment plants or industrial waste treatment facilities. Point sources can also include pollutant loads contributed by tributaries to the main receiving stream.

Pollution: contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the State, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance, or leak into any waters of the State, unless in compliance with a valid permit issued by the Permit Board.

Publicly Owned Treatment Works (POTW): a waste treatment facility owned and/or operated by a public body or a privately owned treatment works which accepts discharges which would otherwise be subject to Federal Pretreatment Requirements.

Regression Coefficient: an expression of the functional relationship between two correlated variables that is often empirically determined from data, and is used to predict values of one variable when given values of the other variable.

Scientific Notation (Exponential Notation): mathematical method in which very large numbers or very small numbers are expressed in a more concise form. The notation is based on powers of ten. Numbers in scientific notation are expressed as the following: *4.16 x 10^(+b)* and *4.16 x 10^(-b) [same as 4.16E4 or4.16E-4]*. In this case, *b* is always a positive, real number. The *10^(+b)* tells us that the decimal point is *b* places to the right of where it is shown. The *10^(-b)* tells us that the decimal point is *b* places to the left of where it is shown.
For example: $2.7X10^{4}$ = 2.7E+4 =27000 and $2.7X10^{-4}$ = 2.7E-4=0.00027.

Sigma (Σ): shorthand way to express taking the sum of a series of numbers. For example, the sum or total of three amounts 24, 123, 16, ($\mathbf{d_l}$, $\mathbf{d_2}$, $\mathbf{d_3}$) respectively could be shown as:

$$\sum_{i=1}^{3} d_i = d_1+d_2+d_3 = 24 + 123 + 16 = 163$$

Total Maximum Daily Load or TMDL: the calculated maximum permissible pollutant loading to a waterbody at which water quality standards can be maintained.

Waste: sewage, industrial wastes, oil field wastes, and all other liquid, gaseous, solid, radioactive, or other substances which may pollute or tend to pollute any waters of the State.

Wasteload allocation (WLA): the portion of a receiving water's loading capacity attributed to or assigned to point sources of a pollutant. It also contains a portion of the contribution from septic tanks.

Water Quality Standards: the criteria and requirements set forth in *State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters*. Water quality standards are standards composed of designated present and future most beneficial uses (classification of waters), the numerical and narrative criteria applied to the specific water uses or classification, and the Mississippi antidegradation policy.

Water quality criteria: elements of State water quality standards, expressed as constituent concentrations, levels, or narrative statements, representing a quality of water that supports the present and future most beneficial uses.

Waters of the State: all waters within the jurisdiction of this State, including all streams, lakes, ponds, wetlands, impounding reservoirs, marshes, watercourses, waterways, wells, springs, irrigation systems, drainage systems, and all other bodies or accumulations of water, surface and underground, natural or artificial, situated wholly or partly within or bordering upon the State, and such coastal waters as are within the jurisdiction of the State, except lakes, ponds, or other surface waters which are wholly landlocked and privately owned, and which are not regulated under the Federal Clean Water Act (33 U.S.C.1251 et seq.).

Watershed: the area of land draining into a stream at a given location.

ABBREVIATIONS

7Q10 .... Seven-Day Average Low Stream Flow with a Ten-Year Occurrence Period

BASINS .... Better Assessment Science Integrating Point and Nonpoint Sources

BMP .... Best Management Practice

CWA .... Clean Water Act

DMR .... Discharge Monitoring Report

EPA .... Environmental Protection Agency

GIS .... Geographic Information System

HUC .... Hydrologic Unit Code

LA .... Load Allocation

MARIS .... State of Mississippi Automated Resource Information System

MDEQ .... Mississippi Department of Environmental Quality

MOS .... Margin of Safety

NRCS .... National Resource Conservation Service

NPDES .... National Pollution Discharge Elimination System

NPSM .... Nonpoint Source Model

RF3 .... Reach File 3

USGS .... United States Geological Survey

WLA .... Waste Load Allocation

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APPENDIX A

This appendix contains printouts of the various model run results. Graph A-1 shows the modeled flow, in cubic feet per second, through reach 03160102001 compared to the USGS flow readings from the Town Creek near Nettleton at Highway 45, station 02436500. Graph A-2 shows the modeled flow, in cubic feet per second, through reach 03160102001 compared to the USGS flow readings from the Town Creek near Nettleton at Highway 45, station 02436500. Graph A-3 shows the calibrated model output, ambient fecal coliform data, and rainfall data. Graph A-4 shows the existing fecal coliform levels in the most downstream reach (03160102001) during the 14-year modeling period using the geometric mean method. The graph contains a reference line at 200 counts per 100 ml.

The graph showing the 30-day geometric mean of instream fecal coliform concentrations representing the loading scenario for the most downstream reach (Graph A-4) was used to identify the critical condition. The TMDL calculation includes the sum of the loads from all identified point and nonpoint sources applied or discharged within the modeled watershed.

