APPENDIX X

SELECTED SECTIONS OF FDEP TMDL CRITERIA

FOR

MERCURY AND FECAL COLIFORM

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration
Bureau of Watershed Restoration

Mercury TMDL for the State of Florida
(Revised Draft)

Watershed Evaluation and TMDL Section

September 20, 2012

1.4 Applicable Water Quality Criteria

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

The State of Florida has adopted (in Chapter 62-302 of the Florida Administrative Code, or F.A.C.) a series of water quality criteria for its five classes of waters, each designed to protect the associated designated use of the classification. These criteria require that the total mercury concentration in ambient water should be less than 0.012 µg/L (12 ng/L) for Class I and Class III freshwater waterbodies, should be less than 0.025 µg/L (25 ng/L) for Class II and Class III marine waterbodies, and should be less or equal to 0.2 µg/L (200 ng/L) for Class IV and Class V waters [per 62-302.530(41), F.A.C.]. Chapter 62-302.500, F.A.C., provides direction for the Department to ensure Minimum and General Criteria are being met in surface waters of the state. Specifically, the Minimum Criteria provide that waters should be "free from" substances that are acutely toxic or "5. Are present in concentrations which are carcinogenic, mutagenic, or teratogenic to human beings or to significant, locally occurring wildlife or aquatic species, unless specific standards are established for such components in Rules 62-302.500(2) or 62-302.530, or (6) Pose a serious danger to the public health, safety or welfare."

There has been recognition of the potential for elemental mercury to be transformed into other forms of mercury (e.g., methylmercury - MeHg) which have been identified as being a human health risk. However, so far, no ambient water MeHg criteria have been established. Florida has not yet adopted criteria limiting the amounts of mercury in fish tissue. Instead, the Department's rules identify waterbodies impaired for mercury pollution based on fish consumption advisories issued by the Florida Department of Health, which are in turn based on observations that mercury tissue concentration in fish samples exceeds the 0.3 mg total mercury /kg of fish tissue recommended by EPA for human health protection. To provide an added level of protection, this TMDL also assesses impact to the more sensitive populations in Florida, specifically women of childbearing age and young children, and uses a target of 0.1 mg total mercury per kilogram of fish tissue, as identified by the Florida Department of Health in their fish consumption advisories.

1.5 Impaired Waterbodies in Florida Listed for Mercury Impairment

For assessment purposes, the Department has divided the entire State of Florida into 6,638 water assessment polygons, with each watershed or waterbody reach (including lakes, rivers, estuaries, and coastal waters) having been assigned a unique waterbody identification (WBID) number. In the mid-1990s, several environmental groups filed "Notices of Intent to Sue" with the US EPA for failing to take significant action to address the nation's polluted surface waters. In total, almost 40 actions were filed, many of which resulted in the signing of court ordered Consent Decrees between the EPA and petitioning groups. In Florida, a Consent Decree was signed in June, 1999, which laid out a 10-year schedule for the examination of almost 2000 potentially impaired waterbody/pollutant problems identified on Florida's 1998 303(d) list. The EPA's 1999 Consent Decree listed 102 Florida waterbodies (freshwater and marine) as impaired for mercury based on fish consumption advisories issued by Florida's Department of Health and therefore were presumed to need TMDLs (**Figure 1.1**). Due to the acknowledged complexity and many unknowns of the science tied to mercury moving through the environment, the mercury listings were identified as a parameter needing considerable added data collection and study and, therefore, were to be addressed in the final year of the Consent Decree (2012).

Table 1.1 summarizes the number of WBIDs listed by the Consent Decree for mercury impairment by waterbody types. A complete list of waterbodies identified on this list is provided in **Appendix A**.

Table 1.1 Number of Water Segments Listed on the 1998 Consent Decree List for Mercury Impairment Based on Fish Consumption Advisory

Waterbody Type	Number of WBIDs Listed
Streams	63
Lakes	13
Estuaries	26

The Department assesses mercury impairments based fish consumption advisories issued by the Florida Department of Health (DOH). The IWR (62-303.470, F.A.C.) requires that at least twelve fish be collected for the assessed waterbody, with an average mercury concentration above the DOH fish tissue concentration threshold. If this occurs, based on the most current data, those waters are placed on Florida's Verified List of impaired waters. For the case of marine fish advisories, the Department lists all coastal waters in acknowledgement that many marine fish are highly mobile (especially pelagic species) and could be caught/consumed in all coastal WBIDs, regardless of whether or not fish tissue data are available for each costal WBID. This is based on Rule 62-303.470(2), F.A.C., which states "Waters with advisories determined to meet the requirements of this section or waters where scientifically credible and compelling information meeting the requirements of Chapter 62-160, F.A.C., indicates that applicable human health-based water quality criteria are not met shall be listed on the verified list."

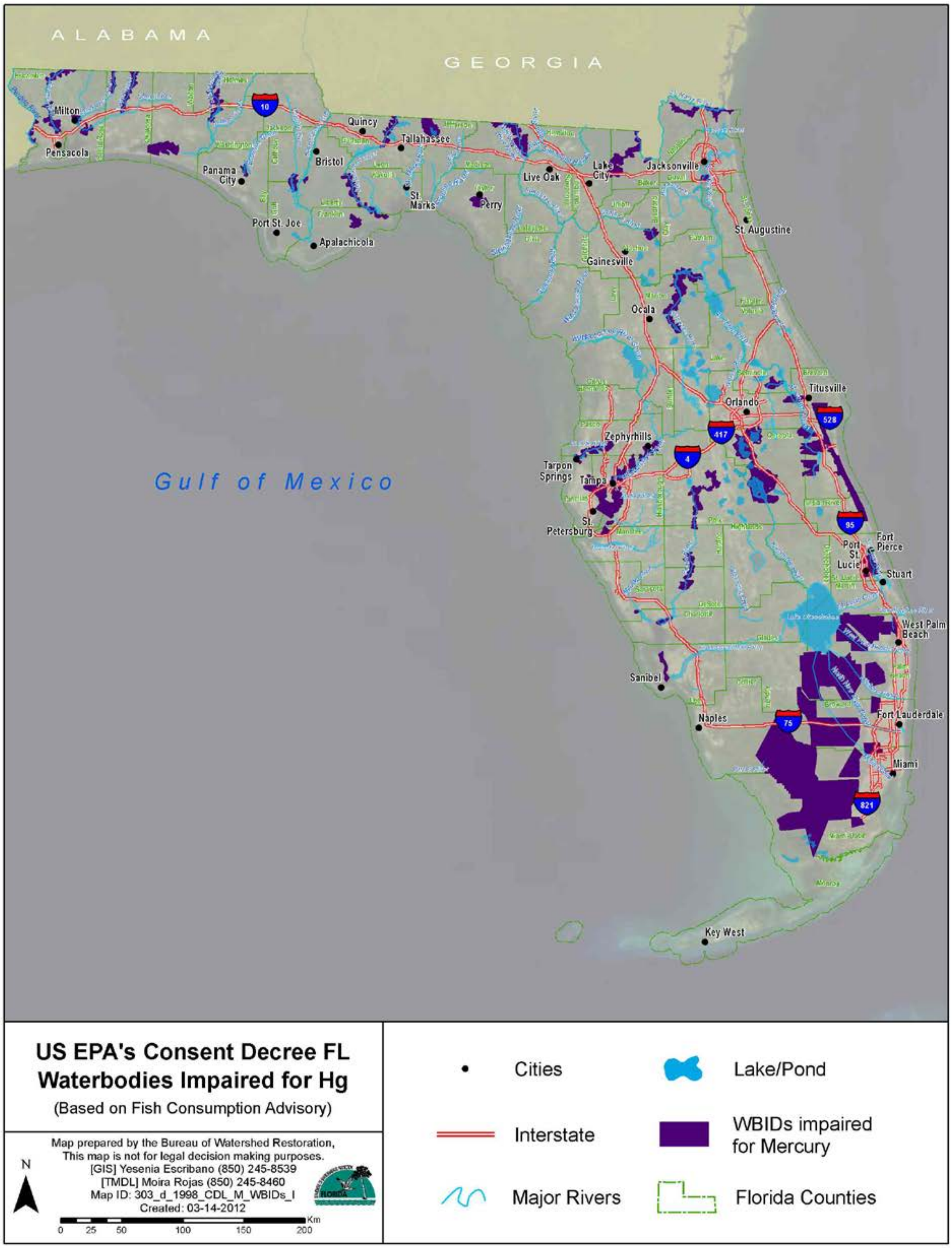

Figure 1.1 Consent Decree Listed Waterbodies for Mercury Fish Tissue Impairment in Florida

Currently in Florida, there are a total of 1,132 WBIDs listed for mercury impairment based on fish tissue data, which represent 12,994 square miles of lakes, estuaries, and coastal waters, and 2,903 miles of streams and rivers. **Table 1.2** presents a breakdown of the number of WBIDs and miles/square miles assessed with mercury fish tissue impairments for different waterbody types. **Figure 1.2** shows the WBIDs on Department's Verified List for Mercury Fish Tissue Impairment. A complete list of freshwater waterbodies verified for mercury impairment is provided in **Appendix B**. Data presented include WBIDs from the most recently completed cycle of the basin rotation (i.e., Cycle 2). **Appendix C** includes regional maps showing WBIDs verified for mercury fish tissue impairment using the IWR listing process.

About two-thirds of all freshwater fish analyzed in Florida exceed the EPA MeHg criterion (0.077 milligrams per kilogram [mg/kg]) for fish-eating wildlife (such as wading birds, osprey, otters, and Florida panthers). One-third of the freshwater fish sampled in Florida exceed the EPA-recommended Total Hg criterion (0.3 mg/kg) for human health. Currently, over 300 freshwater waterbodies in Florida have a consumption limit on recreationally caught fish. Twenty species of freshwater fish are under some level of DOH advisory (FDEP, 2012).

Table 1.2 Number of WBIDs and Miles/Square Miles Impaired for Mercury (in Fish Tissue) by Waterbody Type

Waterbody Type	Number of WBIDs Impaired	Miles Impaired
Streams/Rivers	249	2,903
Waterbody Type	**Number of WBIDs Impaired**	**Square Miles Impaired**
Lakes	127	1,344
Estuaries	504	5,163
Coastal	221	6,487

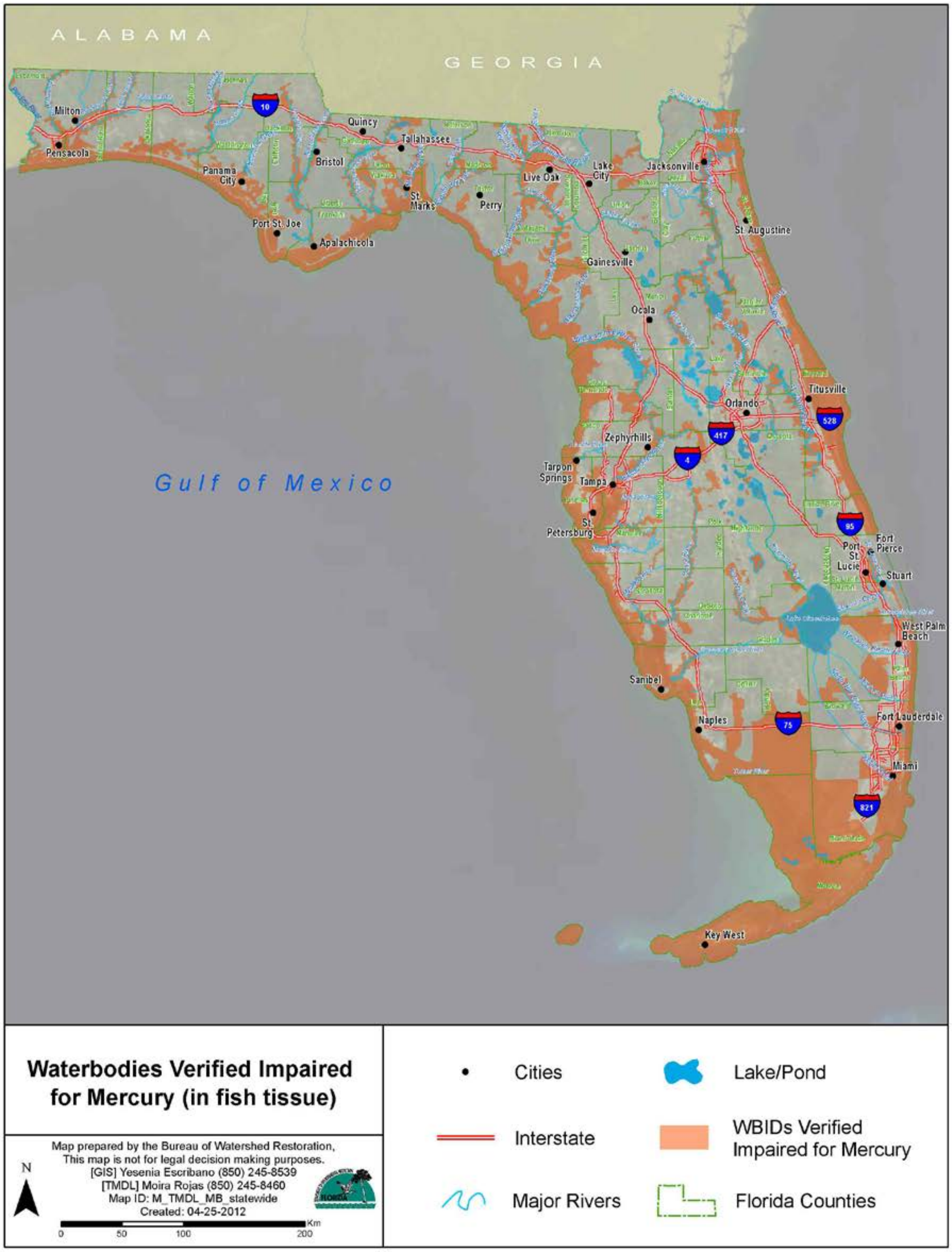

Figure 1.2 Waterbodies on Department's Verified Lists for Mercury Fish Tissue Impairment in Florida

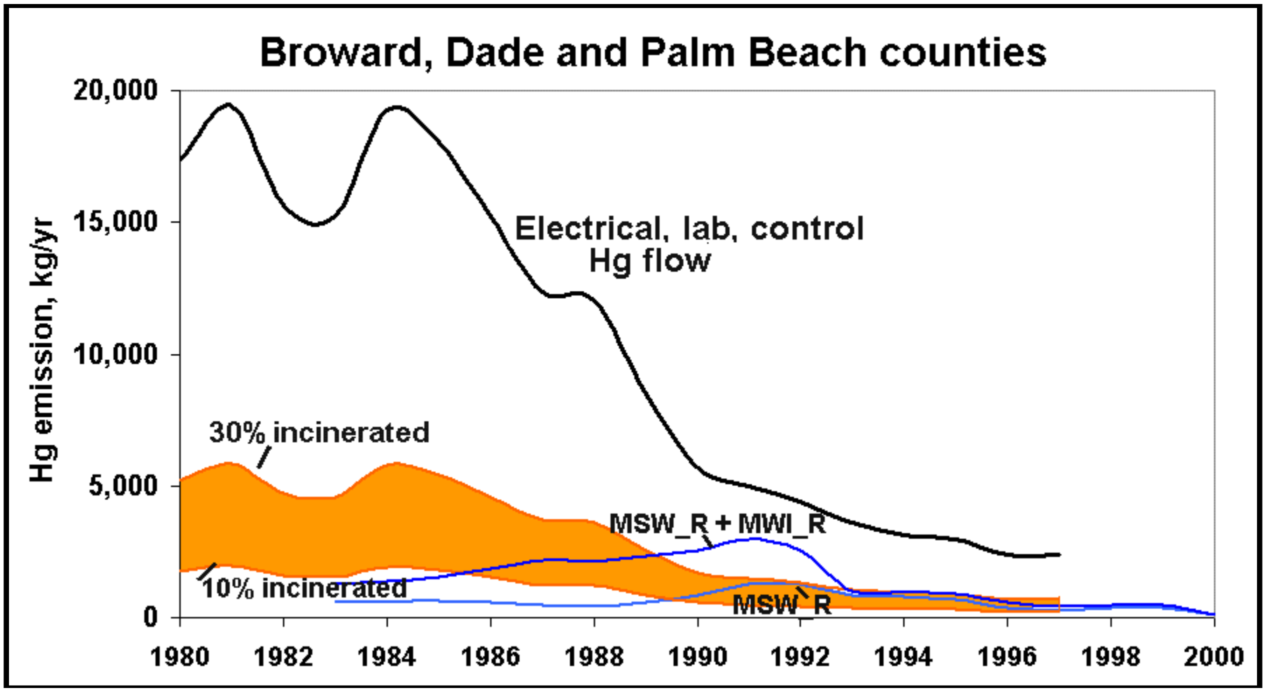

Figure 3.10 Comparison of waste incineration emissions for Broward, Dade, and Palm Beach counties (source: Husar and Husar, 2002)

Mercury emissions falling on Florida, do not follow the trends that the sources of mercury from within Florida have followed in the last 20+ years. Figure 3.11 illustrates trends in mercury wet deposition observed at the Mercury Deposition Network (MDN) site located in Everglades National Park. Within each month's display a trending up of deposition can be observed for 2002-2007. **Figure 3.11**, shows the trends for all of the previous MDN sites in Florida, which show a flattening of deposition loads. However, the variability and spatial distribution of the data, along with the impact of increased global source emissions in the last 5 years, does not allow for a trend to be evaluated.

