EPA PBT Monitoring Strategy

- DRAFT December 19, 2003 -

PBT Monitoring Strategy Writing Team

Office of Research and Development (coordinator)
Office of Water
Office of Prevention, Pesticides and Toxics Substances
Office of International Affairs
Office of Air and Radiation
Region 5
Region 4

For internal EPA review only

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1.0 INTRODUCTION

1.1 Background

Goals for the
PBT Monitoring Strategy

Discern long-term trends of PBTs in the environment, and measure the effectiveness of risk management actions.

Persistent and bioaccumulative toxics (PBTs) are harmful pollutants that transfer easily across air, water, and land, linger for decades in soils and sediments, and can travel long distances through the air, crossing state, regional, and national boundaries. Some of the most persistent, bioaccumulative and toxic of these substances include mercury, dioxin, and polychlorinated biphenyls (PCBs). Mercury, dioxin, and PCBs in the environment pose neurological and reproductive risks for humans and wildlife. Fish consumption advisories for mercury, dioxin, and PCBs put fish consumers at risk in many states and in each of the Great Lakes.[1] The amount of mercury and dioxin found in food is cause for recommendations to limit consumption of certain types of foods to reduce exposure.[2,3] According to the EPA and to the Centers for Disease Control and Prevention, about eight percent of women of child-bearing age in the U.S. in 1999-2000 had, using EPA's methylmercury reference dose (RfD), levels of mercury in their blood associated with increased risk of adverse health effects to children exposed in utero.[4]

Through EPA's PBT Chemical Program, EPA is forging a new approach to reduce risks from, and exposures to, PBTs by creating a cross-agency system that can overcome the challenges associated with pollutants that cross media-specific boundaries. EPA is developing various PBT National Action Plans, several of which cite the need for a national strategy for routine monitoring of PBTs.

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[1] See http://www.epa.gov/waterscience/fish/ for a listing of fish advisories issued by EPA.

[2] Institute of Medicine (2003). "Dioxins and Dioxin-Like Compounds in the Food Supply: Strategies to Decrease Exposure," National Academy of Sciences, July 2003.

[3] Both the EPA and FDA have issued national advisories to women who are pregnant or may become pregnant, nursing mothers, and young children. FDA's national advisory is posted at http://vm.cfsan.fda.gov/~dms/admehg.html. EPA's national advisory is posted at http://www.epa.gov/waterscience/fishadvice/advice.html.

[4] United States Environmental Protection Agency (2003). "America's Children and the Environment: Measures of Contaminants, Body Burdens, and Illnesses," Second Edition. U.S. Environmental Protection Agency, February 2003, EPA 240-R-03-001.

This document responds to a 2000 decision by the EPA Assistant Administrators (AAs), in recognition that a coordinated approach to monitoring PBTs was needed to develop information on long-term trends of PBTs in the environment and on risk management program effectiveness. Mercury, dioxin, and PCBs were identified as a top priority, though other PBTs, in particular emerging PBTs, are to be addressed by the Strategy as well. The Strategy development has been a cross-program effort involving:

- EPA Office of Water (OW);
- EPA Office of Air and Radiation (OAR);
- EPA Office of Prevention, Pesticides, and Toxics Substances (OPPTS);
- EPA Office of International Affairs (OIA);
- EPA Region 5;
- EPA Region 4;
- EPA Region 1; and,
- EPA Office of Research and Development (ORD), who has served to coordinate the effort.

The *PBT Monitoring Strategy* serves to:

- guide the planning and development of a *National Multimedia Monitoring and Assessment Program for PBTs, 2004-2020* (referred to hereafter as the *Program*); and,
- provide specific recommendations that will enhance the envisioned program.

The goals of a *National Multimedia Monitoring and Assessment Program for PBTs,* as outlined in the *PBT Monitoring Strategy*, are to:

- Discern long-term trends of PBTs in the environment, and
- Measure the effectiveness of risk management actions over time.

A national multimedia monitoring and assessment program for PBTs would, through various means, promote closer communication and cooperation among monitoring agencies within and outside EPA. Included among the key activities would be periodic comprehensive assessments over the next two decades to study trends in PBT concentrations in multiple media (e.g., humans, food, air, sediments). These assessments, described in more detail in Chapter 5, would provide EPA and others with information to help achieve the above goals. They would also identify new scientific information needed for progressively improved assessments.

1.2 The Need for a Coordinated PBT Monitoring and Assessment Program

While many programs that monitor PBTs are being conducted by EPA and other federal and state agencies, in general, these programs operate independently, with no integration, coordination, or sharing of information. As a result, gaps and inefficiencies exist in the available monitoring data for PBTs. As noted in EPA's 2003 *Draft Report on the Environment*, "Many government agencies and other groups gather similar environmental data ... Yet, differences ... limit the broader use of data." The report also states that "... standard data collection and analysis approaches are critical to ensuring comparability ... and will enable greater use of ... data already being collected."[5]

A number of views expressed outside the EPA have also voiced concern over the lack of coordination among monitoring efforts. For example, the Government Accounting Office report states that "..." **[Need to fill the "..." in]** The Heinz Commission's report, *The State of Our Nation's Ecosystems*, notes that "We cannot know whether our current environmental policies and practices are sound, and we cannot make new policy with confidence, without a . . . set of . . . measures of fundamental properties of the environment."**[need reference]** The Quick Silver Caucus of the Environmental Council of the States "urges the President of the U.S. and Congress to expand federal and state capacity for mercury-related environmental monitoring . . ." **[need reference]**.

The *PBT Monitoring Strategy* proposes a *National Multimedia Monitoring and Assessment Program for PBTs, 2004-2020*, a cross-agency Strategy for monitoring PBTs in various media. This cross-agency Strategy would establish a new, coordinated multimedia network and assessment program that strengthens and better integrates existing monitoring programs both within and outside of EPA. The Strategy would require a modest new investment, for the most part leveraging the resources of federal agencies and enhancing partnerships with States and Tribes and international counterparts. The key to the Strategy is the coordination of a number of current high-quality PBT monitoring efforts and the integration of results through periodic data assessments.

[5]United States Environmental Protection Agency (2003). *Draft Report on the Environment*, U.S. Environmental Protection Agency, June 2003, EPA 260-R-02-006. Available at http://www.epa.gov/indicators/roe/index.htm

The proposed Strategy will support EPA's corporate goals by:

- providing information for cross-EPA efforts like the *Report on the Environment;*
- strengthening EPA's response to Government Performance and Results Act (GPRA) requirements;
- improving the understanding of the multimedia fate and transport of PBTs;
- demonstrating EPA leadership among federal agencies in addressing the problem of PBTs; and,
- identifying ways to leverage expertise and resources to attain monitoring goals.

In addition, the proposed Strategy will be an important tool in evaluating progress toward achieving the goals of the PBT Chemical Program. EPA expects to assess progress toward meeting the objectives of the PBT Chemical Program through the use of direct and indirect measures, including human health and/or environmental indicators (e.g., the National Health and Nutritional Examination Surveys, National Study of Chemical Residues in Fish). Thus, one component of the Strategy, the integration of monitoring data, for example, could not only demonstrate reductions in estimated air emissions as a result of risk management actions, but it could also reveal whether media transfers of PBTs are occurring and the effect on human body burdens as a result of reduction actions.

The Strategy is expected to provide the U.S. contribution to international monitoring strategies and international programs that have been/are being developed, e.g.,

1. The North American Commission for Environmental Cooperation (CEC), has developed a mercury North American Regional Action Plan on Environmental Monitoring and Assessment (NARAP) for the U.S., Canada and Mexico.

2. The Great Lakes Binational Toxics Strategy has indicated a need for improved monitoring data on PBTs, which could be satisfied by the implementation of a national PBT monitoring Strategy. After passing the halfway mark of a ten-year time frame for achieving the Strategy's goals, EPA and Environment Canada have begun to consider a process for reassessing the 12 Level 1 substances identified as a first priority in the Binational Toxics Strategy. Evaluating the status of the Level 1 substances has proved to be difficult in some cases due to a lack of sufficient monitoring data with which to make sound, scientifically based decisions.

The proposed Strategy is expected to provide information supporting EPA program-specific activities, such as OAR's mercury source emission regulatory efforts, OW's Total Maximum Daily Load (TMDL) program, and OIA's support for international and global efforts, including the United Nations Environment Program's (UNEP) Global Mercury Program. The Strategy also is expected to support EPA's International Transport of Atmospheric Pollutants Initiative (ITAP) and help in understanding international transport.

1.3 Organization of the PBT Monitoring Strategy

The *PBT Monitoring Strategy* discusses all aspects of a coordinated PBT monitoring and assessment program, including the foundation and vision for the *Program*, program objectives, evaluation of current monitoring programs, recommendations for building the *Program*, recommendations for addressing emerging PBTs and cost analysis. A proposed schedule is currently being considered. The document is organized as follows:

Chapter 2.0 summarizes the development of a coordinated PBT monitoring and assessment program. This includes a discussion of the key policy questions, conceptual models used as the scientific foundation for the Strategy, and the needs of stakeholders and partners.

Chapter 3.0 describes the vision for a coordinated PBT monitoring and assessment program, including guiding principles and recommended program design and monitoring objectives.

Chapter 4.0 provides an evaluation of current monitoring programs with respect to the PBT Monitoring Strategy objectives and identifies gaps in the current monitoring infrastructure.

Chapter 5.0 presents recommendations for building a PBT monitoring program in light of the gaps identified in the program assessment, including key players, roles, and anticipated outcomes.

Chapter 6.0 describes how the PBT monitoring network and assessment program could be utilized to detect emerging contaminants.

Chapter 7.0 discusses the estimated costs to implement the PBT Monitoring Strategy over a 10-20 period, building on the foundation of existing domestic and international monitoring programs.

Chapter 8.0 proposes a timeline for baseline and periodic assessments of PBT monitoring data, as well as a schedule for updates and a reassessment of the PBT Monitoring Strategy.

Appendix A illustrates conceptual models for mercury, dioxin, and PCBs, which depict the pathways through which mercury, dioxin, and PCB contamination travel to and affect humans and wildlife.

Appendix B presents detailed assessments of key leveraging programs in each media category.

Appendix C discusses the need for integration of modeling exercises with monitoring activities.

2.0 DEVELOPING A VISION FOR A COORDINATED MONITORING AND ASSESSMENT PROGRAM

Key components in developing a vision for a coordinated monitoring and assessment program:

- Identify key *Program* questions
- Develop conceptual models
- Proactively involve stakeholders

The purpose of the *PBT Monitoring Strategy* is to guide the planning and development of a *National Multimedia Monitoring and Assessment Program for PBTs, 2004-2020.* To ensure the success of a multimedia monitoring and assessment program, a multi-step process was employed in developing the Strategy. Figure 2-1 depicts the framework for developing the *PBT Monitoring Strategy*.

First, a clear vision needed to be established, a vision that defined the *Program* and provided a framework for achieving the Strategy's goals as defined in Chapter 1. This vision establishes the program design and monitoring Strategy objectives that would outline the scope and intent of the *Program* (these objectives are presented in Chapter 3). Once a vision had been developed, the next step was to understand the extent to which current monitoring programs met the objectives as defined in this vision and to identify gaps where the vision was not being met (current monitoring program assessments are presented in Chapter 4). Then, Strategy recommendations were formed to support monitoring efforts that currently contribute to meeting the objectives and to fill any of the gaps preventing the vision from being achieved (the recommendations are presented in Chapter 5).

As Figure 2-1 shows, developing the vision for the *Program* was critical in the overall framework for developing the Strategy. At the foundation of this vision were three primary inputs: 1) key *Program* questions to consider, 2) conceptual models for the transport of the substances in the environment--the scientific foundation for the *Program*, and 3) coordination with partners and stakeholders, to ensure the envisioned program addressed their needs. Each of these three areas provided monitoring, design, and/or assessment implications for PBTs, which helped to both lay the foundation for the vision and to shape the recommendations for the Strategy. The following sections discuss each key area and its resulting implications.

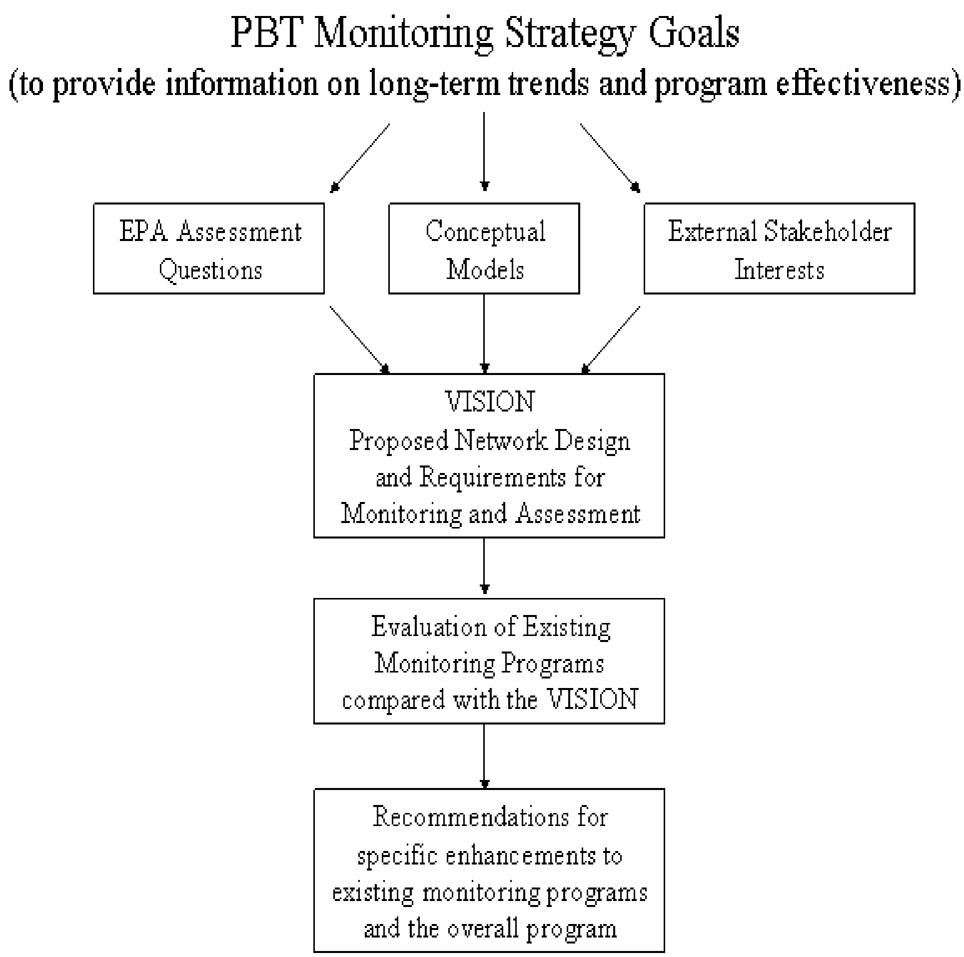

Figure 2-1. The framework for developing the PBT Monitoring Strategy.

