Delaware Estuary PCB Strategy

Problem Statement

PCBs are a class of man-made compounds that were manufactured and used extensively as a dielectric in electrical equipment. Although their manufacture and use was generally banned by federal regulations in the late 1970s, existing uses in electrical equipment and certain exceptions to the ban were allowed. In addition, PCBs may also be created as a by-product in certain manufacturing processes such as dye production. PCBs are hydrophobic, sorbing to organic particles such as soils and sediments and concentrating in the tissues of aquatic biota either directly or indirectly through the food chain.

PCBs are classified as a probable human carcinogen by the U.S. Environmental Protection Agency, and also have also been shown to have reproductive effects, suppress the immune system, and are a possible endocrine disruptor. Starting in the late 1980s, the States of Delaware, New Jersey and Pennsylvania began issuing consumption advisories for the Delaware Estuary for PCBs due to the level of PCBs observed in the tissues of resident and anadromous fish species. Advisories are currently in effect for the entire estuary from the head of tide at Trenton, NJ to the mouth of Delaware Bay. The advisories range from a no consumption recommendation for all species taken between the C&D Canal and the DE-PA border to consumption of no more than one meal per month of striped bass or white perch in Zones 2 - 4.

Goal

The goal of this strategy is to achieve the water quality standards for PCBs for Zones 2, 3, 4 and 5 of the tidal Delaware River ("the Delaware Estuary") specified by the Delaware River Basin Commission (DRBC). These narrative and numerical standards are based upon the protection of human health, aquatic life or wildlife. Achieving the PCB standards will eliminate the necessity for advisories limiting consumption of fish and shellfish caught in the estuary, and protect the health of humans and the living resources using the estuary. In addition, other water quality targets such as the elimination of the need for fish consumption advisories, and sediment criteria for the beneficial use of dredged material may also be established by the Commission as interim or final targets.

Summary

This strategy includes nine major elements designed to establish Total Maximum Daily Loads or TMDLs for Total PCBs including allocations for point and non-point sources, and a margin of safety by September 30, 2003, and initiate a process to identify efficient and effective programs to reduce the loadings of PCBs to the estuary to achieve the TMDLs.

TMDLs will be established for individual or combinations of zones since the water quality standards vary in the different zones of the river. The Delaware River Basin Commission will be the lead agency in this effort. The TMDLs will be based upon a determination by the Commission under Article 4 of the DRBC Water Quality Regulations that allocations of the waste assimilative capacity of the river are necessary to achieve water quality standards for PCBs and to protect water uses. These allocations will then be referred to the appropriate state permitting agency for use in establishing effluent limitations, schedules and other

requirements, as appropriate. The measures necessary to achieve water quality standards for PCBs in the estuary will depend on several factors including the degree of exceedance of the standards in each estuary zone, the reductions required for each source category, the time required to comply with assigned allocations, the degree of voluntary identification and reduction of PCB sources, and attenuation through degradation processes and transport.

The nine elements of the strategy are:

1. Determine the water quality targets for the TMDLs.
2. Characterize PCB concentrations in the estuary ecosystem.
3. Identify and quantify sources and pathways of PCBs.
4. Determine transport and fate of PCB loads within the Delaware Estuary.
5. Establish TMDLs & allocations for sources (i.e. point and non-point sources).
6. Develop an Implementation plan to reduce PCBs entering the Estuary.
7. Increase environmental awareness of toxicity issues in the Estuary.
8. Monitor long-term concentrations of PCBs in air, water and sediments of the Estuary.
9. Monitor long-term concentrations and impacts to living resources of the Estuary.

A description of each of these elements follows.

