

**FINAL**

**Roanoke River PCB TMDL Development  
(Virginia)**

December 2009

Prepared for:  
United States Environmental Protection Agency, Region 3  
Contract EP-C-08-004, Task Order #2008-041

Prepared by:



Tetra Tech, Inc.  
10306 Eaton Place, Suite 340  
Fairfax, VA 22030



## EXECUTIVE SUMMARY

Section 303(d) of the Clean Water Act and the U.S. Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (Title 40 of the *Code of Federal Regulations* [CFR] Part 130) require states to develop Total Maximum Daily Loads (TMDLs) for impaired waterbodies. A TMDL establishes the amount of a pollutant that a waterbody can assimilate without exceeding its water quality standard for that pollutant. TMDLs provide the scientific basis for a state to establish water quality-based controls to reduce pollution from both point sources and nonpoint sources to restore and maintain the quality of the state's water resources.

A TMDL for a given pollutant and waterbody is composed of the sum of individual wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources and background levels. In addition, the TMDL must include an implicit or explicit margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving waterbody. The TMDL components are illustrated using the following equation:

$$TMDL = \sum WLAs + \sum LAs + MOS$$

The objective of the Roanoke River PCB TMDL study is to identify the sources of Polychlorinated Biphenyl (PCB) contamination in the watershed and determine the reductions in pollutant loadings necessary to achieve the applicable water quality standards. The TMDL study drainage area is approximately 2,379 square miles and includes two sections of the Roanoke River watershed—from its headwaters downstream to Niagra Dam (upper Roanoke) and from Leesville Dam downstream to its confluence with the Dan River [lower Roanoke (Staunton)]. The mainstem lengths of the upper and lower sections of the river are approximately 29 and 96 miles, respectively, and run through several Virginia counties, including Montgomery, Roanoke, Bedford, Franklin, Campbell, Pittsylvania, Charlotte, and Halifax.

The impairment listings for stream and reservoir segments in the study area are based on the historical fish tissue and sediment monitoring data record. This TMDL study was designed to address select PCB impairments included on Virginia's 1998 303(d) list. More recent monitoring studies have resulted in the listing of additional PCB-impaired stream and reservoir segments in the watershed, including updates on Virginia's 2008 303(d) list (Table ES-1) and a forthcoming violation listing (2010) of the public water supply use. The framework developed for these TMDLs does not include allocations for impaired segments outside of the study watersheds described above. It does include allocations for all stream segments in the study area, however, and if no other significant sources of PCBs are found, it can be assumed that these TMDLs will significantly improve the more recent PCB impairment listings, as well.

**Table ES-1. 2008 303(d) PCB impaired segments**

Waterbody	Impaired segment description	County/city	Miles/acres <sup>b</sup>	Initial listing <sup>b</sup>	2008 303(d) list ID
Roanoke River	Near Dixie Caverns – Mason Creek confluence	Roanoke, City of Salem, City of Roanoke	12.88 miles	2002	L12L-01-PCB
Roanoke River	Mason Creek confluence – Back Creek mouth	City of Salem, City of Roanoke	15.47 miles	1996	
Peters Creek	Peters Creek headwaters – Roanoke River confluence	Roanoke, City of Roanoke	7.17 miles	2004	
Tinker Creek	Deer Branch confluence – Roanoke River confluence	Roanoke, City of Roanoke	5.35 miles	2006	
Smith Mountain Lake <sup>a</sup>	Back Creek mouth – Smith Mountain Lake Dam (includes Blackwater arm up to Rt. 122 bridge)	Bedford, Franklin	17,157 acres	2002	