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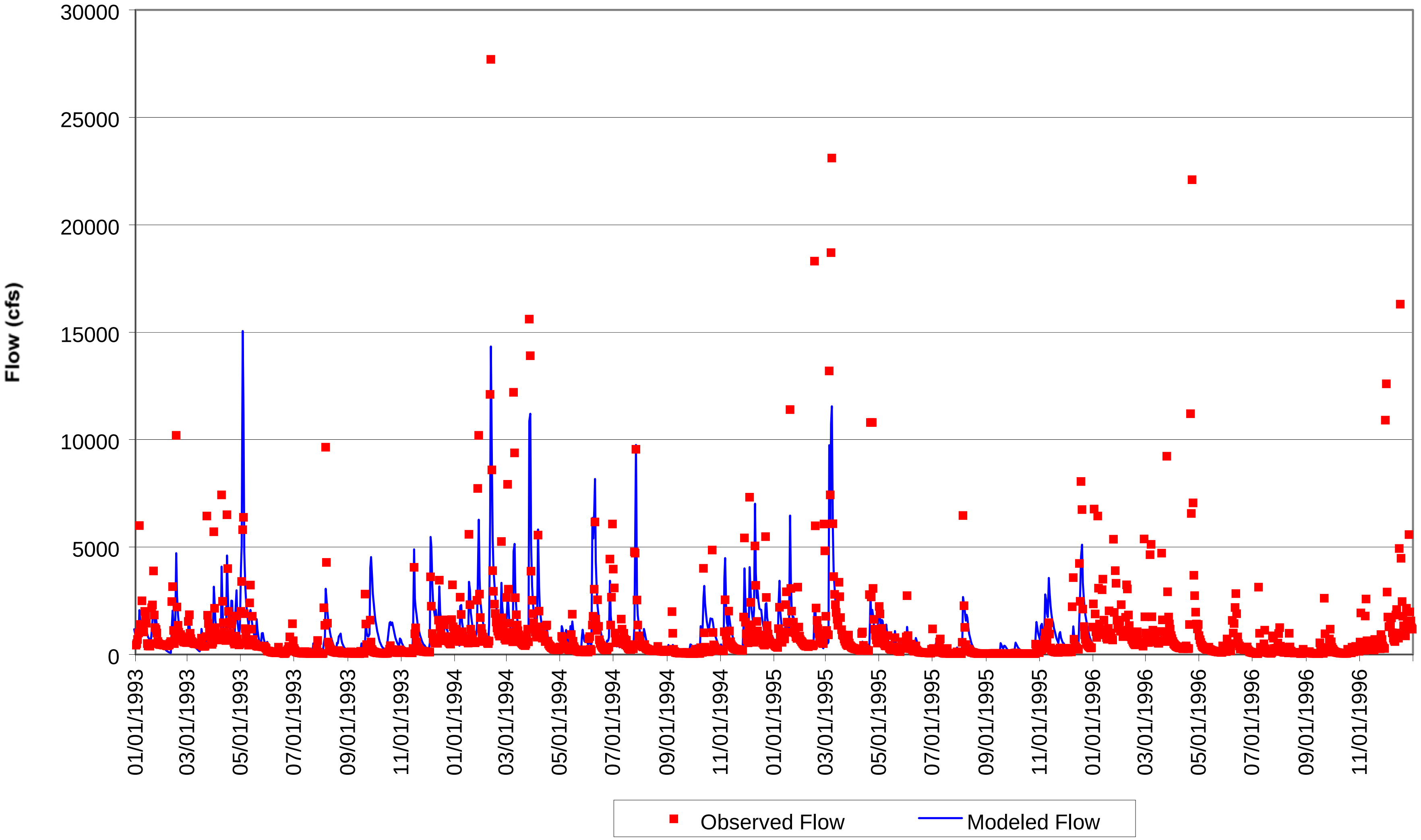
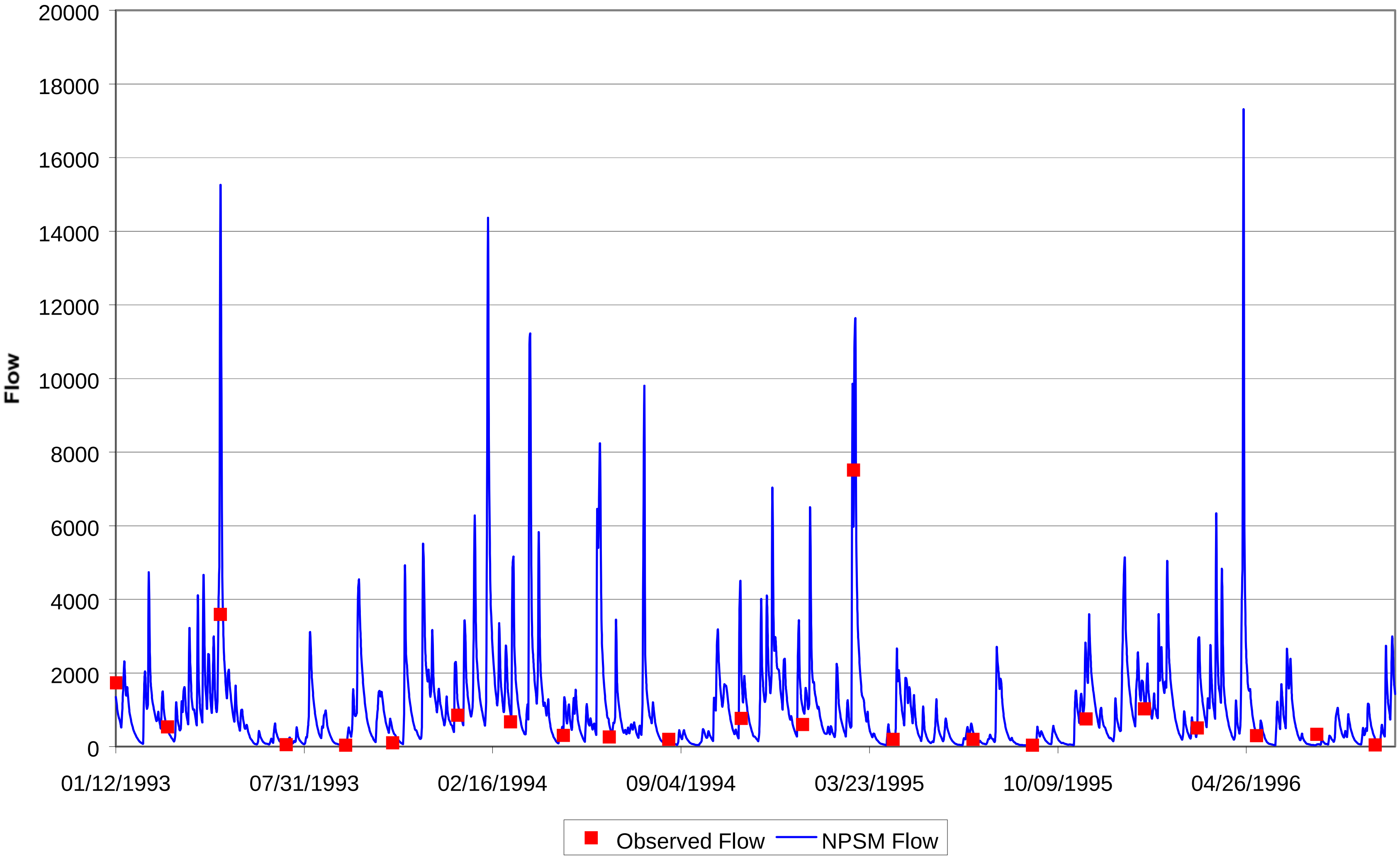
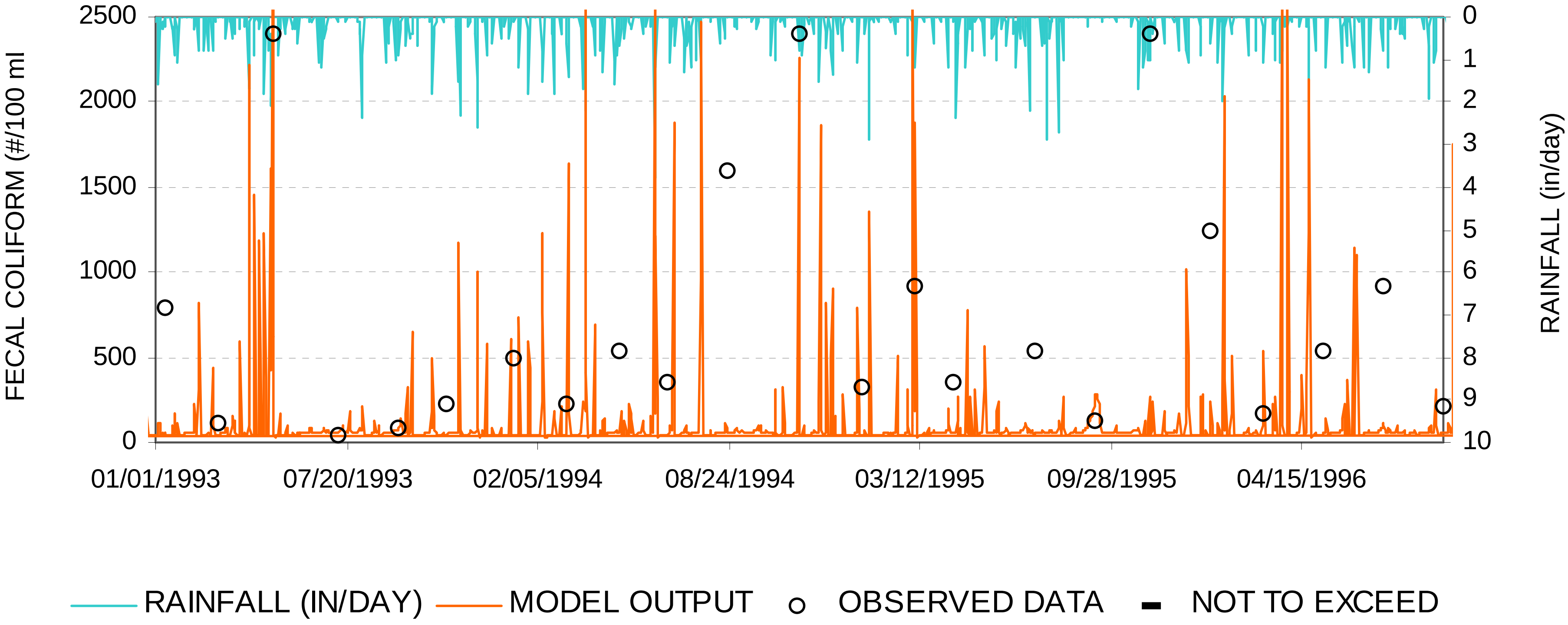
Graph A-1 Daily Flow Comparison between USGS Station 02436500 and Reach 03160102001 for 01/01/1993 - 12/31/1998