1. Determine the water quality targets for the TMDLs for PCBs.

The first step in establishing TMDLs for any pollutant that is impairing the designated uses of a water body is the identification of the target for the TMDLs. These are normally the applicable numerical water quality standards; however, in some cases narrative standards such as prohibitions on nuisance algal conditions or the discharge of toxic substances in "toxic amounts" must be interpreted. In the case of PCBs, numerical water quality standards called stream quality objectives by the DRBC) for Total PCBs for Zones 2 - 5 of the tidal Delaware River were adopted by the DRBC in October 1996. These standards are based upon a cancer potency factor of 7.7 mg/KG - day recommended by the U.S. Environmental Protection Agency in January 1990. The factor was revised in June 1997 to include factors for both high risk and low risk exposures and persistence. High risk exposures include consumption of bioaccumulated PCBs and early life exposure. High persistence includes the bioaccumulation of PCB congeners that appear to be more toxic than the congeners found in commercial PCBs. This information along with more recent data and approaches regarding consumption rates and dioxin-like effects of some PCB congeners needs to be evaluated in revising the current water quality standards.

The standards are different in the four zones due to differences in the designated uses of the river and in the consumption rates used to develop the standards. The standards are as follows:

	Fish & Water Consumption	Fish Consumption Only	
	Freshwater Standard	Freshwater Standard	Marine Standard
Zone 2	0.0444 ng/l		
Zone 3	0.0444 ng/l		
Zone 4		0.0448 ng/l	
Zone 5		0.0448 ng/l	0.0079 ng/l

Note: Shading indicates that a standard of this type does not apply based upon the designated uses of the zone. The more stringent of the freshwater or marine standard applies in Zone 5 of the river below the Delaware Memorial Bridges.

These standards need to be reviewed and revised to incorporate new information on the toxicity of PCBs and other factors such as the consumption rate used in developing the standards. In addition, the NJDEP and U.S. EPA Region II will shortly be adopting wildlife criteria for PCBs to protect avian species including the bald eagle. The Commission currently has the protection of wildlife as a designated use in Zones 2 - 5 but has no numerical criteria. The recent interest in the impact of existing and proposed dredging activities in the estuary suggest that criteria for evaluating the use and disposal of dredged material should also be included as targets in establishing the TMDLs.

Objective

The water quality target(s) for the TMDLs for PCBs must be established as soon as possible since the extent and complexity of the water quality models needed to establish and allocate the TMDLs are driven by the most stringent water quality target. For example, achieving a water quality standard based upon the protection of human health requires model simulation periods of years while achieving a wildlife criteria requires simulation periods of several months. In addition, the complexity of the sediment component of the model will be less if a longer simulation period is used.

Tasks

Tasks	Lead Agencies	Schedule
1. Determine targets for TMDLs	DRBC, TAC	October 2000 to March 2001
– Revise human health water quality criteria for PCBs.	DRBC, TAC	October to December 2000
– Determine the need for and establish wildlife criteria for PCBs.	DRBC, TAC	January to March 2001

Tasks	Lead Agencies	Schedule
– Determine the need for and establish, as appropriate, other targets such as narrative standards, sediment criteria, dredging criteria, or fish residue concentrations.	DRBC, TAC	January to March 2001

2. Characterize environmental concentrations of PCBs in ambient air and waters, sediments and fish tissue of the estuary.

Knowledge of the concentrations of PCBs in the air, water, sediments, and biota of the estuary are needed to identify and prioritize problems, and direct the design of monitoring efforts that will support the establishment of the TMDLs. The studies described below will be used to better quantify inputs of PCBs to the estuary, evaluate relationships between inputs and variables such as tributary flow and sediment loadings, and to design the studies that will provide data to calibrate and validate the PCB water quality model.

Objective

The objective of this task is to determine the concentrations of PCBs in the various compartments of the estuary ecosystem during the development of the TMDLs to identify and prioritize problems, and assist in the design of studies to support development of the water quality model and the establishment of TMDLs for PCBs.