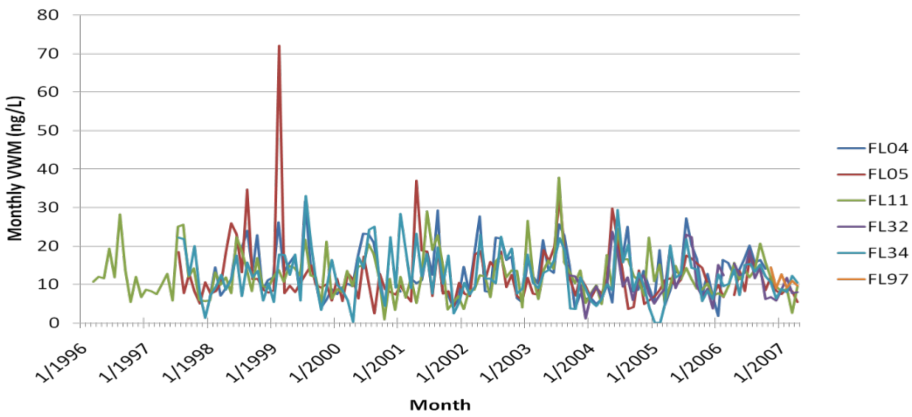

Figure 3.11 Monthly Volume-Weighted Mean Hg at Florida MDN sites

Mercury emissions from Florida sources have been in decline with the installations of emission controls on coal fired EGUs (**Table 3.4**). In several cases, the controls already implemented on coal-fired EGUs are achieving the mercury emission limits required by the pending MATS controls for mercury (**Table 3.5**) at coal-fired EGUs. The table also compares mercury emissions from 2009, a time at which only some mercury controls were fully installed and operational, with the anticipated limits under MATS being for implementation of all required controls.

Table 3.4 Estimated Mercury Reduction Associated with the Mercury Air Toxic Standards Rule (MATS) (Source DARM, 2012) [Repeat table header, with Continued at top of next page]

Plant Name	Unit ID	Capacity (MW)	On Line Year	Wet/Dry Scrubber	Scrubber Online Year	NOx Comb Control	NOx Post-Comb Control	SCR Online Year	SNCR Online Year	PM Control	Approx. Hg Reduction (%)
Seminole	2	658	1984	Wet Scrubber	1984	LNBO	SCR	2009		ESPC	75
Seminole	1	658	1984	Wet Scrubber	1984	LNBO	SCR	2009		ESPC	73
St. Johns River Power Park	2	626	1988	Wet Scrubber	1988	LNB	SCR	2008		ESPC	75
St. Johns River Power Park	1	626	1987	Wet Scrubber	1987	LNB	SCR	2009		ESPC	75
Stanton Energy Center	2	446	1996	Wet Scrubber	1996	LNB	SCR	1996		ESPC	86
Stanton Energy Center	1	440	1987	Wet Scrubber	1987	LNB				ESPC	57
Crystal River	1	379	1966			LNC1				ESPC	0
Crystal River	2	491	1969			LNB				ESPC	0
Crystal River	4	722	1982	Wet Scrubber	2010	LNB	SCR	2008		ESPC	90
Crystal River	5	721	1984	Wet Scrubber	2009	LNB	SCR	2009		ESPC	90
Crist	7	472	1973	Wet Scrubber	2010	LNB	SCR	2004		ESPC	76
Crist	4	78.0	1959		2010	LNB	SNCR		2006	ESPC+ESPH	76
Crist	5	78.0	1961		2010	LNB	SNCR		2006	ESPC+ESPH	76
Crist	6	302	1970	Wet Scrubber	2010	LNB+OFA	SCR	2012	2006	ESPC	76
Scholz	2	49.0	1953							ESPC	0
Scholz	1	49.0	1953							ESPC	0
Lansing Smith	2	195	1967			LNC3	SNCR		2005	ESPC+ESPH	0
Lansing Smith	1	162	1965			LNB	SNCR		2005	ESPC+ESPH	0
Big Bend	BB03	364	1976	Wet Scrubber	1995	LNB	SCR	2009		ESPC	87
Big Bend	BB01	391	1970	Wet Scrubber	1999	LNB	SCR	2009		ESPC	87
Big Bend	BB04	447	1985	Wet Scrubber	1985	LNB	SCR	2007		ESPC	87

Plant Name	Unit ID	Capacity (MW)	On Line Year	Wet/Dry Scrubber	Scrubber Online Year	NOx Comb Control	NOx Post-Comb Control	SCR Online Year	SNCR Online Year	PM Control	Approx. Hg Reduction (%)
Big Bend	BB02	391	1973	Wet Scrubber	1999	LNB	SCR	2009		ESPC	87
Deerhaven Generating Station	B2	228	1981	Wet Scrubber	2009	OFA	SCR	2009		ESPC	83
Northside Generating Station	2	275	2002	Dry Scrubber	2002		SNCR		2002	B	
Northside Generating Station	1	275	2002	Dry Scrubber	2002		SNCR		2002	B	
C D. Mcintosh Jr	3	342	1982	Wet Scrubber	1982	LNB	SCR	2011		ESPC	75
Cedar Bay Generating LP	CBC	83.3	1994	Reagent Injection			SNCR		1994	B	
Cedar Bay Generating LP	CBB	83.3	1994	Reagent Injection			SNCR		1994	B	
Cedar Bay Generating LP	CBA	83.3	1994	Reagent Injection			SNCR		1994	B	
Indiantown Cogeneration LP	AAB0 1	330	1995	Dry Scrubber	1995	LNB+OFA	SCR	1995		B	

Table 3.5 Estimated Mercury Reduction Associated with the Mercury Air Toxic Standards Rule (MATS) (Source DARM, 2012) Repeat header next page

2009 emissions controls reflect EGU operations for the base atmospheric modeling year, and the projected CAMD MATS limits are the projected emission loads allowed based upon the CAMD heat inputs. Some EGUs had controls come online in 2009, which is not reflected in the 2009 loads.

Coal-fired Electric Generation Unit	Emissions with 2009 Controls (lbs/yr)	CAMD Heat Input (MMBtu)	CAMD MATS-limited Hg (lbs/yr)
TECO Big Bend	**106.3**		
Unit 1	65.5	20,504,228	24.6
Unit 2	18.7	12,866,303	15.4
Unit 3	10.9	31,424,714	37.7
Unit 4	11.2	31,965,301	38.4
LEC C.D.McIntosh	**19.6**		
Unit 3	19.6	19,974,895	24.0
Cedar Bay Cogen	**29.0**		
Unit A		7,058,495	8.5
Unit B		7,471,021	9.0
Unit C		6,849,345	8.2
GP Crist	**327.2**		
Unit 4	29.0	2,448,587	2.9
Unit 5	28.5	4,135,866	5.0
Unit 6	96.4	10,635,530	12.8
Unit 7	173.3	22,037,348	26.4
PE Crystal River	**528.0**		
Unit 1	83.0	20,859,374	25.0
Unit 2	110.0	23,734,375	28.5
Unit 4	158.0	42,114,153	50.5
Unit 5	177.0	30,288,500	36.3
GRU Deerhaven	**5.3**		
Unit 2	5.3	14,576,952	17.5
Indiantown Cogen	**19.6**		
Unit 1		15,651,993	18.8
GP Lansing Smith	**150.1**		
Unit 1	70.7	5,486,938	6.6
Unit 2	79.4	9,602,261	11.5
TECO Polk Power	**9.0**		
Unit 1	9.0	10,690,718	26.7
GP Scholz	**13.6**		

Coal-fired Electric Generation Unit	Emissions with 2009 Controls (lbs/yr)	CAMD Heat Input (MMBtu)	CAMD MATS-limited Hg (lbs/yr)
Unit 1	7.3	278	0.0
Unit 2	6.3	125,240	0.2
Seminole Gen. Station	**54.3**		
Unit 1	26.3	29,206,824	35.0
Unit 2	28.0	45,703,994	54.8
JEA SJRPP/NGS	**72.0**		
SJRPP Unit 1	29.7	39,932,826	47.9
SJRPP Unit 2	28.6	49,271,796	59.1
NGS Unit 1	8.6	18,222,684	5.5
NGS Unit 2	5.2	18,438,274	5.5
OUC Stanton	**135.0**		
Unit 1	106.5	33,123,155	39.7
Unit 2	28.4	29,156,501	35.0
TOTALS	**1469.0**		**717.2**

Many of the above referenced units installed air pollution controls in the 2009 timeframe. 2009 emissions do not necessarily represent the full operating capacity of these units. The CAMD information is based on information submitted by the utilities to the EPA Clean Air Markets Division.

Cement production is another relatively significant source of mercury emissions (**Table 3.6**). This is from the combined issues of coal being used as a fuel source in the cooking of the klinker, the mercury in the limestone which is a major raw ingredient for clinker production and also that coal ash from power utilities being a common ingredient used in cement production.

Table 3.6 2009 Florida Portland Cement Production and Estimated Mercury Emissions (source DARM, 2012)

Facility	Mercury (lb/MM ton clinker)	Mercury (Act. lb/yr)	Mercury Permitted (lb/yr)	MACT Limit (lb/MM ton clinker)	Mercury @ MACT (lb/yr)
American Cement					
Kiln No. 1(New)	111	**43**	122/12-month	55	21.08
CEMEX North					
Kiln No.1			No limit (~120)	55	
Kiln No.2			No limit (~120)	55	
TOTAL	0	0	~240		
CEMEX South					
Kiln No.1	154	**40**	262.8	55	14.32
Kiln No.2 (New)	119	**73**	122	55	33.73
TOTAL		**113**			48.05
CEMEX Miami					
Kiln No. 1	83	**62**	182	55	40.68
FRI					
Kiln No. 1	50	**23**	200	55	25.31

Facility	Mercury (lb/MM ton clinker)	Mercury (Act. lb/yr)	Mercury Permitted (lb/yr)	MACT Limit (lb/MM ton clinker)	Mercury @ MACT (lb/yr)
Kiln No.2 (New)	111	**24**	122	55	12.05
TOTAL		**48**			37.36
Sumter Cement					
Kiln No.1 (delayed)			184/12-month		
Suwannee American					
Kiln No. 1	89	**53**	97	55	32.55
Titan					
Kiln No.1	80	**78**	229/12-month	55	53.52
Totals:	**Actual Hg:**	**395**		**MACT Limit Hg:**	**233.23**

These source categories, and the emissions inventory, were updated as part of the Florida Mercury TMDL project for the base case atmospheric modeling year of 2009. Florida emissions, by category, were derived and updated from the US EPA's National Emissions Inventory 2005 (US EPA NEI, 2005), as presented in **Table 3.7**. The table shows an estimated 30% and 50% reduction in coal-fired EGU and waste-to-energy plant emissions, respectively. These reductions can be attributed to new controls and adjustments to the waste stream. The table shows a reduction of ~50% by the cement industry; however, this cannot be attributed to controls and is a result of having identified a dramatically reduced level of production in response economic conditions and the slowing of the housing market. The dramatic increase shown for Gerdau-Ameristeel is a consequence of correcting errors in the NEI 2005 for accurate information on levels of production and production methodologies at this facility.

Table 3.7 2009 Mercury Emissions Inventory in Florida (DARM & UMAQL, 2011)

Source Category	2005 NEI (lbs/year)	Nominal 2009 DARM Update (lbs/year)	Relative Percentage of Annual Mercury Emissions 2009
Coal-fired electric generation	2,094	1,469	37.0%
Cement Industry	710	326	8.2%
Waste to energy plants	692	663	16.7%
Oil-fired electric generation	314	314	7.9%
Waste water treatment plants	102	102	2.6%
Medical waste incineration	4	2	0.1%
Gerdau-Ameristeel	13	250	6.3%
All others	43	43	1.1%
Total:	**3,972**	**3,169**	

3.4 Mercury Deposition and Re-Emission

Mercury deposition can be thought of broadly as occurring under two circumstances: wet and dry deposition. As the names imply wet deposition is that which occurs in precipitation events: rain, sleet, snow, and dew. Wet deposition is measured by capturing the precipitation and securing it so that the mercury cannot evaporate or sublimate from the collection. Wet deposition is especially important in Florida because of the high frequency of convection storms (thunder storms), and the large size of these weather systems in Florida. Convection storms can climb in excess of 10 miles which allows a stripping of atmospheric constituents, including mercury, from these great vertical columns, thus the wet deposition often represents the mercury in a very large volume of the atmosphere. Additionally, thunderstorms can produce winds in excess of 55 mph pulling in still more volumes of air from which the rain, or hail, strips atmospheric pollutants. Across Florida, thunderstorms are more common in inland areas by ~20%; and, across coasts to inland areas thunderstorms occur on average of 80 to 100 days per year. The scale of rain from thunderstorms often in excess of 3 inches in an hour also means that pollutants stripped from the air, and those already deposited on ground surfaces, are washed into mesic, wetland, and aquatic systems.

