**Decision Rationale**
**Total Maximum Daily Loads**
**Polychlorinated Biphenyls (PCBs) and Chlordane**
**West Branch Brandywine Creek**
**Chester County, Pennsylvania**

## I. Introduction

This document sets forth the Environmental Protection Agency's (EPA) rationale for approving the Total Maximum Daily Load (TMDL) for PCBs and chlordane in the West Branch Brandywine Creek in Chester County, Pennsylvania. The document was submitted by the Pennsylvania Department of Environmental Protection (PADEP) for final Agency review, by letter dated March 9, 2001 and received by EPA on March 9, 2001. Our rationale is based on the TMDL document and information contained in Appendicies to the document to determine if these TMDLs meet the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDLs are designed to implement applicable water quality standards.
2) The TMDLs includes a total allowable load as well as individual waste load allocations (WLA) and load allocations (LA).
3) The TMDLs consider the impacts of background pollutant contributions.
4) The TMDLs consider critical environmental conditions.
5) The TMDLs consider seasonal environmental variations.
6) The TMDLs include a margin of safety.
7) There is reasonable assurance that the TMDLs can be met.
8) The TMDLs have been subject to public participation.

## II. Summary

These TMDLs apply to the main stem of the West Branch Brandywine Creek (Stream Code 00085) from Business Route 30 in Coatesville to the confluence of Buck Run, approximately 5.7 miles downstream. The West Branch Brandywine was listed on Pennsylvania's 1996 Section 303(d) list as impaired by PCBs and chlordane from an undetermined source. The basis for the listing was a fish consumption advisory. This segment was included on the1996 Section 303(d) list in State Water Plan (SWP) 3-H as a low priority. It was also included on the 1998 Section 303(d) list in SWP 3-H (Segment ID 9912) as a high priority for TMDL development.

Anglers were first advised to limit consumption of American eels downstream from Coatesville on December 12, 1979 due to a PCB concentration of 2.37 ppm fish tissue concentration, even though that value did not exceed the 5.0 ppm FDA action level in effect at the time. A "Do Not Eat" advisory was issued by Pennsylvania on June 26, 1986 as part of a statewide release due to PCB at 2.6 ppm (above the revised 2.0 ppm FDA Action Level) and chlordane of 1.0 ppm. This advisory remained unchanged until the application of the Great Lakes protocol for the 1998 advisory. As a result of applying the Great Lakes protocol the advisory was changed to restrict consumption of eels to no more than one meal every 2 months (6 meals per year, Group 4) due to PCB. The most recent chlordane data show concentrations below the Action Level (0.217 ppm in 1994 and an estimated 0.110 ppm in 1995). Section 303(d) of the CWA and its implementing regulations, require a TMDL be developed for those waterbodies identified as impaired by the State where technology-based and other controls did not provide for attainment of water quality standards.

According to EPA regulations and guidance, TMDLs must include specific waste load allocations (WLA) to all significant point sources of a pollutant and load allocations (LA) to nonpoint sources. According to Federal regulations at 40 CFR §130.2(g), load allocations are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading. Table 1 below summarizes the elements of the TMDLs for PCB and chlordane developed by PADEP. Despite the fact that EPA believes that annual loads are an appropriate measure for these TMDLs, for the sake of consistency we are breaking the annual TMDL loads down into daily loads. The TMDL calls for a reduction of 99% for PCBs and 20% for chlordane below existing levels.

**Table 1 - Summary of PCB and Chlordane TMDLs for the West Branch Brandywine** Creek

| Pollutant | TMDL | WLA | LA | MOS |
|---|---|---|---|---|
| PCB | 0.0000231 lbs/day | 0 | 0.0000208 lbs/day | 0.00000231 lbs/day |
| Chlordane | 0.0002887 lbs/day | 0 | 0.000260 lbs/day | 0.0000289 lbs/day |

The TMDL is a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standards. The TMDL is a scientifically-based strategy which considers current and foreseeable conditions, the best available data, and accounts for uncertainty with the inclusion of a "margin of safety" value. Conditions, available data and the understanding of the natural processes can change more than anticipated by the margin of safety. The option is always available to refine the TMDL for re-submittal to EPA for approval. The unassessed waters protocol, a method of conducting biological assessments of Pennsylvania's waters, was developed in 1996 and began implementation in 1997. PADEP's goal is a statewide assessment of surface waters in Pennsylvania. After completion of the initial assessments, the long-range goal is to re-assess all waters on a five-year cycle. Therefore, while the TMDL should not be modified at the expense of achieving water quality standards expeditiously, the TMDL may be modified when warranted.

## III. Discussion of Regulatory Conditions

EPA finds that Pennsylvania has provided sufficient information to meet all of the eight basic requirements for establishing PCB and chlordane TMDLs for the West Branch Brandywine Creek. EPA therefore approves the TMDLs. EPA's rationale for approval is set forth according to the regulatory requirements listed below.

*1) The TMDLs are designed to implement the applicable water quality standards.*

A TMDL is required to assure that appropriate water quality standards are attained and maintained. Water Quality Standards include numeric criteria, narrative criteria and designated uses. Because consumption advisories are in place, the use designations are not being met in this segment of West Branch Brandywine Creek. In addition, translation of fish tissue data to water column concentrations can show if the numeric standard for chlordane and PCBs are being met. Pennsylvania's calculations estimate that water column concentrations exceed applicable numeric criteria for PCBs and chlordane.

A goal of a TMDL is to outline a plan to achieve water quality standards in the water body. For this segment of West Branch Brandywine Creek, the TMDL goal is for levels of PCB and chlordane in the water column to be reduced to levels equal to or less than the Commonwealth's water quality criteria. The human health criteria, found in the "Water Quality Toxics Management Strategy - Statement of Policy" (Chapter 16 of the Department's rules and regulations) are 0.00004 ug/L (micrograms per liter, equivalent to parts per billion) for PCB and 0.0005 ug/L for chlordane. Both of these compounds are probable human carcinogens, and these are human health criteria developed to protect against excess cancer risk. Specifically, PADEP's water quality toxics management program controls carcinogens to an overall risk management level of one excess case of cancer in a population of 1 million ($1 \times 10^{-6}$).

Pennsylvania's search for data shows that no in-stream (water column) data for PCB and chlordane exist for the segment of concern or any upstream segment. No water column data were found in EPA's Storage and Retrieval System (STORET) nor in State files.