Tasks

Tasks	Lead Agencies	Schedule
1. Conduct yearly monitoring of tributaries for PCB congeners during both base-flow and storm conditions.	DRBC, U.S. Geological Survey	May 2001 to September 2003
2. Conduct yearly monitoring of the ambient waters of the estuary for PCB congeners.	DRBC	September 2001 to September 2003
3. Conduct periodic surveys (every 3 to 5 years) of the sediments of the estuary.	DRBC	CY 2001
4. Determine wet and dry deposition of PCBs from the atmosphere at selected locations including Washington's Crossing, Camden and Bivalve.	NJDEP, Rutgers University	CY 1999 - 2002

Tasks	Lead Agencies	Schedule
5. Perform special studies of the levels of PCBs in fish and shellfish species not monitored in yearly trend studies.	DRBC	September 2001 to September 2003

3. Identify and quantify sources of PCBs.

While manufacture and use of PCBs in new equipment was restricted in the late 1970's, PCBs continue to enter the environment from multiple sources. These sources include existing electrical equipment ranging from large transformers to smaller capacitors, heat transfer equipment, hydraulic equipment, equipment specifically exempted in the Toxic Substances Control Act (TSCA) for small quantities and specific uses, and sites contaminated by PCBs through either use or improper disposal. Some equipment can be designated as "non-PCB containing" even though it contains trace quantities of PCBs that have significant environmental consequences. For example, PCB transformers containing less than 50 parts per million (mg/KG) of PCBs are classified as non-PCB transformers. In June 1998, the U.S. EPA issued final rules authorizing certain uses of PCBs and the manufacture and distribution of PCBs for use in research and development activities, specifying alternatives for cleanup and disposal of PCBs, and clarifying the process for exceptions to disposal.

Objective

Establishing a TMDL requires the identification of specific sources of PCBs in several categories. Point sources have been identified as significant contributors of PCBs (Frithsen et al, 1995; DRBC, 1998). Point sources principally include discharges of wastewater, cooling water and stormwater from industrial and municipal facilities to the estuary, but may also include permitted discharges from landfills and hazardous waste (i.e., Superfund) sites, and combined sewer overflows (CSOs). Non-point sources consist of those sources not included in the point source category, such as loadings from tributaries (particularly the two largest tributaries, the Delaware and Schuylkill Rivers); atmospheric deposition; landfills, Superfund sites, and stormwater sources not covered under the point source category; and estuary sediments.

Allocations of the TMDL to each of these source categories is essential if water quality standards are to be achieved and maintained. Initial collection results and model sensitivity runs will be used to identify those source categories and specific sources for which additional monitoring is necessary.

Tasks

Tasks	Lead Agencies	Schedule
1. Create an inventory and prepare GIS maps of major sources of PCBs.	U.S. EPA Region III	CY 2000
2. Request monitoring of wastewater, cooling water and stormwater discharges from point sources.	DRBC	February 2000 to May 2001

Tasks	Lead Agencies	Schedule
– Issue letters to dischargers.	DRBC	February & March 2000
– Hold informational meetings.	DRBC, U.S. EPA, States	March & April 2000
– Receive monitoring data.	DRBC	January 2001
– Complete data base entry.	DRBC	May 2001
– Additional monitoring of selected discharges.	DRBC	May 2001 to December 2003
3. Determine loading of PCBs from dry and wet atmospheric deposition.	Rutgers University	CY 1999 to 2001
4. Determine tributary loadings of PCBs.	U.S. Geological Survey, DRBC	April 2000 to January 2001
5. Determine loadings from landfills, Superfund sites and other sources.	U.S. EPA Regions II and III	CY 2000/2001

4. Determine the transport and fate of PCBs entering the Delaware Estuary

Mathematical models are an essential part of this strategy for several reasons. First, they allow the simulation of the important hydrodynamic forces that distribute substances within the estuary. In view of the complex hydrodynamic characteristics of the estuary including the significant tidal influence and regulated nature of the main tributaries to the estuary, a complex mathematical model is needed. Second, they permit the inclusion of significant fate processes for PCBs including volatilization, sorption, biodegradation and bioaccumulation. Third, they allow the sensitivity of the various transport and fate processes to be evaluated to both guide the collection of data during model calibration and validation, and the identification of significant sources of PCBs. Finally, they permit the evaluation of alternative source reduction strategies, and the selection of the most efficient strategy to achieve the water quality standards.