2.1 Key *Program* Questions

One goal of the *National Multimedia Monitoring and Assessment Program for PBTs* is to produce comprehensive periodic assessments of PBT trends in the environment. In considering how these assessments would be designed and what beneficial information these assessments might provide, a set of key *Program* questions was developed. These questions attempt to relate current EPA interests to periodic assessment outcomes. By design, these key *Program* questions also carry with them monitoring implications, which then feed into the development of a vision for the Strategy. The questions and their resulting monitoring implications are presented in Table 2.1.

Clearly these are specific, pointed questions aimed at eliciting detailed, relevant information contributing to the "answers" through planned *Program* assessments. Though this may not be an exhaustive list of current Agency concerns, the fact that answers to these questions are not yet clear is an indication of the gaps that exist in current monitoring and assessment efforts. Certainly the *Program* will not be able to answer all of the questions that exist about the fate of PBTs in the environment, but EPA expects that the implementation of the Strategy will answer some of the pressing PBT questions while providing information and helping to develop the tools and the knowledge necessary to understand how to answer the other questions. In fact, many of these questions touch on the multimedia, multi-regional nature of PBTs. Without a focused, multi-agency effort to address PBTs in the environment, these questions and others like them may never be answered.

Table 2-1. Key *Program* questions and the resulting monitoring implications.

	Questions	Implications
1	Have strategies to reduce mercury emissions from coal fired electric generating units been effective in reducing mercury emissions, deposition, and fish tissue concentrations?	Provide sufficient mercury monitoring (number/location of sites and correct measurements) in coal combustion impacted areas.
		Monitor emissions, deposition, and fish tissue concentrations.
		Develop and apply dry deposition method for mercury.
		Measure speciated mercury emissions.
2	What is the relative impact of domestic sources of mercury on local, regional, and global deposition?	Provide measurements needed to conduct source apportionment analyses (e.g., deposition, co-pollutants, meteorology, etc.).
		Develop and apply dry deposition method for mercury.
		Measure speciated mercury emissions.
3	What are the relative contributions of the small, geographically disperse (e.g., open burning), or non-point (reservoirs) sources of dioxins and PCBs?	Improve characterization of dioxin and PCB sources.
4	Have strategies to reduce dioxin emissions (i.e., MACT standards) been effective in reducing dioxin emissions, deposition, fish tissue concentrations, and concentrations in beef and dairy?	Provide sufficient dioxin monitoring in impacted areas.
		Monitor dioxin emissions, deposition, and fish tissue concentrations.
		Monitor dioxin concentrations in beef and dairy products.
5	What mitigation is needed or what sources should be targeted to reduce PBT loadings to water bodies?	Monitor PBT releases, deposition, and fish tissue concentrations.
6	What are the sources of PBT concentrations in sensitive ecosystems such as the Great Lakes, Chesapeake Bay, and the Everglades?	Monitor regional deposition of PBTs and provide measurements for source apportionment analyses.
7	What are the levels of PBTs in sensitive wildlife species and ecosystems?	Monitor PBT levels in sensitive ecosystems and wildlife species.

Table 2-1. Key *Program* questions and the resulting monitoring implications (continued).

	Questions	Implications
8	What are concentrations of PBTs in fish tissues and how are they responding over time to reduction efforts?	Monitor PBT releases, deposition, and fish tissue concentrations.
9	What are the relationships between PBT releases, deposition, fish and food concentrations, and human and ecosystem exposures?	Provide data to evaluate science and to help establish relationships between media.
10	What are the PBT levels in humans, particularly in sensitive or susceptible subpopulations?	Support existing biomonitoring programs and conduct targeted biomonitoring of subpopulations.
		Monitor food supplies as the primary exposure route for human PBTs.
11	What are the relative contributions of local, regional, continental, and international sources of PBTs to domestic air deposition of PBTs? **[NOTE: This may need discussion with EPA before finalize.]**	Monitor regional deposition of PBTs and provide measurements for source apportionment analyses. Expand monitoring of air flows in key areas to assess contribution from foreign sources transporting across U.S. borders.
12	What are PBT trends in various media by region? How do they compare to levels and trends over time in other regions?	Provide monitoring at sufficient levels to detect regional trends.
13	Based on a suite of routine indicators, what are the trends of PBTs in the environment and how effective have strategies to address PBT chemicals been in reducing PBT levels?	Provide routine monitoring information for PBTs in various environmental media.
		Conduct periodic assessments to measure progress of EPA actions.
		Develop routine indicators in different media to track PBT trends.
		Provide trends for PBT chemicals in various media.
14	Are new PBT chemicals being introduced into the environment? If yes, can we track recent trends?	Monitor emerging PBTs.
		Establish an early warning system.
		Archive samples for possible re-analysis later.

2.2 Conceptual Models

Developing an overall vision of how to coordinate the multimedia monitoring and assessment of PBTs requires an understanding of how PBTs behave in the environment. Because of their physical-chemical properties, individual PBTs often behave differently from each other in the environment. Thus, it is critical to understand how each of these pollutants are emitted into the environment, their fate and transport within and between various environmental media, and, ultimately, how humans and wildlife are exposed. To provide this information, conceptual models for three PBTs of priority focus for the Strategy were developed. Conceptual models provide a clear written and graphical description, based on the current state of knowledge, of: 1) the physical, biological, and chemical properties of a PBT that are significant for its fate, transport, and exposure; and 2) the causal linkages, to an appropriate level of detail, of sources, pathways, stressors, and human and wildlife receptors. The conceptual models also provide critical information about key monitoring targets (i.e., which sources, media, and receptors to monitor), as well as the temporal and spatial monitoring needs of a given compound. Thus, the conceptual models provide the scientific underpinnings for the Strategy's recommendations. Because the information conveyed by a model may vary from one PBT to another, separate conceptual models were developed for mercury, dioxins, and PCBs. The conceptual models are presented in Appendix A. The specific monitoring implications for each PBT that were derived from these models are presented below.

2.2.1 Monitoring Implications from the Mercury Conceptual Model

For the purposes of the PBT Monitoring Strategy (i.e., to discern long-term trends and measure the effectiveness of risk management actions), the mercury conceptual model suggests the following:

- The most important media to monitor are emissions, air/air deposition, food (e.g., fish/marine mammals), and humans.
- Monitoring of the food supply, for the most part, can be limited to fish (freshwater and saltwater).
- Trends in air emissions are the most responsive measure of the effectiveness of risk management actions.
- There is a need to know the relative contributions of local, regional, continental, and global sources and their chemical speciation to adequately estimate deposition.
- The variability of bioaccumulation processes from one water body to another reduces the value of cross-sectional monitoring of water-column and sediments.

2.2.2 Monitoring Implications from the Dioxin Conceptual Model

For the purposes of the PBT Monitoring Strategy (i.e., to discern long-term trends and measure the effectiveness of risk management actions), the dioxin conceptual model suggests the following:

- The most critical media to monitor are air emissions, air concentrations (to predict deposition), food (e.g., milk, beef, poultry, and fish) and human blood serum.
- Estimates are needed for contributions from uncontrolled combustion and reservoir sources, which drive current exposures but are not well characterized.
- Because dioxins are less mobile than many PBTs, local and regional scale monitoring are more important than trans-continental or trans-oceanic monitoring.
- The mechanism by which dioxin enters the food chain is believed to be through release to the air, air deposition to vegetation, and uptake of vegetation by animals.
- Greater than 95 percent of human exposure to dioxin is from consumption of animal fats in the commercial food supply, with no clear geographical variation.

2.2.3 Monitoring Implications from the PCB Conceptual Model

For the purposes of the PBT Monitoring Strategy (i.e., to discern long-term trends and measure the effectiveness of risk management actions), the PCB conceptual model suggests the following:

- The most important media to monitor are emissions, food, and humans.
- Continued environmental cycling of residual contamination from past releases and uses is considered to be a major current source.
- Sediment concentrations of PCBs are several orders of magnitude higher than in water. Important air sources are not well characterized or known.
- Long-range transport from other countries is a current source of PCBs.
- PCBs most commonly enter the food chain via the sediment-fish pathway.
- Like dioxins, PCBs are fat-soluble and tend to accumulate in fatty tissues.
- PCB exposures occur through ingestion of food, particularly fish.

2.2.4 General Monitoring Implications

Many of the monitoring implications for individual PBTs hold true for all PBTs presented above. In general, air emissions/deposition, food, and humans are important media to monitor for PCBs, mercury, and dioxins. Because these three media are so valuable for all of the PBTs being considered, initial Strategy recommendations focus on expanding existing programs to include monitoring for these compounds in air, food, and humans. Furthermore, the conceptual models indicate that food is an important, if not the most important, route of exposure for humans to these PBTs. In particular, fish consumption plays a major role in human exposure to PCBs, mercury, and dioxins. As such, coordination and expansion of fish monitoring programs are crucial to understanding human exposure to, and the fate of, PBTs.

Despite these similarities, there are differences in the monitoring implications for PCBs, mercury, and dioxins. For instance, dioxins are less mobile in the environment than mercury or PCBs. This means that they are less likely to show a strong "grasshopper" effect, not migrating well around the globe through transport, deposition, and revolatilization. Thus, local and regional scale monitoring (only) may be more important for dioxins than mercury, whose conceptual model indicates that the relative contributions of continental and global sources, in addition to local and regional sources, are important to understanding its environmental fate.

Because each of the PBT conceptual models relies on the current scientific knowledge about PCBs, mercury, and dioxins, there are some uncertainties associated with each model. However, because each PBT can behave differently in the environment, the uncertainties associated with each model differ with each PBT. For example, much uncertainty lies in the transport, transformation, and fate of mercury in the atmosphere, as well as in aquatic and terrestrial media. These uncertainties indicate the need for more monitoring of mercury and its products throughout the environment. Unlike mercury, the environmental fate of PCBs is fairly well understood. However, significant non-reservoir releases of PCBs to air remain uncharacterized. Increased urban air monitoring of PCBs could provide the needed characterization to fully understand non-reservoir sources of PCBs. The dioxin conceptual model, on the other hand, indicates that the quantitative nature of the fate and multimedia transport of dioxin and dioxin-like compounds is lacking. The monitoring implications here are for further dioxin monitoring in all of the key media.

It is clear from Appendix A and the above discussions that, by describing the sources and behaviors of mercury, dioxin, and PCBs, the conceptual models provide the scientific foundation for the Strategy. These models and the monitoring implications derived from them guided the establishment of the Strategy's program design and monitoring objectives and formed the basis for the Strategy recommendations presented in Section 5.0.

2.3 Coordination With Stakeholders and Partners

The *PBT Monitoring Strategy* relies on the ability to leverage existing monitoring programs managed by numerous agencies at different levels including EPA, other federal agencies, and various state and local governments. Thus, it was critical that the needs of both internal (within EPA) and external stakeholders were considered in the process of developing the *PBT Monitoring Strategy*. To this end, workshops were held with pertinent stakeholders not only to involve them in the development of the Strategy, but also to ensure that a coordinated, shared vision was established among all who would be involved in the Strategy or its outcomes. Stakeholder workshops and stakeholder input at various stages also led to design and monitoring implications for the Strategy. The stakeholders involved in developing the Strategy included representatives from individual EPA Regions, EPA offices (e.g., OAR, ORD, OPPTS, OW), state environmental agencies, Tribes, and other Federal agencies (e.g., National Oceanic and Atmospheric Administration (NOAA), U.S. Geological Survey (USGS), international organizations, such as the North American Commission for Environmental Cooperation (CEC), and industry).

2.3.1 Internal Stakeholders

Internal stakeholders provided critical information regarding EPA programs designed to address the environmental concerns related to PBTs (e.g., PBT National Action Plans) as well as insight as to how monitoring PBTs could improve the effectiveness and accountability of EPA's programs. In fact, many of the PBT National Action Plans specifically cite the need for the development of a national strategy for routine monitoring of PBTs. These National Action Plans clearly define the multimedia nature of PBTs and indicate where monitoring efforts, and thus data, are lacking for individual PBTs. The need for a multimedia understanding of PBTs and the specific limitations to this understanding, as defined in the National Action Plans, was a primary driver for the *PBT Monitoring Strategy*.

Internal stakeholders also provided valuable insight and feedback on draft strategy outputs and documents. In addition to informal review and feedback, EPA stakeholders provided input on several different items related to the Strategy at the PBT Monitoring Workshop held in May 2001. This workshop was attended by representatives of various EPA program offices and a small number of key federal agencies known to gather data for environmental media and pollutants of particular relevance to the Strategy. Consensus was reached among the various programs within EPA that a PBT monitoring strategy would be beneficial.

Monitoring Implications: Scope and design issues were discussed at the PBT monitoring workshop held in May 2001. With much discussion and input from the stakeholders and partners at the workshop, key questions regarding the scope and design of the Strategy were established. These questions encompassed everything from the type of media that should be monitored in a national, multimedia program to the appropriate geographic and monitoring time scale that should be employed. The questions also included concerns about the roles of individual EPA offices and the extent to which the Strategy would rely on existing monitoring programs. These questions led to monitoring and design implications for the Strategy and played a key role in the definition and refinement of the objectives presented in Chapter 3.

2.3.2 External Stakeholders

The cooperation of external EPA stakeholders was considered imperative to the success of the Strategy. Many key monitoring activities in various media are performed by federal and state agencies, and other organizations, including ones in the private sector. Communications with non-EPA stakeholders were initiated to involve them in the Strategy development effort and obtain their insight on issues related to PBT monitoring.

The most significant external outreach effort was the second PBT Monitoring Workshop held in Raleigh, North Carolina, in April 2002. This workshop was co-sponsored by USGS, NOAA, the Centers for Disease Control (CDC), and CEC. The workshop included a more diverse group of attendees than the first workshop with internal EPA stakeholders. Participants included representatives of States (e.g., Vermont, Alaska, North Carolina), Native American

Tribes (e.g., the Manilaq Association (Alaska)), academia (e.g., North Carolina State University), and industry (e.g., the Electric Power Research Institute and the American Petroleum Institute). This meeting not only provided valuable input and feedback on the draft Strategy objectives, but it also resulted in wide agreement among the attendees that a national PBT monitoring Strategy would be beneficial.