In order to compare current conditions to the water quality criteria, Pennsylvania estimated water column concentrations based on existing fish tissue concentrations and bioconcentration factors. The calculation involved dividing the average fish tissue concentration by the bioconcentration factor to obtain a projected water column concentration. The equation used by Pennsylvania is:

$$\frac{TC}{BCF} = WC \times 1000$$

Where:

TC = Tissue Concentration in mg/kg (equivalent to mg/L)
BCF = EPA Bioconcentration Factor in L/kg (adjusted for a 15% lipid for eel from the 3% for other fish)
WC = Water Column Concentration (estimated) in mg/L
Multiply by 1000 to obtain ug/L

The average concentration was used for two main reasons: 1) the fish tissue samples are composites, and 2) use of an average value considers the natural variation in tissue burden found in wild fish populations.  The PCB bioconcentration factor (BCF) of 31,200 from the EPA criteria development document (EPA 440/5-80-068, October 1980) was used.  The chlordane BCF of 14,100 from the EPA criteria development document (EPA 440/5-80-027, October 1980) was also applied.  The BCFs were used because no Bioaccumulation Factors (BAFs) are available for statewide use.  The use of the BCFs is consistent with the provisions of Pennsylvania's water quality toxics management strategy were used to derive the water quality standard for PCBs, so this method is acceptable.

Based on Pennsylvania's calculations, in-stream concentrations were estimated; these are noted in Table 2, below.  As can be seen, the estimated in-stream concentrations greatly exceed the State's water quality standard for each pollutant.  However, Pennsylvania notes that while the actual concentrations in the water column are not known, they are likely to be lower than the calculated estimates.  The estimates still show a need for the development of a TMDL.

**Table 2 - PADEP Estimated In-Stream Concentrations**

| Pollutant | Column Concentration | Water Quality Standard |
|---|---|---|
| PCB | 0.0106 ug/l | 0.0005 ug/l |
| Chlordane | 0.00627 ug/l | 0.00004 ug/l |

PCB contamination was found in sediment at 6 ug/kg within the West Branch Brandywine Creek (USGS 1994).  PCB binds preferentially to the organic materials found in the sediment however, a portion will partition into the water column.

2) ***The TMDLs include a total allowable load as well as individual waste load allocations and load allocation***.

In order to determine the allocations for each pollutant, significant sources must be identified. Pennsylvania conducted a source assessment using various methods.  The EPA Permit Compliance System (PCS) database was searched for any major discharge permits containing PCB or chlordane as an effluent limitation but no known point sources were identified from this search.

Both PCB and chlordane have been banned for over 10 years (since 1979 for PCB and 1989 for chlordane).   However, contaminated soils and water sediments may still contribute to instream concentrations of the pollutants.  There are NPDES permitted discharges that also contribute PCBs to the environment.   In addition, Superfund sites may also provide a source for both chlordane and PCBs.  PCB is very resistant to breakdown and thus remains in river and lake sediments for many years.  Air deposition may also be a pathway for PCBs entering surface waters.

Pennsylvania conducted a search for potential sources of chlordane or PCB related to uncontrolled waste sites through the use of EPA's Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), a search of records within EPA's remedial and removal programs, and telephone interviews with representatives of PADEP's hazardous sites cleanup program. Other searches included USGS reports and data, and literature searches of scientific journals. This search of records indicated that PCB is present at two hazardous waste sites located near Coatesville: Luria Brothers Scrap Yard and Modena Yard. Although Pennsylvania identified them as separate sites, EPA's search of the site records indicate that these are actually the same site. No chlordane point or nonpoint sources in this study area were found.

**Modena Yard**

Records from Pennsylvania's Environmental Clean-Up Program (ECP) and EPA indicate that PCB is present at one hazardous waste site located near Coatesville that could contribute PCB contamination through soil erosion. The site, Modena Yard, is located in Chester County, north of Creek Road in Modena, Pennsylvania. The facility is identified by EPA number PAD982363871. The site comprises 21.6 acres and is bordered on the north by Creek Road, on the south by the West Branch of Brandywine Creek, on the west by private residences and the east by wooded areas. The site has been used as a scrap yard and a rail car dismantling facility. All industrial activities at the site have been terminated. The site is vacant and unpaved except for 5 buildings located in the northwest and central portions of the site. The total area occupied by the buildings is 0.24 acres. Based on data collected in 1996, the site is located within the 100-year flood plain of West Branch Brandywine Creek.

Previous studies were conducted on the site beginning in 1987, including a Preliminary Assessment by the Pennsylvania Department of Environmental Resources (PADER), which is currently known as PADEP. The EPA performed a site inspection in 1988. This investigation found elevated levels of PCB in the soil. Following this investigation, a multimedia sampling event was conducted on November 17, 1988. Elevated levels of PCB in soil were again found at the site. On September 29, 1999, U.S. EPA signed into effect an Administrative Order by Consent for Removal Response Action (AOC) for the Modena Yard Site. This order requires the development and implementation of a Response Action Plan (RAP) that was submitted in October 1999 and approved by EPA in December 1999.

In March 2000, RMT, Inc. developed a Site Characterization Report and a Response Action Work plan for Cleanup Action to thoroughly characterize the extent and nature of contamination at the Modena site and specify necessary remedial activities. Soil sampling and analyses showed elevated concentrations of PCB in soils at varying depths throughout the site. Concentrations of PCB measured in surface soil samples (0 to 1 foot) ranged from non-detect to 407 mg/kg with an average concentration of 20 mg/kg. The report recommended remediation of those areas of the site with contamination above the cleanup criterion of 25 mg/kg for PCB. The remediation alternative recommended is the installation of a cap over contaminated areas and a silt control fence around the southern and eastern borders of the site. This will eliminate any possibility of erosion of the contaminated soil and therefore remove the pathway for PCBs entering the West Branch Brandywine Creek through soil erosion from the Modena site.

The Pennsylvania TMDL report indicates that PCB contamination was found in sediment at 6 ug/kg within the West Branch Brandywine Creek (USGS 1994). PCB binds preferentially to the organic materials found in the sediment; however, a portion will partition into the water column.

**Atmospheric Deposition**

Atmospheric deposition can contribute to background concentrations of PCB in water bodies. Studies have shown that air deposition can be a significant source of PCB load to a water. However, other studies are inconclusive and suggest that volatilization from the water column and sediments is likely to result in continuing PCB loss from the water body, thereby reducing, or negating, the atmospheric load. The PCB TMDL study now underway for the Delaware Estuary will be looking at the role of air deposition to water bodies. Until that study is complete EPA agrees with Pennsylvania that air sources of PCBs need not be quantified for this TMDL. However, EPA recommends that Pennsylvania continue to review the impact of air deposition and, if the need arises, revisit this TMDL to consider the impacts of air sources.

## Total Allowable Loads

Pennsylvania utilized the water quality criteria and flow data from the U.S. Geological Survey (USGS) surface water discharge station located on the left bank of West Branch Brandywine Creek, at a bridge on SR 15068 at Modena (USGS Station # 01480617) to calculate the TMDL. The segment harmonic mean flow was used in calculating the TMDL by multiplying it by the water quality criterion. EPA agrees with this approach for calculating the TMDL. The total allowable loadings are presented below:

| Pollutant | TMDL | % Reduction |
|---|---|---|
| PCB | 0.0000231 lb/day | 99.6 |
| Chlordane | 0.000289 lb/day | 20.3 |

**Wasteload Allocations**

Pennsylvania found no permitted point sources contributing to the load of either chlordane or PCBs to the West Branch Brandywine Creek. Therefore the WLA was assigned a value of 0. EPA agrees with this.