Objective

A calibrated and validated model of the estuary for PCBs must be developed in order to establish numerical values for the TMDL in each of the four zones of the estuary, and determine wasteload allocations for significant point sources and load allocations for significant non-point sources. The model will include at least two major components: a hydrodynamic model and a water quality model. A one dimensional and three-dimensional hydrodynamic model of the estuary have been established by the Commission to address oxygen-demanding, bacterial and toxic pollutants in the Delaware Estuary. A water quality model or models will need to be developed to accept the loadings from the various source categories, partition the PCBs between various phases (e.g., dissolved, particulate), and apply degradation processes. Other model components that will either be separate submodels or will be integrated into the water quality model include sediment and bioaccumulation models. An expert panel will be formed to define the scope of the models

and guide the modeling efforts.

Tasks

Tasks	Lead Agencies	Schedule
1. Establish expert panel to guide model development and model calibration.	DRBC	Summer 2000
2. Define the scope of the models.	Expert panel, DRBC, States, U.S. EPA	Fall 2000
3. Develop mathematical model to simulate the transport and fate of PCBs in the Delaware Estuary.	DRBC	July 2000 to June 2001
4. Collect ambient water, sediment and significant source data for model calibration and validation.	DRBC	July to October 2001
– Monitor significant tributaries and seaward boundary.	DRBC	July to October 2001
– Collect samples at significant point and non-point sources.	DRBC	July to October 2001
– Collect sediment samples where needed based upon characterization studies.	DRBC	July to October 2001
– Collect ambient water samples for comparison to model predictions.	DRBC	July to October 2001
– Determine atmospheric deposition of PCBs to refine loading estimates for specific model segments during the calibration/validation of the water quality model.	Rutgers University	July 2001 to June 2002
5. Perform calibration and validation of the PCB model.	DRBC	January 2002 to June 2002

5. Establish TMDLs and associated components for PCBs.

Several policies and procedures, particularly for non-point sources, also need to be developed to guide the establishment of the TMDLs. These include allocations of the TMDL to a margin of safety and a reserve, identification of design conditions, the initial loading values to be assigned, and the allocation procedures to be followed.

Objective

Establishment and allocation of TMDLs for PCBs in each of the 4 zones of the estuary requires the utilization of existing policies and procedures for continuous point source discharges, and the development of policies and procedures for non-point sources and other types of point source discharges such as cooling water and stormwater discharges. The policies and procedures will then be utilized with the mathematical models to establish and allocated the TMDLs. Finally, public participation of the proposed TMDLs and allocations will be conducted through public hearings and the solicitation of public comment prior to consideration by the Commission.

Tasks

Tasks	Lead Agencies	Schedule
1. Develop policies and procedures for developing TMDLs including load allocation procedures, design conditions, initial loading values, reserve and margin of safety.	DRBC, TAC	October 2000 to June 2002
2. Utilize the PCB model to establish TMDLs, wasteload allocations and load allocations.	DRBC	July 2002 to October 2002
3. Conduct public hearings and solicit comment on the proposed TMDLs and allocations.	DRBC	January to June 2003

6. Develop an Implementation Plan to Reduce PCBs in the Estuary System

Due to the many sources and pathways of PCB contamination it will require a significant level of cooperation and investment to reduce PCBs in the estuary. This section of the strategy sets up mechanisms to: 1) develop a GIS-based data base to facilitate analysis of implementation alternatives; 2) track down existing problem and develop cleanup plans; 3) educate owners and operators of facilities with potential PCB contamination of proper disposal methods; 3) establish a pollution prevention / incentives program, and 4) create a group of stakeholders to advise the DRBC Commissioners on implementation strategies.