Dry deposition as the name implies is that which occurs external to precipitation events. Dry deposition characteristics and rates are far less studied than wet deposition. This is due to the increase in complexity of capturing and measuring this form of deposition. Prior to the Department's recent applied science to document levels attributable to dry deposition, estimates of the relative contribution from dry deposition ranged as being 20% to being equal to wet deposition. The clear need to have accurate empirical measures for dry deposition to quantify loading of mercury deposition required state of the art science to be put in place across Florida to make dry deposition measures. Knowing only the net amount of dry deposition while being an important measure would leave so many more questions as to the nature and composition of dry deposition. The Mercury TMDL Project applied measuring methodologies that provided fine time resolution, as well as speciation of dry deposition. These provide critical data to be used toward a better understanding atmospheric chemistries and which aid in understanding mercury movement through the environment. The Department chose to measure primary atmospheric pollutants continuously such as NOx, SO2, O3, CO, as well as total mercury (THg). Mercury speciation was measured at two-hour intervals continuously. These dry deposition measures were collected at the four supersites (Pensacola, Jacksonville, Tampa, and Davie) for 14-18 months from 2009 to 2010. While rates of dry deposition varied spatially and temporally across the state, it was always close to being equal to the event driven wet deposition in terms of total mercury. The dry deposition mercury speciation and continuous measures are important in understanding the specifics and dynamics of mercury cycling within Florida. Atmospheric dry mercury is stripped by forests in leaf and needle uptake as well as in resistance knocking mercury from the air to the forest floor. Atmospheric dry mercury is taken up by prairie, shrub, and wetland plants, where this may be a critical avenue of entry into food webs, and a means of having mercury bound to organic matter enter aquatic systems.

Based upon the literature, estimates of a mean volatilization rate of Hg^0 from soil is roughly 11 pg per square-meter per hour. This rate would reemit most of the atmospheric Hg^0 deposition onto bare soils or hard surfaces. However, the uncertainty of this process identifies an area for additional research on Hg re-emissions. This re-emission cycle would be especially important in areas which can subsequently have deposition enter ecological systems, such as areas with significant cover of wetlands or forests, and with high levels of rainfall and daily dew deposition.

3.5 Mercury Movement in the Environment

Before we get into the detailed discussion of mercury transport in different ecosystems, we can use a general summary here to describe the major pools of mercury in natural systems and the dynamics of mercury among these pools (see Figure 2.1).

Some studies looking at the environmental fate of mercury showed high THg and MeHg concentrations locations far from identified point source emissions. What has uniformly identified locations where mercury is accumulating in the environment is low lying, flat areas (wetter systems, e.g., mesic and wetland systems) (Dennis et al., 2005); those areas where precipitation accumulates in landscapes. Also Total Organic Carbon (TOC) correlated well with THg and MeHg; and. For Florida this indicates that environment – flat, wet, high in mesic forest and wetland cover – is very suitable in almost all areas of the state and such cover is close to all emission sources. In Washington State, a study looked at sediment profiles in three lakes of varying distance from the emission source a coal fired power plant, and found mercury profiles in sediments reflecting the emissions history of the regional source, by load and distance.

Mercury risks to human health, or wildlife, require exposure that occurs primarily, though not exclusively, through fish consumption. The amount of mercury that is methylated in ecosystems is only a very small fraction of the mercury that is deposited in ecosystems. Sources that deposit mercury into ecosystems, whether from emissions or direct discharge, natural or anthropogenic, are the means by which mercury becomes available to be transformed into toxic methylmercury within the ecosystems and then bioaccumulated up food chains into fish.

3.5.1 Mercury transport and fate in forest ecosystems

Studies of direct soil sequestration of Hg, immobilization of Hg in forest soil, show a correlation with the retention of organic carbon (Schwiseg, 1999). Pools of Hg in upland soils in northern temperate regions are about 7 mg per m2, with higher levels reported around the globe, so this is only a reference number. The export of Hg by waters draining upland soils to surface waters is generally low. Concentrations and fluxes of Hg in soil waters, analogously to the pattern in soil, are closely related to dissolved organic carbon content. Concentrations of total Hg are highest in waters draining the upper soil, coinciding with high concentrations of DOC. The conditions optimal for this occurrence are shallow, flat systems with wet high organic soils as is predominant in Florida. Concentrations and fluxes of total Hg decrease as DOC is immobilized with depth in mineral soil (Grigal, 2002). Limited studies suggest that MeHg concentrations in upland soils and ground waters are generally low, although higher concentrations occur in upper soil waters and decrease with soil depth. Low concentrations and fluxes of MeHg in drainage waters suggest that rates of methylation are low, and freely draining upland soils are generally not important in the supply of MeHg to downstream surface waters, with the possible exception of recently harvested forests (Porvari et al., 2003).

3.5.2 Mercury in Wetlands: transport and transformation

Wetlands influence the composition and supply of different Hg species to adjacent surface waters. Wetlands are typically net sinks of total Hg and sources of MeHg (Grigal 2002). Rates of total Hg accumulation are greater in wetlands than in upland soils because of the strong association of Hg with organic matter (Grigal, 2003). Annual rates of MeHg production in wetlands are approximately 0.1 to 1 µg per m^2 per year (Galloway and Branfiruen, 2004). The factors controlling methylation of Hg in wetlands are not completely understood, but they most likely involve the amounts and types of organic matter, water and soils chemistries, hydrologic flow paths, microbial composition, microbial locations relative to flow paths, and rates of microbial activity, as well as any limiting resource for microbial activity. Organic matter produced in wetlands forms complexes with both ionic Hg and MeHg, enhancing the transport of these Hg species to surface waters. There is debate on how these complexes in some cases enhance later consumption by single celled organisms or are perhaps incidental in consumption by first level secondary consumers. An elevated supply of DOC to downstream surface waters may stimulate conditions for mercury methylation, and limit mercury available for photodegradation and photoreduction of HgII. Concentrations of MeHg in wetland pore waters and surface waters vary seasonally, with the highest concentrations evident during the late summer, as a result of warmer temperatures, higher rates of microbial activity, and longer hydraulic residence times (Galloway and Branfireun 2004).

3.5.3 Mercury in surface waters

Freshwater ecosystems vary in how they response to Hg pollution. Total Hg concentrations in surface waters in the Northeast vary by more than an order of magnitude across systems, from less than 0.5 to 12.7 nanograms per liter, the 5th to 95th percentile respectively (Dennis et al., 2005). Most of the Hg in surface water occurs as HgII, with MeHg ranging from 1% to 35% of total Hg. Under conditions of high total Hg loading, MeHg production can vary widely, depending on the methylation efficiency of a particular ecosystem.

Other factors controlling mercury in surface waters

Other factors, such as water chemistry, land cover and land use, and watershed disturbances, alter the transport, transformation, and bioavailability of Hg in surface waters. Acidic deposition and the associated sulfur alter the acid-base status of surface waters, thus influencing Hg transformation potentials, may influence Hg uptake by sulfur reducing bacteria (SRB), and associated bioaccumulation in fish. Sulfur chemicals are closely coupled with Hg dynamics. The solubility of Hg increases with sulfide concentrations in anoxic waters through complexation reactions, potentially increasing the pool of Hg available for methylation (Benoit et al., 2005). The relationship of mercury to acidification is also related as the required controls under Acid Rain Rules promulgated under the Clean Air Act serve to control SO_2 and NOx emissions which directly cause acid rain which brings about surface water and soil acidification.

Watersheds with mixed agriculture and forest land cover had the highest methylation efficiency, even where these watersheds had low total Hg in sediments. Waters draining agricultural landscapes have relatively high concentrations of total Hg and MeHg due to mercury binding to organic particulates and higher methylation rates. These can also have lower concentrations in fish, due to algal "bloom dilution" associated with high phosphorus loading or elevated DOC concentrations (which stimulate methylation but limit bioaccumulation), or both (Kamann et al., 2004). Forest harvesting has been shown to increase export of total Hg and MeHg (Porvari et al., 2003). Fire results in a complex pattern of Hg loss from watersheds. During and shortly after fire, elevated Hg losses are associated with volatilization from soils and losses from erosion, as well as increased pore water flushing (Grigal 2002). It is important to remember that while forest harvesting increases turnovers and scales by anthropogenic actions, that human initiated forest fires are reflecting natural fire ecology. Thus, forest harvesting can expose soils increasing aspects of the mercury cycle, managed fires are merely mimicking natural fire ecology and not increasing mercury loads. Deforestation efforts, especially areas without a natural fire ecology, as seen in the developing world, are a source of mercury through both the burning of above ground biomass and through the exposure, including associated tilling, of soils which readily volatilize any associated mercury. Activities that manage water levels create significant exposure-saturation patterns, especially systems such as reservoirs or soil management programs as with rice, soybeans, or sugar cane, can be sources of increased mercury emissions and increased pulses of MeHg formation. These often located in floodplains and converted wetland systems, provide areas of mercury binding to organic matter enhanced by soil management associated with planting and prime environments for methylation. In reservoir systems the littoral zone can fluctuate wetting and drying, thereby varying natural cycles of reduction and oxidation both by location and extent, enhancing the production of MeHg (Evers et al., 2007; Sorensen et al., 2005).

Habitat type also has an important influence on MeHg concentrations. Data for two-lined salamanders (Eurycea bislineata) identified in headwater streams have significantly higher MeHg concentrations than those in lakes (Bank et al., 2005). Larval insects in reservoirs have been shown to have THg concentrations that are 3 to 10 times higher than those in natural lakes (Tremblay et al. 1996). Crayfish (Orconectes virilis) in headwater streams have THg concentrations up to five times greater than those in lakes (Pennuto et al., 2005). The landscape position of each of these may explain the differences observed.

Forested regions, where wetlands are prevalent, and with low productivity surface waters, promote high concentrations of mercury in freshwater biota and thus are particularly sensitive to mercury deposition.

3.5.4 Mercury moving through organisms

Biota are exposed to MeHg primarily through the roles played by bacteria, and fish and insect consumption. The Northeastern Ecosystem Research Cooperative (NERC) data establish robust Hg exposure profiles for fish, birds, and mammals and highlight the importance of habitat type, foraging guild, trophic structure, and demographics on MeHg exposure (Evers et al., 2005). In general, THg concentrations vary by species taxonomy. As a general rule, MeHg increases with increasing trophic position. Mercury in benthic invertebrates and larval insects has been studied in northeastern lakes and reservoirs, where it was observed that even in invertebrates, increased mercury per biomass is associated with an increase in trophic level (odonates > hemipterans / coleopterans > trichopterans > dipterans / ephemeropterans) (Tremblay et al., 1996). The NERC data on Hg in over 15,000 fish show that the mean fillet THg levels in 10 of the 13 species are above EPA guideline of 0.3 µg/g and highest in top level predators such as walleye (*Sander vitreus*) and lake trout (*Salvelinus namaycush*).

Chapter 4: TMDL Approach

4.1 General Approach

To address the mercury impairment in Florida waters, the Department selected a statewide approach for mercury TMDL development, rather than a waterbody-specific TMDL approach for the following reasons. First, the predominant source of mercury leading to impaired waters in Florida is from atmospheric deposition. The majority of atmospheric mercury deposited on Florida, as well as the emission sources, comes from outside of Florida. Mercury in the atmosphere is transported across multiple watershed boundaries, where it is deposited and biologically magnified through the food web, resulting in high fish tissue concentrations. While a watershed-based TMDL approach is typical for most pollutants, the phenomenon of atmospheric transport of mercury makes a regional or statewide approach the only practical method for TMDL development. This approach is consistent with other mercury TMDL efforts supported by US EPA, including multi-state efforts. EPA recognized the sources of the mercury impairments were largely from outside the borders of individual states and issued a guidance document (USEPA, 2008), which supported the concept of addressing the problem at scales ranging from waterbody-specific, regional, statewide, or multi-state.

Second, the statewide approach will be far more cost-effective than the waterbody oriented approach. Using the IWR listing process, the Department has verified the mercury fish tissue impairment in more than 1100 water segments, as shown in **Table 1.2**. Rather than attempting to develop a mercury TMDL for each of these waterbodies, the proposed approach will focus on reducing mercury emissions statewide to benefit all Florida waterbodies, especially those susceptible to mercury bio-magnification (*e.g*., oligotrophic, low alkalinity systems). Although the concept of conducting this type of regional TMDL analysis is relatively novel, a similar predicate was established as part of the 1990 National Acid Precipitation Assessment Program Integrated Assessment. For that program, EPA conducted regional simulations for thousands of lakes in the Upper Midwest, the Adirondacks, and Florida to evaluate how lakes would behave in response to Clean Air Act mandated changes in sulfate emissions, which in turn were predicted to reduce acidic deposition.

Key elements that a mercury TMDL should consider were recommended by EPA (USEPA, 2008). These elements include:

(1) Identification of waterbodies, pollutant sources
(2) Water quality standards and TMDL target
(3) Loading capacity – Linking water quality and pollutant sources (including point and nonpoint sources)
(4) Conducting load and wasteload allocations to nonpoint and point sources
(5) Establishing a margin of safety of the TMDL to address the uncertainties associated with the target development.

A technical framework was established by the Department to address the TMDL needs listed above (**Figure 4.1**). A sampling protocol was designed to measure fish tissue mercury concentrations, concentrations of total mercury, MeHg, and other biogeochemical parameters (for both water column and sediment from lakes) that may influence the mercury dynamics in Florida waters were collected in numerous Florida streams and lakes that were chosen based on a statistical sampling design. Historic data, including fish tissue mercury concentration data collected through the fish consumption advisory program jointly carried out by the Department of Health (DOH), Florida Fish and Wildlife Conservation Commission (FFWCC), and the Department, water chemistry data collected through Department's Integrated Water Resource Monitoring Network (IWRM) were also examined to identify the historic trend of mercury impairment in the State of Florida. These data were used to establish the statewide TMDL for mercury.

In addition, to aid with subsequent evaluations of the impacts to Florida's waters, from sources both within and outside Florida, the Department developed a technical framework designed to quantify and assess the sources and impacts of mercury from atmospheric deposition. Technical components included quantifying mercury loadings into Florida and identifying the contribution from local sources, regional sources, United States sources, and sources in other countries. In order to quantify the mercury loading into the state, predictive atmospheric models were used to simulate mercury loadings from different sources and quantify the atmospheric deposition flux. Air monitoring networks were also established to measure wet and dry depositions at several strategic locations across the State to provide measurements for model evaluation, to characterize seasonal dynamics of the air deposition, and to examine the spatial effects of major emission centers in the states. Site monitoring locations were specifically established within regions of known point source emissions, which differs from MDN locations which are deliberately located away from known emission sources. The TMDL approach of assigning percent reduction to sources, has each respective mercury source be responsible only to their loading, i.e., no source is more weighted for reductions than another.