## Load Allocations

Pennsylvania found that insufficient information was available for the two hazardous waste sites near Coatesville (Luria Brothers Scrap Yard and the Modena Yard, i.e., the Modena Yard) to calculate specific allocations for the site(s) for PCBs. (As noted above EPA has found that these two sites as identified by Pennsylvania actually represent one site.) The state also concluded that because there is no way to quantify accurately loadings from groundwater or erosion from the Superfund site (Modena Yard), the PCB TMDL minus the margin of safety of 0.0000208 lbs/day is assigned to a Load Allocation for the in stream sediment.

Although PADEP does not specifically allocate load to the Superfund site, Pennsylvania's TMDL, which includes an explicit margin of safety and allocation of the remainder of the TMDL to sediment, provides an implicit allocation of zero to the known PCB source (Modena Yard). EPA finds this allocation acceptable.

Using detailed information from our Superfund site files, we have calculated the PCB loading coming from the site (see Appendices A, B and C) and believe an existing loading rate and required reduction for the site in order to meet the implicit allocation of zero to the Modena Yard can be determined. Based on the information reviewed by EPA and the subsequent calculations completed by EPA, we believe an allocation of zero to the site would be feasible. As noted in the Pennsylvania TMDL report, page 6, "The remediation alternative recommended is the installation of a cap over contaminated areas and a silt control fence around the southern and eastern borders of the site. This will eliminate any possibility of erosion of the contaminated soil." The elimination of any possible erosion of contaminated soil from the site, removes the pathway for the runoff of PCBs from the site. Therefore, the zero allocation, or 100% reduction, for the Modena Yard is reasonable.

Based on our analysis of this TMDL, whereby we find an implicit allocation of zero to the Modena Yard, EPA finds this TMDL for PCBs to be acceptable.

EPA believes that such an allocation for the Modena site serves as a goal that can be used by the Superfund program as the specific site is addressed. A TMDL is a planning tool that may change over time as the data improves and the watershed change. If additional data are collected and the identified sources of PCBs are re-evaluated, a determination can be made as to whether this new data is significant and a TMDL revision is necessary. While it is expected that a TMDL will serve as a decision tool for those remediation plans, it may be found that the removal of the sediment/runoff pathway may not be feasible or acceptable for other reasons. If this should be the case, the TMDL could be reopened and the allocations re-distributed, but still meeting the total allowable load from all sources, to take into consideration the final remediation plan. However, it is important at this time to provide a goal that is based on the need to meet water quality standards to serve as a focal point for site plan development.

Because there are no known sources of chlordane in this West Branch Brandywine Creek segment, it is also treated as a nonpoint source contaminant that may be introduced to surface water through contaminated ground water or surface runoff. The TMDL for chlordane is assigned to the Load Allocation, that portion of the load contributed by nonpoint sources. Chlordane also becomes associated with soil particles and enters the sediments once in a water body, and fish tissue contamination results from this sediment load. Because of this, the chlordane TMDL minus the margin of safety of 0.000260 lbs/day in this reach of West Branch Brandywine Creek is assigned to a Load Allocation for the in-stream sediment. EPA agrees with this approach for chlordane.

*3) <u>The TMDLs consider the impacts of background pollutant contributions.</u>*

Development of TMDLs includes consideration of background pollutant contribution, appropriate and/or critical stream flow, and seasonal variation. Page 6 of Pennsylvania's TMDL report indicates that "the TMDL for the West Branch Brandywine Creek considers background pollutant contributions. The natural in-stream background concentration of chlordane is assumed to be zero because chlordane is a man-made product and there are no natural sources. PCB is also a man-made product and no natural sources of PCB load exists in the environment. Nonetheless, due to the pervasive use of PCBs prior to their ban in the late 1970s and their slow degradation rates, PCBs are now widespread in the environment. This pervasive distribution of PCBs in air, soil, and water effectively creates a background load of PCB in all water bodies." EPA agrees with the assumption of zero background for chlordane and the need to further consider background concentrations for PCBs.

PADEP assumed a zero background concentration for both pollutants in their calculations. Pennsylvania's assumption for use of that value is that further stream specific data needs to be developed before a background concentration can be calculated with sufficient scientific certainty for PCBs. EPA agrees that more information should be collected to determine what the background contributions of PCBs are for this water. We believe that given the data that exist for other areas in the Brandywine River watershed as well as the Delaware River watershed (see Appendix D for a summary of this data), it is likely that Pennsylvania will find some level of background above zero is likely to exist. In addition, data exist for portions of the Brandywine watershed that show fish tissue concentrations that, when converted to water column concentrations, exceed the state's water quality standards. Other fish tissue data exist throughout the state to confirm that PCBs are widespread throughout the environment, as Pennsylvania noted on page 6 of their report.

In order to address the pervasiveness of PCBs, PADEP has committed to collecting in-stream data to either support an assumption of zero concentration or some other value in the future (Commitment provided by PADEP in an e-mail from Mr. Frederick Marrocco to Joseph Piotrowski, April 2, 2001). The commitment which Pennsylvania has made is as follows: "DEP will review the basis for the zero background assumption to determine if it continues to be valid. If the review determines that the zero background assumption is no longer valid, PADEP will assess available and practical options for conducting background monitoring for PCB. Factors to be considered in this assessment include, the on-going water quality monitoring program and priorities, fish tissue sampling, sediment sampling, water quality sampling, and the availability of EPA approved analytical methods. PADEP will consider the results of this assessment in establishing a plan for the conduct of additional PCB data collection efforts. Any new data collected under this plan will be assessed for possible revision to the PCB TMDL." We suggest any monitoring plan to verify the background concentration of PCBs in the water up stream of the known sources of PCB should include an appropriate number of samples collected for various stream flow regimes. In addition, the plan should include the use of the more sensitive EPA method of 1668A. This method would better allow comparison of the water column data with the state standards for PCBs.

The Toxics Advisory Committee of the Delaware River Basin Commission is now involved in the preliminary data collection program for the development of a TMDL for PCBs for the Delaware Estuary. This same committee has recommended the use of the method 1668A for data analysis. EPA Headquarters has recommended the use of this method as appropriate for a variety of PCB measurement uses under the Clean Water Act on a case-by-case basis. EPA Headquarters is prepared to assist regulatory agencies who choose to use the method.

In addition to the Delaware Estuary PCB TMDL, EPA is using the 1668A method for the development of a PCB TMDL for the Shenandoah River in Virginia. Further, EPA has used more sensitive methods not yet approved for dioxin analysis in the development of a TMDL for the Kanawha River, Pocatalico River and Armour Creek in West Virginia and for the development of a dioxin TMDL for the Ohio River. The Ohio River Valley Sanitation Commission (ORSANCO) and the states of West Virginia and Virginia have accepted these non-approved approaches in the development of TMDLs. Further, the regulated and environmental communities have accepted the final TMDLs for the Kanawha River, Pocatalico River and Armour Creek and the Ohio River based on data analyzed using these non-approved methods.

