FINAL REPORT

TMDL Development for Flat Fork Creek Watershed, West Virginia

U.S. Environmental Protection Agency
Region 3
1650 Arch Street
Philadelphia, PA

September 2001

Table of Contents

List of Figures

List of Tables

1.0 Problem Understanding

Section 303(d) of the Clean Water Act requires states to develop Total Maximum Daily Loads (TMDLs) for waters that do not meet water quality standards. The objective of the Flat Fork Creek PCB TMDL is to achieve water quality standards for polychlorinated biphenyls (PCBs) in the waterbody. The TMDL development process quantitatively assesses the impairment factors so that states can establish water quality-based controls to reduce pollution from both point and nonpoint sources and to restore and protect the quality of their water resources. As a result of the settlement of the TMDL lawsuit in West Virginia, the U.S. Environmental Protection Agency (EPA) will be complete TMDLs for the waters included on West Virginia's 1998 303(d) list of waters.

1.1 Background Information

The West Virginia Department of Environmental Protection (WVDEP) has listed Flat Fork Creek on the state's section 303(d) list because PCBs were found in fish tissue samples (Table 1-1), resulting in a fish consumption advisory (issued by WVDEP) and nonsupport of the designated uses set by the state for the waterbody: propagation of fish and other aquatic life and contact recreation (46 CSR 1).

The Flat Fork Creek watershed is part of the Lower Kanawha basin (HUC 05050008) in the southeastern part of West Virginia (Figure 1-1). Flat Fork Creek is a tributary of the Pocatalico River, and the impaired segment is 5.0 miles long. The watershed encompasses 30.51 square miles (19,528 acres) of land that occupies portions of Roane County. The city of Charleston, West Virginia, is approximately 25 miles to the south-southwest of the watershed. The major land use in the Flat Fork Creek watershed is forest, the rest of the watershed is primarily agricultural.

The stream segment in the Flat Fork Creek watershed that is impaired due to PCBs is influenced by the Spencer Transformer industrial site, which is a Superfund site for which cleanup and remedial actions were conducted from 1991 to 1994 because of PCB contamination onsite.

Table 1-1. Summary of West Virginia 1998 303(d) stream listing

Stream Name	Stream Code	Miles Affected	Potential Source(s)	Pollutant(s) of Concern
Flat Fork Creek	KP-33	5.0	Spencer Transformer Harmony, WV	PCBs*

* Contaminant found in fish tissue.

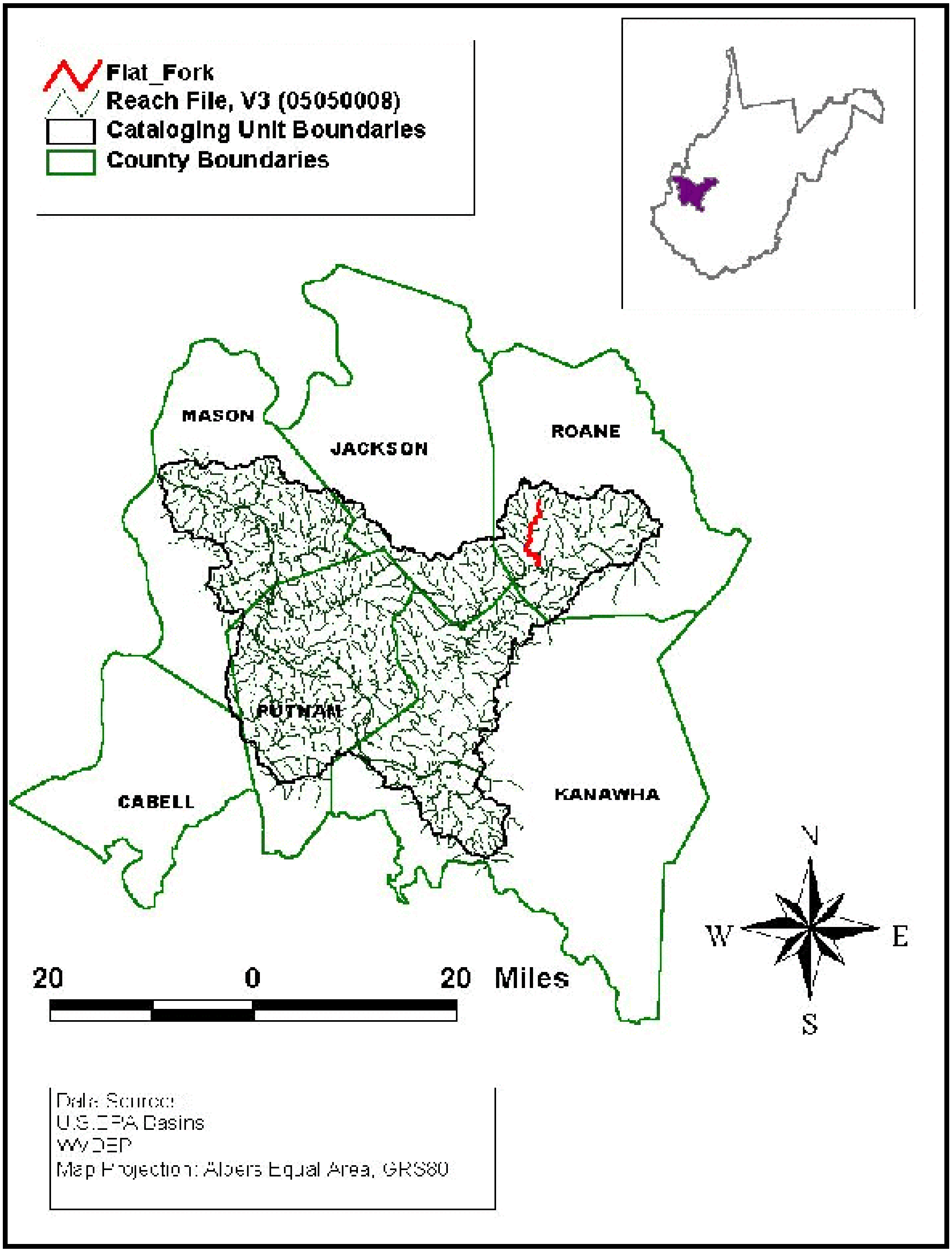

Figure 1-1. Location of Flat Fork Creek in the 8-digit Hydrologic Unit (05050008)