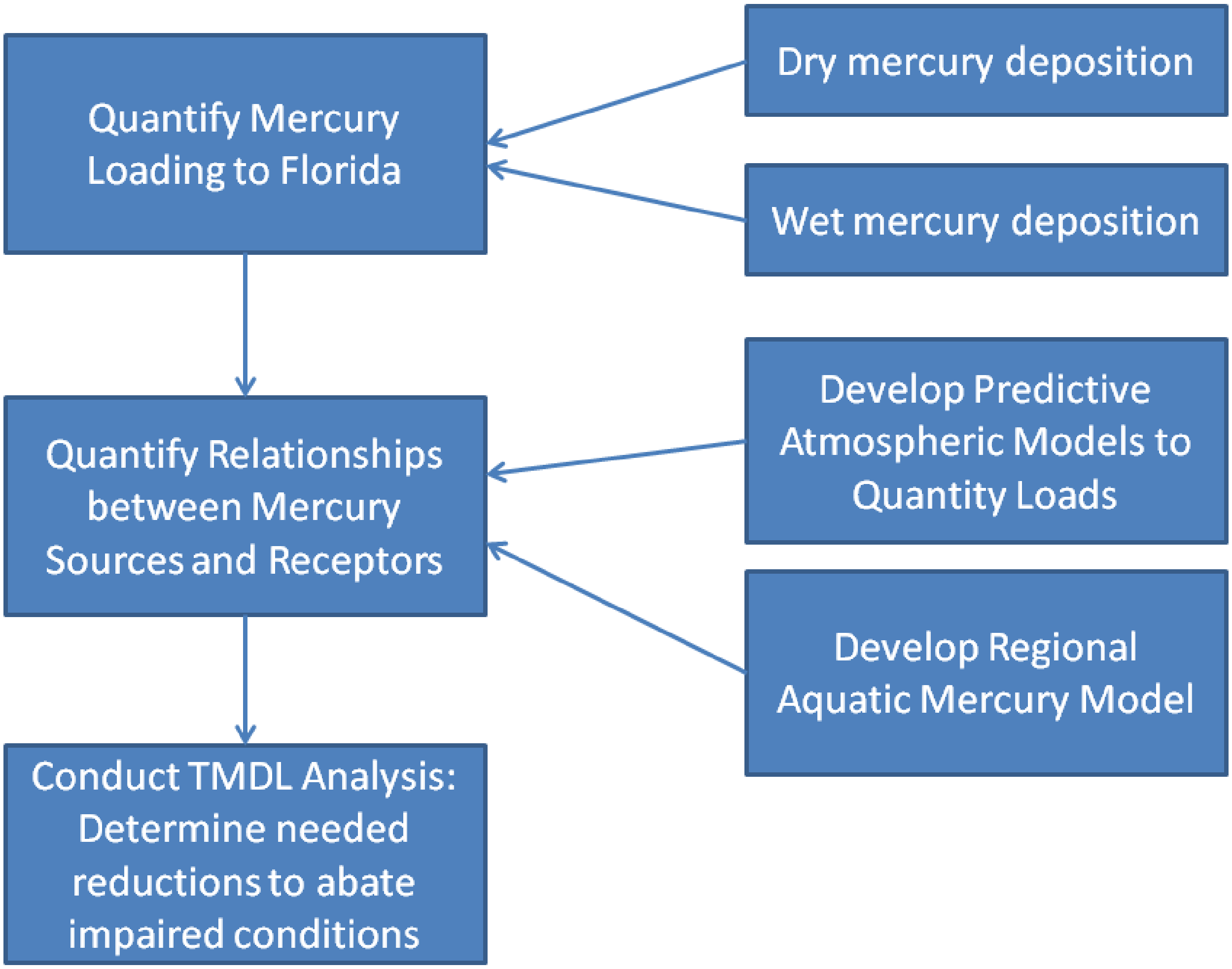

Figure 4.1 Overview of Technical Components of a Statewide Mercury TMDL Project

4.2 Mercury Atmospheric Deposition Monitoring

The Department contracted with the University of Michigan to conduct extensive field sampling activities at four site in Florida (Pensacola, Jacksonville, Tampa, and Davie) in the period 2008-2010. The atmospheric sampling sites were established to be able to collect wet and dry deposition data. Details of these efforts are contained in Appendix F.

Table 4.1 Initiation & End Dates of Supersite and Wet Only Site Data Collections

Site	Air & Dry Deposition		Wet Deposition	
	Start	End	Start	End
Davie	4/3/2009	8/31/2010	2/2/2009	8/29/2010
Tampa	1/12/2009	8/31/2009	1/29/2009	8/24/2010
Jacksonville	3/9/2009	8/30/2010	3/18/2009	8/29/2010
Pensacola	10/1/2008	8/31/2010	10/7/2008	8/29/2010
Orlando			3/21/2009	8/2/2010
ENP			11/30/2008	8/30/2010

4.3 Mercury Atmospheric Modeling

The Department also contracted with the University of Michigan to perform atmospheric modeling follows scaled analyses starting at a global scale and concluding at a 4 km grid scale for Florida. The details of this effort are described in Appendix F.

4.4 Mercury Aquatic Cycle Modeling

The Department also contracted with ALL to perform Aquatic Modeling takes the approach of a statistical assessment applying partition analyses for the lakes (more than 7,700 lakes greater than 4 ha in size) and stream/river reaches (more than 83,400 km of stream and riverine reaches) within Florida.

4.5 Sampling of Fish Tissue and Collection of Chemical and Biochemical Data from the Water Column and Sediment

Developing Mercury Aquatic Models is an essential part of the statewide Mercury TMDL development for impaired Florida waters. The goal of the modeling is to establish a functional relationship between the mercury loading into receiving waters and the fish tissue mercury concentration in these waterbodies. Past studies have demonstrated that, while fish tissue mercury concentration for each individual receiving waterbody may show a linear response to the change of mercury loading into the waterbody, the fish tissue mercury concentrations across lakes and streams were dominated by biogeochemical and landscape variables other than mercury loadings (Riva-Murray et al., 2011; Liu et al., 2009; Kamman et al., 2005; Selvendiran et al., 2008). Therefore, collecting water quality and sediment samples in tandem with the collection of fish tissue mercury concentration is required in order to develop aquatic models. These needed data were collected and analyzed by the Florida Fish and Wildlife Conservation

Commission (FWCC) and the Department jointly through a monitoring program conducted in a period from September of 2008 through October of 2010.

In order to ensure a sufficiently broad data range and reasonably even distribution of data across the gradient of each sampled parameter for statistical analyses, sampling sites for needed parameters were chosen using a stratified random sampling design. Basically, the concentration ranges of three target variables (pH, color, and chlorophyll a for lakes; pH, color, and nitrate for streams) from lakes and streams included in the Department's Status Monitoring Network (SMN) were examined. The identified concentration ranges of these parameters were divided into 5 concentration intervals for each parameter, which yielded a possible 125 unique variable interval combinations (5x5x5) or sampling bins. The actual numbers of bins that were populated by at least one lake or stream reach were 101 and 95, respectively. Additional lakes and streams were sampled at random from individual bins to produce a total number of 133 lakes and 131 streams segments for the sampling.

For each selected waterbody, 12 large-mouth bass (LMB) were collected for total mercury analyses. LMB were selected as representing a top level predator in systems in which they are present, thus having the greatest rates of bioaccumulation. Size of sample fish was determined by the current (FY08/09) FFWC's size regulations for black bass; however, LMB up to 2" less than the minimum size regulation up to approximately 20" were collected in order to establish robust relationship between fish tissue concentration and fish size. Where it was infeasible to collect 12 LMB, spotted sunfish (SPSU) were collected across a range of available sizes. Preliminary analyses comparing concurrently collected LMB and SPSU indicated well-correlated tissue mercury concentrations between these two fish species. These sample fish were collected by FWCC and shipped to Eustis Fisheries Research Laboratory, or other FWCC facilities for tissue sample preparation. Prepared fish tissues samples were transported to Department's Central Laboratory for total mercury analyses.

Other than fish sample collection, FWCC also collected concurrent water quality samples from the same lakes and streams where fish samples were collected. Water quality samples were collected for measurement of aqueous mercury species and ancillary water quality parameters including major ion, dissolved organic carbon (DOC), color, total suspended solid (TSS), and nutrients. Field measurements, including dissolved oxygen, conductivity, and Secchi depth, were also collected. Water quality samples collected by the FFWC were shipped via overnight courier to Department's Central Laboratory in Tallahassee for analyses.

In order to provide a complete dataset to describe factors that influence the mercury fish tissue concentrations in Florida waters, sediment sample were also collected in lakes where fish and water quality samples were collected. Lake sediment sample collections were conducted by the Department and were in parallel to the sample fish and water quality sample collection efforts made by FWCC. Sediment sample analyses were conducted by Department's Central Laboratory. These analyses focused on mercury and MeHg, metals (aluminum, arsenic, cadmium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, nickel, lead, antimony, selenium, strontium, titanium, vanadium, and zinc and nutrients.

All sample collections were conducted in the period from September of 2008 through October of 2010. Sample collections were conducted once for each selected waterbodies. **Figure 4.2** shows the location of sampling sites. Results from sample analyses were summarized in Chapter 5 of this report. All field and laboratory procedures for collection of fish samples adhere to the guidelines established in the Comprehensive Quality Assurance Plans for Collection of Fish established for FWCC (FWC Chemistry Laboratory SOP, HGSOP 4/03) and FDEP (DEP-SOP-001/01, FS6000 General Biological Tissue Sampling). All field and laboratory procedure for collection and analysis of water samples and laboratory analysis of fish tissue samples were adhere to the requirements set forth in Department's Quality Assurance Rule, Chapter 62-160, F.A.C), including Department's Standard Operating Procedure (SOPs) for field activities (DEP-SOP-001/01).

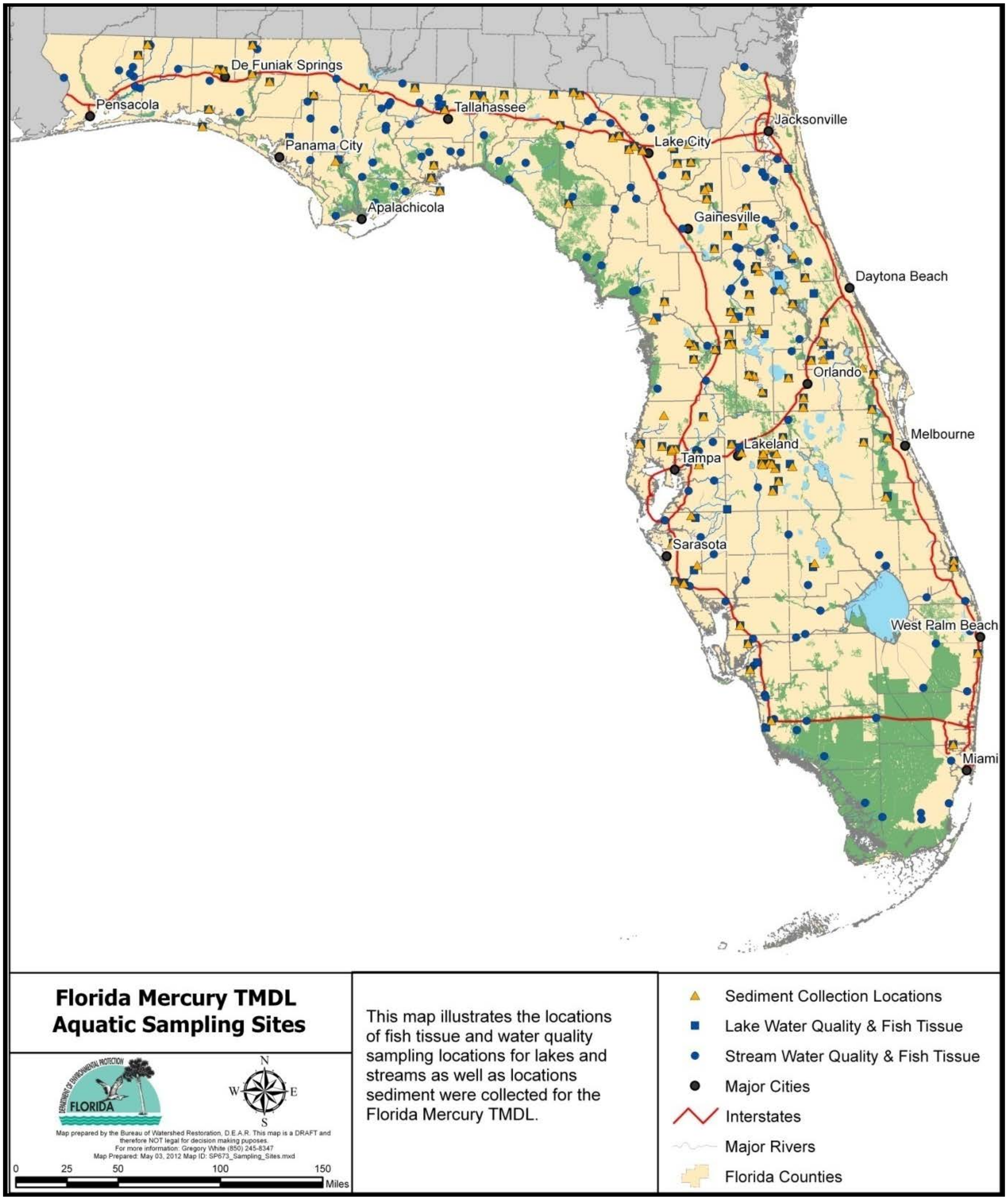

Figure 4.2 Statewide Mercury TMDL Project Sampling Sites

4.6 Historic Data for Fish Tissue Mercury Concentration and Water Column Chemistry

Other than the fish tissue, water column, and sediment data collected during the 2008-2010 monitoring program, historical data collected through the fish consumption advisory program jointly carried out by the Department, FFWC, and DOH, and by the Department's Integrated Water Resource Monitoring Network (IWRMN) were also examined in order to identify the temporal trend of mercury fish tissue impairment in Florida.

Since 1983, FWCC, DOH, and the Department have been jointly conducting investigations on fish tissue mercury impairment in Florida waters. This effort primarily focuses on waterbodies and fish species that are important for fishing activities. Samples of popular fish species, such as LMB, bluegill, redear, sunfish, warmouth, spotted sunfish redbreast sunfish, black crappie, catfish, some exotics such as Oscars, butterfly peacocks, and Mayan cichlids, and over 100 salt water species such as Atlantic croaker, black grouper, dolphin, fantail mullet, gray snapper, gulf flounder, king mackerel, spotted seatrout, and yellowfin tuna, have been collected by FWCC from freshwater and marine waterbodies identified by FWCC and shipped to the Department for tissue mercury analysis. Fish consumption advisories for specific water bodies are issued by DOH if the mercury concentration found in fish is at levels that may pose a risk to human health. Advisories for mercury in Florida waters have been issued since 1989. The DOH Web site (www.doh.state.fl.us/floridafishadvice) offers regularly updated consumption advisories containing specific advice about eating fish from Florida's fresh and marine waters. These advisories are not intended to discourage fish eating but to provide guidance for choosing the right fish and also limit eating fish from waterbodies of high concern of mercury pollution. For the statewide mercury TMDL, the Department obtained fish tissue results of over 30,000 fish samples collected from more than 300 freshwater segments. Result summarizations of these data are provided in Chapter 5 of this report.

As mercury fish tissue concentrations can be influenced both by external mercury loadings into the aquatic system and biogeochemical characteristics of receiving waters, it is desirable to pair the analyses on mercury fish tissue concentration data with the analysis of water quality data. The water quality data used in these analyses were primarily retrieved from Department's IWR Database, which included data collected by Florida's Integrated Water Resource Monitoring Network (IWRM, http://www.dep.state.fl.us/water/monitoring/index.htm). This network was initiated in 1996 by the Department in an effort to refining its water resource monitoring and included three tiers of monitoring programs. Tier I monitoring program include status monitoring and trend monitoring. These monitoring networks primarily focus on providing the spatial and temporal water quality trend in Florida at the state level. Tier II monitoring program is watershed and waterbody oriented. It includes not only the monitoring efforts of the Department on individual waterbodies, but also collects water quality monitoring results from more than 90 other entities including other state agencies, county and local governments, universities, and voluntary groups. Water quality results from the Tier II monitoring program constitute the vast majority of the water quality data that the Department uses to conduct the IWR listing process and develop TMDLs for impaired waters. Tier III monitoring are primarily associated with the monitor activities required through the Department's regulatory permits, which is used to evaluate the effectiveness of point source discharge reductions and implementation of best management practices required by TMDLs.