Calculating the TMDL for PCBs based on a zero background or a value greater than zero will have no noticeable impact on the reductions necessary for the various sources of the pollutant for this watershed. Therefore, we accept the State's approach to the use of a zero background for PCBs. However, as will be discussed later, the consideration of background loads to this water segment may have an impact of reasonable assurances that the TMDL can be met.

*4) The TMDLs consider critical environmental conditions.*

EPA regulations at 40 CFR §130.7(c)(1) require TMDLs to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of West Branch Brandywine Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards.[1] In specifying critical conditions in the waterbody, an attempt is made to use a reasonable “worst-case” scenario condition. Critical conditions are the combination of environmental factors (e.g., flow, temperature, etc.) that results in attaining and maintaining the water quality criterion and has an acceptably low frequency of occurrence. For example, stream analysis often uses a low-flow (7Q10) design condition as critical because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

PCB and chlordane are probable human carcinogens. Carcinogenesis is a nonthreshold effect, an adverse impact that may occur at any exposure greater than zero. Such an effect is often related to long-term exposure to low levels of a particular chemical or compound, rather than an immediate effect due to a short duration exposure to a high level. As noted earlier, PADEP’s water quality toxics management program uses a cancer risk level of $1 \times 10^{-6}$ to protect human health.

Attainment of this risk level is predicated on exposure that includes drinking 2 liters of water and ingesting 6.5 grams of fish per day over a 70-year lifetime. The PADEP uses harmonic mean flow as the appropriate design condition for dealing with exposure to carcinogens. This is a long-term flow condition that will, when applied to the Total Maximum Daily Load, represent long-term average exposure. Because seasonal increases and decreases in concentration are less important than the long-term exposure to a carcinogen, use of harmonic mean flow adequately considers the critical environmental conditions and seasonal variations in PCB and chlordane concentrations. EPA believes that this approach satisfies the requirement to consider critical environmental conditions.

*5) The TMDLs consider seasonal environmental variations.*

Attainment of this risk level is predicated on exposure that includes drinking 2 liters of water and ingesting 6.5 grams of fish per day over a 70-year lifetime. The PADEP uses harmonic mean flow as the appropriate design condition for dealing with exposure to carcinogens. This is a long-term flow condition that will, when applied to the TMDL, represent long-term average exposure. Because seasonal increases and decreases in concentration are less important than the long-term exposure to a carcinogen, use of harmonic mean flow adequately considers seasonal variations in PCB and chlordane concentrations. EPA believes that this approach satisfies the requirement to consider seasonal environmental variations.

*6) The TMDLs include a margin of safety.*

This requirement is intended to add a level of safety to the modeling process to account for any

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[1] EPA Memorandum regarding EPA Actions to Support High Quality TMDLS from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Water Management Division Directors, August 9, 1999.

uncertainty. Margins of safety (MOS) may be implicit, built into the modeling process, or explicit, taken as a percentage of the wasteload allocation, load allocation, or TMDL.

Achievement of the TMDLs will generally ensure achievement of the water quality criteria. To account for uncertainties that may be associated with the TMDL calculations, the Department proposes to hold 10% of the TMDLs in reserve. Applying this results in an explicit margin of safety for PCB of 0.00000231 pounds per day and for chlordane 0.0000289 pounds per day. EPA concurs with this approach to considering a MOS.

*7) <u>There is reasonable assurance that the TMDLs can be met.</u>*

In March 2000, RMT, Inc. developed a Site Characterization Report and a Response Action Workplan for the Modena site for the Cleanup Action to thoroughly characterize the extent and nature of contamination at the site and specify necessary remedial activities. Soil sampling and analyses showed elevated concentrations of PCB in soils at varying depths throughout the site. Concentrations of PCB measured in surface soil samples (0 to 1 foot) ranged from non-detect to 407 mg/kg with an average concentration of 20 mg/kg. The report recommended remediation of those areas of the site with contamination above the cleanup criterion of 25 mg/kg for PCB. The remediation alternative recommended is the installation of a cap over contaminated areas and a silt control fence around the southern and eastern borders of the site. This will eliminate any possibility of erosion of the contaminated soil and therefore remove the pathway for PCBs entering the West Branch Brandywine Creek through soil erosion from the Modena site.

There are two options for the remediation of PCBs and chlordane in the stream sediment: 1) dredge and remove the contaminated sediment, or 2) allow natural attenuation to remove the source. Although not entirely clear in the Pennsylvania TMDL report, the recommended option is for natural attenuation. If the sources are removed, such as the soil erosion from the Modena site, eventually natural forces, such a overburden by clean sediments, will remove the threat of PCB contamination by PCBs.

Pennsylvania intends to continue periodic fish tissue sampling for the West Branch Brandywine Creek to determine if contamination continues. EPA agrees with this monitoring activity, however, we also believe that additional monitoring is necessary. The combination of removing the pathway of the PCBs from the known source (Modena Site), and the natural recovery of the in stream sediments provides some reasonable assurance that the TMDL, and hence the applicable water quality standard, can be met. EPA believes that the state should undertake additional monitoring to provide some further assurances. This would include measuring background concentrations of PCBs. If it is found that PCB concentrations entering the segment are significant, natural clean-up of existing sediment contamination may not occur or may be delayed, or the incoming concentrations themselves may exceed applicable water quality standards. Some fish tissue data for the Red Clay Creek suggest that applicable water column standards may be exceeded in areas with no known or identifiable sources. This needs to be addressed by the state in any further analysis of PCB contamination in the West Branch Brandywine Creek. In order to assure that sampling/analysis provides useful information, EPA further recommends the use of  testing method 1668A.  EPA also recommends that the state continue to analyze the impacts of air deposition of PCBs to this water.

*8) <u>The TMDLs have been subject to public participation</u>.*

Request for Comment and Notice of Public Meeting for the draft TMDL was published in the *Pennsylvania Bulletin* on September 30, 2000 and in the *West Chester Daily Local News* on October 2, 2000  with a 60 day comment period provided.  A public meeting was held at the PADEP Southeast Regional Office, on November 15, 2000 to discuss the TMDLs.  Written comments were submitted by the Environmental Protection Agency, Region III and Mid-Atlantic Environmental Law Center.  Notice of final TMDL approval will be posted on the Department website.

Pennsylvania provided a Response to Comments document along with the final TMDL.  We believe that this document responds to all comments provided during the public comment period, but cannot verify since the actual comment letters were not provided.