1.2 Polychlroninated Biphenyls (PCBs)

Polychlorinated biphenyls (PCBs) consist of 209 related chemical compounds that were manufactured and sold as mixtures under various trade names, including Aroclor, Phenoclor, Clophen, and Kenechlor (GE, 1999). They were used from approximately the 1940s through the 1970s. Because they have excellent dielectric and flame-resistant properties, PCBs were extensively used as heat transfer fluids, hydraulic fluids, flame retardants, and dielectric fluids. These same properties cause PCBs to accumulate in the fatty tissue of biota and bioaccumulate in the food chain. Concerns regarding potential human health effects led to the cessation of PCB production and use in the United States in 1979.

Each of the 209 possible PCB compounds (called congeners) consists of two phenyl groups and chlorine atoms (chlorination). Individual PCB congeners differ in the number and position of the chlorine atoms. Aroclor is one of the trade names under which PCBs were manufactured and sold in the United States (GE, 1999), and several Aroclor products were manufactured. The five principal compounds were Aroclor 1221, 1242, 1016, 1254, and 1260. These products differed in their degree of chlorination.

1.3 Water Quality Standards

West Virginia's *Requirements Governing Water Quality Standards* (WVWQS, 1999) have defined water quality criteria for surface waters as a numeric constituent concentration or a narrative statement representing a quality of water that supports a designated use or uses of the waterbody. PCBs are given numeric criteria under the aquatic life and the human health use designation categories (Table 1-2).

Table 1-2. Applicable West Virginia water quality criteria for total PCBs

POLLUTANT	USE DESIGNATION						
	Aquatic Life				Human Health		All Other Uses
	B1, B4		B2		C [c]	A [d]	
	Acute[a]	Chronic[b]	Acute[a]	Chronic[b]			
PCB[e], Total (ng/L)	-	14.0	-	14.0	0.045	0.044	0.045

B1 = warm water fishery streams, B4 = wetlands, B2 = trout waters, A = public water supply

[a] One-hour average concentration not to be exceeded more than once every 3 years on the average.

[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.

[c] Unless otherwise noted, these criteria have been calculated to protect human health from toxic effects through fish consumption.

[d] Unless otherwise noted, these criteria have been calculated to protect human health from toxic effects through drinking water and fish consumption.

[e] Known or suspected carcinogen. Human health standards are for a risk level of 10^{-6}.

Source: WVWQS, 2000.

The state has both fish tissue and water column human health criteria for PCBs. West Virginia's human health water column standards are based on a $1:10^6$ risk assessment. The human health-based water quality standard of 0.044 ng/L is for total PCBs. Both the U. S. Food and Drug Administration (FDA) and the state of West Virginia have established fish consumption advisories. The FDA advisory level was formulated to reduce the cancer, reproductive, and developmental risks to the general population from exposure to PCBs through fish consumption. Recognizing that a subpopulation, recreational fishermen, was underprotected, West Virginia moved from the FDA advisory level to risk-based consumption advisories in July 2001. The FDA advisory level is 2.0 mg of PCBs/kg of raw fish tissue while the West Virginia advisory level is 0.036 mg of PCBs/kg of raw skin-off fish fillet (catfish) and 0.05 mg of PCBs/kg of raw fish fillet with skin (such as bass and bream) for Risk Group 1. No sediment criteria have been identified. Table 1-3 defines West Virginia's risk groups and the associated fish tissue concentrations for PCBs.

Table 1-3: Risk-based fish consumption advisory groups

Risk-based PCB Fish Consumption Advisory Groups	Assumed Consumption Weight of Raw Fish per day (grams)	PCB Concentration in Raw Fish Fillet (mg/kg)	
		Skin-on Fillet (e.g. Bass)	Skin-off Fillet (e.g. Catfish)
Group 1- Unrestricted	140 g/day	<0.05	<0.036
Group 2- Up to 1 meal / week	32 g/day	0.5 to 0.22	0.036 to 0.16
Group 3- Up to1 meal / month	7.4 g/day	0.22 to 0.95	0.16 to 0.68
Group 4- Up to 6 meals / year	3.7 g/day	0.95 to 1.98	0.68 to 1.35
Group 5- Do not eat	none	> 1.89	>1.35

Source: West Virginia Department of Environmental Protection.

Table 1-4 summarizes the mass conversion factors.

Table 1-4: Mass conversion table.

Unit	Gram (g)	Milligram (mg)	Microgram (µg)	Nanogram (ng)	Picogram (pg)
Gram (g)	1	1.00E+03	1.00E+06	1.00E+09	1.00E+12
Milligram (mg)	1.00E-03	1	1.00E+03	1.00E+06	1.00E+09
Microgram (µg)	1.00E-06	1.00E-03	1	1.00E+03	1.00E+06
Nanogram (ng)	1.00E-09	1.00E-06	1.00E-03	1	1.00E+03
Picogram (pg)	1.00E-12	1.00E-09	1.00E-06	1.00E-03	1

The fish tissue levels can be compared to the water column standards using an EPA bioconcentration factor (BCF). The transfer of PCBs through the food web can be described as a bioconcentration factor or BCF. The BCF is a ratio of the contaminant concentration in the species of interest to the concentration in the exposure source. In this case, it describes the accumulation of PCBs in fish tissue from the water column. The BCF is often used as a screening level description of bioaccumulation for all aquatic biota. The BCF for PCBs is 31,200 L/kg (EPA 440/5-80-068) and represents the accumulation rate of PCBs in fish tissues.