Monitoring Implications: External stakeholders expressed needs and concerns to be addressed in the development of the Strategy. These concerns had implications for the design of the Strategy. Specifically, state representatives indicated a willingness to participate in a national program but forewarned that shifts in funding or incentives would be needed to allocate resources to PBT monitoring. In general, external stakeholders agreed that EPA should provide a "guidance and integration" function related to monitoring priorities, common measurement methods, and information accessibility. Also, a tribal representative felt that federal rules sometimes do not adequately address the needs of Tribes and rural communities and that cultural concerns should be considered in developing the Strategy. Finally, an industrial representative spoke of the need for good sampling and analytical methods to ensure sufficient data quality and thus valid interpretations. These implications were taken into consideration as the Strategy development process continued, and they played an important role in developing the vision for a national multimedia monitoring and assessment program.

3.0 THE VISION: WHAT A COORDINATED MONITORING AND ASSESSMENT PROGRAM LOOKS LIKE

3.1 Strategic Principles

Benefits of Realizing the Shared Strategic Vision of the PBT Monitoring Strategy

- Integration of currently disparate monitoring programs
- Widespread monitoring efficiencies and cost savings
- Comprehensive multimedia and multi-pollutant data assessments.

Based on stakeholder input and Strategy development discussions, a set of strategic principles were developed. These principles serve as a guide for the establishment of a *National Multimedia Monitoring and Assessment Program for PBTs,* providing a foundation upon which to build the Strategy's vision and describing characteristics that the Strategy should embody. There are three main strategic principles:

1) *Cooperation and Mutually Beneficial Partnerships:* Facilitate mutually beneficial partnerships, which will improve cooperation and integration of multimedia monitoring programs managed by various organizations.

2) *Leveraging:* Maximize the use of incremental investments and value-added opportunities by considering existing activities and building upon those activities where possible.

3) *Reasonable Cost:* Make more efficient use of current program funding and reduce the need for additional support by integrating and leveraging existing programs and resources where possible and by establishing successful cross-program partnerships.

The main principles of the Strategy advise leveraging existing resources and establishing mutually beneficial partnerships. To achieve this, it is crucial that a *National Multimedia Monitoring and Assessment Program for PBTs* provide value not only to EPA stakeholders, but also to other shareholders. To this end, the *PBT Monitoring Strategy* was developed with the input of other federal agencies, States, Tribes, and stakeholders. It is also important that, as the *Program* develops, the partners who provide data for the *Program* find value in the collective information gathered and the resulting data assessments. Otherwise, there may be little incentive for partners to continue providing the needed information over the long term. In the interest of the lasting success of the *Program*, EPA will continue to seek input from its partners and stakeholders so that value for these shareholders is maintained throughout the course of the *Program*.

As multinational PBT strategies develop, it is expected that international partners, such as CEC's monitoring efforts planned across the U.S., Canada, and Mexico, will also find value in a U.S. PBT monitoring strategy.

Leveraging existing monitoring programs involves considering and integrating PBT data collected through a variety of EPA programs and other efforts. It is expected that data collected by States, Tribes, and other federal departments and agencies will considerably supplement data collected by EPA. By using and integrating existing data collection efforts, the Strategy will make efficient use of scarce resources. In addition, sharing data offers value for individual data providers, such as States or Tribes, by enabling them to examine their data within a larger geographic setting than their own jurisdiction. Existing monitoring networks also provide the available infrastructure and thus opportunity to increase or establish PBT monitoring in key media where data are otherwise lacking.

Within the first two principles (leveraging and mutually beneficial partnerships) is the underlying theme of the third strategic principle, that the Strategy should strive to be implemented at a reasonable cost to all participating parties. A significant amount of valuable monitoring information is generated by many monitoring programs that address PBTs in various media. These programs, however, have not been working together with any sense of shared strategic vision. Simply integrating these existing programs will go a long way toward achieving the Strategy's goal without presenting an additional cost of establishing new networks. Cross-program partnerships and collaborations are also important in reducing costs. A number of successful partnerships upon which to build already exist, such as the Mercury Deposition Network (MDN), a collaborative network sponsored by federal and state agencies, Native American Tribes, and others. Moreover, a general willingness to cooperate in developing a PBT monitoring strategy has been expressed at various levels by those in the monitoring/modeling community. For these reasons, developing a coordinated routine PBT multimedia monitoring program at reasonable cost appears feasible.

3.2 Objectives

To achieve the Strategy's goals of discerning trends and evaluating program effectiveness, it is necessary to provide objectives that are sufficiently detailed so as to guide the planning and management of a PBT monitoring network and assessment program. The monitoring and design implications (see Chapter 2) from the key *Program* questions, the conceptual models, and the stakeholder input formed the foundations for the development of these Strategy objectives. These objectives convey the vision for a national network and assessment program, helping to guide the formation of monitoring and assessment efforts that will integrate and report information in a useful way for EPA and others. This section describes the Strategy's objectives.

3.2.1 Scope Objectives

Build upon Existing Programs

The third strategic principle of “reasonable cost” proposes building a *National Multimedia Monitoring and Assessment Program for PBTs* without significant capital investment by using existing programs as a base upon which to integrate and expand PBT monitoring to fill current data gaps. Building on existing programs may include:

- adding monitoring sites to a network to improve geographic coverage;
- analyzing current samples for PBTs, in addition to base program analytes; or
- simply continuing current monitoring of PBTs.

A number of existing programs have expressed an interest in cooperating to establish a PBT monitoring program, as evidenced by their support and involvement in Strategy development efforts. For instance, USGS, NOAA, CDC, and CEC co-sponsored EPA's *Second Routine Persistent Bioaccumulative Toxics Monitoring Strategy Workshop* held on April 22-24, 2002.

Integrate Existing Information Across Various Efforts

PBT data shared by many States, federal agencies, and Tribes will be essential to accomplish the Strategy's overall goals of assessing trends and determining the effectiveness of management control actions. Because data collected by EPA cannot fully account for all PBTs in all of the key media, it is expected that these shared data will considerably supplement data collected by EPA. Data contributed by multiple partners will be integrated to create regional and national data "pictures." The use of consistent methods and protocols for data collection and analysis would enable the best comparisons across various programs and jurisdictions at different geographic scales (i.e., local, regional, national, and international). Efforts in terms of sample collection timing and PBTs monitored could be coordinated among existing programs to fill data gaps and help further the multimedia understanding of these pollutants.

With data being provided by various programs and agencies, communication among monitoring communities will contribute to the coordination and success of the *Program*. To achieve this, structured communication among monitoring communities will be established. An interagency committee consisting of representatives from participating EPA offices would be established at the national level, with counterpart committees at regional and state levels. This structure would allow data to flow easily between levels, create footholds for participating stakeholders to ensure that value for them is maintained in the *Program*, and establish a chain of communication that is necessary for the successful integration of monitoring networks across jurisdictional boundaries. This will also allow for the EPA to provide a guidance and integration role as suggested by the external stakeholders.

Include Appropriate Media for the Particular PBT Being Monitored

Once released into the environment, PBT chemicals will often partition across multiple environmental media. The way in which partitioning occurs depends on the nature of the release, the environmental conditions, and the physical and chemical properties of the specific PBT. These factors also influence the amount of PBT exposure that individual wildlife receive. The levels of PBTs found in various environmental compartments and wildlife, along with the toxicity of these chemicals, influence the adverse human health risks posed by PBTs. Accordingly, the appropriate media to monitor depend on the chemical and its behavior and fate in the environment. With the use of conceptual models (see Appendix A and Chapter 2), monitoring implications were derived to determine the appropriate media to monitor for each PBT on a case-by-case basis. The key media to monitor for mercury, dioxin, and PCBs are emissions/releases, ambient air and air deposition, food, and human matrices.

Include Appropriate Monitoring Time Scales

As the key *Program* questions indicate, assessing trends for PBTs in various media is an important implication for this Strategy. In addition to focusing on data that demonstrate the environmental significance of PBTs in the environment, EPA will consider the relative length of time that certain monitored media respond to changes in the loading of PBTs to the environment. For instance, significant reductions in PBT air emissions will generally be reflected in air monitoring data much earlier than would be expected from nearby surface water samples. Similarly, because fish retain PBTs in their fat or muscle tissue, reductions of PBTs in water, air, and sediment would not be reflected in fish tissue samples for a long period of time. The existence of PBTs in multiple environmental media (e.g., water, sediments, fish) generally lengthens the period of time in which change can be detected through monitoring, particularly for fish. The appropriate monitoring time scale for assessing environmental trends is generally considered to be on the order of decades. Thus, the Strategy proposes a *National Multimedia Monitoring and Assessment Program for PBTs* that collects and assesses data over the next 10-20 years.

Identify Relative Contribution of Various Geographic Scales

Once released into the air, PBTs can be subject to long-range transport, or transported through the atmosphere and deposited considerable distances from their point of release. In addition to factors such as temperature, wind speed, rainfall rate, and prevailing circulation patterns, the atmospheric transport of a PBT depends upon its persistence in the environment. The longer a PBT can resist either chemical breakdown or removal from the atmosphere, the farther it can travel from its point of origin and be deposited onto soils, plants, or waterbodies in other regions or other parts of the earth. For example, the atmospheric degradation of mercury and hexachlorobenzene is extremely slow (months or years) or is nonexistent, allowing these chemicals to be transported far from a point of origin into the atmosphere.

The monitoring implications presented in Chapter 2 clearly demonstrate the need to enhance efforts to understand the long-range transport of PBTs. These implications include providing monitoring to help determine the relative contributions of PBTs to the U.S. from sources outside the U.S., as well as to determine the contributions of domestic sources to local, regional, continental, and global PBT loadings. To better inform management decisions, the *Program* will encourage such monitoring enhancements in an effort to provide data to improve such estimations of the contribution of long range transport.

Mapping of monitoring data can be a useful visualization and analysis tool in identifying the relative contributions from various geographic scales. Mapping can also be used to help identify gaps and priorities in monitoring, thus aiding in the process of site selection. Mapping the results from a calibrated atmospheric model provides a means of estimating conditions between monitors. Within the Strategy's "nested" monitoring network design, mapping will play a key role in illustrating the geographical distribution of PBTs across the U.S. and in presenting spatial evaluations of PBT trends.

Make Air Modeling an Integral Component of the Strategy

The use of quantitative, computerized models to predict pollutant behavior in the environment was recognized as an integral component of the *Program* by participants in the planning workshops, and others developing the Strategy. The implications derived from the key *Program* questions also indicate that modeling analyses, such as source apportionment, are important tools in understanding the behavior of PBTs in the environment. While monitoring alone can fairly accurately determine the concentration of a given compound in a given media at a specific location, it has limitations, such as uncertainty about how large an area each monitor site represents, and limits on the number of monitors which can be supported. If monitoring of pollutants is combined with on-site meteoroligic or hydrologic measurements, then analysis of the data can provide some indication of nearby sources, though such techniques are limited. The combination of modeling with monitoring, however, can overcome many of the limitations of monitoring alone and provide a better understanding of the behavior of PBTs in the environment. For example, with sufficiently precise models, modeled data can substitute for or provide spatial and/or temporal interpolations of monitored data. In the case of mercury dry deposition, current monitoring techniques cannot measure this pathway. Estimation of the dry deposition of mercury requires atmospheric modeling. Some of the ways in which modeling can complement monitoring data include:

- Provide alternative estimates at locations and times where there are gaps in monitoring data;
- Reduce the number of sites needed, lowering the cost of a network;
- Provide estimates for pathways where monitoring techniques have not been developed;
- Analyze trends and patterns across geographic areas;
- Assess the relative contributions of PBTs from potential sources;
- Project deposition patterns from a source or source area;
- Evaluate or design a network of monitors;

- Incorporate current research to evaluate complex conditions; and
- Evaluate past or future scenarios of management actions.

The Strategy recommends the use of atmospheric models for transport and fate, including deposition, as part of periodic assessments for several reasons. First, many PBTs are emitted to air, where they can be transported short, medium, or long distances before depositing onto soil, vegetation, and water surfaces. Recent evaluations of the routes of PBTs from sources to human and wildlife exposures show that air emissions and transport are more important, nationally, than other release pathways (e.g., water discharges). Second, some of the more developed, better understood, and spatially comprehensive models are those for atmospheric fate and transport. Third, atmospheric models are an important tool in evaluating the influence of international sources of PBTs on the U.S., as well as the impacts of PBTs leaving the U.S. on other nations and international seas.

Include Emissions and Discharge Information

As the monitoring implications in Chapter 2 indicate, answering many of the key questions about the behavior of PBTs in the environment relies on characterization of emissions and discharges of those PBTs. In fact, the conceptual models indicate that one of the most critical media to monitor for all three priority PBTs is emissions. With the use of models, characterizations of air emissions and water discharges are needed as inputs into environmental modeling evaluations. Air modeling enables air emission data to be linked with air deposition determinations and PBT levels in the environment, a critical exercise in the search to understand the fate and transport of PBTs. Some substances, like mercury, undergo chemical changes during atmospheric transport. As the monitoring implications for mercury indicate, emission characterizations should include speciated mercury emissions. Similar emissions for other PBTs should be monitored where relevant. In addition to characterizing anthropogenic sources (including international sources), estimates of releases from reservoir[6] sources should also be considered because in some cases, as the monitoring implications for PCBs and dioxins denote, they may represent significant sources of PBT loadings to the environment. Reservoir sources for dioxins and PCBs are also poorly characterized, further supporting the need for characterizing such sources. Accordingly, the collection of air emissions and water discharge data will be included in the *Program*.

Provide Added Value to Partners and Stakeholders

The Strategy has been carefully considered and discussed with other federal agencies, States, Tribes, and stakeholders. The design and approach of this Strategy take into consideration the implications resulting from these discussions. Implementation of the Strategy will enable EPA to evaluate trends and determine the effectiveness of management actions to effectively manage mercury, dioxin, PCBs, and other PBTs. It is important, however, that

[6]"Reservoirs" are environmental media in which naturally or anthropogenically produced contaminants are temporarily stored and may be subsequently released and re-circulated into the environment.

partners who provide data and those who use it find value in the collective information, the trend evaluations and comprehensive assessments, or there may be little incentive to continue providing the needed information over a long term. In the interest of the long-term success of the Strategy, EPA will continue to seek input from its partners and stakeholders so that value for them is designed into the *Program* and derived from it upon implementation.

A key value-added component of the *Program* will be multimedia assessments of PBT data every three to five years. **[NOTE: This would be a good place to include an example assessment in an Appendix.]** These assessments will analyze the monitoring data generated by individual programs and agencies in light of the goals (i.e., trends, overall program accountability) and objectives (e.g., nesting) of the *PBT Monitoring Strategy*. Part of the assessment will use tools established by the Strategy objectives (e.g., modeling) to determine media partitioning for individual PBTs and describe trends observed for the key media for each individual PBT. Also, assessments will reflect a multi-pollutant approach, that is, looking across PBTs within each media, where feasible and appropriate.