**APPENDIX A**

EPA Calculations of TMDL/WLA/LA based on Background Concentrations and Allocating to Identified Sources for PCBs and Chlordane

<u>Endpoint Identification</u>

For this segment of West Branch Brandywine Creek, the TMDL goal is for levels of PCB and Chlordane in the water column to be equal to or less than the DEP's water quality criteria. The criteria, found in the "Water Quality Toxics Management Strategy - Statement of Policy" (Chapter 16 of the DEP's rules and regulations) are 0.00004 micrograms per liter (ug/L) (equivalent to parts per billion [ppb]) for PCB and 0.0005 ug/L for chlordane.

$$WC = \frac{TC}{BCF} \qquad (1)$$

TC = Tissue Concentration in mg/kg (equivalent to mg/L)
BCF = EPA Bioconcentration Factor in L/kg (31,000 for PCB, 14100 for Chlordane)
WC = Water Column Concentration (estimated) in mg/L

Table 1:
Fish Tissue Data Used to calculate the TMDL for the West Branch Brandywine Creek

| Parameter | Fish Species | Number of Data Sets | Range of Years | Years |
|---|---|---|---|---|
| PCB | Eel | 3 | 1984 -1995 | 1984, 1994, 1995 |
| Chlordane | Eel | 3 | 1984 - 1995 | 1984, 1994,1995 |

The average PCB level in American eel from this segment of West Branch Brandywine Creek is 1.65 milligrams per kilogram (mg/kg). The average chlordane concentration in American Eel is 0.442 mg/kg. The lipid content of eel is approximately 15 percent. In order to use the BCFs for fish tissue the tissue concentrations must be normalized to 3 percent lipid content. The normalization is performed using a simple proportional ratio which is consistent with the EPA document cited above, and is expressed below.

PCB

$$\frac{65 \text{ mg/kg}}{X} = \frac{0.15}{0.03}$$

$$X = 0.330 \text{ mg/kg}$$

Chlordane

$$\frac{442 \text{ mg/kg}}{X} = \frac{0.15}{0.03}$$

$$X = 0.0884 \text{ mg/kg}$$

The variable X represents the fish tissue concentration normalized to 3 percent lipids. Using equation (1), the calculation to estimate the water column concentration is expressed as follows:

PCB

$$\frac{330 \text{ mg/kg}}{31{,}200 \text{ L/kg}} = Y$$

$$Y = 0.0000106 \text{ mg/L}$$

Chlordane

$$\frac{0.0884 \text{ mg/kg}}{14{,}100 \text{ L/kg}} = Y$$

$$Y = 0.00000627 \text{ mg/L}$$

The variable Y represents the estimated concentration of PCB and chlordane in the water column. This value for PCB is estimated as 0.0106 ug/L. The corresponding estimated water column concentration for chlordane is 0.00627 ug/L. These estimated concentrations exceed the applicable water quality criteria. The back-calculations from tissue level to water column concentration were performed using data on a species for which consumption advisories have been issued, i.e., fish with elevated tissue levels of these compounds. While the actual concentrations in the water column are not known, they are likely to be lower than the calculated estimates.

## Source Identification

There are four possible sources of PCB and chlordane contamination in the water column of West Branch Brandywine Creek. They are: direct discharge from point sources, soil erosion from uncontrolled sites, stream bed sediment release and air deposition.

### Direct Discharge from Point Sources

No discharge point sources of PCB or Chlordane (i.e., discharge permits) to West Branch Brandywine Creek were identified during the search of the EPA PCS.

### Soil Erosion from Uncontrolled Sites

A second possible source of PCB load is through the transport of contaminated soil into the creek through soil erosion from uncontrolled sites. Pennsylvania's Environmental Choice Program (ECP) and EPA indicate that PCB is present at one hazardous waste site located near Coatesville that could contribute PCB contamination through soil erosion. The site, Modena Yard, is located in Chester County, north of Creek Road in Modena, Pennsylvania. The facility is identified by EPA number PAD982363871. The site comprises 21.6 acres and is bordered on the north by Creek Road, on the south by the West Branch of Brandywine Creek, on the west by private residences and the east by wooded areas. The site has been used as a scrap yard and a rail car dismantling facility. All industrial activities at the site have been terminated. The site is vacant and unpaved except for 5 buildings located in the northwest and central portions of the site. The total area occupied by the buildings is 0.24 acres. Based on data collected in 1996, the site is located within the 100-year flood plain of West Branch Brandywine Creek.

Previous studies were conducted on the site beginning in 1987, including a Preliminary Assessment by the Pennsylvania Department of Environmental Resources (PADER), which is currently known as DEP. The EPA performed a site inspection in 1988. This investigation found elevated levels of PCB in the soil. Following this investigation, a multimedia sampling event was conducted on November 17, 1988. Elevated levels of PCB in soil were again found at the site. On September 29, 1999, U.S. EPA signed into effect an Administrative Order by Consent for Removal Response Action (AOC) for the Modena Yard Site. This order requires the development and implementation of a Response Action Plan (RAP) that was submitted in October 1999 and approved by U.S. EPA in December 1999.

In March 2000, RMT, Inc. developed a Site Characterization Report and a Response Action Workplan for Cleanup Action to thoroughly characterize the extent and nature of contamination at the site and specify necessary remedial activities. Soil sampling and analyses showed elevated concentrations of PCB in soils at varying depths throughout the site. Concentrations of PCB measured in surface soil samples (0 to1 foot) ranged from non-detect to 407 mg/kg with an average concentration of 20 mg/kg. The report recommended remediation of those areas of the site with contamination above the cleanup criterion of 25 mg/kg for PCB. The remediation alternative recommended is the installation of a cap over contaminated areas and a silt control fence around the southern and eastern borders of the site.

Chlordane sources from uncontrolled sites in this study area were not found.

### Sediment Release

The final source of PCB and chlordane addressed in this TMDL is that from sediment release. PCB contamination was found in sediment within the West Branch Brandywine Creek (USGS 1994). PCB and chlordane bind preferentially to the organic materials found in the sediment. However, a portion of the PCB and chlordane will partition into the water column.

### Atmospheric Deposition

Atmospheric deposition of PCB plays a dominant role in PCB cycling in many freshwater systems. Monitoring conducted under the Integrated Air Deposition Network (IADN) and the Great Waters Program indicate that wet and dry deposition of PCB can vary greatly both regionally and by season. According to EPA's Lake Michigan Mass Balance (LMMB) Study, atmospheric transport and deposition of PCB provides about 82 percent of the total PCB load to Lake Michigan. Because PCB is no longer produced, the major source of PCB to the atmosphere is volatilization from sites where they have been stored, disposed, or spilled; from incineration of PCB-containing products; and, to a lesser extent, from PCB formation during production processes.

PCB air deposition values specific to Pennsylvania have not yet been identified, although air deposition data for southern New Jersey will be published in the near future. There are, however, readily available data related to studies recently done for Lake Michigan under the IADN and the Great Waters Program. PCB concentrations in air over Lake Michigan have been observed to range from 440 picograms per cubic meter ($pg/m^3$) ($4.12 \times 10^{-2}$ parts per trillion [ppt]) in the southern and mid region of the lake to 170 $pg/m^3$ ($1.59 \times 10^{-2}$ ppt) in the northern part of the lake (McConnell et al, 1998). Because recent studies have demonstrated that urban areas such as Chicago (located on the southwest region of the lake) observe greater concentrations of PCB in air than other areas, the average air concentration values observed over the area of Lake Michigan is more likely to reflect values observed in rural and suburban Pennsylvania.