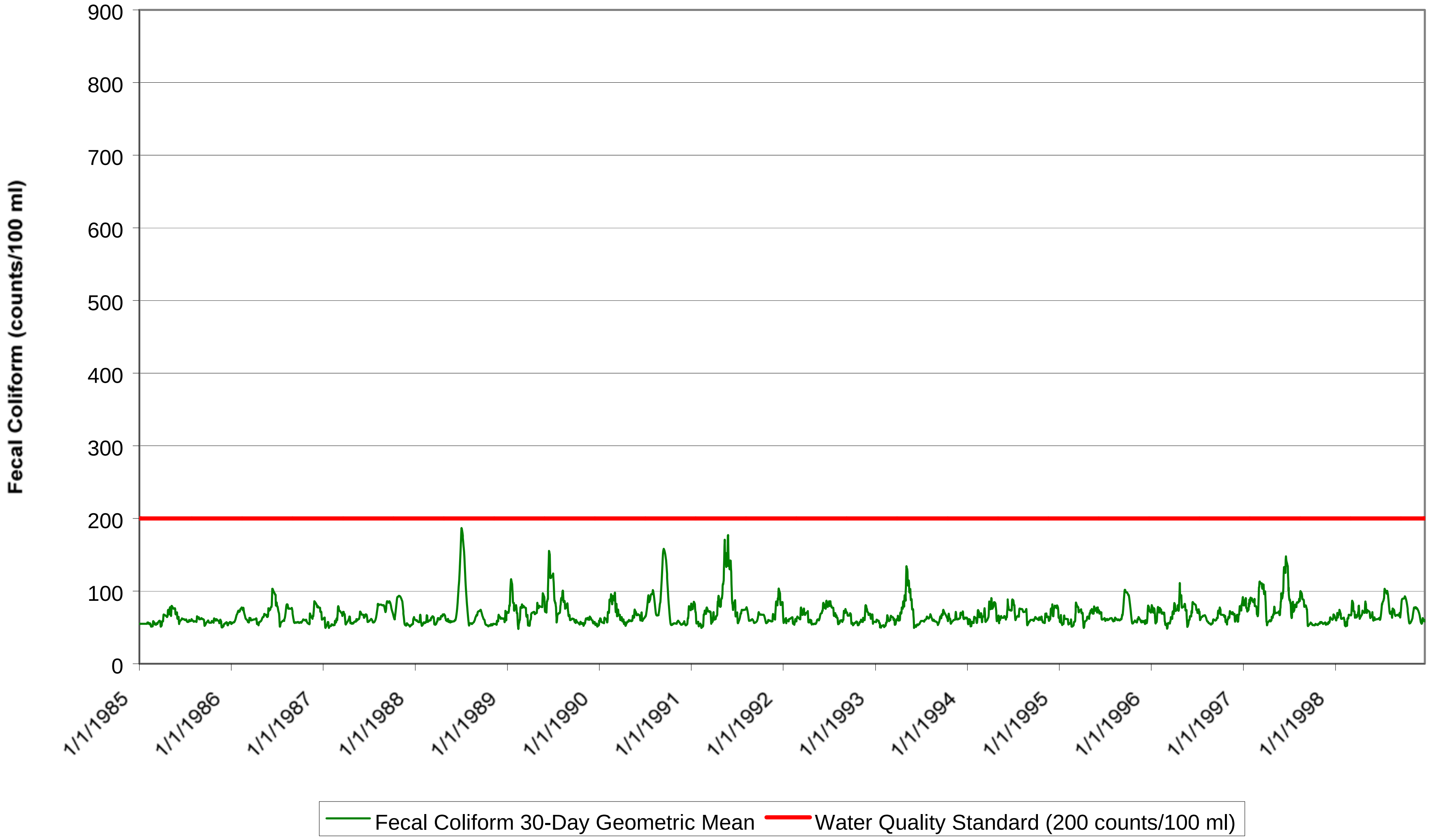
Graph A-2 Daily Flow Comparison between DEQ Ambient Monitoring Station 02436500 and Reach 03160102001 for 1/12/1993-10/01//1996