Periodic multimedia assessments will provide valuable PBT trend information. Assessments will also help to establish where data, and thus monitoring gaps, exist. Recommendations for filling monitoring gaps, and thus achieving a more complete multimedia understanding of each PBT, can be made on the basis of these findings. Multimedia assessments will also seek to generate information that will assist in setting priorities for EPA's risk management. The information produced will also feed into other assessments, such as EPA's Draft Report on the Environment.

3.2.2 Design Objectives

Feature a "Nested" Regional Design

A desired outcome of the *Program* is that it be able to identify the relative contributions of multiple spatial scales, e.g., local, regional, national, and global. Many of the monitoring implications for PBTs indicate that monitoring on a regional scale is important to understanding the behavior of these pollutants. For example, because dioxins are less mobile than many PBTs, regional and local scale monitoring are most important. For the more mobile PBTs, such as mercury and PCBs, the implications are that national and global scale monitoring may be more important. One way to address multiple geographic scales is through a monitoring framework designed at a regional level using a "nested" approach. In a "nested" approach, PBT monitors would be located within individual regions, using representative sampling, such that the data provide valid representations of PBT status and trends within each regional area, yet could also be aggregated to comprise a national picture. This approach would also allow the PBT data collected to be incorporated into multinational strategies.

Due to regional differences, it is expected that there will be some variation in the type of data portrayed by each region. For instance, regions with more lakes and rivers may have more data describing fish tissue concentrations and PBT tissue levels in piscivorous birds. A network featuring a “nested” regional design would provide data that both uniquely characterize each region and present a national summary. Such a design avoids concerns with a framework that considers a purely national summary and is not useful in addressing regional issues. At the other extreme, a "nested" design avoids issues with data reflecting local concerns based on subjective site selection, which would not, when aggregated, provide an unbiased regional or national picture or provide adequate information for multinational strategies.

Beyond describing the mosaic of regional composites from a nationwide perspective, national portrayals of PBT trends may help in understanding the overall general environmental behavior of PBTs. For instance, a national perspective may illustrate whether progress is being made to reduce PBTs in nationally distributed food or to determine the percentage of total loadings of mercury to the U.S. from the global mercury pool. Regional "pictures" will allow local and regional data providers to interpret their data within a larger geographic context and will provide information about concentrated PBT "hotspots" in the nation, while also allowing estimations of overall national trends.

On a multinational level, EPA intends to work with international partners to make U.S. regional and national PBT trends "nest" with the North American PBT monitoring efforts planned across Mexico, the U.S., and Canada. Ideally, the U.S. and North American PBT monitoring efforts will also integrate well with global efforts to monitor PBTs.

Use Representative Sampling

For greatest efficiency, the use of probabilistic sampling will be encouraged to allow for unbiased, representative sampling. In this way, broad trends can be determined at reasonable cost and can be evaluated statistically. Data that are the most representative of the media being sampled will be used, to the extent practical and feasible. However, many current monitoring programs, with much valuable data to offer for integration in a multimedia assessment, were not designed based on probabilistic sampling protocols. In order to make the best use of available data, and to enhance the value of the desired regional and national "pictures," the Strategy will seek to complement probabilistically based data with data collected from other monitoring designs (e.g., targeted sampling).

Use Appropriate Sample Monitoring Frequencies

The frequency (or time span) of data collection can vary among monitoring programs (e.g., weekly, monthly, annually). Factors that can influence sample monitoring frequencies include: the behavior of a chemical in the environment (e.g., seasonal variations), events (e.g., rainfall, fire), available monitoring resources, frequencies of other monitoring efforts, and the intended use of the data (e.g., to interpret source/receptor relationships through modeling). The choice of monitoring frequency may be determined by one or more factors. The frequencies of other monitoring efforts are important for comparing data across programs. For instance, air emission data collected once per year from a PBT source will be of limited value in elucidating changes in ambient air concentrations measured on a more frequent (e.g., quarterly) basis. Also, many monitoring implications indicate a need to monitor PBTs across multiple media, with the idea of eventually integrating such data for multimedia analysis. Consistent sampling intervals within each media are important to such an integration. Often, shorter intervals between sampling events (higher frequency) are desired when modeling tools are used. Higher sampling frequencies generally incur greater sampling and analysis costs. To utilize existing data to the fullest extent, the *Program* will review and recommend appropriate sample frequencies to provide the best information at a reasonable cost.

Encourage Data Collection at Multi-pollutant Sites

The Strategy will rely on the use of PBT data collected by federal, state, local, and tribal monitoring networks and sampling programs. Where gaps in information exist, the Strategy recommends the extent to which existing monitoring and sampling efforts might be augmented or consolidated to efficiently provide the desired lacking information. This includes encouraging monitoring for more than one pollutant at a site, where feasible. For a basic set of monitors, multi-pollutant sites may include monitoring of PBTs as well as criteria pollutants (e.g., particulate matter).

Though each PBT has unique features of how it moves through the environment and how humans are exposed, PBTs share some common characteristics. All PBTs, by their nature, exist in multiple media. Exposure to PBTs often includes exposure to more than one pollutant. Analytical measurements for one PBT can be valid for other PBTs in the same media. Multi-pollutant monitoring sites would not only take advantage of similar chemical and physical properties, but they could also aid in promoting more reasonable costs for the *Program*. Furthermore, encouraging the collection of multiple pollutants at a site will also be helpful in monitoring emerging PBTs, as implementing protocols to detect emerging PBTs will be easier if multiple pollutants are already being considered in the analysis of sampling media at a particular site.

4.0 EVALUATION OF CURRENT MONITORING PROGRAMS

Strategic Principles for the PBT Monitoring Strategy

Leveraging: Maximize the use of incremental investments and value-added opportunities by considering existing activities and building upon those activities where possible.

There are many monitoring programs currently in operation that measure PBTs in various environmental media, such as air, water, and biota. These programs are conducted by various Federal, State, Local, and Tribal Governments as well as other organizations (e.g., industry groups, universities). The key to accomplishing the objectives of a *National Multimedia Monitoring and Assessment Program for PBTs,* and thus to better address the multimedia aspects of PBTs, is to leverage existing PBT monitoring programs. This means integrating data from individual monitoring programs across all media for interpretation. Unfortunately, the media and biota sampled, the pollutants covered, and the approach, methods, and purpose vary considerably from program to program. Moreover, these programs appear to be largely disparate, without any sense of shared integrated strategic vision. Such differences among programs can result in substantial monitoring and data gaps from a multimedia assessment standpoint. To better understand the potential data gaps and limitations to integration, assessments were conducted of currently available data from a core set of existing monitoring programs that were identified as critical for leveraging.

Before these program assessments could be conducted, a few basic steps had to be taken. First, five media categories that are seen as critical to a multimedia assessment of PBTs were established. They are: Emissions/Releases Inventories, Ambient Air and Deposition Monitoring, Water and Ecosystem Monitoring, Food Monitoring, and Human Exposure Studies. Next, an inventory of the existing monitoring programs in each category was taken (this inventory can be found in the documentation accompanying the Strategy). Based on evaluations of existing programs, key leveraging programs from each media category were determined. Detailed assessments were then conducted on each of these key programs to identify data gaps and limitations to the integration of these programs that might exist. The detailed assessments of key leveraging programs from each category (not including Water and Ecosystem Monitoring) can be found in Appendix B. This chapter provides an overview of the results from the program assessments and the implications of these results to a *National Multimedia Monitoring and Assessment Program for PBTs*.

The *PBT Monitoring Strategy* does not analyze current water and ecosystem monitoring activities because monitoring PBTs in other media (e.g., air/air deposition, food, and humans) is a higher priority than water, soil, and sediment monitoring at this time. The following sections discuss potential leveraging opportunities in current emissions/release opportunities, ambient air and atmospheric deposition monitoring, food monitoring, and human exposure studies.

4.1 Emissions/Releases Inventories

Emissions inventories provide information about the sources of PBTs, such as stationary and mobile sources, and the relative contributions of these sources to total PBT releases. Emissions inventories can also provide information on spatial and temporal trends in PBT releases. Releases of mercury, dioxin, and PCBs, as well as several other PBT substances, are reported in national inventories. Air emissions of several PBT substances are estimated in a regional inventory for the Great Lakes states. Current emissions inventory programs include EPA's National Emissions Inventory (NEI, formerly National Toxics Inventory (NTI)), EPA's Toxics Release Inventory (TRI), EPA's Dioxin Reassessment Emissions Inventory, and the Great Lakes Regional Air Toxic Emissions Inventory Project. The key leveraging program identified for a national PBT monitoring strategy is the NEI.

The NEI is an inventory of stationary and mobile sources of hazardous air pollutants (HAPs) in all 50 states, the District of Columbia, Puerto Rico, and the Virgin Islands. The objectives of EPA's NEI are to support national/regional/local-scale air quality and human exposure modeling, support Clean Air Act (CAA) programs, perform regulatory impact analysis, support risk assessment studies, provide emission trends, and support Government Reporting and Results Act (GPRA) reporting for air toxics programs. The NEI is released by the U.S. EPA every three years. Inventories have been developed for 1993, 1996, and 1999.

A detailed assessment of available NEI PBT data was performed (see Appendix B) to ascertain potential data gaps in this program that might limit its integration in a multimedia assessment of PBTs. The main limitation of NEI data is the comparability between datasets. The NEI data are not collected on the basis of a probability-based design but rather are compiled from other inventories, such as TRI and state and local HAP inventories. The 1993 inventory was compiled from county-level data and data collected before EPA's Maximum Achievable Control Technology (MACT)-related databases were formed. The 1996 inventory, however, was compiled from state- and local-level emissions data and includes data from MACT-related databases as well as facility-specific data. The 1996 inventory also aggregated emissions for certain HAPs groups, such as metals, introducing uncertainties into air quality modeling that relies on differences in individual metals species for assessments. The 1999 emissions inventory has been prepared in an even more integrated fashion than previous years. The changing compilation of data every three years compromises the integrity of the data for trends analysis.

4.2 Ambient Air and Atmospheric Deposition Monitoring

Both ambient air monitoring networks and air deposition networks provide information on PBTs that are emitted into the atmosphere. In addition to providing information on ambient concentrations and deposition rates, when combined with information from emission inventories and air dispersion models, data from air monitoring networks can provide information about the fate, transport, and transformation of PBTs. Current air monitoring programs include the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), the Mercury Deposition Network (MDN), the Clean Air Status and Trends Network (CASTNet), the Atmospheric Integrated Research Monitoring Network (AirMoN), Satellite Sensor Technology, the National Dioxin Air Monitoring Network (NDAMN), the PM2.5 Speciation Network, the Interagency Monitoring of Protected Visual Environments (IMPROVE), EPA's National Air Toxics Trends Sites (NATTS) Monitoring Network, EPA's Urban Air Toxics Monitoring Program (UATMP), and the Integrated Atmospheric Deposition Network (IADN). Many of these networks do not comprehensively monitor PBTs, which presents significant gaps in the understanding of atmospheric PBTs both regionally and nationally. *There are three key PBT air monitoring networks, however, that provide initial leveraging opportunities for a national PBT monitoring strategy: MDN, NDAMN, and IADN.*

The MDN, part of the National Atmospheric Deposition Program (NADP), started with 17 sites in 1995 and has grown since then to encompass more than 70 sampling sites throughout the U.S. and Canada. The MDN monitors total mercury in precipitation through the collection of weekly samples. NDAMN was established by the EPA in 1997 to determine the temporal and geographical variability of atmospheric levels of chlorinated dibenzo-p-dioxins (CDDs), chlorinated dibenzofurans (CDFs), and dioxin-like PCBs in mostly rural and non-impacted areas of the United States. NDAMN has 34 sampling sites located throughout the U.S., which collect samples four times a year by sampling for 24 days over a 28 day period. The IADN is a joint venture of the U.S. and Canadian governments that monitors PAHs, PCBs, and pesticides in the atmosphere near the Great Lakes. Atmospheric data are collected every 12 days through a network of five master and 11 satellite stations distributed across the Great Lakes.

A detailed assessment of MDN, NDAMN, and IADN (see Appendix B) indicated some similarities in the limitations of these air monitoring programs across all or some of the networks. Sampling site dispersment could be a limiting factor for MDN and IADN. The majority of MDN sites are in the eastern half of the U.S., with few sites in the central and western U.S. Furthermore, the MDN was not established using a probability-based design. Instead, sampling sites tend to either be in rural locations or in "hotspots" where people are interested in mercury. IADN, on the other hand, is a regional network focusing on the Great Lakes basin. While IADN may provide extensive coverage of atmospheric PBTs near the Great Lakes, no other comparable networks monitoring multiple PBTs exist for the entire nation, presenting significant data gaps for national trend studies.

Other major limitations to these air monitoring networks are their age and the number of PBTs they measure. MDN and NDAMN are both young networks that have only been in operation for up to eight and six years, respectively. Because temporal trends in PBTs tend to be on the order of decades, the limited amount of available data from MDN and NDAMN weakens the potential for meaningful trends analysis from these networks at the current time. Though they are national networks, MDN and NDAMN are also fairly specialized in the data that they collect. MDN does not currently monitor methylmercury consistently at all of its sites and NDAMN only monitors dioxins and coplanar PCBs. Likewise, IADN does not monitor dioxins and only measures mercury at select sites. A national PBT monitoring strategy needs a broader range of PBT measurements at multiple sites across the U.S. These existing air monitoring networks, however, provide a good starting point and present potential opportunities for future integration efforts.

4.3 Food Monitoring

Food monitoring and fish and wildlife survey programs provide essential information about the levels of PBTs in foods consumed by the human population. This information provides an estimate of dietary exposure, and when high concentrations are found, allows actions to be taken or consumption advisories to be issued to limit exposure. Current food monitoring programs include the National Fish Tissue Study, National Listing of Fish and Wildlife Advisories, the Food and Drug Administration's (FDA) Total Diet Study (TDS), FDA's Pesticide Residue Monitoring Program, USDA's Pesticide Data Program (PDP), USDA's Food Safety Inspection Service (FSIS) National Residue Program (NRP), and the National Milk Study on PBTs. *Of these food monitoring programs, the key leveraging programs identified for a national PBT monitoring strategy are the National Fish Tissue Study, the FDA Total Diet Study, and the USDA NRP.*

A detailed analysis of each program is presented in Appendix B. The National Fish Tissue Study was started by the EPA in 1999 as an effort to estimate the national distribution of the mean levels of selected PBT chemical residues in fish tissue from lakes and reservoirs of the continental U.S. For this study, fish are being sampled from 500 randomly selected lakes and reservoirs over a period of four years. The FDA Total Diet Study determines the levels of various pesticide residues, contaminants, and nutrients in foods for the purpose of estimating intakes of these substances in representative diets of specific age/sex groups in the U.S. population. Some PBTs have been measured as part of the Total Diet Study since 1991. The NRP is a multi-component analytical testing program for residues (drugs, pesticides, and environmental contaminants) in domestic and imported meat, poultry, and egg products. The NRP has been in effect since 1967, though some PBTs have not been monitored for this entire time.