The conversion equation is:

$$\text{Tissue level} = \text{water concentration} * \text{BCF} * \text{unit conversions} \qquad (1\text{-}1)$$

Table 1-5 summarizes the advisory criteria and water quality criteria and provides a direct comparison between tissue and water column levels. To meet the water quality criteria in all the impaired sections of the Flat Fork Creek, the water column concentration of 0.044 ng/L must be met. This concentration has therefore been identified as the TMDL endpoint.

Table 1-5: Water Quality Criteria for Total PCBs

Media	Agency	Tissue Level (mg/kg)	Tissue Level (µg/kg)	Water Level (ng/L)
Fish	FDA[c]	**2.0**[a]	2000	64.1
Fish	WV	**0.0354**[ab]	35.4	1.134
Water	WV	0.0014	1.4	**0.044**[a]

[a] Water quality standards. All others are calculations.

[b]Action level of WV's Risk Group 1 for fillet without skin which is the most conservative of all five groups.

Source: WVDEP, 1998.

2.0 Data Assessment and Analysis

This section examines and identifies the potential sources of PCBs in the Flat Fork Creek watershed. A wide range of data were used to identify potential sources and to characterize the relationship between point and nonpoint source discharges and in-stream response at monitoring stations.

2.1 Data Inventory and Review

A wide range of data and information were reviewed for potential use in the development of TMDL for the Flat Fork Creek watershed. The categories of data used include physiographic data, which describe the physical conditions of the watershed, and environmental monitoring data, which identify potential pollutant sources and their contribution and include in-stream water quality monitoring data. Table 2-1 shows the various data types and data sources reviewed.

Table 2-1. Inventory of data for the Flat Fork watershed

Data Category	Description	Data Source(s)
Watershed Physiographic Data	Land Use (GAP[a] 2000)	USGS
	Stream Reach Coverage	USGS, WVDNR
	Weather Information	National Climatic Data Center
Environmental Monitoring Data	NPDES Data	WVDEP OMR, EPA PCS
	Discharge Monitoring Report Data	WVDEP
	303(d) Listed Water	WVDEP
	Hazardous Waste Site Data	EPA Superfund
	Water Quality Monitoring Data	EPA STORET, WVDEP

[a] Gap Analysis Program (GAP) land use developed by USGS Biological Resources for assessing regional conservation status of vertebrate species and land cover types.

2.2 Water Quality Data

The inclusion of the listed segments on the West Virginia 303(d) list is based on WVDEP monitoring data. In-stream water quality data from EPA's STORET database were analyzed to characterize potential sources of PCBs within the entire Flat Fork Creek watershed.

Table 2-2 lists the water quality stations in close proximity to Flat Fork Creek. No PCB data were available for these stations. These water quality stations are primarily monitoring pH, metals, and some organic chemicals.

Table 2-2. Water quality stations in the Flat Fork Creek watershed

Station ID	Type	Location	Longitude	Latitude
550572	Ambient/Stream	Flat Fork below Harmony, WV	-81.47889	38.68473
383832081282339	Ambient/Stream	U04.Flat Fk@ HWY 32BR @ Ryan, WV	-81.47306	38.64223
KP-32-.5A	Ambient/Stream	Sugar Camp Hollow near Cicerone, WV	-81.49934	38.63603
KP-33-{0.1}	Ambient/Stream	Flat Fork near Ryan, WV	-81.47373	38.63084
KP-33-{5.8}	Ambient/Stream	Flat Fork near Harmony, WV	-81.48253	38.67042
KP-33-D-{0.8}	Ambient/Stream	Coon Run near Harmony, WV	-81.49587	38.69264
KP-33-G	Ambient/Stream	Cabbage Fork near Gandeeville, WV	-81.44623	38.70984

Source: EPA's STORET.

The Spencer Transformer Superfund site personnel monitored aqueous and sediment samples were monitored during the cleanup process. Few aqueous samples have been sampled for PCBs with results below the detection level of 0.05 ug/L. One sample collected in April 1990 (Table 2-3) was recorded as 0.06 ug/L. This PCB value exceeds the West Virginia water quality criterion of 0.044 ng/L. The majority of sediment samples were collected in June 1990 at several points near the Spencer Transformer site, and PCB concentrations ranged from 0.02 to 0.42 ppm (Table 2-4). The extent of analysis on the PCB samples is limited because of the low number of samples available.

Table 2-3. Aqueous samples from Flat Fork Creek

Date	No. of Samples	Total PCBs	Comments
10/31/91	7	Non-detected	
April, 90	3	Non-detected	Detection level 0.05 ug/L
April, 90	1	0.06 ug/L	Detection level 0.05 ug/L

Source: Spencer Transformer.

Table 2-4. Sediment data for Flat Fork Creek

Date	Location	Total PCBs (ppm)
06/90	Spencer Transformer-CS1	0.05
06/90	Spencer Transformer-CS2	0.04
06/90	Spencer Transformer-CS3	0.02
06/90	Spencer Transformer-CS4	0.34
06/90	Spencer Transformer-CS5	0.05
06/90	Spencer Transformer-CS6	0.02
06/90	Spencer Transformer-CS7	0.26
04/90	Spencer Transformer	0.30
06/90	Spencer Transformer (collected 7 samples)	0.02-0.34
04/90	Spencer Transformer	0.312
09/83	Spencer Transformer	0.42

Source: Spencer Transformer.

WVDEP collected fish tissue samples in 1990, 1993, and 1999. A total of 12 composite samples were collected; each consisting of composites of four to six individual fish. Eight percent of the samples were found to exceed the FDA criterion of 2.0 ppm (mg/kg) for PCBs (Table 2-5). All exceedances were observed during the 1990 monitoring event. No samples exceeded the FDA criterion in either the 1993 or 1999 monitoring event. Although the FDA advisory level is 2.0 mg of PCBs/kg of raw fish tissue, the 2001 West Virginia advisory level is 0.036 mg of PCBs/kg of raw skin-off fish fillet (catfish) and 0.05 mg of PCBs/kg of raw fish fillet with skin such as bass and bream. Table 2-5 shows whether the samples exceeded the FDA criterion as well as West Virginia's five advisory risk groups.