Graph A-3 Water Quality Calibration Plot for Reach 03160102001 and DEQ Ambient Monitoring Station 02436500



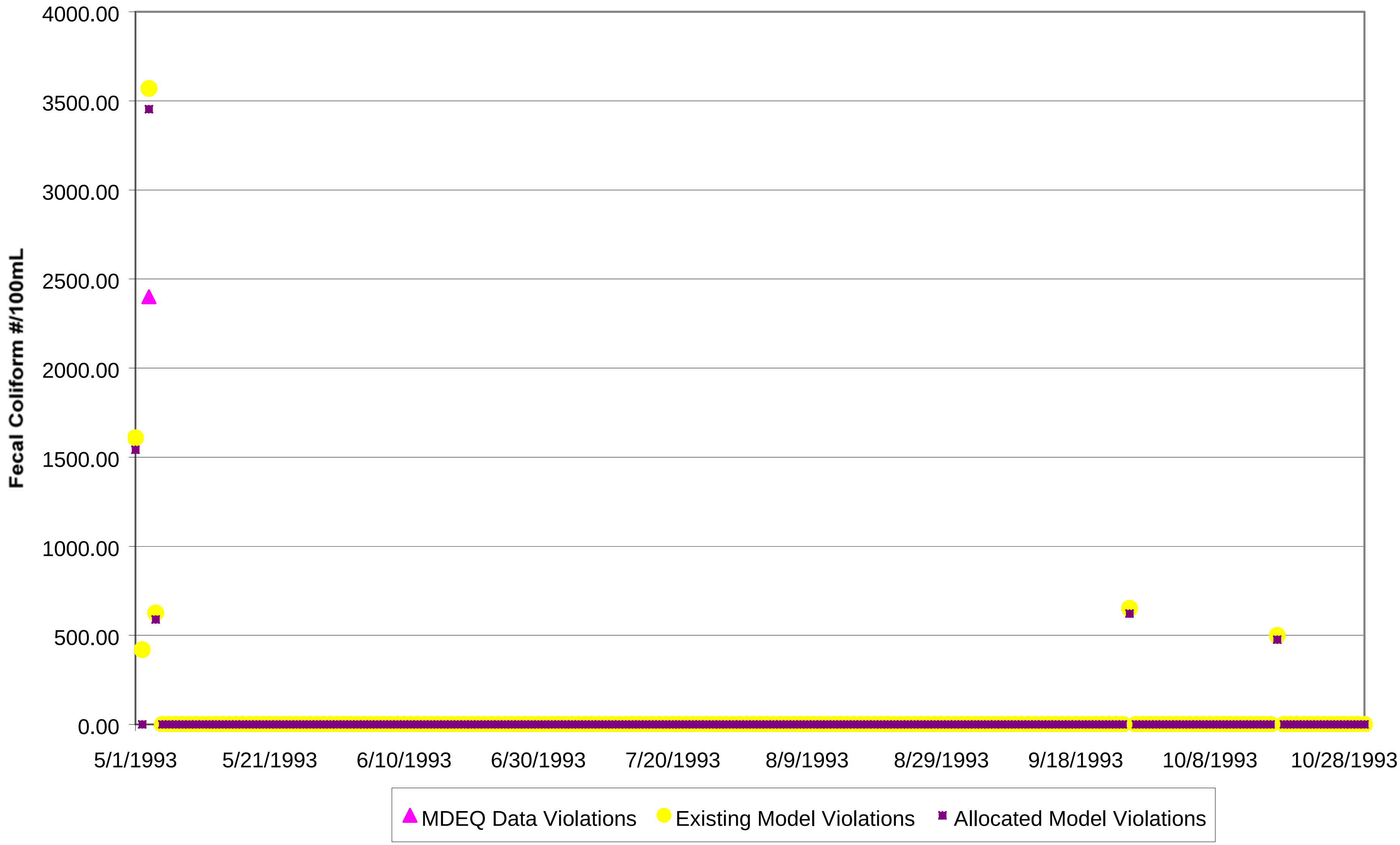
Graph A-4 Modeled Fecal Coliform Concentrations Under Existing Conditions for Reach 03160102001