Chapter 8: Determination of the TMDL

8.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \square \mathrm{WLAs} + \sum \square \mathrm{LAs} + \mathrm{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \square \mathrm{WLAs}_{\textbf{wastewater}} + \sum \square \mathrm{WLAs}_{\textbf{NPDES Stormwater}} + \sum \square \mathrm{LAs} + \mathrm{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The sources of mercury in a stormwater collection system are from wet and dry deposition, and atmospheric deposition is considered a component of the nonpoint source load allocation.

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. Florida’s statewide TMDL for mercury is expressed in terms of a percent reduction, and represents the maximum daily load Florida’s lakes, streams, estuaries, and coastal waters can assimilate without exceeding the water quality criteria for mercury (**Table 8.1**).

8.2 Load Allocation

A reduction in mercury of 86 percent is needed from nonpoint sources contributing to all of the fresh and marine waters in Florida to address our water quality limited segments and to protect public health. As this reduction is expressed as a percent, the value is applicable over any time period, and thereby meets EPA’s requirement that TMDLs must be expressed as a “daily” value. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix K**). As the predominant nonpoint source of mercury to Florida’s waters arrives via atmospheric deposition, from sources both within and outside of Florida, specific allocations cannot be made at this time. This 86 percent reduction is needed both within and outside of Florida and does not preclude consideration of reductions already being achieved by

Florida sources as identified in Chapter 9. Reductions, as deemed necessary and practicable (recognizing technological, fiscal, and legal constraints) will be assigned during the subsequent TMDL implementation phase, described more completely in Chapter 9.

Table 8.1 TMDL Components for Mercury in Florida's Fresh Water Lakes, Streams, and Estuarine and Coastal Waters

This is a six-column table. Column 1 lists the parameter, Column 2 lists the TMDL, Column 3 lists the WLA for wastewater, Column 4 lists the WLA for NPDES stormwater, Column 5 lists the LA (percent reduction), and Column 6 lists the MOS.

Parameter	**TMDL** (% reduction)	**WLA for Wastewater (Kg/year)**	**WLA for NPDES Stormwater**	**LA (% reduction)**	**MOS**
Mercury	86	23 kg*	**	86	Implicit

* Based on all readily available data, the Department estimated the current permitted mercury load being discharged to waters of the state. This value represents less than 0.5 % of the total mercury load from point and nonpoint sources in Florida. Mercury minimization is expected for major facilities.

** NPDES MS4 Permits may require reductions to meet the TMDL goal if sources of mercury under the direct control of a MS4 permittee or co-permittee are found to exist.

8.3 Wasteload Allocation

8.3.1 NPDES Wastewater Discharges

The WLA for the statewide mercury TMDL is established as 23 kg/year. This value translates to 0.063 Kg/day. Consistent with the findings of other approved TMDLs established on a regional, statewide, or multi-state basis, Florida has determined that the mercury contribution from NPDES-permitted point source discharges are minor relative to the loads being deposited on Florida's land and waters (fresh and marine) from atmospheric deposition.

In Florida, the existing point source load for the entire state has been estimated as being approximately 0.5 % of the total mercury loading to the land and waters of the state. According to EPA's *Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion* (EPA, 2010), point source discharges are considered a small contribution if the loading or cumulative loading of all point sources to the receiving water are expected to account for a small or negligible portion of the total mercury loadings. **Table 8.2** provides a summary of the fraction the proposed Wasteload Allocation for NPDES permitted facilities versus the existing total mercury load for Florida and how those values compared to statewide or regional mercury TMDLs approved elsewhere in the United States. The Department anticipates that the significant decreases in mercury loading to Florida's waters have been and will continue to be associated with reductions in atmospheric emissions from anthropogenic sources within and outside of Florida.

Table 8.2 TMDL Comparison of Wasteload Allocations for Mercury as a Percentage of Total Mercury Load for Florida and Other State or Regional TMDLs

State or Region	Total Mercury Load	Wasteload Allocation	WLA/Total Load (%)
Minnesota	2781 Kg/yr	11 Kg/yr	0.40
Northeastern States	6,651 Kg/yr	38 Kg/yr	0.57
New Jersey	601 Kg/yr	6.8 Kg/yr	1.13
Florida	4,793 Kg/yr	23 Kg/yr	0.48

Once this TMDL is in effect, any new requirements will generally be evaluated and addressed in the renewal of existing NPDES permits for point sources, if not earlier through a reopener clause. The need for compliance schedules to meet the TMDL requirements may be established in a BMAP and/or in NPDES permits or an associated Administrative Order. In cases where there are sufficient data to determine whether the NPDES discharger has quantifiable concentrations of mercury, NPDES permits except domestic facilities discharging less than 1 MGD will include a set of additional conditions for implementation of a mercury minimization program to ensure that point sources are discharging the minimum amount of mercury practicable. For domestic facilities with quantifiable concentrations of mercury and discharging greater than 1 MGD, a mercury minimization plan shall include annually the identification of dental operations, hospitals and educational facilities (i.e., Universities and K-12 schools) within their service area; the production or adoption of best management practices (BMPs) for the appropriate industries as applicable; and promulgation of the BMP program. This option will meet the applicable federal regulatory guidance and requirements (EPA, 2010).

All of the NPDES-permitted domestic wastewater facilities were assessed using data available the WAFR database (as of July 2012) and the combined permitted flows were calculated. The result of combining the permitted flows from domestic facilities (1353 MGD) with those for the industrial facilities (785 MGD) yielded a total of 2138 MGD. In addition, the permitted industrial wastewater flows were also calculated, but with two caveats. First, not all of the industrial facilities have permit limits for flow. Second, for power plants that use once-through cooling water, those volumes were calculated separately from the total for other industrial sources. It is also presumed that “Intake Credits” can be provided for any mercury that is passing through the facility via once-through cooling water. However, other waste streams (e.g., discharges from coal ash storage facilities or ponds) are not excluded from subsequent investigations, whose findings may be addressed in mercury minimization plans.

8.3.2 NPDES Stormwater Discharges

The WLA for stormwater discharges with an MS4 permit has been determined to be generally not applicable. Any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction. Therefore, as the mercury levels that may be present in stormwater are a result of nonpoint sources linked to atmospheric deposition, no reductions are required of the MS4 permittees in Florida. However, if through the course of monitoring or in light of other information becoming available, local sources of mercury under the control of the MS4 permittee or a co-permittee are found to exist, the permit holder will be subject to implementing necessary controls to reduce mercury loads associated with those local sources, so as to meet the requirement of this TMDL.

8.4 Margin of Safety

There are multiple lines of evidence to support the use of an implicit margin of safety in this TMDL. Consistent with the recommendations of the Allocation Technical Advisory Committee (Department, 2001), an implicit MOS was used in the development of this TMDL. Included in this implicit MOS is the assumption that all of the mercury in fish tissue is in the form of MeHg (the harmful fraction) and it is not. As discussed in Section 2.2, the application of a multifold increase in setting of the reference dose for MeHg is another significant component of the Margin of Safety (MOS). As noted previously, compared to other fish species, Largemouth Bass have higher overall tissue MeHg concentration because their position in the food chain dictates a longer food chain length for bioaccumulation. Use of Largemouth Bass for the TMDL target development provides another margin of safety to the TMDL as all other fish living at lower trophic levels will also benefit.

Chapter 9: Ongoing Activities and Implementation Plan Development

9.1 Implementation Plan Development

Following the adoption of this TMDL by rule and adoption or approval by EPA, the Department will determine the best course of action regarding its implementation. The TMDL alone does not create new legal authorities and the LA and WLA discussed herein are enforceable to the extent independent legal authorities exist under state law. In general and depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Agency actions to implement this TMDL are subject to Section 403.067, Florida Statutes as well as the notice and hearing processes of Chapter 120 of the Florida Statutes. Implementation can be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are one mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.).

If the Department determines that a BMAP is needed to support the implementation of this TMDL, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective and technically feasible, and that meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources.

However, in some basins and for some parameters the development of a BMAP is not the most efficient way to restore a waterbody such that it meets its designated uses. This is because some impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. The Department can rely on existing permitting programs, local or industry initiatives, or a combination of both as a more cost-effective and simplified approach to identify the actions needed for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.

9.2 Ongoing Mercury Reduction Activities in Florida

An important element of implementation planning is consideration of mercury reductions already in place or in progress as well as the cost effectiveness of minimization efforts. Global anthropogenic emissions of mercury are the source of the vast majority of mercury deposition in Florida. Thus, Florida's achievement of the TMDL is dependent upon not only out-of-state but out-of-country mercury emission reductions. Florida sources are, however, implementing mercury reduction efforts that must be taken into account. On the point source side, many NPDES Industrial and Domestic Permitted Sources are already regulated for mercury and it is anticipated EPA will be revising its effluent limitation guidelines to further limit discharges of metals from some source categories. On the non-point source side, as discussed previously, there has been a significant reduction in air emissions of mercury from Florida facilities. In addition, there are also numerous, ongoing waste reduction efforts being implemented to reduce mercury from Florida's waste stream.

Mercury Waste Reduction Strategies in Florida

Florida is a recognized leader among states in managing mercury waste and reducing its use in products. Florida's statutes and rules governing mercury predate federal regulations and helped drive national policy.

DEP Waste Management Program involvement is characterized with the following activities which are also described with more detail below. The list starts with programs currently having the most potential or actual impact on reducing mercury in Florida's environment.

• Reducing mercury from batteries through legislation

• Promoting recycling of mercury containing lamps and devices through regulation and education

• Helping operators safely use drum top crushers according to regulation for volume reduction of spent fluorescent lamps

• Recycling mercury from homeowners and Conditionally Exempt Small Quantity Generators through Florida's Household Hazardous Waste program

• Providing a convenient mercury recycling agreement for state and municipal agencies

• Innovatively reducing mercury use in hospitals,
• Providing mercury thermometer exchange programs,

• Adopting the Thermostat Recycling Corporation (TRC) program and leading in the nation in recycling mercury thermostats,

• Participating in the national End of Life Vehicle Solutions (ELVS) program for auto mercury

• Creating a mercury amalgam management BMP brochure,

• Requiring recycling of mercury-containing lamps and devices in the Green Lodging program,

• Requiring recycling of bilge pump switches in the Clean Marina program,

• Recommending removal of mercury-containing lamps and devices from buildings prior to demolition,

• Developing beneficial reuse of fluorescent lamp glass generated through recycling

• Providing data on metal loading in ash and leachate from ash disposal

Federal legislation has also helped reduce mercury waste in Florida. Florida has adopted the Universal Waste Rule to help manage waste mercury and ensure its proper recycling. The federal ban on sale of mercury fever thermometers has helped eliminate one of the largest sources of mercury in the home.

Regulations and Statutes
Chapter 62-737, Florida Administrative Code, titled "The Management of Spent Mercury-Containing Lamps and Devices Destined for Recycling" details requirements for recycling and has contributed to better management of mercury waste in Florida. Statutory authority for the environmentally sound management of mercury-containing lamps and devices, elimination of mercury in packaging, and elimination of mercury from batteries sold in Florida (Sections 403.7186, 403.7191, and 403.7192, Florida Statutes, respectively) have been important components of proper mercury waste management in Florida. Rules and Statutes pertaining to mercury can be found at: http://www.dep.state.fl.us/waste/categories/mercury/pages/laws.htm. Regulations from other states have also helped mercury waste management in Florida. An example is the strict labeling regulations adopted in some New England states. Product manufacturers have used labeling on products sold nation-wide as a result which helps show Florida consumers what products contain mercury and should be recycled.

Reduction of Mercury from Batteries
Legislation [403.7192, Florida Statutes] sets limitations on the mercury content of alkaline-manganese/zinc-carbon batteries and button batteries; prohibits sale of button-shaped batteries with a mercury electrode; and establishes a disposal ban and take back requirements for other batteries with a mercury electrode. This has resulted in a reduction of mercury in municipal solid waste and a concomitant reduction in mercury content in sentinel species, primarily freshwater fish and wading birds.

Mercury-Containing Lamps Recycling
No report on mercury management in Florida would be complete without discussing how lamps are recycled. Florida currently has one permitted mercury reclamation/recovery facility, one permitted mercury recovery facility, and a third mercury recovery facility in the permitting process. This means we have the ability to recycle our mercury in-state and keep recycling costs lower for our regulated community. Handler/transporter businesses register with the Department to provide more transparency in their operations.

Drum Top Crushers for Fluorescent Lamps
Another aspect of lamp recycling in Florida is the use of drum top crushers (DTC) for fluorescent lamps. These devices can be used for recycling a generator's lamps on site. The ease of operation and convenience make them a popular method of lamp management in Florida, and facilities with storage issues find them particularly appealing. A 2010 interpretation of 62-737.400(6)(b), F.A.C., resulted in an additional use memo that allows a DTC to be put on a truck and taken to the generator's site. At least one company is using this to recycle the copious numbers of lamps generated at tanning salons, a class of generators that have historically not recycled their lamps. The memo and other information about drum top crushers is here: http://www.dep.state.fl.us/waste/categories/mercury/pages/drum-top.htm

Household Hazardous Waste Program
The Department's strong state-wide Household Hazardous Waste program has been an important contributor to the recycling of mercury statewide. Thermometers, fluorescent lamps, thermostats, other mercury containing devices and even bottles of elemental mercury have been properly recycled and kept out of the waste stream. The HHW web pages are here: http://www.dep.state.fl.us/waste/categories/hazardous/pages/household.htm .

Recycling Agreement for State and Municipal Government Entities
The Florida Department of Management Services has provided a State Purchasing Agreement for municipal and state government facilities to recycle their mercury-containing lamps and devices at a competitive price. The State Purchasing Agreement that is renewed annually can be viewed here: http://www.dep.state.fl.us/waste/categories/mercury/pages/contract.htm.

Hospital Mercury Reduction Program
Starting in 1998, various hospitals were visited and received recycling information and, more importantly, information on alternatives to mercury-containing devices. Presentations at conferences for hospital waste management personnel also helped disseminate this information. Hospitals learned how to store and recycle their mercury-containing lamps and devices. Perhaps the most important component was a strong push to eliminate the use of mercury sphygmomanometers. Working with the national programs Hospitals for a Healthy Environment and Healthcare Without Harm brought additional resources to Florida's hospitals. The Department also worked with Florida's Department of Health to write a letter banning the use of mercury sphygmomanometers in Florida's health clinics, resulting in the recycling of these devices as they have been replaced with mercury-free alternatives. Two reports on the medical program can be found here:
http://www.dep.state.fl.us/waste/categories/mercury/pages/medical_facilities.htm .
Staff continues to work with Hospitals for a Healthy Environment as a reviewer and judge for their "Making Medicine Mercury Free" annual national awards program.

Thermometer Exchange Programs
The Department's Pollution Prevention efforts helped develop more mercury awareness by holding and participating in mercury thermometer exchange programs in various parts of the state and also through programs during Earth Day celebrations. These collection programs were an important step that preceded the federal ban on sale of mercury fever thermometers for home use.

Thermostat Recycling Corporation Participation in Florida
Thermostat Recycling Corporation is a national product stewardship program. Member heating, ventilation and air conditioning (HVAC) contractors and wholesalers can use the program to send mercury thermostats for recycling at no cost. Since its inception, Florida has led the country in number of participating wholesalers and in thermostats recycled. Recently many of our Household Hazardous Waste programs have also become TRC members, broadening the reach of the program. The website for the national program is http://www.thermostat-recycle.org/pages/the-program

Automotive Mercury Recycling
A small amount of mercury has historically been used in automobiles. Small ampoules are used in tilt switches in anti-lock brake systems (ABS), trunk lighting systems and sometimes in hood lighting systems. Although they have been engineered out of most vehicles, millions of vehicles are still in operation with these switches intact. As they aged, the majority of them were being sent to scrap yards with the mercury still in the vehicle until a national program was set up in 2000 to capture these small ampoules for recycling. ELVs (End of Life Vehicle Solutions) even provided a bounty for the switches until their funds expired. This program has helped keep tons of elemental mercury out of the waste stream nationwide. Florida has collected at least 318.15 pounds of mercury from over 145,000 switches to date. More information is available at http://www.elvsolutions.org/ .