Although this analysis predicts that atmospheric deposition may provide a significant source of PCB load to the water body, volatilization from the water column and sediments is likely to result in continuing PCB loss from the water body, thereby reducing, or negating, the atmospheric load. Hillery, et. al., (1998) found that the Great Lakes are currently experiencing a net loss of PCB. In each of the five Great Lakes, the net deposition of PCB is believed to be insignificant because gas transfer out of the lakes counteracts the flow into the lakes from wet and dry deposition. Similar processes are possibly occurring in Pennsylvania water bodies. Air deposition will not be included in this TMDL.

<u>TMDL Calculation</u>

Calculation of the Total Allowed Load

Development of TMDLs includes consideration of background pollutant contribution, appropriate and/or critical stream flow, and seasonal variation. Attainment of this risk level is predicated on exposure that includes drinking 2 liters of water and ingesting 6.5 grams of fish per day over a 70-year lifetime. DEP uses harmonic mean flow as the appropriate design condition for dealing with exposure to carcinogens. This is a long-term flow condition that will, when applied to the TMDL, represent long-term average exposure. Because seasonal increases and decreases in concentration are less important than the long-term exposure to a carcinogen, use of harmonic mean flow adequately considers seasonal variations in PCB and chlordane concentrations.

The calculation of the West Branch Brandywine Creek TMDL uses the water quality criteria and flow data from the U.S. Geological Survey surface water gauging station, located on the left bank of West Branch Brandywine Creek, at a bridge on SR 15068 at Modena, Pennsylvania (USGS Station # 01480617). The harmonic mean flow (Qhm) was calculated by dividing the flow at the gauge (52.79 cubic feet per second [cfs]) by the drainage area at the gauge (55 square miles) and applying the yield (0.959818 cubic feet per second per square mile or cfsm) to the drainage area of the TMDL segment (111.6 square miles), as described in DEP's "Implementation Guidance - Design Stream Flows" (Document No. 391-2000-023). The segment Qhm for the West Branch Brandywine Creek is 107.12 cfs.

The Segment Qhm is used in calculating the Total Daily Maximum Load (TMDL) by multiplying it by the water quality criterion and multiplier to convert the results to pounds per day (lb/day). The conversion multiplier is calculated as follows:

$$28.3 \text{ L/ft}^3 / (10^{-6} \text{ mg/g}) / (454 \text{ g/lb}) = 0.00539$$

The PCB TMDL is calculated as follows:

$$107.12 \text{ cfs} \times 0.00004 \text{ ug/L} \times 0.00539 = 0.0000231 \text{ lb/day}$$

The chlordane TMDL is calculated as follows:

$$107.12 \text{ cfs} \times 0.0005 \text{ ug/L} \times 0.00539 = 0.000289 \text{ lb/day}$$

## Margin of Safety (MOS)

Achievement of the TMDLs will generally ensure achievement of the water quality criteria. To account for uncertainties associated with the data used to perform the TMDL calculations, 10% of the TMDLs in reserve. Applying this methodology results in a margin of safety of 0.00000231 lb/day for PCB and 0.0000289 lb/day for chlordane. The TMDLs for West Branch Brandywine Creek can be summarized as follows:

## TMDL Summary

Since there are no known point sources, the WLA has been set to 0. The margin of safety is then subtracted form the TMDL to get the LA. A summary of the total loads allowed and the allocated loads to the point sources and the combined nonpoint sources is summarized below.

Table 2
TMDL Summary

| Pollutant | TMDL | WLA | LA | MOS |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| PCB | 0000231 lb/day | 0 | 0.0000208 lb/day | 0.00000231 lb/day |
| Chlordane | 0.000289 lb/day | 0 | 0.000260 lb/day | 0.0000289 lb/day |

*Background Concentrations are included in the Load Allocation.

Calculations of Individual Allocations

Estimation of Background Concentrations

Background concentrations of PCB in the West Branch Brandywine Creek water column have not yet been scientifically established. However, sampling data for tributaries in the Delaware River basin with no known point source or uncontrolled land-based sources have confirmed the presence of background concentrations of PCB. Limited background sampling in Pennsylvania suggests that background concentrations of PCB could be present at concentrations below or above the water quality standard of 0.00004 mg/L.

For the purposes of TMDL development, it is assumed that the background concentration of PCB in West Branch Brandywine Creek is equal to one-half the PCB water quality criterion. This background concentration (0.00002 mg/L) is assumed due to the uncertainties inherent in predicting background loads of PCB from atmospheric deposition and land-based sources. Future updates to the TMDL may be able to quantify a background PCB concentration based on additional surface water data that may be generated and from ongoing atmospheric deposition studies under the integrated air monitoring network. Also, additional studies related to the rates of PCB loss from water bodies through volatilization are likely to be completed. The PCB background load is calculated as follows:

$$107.12 \text{ cfs} \times 0.00002 \text{ ug/L} \times 0.00539 = 0.0000115 \text{ lb/day}$$

Soil Erosion from Uncontrolled Sources

The magnitude of soil erosion from Modena Yard is assessed by the Universal Soil Loss Equation (USLE). The use of this equation is taken from the PATG Section I Erosion Prediction document (1991). The equation is stated as follows:

$$A = RKLSCP \qquad (2)$$

The calculation of the contribution of PCB from Modena Yard is included in Appendix A. The calculated contribution of PCB from Modena Yard soil erosion is 0.0308 lb/day.

Sediment Release

The following discussion outlines the approach for determining the daily load of PCB and chlordane that will partition to the water column from the observed concentration of PCB found in the West Branch Brandywine Creek sediment. The observed concentrations were taken from United States Geological Survey (USGS) Water-Resources Investigation Report 94-4060 (USGS 1994) for a location within the study area.

The levels of chlordane and PCB predicted and observed in West Branch Brandywine Creek are presented in the following table. Chlordane concentrations were reported as below the detection limit (USGS 1994). As a result, the chlordane concentration in sediment is estimated at half the detection limit.

Table 3
Chlordane and PCB Concentrations in Existing Sediment

| Contaminant | Observed Sediment Concentration (ug/kg sediment) |
| --- | --- |
| Chlordane | 0.5 |
| PCB | 6.0 |

The *Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning* (EPA-822-R-93-011) provides a method to determine the appropriate load allocation for in-stream sediments. The KEPT methodology can be used to determine the pore-water concentration of chlordane and PCB within the sediments. Overlying water column concentrations cannot be directly determined using this methodology; however, it is reasonable to assume that the overlying water column concentration derived from sediment release will be less than the pore-water concentration. As a result, using the pore water concentration to estimate the water column concentration is protective.

The calculation of this contribution is included in Appendix B. Using this relationship, the PCB and chlordane load from sediment are 0.0000269 lb/day and 0.00000281 lb/day respectively.