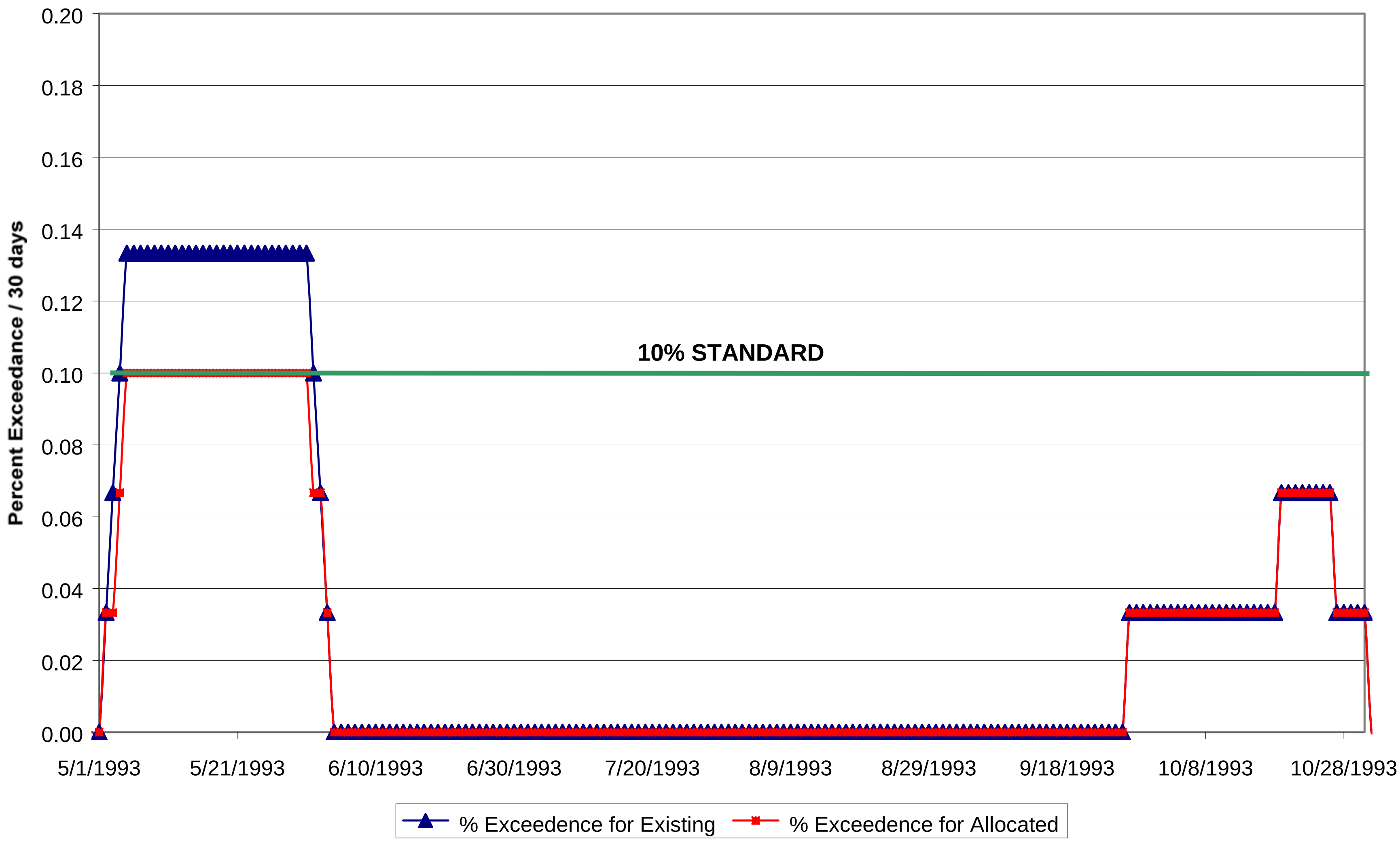
APPENDIX B

This section contains graphs of the violation in Town Creek comparing the model data to the 400 instantaneous standard. Since the modeled results did not show a violation of the geometric mean, as shown in Appendix A, MDEQ looked at the summer modeled results for the period in which actual samples were collected (1993-1996). Graphs B-1, B-3, B-5, and B-7 show the fecal coliform values collected by MDEQ as well as the existing and allocated fecal values from the model. Graphs B-2, B-4, B-6, and B-8 show the existing and allocated percent violation in reach 03160102001 of Town Creek.