In general, these three studies provide good potential for integration with other studies and each other in a national PBT monitoring program. The National Fish Tissue Study is a non-recurring study, so continued monitoring of contaminants in fish will require additional ongoing data collection. The NRP does not consistently screen for the PBTs of interest to a national PBT monitoring strategy. The NRP is also designed to detect specific compounds in each designated production class. It was not designed to provide an estimate of an overall national percentage of violations for all chemical residues or production classes tested. Thus, national interpretations of these data can be limited in scope.

4.4 Human Exposure Studies

Human exposure studies can provide valuable information about human body burdens of PBTs. However, these studies are best utilized when supplemented by knowledge of sources, pathways, concentration, duration, and location of exposure. This knowledge can be used to relate sources and pathways of PBTs to human body burden levels. Current human exposure studies include the Center for Disease Control and Prevention's (CDC) National Health and Nutrition Examination Survey (NHANES), EPA's National Human Exposure Assessment Survey (NHEXAS), the National Human Adipose Tissue Survey (NHATS), the Arctic Monitoring and Assessment Program (AMAP), the Alaska Maternal and Umbilical Cord Blood Monitoring Project, and the Children's Total Exposure to Persistent Pollutants (CTEPP). *The key leveraging program identified for a national PBT monitoring strategy is NHANES.*

NHANES, conducted by the CDC's National Center for Health Statistics, traces the health and nutritional status of U.S. civilians through interviews and direct physical examinations. The study design uses a representative sample of the U.S. population to collect exposure data. NHANES did not address most PBTs until 1999. A detailed assessment of NHANES (see Appendix B) revealed that its major data limitation is the lack of PBT analysis prior to 1999. While this limits the current functionality of NHANES in a multimedia PBT framework, the continued collection of PBTs through this program will make a significant contribution to the understanding of PBTs across all media.

4.5 Summary

The key leveraging programs discussed above provide initial opportunities for a national PBT monitoring strategy to integrate networks across multiple environmental media. Ideally, most of the existing monitoring programs could be used in future multimedia assessment efforts by the Agency. It is also important to consider a holistic evaluation of current monitoring programs. Table 4-1 presents a summary of all of the current monitoring programs discussed above as well as other important programs in each media category. The key leveraging programs are highlighted in red. The programs presented in Table 4-1 are divided into the five media categories discussed above. For each program, the managing agency, PBTs monitored, geographic scale, and monitoring frequency are given. The perceived level of integration for each program into a national PBT monitoring strategy is also given, along with a potential modeling contribution assessment.

Table 4-1. Summary of current monitoring programs grouped by different media.

Monitoring Activity	Managing Agency	PBTs Monitored					Geographic Scale	Monitoring Frequency	Level of Integration	Modeling Contribution
		Mercury	Dioxin/Furans	PCBs	Other Level 1's	Level 2's				
EMISSIONS/RELEASE INVENTORIES										
1996 National Emissions Inventory (NEI)	EPA/OAQPS	✔	✔	✔	✔	✔	National	Every 3 years		High
Toxics Release Inventory (TRI)	EPA	✔	✔	✔	✔	✔	National	Annually		Medium
Great Lakes Regional Air Toxics Emissions Inventory	EPA/GLNPO, Great Lakes States, Ontario	✔	✔	✔	✔	✔	Regional	Expected to be annual		
AMBIENT AIR AND AIR DEPOSITION MONITORING										
Air Toxics Monitoring Network	EPA/OAQPS	✔	✔	✔	✔	✔	National	Routine		High
Integrated Atmospheric Deposition Network (IADN)	EPA, EC, OME			✔	✔	✔	Regional	Routine	High	High
National Dioxin Air Monitoring Network (NDAMN)	EPA/NCEA		✔				National	Quarterly	High	High
Mercury Deposition Network (NADP/MDN)	approx. 20 organizations	✔					National	Weekly		High
National Trends Network (NADP/NTN)	USGS, over 100 organizations	✔					National	Weekly		High
CASTNet	EPA/OAR, NPS	✔			✔	✔	National	Weekly, Hourly, Every 3 days		High
AirMoN	primarily NOAA						National	Daily		High
PM2.5 Speciation Network	EPA/OAQPS	✔				✔	National	Every 3 days	High	High
IMPROVE	EPA, NPS, others						National	Every 3 days		High
Satellite Sensor Technology	e.g., NASA, NOAA, USGS						Global	Routine		Medium

Table 4-1. Summary of current monitoring programs grouped by different media (continued).

Monitoring Activity	Managing Agency	PBTs Monitored					Geographic Scale	Monitoring Frequency	Level of Integration	Modeling Contribution
		Mercury	Dioxin/Furans	PCBs	Other Level 1's	Level 2's				
WATER AND ECOSYSTEM MONITORING										
NOAA's National Status and Trends Program - Mussel Watch Project	NOAA	✔	✔	✔	✔	✔	National	Routine		High
National Water Quality Assessment Program	USGS	✔		✔	✔	✔	National	Rotational		High
National Sediment Quality Survey Database	EPA/OW/OST	✔		✔	✔	✔	National	Routine		
Environmental Monitoring and Assessment Program (EMAP)	EPA	✔		✔	✔	✔	National	Annual	High	High
U.S. Long Term Ecological Research (LTER) Network	NSF						National	Hourly to annually	High	High
Clean Water Action Plan: Coastal Research and Monitoring Strategy	NOAA, EPA, DOI, USDA	✔	✔	✔	✔	✔	National	TBD	High	High
Lake Michigan Mass Balance Project	GLNPO	✔	✔	✔	✔		Regional	One-time study		High
FOOD MONITORING										
National Fish Tissue Study	EPA/OW/OST	✔	✔	✔	✔	✔	National	Episodic		
National Listing of Fish and Wildlife Advisories	EPA/OW	✔	✔	✔	✔	✔	National	Annual		
FDA Total Diet Study	FDA	✔		✔	✔	✔	National	4 times per year		
FDA Pesticide Residue Monitoring Program	FDA				✔	✔	National	Routine		
USDA Pesticide Data Program (PDP)	USDA				✔	✔	National	Monthly		High
USDA Food Safety Inspection Service NRP	USDA			✔	✔	✔	National	Routine		N/A
Environmental Radiation Ambient Monitoring System (ERAMS)	EPA/ORIA						National	Routine	High	
National Milk Study on PBTs	EPA	✔	✔	✔	✔		National	Episodic		Low

Table 4-1. Summary of current monitoring programs grouped by different media (continued).

Monitoring Activity	Managing Agency	PBTs Monitored					Geographic Scale	Monitoring Frequency	Level of Integration	Modeling Contribution
		Mercury	Dioxin/Furans	PCBs	Other Level 1's	Level 2's				
HUMAN EXPOSURE STUDIES										
National Health and Nutrition Examination Surveys (NHANES)	CDC	✔	✔	✔	✔	✔	National	Annually		High
EPA's National Human Exposure Assessment Survey (NHEXAS)	EPA/ORD	✔		✔	✔	✔	National	Pilot studies		
National Human Adipose Tissue Survey (NHATS)	EPA		✔	✔	✔	✔	National	Archive		High
Arctic Monitoring and Assessment Program (AMAP) Monitoring	AMAP Council	✔	✔	✔	✔	✔	Global	Routine		High
Alaska Maternal and Umbilical Cord Blood Monitoring Project	EPA/OIA, Indian Health Service, others	✔	✔	✔		✔	Regional			
Children's Total Exposure to Persistent Pesticides and Other Persistent Organic Pollutants (CTEPP)	EPA/ORD			✔	✔		NC and OH	Pilot study		High
DATABASES										
Permit Compliance System (PCS)	EPA/OECA	✔	✔	✔	✔	✔	National	Ongoing		
Storage and Retrieval (STORET) Database	EPA/OW, USGS						National	Ongoing		High
Aeromatic Information Retrieval System (AIRS) Database	EPA/OAQPS	✔			✔		Global	Routine		High
Air Toxics Data Archive	EPA/OAQPS	✔	✔	✔	✔	✔	National	Archive		High
National Drinking Water Contaminant Occurrence Database (NCOD)	EPA				✔	✔	National	Ongoing		

Level of Integration Rating System: High = Appears to have potential to be expanded; Medium = Some opportunities to expand; Low = No apparent opportunity to expand.

Modeling Contribution Rating System: High = Data make a significant contribution for modeling; Medium = Data provide some input for modeling efforts; Low = Data are marginally useful for modeling.

As Table 4-1 shows, there are a large number of programs across many media, providing a strong base for a national PBT monitoring strategy. Specific examples by media of key leveraging programs have been detailed above. The overall ability of these monitoring programs to address the objectives of the proposed Strategy are described in Chapter 3 and reiterated below. The objectives are given first, followed by a brief evaluation of current programs' capacity to fulfill these objectives.

Scope Objectives

Build upon Existing Programs

As detailed in this chapter, there are existing programs in each medium that offer opportunities for leveraging into a national PBT monitoring strategy.

Integrate Existing Information Across Various Efforts

While current monitoring programs in each medium cover the range of PBTs of interest to a national PBT monitoring strategy, the available data collected from existing monitoring programs are not currently integrated or synthesized into a comprehensive assessment. As detailed in Sections 4.1 through 4.4, there are potential limitations to the integration of data from current monitoring networks. Data gaps exist both spatially and temporally, which would impact the ability to detect trends. Difficulties in integrating data for individual media may be encountered due to the different methods, procedures, and schedules defined for each program. Such discrepancies could also influence the evaluation of data integrated across media. The integration of data across agencies and monitoring networks would require a concerted, centralized effort. No such centralized body currently exists to guide such efforts, presenting another limitation to potential integration activities.

Include Appropriate Media for the Particular PBT Being Monitored

As the conceptual models indicate (see Appendix A), understanding the behavior of PBTs in the environment is dependent on understanding PBTs in multiple media. The inventory of current monitoring programs (see Table 4-1) indicates that key PBTs are generally already being monitored in the appropriate media. For example, the conceptual model for dioxins indicates that it is critical to monitor for these compounds in air emissions and deposition, food, and human matrices. An examination of Table 4-1 shows that various programs such as NDAMN and the National Fish Tissue Study are currently measuring dioxins in the media that are critical to understanding the behavior of these compounds. Such programs provide the leveraging needed to expand the monitoring of PBTs in the appropriate media so that their behavior in the environment can be properly studied and understood.

Include Appropriate Monitoring Time Scales

Many of the current monitoring programs are young or have only been monitoring PBTs for a fraction of their intended operation. Longer-term monitoring is required for successful temporal trends analyses of PBTs, as environmental data are often best assessed on the order of decades, rather than years. Furthermore, data from different media and different programs are often on different time scales, making long-term multimedia assessments of temporal trends difficult. Ideally, the integration of these various programs into a national PBT monitoring strategy will help to coordinate monitoring in different media such that time scales would become comparable, as needed.

Identify Relative Contribution of Various Geographic Scales

Current monitoring programs in various media span the range from local to national levels. The integration of these programs and their data into a national PBT monitoring strategy would allow for estimates of the relative contribution of each geographical scale to loadings of PBTs to the U.S. as a whole. Understanding the contribution of PBT loadings to and from the U.S. on a global scale is also important. Current monitoring efforts, however, do not provide adequate coverage at transboundary sites to allow for such analysis.

Make Air Modeling an Integral Component of the Strategy

Existing monitoring programs rarely include an assessment component that utilizes modeling. By including modeling as part of an assessment component, monitoring data from current programs could be used to a fuller extent.

Include Emissions and Discharge Information

Emissions and discharge information is currently available from the NEI, TRI, and other emissions inventories. These programs would likely be included as part of a national PBT monitoring strategy. The NEI, in particular, has been identified by the PBT monitoring strategy as a key leveraging program. Despite the wealth of emissions data available through such inventories, these programs do not provide sufficient characterization of all the sources important to understanding PBTs. For example, reservoir sources are thought to be significant drivers for current exposures to PCBs and dioxins, yet little is known about these sources. Expansion of current emissions inventories to cover such source categories would greatly improve our understanding of these sources.

Provide Added Value to Partners and Stakeholders

The funding and support of current monitoring programs is evidence of their value to partners and stakeholders. The inclusion of existing monitoring programs in a national PBT monitoring strategy would expand and enhance their value to partners and stakeholders by sharing information collected from a single program with information obtained across many programs. Furthermore, the integration of data across various efforts would also allow for multimedia assessments of available data. These assessments would provide a much needed analysis of the trends and behavior of PBTs within and across media to help better inform risk management decisions.

Design Objectives

Feature a "Nested" Regional Design

There are some regions in the U.S. where monitoring data are lacking because current monitoring programs lack sampling sites in those areas. Such "missing" data could prohibit a true "nested" data design as some regional pictures could be missing or incomplete. Also, because different programs have different data outputs, the ability of data from smaller-scale programs (local or regional) to be nested across geographic scales could be compromised or at least pose a difficulty. However, opportunities to implement such a "nested" regional design may already exist, given the broad range of monitoring programs currently in operation and the number of national programs with consistent data outputs.

Use Representative Sampling

Many of the current sampling networks were not conceived and implemented on a probability-based design. Notable exceptions are the National Fish Tissue Study and NHANES, both of which were designed to be nationally representative and are considered key leveraging programs for the PBT monitoring strategy.

Use Appropriate Sample Monitoring Frequencies

Current monitoring programs collect data over a wide range of frequencies, varying from every three days to every three years. For the most part, existing programs monitor with sufficient frequency to provide data with a range of analysis possibilities.

Encourage Data Collection at Multi-pollutant Sites

Several of the key leveraging programs (e.g., NEI, TRI, National Fish Tissue Study, NHANES) include multiple PBTs. Others monitor a single PBT or do not include all of the priority PBTs (mercury, dioxin, PCBs).

A holistic look at current monitoring programs, in light of the proposed objectives of the PBT monitoring strategy, reveals that a wide range of monitoring programs are currently available, despite some limitations to their ability to address the network design and monitoring objectives. One or more existing networks in each media category can be identified as key leveraging opportunities for building a cost-effective *National Multimedia Monitoring and Assessment Program for PBTs.* This analysis has shown that the *Program*:

- is needed to fill the gaps in PBT monitoring,
- can be established cost-effectively by leveraging and enhancing existing programs, and
- would provided added value to partners and stakeholders by providing integrated monitoring data to inform decision-making over the next two decades.