Individual Source Loadings and Allocations Summary

Table 4

Summary of Loadings and Load Allocations for PCB

| Source | Loading Rate PCB | LA PCB | Loading Rate Chlordane | LA Chlordane |
|---|---|---|---|---|
| | lb/day | lb/day | lb/day | |
| Soil Erosion | 0.0308 | 0 | NA | NA |
| Sediment Release | 0.0000269 | 0.00000930 | 0.00000281 | 0.000260 |
| Background | 0.0000115 | 0.0000115 | NA | NA |
| TOTAL | | 0.0000208 | | 0.000260 |

<u>Wasteload Allocations (WLAs) and Load Allocations (LAs)</u>

As previously stated, there are no known point sources of PCB discharging to West Branch Brandywine Creek. Therefore, the PCB load is contributed by non-point sources alone through soil erosion from uncontrolled sources, atmospheric deposition and sediment release. The entire PCB load in the West Branch Brandywine Creek is assigned to the Load Allocation (LA). The Source Assessment notes that once in a water body, PCB becomes associated with soil particles and enters the sediments. Fish tissue contamination results from this sediment load.

Percent Reduction

The goal of this TMDL is to achieve the water quality criteria in order to protect public health. In order to achieve this, the loading from each source must be reduced from the estimated current levels ( calculated on Page 7) to the load allocation. Percent reduction is calculated using the following formula:

% Reduction = (1 - LA/ Existing Load) x 100

For PCB, the percent reduction is calculated as follows for each source:
*Soil Erosion from Uncontrolled Sources*

Future remediation activities at the Modena Yard site will consist of the installation of a cap over the contaminated areas. This will eliminate the possibility of erosion of the contaminated soil.

Therefore, the load allocation is zero, yielding a 100 percent reduction exhibited as follows:

% Reduction = (1 – 0/0.0308) x 100
% Reduction = (1 – 0) x 100 = 100%

*Background*

The level of PCB in the water column originating as background cannot be reduced. Therefore, the load allocation for background is equal to the load.

Sediment Release

The load allocation for sediment release is equal to the total load allocation less that attributed to background. The reduction necessary to achieve this level is calculated as follows:

% Reduction = (1 - 0.00000930/0.0000269) x 100
% Reduction = (1 – 0.3457) x 100 = 65.4%

Summary of Individual Allocations

Table 5
Summary of Load Allocations and Percent reductions

| Source | Loading PCB | LA PCB | Reduction PCB % | Loading Chlordane | LA Chlordane | Reduction Chlordane % |
|---|---|---|---|---|---|---|
| Units | lb/day | lb/day | | | | |
| Soil Erosion | 0.0308 | 0 | 100 | NA | NA | NA |
| Sediment Release | 0.0000269 | 0.00000930 | 54 | 0.00000281 | 0.000260 | 54 |
| Background | 0.0000115 | 0.0000115 | 0 | NA | NA | NA |
| TOTAL | | 0.0000208 | | | 0.000260 | |

Related to chlordane, there are no known sources in this West Branch Brandywine Creek, therefore it is treated as a non-point source contaminant that may be introduced to surface water only through contaminated sediment release. Therefore, the entire chlordane LA (0.000260 lb/day) can be allocated to sediment release. However, because the estimated load of chlordane from sediment release (0.00000281 lb/day) is less than the LA, no reductions have been made for chlordane. As noted above, recent fish tissue assessments have indicated that chlordane levels have fallen below action levels. Continuing natural attenuation of chlordane in stream sediments is likely to reduce the chlordane load to the water column and thus maintain fish tissue concentrations below the fish consumption advisory action levels. Nonetheless, the water body should still be monitored for chlordane to ensure compliance with water quality standards.

## APPENDIX B

Universal Soil Loss Equation Calculation

The Universal Soil Loss Equation assesses the magnitude of soil erosion. The use of this equation is validated by the PATG Section I Erosion Prediction document (1991). The information needed for its completion is from the Site Characterization Report and Response Action Work plan for Cleanup Action, Modena Yard Site, completed by RMT, Inc. in March of 2000. This value is calculated using the following equation:

$$A = RKLSCP$$

where:

A= Estimated average annual soil loss in tons/acre/year
R= Rainfall/runoff factor
K= Soil erodibility factor
L= Slope length factor
S= Slope gradient factor
C= cover and management factor
P= Support practice factor

The steps in the calculation are as follows:

**Step 1:** Measure slope length along each test pit line as presented in the RMT report:

| **Test Pit Line** | **Slope Length (feet)** |
|---|---|
| L1 | 325 |
| L2 | 275 |
| L3 | 125 |
| L4 | 175 |
| L5 | 188 |
| L6 | 250 |
| L7 | 225 |
| L8 | 163 |

| **Test Pit Line** | **Slope Length (feet)** |
|---|---|
| L9 | 250 |
| L10 | 350 |
| L11 | 375 |
| L12 | 475 |
| L13 | 475 |
| L14 | 350 |
| L15 | 300 |
| **Minimum** | **125** |
| **Average** | **287** |
| **Maximum** | **475** |

**Step 2:** Estimate average surface soil PCB concentration along each test pit line:

| **Test Pit Line** | **PCB concentration* (mg/kg)** |
|---|---|
| L1 | 15.9 |
| L2 | 29.1 |
| L3 | 8.2 |
| L4 | 131.6 |
| L5 | 7.1 |
| L6 | 6.5 |
| L7 | 6 |

| Test Pit Line | PCB concentration* (mg/kg) |
|---|---|
| L8 | N/A |
| L9 | 13.5 |
| L10 | 7.1 |
| L11 | 9.9 |
| L12 | 1.9 |
| L13 | 44.5 |
| L14 | 8.4 |
| L15 | 33.1 |

* Surface soils upgradient where PCB concentrations were below 5 mg/kg were not considered in the calculation of areas associated with PCB contribution to the waterway.

**Step 3:** Calculate weighted average of surface soil PCB concentration:

$$C_{area} = \frac{L_1\text{-}C_1 + L_2\text{-}C_2 + \cdots + L_iC_i}{S*L}$$

where:

C is the average concentration of each test pit line
L is the slope length of each test pit line

$C_{area}$ is 20.8 mg/kg.

Note: Test pit line L8 is not included due to the absence of PCB analytical data.

**Step 4:** Calculate average site slope.

The slope was calculated for even numbered test pit lines (L2, L4, L6, L8, L10, L12, L14) creating a range of slope values using the following relationship:

$$\text{Slope} = \frac{\text{Elevation 2} - \text{Elevation 1}}{\text{Slope length}}$$

Elevation 2 was determined for each test pit line from the site map as presented in the RMT report. The downstream elevation of West Branch of Brandywine is 264 feet above mean sea level and this value was used as elevation 1. The following elevations were used for the calculation:

| Test Pit Line | Elevation 1 | Elevation 2 | Slope Length | Percent Slope |
|---|---|---|---|---|
| L2 | 264 | 275 | 275 | 4.0 |
| L4 | 264 | 275 | 175 | 6.3 |
| L6 | 264 | 275 | 250 | 4.4 |
| L8 | 264 | 272 | 163 | 4.9 |
| L10 | 264 | 275 | 350 | 3.1 |
| L12 | 264 | 278 | 475 | 2.9 |
| L14 | 264 | 275 | 350 | 3.1 |

The slopes range from 2.9 percent to 6.3 percent. It is valid to ascribe the slope of the entire site to be within this range, this value was chosen to be 5 percent.