Objective

The objective of the PCB strategy is to reduce the levels of PCBs in the Delaware Estuary in order to protect the health of humans, fish and wildlife. While the previous tasks centered on the science necessary to develop TMDLs and analyze sources and pathways, this element deals with implementation. Due to the nature of PCBs, the clean up can be very far reaching and costly. The tasks described here are meant to assess multiple ways of reducing the contaminant and allowing input from many stakeholders. The end product will be a clean up plan that achieves the environmental goals in a way the region can implement.

Tasks

Tasks	Lead Agencies	Schedule
1. Create and continually update GIS-based graphic database to show potential sources of PCBs (from Element 2 & 3) to analyze and assess sources and impacts and for use in public outreach.	EPA with States and DRBC	January 2001 to September 2003
2. Establish TMDL Implementation Advisory Committee		
– Establish funding base	DRBC, EPA with others	January to September, 2001
– Hire facilitator with experience in interest-based negotiation	DRBC /EPA	January to June 2001
– Through interview process select members	Facilitator and Outreach Sub-Committee	February to June 2001
– Work with Implementation AC to recommend a cost effective control strategy to achieve water quality targets considering all sources of PCBs to the estuary.	All	June 2001 to September 2003
3. Initiate and conduct a PCB Trackdown Study in selected municipal sewage collection systems.	DRBC, states, EPA, Philadelphia, Camden & Wilmington	February 2000 to February 2002
– Develop scope of work for study	DRBC, EPA, States and municipalities	February 2000 to February 2001
– Issue contract to perform study	DRBC	March to June 2001
– Conduct pilot study and prepare report	Consultant	June to December 2001
– Develop a compliance and incentive program to reduce noted sources.	States	January 2002 to June 2002
4. Develop a strategy for and initiate a PCB Pollution Prevention and Clean-up Program	EPA &States	April 2001 – June 2003
– Establish partnerships with other federal agencies such as GSA, DOD to develop a self-inspection program to identify equipment containing PCBs and sites contaminated with PCBs	U.S. EPA	

– Work with owners and operators of sites potentially contaminated with PCBs to identify and remove contaminated equipment and parts prior to disposal.		
– Recommendations to EPA and COE on PCB contaminated sediment management and remediation prioritization.		

7. Increase Environmental Awareness of Toxicity Issues in the Delaware Estuary

It is important to educate the affected parties and general public about PCBs and other toxic contaminants in order to help reduce existing levels of these substances and to thwart additional inputs to the system. A common misconception is that current PCB contamination is solely a result of practices that were banned in the late 1970s. Although PCBs are no longer being commercially manufactured, existing PCBs continue to enter the environment from a variety of pathways. In addition, safe levels of PCBs in the environment are extremely low (in parts per quadrillion) so that even small amounts of PCBs can impact living organisms, including humans.

It is important to include an education component in the strategy that addresses past and present sources and pathways, impacts to humans and wildlife, and the proper care and disposal of materials that contain or have been contaminated by PCBs. The educational materials and outreach sessions should also touch on other toxics in the estuary and their similarities and differences from PCBs.

Tasks

Tasks	Lead Agencies	Schedule
1. Work with agencies and stakeholders to develop an education and outreach program	DRBC, EPA	On-going, beginning October 2000 to September 2003
2. Produce pamphlets addressing common sources of PCBs and their impact on human health, aquatic life and wildlife.	U.S. EPA and Outreach Subcommittee	October 2001
3. Write articles for relevant newsletters including the Estuary News	Multiple authors	October 2000 to September 2003
4. Develop and update web site with educational information about PCBs in the estuary environment	DRBC with input from others	Beginning April 2001 – September 2003

5. Organize and run series of public educational meetings	DRBC, EPA, states, stakeholders	Feb./March 2001 Jan/Feb 2002 Jan./Feb 2003
6. Distribute information on PCB regulations, proper disposal procedures and proactive approaches.	U.S. EPA	July to October 2001