Dental Amalgam Management Guidance
In 2000, Florida DEP developed and printed a brochure, "Best Management Practices for Scrap Dental Amalgam." By partnering with the Florida Department of Health, Florida Department of Transportation and the Occupational Safety and Health Administration (OSHA), the Department ensured that this guidance included proper management solutions that were acceptable by all agencies affected. This guidance includes a recommendation for Florida dentists to install amalgam separators to eliminate the greatest portion of the mercury generated in a dental operatory. The Department maintains its dialogue with the Florida Dental Association to ensure the most up-to-date regulatory information is available to their member dentists. The brochure can be downloaded from here:
http://www.dep.state.fl.us/waste/categories/mercury/pages/medical_facilities.htm.

Green Lodging Program
The Green Lodging program has been instrumental in creating a database of hotels and motels across Florida that have adopted green practices. With several hundred designated facilities to date, this program has helped establish proper recycling programs for mercury-containing lamps and devices. The program website is here: http://www.dep.state.fl.us/greenlodging/default.htm

Clean Marina Program
The Clean Marina program includes recycling mercury bilge pump switches in their "Clean Marina Action Plan Guidebook." Keeping this source of mercury from being dumped in our waterways is important. There are other smaller sources of mercury on boats and at marinas that also require proper management like mercury containing lamps and thermostats. Visit their web site here: http://www.dep.state.fl.us/cleanmarina/

Deconstruction and Demolition Guidance
Deconstruction and demolition of existing structures is on-going. A booklet, "Recommended Management Practices for the Removal of Hazardous Materials from Buildings Prior to Demolition" includes information on identifying and properly managing mercury-containing components that should be recycled. See the booklet here:
http://www.dep.state.fl.us/waste/quick_topics/publications/shw/hazardous/fact/c&dwaste.pdf

Beneficial Reuse for Fluorescent Lamp Glass Generated Through Recycling
The Department will start using fluorescent lamp glass (FLG) as a substitute for a percentage of the washed sand aggregate in flowable fill used to remediate contaminated petroleum sites in north Florida. This glass, generated by mercury processors while recycling fluorescent lamps, has traditionally been difficult to recycle and the current disposal method has primarily been as daily cover at landfills. There is a potential demand for 50,000-75,000 tons/year of FLG for this innovative program, exceeding the current estimates of FLG supply in Florida.

Mercury in Waste-to-Energy Plant Ash Database
In Florida, the ash generated from solid waste combustors (Waste to Energy, WTE) that primarily receive and burn solid waste collected from residential, commercial and industrial sources is regulated under 62-701 of the Florida Administrative Code (F.A.C.). Under Chapter 62-701, F.A.C., any WTE ash disposed of in Florida must be placed in disposal units that have either a composite liner or a double liner and the leachate from these lined units must be properly managed. In addition, if not addressed in another Department permit or certification,

WTE facilities must obtain waste processing facility solid waste permits to address management of the incoming solid waste stream and the ash generated by the combustion process. These permits ensure the ash is then properly disposed of or recycled.

Ash residue may only be recycled or disposed of in a landfill. If the ash is recycled, the recycler must demonstrate that processed ash residue or products using ash residue will not endanger human health or the environment. Exposure risks to be considered include, but are not limited to, inhalation, ingestion, skin contact, and migration to soil, surface and ground water. If the ash is disposed of it may only be placed or deposited in a lined landfill with a leachate collection and removal system and liner system that complies with the most protective liner requirements detailed in chapter 62-701, F.A.C.

In order to inform the public and regulated community of the metals loading in ash and leachate from ash disposal, the Department has developed a web-based tool that allows the user to query historical data on the level of metal contamination present in WTE ash for each ash generating facility in Florida. While as of December 8, 2011 this data is no longer required (the ash rule, Chapter 62-702, was repealed), the Department believes the previously compiled data is still representative of WTE ash and leachate in Florida. The results of the historical chemical analysis of ash from WTE facilities located in Florida are presented in the form of automated reports that can be found at the following web address:
http://www.dep.state.fl.us/waste/ash/wte_rprtfrm.asp

9.3 Considerations in Wasteload Allocation

Mercury contributions from point sources in Florida are estimated to be 23 kilograms (50.5 pounds) per year. This contribution is insignificant when compared with nonpoint source contributions from the state, nation and around the world. In addition, NPDES Industrial and Domestic permitted sources are already regulated for mercury and it is anticipated EPA will be revising its effluent limitation guidelines to further limit discharges of metals from some source categories. As Florida point sources are such an insignificant portion of Florida's mercury loading when compared with nonpoint sources, it is not appropriate or necessary to assign specific allocations as part of this TMDL. NPDES Sources may be required through their permit to determine if their facility adds to the mercury load or if the presence of mercury is due solely to facility pass-through or because of storm water conveyance. Facilities that do not add to the mercury load will not need to have a permit condition to address mercury in their effluent; whereas facilities that do add to the mercury load may receive an effluent limit and will be required to meet the limit or develop and implement a waste minimization plan if one is not already in place. In light of the foregoing, this TMDL will not require specific allocations or require reductions from point source discharges; however, cost-effective mercury minimization programs will ensure mercury discharges from point sources, in total, will not exceed the WLA.

9.4 Considerations in Load Allocation

As stated previously, global anthropogenic emissions of mercury are the source of the vast majority of mercury deposition in Florida. However, Florida sources are implementing significant mercury reduction efforts. Mercury emissions in Florida have decreased over the past 20-25 years due to air pollution emission reductions required by the federal Clean Air Act (including the Clean Air Interstate Rule that has been replaced by the Cross-State Air Pollution Rule) and Florida's rules implementing the federal Clean Air Act. In light of or anticipation of these rules, many of Florida's industries have installed sophisticated mercury controls resulting in dramatic emission reductions. In 1988, Florida's anthropogenic mercury emissions were approximately 70-75 megagrams (165,300 - 154,300 pounds) and by 1997, these emissions were approximately 14 megagrams (30,800 pounds) per year (see Figure 3.9). Based upon emissions estimates for 2009, Florida's mercury emissions decreased to 3,169 pounds (see Table 3.7). This represents a significant and dramatic reduction in mercury air emissions.

More specifically, the mercury emission reductions in the waste-to-energy and coal-fired electric utility industries have been dramatic over the last two decades. These reductions are discussed in much more detail in Chapter 3 of this document. As indicated in Table 3.4, many of Florida's coal fired electric utilities have installed control equipment that is reducing mercury emissions from this industry. Further, it is anticipated that implementation of other Clean Air Act programs such as Best Available Retrofit Technology (BART) and Maximum Achievable Control Technology (MACT) for the cement and power industry will result in still further reductions in mercury emissions in Florida over the next several years. EPA estimates that its utility MACT rule would result in approximately a 90% reduction in mercury emissions from coal-fired electric utilities based on pre-controlled emissions. Based upon the progress in reducing mercury emissions from coal-fired electric utilities in Florida and the fact that EPA has established a maximum achievable technology standard for mercury from such utilities that is reasonably anticipated to take effect by 2015, this TMDL will not require additional reductions of mercury air emissions from existing coal-fired electric utilities in Florida. In addition, the Department will not be opening or revising federal, Clean Air Act permits as part of the Clean Water Act's TMDL program.

Achievement of this TMDL is dependent upon reduction of global mercury sources. As discussed further in Appendix L, computer modeling estimates of the fractional contributions of Florida sources to Florida's lakes and rivers/streams was generally below 5% with only ~4% of the sites having contributions in excess of 10%. Based upon this effort, it appears that eliminating the fraction of atmospheric Hg loadings to Florida lakes and streams/rivers was predicted to be quite small, with (weighted) reductions averaging about 0.01 and 0.02 mg/kg for large and small lakes, respectively and about 0.01 and 0.02 mg/kg for rivers and streams, respectively.

9.5 Identification of Impaired Waters

Another impact that this TMDL may have is on the Department's Impaired Waters Rule (IWR) listing process. The IWR listing is a continuous process that rotates through the State's 52 hydrologic basins to identify water segments impaired for various pollutants. Mercury fish tissue impairment will continuously be one of the parameters that the IWR listing will cover. After this TMDL becomes effective, if new water segments are listed for mercury fish tissue impairment, the Department will examine possible sources of mercury that may have resulted in the listing. Unless the Department finds that the new listing is caused by conditions that are not covered in this TMDL (e.g. local emission or effluent sources that are not covered by this TMDL), the Department will considered the listing is covered by this TMDL and, therefore, no new TMDL will be developed.

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration

SOUTHEAST DISTRICT • SOUTHEAST COAST–BISCAYNE BAY BASIN

FINAL TMDL Report

Fecal Coliform TMDL for C-14 (Cypress Creek) Canal (WBID 3270), C-13 West (Middle River) Canal (WBID 3273), C-13 East (Middle River) Canal (WBID 3274), C-12 (Plantation) Canal (WBID 3276), New River (North Fork) (WBID 3276A), New River Canal (South) (WBID 3277A), North New River (WBID 3277C), Dania Cut-off Canal (WBID 3277E), C-11 (South New River) Canal (WBID 3279), and C-11 (East) Canal (WBID 3281)

Moira Rojas

May 16, 2012

Chapter 1: INTRODUCTION

1.1 Purpose of Report

This report presents the Total Maximum Daily Loads (TMDLs) for fecal coliform bacteria for 10 waterbodies located in the Southeast Coast–Biscayne Bay Basin: C-14 (Cypress Creek) Canal, C-13 West (Middle River) Canal, C-13 East (Middle River) Canal, C-12 (Plantation) Canal, New River (North Fork), New River Canal (South), North New River Canal, Dania Cut-off Canal, C-11 (South New River) Canal, and C-11 (East) Canal. These waterbodies were verified as impaired for fecal coliform and therefore were included on the Verified Lists of impaired waters for the Southeast Coast–Biscayne Bay Basin that were adopted by Secretarial Order in May 2006 or November 2010. The TMDLs establish allowable fecal coliform loadings to these segments that would restore the waterbodies so that they meet the applicable water quality criterion for fecal coliform.

1.2 Identification of Waterbody

For assessment purposes, the Florida Department of Environmental Protection (Department) has divided the Southeast Coast–Biscayne Bay Basin into water assessment polygons with a unique **w**ater**b**ody **id**entification (WBID) number for each watershed or stream reach. **Table 1.1** lists the WBID numbers for the waterbodies addressed in this report.

These waterbodies comprise 10 of the 22 waterbody segments in the Broward County Planning Unit of the Southeast Coast–Biscayne Bay Basin. WBIDs 3270, 3273, 3276, 3277A, 3279, and 3281 are 6 of 19 waterbody segments in the Southeast Coast–Biscayne Bay Basin included on the initial 1998 303(d) list submitted by the Florida Department of Environmental Protection (Department) to the U.S. Environmental Protection Agency (EPA). The initial 1998 303(d) list was incorporated into a 1999 Consent Decree between the EPA and Earthjustice.

Table 1.1. WBID Numbers for the Waterbodies Included in This TMDL Report

This is a two-column table. Column 1 lists the WBID number, and Column 2 lists the waterbody segment.

WBID	Waterbody Segment
3270	C-14 (Cypress Creek) Canal
3273	C-13 West (Middle River) Canal
3274	C-13 East (Middle River) Canal
3276	C-12 (Plantation) Canal
3276A	New River (North Fork)
3277A	New River Canal (South)
3277C	North New River Canal
3277E	Dania Cut-off Canal
3279	C-11 (South New River) Canal
3281	C-11 (East) Canal

The initial list used data from sampling stations listed in the Department's 1996 305(b) report, which incorporated the best available information at the time to generally characterize the quality of Florida's waters. However, some of the delineations of waterbody areas and locations of sampling stations for the 1998 303(d) list were inaccurate due to metadata limitations at that time.

With the primary goal of providing more accurate assessments, the Department has revised the delineations over time. The EPA has labeled the redrawing of WBID boundaries "resegmentation," as the original stations corresponded to specific WBID areas or segments. Resegmented WBIDs are those WBIDs that have been altered from the initial 1998 303(d) Consent Decree or previous cycle boundaries. As a result of the resegmentation process for the Group 4 basins, there are currently 37 Consent Decree waterbody segments in the Southeast Coast–Biscayne Bay Basin, including WBIDs 3274, 3276A, 3277C, and 3277E. This number is based on Impaired Surface Waters Rule (IWR) Run 41x.

The WBIDs addressed in these TMDLs are located within Broward County (**Figures 1.1** and **1.2**), which comprises a highly engineered and managed, complex system of canals. The hydrology within the county is manipulated by a series of water control structures, pumps, and levees that have altered the natural hydroperiods and flows of these watersheds (Broward County Department of Planning and Environmental Protection [BCDPEP] 2001a), and have resulted in the effective management of water in the region, allowing for the current urban development and agricultural landscape (South Florida Water Management District [SFWMD] 2010a).

The primary drainage system in the county, managed by the SFWMD, comprises nine major canals and their drainage basins: Hillsboro Canal, C-14 (Cypress Creek) Canal, Pompano Canal, C-13 (Middle River) Canal, C-12 (Plantation) Canal, North New River Canal, C-11 (South New River) Canal, C-9 (Snake Creek) Canal, and C-10 Canal. Except for the western segment of the C-11, which is normally back-pumped into the Everglades' Water Conservation Areas (WCAs), these major canals, along with secondary and tertiary canals, eventually drain to estuarine waters (BCDPEP 2001a) (**Figure 1.3**).

The canals were built to meet population needs by controlling water levels and movement for water supply, flood control, drainage, and navigation, in addition to providing water necessary to maintain natural communities in lakes, wetlands, rivers, and estuaries (SFWMD 2010a). Water levels are managed to maintain ground water levels during dry periods, which is particularly important for water supply needs by preventing saltwater intrusion. During these periods, stored water can be delivered throughout the county to help meet local urban and agricultural needs and prevent saltwater intrusion. During wet periods, the canals remove excess water from drainage basins to prevent flooding.

Within urban areas, the canals are used primarily for flood control. However, secondary uses include the drainage of land for development, wellfield recharge for local municipalities, and the discharge of excess water to and from the WCAs (Cooper and Lane 1987), with primary canals functioning as an outlet for excess water from the Everglades and Lake Okeechobee during wet periods.