Waterbody	Impaired segment description	County/city	Miles/ acres <sup>b</sup>	Initial listing <sup>b</sup>	2008 303(d) list ID
Blackwater River <sup>a</sup>	Maggodee Creek confluence – Blackwater River arm of Smith Mountain Lake	Franklin	11.43 miles	2006	
Staunton (Roanoke) River	Leesville Dam – Pipeline crossing 5.4 miles downstream of Rt. 360 bridge	Charlotte, Halifax, Campbell, Pittsylvania	83.9 miles	1998	L19R-01-PCB
Staunton (Roanoke) River	Pipeline crossing 5.4 miles downstream of Rt. 360 bridge – Kerr Reservoir	Halifax, Charlotte	4.49 miles	1998	
Cub Creek	Rough Creek Rd. – Roanoke River confluence	Charlotte	14.25 miles	2008	
Little Otter River	West of Rt. 680 at Cobbs Mountain – mouth of the Little Otter River on the Big Otter River	Bedford	14.36 miles	2002	L26R-01-PCB

a. These segments are not included in the TMDL study area

b. Source: <http://www.deq.state.va.us/wqa/ir2008.html>

TMDL reductions were calculated on the basis of meeting water quality targets in the upper and lower sections of the Roanoke (Staunton). Water quality targets were derived from Bioaccumulation Factors (BAF) and the Virginia Department of Environmental Quality (VADEQ) fish tissue criterion for total PCBs (tPCBs). BAFs allow for the back-calculation of a water concentration equivalent from a fish tissue concentration, in this case a threshold level of 54 parts per billion (ppb). Two endpoints were developed corresponding to the upper [390 picograms per liter (pg/L)] and lower (140 pg/L) sections of the Roanoke (Staunton) River basin on the basis of the available water quality and fish tissue monitoring data. The decision to evaluate the upper and lower sections separately was made because of the large reservoirs that separate them and the differences in the magnitude and composition of PCB contamination.

The TMDL endpoints have been developed to be protective of fish for human consumption and are more stringent than the 1,700 pg/L state criterion for human health. The human health criterion applies to waterbodies used for public water supply, in addition to all other surface waters. The TMDL endpoints, therefore, are more than adequate to protect the water supply use and address the forth coming violation listing (2010) of the public water supply use in the Roanoke River watershed.

A watershed modeling framework, consisting of the Loading Simulation Program C++ (LSPC) with sediment PCB modeling enhancements was developed, calibrated, and validated for the Roanoke River study watershed. LSPC is a dynamic watershed model that generates precipitation-driven simulation of time-variable flow and water quality. The LSPC model was configured to simulate PCBs in both the dissolved- and sediment-associated states. Sediment-associated PCB loading and in-stream transport, deposition, burial and resuspension processes, along with partitioning of PCBs in the water and sediment layer were incorporated into the model simulations. A summary of the TMDLs, LAs, and WLAs developed for streams in the Roanoke River watershed is presented in Table ES-2. Streams listed as impaired for PCBs on Virginia's 2008 303(d) list are identified by their associated list ID. A summary of the TMDLs, LAs, and WLAs by source category is presented in Table ES-3.

**Table ES-2. Average annual tPCBs TMDLs for Roanoke River watershed streams**

Stream	2008 303(d) list ID	Baseline (mg/yr)	WLA (mg/yr)	LA (mg/yr)	MOS (mg/yr)	TMDL (mg/yr)	% Reduction
<b>Upper Roanoke River</b>							
North Fork Roanoke River	Not listed	4,923.2	28.2	630.3	34.7	693.2	85.9
South Fork Roanoke River	Not listed	3,532.2	230.2	788.6	53.6	1,072.5	69.6
Masons Creek	Not listed	1,777.5	9.1	193.2	10.6	212.9	88.0