8. Monitor long-term concentrations of PCBs in air, water and sediments of the Estuary.

One required element of a TMDL is the reasonable assurance that the TMDLs are actually achieved. This is particularly important where non-point sources of a pollutant are a component of a TMDL since point sources may be assigned a less stringent wasteload allocation based upon the assumption that non-point source load reductions will occur as a result of the implementation of best management practices or other non-regulatory requirements. Monitoring of the concentrations of PCBs in the various compartments of the Delaware Estuary ecosystem will provide information on the success of the implementation plans and the achievement of the TMDL. The monitoring will also provide information on the distribution of PCBs within the ecosystem following the source reductions to ensure that problems are not created in another media.

Objective

The objective of this element is to track the trend in the concentrations of PCBs in the various compartments of the Delaware Estuary ecosystem (i.e., air, water, sediments and biota) to determine if the components of the implementation plan have resulted in the achievement of the TMDLs.

Tasks

Tasks	Lead Agencies	Schedule
1. Monitor concentrations of PCBs in tissues of important fish species.	DRBC and States	CY 1990 to 2010
2. Conduct yearly monitoring of tributaries for PCB congeners during both base-flow and storm conditions.	DRBC, U.S. Geological Survey	CY 2004 to 2010
2. Conduct yearly monitoring of the ambient waters of the estuary for PCB congeners.	DRBC	CY 2004 to 2010
3. Conduct periodic surveys (every 3 to 5 years) of the sediments of the estuary.	DRBC	CY 2005 & 2010
4. Determine wet and dry deposition of PCBs from the atmosphere at selected locations in the estuary airshed.	NJDEP, PADEP, DE DNREC and U.S. EPA	CY 2004 to 2010

9. Monitor long-term concentrations and impacts to living resources of the Delaware Estuary.

Living organisms such as fish and birds are important components of the Delaware Estuary ecosystem that includes man. These organisms not only provide enjoyment to humans for sport and esthetic reasons, but are also key elements in the structure and function of the ecosystem. Fish species such as the American shad, striped bass and channel catfish provide sport and sustenance to the population of the Delaware Valley. Raptors such as bald eagles and ospreys are important sentinels of environmental contamination given their high trophic level position. Monitoring of tissues of both fish and raptors for PCBs and other contaminants will permit the evaluation of the contribution of these contaminants to observed reproductive and development effects in raptors, and the assessment of long-term trends in environmental concentrations.

Objective

The issuance of fish consumption advisories by states bordering the estuary, and the documented failures of nests of bald eagles and other raptors require continued monitoring of the levels of PCBs and other chlorinated organic chemicals in the tissues of resident fish and avian species (Clark et al, 1998). The tasks in this element will continue and expand the existing data base on contaminants levels and trends in the tissues of these species. This data will be essential to monitor the effectiveness of control strategies in reducing PCB contamination and the need for fish consumption advisories to protect human health.

Tasks

Tasks	Lead Agencies	Schedule
1. Monitor concentrations of PCBs in tissues of important fish species.	DRBC and States	1990 to present
2. Monitor concentrations of PCBs and other organochlorines in bald eagles and ospreys.	NJDEP	July 2000 to June 2002
– Collect and analyze sediment samples from bald eagle nesting areas.	NJDEP	July 2000 to June 2001
– Collect and analyze fish prey species of bald eagles.	NJDEP	July 2000 to June 2002
– Analyze eagle eggs, tissue and blood samples.	NJDEP, DE DNREC	July 2000 to June 2002
3. Monitor eagle foraging and nesting areas.	NJDEP	July 2000 to June 2001
4. Compile existing data on contaminants in osprey eggs and nestlings.	NJDEP	July 2000 to June 2002
5. Monitor concentrations of PCBs in tissues of bald eagles, ospreys and other important avian species.	NJDEP, DE DNREC & U.S. F&WS	CY 2004 to 2010

References

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