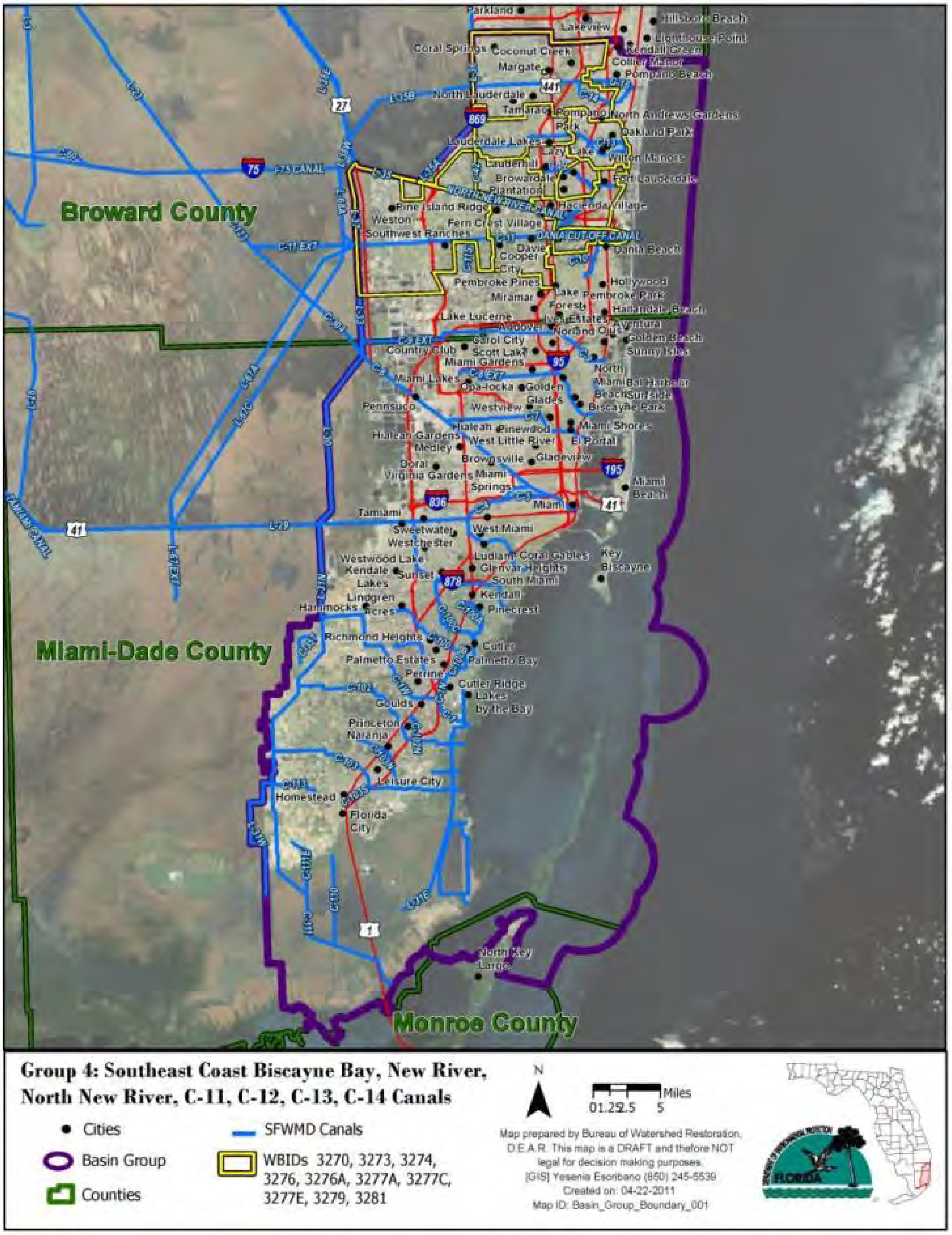

Figure 1.1. Location of WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281 in the Southeast Coast–Biscayne Bay Basin and Major Hydrologic and Geopolitical Features in the Area

Figure 1.2. Location of WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281 in Broward County and Major Hydrologic and Geopolitical Features in the Area

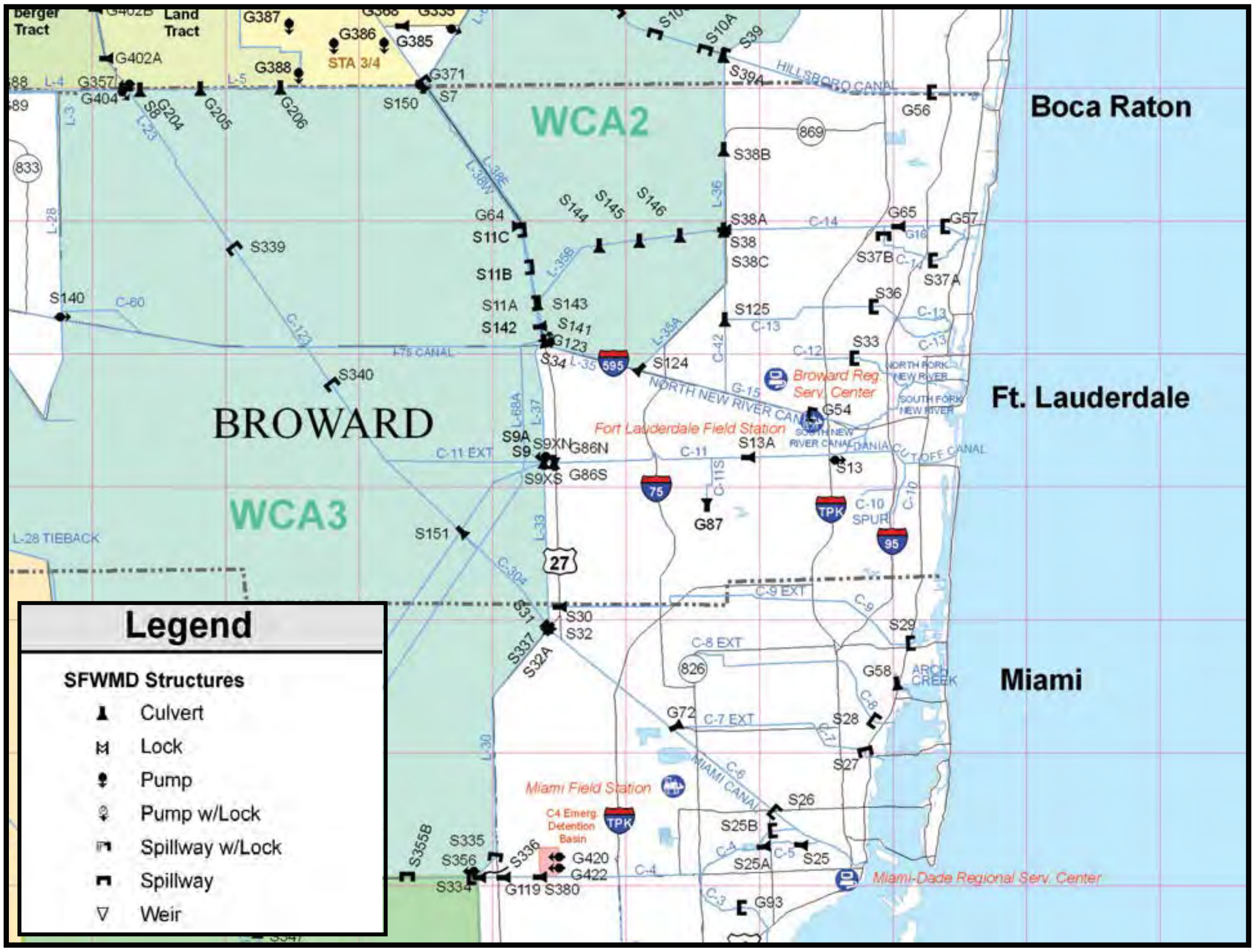

Figure 1.3. Location of Canals, WCAs, and Water Control Structures in Broward County (SFWMD 2010a)

All canal segments contain either a water control structure within them or are directly influenced by the operation of an upstream or downstream control structure (SFWMD 2010a) (**Figure 1.3**). Structures regulate the flow and level of water in these canals. Coastal structures also prevent salt water from a tidal or storm surge from entering canals that discharge to tide.

Canals are notably different from most natural waterbodies. As a result of their design, management, and maintenance, these systems provide limited support for aquatic life. In addition, water levels and flow can have extreme fluctuations depending on operational needs. While canals are designed to move high flows at high velocities, during periods of drought and dry season operations, they may be stagnant for extended periods, and some may contain little or no water (SFWMD 2010a).

The C-14 (Cypress Creek) Canal (WBID 3270) is located in northern Broward County. The western portion of this watershed was designed for 1 in 10-year flood protection and the eastern portion for 1 in 30-year flood protection (SFWMD 2010a). In addition to flood protection, the C-

14 Canal and its associated water control structures supply water, maintain the water table, transport excess water from WCA-2A to tidewater, and intercept and control seepage from WCA-2A (SFWMD 2010a). Although in general the C-14 Canal flows to the eastern estuarine waters from WCA-2A, the S-37B structure can act as a separator based on specific hydrologic conditions (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

The C-13 (Middle River) Canal, located in north-central Broward County, is divided into an eastern portion (WBID 3274) and a western portion (WBID 3273). The western portion includes the entire freshwater section of the C-13 Canal. In general, water flows from the confluence of the C-42 Canal to the eastern estuarine waters via the S-36 water control structure (BCDPEP 2001a). The canals and associated water control structures in the C-13 watershed provide flood protection and drainage, supply water, intercept and control seepage from WCA-2B, and maintain the elevation of the ground water table west of S-36 to prevent saltwater intrusion (SFWMD 2010a) (**Figures 1.2** and **1.3**).

The C-12 Canal (WBID 3276) is located in east-central Broward County. The canal and its associated water control structure provide flood protection and drainage, and maintain ground water levels west of S-33 (SFWMD 2010a). The C-12 is the headwaters of the North Fork of the New River. Unlike other canals in Broward County, the canal has no direct or indirect connection to seepage water from the WCAs; water supply in the watershed is limited to rainfall. Studies have determined that the watershed is stagnant (no flow occurs) 85% of the time at the S-33 structure (BCDPEP 2001a), and thus the canal is considered a “closed” waterbody, receiving inputs mainly from ground water and stormwater based on rainfall patterns (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

The New River watershed, located in east-central Broward County, is one of two large estuarine reaches in Broward County, the other being the Intracoastal Waterway (ICW) (BCDPEP 2001a) (**Figures 1.2** and **1.3**). It is divided into three distinct areas: the main New River, the North Fork (WBID 3276A), and the South Fork (WBID 3277A). The North Fork, a shallow, meandering tributary of the New River, has minimal tidal flow and limited exchanges of tidal waters (BCDPEP 2001b). Most of the North Fork’s freshwater input is stormwater, with seasonal ground water contributions (BCDPEP 2001a). The South Fork, made up of two freshwater tributaries, the C-11 and the North New River Canal (WBID 3277C), has a relatively dynamic, high flow rate and does not consistently receive flow from C-12 Canal discharges. As a result, the North Fork functions mainly as a tidal “pond” characterized by stagnant waters with restricted outflow to the main New River (BCDPEP 2001a). The southwestern portion of the South Fork includes a large natural area (Pond Apple Slough) as well as other vegetated expanses (Griffey Tract) containing large areas of mangrove forests and leatherfern stands (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

The North New River Canal (WBID 3277C) is located in east-central Broward County. The North New River was excavated and extended to drain the Everglades and to provide a transportation route between Lake Okeechobee and the east coast (SFWMD 2010a). This canal flows to the southeast, discharging to the South Fork of the New River east of the G-54 lock (SFWMD 2010a). The freshwater portion of the New River Canal (North) is a bordering waterway from the WCA tailwaters to an estuarine discharge point at the G-54 structure (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

The C-11 (South New River) Canal, located in southwest Broward County, is divided into a western watershed (WBID 3279) and an eastern watershed (WBID 3281). The C-11 extends from the L-37 Borrow Canal on the west to the S-13 water control structure. The eastern portion of the canal flows to the east, discharging to the South Fork of the New River. Any excess water in the eastern watershed is discharged to the east by the C-11 and S-13 to the South Fork of the New River. Additional quantities of excess water from the western watershed can be discharged to the eastern watershed through the S-13A water control structure if the S-13 is not pumping to capacity (SFWMD 2010a). The western segment of the C-11 is normally backpumped into the WCAs (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

The Dania Cut-off Canal (WBID 3277E) is located in the southeast corner of Broward County. Fresh water in the canal originates mainly from the C-11 Canal to the west (upstream) of the Dania Cut-off Canal and is controlled by releases through the S-13 water control structure. The Dania Cut-off Canal flows east to join the ICW just south of Port Everglades. Tidewater primarily comes from the Port Everglades Inlet, with some tidal interaction also occurring with the South Fork of the New River in the western portion of the Dania Cut-off Canal (BCDPEP 2001a) (**Figures 1.2** and **1.3**).

WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281 are located in the Atlantic Coastal Ridge and Everglades physiographic regions, which occupy the eastern portions of Broward, Miami–Dade, and Palm Beach Counties. In Broward County, the ridge is composed of both sand and limestone (Schroeder *et al.* 1956). The Everglades, an area of organic soils, is located west of the ridge and is dedicated primarily to agriculture and conservation areas (Schroeder *et al.* 1956).

This part of southeastern Florida is underlain by the Biscayne aquifer, an unconfined and shallow part of the surficial aquifer system that consists of highly permeable limestone and less permeable sandstone and sand (Fish 1988). The aquifer supplies large quantities of water for municipal, industrial, and irrigational use in Broward County. The Biscayne aquifer is particularly susceptible to contamination because it is unconfined, highly permeable, and shallow, and because it is located near the surface in highly urbanized areas (Whitman1997). Potential sources of contamination include saltwater encroachment and infiltration of contaminants carried in canal water, direct infiltration of contaminants (chemicals or pesticides applied to or spilled on the land, and fertilizer carried in surface runoff), landfills, septic tanks, sewage plant treatment ponds, and wells used to dispose of stormwater runoff or industrial waste (Miller 1990). Additional information about the hydrology and geology of the area is available in the *Broward County, Florida Historical Water Quality Atlas: 1972–1997* (BCDPEP 2001a).

Table 1.2 lists the area (in square miles and acres) within each WBID boundary. Land use in the WBIDs is predominantly medium- and high-density residential.

Table 1.2. Area within Each WBID Boundary in Square Miles and Acres

This is a four-column table. Column 1 lists the WBID number, Column 2 lists the waterbody name, Column 3 lists the WBID area in square miles, and Column 4 lists the WBID area in acres.

WBID	Waterbody	WBID Area (square miles)	WBID Area (acres)
3270	C-14 (Cypress Creek) Canal	56.1	35,884
3273	C-13 West (Middle River) Canal	20.6	13,188
3274	C-13 East (Middle River) Canal	15.2	9,723
3276	C-12 (Plantation) Canal	8.8	5,621
3276A	New River (North Fork)	7.1	4,523
3277A	New River Canal (South)	16.1	10,281
3277C	North New River Canal	8.7	5,555
3277E	Dania Cut-off Canal	7.4	4,719
3279	C-11 (South New River) Canal	70.9	45,367
3281	C-11 (East) Canal	22.8	14,623

1.3 Background

This report was developed as part of the Department's watershed management approach for restoring and protecting state waters and addressing TMDL Program requirements. The watershed approach, which is implemented using a cyclical management process that rotates through the state's 52 river basins over a 5-year cycle, provides a framework for implementing the TMDL Program–related requirements of the 1972 federal Clean Water Act and the 1999 Florida Watershed Restoration Act (FWRA) (Chapter 99-223, Section 403.067, Laws of Florida).

A TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet water quality standards, including its applicable water quality criteria and its designated uses. TMDLs are developed for waterbodies that are verified as not meeting their water quality standards. They provide important water quality restoration goals that will guide restoration activities.

This TMDL report will be followed by the development and implementation of a restoration plan designed to reduce the amount of fecal coliform that caused the verified impairment of WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281. These activities will depend heavily on the active participation of the SFWMD, local governments, businesses, and other stakeholders. The Department will work with these organizations and individuals to undertake or continue reductions in the discharge of pollutants and achieve the established TMDLs for impaired waterbodies.