Soil data were obtained from Superfund records. The soil data were analyzed to determine whether the soils at the Spencer Transformer site are a major component of the PCB pollution in the Flat Fork Creek. Table 2-6 summarizes some of the analytical results for PCB concentrations taken in several locations within the Spencer Transformer site. Most of the problems appear to be in the early 1990's. Sample site ST-10, shows the highest concentration of 5,200 mg/kg which is near an old storage area of transformers. Mot of the soil samples have significant levels of PCBs.

Table 2-5. Fish tissue data for Flat Fork Creek

Date	Location	No. of Fish	Total PCBs (ppm)	FDA Exceedances[a]	2001 WV Criteria Exceedances[b]				
					G1	G2	G3	G4	G5
6/22/99	Roane County	6	0.00	NO	NO	NO	NO	NO	NO
6/22/99	Roane County	6	0.06	NO	YES	NO	NO	NO	NO
10/29/93	Below Pigeon Roost Run	4	1.87	NO	YES	YES	YES	YES	NO
10/29/93	Below Pigeon Roost Run	4	0.69	NO	YES	YES	YES	NO	NO
10/29/93	Above Trace Fork	4	0.04	NO	YES	NO	NO	NO	NO
10/29/93	Above Trace Fork	5	0.11	NO	YES	NO	NO	NO	NO
9/13/90	Mouth of Cabbage Creek	5	0.18	NO	YES	YES	NO	NO	NO
9/13/90	Mouth of Trace Fork	4	0.03	NO	NO	NO	NO	NO	NO
9/13/90	Mouth of Trace Fork	5	0.13	NO	YES	NO	NO	NO	NO
9/13/90	300 yards Below Pigeon Roost Run	5	4.00	YES	YES	YES	YES	YES	NO
9/13/90	300 yards Below Pigeon Roost Run	4	1.10	NO	YES	YES	YES	NO	NO
9/13/90	Mouth of Cabbage Creek	5	0.46	NO	YES	YES	NO	NO	NO

[a] Based on FDA criterion for PCBs of 2.0 ppm.
[b] Based on West Virginia criteria (adopted July, 2001) for PCBs. Advisory Risk Groups assumed tissue is fillet without skin.
Source: WVDEP.

Soil data was obtained from Superfund records. The soil data was analyzed to determine whether the soils at the Spencer Transformer site are a major component of the PCB pollution in the Flat Fork Creek. Table 2-6 summarizes some of the analytical results for PCB concentrations taken in several locations within the Spencer Transformer site. Most of the problems appear to be in the early 1990's. Sample site ST-10 shows the highest concentration of 5,200 mg/kg which near an old storage area of transformers. The majority of soil samples have significant levels of PCBs.

Table 2-6. Soil data for Spencer Transformer Site

Date	Location	Total PCBs (mg/kg)
06/90	Spencer Transformer-ST-10	5,200
06/90	Spencer Transformer-S-1	120
06/90	Spencer Transformer-S-2	12
06/90	Spencer Transformer-S-3	ND
06/90	Spencer Transformer-S-4	29
06/90	Spencer Transformer-S-6	8.6
06/90	Spencer Transformer-S-7	0.02
06/90	Spencer Transformer-S-8	25
06/90	Spencer Transformer-S-9	4.9
06/90	Spencer Transformer-S-10	1.3
06/90	Spencer Transformer-S-11	0.86
06/90	Spencer Transformer-S-12	1.0
06/90	Spencer Transformer-S-13	0.02
06/90	Spencer Transforme -CB-1	4.6
06/90	Spencer Transformer-CB-2	0.10
06/90	Spencer Transformer-CB-3	0.10
06/90	Spencer Transformer-CB-4	0.19
06/90	Spencer Transformer-CB-5	0.14
06/90	Spencer Transformer-CB-6	0.25

N.D.= not-detected
Source: Spencer Transformer.

2.3 Flow Data

No USGS gauge stations were identified in Flat Fork Creek. Two gauge stations were found in the Pocatalico River and one in Johnson Creek, which are located in adjacent watersheds to the Flat Fork Creek watershed. Table 2-7 lists the three gauge stations and their respective coordinates.

Table 2-7: USGS gauge stations near Flat Fork Creek

Station ID	Latitude	Longitude	Stream Name	Drainage Area (mi^2)	Period of Record
USGS03200800	38.6317	-81.3928	McKown Creek at Walton	N.A.	N.A.
USGS03154200	38.6250	-81.3536	Spring Creek at Spencer	N.A.	N.A.
USGS03201000	38.5297	-81.6297	Pocatalico River at Sissonville, WV	238	10/1/96-9/30/97 12/1/97-8/20/98

N.A.= information not available. Source: USGS.

2.4 Land Use

The predominant land uses in the Flat Fork River watershed were identified based on the West Virginia GAP 2000 Database (Table 2-8). Figure 2-1 illustrates the Flat Fork Creek land use distribution. According to the GAP 2000 land use data, the major land uses in the Flat Fork Creek watershed are forest (69 percent) and pasture (25 percent).

Table 2-8: Landuse distribution in the Flat Fork Creek watershed

Landuse Type	Area (mi^2)	Percentage (%)
Scrubland	0.142	0.47
Woodland	1.445	4.73
Water	0.005	0.02
Low Intensity Urban	0.018	0.06
Moderate Urban	0.008	0.03
Intensive Urban	0.019	0.06
Row Crop	0.003	0.01
Pasture/grassland	7.769	25.46
Barren	0.060	0.20
Flood Plain Forest	0.413	1.35
Surface Water Combined	0.009	0.03
Cove Hardwood	0.003	0.01
Mesophilic	15.686	51.41
Conifer Hardwood	0.116	0.38
Oak Forest	4.818	15.79
Total	**30.51**	**100**

Source: GAP 2000.