5.0 RECOMMENDATIONS FOR BUILDING THE *PROGRAM* IN LIGHT OF IDENTIFIED GAPS

Recommendations for Building the *Program*

- Extensively leverage existing intra- and interagency PBT monitoring programs through coordination and collaboration
- Supplement existing emissions/releases, air/air deposition, soil/sediment, food, and human tissue PBT monitoring efforts
- Encourage additional research studies to support PBT monitoring activities

In order to develop an effective monitoring and assessment program that will provide information for assessing both the long-term trends of PBTs in various media and the effectiveness of risk management actions, current monitoring programs, and any additional supplemental monitoring that might be needed, will need to be developed into a cohesive whole. However, based on the findings from the assessment of key monitoring programs (see Chapter 4) as well as the analysis of individual PBT conceptual models, multiple gaps and limitations present barriers to a sufficient multimedia understanding of PBTs under current monitoring programs. These gaps include a lack of geographic coverage, non-standard methods and sampling protocols among existing networks, gaps in pollutants monitored in key media, and limited assessments of current data, particularly in terms of multimedia interactions. In an effort to overcome these current limitations and gaps, this chapter focuses on cross-media and cross-pollutant recommendations, along with individual PBT strategies, that will improve coordination, collaboration, and integration of monitoring for PBTs in general.

5.1 Recommendations For Improving Overall Coordination and Assessment

A key component in a successful coordinated PBT Monitoring *Program* will be establishing a strong, integrated institutional framework for the implementation of the Strategy. As Chapter 4 revealed, multiple PBT monitoring programs currently exist, already providing valuable data in the key media defined by this Strategy. The goal of this Strategy is to integrate and supplement existing data and provide periodic assessments of trends in various media. Unfortunately, existing data have not always been brought together and presented in a comprehensive manner. In fact, much existing data cannot be easily integrated because of varying methods and data gaps and limitations. Through a strong institutional foundation, otherwise disparate monitoring programs can be coordinated and data can then flow easily between agencies, enabling multimedia assessments and thus a better understanding of PBTs. This section will present the recommended institutional framework for the implementation of the Strategy, along with recommendations for periodic multimedia assessments.

5.1.1 Coordination

Intra-agency PBT Monitoring Steering Committee. Spearheading the implementation of the Strategy will be an intra-agency PBT Monitoring Steering Committee. This committee will be composed of representatives from various EPA headquarters and regional offices, who are already involved in PBT monitoring concerns. The Steering Committee will address various coordination issues, such as data comparability and improving data accessibility. Using a combination of means, including possibly contractor assistance, it would compile, analyze, interpret, and periodically report on the monitoring data that are obtained from the *Program*. The committee will also provide guidance and integration for both internal and external stakeholders in relation to monitoring priorities, common measurement methods, and information accessibility.

As the Steering Committee will provide mostly a leadership role, it will need to rely on the support of other state and federal agencies, along with internal EPA offices, for the successful implementation of the Strategy. The goal is to have other agencies participate and interact with the PBT Monitoring Steering Committee through various supporting roles and feedback scenarios such that this intra-agency Steering Committee can evolve into an interagency committee, providing value for all involved partners. This means that various programs run by Federal and state agencies other than the EPA, such as CDC's National Health a are critical to the success of the Strategy. Some key federal programs include the CDC's. Other Federal agencies also have expertise in PBT monitoring that complements or supplements that of EPA. Continued support of these programs by the operating agency will provide critical data for a multimedia assessment of PBTs as well as ensure that monitoring needs are being met in key media. Furthermore, the experience of such federal agencies in PBT monitoring and data analysis will provide valuable input and feedback to the PBT Monitoring Steering Committee.

State and tribal involvement in the Strategy's implementation will also be important. As with federal agencies, many States currently operate valuable PBT monitoring programs that could be integrated into the Strategy's monitoring efforts. Some States have already expressed a desire to participate in a comprehensive national PBT monitoring effort. Under the leadership of a central body, such as the PBT Monitoring Steering Committee, the States could provide sampling, analytical, and other in-kind services, with the benefit of receiving data for their particular state that are comparable to that for other states and regions. For example, States operate fish sampling programs for the purpose of generating fish consumption advisories. These programs would give broad spatial coverage to a national fish tissue database and provide data for comparison to and integration into studies conducted by Federal agencies. As with many monitoring programs, field and laboratory protocols used by the States vary, and one future activity of the PBT Monitoring Steering Committee would be to unify protocols among States and to bring data together to examine national and regional trends.

Various means will be considered to maintain communication links with various other stakeholders and to gain their input on their direction of the *Program*. Consideration will be given to conducting workshops on various related topics and to having various publics input to the periodic assessments that will be conducted..

Aside from the more general support discussed above, support from EPA partners will also come in the form of fulfilling several specific functions critical to the needs of a national, multimedia monitoring and assessment program. Many of these duties are already being performed by individuals working in current monitoring programs. In some cases, in an effort to fill in spatial and data gaps, the same functions will need to be fulfilled for additional chemicals or monitoring sites. Ideally, persons currently performing certain functions would be used for such additional monitoring. They could provide services, training, or protocols to additional staff. The following functions will need to be fulfilled by federal, state, and other partners:

- Sampling/field operations
- Laboratory analyses
- Quality assurance/control
- Central data repository, data sharing, and distribution
- Modeling (use of monitoring data)
- Interpretation of data and modeling results
- Reporting/accountability
- Risk management action follow-up
- Research action follow-up

Sampling and Field Operations

Sampling and field operations would be provided by all partners: EPA, other federal agencies, States, and Tribes. Site operators for current monitoring programs would continue to provide services at existing sites and possibly at new sites. To assist in making field methods consistent, EPA personnel and other monitoring experts would need to provide Standard Operating Procedures (SOPs) and train new field staff.

Laboratory Analyses

The EPA, other federal and state partners, and private contractors could provide laboratory capacity. Again, SOPs should be provided to ensure similar laboratory analysis protocols are used in all programs. The EPA (or another federal agency as appropriate, depending on existing monitoring programs) would take the lead in obtaining, revising, or developing standard operating procedures (SOPs) for use in monitoring activities that contribute to a national database. Some standard methods are already in place. For example, as a result of EPA Office of Research and Development polar studies, various mercury speciation methods developed by EPA are being used by scientists in the U.S., Canada, Norway, Italy, Germany, Denmark and Sweden.

The adoption of standardized methods helps reduce costs by making it easier for others to contribute to a nationwide PBT monitoring effort with less up-front work. An example would be States wishing to begin monitoring but lacking knowledge of sampling methods and analysis protocols. Standard SOPs would give States, for example, procedures to follow to quickly begin site operation and laboratory analysis services. Another advantage of standardized methods is the ease of incorporating new, superior technology into sampling and analytical methodologies on a nationwide basis. Such a nationwide change would ensure comparability between data from different locations. However, methodological changes could cause differences in data from year to year (and hence, complications in interpreting a trend), so the advantages and complications of such changes would have to be considered by the PBT Monitoring Steering Committee, with input from partners and stakeholders, before action would be taken.

Quality Assurance/Quality Control

The adoption of SOPs describing quality control measures to be implemented at the field and laboratory level (field and laboratory blanks and duplicates, etc.) would be beneficial. There should to be uniform quality control of data at the individual laboratory as well as at the centralized database level. For example, in the Integrated Atmospheric Deposition Network (IADN) air monitoring program, individual laboratory managers check the data for accuracy and field remarks, etc., while the centralized database manager uses a SAS® program to check for outliers and flag data from all participating agencies. A similar system could be implemented for the PBT Monitoring Strategy, where individual laboratories flag for field and laboratory errors while quality control at a finer scale is done at the central database level.

Central Data and Information Clearinghouse, Data Sharing, and Distribution

The EPA would provide a central data and information clearinghouse that would provide for all PBT data from all partners. This clearinghouse would link data in various systems and provide some means for ensuring compatibility of data and accessability to all participants.

Participating programs and laboratories would submit data on a regular basis (for example, every six months). After each comprehensive PBT monitoring assessment was completed, data contacts for each program would also submit an estimate of what data would be ready by the time of the next assessment.

The value of PBT monitoring products, including data, guidance (methods, etc.), and reports, will be maximized if they are freely available. EPA and its partners could make such information available online in a PBT Monitoring Information Clearinghouse, which would act as a public arm of the central database. Data contacts would submit data and a description of their monitoring program (including SOPs) to the PBT Monitoring Information Clearinghouse. Online data would be available in summary form (the level of detail is to be determined, but it could be available as maps of averages, etc.) and in the published assessments. Raw data would be available by request so that its use and need could be tracked.

Modeling

EPA and its partners will formalize the use of PBT data in established and novel modeling applications (see Appendix C for more information on the integration of modeling and monitoring). Modelers with expertise in different media and modeling techniques are currently housed in varying offices and agencies. To bring together this experience and apply it to understanding the multimedia behavior of PBTs in the environment, the Steering Committee will coordinate closely with EPA's Council of Regulatory Environmental Modeling (CREM). The PBT Monitoring Steering Committee and the Modeling Consortium would then work together to decide which modeling activities are needed in the future and the modeling analyses for which results would be reported in upcoming PBT Monitoring Data Assessments. An additional, but probably not a stand-alone option, would be to dedicate a few modeling staff to the PBT Monitoring Strategy only. The assistance of modeling staff in various agencies would be needed to round out the areas of expertise of dedicated staff.

Reporting and Accountability

The PBT Monitoring Steering Committee would produce a comprehensive data assessment report every three to five years. Data compiled in the central data repository would be analyzed and interpreted to describe spatial and temporal trends in ambient levels of PBTs, exposure (or surrogate measures of exposure such as blood concentrations) to these compounds, and source releases and emissions. Analysis on a multimedia scale would also be conducted. These analyses will be discussed in more detail later in this chapter. Partnerships with public affairs departments and other outreach groups would be formed to increase agency and public knowledge of PBT monitoring, its results, and implications for pollution prevention and remediation.

Baseline assessments of monitoring data have already been developed and reported in some way for PCBs, dioxins, and mercury (e.g., *Mercury Report to Congress*, etc.) through chemical-specific workgroups. Such workgroup activity should continue to be supported, and the assessments produced by a PBT Monitoring Steering Committee should build on those made by the workgroups while also presenting data in a summarized and multi-pollutant manner.

Data and reports from the PBT Monitoring Steering Committee are also expected to be useful for indicator/performance measure reports published by other groups within EPA and other agencies.

Risk Management and Research Action Follow-Up

Results from the assessment report would be related back to PBT reduction actions to the extent possible. With each assessment, a series of presentations would be made to internal and external stakeholders. Each report would present decisions to be made and make recommendations for consideration based on the existing data. These decisions and recommendations could involve additional monitoring, and/or the identification of additoinal research needs.

Similarly, if research questions were to be developed by the PBT Monitoring Steering Committee during the process of creating the assessment, these questions would be referred to the appropriate office(s), region(s), and chemical-specific workgroups so that budgets, funding guidance, and priorities for grant programs could be revised if necessary. Such research-oriented follow-up might include short-term monitoring or process-oriented research (for example, questions on fate and transport of PBTs or characterization of sources).

Recommended research and/or program enhancement or actions will also be prioritized, if possible, to assist in budget activities. Follow-up assessments would provide updates on actions taken. Each assessment would relate environmental data back to actions taken under chemical-specific PBT action plans and regulatory or voluntary PBT reduction efforts.

5.1.2 Assessment

As discussed above, the PBT Monitoring Steering Committee will conduct assessments every three to five years based upon the historical and most recent data pooled from PBT monitoring programs. These assessments will then use data from current programs, in particular the key leveraging programs identified in the Strategy (see Chapter 4) and highlighted in red in Table 4-1. Moreover, they will build on data assessments that might already have been done in those programs. Thus, programs such as NEI, MDN, and NHANES will play a critical role in the periodic assessments. These assessments will analyze the monitoring data generated by such federal, state and tribal programs in light of the goals (trends, overall program accountability) and objectives (e.g., nesting) of the *PBT Monitoring Strategy*. Furthermore, these assessments will seek to answer the *Program* questions presented in Chapter 2. These questions not only provide the foundations for the Strategy but will also help to guide the periodic assessments as attempts to answer these questions will determine the nature of the assessments to be conducted. While reporting on trends and the status of PBTs in the environment, the periodic assessments will also serve to guide future PBT monitoring and sampling efforts by highlighting data gaps and limitations that inhibit the accomplishment of the Strategy objectives, thus focusing additional efforts on filling those holes by making appropriate recommendations for future monitoring and research.

There will be some limitations to these periodic assessments. While the assessments will provide information useful to risk management activities, they will not attempt to quantitatively assess human and ecological exposures, except in relatively simple terms, nor will they characterize human health and ecological risks, since, in each of these cases, additional information would be needed. However, these assessments should provide risk managers a more complete picture of PBTs and their status in the environment, with some feeling for the linkages among media. Moreover, while the assessments will provide information that can direct research, they will not attempt to fully characterize or answer all scientific questions relating to the fate and transport and exposure of PBTs. Despite such limitations, the periodic assessment of PBT data will provide added value to all involved partners and stakeholders, particularly through their attempts to provide information that will help answer the *Program* questions (that are identified in Chapter 2.

The assessments will reflect a two-level approach: multimedia and within media. The “within media” approach will examine individual PBT data within each of the four key media separately (emissions, air, food, humans). For example, PCB concentrations will be examined in emissions, air data, fish, and human exposure surrogates. Data from IADN would be used to evaluate temporal trends in atmospheric PCB concentrations in the Great Lakes region. This regional information could then be integrated with other atmospheric PCB concentrations found in New Jersey by the New Jersey Atmospheric Deposition Network (NJADN) and those found in other areas of the country to develop a national picture of PCB trends in the atmosphere. This approach would also involve a multi-PBT component where the analysis would look across pollutants within each medium. In this case, trends in concentrations of PCBs, dioxins, and mercury would be considered in one key medium. It is noted that modeling would likely play a crucial role in the assessment of ambient air and atmospheric deposition data (see Appendix C). Modeling can provide estimates of the status of PBTs between monitoring sites and the influences of regional weather variation on PBT trends. In addition, modeling can be used to develop estimates of certain aspects of long-range transport, such as the amount of PBTs imported into the U.S. from around the globe, the amount of PBTs exported across U.S. borders, and conditions of PBTs in the environment under future scenarios. Modeling, in combination with data from key leveraging programs, will be important tools in the periodic assessments of PBTs as part of a national multimedia monitoring and assessment program.