Chapter 2: DESCRIPTION OF WATER QUALITY PROBLEM

2.1 Statutory Requirements and Rulemaking History

Section 303(d) of the federal Clean Water Act requires states to submit to the EPA lists of surface waters that do not meet applicable water quality standards (impaired waters) and establish a TMDL for each pollutant causing the impairment of listed waters on a schedule. The Department has developed such lists, commonly referred to as 303(d) lists, since 1992. The list of impaired waters in each basin, referred to as the Verified List, is also required by the FWRA (Subsection 403.067[4], Florida Statutes [F.S.]); the state's 303(d) list is amended annually to include basin updates.

Florida identified 19 impaired waterbodies in the Southeast Coast–Biscayne Bay Basin on its initial 1998 303(d) list. As a result of the resegmentation process for the Group 4 basins, there are currently 37 Consent Decree waterbody segments in the Southeast Coast–Biscayne Bay Basin (see **Section 1.2**). However, the FWRA (Section 403.067, F.S.) stated that all Florida 303(d) lists created before the adoption of the FWRA were for planning purposes only and directed the Department to develop, and adopt by rule, a new science-based methodology to identify impaired waters. After a long rulemaking process, the Environmental Regulation Commission adopted the new methodology as Rule 62-303, Florida Administrative Code (F.A.C.) (Identification of Impaired Surface Waters Rule, or IWR), in April 2001; the rule was modified in 2006 and 2007.

2.2 Information on Verified Impairment

The Department used the IWR to assess water quality impairments in WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281, and has verified that these waterbody segments are impaired for fecal coliform bacteria. The verified impairment was based on the observation that, with a 90% confidence limit based on binomial distribution, more than 10% of the values exceeded the assessment threshold of 400 counts per 100 milliliters (counts/100mL) (see **Section 3.2** for details) in all these WBIDs.

WBIDs 3274, 3276A, and 3277A were verified as impaired during the Cycle 1 verified period (January 1, 1998–June 30, 2005). These impairments were confirmed in the Cycle 2 verified period (January 1, 2003–June 30, 2010). WBIDs 3270, 3273, 3276, 3277C, 3277E, 3279, and 3281 were verified as impaired during the Cycle 2 verified period.

Tables 2.1a summarizes fecal coliform monitoring results used for verified impairment for the Cycle 1 verified period for WBIDs 3274, 3276A, and 3277A. **Table 2.1b** summarizes fecal monitoring results used for verified impairment for the Cycle 2 assessment (based on IWR Run 41x) for all WBIDs. As they better represent the current conditions, only the results for the Cycle 2 verified period were used in the TMDL development process.

Table 2.1a. Summary of Fecal Coliform Monitoring Data for WBIDs 3274, 3276A, and 3277A During the Cycle 1 Verified Period (January 1, 1998–June 30, 2005)

This is a four-column table. Column 1 lists the parameter, and Columns 2 through 4 list the WBID numbers and corresponding Cycle 1 results.

Parameter	WBID 3274	WBID 3276A	WBID 3277A
Total number of samples	205	104	144
IWR-required number of exceedances for the Verified List	27	15	20
Number of observed exceedances	39	45	22
Number of observed nonexceedances	166	59	122
Number of seasons during which samples were collected	4	4	4

Table 2.1b. Summary of Fecal Coliform Monitoring Data for WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281 During the Cycle 2 Verified Period (January 1, 2003–June 30, 2010)

This is an 11-column table. Column 1 lists the parameter, and Columns 2 through 11 list the WBID numbers and corresponding Cycle 2 results.

Parameter	WBID 3270	WBID 3273	WBID 3276	WBID 3279	WBID 3281	WBID 3277C	WBID 3277E	WBID 3274	WBID 3276A	WBID 3277A
Total number of samples	144	70	57	74	30	84	67	153	53	111
IWR-required number of exceedances for the Verified List	20	11	10	12	6	13	11	21	9	16
Number of observed exceedances	23	11	13	21	14	16	18	50	39	30
Number of observed nonexceedances	121	59	44	53	16	68	49	103	14	81
Number of seasons during which samples were collected	4	4	4	4	4	4	4	4	4	4
Highest observation (counts/100mL)	5,200	2,600	7,400	9,800	9,100	5,800	9,400	9,600	10,000	6,400
Lowest observation (counts/100mL)	1.8	1.8	6	1.8	44	1.8	1.8	1	150	7
Median observation (counts/100mL)	110	69	94	205	400	98	250	244	630	220
Mean observation (counts/100mL)	282	226	570	510	1,415	288	823	570	1,734	675

Chapter 3. DESCRIPTION OF APPLICABLE WATER QUALITY STANDARDS AND TARGETS

3.1 Classification of the Waterbody and Criterion Applicable to the TMDLs

Florida's surface waters are protected for five designated use classifications, as follows:

Class I	**Potable water supplies**
Class II	**Shellfish propagation or harvesting**
Class III	**Recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife**
Class IV	**Agricultural water supplies**
Class V	**Navigation, utility, and industrial use (there are no state waters currently in this class)**

All WBIDs addressed in this report are Class III waterbodies, with a designated use of recreation, propagation, and maintenance of a healthy, well-balanced population of fish and wildlife. WBIDs 3274, 3276A, 3277A, and 3277E are Class III marine waterbodies, and WBIDs 3270, 3273, 3276, 3277C, 3279, and 3281 are Class III freshwater waterbodies. The criterion applicable to these TMDLs is the Class III (marine and freshwater) criterion for fecal coliform.

3.2 Applicable Water Quality Standards and Numeric Water Quality Target

Numeric criteria for bacterial quality are expressed in terms of fecal coliform bacteria concentration. The water quality criterion for the protection of Class III waters (marine and freshwater), as established by Rule 62-302, F.A.C., states the following:

> ***Fecal Coliform Bacteria:***
>
> *The most probable number (MPN) or membrane filter (MF) counts per 100 mL of fecal coliform bacteria shall not exceed a monthly average of 200, nor exceed 400 in 10 percent of the samples, nor exceed 800 on any one day.*

The criterion states that monthly averages shall be expressed as geometric means based on a minimum of 10 samples taken over a 30-day period. There were insufficient data (fewer than 10 samples in a given month) available to evaluate the geometric mean criterion for fecal coliform bacteria. Therefore, the criterion selected for these TMDLs was not to exceed 400 counts/100mL for fecal coliform.

Chapter 6: DETERMINATION OF THE TMDL

6.1 Expression and Allocation of the TMDL

The objective of a TMDL is to provide a basis for allocating acceptable loads among all of the known pollutant sources in a watershed so that appropriate control measures can be implemented and water quality standards achieved. A TMDL is expressed as the sum of all point source loads (wasteload allocations, or WLAs), nonpoint source loads (load allocations, or LAs), and an appropriate margin of safety (MOS), which takes into account any uncertainty concerning the relationship between effluent limitations and water quality:

$$\textbf{TMDL} = \sum \textbf{WLAs} + \sum \textbf{LAs} + \textbf{MOS}$$

As discussed earlier, the WLA is broken out into separate subcategories for wastewater discharges and stormwater discharges regulated under the NPDES Program:

$$\textbf{TMDL} \cong \sum \textbf{WLAs}_{\textbf{wastewater}} + \sum \textbf{WLAs}_{\textbf{NPDES Stormwater}} + \sum \textbf{LAs} + \textbf{MOS}$$

It should be noted that the various components of the revised TMDL equation may not sum up to the value of the TMDL because (a) the WLA for NPDES stormwater is typically based on the percent reduction needed for nonpoint sources and is also accounted for within the LA, and (b) TMDL components can be expressed in different terms (for example, the WLA for stormwater is typically expressed as a percent reduction, and the WLA for wastewater is typically expressed as mass per day).

WLAs for stormwater discharges are typically expressed as “percent reduction” because it is very difficult to quantify the loads from MS4s (given the numerous discharge points) and to distinguish loads from MS4s from other nonpoint sources (given the nature of stormwater transport). The permitting of stormwater discharges also differs from the permitting of most wastewater point sources. Because stormwater discharges cannot be centrally collected, monitored, and treated, they are not subject to the same types of effluent limitations as wastewater facilities, and instead are required to meet a performance standard of providing treatment to the “maximum extent practical” through the implementation of best management practices (BMPs).

This approach is consistent with federal regulations (40 CFR § 130.2[I]), which state that TMDLs can be expressed in terms of mass per time (e.g., pounds per day), toxicity, or other appropriate measure. The TMDLs for WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281 are expressed as a percent reduction, and represent the maximum daily fecal coliform load each stream can assimilate without exceeding the fecal coliform criterion (**Table 6.1**).

6.2 Load Allocation

Based on a percent reduction approach, the LA for percent reduction in fecal coliform from nonpoint sources for each WBID is presented in **Table 6.1**. It should be noted that the LA includes loading from stormwater discharges regulated by the Department and the water management districts that are not part of the NPDES Stormwater Program (see **Appendix A**).

Table 6.1. TMDL Components for Fecal Coliform in WBIDs 3270, 3273, 3274, 3276, 3276A, 3277A, 3277C, 3277E, 3279, and 3281

This is an eight-column table. Column 1 lists the WBID number, Column 2 lists the waterbody name, Column 3 lists the parameter, Column 4 lists the TMDL (counts/100mL), Column 5 lists the WLA for wastewater (counts/100mL), Column 6 lists the WLA for NPDES stormwater (percent reduction), Column 7 lists the LA (percent reduction), and Column 8 lists the MOS.

[1] N/A = WLA for wastewater is not applicable as permitted facilities discharge outside WBID boundaries
[2] N/A = Not applicable

WBID	Waterbody Name	Parameter	TMDL (counts/ 100mL)	WLA for Wastewater (counts/100mL)	WLA for NPDES Stormwater (% reduction)	LA (% reduction)	MOS
3270	C-14 (Cypress Creek) Canal	Fecal coliform	400	N/A[1]	22%	22%	Implicit
3273	C-13 West (Middle River) Canal	Fecal coliform	400	N/A[2]	22%	22%	Implicit
3274	C-13 East (Middle River) Canal	Fecal coliform	400	N/A[2]	67%	67%	Implicit
3276	C-12 Canal	Fecal coliform	400	N/A[2]	52%	52%	Implicit
3276A	New River (North Fork)	Fecal coliform	400	N/A[2]	94%	94%	Implicit
3277A	New River Canal (South)	Fecal coliform	400	N/A[2]	69%	69%	Implicit
3277C	North New River	Fecal coliform	400	N/A[2]	31%	31%	Implicit
3277E	Dania Cut-off Canal	Fecal coliform	400	NA[2]	78%	78%	Implicit
3279	C-11 (South New River) Canal	Fecal coliform	400	N/A[2]	31%	31%	Implicit
3281	C-11 (East) Canal	Fecal coliform	400	N/A[1]	93%	93%	Implicit

6.3 Wasteload Allocation

6.3.1 NPDES Wastewater Discharges

Several NPDES-permitted wastewater facilities were identified within the WBID boundaries (see **Table 4.1a**). Two of these are domestic wastewater facilities: the Broward County North Regional WWTP and the Town of Davie WWTP (Permit Numbers FL0031771 and FL0040541, respectively). However, treated wastewater from both facilities is transported to the Atlantic Ocean via ocean outfalls, and therefore does not contribute to the observed levels of fecal coliform bacteria within the WBID where they are located.

It should be noted that the state requires all NPDES-permitted wastewater point source dischargers to meet bacteria criteria at the end of the pipe. It is the Department's current practice not to allow mixing zones for bacteria. Any future point sources that may discharge in the WBID in the future will also be required to meet end-of-pipe standards for coliform bacteria.

6.3.2 NPDES Stormwater Discharges

Table 6.1 presents the percent reduction for stormwater discharges with an MS4 permit in current fecal coliform loading for each WBID.

It should be noted that any MS4 permittee is only responsible for reducing the anthropogenic loads associated with stormwater outfalls that it owns or otherwise has responsible control over, and it is not responsible for reducing other nonpoint source loads in its jurisdiction.

6.4 Margin of Safety

Consistent with the recommendations of the Allocation Technical Advisory Committee (Department 2001), an implicit MOS was used in the development of this TMDL by not subtracting contributions from natural sources and sediments when the percent reduction was calculated. This makes the estimation of human contribution more stringent and therefore adds to the MOS.

Chapter 7: TMDL IMPLEMENTATION

7.1 Basin Management Action Plan

Following the adoption of these TMDLs by rule, the Department will determine the best course of action regarding their implementation. Depending on the pollutant(s) causing the waterbody impairment and the significance of the waterbody, the Department will select the best course of action leading to the development of a plan to restore the waterbody. Often this will be accomplished cooperatively with stakeholders by creating a Basin Management Action Plan, referred to as the BMAP. BMAPs are the primary mechanism through which TMDLs are implemented in Florida (see Subsection 403.067[7], F.S.). A single BMAP may provide the conceptual plan for the restoration of one or many impaired waterbodies.

If the Department determines that a BMAP is needed to support the implementation of these TMDLs, a BMAP will be developed through a transparent, stakeholder-driven process intended to result in a plan that is cost-effective, technically feasible, and meets the restoration needs of the applicable waterbodies. Once adopted by order of the Department Secretary, BMAPs are enforceable through wastewater and municipal stormwater permits for point sources and through BMP implementation for nonpoint sources. Among other components, BMAPs typically include the following:

- *Water quality goals (based directly on the TMDL);*
- *Refined source identification;*
- *Load reduction requirements for stakeholders (quantitative detailed allocations, if technically feasible);*
- *A description of the load reduction activities to be undertaken, including structural projects, nonstructural BMPs, and public education and outreach;*
- *A description of further research, data collection, or source identification needed in order to achieve the TMDL;*
- *Timetables for implementation;*
- *Implementation funding mechanisms;*
- *An evaluation of future increases in pollutant loading due to population growth;*
- *Implementation milestones, project tracking, water quality monitoring, and adaptive management procedures; and*
- *Stakeholder statements of commitment (typically a local government resolution).*

BMAPs are updated through annual meetings and may be officially revised every five years. Completed BMAPs in the state have improved communication and cooperation among local stakeholders and state agencies; improved internal communication within local governments; applied high-quality science and local information in managing water resources; clarified the obligations of wastewater point source, MS4, and non-MS4 stakeholders in TMDL implementation; enhanced transparency in the Department's decision making; and built strong relationships between the Department and local stakeholders that have benefited other program areas.

7.2 Other TMDL Implementation Tools

However, in some basins, and for some parameters, particularly those with fecal coliform impairments, the development of a BMAP using the process described above will not be the most efficient way to restore a waterbody, such that it meets its designated uses. This is because fecal coliform impairments result from the cumulative effects of a multitude of potential sources, both natural and anthropogenic. Addressing these problems requires good old-fashioned detective work that is best done by those in the area.

Many assessment tools are available to assist local governments and interested stakeholders in this detective work. The tools range from the simple (such as Walk the WBIDs and GIS mapping) to the complex (such as bacteria source tracking). Department staff will provide technical assistance, guidance, and oversight of local efforts to identify and minimize fecal coliform sources of pollution. Based on work in the Lower St Johns River Tributaries and Hillsborough Basins, the Department and local stakeholders have developed a logical process and tools to serve as a foundation for this detective work.

In the near future, the Department will be releasing these tools to assist local stakeholders with the development of local implementation plans to address fecal coliform impairments. In such cases, the Department will rely on these local initiatives as a more cost-effective and simplified approach to identify the actions needed to put in place a road map for restoration activities, while still meeting the requirements of Subsection 403.067(7), F.S.