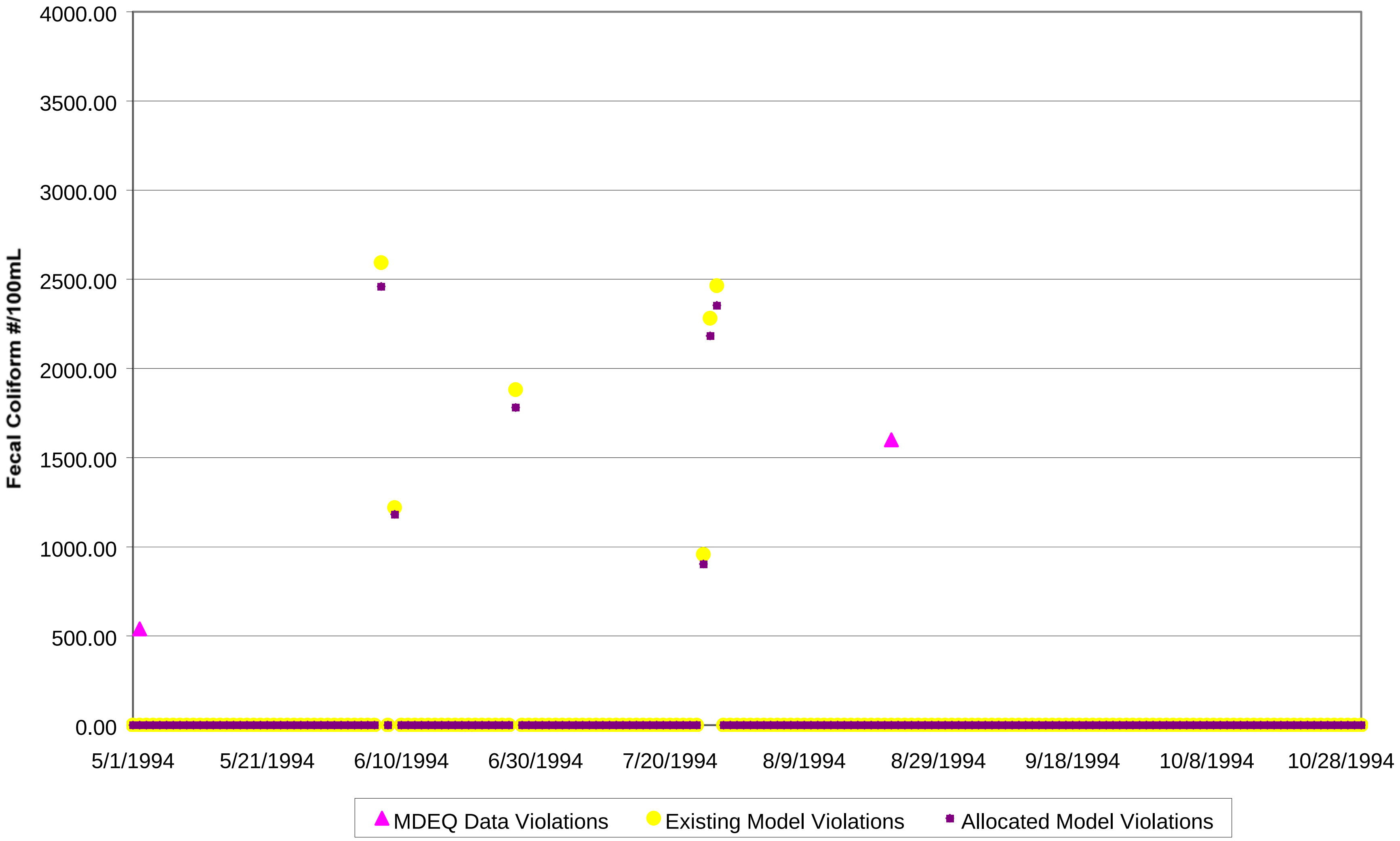
Graph B-1 Fecal Coliform Data for Reach 03160102001 of Town Creek for 1993



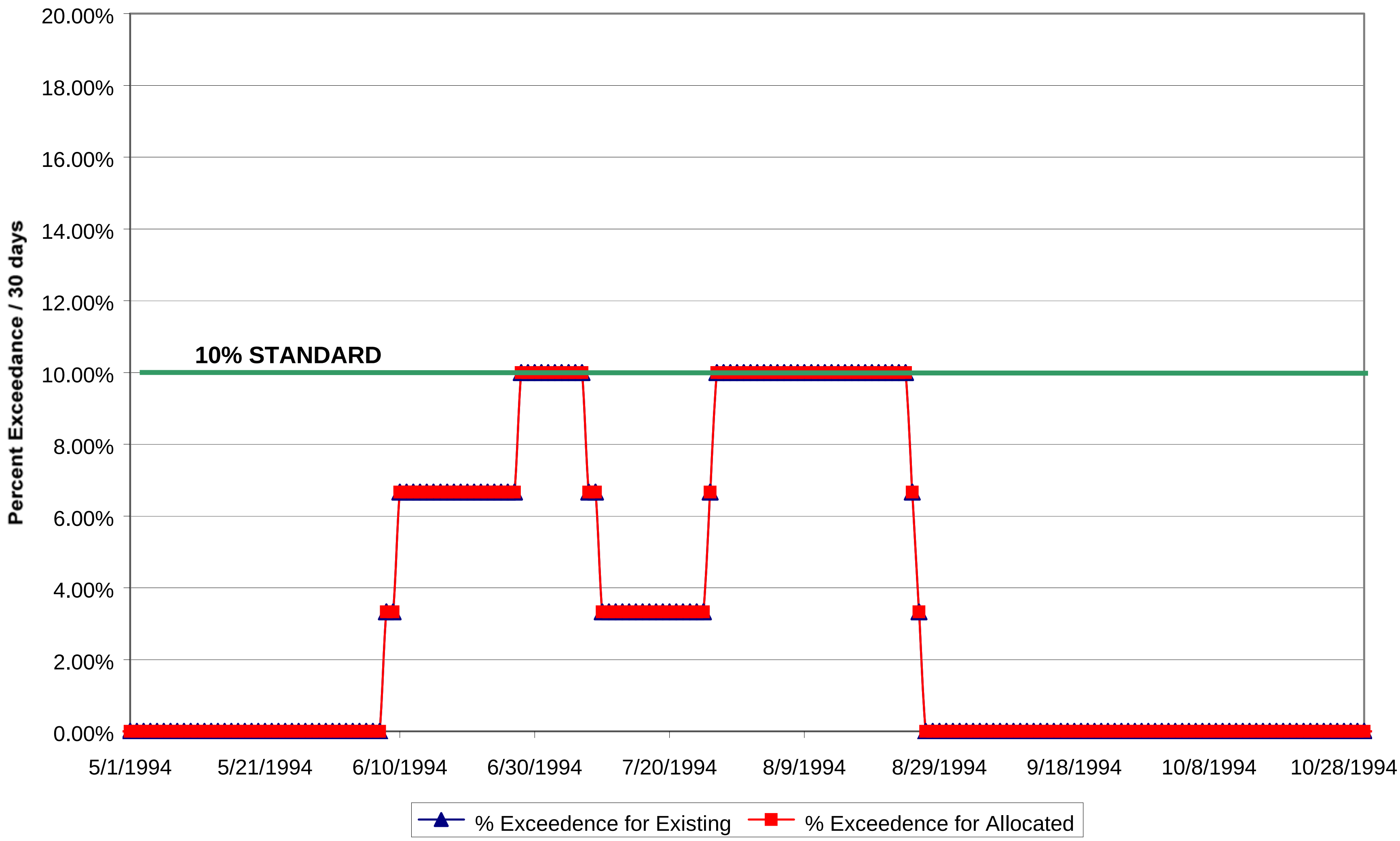
Graph B-2 Violations in Reach 03160102001 of Town Creek for 1993