The second level of analysis will be to evaluate connections/interrelations across media in an effort to gain a multimedia understanding of PBT behavior in the environment. This type of multimedia assessment will be one of the key results of implementing the Strategy. Because PBTs exist in more than one medium and interact across media, understanding the behavior of PBTs is critical in enabling the proper risk reduction strategies to be formulated. For example, atmospheric emissions of mercury are deposited into water bodies where the mercury can be taken up by fish and start to bioaccumulate, eventually resulting in human exposure to mercury through fish consumption. Multimedia mercury assessments involving MDN, The National Fish Tissue Study, and NHANES data could help to better understand the linkages between these media (air deposition, fish, and humans) in an effort to better inform risk management actions to reduce the human exposure to mercury. Thus, this multimedia level of assessment will help to reveal for managers and decision-makers the much needed comprehensive picture or implications of current trends in PBT behavior. Models will be an important tool in this multimedia assessment of PBTs. It should be noted, however, that these multimedia assessments will not be comprehensive, quantitative analyses. The ability to run models for all inter-media pathways is not anticipated, nor is it the goal of the Strategy to run any sort of risk/physiological model that relates exposure to PBTs to health effects/disease. Rather, the idea of a multimedia assessment is to better understand media interactions to better inform decisions.

5.2 PBT-Specific Recommendations For Enhancing Ongoing PBT Monitoring Activities

The monitoring programs assessment discussed in Chapter 4 details gaps and limitations that exist in the current PBT monitoring infrastructure as well as data flowing from that infrastructure. As discussed in Chapter 2, the conceptual models (see Appendix A) present monitoring implications for each PBT, and address potential gaps in current monitoring activities. Based on the gaps identified in the current program assessments and conceptual models, PBT-specific recommendations were developed to enhance current monitoring activities in an effort to eliminate these gaps so that multimedia assessments of PBT data could be conducted and a broader understanding of these compounds could be gained.

5.2.1 Recommendations for Mercury

As the conceptual model of the transport of mercury in the environment indicates (see Appendix A), mercury is released into the air, transported long or short distances, deposited on land or water, transformed in the aquatic environment, accumulated in fish, and ingested by humans or wildlife. The goal of the Strategy is to find the most efficient points along that flow to determine the trends in environmental levels and whether they are responding to control and reduction measures. Each element of the Strategy represents a trade-off of two conflicting considerations: to detect changes as quickly as possible and with the greatest relevance to the endpoints of ultimate concern. The elements closest to the start of the cycle, such as emissions and deposition, are the quickest to respond to changes but they are the furthest from actual exposure of humans and wildlife. On the other hand, concentrations in fish tissue and human and wildlife tissues are much closer to the Strategy's actual goals, but they respond relatively slowly to control measures.

The basic strategy is to select points along the transport path to monitor, in such a way as to yield a national snapshot of a critical element of the path. To keep costs reasonable, the Strategy recommends building on existing programs. Table 5-1 shows a summary of the monitoring strategy for mercury, identifying the environmental media of concern, existing programs that address them, and enhancements that are both feasible and important to improving the utility of the data.

Air Emissions

Atmospheric transport is the primary focus for mercury monitoring and modeling, as it is the dominant means for cycling mercury from anthropogenic sources, such as utility combustion sources, into other media. Ecological and human exposures result primarily from air deposition to water bodies, which then results in methylation, uptake and bioaccumulation of the methylated species in fish, and ingestion of fish by humans and piscivorous marine mammals.

The recommended monitoring strategy for mercury air emissions builds upon two existing EPA programs: the National Emissions Inventory (NEI), operated by the Office of Air, which estimates emissions; and the Toxics Release Inventory (TRI), which supplements the NEI. Based on the data currently generated by these programs and the information that is needed to understand mercury's environmental cycling, three enhancements to the TRI and NEI programs are recommended. First, newly recognized source categories for mercury need to be included in NEI's emission inventories, with updates to these categories every few years. For example, it is known that automobiles emit mercury, yet this source is ill-defined. Releases from automobiles could be included in future NEI and TRI databases in an effort to define contributions from this source to overall atmospheric levels of mercury. Second, speciated emissions estimates need to be included in the emission inventories to the extent possible, as this helps determine the range of transport, whether local, regional or global, for mercury. Finally, it is important to track changes in emissions over time. It would be valuable to determine whether differences in emissions through the years are because of actual changes in source releases or because of different sources, data, or variables for estimating the emissions. If consistent methodology is continually used in developing emissions inventories, then it would be possible to determine whether emissions are increasing or decreasing over time. As there is little time delay between the implementation of a control measure and changes in source emissions, a consistent inventory database can help indicate the effectiveness of risk management decisions.

Table 5-1. Monitoring Strategy recommendations for mercury.

Environmental Medium	Current Program	Proposed Enhancements
Emissions/Releases	National Emissions Inventory, Toxics Release Inventory	Include newly recognized source categories
		Include speciated emission estimates
		Track changes in emissions
Air/Air Deposition	Existing sites, including "Super sites" near borders	Expand to ensure adequate coverage
	Mercury Deposition Network	Improve geographical coverage in West
		Develop methods to routinely measure or estimate dry deposition
		Develop standardized national modeling results for air deposition, calibrated to MDN and other deposition data
Soil/Sediment	USGS (and others) research	Continue lake core studies, but do not attempt comprehensive coverage
Food	National Fish Tissue Study	Continue or repeat survey, and expand to Alaska. Determine how to utilize/integrate data generated outside of EPA
	FDA commercial fish monitoring	Encourage FDA to undertake continuing, low-level monitoring of commercial fish; coordinate with NOAA/others
Human tissues	NHANES (general population)	Encourage continuing monitoring of blood mercury
		Expand to include selected State/Regional estimates
	Non-routine monitoring of highly-exposed populations	Conduct biomonitoring of subpopulations; Continue Alaska cord blood studies; pursue opportunities as they occur
Wildlife	Non-routine monitoring	Conduct feasibility study

*Shading indicates secondary recommendations. No shading indicates primary recommendations.

Transboundary Air Transport

It is important that the Strategy address transboundary air transport, as atmospheric mercury concentrations are affected by the emissions of other countries which cycle at various scales. A better understanding of the contribution of global sources to national mercury levels will aid in enacting measures to reduce or prevent such pollution transfer. There currently are some mercury “super sites” where speciation occurs and sufficient variables (particulates and halides measurements, for example) are measured to interpret sources through back trajectory modeling. For instance, it is possible at these sites, such as in the Ohio River Valley and in Southern Florida, to determine the influence of local sources versus global sources. These sites also help us to better understand atmospheric chemistry processes influencing the transformation and fate of atmospheric mercury. Currently, speciated mercury measurements are being made and their halide chemistry is being analyzed at a high altitude site at Mauna Loa, Hawaii, in an attempt to better understand the transformations of elemental mercury into reactive gaseous mercury at high altitudes. More strategically-positioned sites are needed, including along U.S. borders, where multiple types of mercury air measurements can be made so that the data can be assessed for trends, and transects for transport patterns can be developed. An assessment is needed to determine which additional sites can provide coverage of the major air masses entering U.S. air space. An immediate planned enhancement is to establish the Ny Alesund, Norway, site as an international “super site” with many countries leveraging resources to take samples and share data.

Air Deposition

Air deposition is currently measured through the Mercury Deposition Network (MDN), which monitors wet deposition utilizing a non-probabilistic network design. The MDN provides a good starting point for mercury air deposition monitoring, though some enhancements are needed to fulfill the goals of the Strategy. Analyses have shown that the national coverage of this network could be improved by adding sites in the West. Also, the program could be expanded to include dry deposition. There is a research method currently in use for dry deposition that could be further developed and utilized for routine sampling. Another enhancement is increasing the frequency of collection. MDN currently averages weekly samples, but some of the specific data needed for understanding transport patterns and for modeling require event-specific sampling.

Sediment and soil

Aquatic sediments play an important role in the mechanism of mercury bioaccumulation. Mercury deposited in a water body from air deposition or land runoff is typically sorbed to particles that settle into the sediment, where it is available for methylation and uptake by benthic organisms. Mechanistic research into the bioaccumulation process clearly needs to include a focus on sediments. However, for the purposes of this Strategy, routine nationwide monitoring of sediments is not proposed. Levels in sediments respond much more slowly than air deposition and are much further from the ultimate endpoints of interest than fish-tissue levels. In addition, because of the variability of the methylation process, sediment levels are not a good surrogate for fish-tissue levels.

Analysis of sediment core profiles provides the only source of very long-term historical records of air deposition, extending into pre-industrial and pre-European times, although it is slow to reflect the most recent trends. This is a unique form of data that provide a historical perspective on air-deposition rates. For this reason, the Strategy supports the continuation of sediment core studies conducted by USGS and others but does not propose an expansion of this effort or an attempt to provide systematic national coverage.

Food

For mercury, unlike some other PBTs, human and wildlife exposure is almost solely through fish consumption. Therefore, monitoring of other parts of the food supply is not a priority.

The National Fish Tissue Study, currently being conducted by the Office of Water, provides a one-time probabilistic sample of contaminants in fish tissue in freshwater lakes, including mercury as well as other PBTs. This study will provide a probabilistically-based baseline distribution of mercury levels in fish. To be of use in determining trends, it needs either to be continued after the current phase is completed or to be repeated periodically in the future. In addition, the current survey has certain limitations resulting from cost considerations: it does not include Alaska, Hawaii, or waterbody types other than freshwater lakes. Future monitoring efforts should consider representing these sub-populations as well.

Most human exposure to methylmercury is through the ingestion of fish. Monitoring of commercial fish is within the purview of the Food and Drug Administration (FDA). In recent years, the FDA's monitoring of mercury in fish in recent years has been limited. The Strategy encourages the FDA to institute routine monitoring of commercial fish for mercury, either through direct monitoring or by obtaining and making available mercury data gathered by the fishing industry.

Human Tissues

Beginning in 1999, the EPA and other federal agencies funded an add-on to the National Health and Nutrition Examination Study (NHANES) to measure mercury in the blood and hair of a national sample of women of child-bearing age and children. This effort, which is still ongoing, provided the first systematic data on actual mercury exposure levels in the U.S. population. NHANES intends to continue to gather blood mercury data in these populations, making it possible to identify trends over time. This medium comes as close as possible to the endpoint of interest, although it is likely to react slowly to control measures. The Strategy strongly recommends that NHANES continue to make these measurements.

The NHANES sample design does not allow statistically robust estimates at the state or regional level or in small, highly-exposed sub-populations. Expansion of the study to allow such estimates would require a different, much more expensive sample design and is not feasible at current or likely budget levels. However, the EPA will remain alert to opportunities to study highly-exposed sub-populations so as to gain insight into the extreme upper end of the exposure distribution.

Adverse effects of mercury in fish-eating birds and non-human mammals are in principle of similar importance to effects in humans. In practice, however, the infrastructure for systematic monitoring of mercury levels in hair, blood, feathers, or eggs of these animals is not maintained. Given resource limitations, it is recommended that such monitoring be limited to research studies.

5.2.2 Recommendations for Dioxins

Dioxins are continually cycled through and among environmental media (see Appendix A). Unlike mercury, there is not a large global component to dioxin sources in the U.S. because dioxins are less mobile than other PBTs. The largest route of human exposure to dioxins is through food, specifically the consumption of animal fats in the commercial food supply. Thus many of the recommended enhancements for current dioxin monitoring focus on food and resources on a national level. Table 5.2 shows the recommended monitoring enhancements for dioxins in all key media.

Air Emissions

Current levels of dioxins in the atmosphere come mainly from combustion sources. These combustion sources are thought to be currently dominated by uncontrolled combustion (from rural burning of household waste, agricultural burning, landfill fires, or forest fires). Other dioxin sources include reservoir sources (old releases of dioxins that are temporarily stored in environmental compartments to later be reintroduced into the circulating environment), which are thought to account for a significant amount of dioxin-like PCB emissions. The actual quantitative contribution of these different source categories is currently unknown. Characterization of these sources can be improved through enhancement of existing emissions inventory activities being conducted by the National Release Inventory of Dioxin and Dioxin-like Compounds and the Great Lakes Regional Air Toxics Emissions Inventory. By including less characterized source categories with those that are already monitored, insights into the actual contribution of such sources to overall dioxin emissions can be gained.

As with mercury emissions, it is important that changes in emissions over time are tracked. The National Release Inventory of Dioxin and Dioxin-like Compounds presents the best opportunity for tracking dioxin emissions. Thus, the Strategy recommends periodic updating of this inventory every three to five years.

Air Deposition and Transport

The main mode of transport for dioxins is atmospheric transport. Dioxins can be transported from their source region to other areas where they are deposited into existing vegetation, which are then consumed by domestic livestock, allowing dioxins to enter the commercial food supply. Because greater than 95 percent of dioxin exposure to the general population comes from this food supply, it is important to understand air concentrations and trends in atmospheric levels of dioxins (and dioxin-like compounds) near food and feed production areas. This can be accomplished through maintenance of current sites and integration of additional sites into NDAMN.

Understanding regional pictures of dioxins in the atmosphere as well as potential transboundary scenarios is also important to the overall understanding of dioxins in this key medium. A Great Lakes regional picture can be easily established by integrating dioxin monitoring into the existing PBT monitoring occurring in the IADN. In fact, plans are already in motion to accomplish this. Transboundary air transport data can be obtained by utilizing existing NDAMN border sites and supporting the establishment of a Mexican counterpart to NDAMN, already begun, such that dioxins can be tracked from Mexico to the U.S.

Table 5-2. Monitoring Strategy recommendations for dioxins.

Environmental Medium	Current Program(s)	Proposed Enhancements
Emissions/Releases	National Release Inventory of Dioxin and Dioxin like Compounds, Great Lakes Regional Air Toxics Emissions Inventory	Improved characterization of dioxin and coplanar PCBs sources, particularly open burning, metal smelting, and reservoir sources
		Track changes in emissions through periodic updating of National Release Inventory of Dioxin and Dioxin-like Compounds (2002, 2005, 2010)
Air/Air Deposition	National Dioxin Air Monitoring Network (NDAMN), Integrated Atmospheric Deposition Network (IADN), Existing border sites	Maintain NDAMN station coverage sufficient to monitor reductions in dioxin air concentrations in primary food and feed production areas and to detect national trends
		Support establishing Mexican network (already begun) to determine transboundary dioxin flux (6 stations for at least 4 years of operation on the NDAMN protocol synchronized with U.S. network operations)
		Utilize infrastructure and resources in place for PM/Criteria pollutant networks and Air Toxics Monitoring Network, adding co-coplanar PCBs and dioxin to IADN sites (in the works)
Soil/Sediment	National Soil Survey	Expand existing soil survey (phase one) to characterize background soil levels and broad area hot spots (road way, power lines, and railroad right of ways)
		Initiate National Sediment Survey to characterize strength and geographic distribution of the sediment reservoir
Food	FDA Market Basket Survey (D/F coplanar PCBs)	Encourage FDA to continue its expanded dioxin monitoring effort
	FSIS (USDA) National Meat Surveys (D/F coplanar PCBs)	Encourage periodic (5 year) resampling and analysis of beef, pork, and poultry
	ERAMS milk network	Expand analysis of ERAMS collected milk
	Great Lakes Fish Contaminant Program	Fold reporting into national study reporting
	State fish monitoring	Establish regular access to state data and incorporate into national database
Human Tissues	NHANES (general population) (includes coplanars)	Encourage continued monitoring of blood serum

*Shading indicates secondary recommendations. No shading indicates primary recommendations.