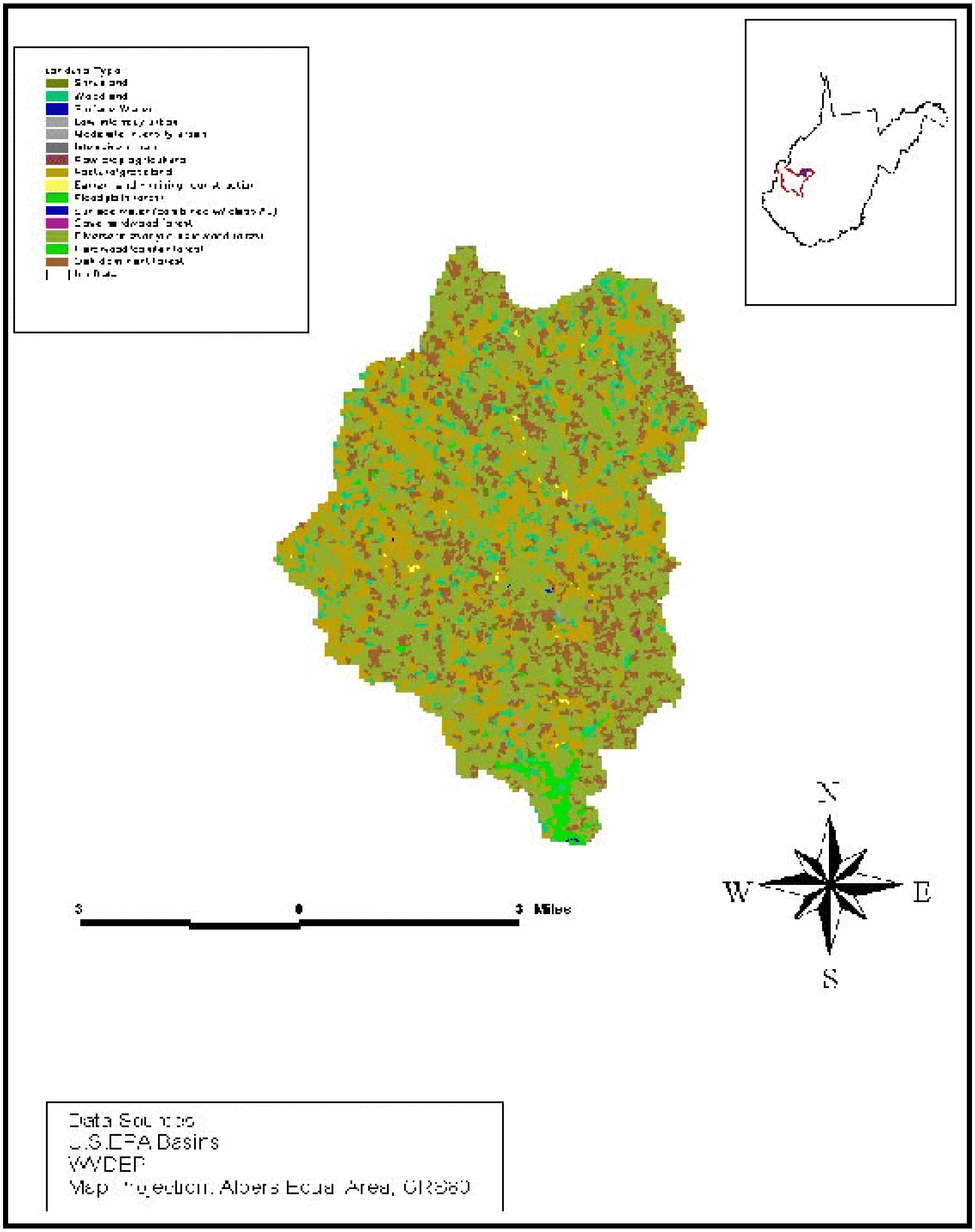

Figure 2-1. Landuse distribution for Flat Fork Creek watershed

3.0 Source Assessment

3.1 Point Sources

Point sources represent permitted discharges at discrete locations in the Flat Fork Creek watershed. Potential point sources include facilities permitted to discharge PCBs (i.e., industrial and municipal facilities). EPA's Permit Compliance System (PCS) database was used to identify historical and active permitted discharges within the Flat Fork Creek watershed. No facilities were found to discharge to the Flat Fork Creek; therefore no point sources contribute PCBs.

3.2 Nonpoint Sources

In addition to point sources, nonpoint sources might contribute to water quality impairments in the Flat Fork Creek watershed. Nonpoint sources represent contributions from diffuse, nonpermitted sources. Potential nonpoint sources are runoff from urban land (industrial, commercial, other), contributions from landfills, and contributions from hazardous waste site deposition. Several data sources were investigated. The review of databases associated with the Toxic Substance Control Act (TSCA), which controls hazardous waste materials and the Resource Conservation and Recovery Act (RCRA), which oversees hazardous waste sites and solid waste sites, resulted in no facilities found within the Flat Fork Creek watershed. However, review of Superfund sites, under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) found one site was listed for PCB contamination. The site was the Spencer Transformer facility. Detailed information about this site is described below.

3.2.1 Hazardous Waste Site- Spencer Transformer

The Spencer Transformer site is located in the rural area of Roane County, West Virginia, about 2 miles west of Gandeeville, West Virginia. The site is situated at the confluence of tributaries of Flat Fork Creek and is bordered on the east by Roane County Road 13, and on the south by the confluence of two additional tributaries of Flat Fork Creek. It covers around 17 acres, 7 of which are wooded uplands (WV DWR).

B.F. Hopkins has owned the Spencer Transformer site since 1978. The site was operated by STE along with W.C. Hopkins, and the Electric Motor Service Company, as an electric equipment salvage yard for recovering and reselling parts and materials from electric motors and other electric equipment. Hopkins began operations at the site as early as 1973. The facility contained one main building, a transformer storage area, a cement pad where transformers were handled, at least two storage tanks containing PCB fluids, and an ash pile. According to W.C. Hopkins, transformers and other electrical equipment and materials were burned at the site of the ash pile.