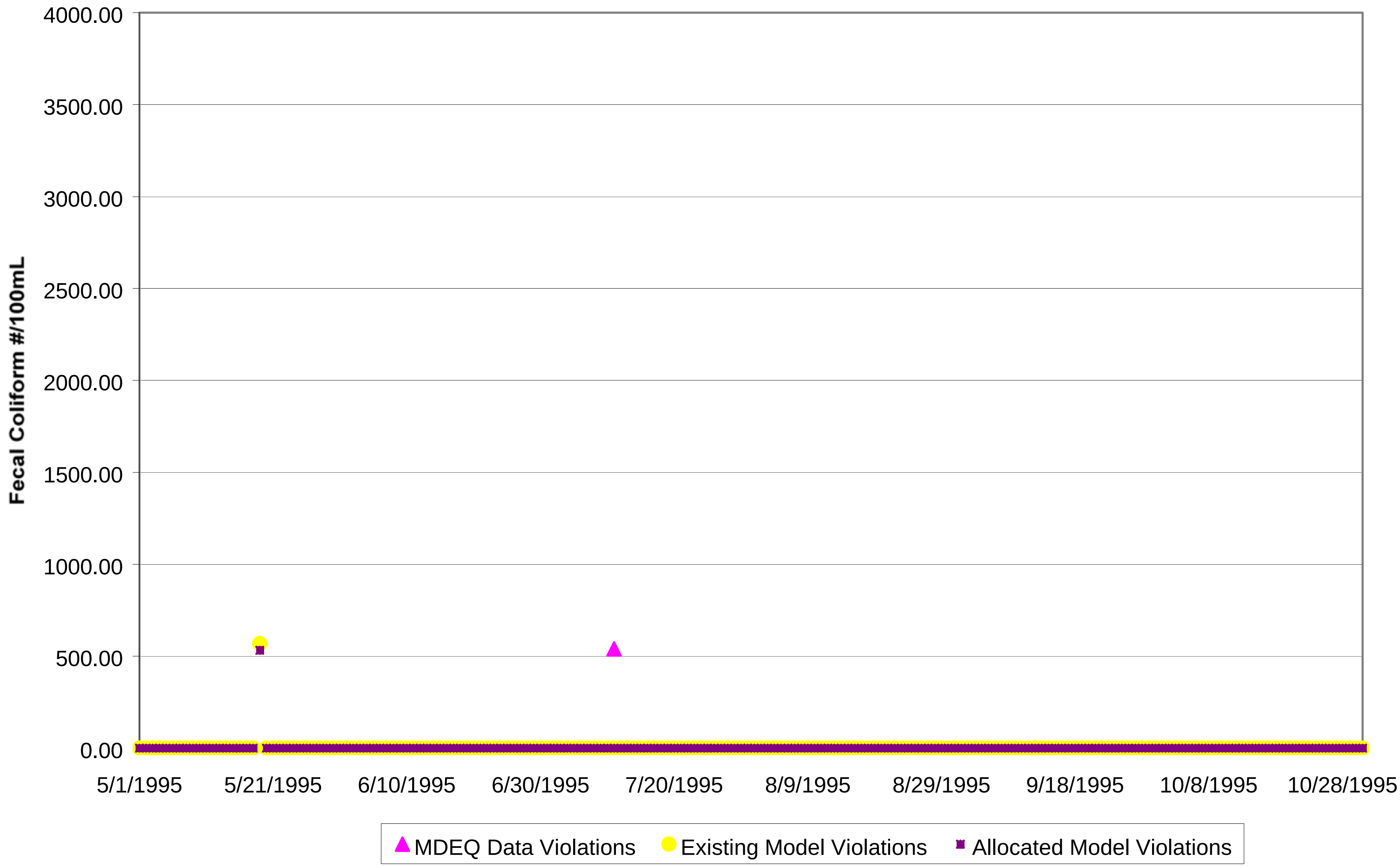
Graph B-3 Fecal Coliform Data for Reach 03160102001 of Town Creek for 1994



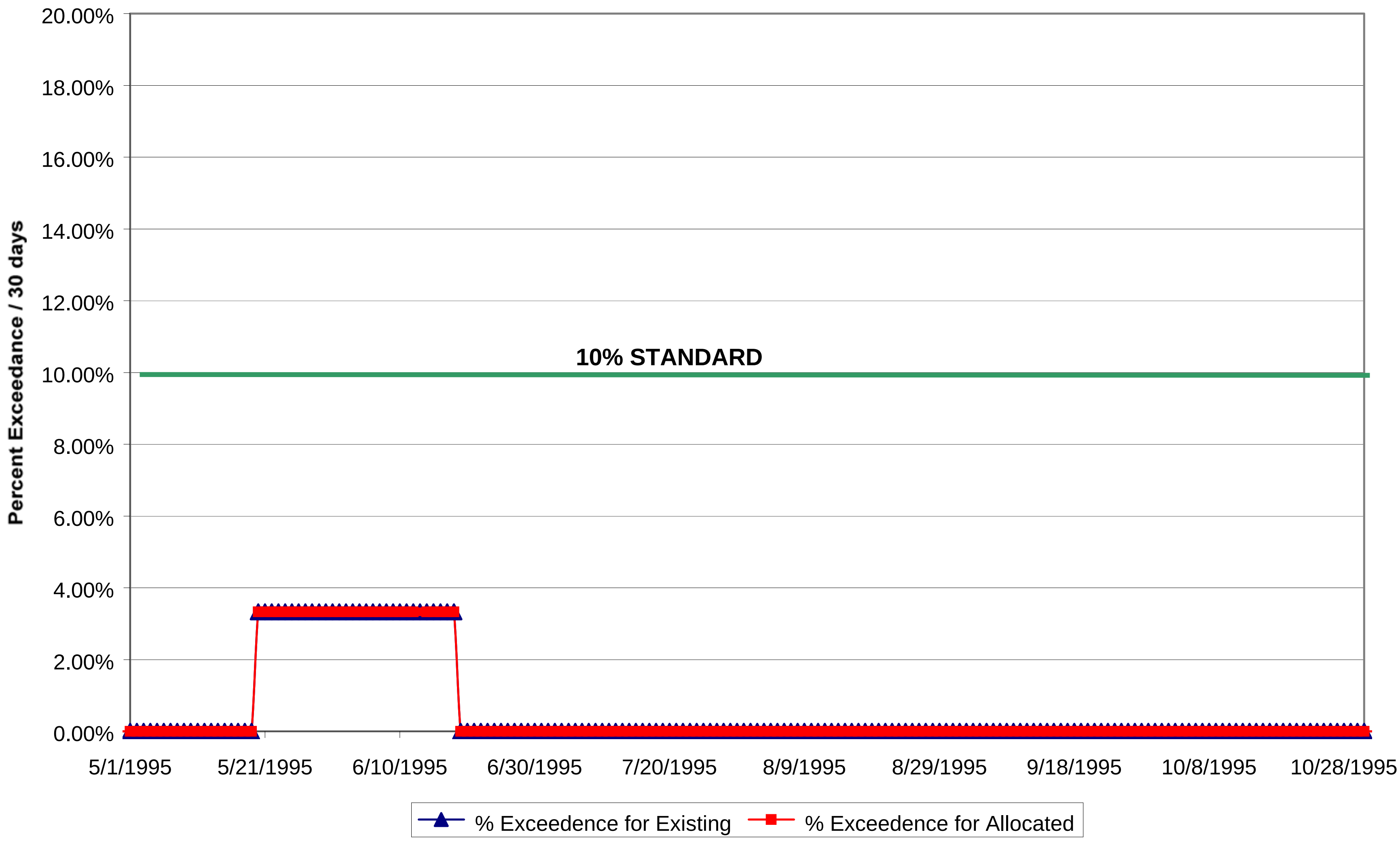
Graph B-4 Violations in Reach 03160102001 of Town Creek for 1994