Stream	2008 303(d) list ID	Baseline (mg/yr)	WLA (mg/yr)	LA (mg/yr)	MOS (mg/yr)	TMDL (mg/yr)	% Reduction
Peters Creek	L12L-01-PCB	1,742.6	65.4	31.2	5.1	101.7	94.2
Tinker Creek	L12L-01-PCB	16,593.6	103.9	3,414.2	185.2	3,703.2	77.7
Wolf Creek	Not listed	1,078.4	10.0	20.3	1.6	31.9	97.0
Unnamed Trib to Roanoke River	Not listed	59.4	0.5	1.3	0.1	1.9	96.8
Roanoke River	L12L-01-PCB	133,207.2	28,157.7	3,455.7	1,663.9	33,277.3	75.0
<b>Upper Total</b>		<b>162,914.1</b>	<b>28,605.0</b>	<b>8,534.8</b>	<b>1,954.7</b>	<b>39,094.5</b>	<b>76.0</b>
<b>Lower Roanoke (Staunton) River</b>							
Goose Creek	Not listed	5,400.9	0.1	1,812.4	95.4	1,907.9	64.7
Sycamore Creek	Not listed	93,226.4	1.4	186.3	9.9	197.6	99.8
Lynch Creek	Not listed	7,670.6	0.1	17.8	0.9	18.8	99.8
Reed Creek	Not listed	253.4	0.0	75.9	4.0	79.9	68.5
X-trib	Not listed	215,127.2	0.1	1.3	0.1	1.5	100.0
Unnamed Trib to Roanoke River	Not listed	12,848.6	0.1	19.1	1.0	20.2	99.8
Little Otter River	L26R-01-PCB	3,934.3	0.0	596.2	31.4	627.6	84.0
Big Otter River	Not listed	7,630.9	0.0	2,462.8	129.6	2,592.4	66.0
Straightstone Creek	Not listed	464.8	0.0	279.0	14.7	293.7	36.8
Seneca Creek	Not listed	692.9	0.0	400.8	21.1	421.9	39.1
Whipping Creek	Not listed	398.4	0.0	157.7	8.3	166.0	58.3
Falling River	Not listed	4,135.2	0.0	1,746.5	91.9	1,838.4	55.5
Childrey Creek	Not listed	390.2	0.0	201.3	10.6	211.9	45.7
Catawba Creek	Not listed	168.8	0.0	94.8	5.0	99.8	40.9
Turnip Creek	Not listed	376.2	0.0	272.6	14.3	286.9	23.7
Hunting Creek	Not listed	86.6	0.0	65.2	3.4	68.6	20.7
Cub Creek	L19R-01-PCB	1,376.7	0.0	997.4	52.5	1,049.9	23.7
Black Walnut Creek	Not listed	181.9	0.8	46.5	2.5	49.7	72.7
Roanoke Creek	Not listed	2,446.8	0.0	1,429.6	75.2	1,504.8	38.5
Difficult Creek	Not listed	823.2	0.0	462.1	24.3	486.5	40.9
Roanoke River	L19R-01-PCB	239,207.9	1,931.8	11,961.7	731.2	14,624.8	93.9
<b>Lower Total</b>		<b>596,841.9</b>	<b>1,934.3</b>	<b>23,287.0</b>	<b>1,327.4</b>	<b>26,548.8</b>	<b>95.6</b>

Table ES-3. Average annual tPCBs TMDLs for Roanoke River source categories

Source Category	Baseline (mg/yr)	WLA (mg/yr)	LA (mg/yr)	% Reduction <sup>a</sup>
<b>Upper Roanoke River</b>				
VPDES Dischargers	17,665.8	28,267.1		-60.0
Individual Industrial/General Permits	6,827.4	5.3		99.9
MS4	109,622.4	332.7		99.7
Contaminated Sites	7,853.5		1.0	100.0
Urban background (unknown sites)	12,082.4		114.4	99.1
Atmospheric Deposition	8,862.5		8,419.4	5.0
<b>Total</b>	<b>162,914.1</b>	<b>28,605.0</b>	<b>8,534.8</b>	<b>77.2</b>
<b>Lower Roanoke (Staunton) River</b>				
VPDES Dischargers	78,305.9	1,926.7		97.5

Source Category	Baseline (mg/yr)	WLA (mg/yr)	LA (mg/yr)	% Reduction <sup>a</sup>
Individual Industrial/General Permits	388,012.2	7.5		100.0
MS4	11.7	0.1		99.3
Contaminated Sites	83,901.8		1.2	100.0
Urban background (unknown sites)	22,244.9		138.7	99.4
Atmospheric Deposition	24,365.4		23,147.2	5.0
<b>Total</b>	<b>596,841.9</b>	<b>1,934.3</b>	<b>23,287.0</b>	<b>95.8</b>

a. WLA and LA percent reductions differ from TMDL percent reductions because they do not include an MOS load