Until at least 1978, transformers containing PCBs were salvaged at the site. In 1979 EPA, through the implementation of TSCA, began to regulate the handling, storage and disposal of PCB transformers. According to W.C. Hopkins, approximately 80 transformers and two tanks containing PCB fluids existed on the site at the time TSCA was enacted. Some of these transformers were rusted, had no tops, and were in generally poor condition. The total volume of PCB fluids stored at the site was estimated to have been in the range of 19,000 to 25,000 gallons.

In the early 1980s the Spencer Transformer site was initially investigated and brought to the attention of

EPA by the West Virginia Department of Natural Resources although the site is now regulated by WVDEP.

In May 1983 EPA inspected the site and documented several violations of TSCA. Samples were taken at the site, and the analyses revealed PCB concentrations in excess of TSCA regulatory and cleanup levels in soils, equipments and oils on the site.

In June 1990 EPA conducted a site assessment and identified several PCB containing transformers and transformer handling areas. Analyses of the June samples showed PCB contaminated soils in excess of TSCA cleanup levels.

In September 1990 WVDNR sampled fish tissues in Flat Fork Creek near the site. The analyses showed the presence of PCBs in fish tissues caught upstream, downstream and adjacent to the site. WVDNR issued a health advisory on fish for the Flat Fork Creek in February 1991.

From 1991 to 1994 the Spencer Transformer site was under Superfund activities for removal and cleanup processes.

4.0 TMDL Development

The overall goal of the Federal Clean Water Act is to have all waters "fishable/swimmable". Because consumption advisories are in place, the fishable/swimmable goal is not being met in the Flat Fork Creek and a TMDL is needed (segment KP-33).

The specific goal of a TMDL is to outline a plan to achieve water quality criteria in the waterbody. For Flat Fork Creek, the TMDL target is for the level of PCBs in the water column to be equal to or less than the West Virginia water quality criteria of 0.044 ng/L. PCBs are probable carcinogens, and the West Virginia criteria are human health criteria developed to protect against excess cancer risk. Specifically, the water quality toxics management program controls carcinogens to an overall risk management level of one expected case of cancer in a population of 1 million (1×10^{-6}), or the probability of an individual's developing cancer is increased by a factor of 1 in 1 million.

The fish tissue concentrations reported by the WVDEP (Figure 4-1) imply a decreasing trend for the total average PCB concentration in the Flat Fork Creek, although continued monitoring is needed to verify the trend. This implied decreasing trend supports the assumption that no active sources are present in the Flat Fork Creek watershed. It is possible that the PCBs in fish are due to the presence of contaminated sediments in Flat Fork Creek.

PCBs are hydrophobic (resist mixing in the water) and sorb onto the soils in streambanks and onto the sediments downstream of the discharge point. Streambank erosion deposits the contaminated soils in the streambed. Contaminated streambed sediments are available for consumption by the aquatic biota (through dissolved particles and/or resuspended particles) or are transported downstream. The transport can result in the sediment's being flushed out of the system or being trapped behind downstream dams. Existing PCBs projects for the Hudson River (GE, 1999) in New York and the Housatonic River in Massachusetts have found that historical discharges have resulted in sediment contamination and that the contaminated soils collect in slow river stretches or reservoirs. The contaminated soils remain there until dredged or dislodged by storms.

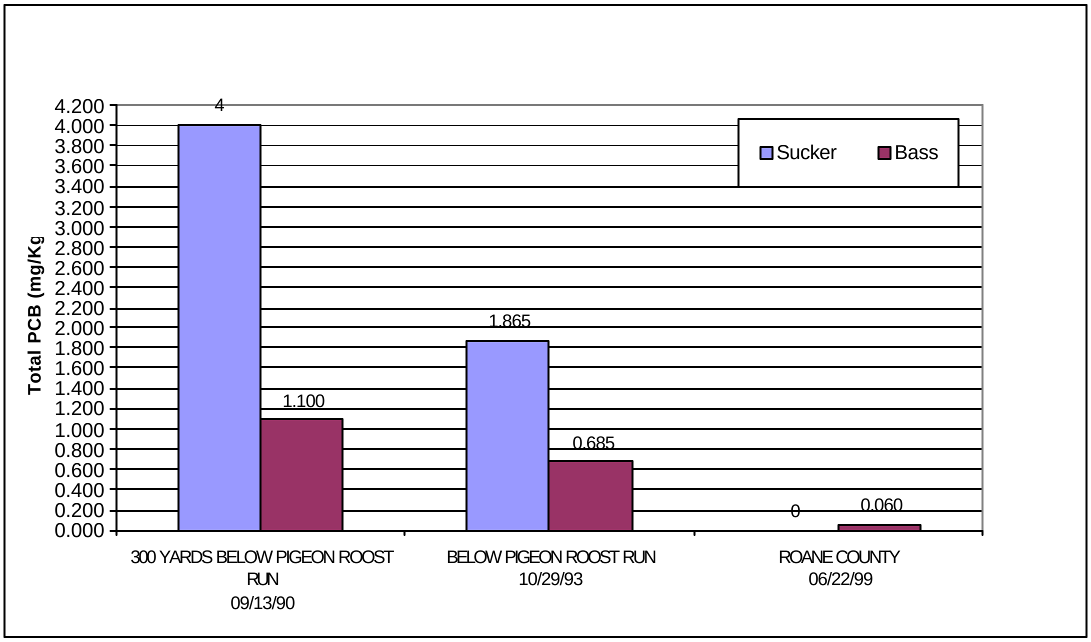

Figure 4-1. Average Fish Tissue Down Gradient Concentration Profile in Flat Fork Creek.

4.1. TMDL Approach

A bioaccumulation mass balance approach was taken to determine source load allocations for Flat Fork Creek, because of no known active PCBs sources. PCBs within Flat Fork are assumed to be contained within the sediment portion of the stream.