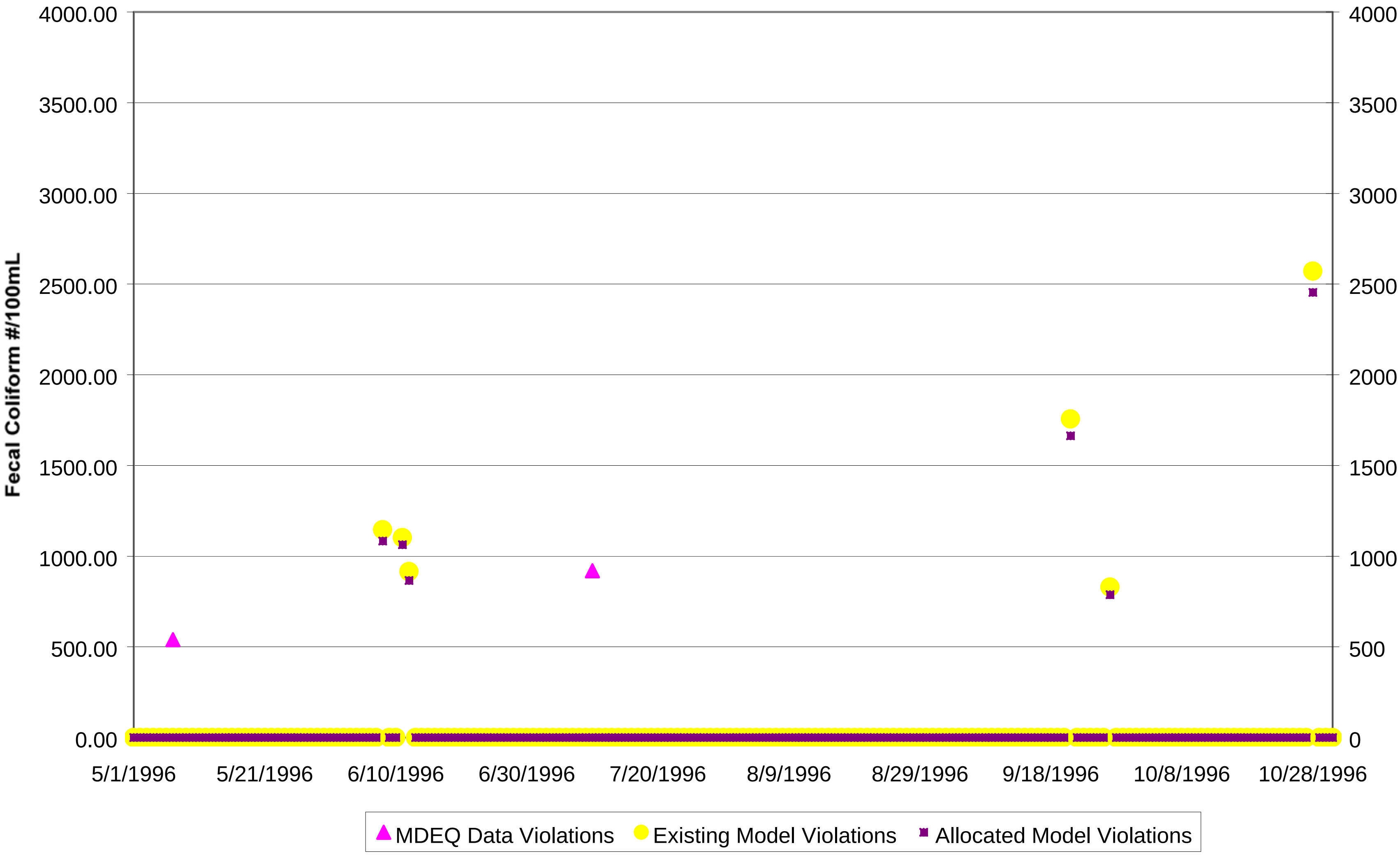
Graph B-5 Fecal Coliform Data for Reach 03160102001 of Town Creek for 1995



Graph B-6 Violations in Reach 03160102001 of Town Creek for 1995



Graph B-7 Fecal Coliform Data for Reach 03160102001 of Town Creek for 1996



Graph B-8 Violations in Reach 03160102001 of Town Creek for 1996