**Step 5:** Select values for variables in the USLE equation.

A: Locate the correct rainfall/runoff factor, R, by referring to the R Factor Value table. Each county has its own R factor. West Branch of Brandywine Creek is located in Chester County, which has an R value of 175.

B: Values for the soil erodibility factor, K, are listed by county and texture. It is necessary to know the nature of the soil, such as silt sand, clay, etc. The soils in the WB watershed are silty sand indicated by SIL-L, and locating Chester County on the table, we arrive at a K value of 0.32.

C: The LS value is determined by the use of a graph contained in the erosion document. The slope and slope length of the site are needed to extrapolate the LS value from the graph. Using the slope of 5 percent and the slope length of 162.5 feet, the LS factor is discovered to be approximately 0.7.

D: There are a number of tables in the erosion document in reference to the cover and management factor, C. If the site has not been used for any type of agriculture, it is appropriate to use the table for permanent pasture and idle land, Table C-3. It is necessary to know the approximate percentage of the site covered with a vegetative canopy and the height of this canopy.  As well as the percent and type of groundcover in direct contact with the soil.

Based on the fact that this site has no appreciable vegetation and is overwhelmingly vacant and unpaved, except for an few buildings, and piles of miscellaneous scrap can be found at various locations, a C-factor of 0.45 has been designated (Site Characterization report, 2000. pg 2).  Therefore, the runoff calculation will represent the potential runoff if no vegetative cover is in place

E: The final parameter is the support practice factor, P.  This value is based on the contours of the land and any farming practices such as contour strip cropping and terracing. Depending upon the practice implemented, different tables can be used  It is appropriate to assume a support practice factor of 1 if there has been no implementation of farming practices at the site.  This is the case at Modena Yard, where there have not been any farming practices.

Once values have been chosen for all parameters, the result is calculated as follows:

$$A = (175)(0.32)(0.7)(0.45)(1) = 17.64 \text{ tons/acre/yr}$$

The solution is given in tons/acre/year.  The final load of PCB into the stream is calculated by the following equations:

Soil Erosion (tons/acre/yr) * Area of PCB contamination (acres) = Soil Load (tons/yr)

For Modena Yard the values are 17.64 tons/acre/year over an area of 15.3 acres respectively. Multiplying those values gives a result of 269.89 tons/year of estimated soil erosion.  The following calculation is then used to develop an estimate of PCB (lb/day) entering West Branch Brandywine Creek, where 20.8 mg/kg is the average surface soil PCB concentration over the contaminated area:

(269.89 tons/yr) x (2,000 lb/ton) x (20.8 mg/kg) x (1E-6 kg/mg) / (365 day/yr) = 0.0308 lb/day

## APPENDIX C

## PCB Partitioning from Sediment

The Technical Basis for Deriving Sediment Quality Criteria for Nonionic Organic Contaminants for the Protection of Benthic Organisms by Using Equilibrium Partitioning (EPA-822-R-93-011) provides a method to determine the appropriate load allocation for in-situ sediments. The information necessary for these calculations originate from Appendix A, A Primer on Random Walk Techniques for Mass Transport Groundwater Modeling and the Soil Survey for Chester and Delaware Counties, Pennsylvania. The equilibrium partitioning (KEPT) methodology can also be used to determine the pore-water concentration of chlordane and PCB within the sediments. Overlying water column concentrations cannot be directly determined using this methodology; however, it is reasonable to assume that the overlying water column concentration derived from sediment release will be less than the pore-water concentration. As a result, using the pore water concentration to estimate the water column concentration is protective. This estimation also applies to the contribution made through soil erosion. This is applicable if it is assumed that the entire volume of soil present is used in the calculation.

Based upon the KEPT relationship, the pore-water (interstitial) concentration of chlordane and PCB can be determined as follows:

$$C_s / C_d = f_{oc} * K_{oc(1)}$$

where:

$C_s$ = sediment concentration
$C_d$ = pore water concentration
$f_{oc}$ = mass fraction of organic carbon for the sediment
$K_{oc}$ = partition coefficient for sediment organic carbon

Therefore, the pore water concentration of PCB and chlordane in sediment are:

Chlordane:

$C_d$ = $C_s / f_{oc} * K_{oc}$
= 0.5 ug/kg / (0.0155 g/g * 279,000L/kg)
= 0.000116 ug/L

PCB:

$C_d$ = $C_s / f_{oc} * K_{oc}$
= 6.0 ug/kg / (0.0155 g/g * 349,462 L/kg)
= 0.00111 ug/L

The load of chlordane and PCB partitioning to the water column from the sediment is then determined by estimating the flow passing over the sediment in a given day. The harmonic mean flow in West Branch Brandywine Creek is estimated at 107.12 cfs (3033.3 L/s). As a result, the total PCB and chlordane load from the sediment is determined as follows:

Daily contaminant load =

Pore water concentration * Harmonic mean daily flow * 3,624 seconds/day

(2) Chlordane Load =

0.000116 ug/L * 3033.3 L/s * 3,624 sec/day = 1275.2 ug/day (0.00000281lb/day)

PCB Load =
0.00111 ug/L * 3033.3 L/s * 3,624 sec/day = 12,201.9 ug/day (0.0000269 lb/day)

**APPENDIX D**

Total PCB Values Found in Selected Tributaries of the Delaware Estuary

| Tributary | Dry Weather | | Wet Weather | |
|---|---|---|---|---|
| | Total PCB ng/l | Total PCB gm/day | Total PCB ng/l | Total PCB gm/day |
| Upper Christina River | 2.01 | 0.06 | 10.97 | 5.37 |
| Brandywine Creek | 0.8 | 0.74 | 2.19 | 5.26 |
| White Clay Creek | 0.68 | 0.15 | 3.08 | 3.99 |
| Red Clay Creek | 0 | 0 | 9.96 | 5.48 |
| Raccoon Creek | 5.01 | 0.26 | 1.06 | 0.17 |
| Rancocas Creek | 0.68 | 0.46 | 2.18 | 2.29 |
| Crosswicks Creek | 0 | 0 | 1.76 | 1.76 |
| Delaware River | 0 | 0 | 1.08 | 30.18 |
| Neshaminy Creek | 0 | 0 | 1.57 | 1.54 |
| Schuylkill River | 0 | 0 | 3.42 | 27.68 |

Source: “Study of the Loadings of Polychlorinated BiPhenyls from Tributaries and Point Sources Discharging to the Delaware River”, Delaware River Basin Commission, June 1998.

State water quality standard for PCBs = 0.0004 ug/l or 0.4 ng/l