The water quality criterion of 0.044 ng/L was used to back-calculate an allowable load, which is attributed to sediments. For comparative purposes, the existing (current) in-stream PCB concentration was estimated based on a bioaccumulation approach. This approach used existing fish tissue concentration observations and a bioaccumulation factor to represent the transfer of PCBs from water to the food web (GE, 1999).

4.1.1. Analytical Considerations

Considerations and assumptions used to support TMDL development include the following:

- The natural in-stream background concentration of PCBs is assumed to be negligible (no active sources).

- The 7Q10 flow is used as the critical design condition for calculation of the TMDL.
- An explicit 10 percent margin of safety is applied to account for uncertainty in the analysis.
- Spencer Transformer is the only known historical source of PCB contamination in Flat Fork Creek and is assumed to be fully remediated with no further contribution of PCB contamination.

4.1.2. Background Condition

Nonpoint source contributions of PCBs to Flat Fork Creek might include runoff from contaminated locations, atmospheric deposition, and historically contaminated sediment within the stream or along the stream. Natural and background conditions are considered negligible, so they were omitted as contributing sources. The in-stream water column background concentration of PCBs is assumed equal to zero.

4.1.3. Existing Condition

The lack of recent in-stream PCB concentration observations prevents a direct comparison to the water quality criterion. To make a relative comparison between existing conditions and the criteria, a bioaccumulation approach was applied. The fish tissue levels are compared to the water column criteria using an EPA Bioconcentration Factor (BCF). The BCF for PCBs is 31,200 L/kg (EPA 440/5-80-068) and represents the accumulation rate of PCBs in fish tissues. This approach is simplistic because it does not include sediment transfer, but it is applicable for relative comparison purposes when data are sparse.

The conversion equation is:

Tissue Level = Water concentration * BCF * unit conversions (4-1)

The most recent bass tissue concentration was used to predict the existing in-stream condition using the average concentration of 0.06 mg/kg found in bass tissue (1999) equation 4-1 gives a predicted in-stream PCB concentration of 1.923 ng/L. Table 4-1 shows that the state in-stream water quality standard of 0.044 ng/L total PCBs is more stringent than the predicted in-stream total PCB concentrations that equate to the tissue concentrations identified for the five risk-based PCB fish consumption advisory groups.

Table 4-1: Predicted In-stream Total PCB Concentrations that Equate to the Tissue Concentrations Identified for the Five Risk-based PCB Fish Consumption Advisory Groups

Risk- Based PCB Fish Consumption Advisory Groups	With Skin (Bass)		Without Skin (Catfish)	
	Fillet Conc. (mg/kg)	Water Conc. (ng/L)	Fillet Conc. (mg/kg)	Water Conc. (ng/L)
Group 1- Unrestricted	<0.05	<1.602	<0.036	<1.134
Group 2- Up to 1 meal / week	0.5 to 0.22	<7.051	0.036 to 0.16	<5.128
Group 3- Up to1 meal / month	0.22 to 0.95	<30.448	0.16 to 0.68	<21.794
Group 4- Up to 6 meals / year	0.95 to 1.98	<63.461	0.68 to 1.35	<43.269
Group 5- Do not eat	> 1.98	>63.461	>1.35	>43.269

Source: West Virginia Office of Environmental Health Services, 2001.

4.1.4. TMDL Loading Capacity

The calculation of the Flat Fork Creek TMDL used the water quality criteria and flow data. Because there is no flow gauge station on the Flat Fork Creek, an area weighted approach was used (based on the USGS station located downstream of the Flat Fork Creek, USGS 03201000). The 7Q10 flow for Flat Fork Creek is used in calculating the TMDL by multiplying it by the water quality criteria and a multiplier to convert from (cfs x µg/L) to(lb/day). This load represents the Total Maximum Daily Load of PCBs in the Flat Fork Creek.

TMDL = WQ(std) * 7Q10*0.00539 **(4-2)**

TMDL = 0.000044 (µg/L) *0.01 (cfs)*0.00539

TMDL = 2.0 $x10^{-9}$ lbs/day or 8.65$x10^{-7}$ lbs/yr

4.1.5. Load Allocations (LAs)

The load allocation is the amount of pollutant that reaches the waterbody through nonpoint source contributions as well as any natural background in the waterbody itself. The natural background is assumed to be negligible. However, PCBs were introduced to Flat Fork Creek through runoff from the Spencer Transformer facility and have contaminated the stream sediments. Therefore, the load allocation represents contributions from the streambed sediments due to resuspension and streambank erosion. Currently, there are no other known nonpoint sources of PCBs in the basin.

4.1.6. Waste Load Allocations (WLAs)

No facilities actively contributing PCBs (point sources) were identified in the Flat Fork Creek watershed.

4.1.7. Margin of Safety

The margin of safety is intended to add a level of conservation to the analytical process to account for any uncertainty. Margin of safety may be implicit, built into the modeling process, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL. A ten percent margin of safety was applied to account for uncertainty in this TMDL.

4.1.8. TMDL Allocations

To achieve the West Virginia water quality criteria, the contributing PCB load needs to be adjusted. Currently, there are no known direct discharges of PCBs (waste loads are equal to zero), and no known nonpoint source contributions in the Flat Fork. The PCB contamination of the Flat Fork is attributed to historical contributions from the Spencer Transformer site, resulting in accumulation of PCBs in the sediment particulate matter. Based on the above conditions, the allocation of the allowable PCB loading to Flat Fork Creek was attributed to the in-stream sediment (Table 4-2).

Table 4-2. TMDL summary

Pollutant	TMDL (lb/yr)	WLA (lb/yr)	LA (lb/yr)	MOS (lb/yr)
Total PCBs	$8.65x10^{-7}$	0	$7.79x10^{-7}$	$8.65x10^{-8}$

4.1.9. Seasonal Variations

Seasonal variations involve changes in stream flow as a result of hydrophobic and climatological patterns. In the continental United States, seasonally high flow normally occurs during the winter and early spring; seasonally low flow typically occurs during the summer and early fall. West Virginia uses 7Q10 flow (the lowest seven day average flow with a recurrence interval of ten years) as the design stream flow for permitting purposes. This low flow represents the minimum in-stream load (assimilative) capacity of Flat Fork Creek. Due to the lack of monitoring data, no relationship between flow and PCB water column concentration could be ascertained. The 7Q10 flow was applied with the assumption that any greater flow would represent an increase in load capacity of the creek, thereby reducing the conservativeness of the TMDL.

5.0 Reasonable Assurances

The implied decreasing trend of fish tissue concentrations coupled with the only known source of PCBs having been rededicated supports reliance on natural attenuation as an appropriate action alternative to ensure that the TMDL is met and water quality standards are achieved. The natural attenuation involves allowing natural processes, such as burial and flushing of sediment during high-flow events, to decrease the in-stream sediment and thus the water column concentrations of PCBs. The alternative, mechanical or vacuum dredging, is not currently justified as a viable approach given the possible habitat destruction, resuspension of pollutants, and cost. To assess the progress made toward achieving the TMDL, monitoring of fish tissue should be continued. It is recommended that an increase in the frequency of monitoring will provide better feedback on achieving the TMDL goal.

5.1 Follow-up Monitoring

In 2000 West Virginia created an interagency Fish Consumption Advisory Technical Committee. Representative agencies are the Bureau for Public Health, the Division of Natural Resources, and WVDEP. One of the goals of the Committee is to establish a statewide fish monitoring program and to apply risk-based advisories to the resultant fish contaminant data. To achieve this goal, the Committee has applied for a fish tissue grant from USEPA headquarters. These monies will be used to monitor fish tissue statewide for mercury and PCBs.

Sampling efforts will place emphasis on localities of concern (such as Flat Fork Creek) and areas that receive significant fishing pressure. Preferably, fish samples will be targeted toward those species most frequently caught and consumed by anglers (e.g., bass, sauger, catfish). However, if these species cannot be captured during the sampling event, less desirable species (e.g., carp, suckers) may be used.

Sampling and analysis will be preformed by the West Virginia University/US Geological Survey Cooperative Fish and Wildlife Unit, under the direction of Patricia Mazik. Assuming a timely grant award, the project will begin in September 2001 and conclude in August 2003.

The Committee will evaluate the results of this monitoring effort. Advisories will be issued and/or revised based on the most recent reference dose/cancer slope factor values available in the West Virginia Sportfish Consumption Advisory Guide (West Virginia Office of Environmental Health Services, 2001).

References

Burns, N. M. and Rosa, F. 1980. "In Situ Measurement of the Settling Velocity of Organic Carbon Particles and 10 Species of Phytoplankton". *Limnol. Oceanogr*. 25:855-864

Chapra, S. C. 1997. *Surface Water-Quality Modeling*. McGraw Hill Publication.

Chawarzenbach. R.P., Gschwend, P.M., and Imboden, D. M. 1993. *Environmental Organic Chemistry*. John Wiley & Sons, Inc., New York, NY.

General Electric. 1999. *PCBs in the Upper Hudson River PCBs, Vol. 1 Historical Perspective and Model Overview*. Albany, NY.

Thomann, R. V. and Mueller, J. A. 1987. *Principles of Surface Water Quality Modeling and Control*. Harper International Edition

Thomann, R. V., and D. M. Di Toro, 1983. *Physico Chemical Model of Toxic Substances in the Great Lakes, J. Great Lakes Res*. 9(4):474-496

Toxic Substance Control Act. 1976. *SCA15 U.S.C. s/s 2601 et seq.*

U.S. Environmental Protection Agency. 2001. http://www.epa.gov/region5/defs/html/tsca.htm

U.S. Environmental Protection Agency. 2001. http://www.epa.gov/region5/defs/html/cercla.htm

U.S. Environmental Protection Agency. 2001. http://www.epa.gov/region5/defs/html/rcra.htm

U.S. Environmental Protection Agency .2000. *National Sediment Quality Survey*. Office of Water, Office of Science and Technology, Washington, D.C.

U.S. Environmental Protection Agency. 1995. *Technical Guidance Manual for Developing Total Maximum Daily Loads*. Office of Water. EPA 823-B-95-007.

U.S. Environmental Protection Agency 1980. *Ambient Water Quality Criteria for PCBs*. EPA 440/5-80-068

U.S. Environmental Protection Agency. Technical Guidance Manual for Perfoming Waste Load Allocations: Book II Streams and Rivers - Chapter 3 – Toxic Substances Impact. U.S.

Environmental Protection Agency, Office of Water, Regulations and Standards, Monitoring and Data Support Division, Washington, D.C. June 1984.

U.S.Geological Survey. 1995. *Distribution and Transport of PCBs and Associated Particulates in the Hayton Millpond, South Branch Manitowoc River, Wisconsin*. Report 99-4101.

West Virginia Department of Environmental Protection. 1998. *1998 303(d) List*. West Virginia Division of Environmental Protection.

West Virginia Division of Water Resources. 1984. *Preliminary Assessment Report*.

West Virginia Office of Environmental Health Services. 2001. *West Virginia Sportfish Consumption Advisory Guide.*

West Virginia Environmental Quality Board. 2000. *Requirements Governing Water Quality Standards*. 46CSRI Legislative Rule.

West Virginia. 1999. *Code of State Rules, Title 46: Legislative Rule Environmental Quality Board, Series 1, Requirements Governing Water Quality Standards*. West Virginia Secretary of State, Charleston, WV.

Weston. 1989. Storm Sewer Compliance Investigation Report, Avtex Fibers, Incorporate. Roy F. Weston Inc. West Chester, PA.

Wetzel, R. G. 1983. *Limnology*. 2d ed. Sunders, Philadelphia