Soil/Sediment

Dioxins are hydrophobic and thus tend to settle out with particles in the water column into the underlying sediment. Levels of dioxin in fish are also thought to be driven by these sediment reservoirs. As fish are a potential exposure route for humans to dioxins, it is important that sediment reservoirs be properly characterized so that future remediation and dredging activities can be properly focused. Current monitoring activities do not address dioxins in sediment in any systematic fashion. The Strategy recommends initiating a National Sediment Survey so that the strength and geographic distribution of PBT sediment reservoirs can be properly characterized. Similarly, current efforts under the National Soil Survey are supported by the Strategy, with an emphasis on expanding the survey to include analysis of background levels of dioxins in soils as well as levels in known hot spots.

Food

Food is the major exposure route for humans to dioxins. Thus, food monitoring provides the most direct measure of current exposure. Current food monitoring efforts are a shared responsibility of the EPA, FDA, and the USDA. Any enhancements to these efforts must be made in the form of support or encouragement to these collaborating agencies as the EPA does not have direct control over these programs. The Strategy encourages the FDA to expand its dioxin monitoring efforts as part of its Market Basket Survey. Likewise, the Strategy supports periodic (five year) re-sampling and analysis of beef, pork, and poultry as part of the USDA's National Meat Survey program. The National Milk Study, conducted in 199? used the EPA's Environmental Radiation Ambient Monitoring System (ERAMS) to collect milk samples and analyze them for dioxins and dioxin-like compounds. The Strategy recommends expanding ERAMS to include the analysis of these compounds to better characterize exposure to dioxins through the commercial milk supply.

Fish are also an important part of the exposure route for dioxins to humans and wildlife. Currently, state and regional fish monitoring programs provide the best leveraging opportunities for incorporating fish tissue concentrations into the Strategy's database. The Great Lakes Fish Contaminant Program has been monitoring PBTs in fish from the water of the Great Lakes for decades. The reporting of these data could simply be folded into the national study reporting from this Strategy. States also monitor PBT concentrations in fish so that they can establish fish advisories when necessary. The Strategy recommends establishing regular access to fish data from individual States and then incorporating these data into a national database so that trends on a national level can be examined.

Human Tissues

In 1999, NHANES began analyzing dioxins in human blood serum. As part of efforts of this Strategy to enhance current PBT monitoring, the CDC is encouraged to continue monitoring dioxins and dioxin-like compounds in blood serum samples taken in future surveys.

5.2.3 Recommendations for PCBs

The manufacture and use of PCBs have been banned in the U.S. since 1977. Many other countries followed suit and banned the production of PCBs in the late 1970s and 1980s. Thus, unlike the case with mercury and dioxin, there are no active anthropogenic sources generating PCBs. Despite these bans, PCBs are ubiquitous, found in all of the key media. Some of the more volatile PCB congeners can be quite mobile in the environment, transferring among media and participating in long-range transport. Because of their mobility and cross-media interactions, recommendations for monitoring enhancements for PCBs focus on all media categories. Many of the recommendations are similar to those for dioxins (see Table 5.2). Table 5.3 presents the recommended monitoring enhancements for PCBs. In general, recommendations for enhancements to current PCB monitoring efforts in soils/sediment, food, and human tissues are the same as those for dioxins, so they will not be discussed in further detail here. Specifics related to the transfer of PCBs into the key media can be found in Appendix A.

Air Emissions

Because PCBs have been banned for so many years, their sources to the atmosphere come mainly from revolatilization from terrestrial and aquatic sources known as reservoirs. In fact, environmental reservoirs are thought to be the dominant source of PCBs in the U.S. environment. Aside from the general background levels of PCBs in terrestrial and aquatic systems, environmental reservoirs include contaminated sites, such as unremediated manufacturing, processing, and federal/military sites; unremediated dumps and spills; highly contaminated sediment “hotspots”; and pre-TSCA landfills. Other PCB emission sources include leaks from PCB-contaminated electrical equipment and non-reservoir releases to the air, such as sludge-drying beds. Though emissions from some of these reservoirs have been studied, others remain uncharacterized, with wide gaps remaining in understanding their emissions to air. Incorporating reservoir sources into emissions that are monitored under NEI, TRI, and the Great Lakes Regional Air Toxics Emissions Inventory will go a long way toward advancing current knowledge and understanding of these sources. An additional enhancement would be to incorporate PCBs into the Dioxin Source Inventory program **[Can we reference?**] in an effort to help quantify uncharacterized reservoir sources.

Air Deposition and Transport

PCBs in the atmosphere are currently well-characterized in the Great Lakes region through the IADN. Unfortunately, gaps exist in atmospheric monitoring efforts in other regions, making a national trends picture difficult to realize. The addition of non-planar PCBs to monitoring at existing NDAMN sites would make use of existing resources to enable national trends assessments.

Table 5-3. Monitoring Strategy recommendations for PCBs.

Environmental Medium	Current Program(s)	Proposed Enhancements
Emissions/Releases	National Emissions Inventory, Toxics Release Inventory, Great Lakes Regional Air Toxics Emissions Inventory	Improved characterization of PCBs sources, including reservoir sources
		Incorporate PCBs into Dioxin Source Inventory
Air/Air Deposition	National Dioxin Air Monitoring Network (NDAMN), Integrated Atmospheric Deposition Network (IADN), Existing border sites	Add non-coplanar PCBs to NDAMN
		Utilize infrastructure and resources in place for PM/Criteria pollutant networks and Air Toxics Monitoring Network, adding co-coplanar PCBs and dioxin to IADN sites (in the works)
Soil/Sediment	National Soil Survey	Expand existing soil survey (phase one) to characterize background soil levels and broad-area hot spots (road way, power lines, and railroad right of ways)
		Initiate National Sediment Survey to characterize strength and geographic distribution of sediment reservoirs
Food	FDA Market Basket Survey (D/F coplanar PCBs)	Encourage FDA to continue its expanded dioxin/PCB monitoring effort
	FSIS (USDA) National Meat Surveys (D/F coplanar PCBs)	Encourage Periodic (5 year) resampling and analysis of beef, pork, and poultry
	ERAMS milk network	Expand D/F/PCB analysis of ERAMS collected milk
	Great Lakes Fish Contaminant Program	Fold reporting into national study reporting
	State fish monitoring	Establish regular access to state data on PCBs and incorporate into national database
Human Tissues	NHANES (general population) (includes coplanars)	Encourage continued monitoring of human blood serum for PCBs

*Shading indicates secondary recommendations. No shading indicates primary recommendations.

5.3 PBT-Specific Recommendations for Research to Support Monitoring

Enhancing current monitoring efforts for mercury, dioxins, and PCBs will certainly help fill in gaps in spatial coverage for these compounds as well as gaps in coverage in the key media identified in the *PBT Monitoring Strategy*. This in turn will help to eliminate limitations to current data in a multimedia assessment scenario. However, enhancements to current monitoring efforts will not eliminate all gaps and data limitations, nor will they provide the framework for a complete understanding of PBT behavior in the environment. Some efforts will have to be made through research activities to support the monitoring efforts and enhancements that have been discussed throughout this Strategy. This chapter discusses PBT-specific recommendations for such research activities.

5.3.1 Recommendations for Research to Support Mercury Monitoring

Many of the limitations to understanding the behavior of mercury in and between media lie in the poorly understood transport, transformation, and fate processes for mercury in terrestrial and aquatic media as well as in the uncharacterized emissions of some sources of mercury. EPA's *Mercury Research Strategy* (2000) has included these in a short list of prioritized research needs relating to mercury. The following discussion is based on the research needs identified in the *Mercury Research Strategy*.

While the general outlines of mercury sources, fate and transport, and bioaccumulation are well understood, there remains considerable uncertainty, particularly concerning the detailed processes involved in mercury transport and fate and the rate-controlling factors. Current knowledge in this area is lacking to the extent that estimates of reductions in methylmercury concentrations in fish based on reductions in source emissions cannot be made. As efforts to control mercury levels in fish would start with source reduction efforts, and because emissions (not fish) would readily respond to source reduction efforts, the inability to link these media (emissions and fish) is troubling and presents a roadblock to effective risk management actions. An improved understanding of the transport, transformation, and fate of mercury, however, would remove this roadblock. An improved understanding would also guide monitoring efforts for mercury to ensure proper coverage of the key media (or representative media) in the most cost effective manner possible. This understanding can only be found through research.

Research needed to understand the transport, transformation, and fate of mercury in the atmosphere and aquatic and terrestrial environments includes information on the atmospheric fate of different mercury species. This means understanding the mechanisms for mercury depletion in the atmosphere as well as the deposition behavior of different species. Results from this research could influence where, when, and how air deposition monitoring is performed.

For a better understanding of the long-range transport of mercury, field tests of innovative measurement technology for the determination of gas-phase and particle-phase mercury is needed along with information mercury's transboundary transport mechanisms for this PBT. Understanding transport mechanisms could influence monitoring site placement as well as the technology used to monitor atmospheric mercury. The development of models will also play a key role in research efforts to understand the fate and transport of mercury. As emphasized in Appendix C, monitoring and modeling serve to complement each other.

Characterizing ill-defined source emissions will also support monitoring efforts through this Strategy. Research in this area includes increased testing and evaluation of continuous emissions monitors (CEMs) for mercury. Though such instruments are generally used to determine compliance with mercury regulations, the use of CEMs will help to define sources and guide monitoring site placement to properly characterize emissions from these sources. Along the same lines, research into CEMs for various mercury species is also encouraged.

As with PCBs, mercury releases from sources and sinks are not well understood. Reservoir sources are not only uncharacterized, but often not well defined, making monitoring difficult. Research efforts are recommended to define these sources as well as improve monitoring techniques to quantify them. Such research efforts will lead to more efficient monitoring by helping to guide any additional monitoring that is needed and ensuring that data gaps are eliminated.

5.3.2 Recommendations for Research to Support Dioxin Monitoring

[Note: This section will be completed using research described in the text]

5.3.3 Recommendations for Research to Support PCB Monitoring

As detailed in Appendix A, there are still wide gaps in knowledge about PCB emissions from various uncharacterized, non-reservoir sources. These sources include things such as electrical equipment and sludge drying beds. Some recent research efforts have attempted to link sources of PCBs in landfills and sludge drying beds to downwind atmospheric concentrations[7]. This research used field sampling in conjunction with receptor modeling to locate and quantify PCB sources in an urban area. Unfortunately, there are not many similar efforts, thus large gaps still exist in understanding these sources. More research and monitoring needs to be focused on characterizing these sources as they are thought to be major contributors to levels of PCBs in the environment.

Research is also needed to understand the long-range transport of PCBs. EPA does not yet know the percentage contribution of international long-range transport of PCBs to total U.S. atmospheric loadings of PCBs. Similarly, on a smaller scale, it is difficult to ascertain contributions to an area from local, regional, continental, and global sources. Research points to international emissions contributing to U.S. PCB loadings, and corresponding U.S. emissions contributing to loadings of PCBs abroad. However, more exploration is needed in this area to fully understand such contributions.

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[7]Hsu, Y.; Holse, T. M.; Hopke, P.K. Locating and quantifying PCB sources in Chicago: Receptor modeling and field sampling, *Environmental Science and Technology*, **2003**, *37*, 681-690.

PCBs enter aquatic systems, such as the Great Lakes, mainly through the atmosphere. This means that understanding their deposition is important to maintaining the health of sensitive ecosystems such as the Great Lakes or the Chesapeake Bay. Current efforts to quantify this deposition are limited by the nature of physical-chemical parameters available for such calculations, such as the accuracy of Henry's Law constants. Attempts to understand such deposition then are relying on improved research activities to better estimate the parameters necessary for these calculations. Furthermore, urban areas can have an effect levels of PCBs in the air and therefore on the atmospheric deposition of PCBs to water bodies. Though there have been many attempts to understand urban influences in the Chicago/Lake Michigan area, similar attempts in other urban area have been limited. Further research consideration of the influence of urban areas is needed in order to discern how the atmospheric deposition of PCBs to large water bodies like the Great Lakes is influenced by nearby cities.

6.0 RECOMMENDATIONS FOR ADDRESSING EMERGING PBTS WITHIN THE *PROGRAM*

Benefits of Using the PBT Monitoring Strategy To Detect Emerging Pollutants

- Early warning system
- Cost-effective sample collection
- National network to assess extent of emerging chemical contamination.

Emerging PBTs are those that are currently not a high environmental priority but are gaining increasing attention. Typically, they are chemicals or groups of chemicals for which 1) there is evidence of their PBT-like characteristics and 2) levels in the environment may be increasing. Examples of emerging pollutants of current interest include: the metals thallium and platinum, polybrominated diphenyl ethers (PBDEs), and perfluorooctane compounds (PFOA/PFOS).

6.1 Early Warning System

In addition to meeting the goals of the *PBT Monitoring Strategy*, a *National Multimedia Monitoring and Assessment Program for PBTs* would provide a framework for identifying emerging PBTs before they increased to levels of concern in the environment. Samples collected through the *Program* would be analyzed for a target list of PBTs (e.g., mercury, dioxin, PCBs). Emerging pollutants would not be routinely monitored in the *Program*, unless environmental levels warrant their inclusion on a target list. Rather, the presence of an emerging pollutant would be ascertained only where its presence might be suspected or when evidence of an unusual suspect presented itself (e.g., as an unexplained peak in a chromatograph). Unidentified peaks appearing in the results could be investigated further for the presence of potential emerging pollutants. In this way, the *Program* could be used as an early warning system that detects emerging PBTs or other substances of concern to EPA or its partners.

The *Program* would provide a nationwide, multimedia network of monitoring sites through which the extent of emerging chemical contamination could be assessed. That is, a substance of concern could be analyzed in different media at a number of representative sites to determine whether its environmental presence was limited to one location and medium or was widespread geographically and ubiquitous in environmental media.

As another example of the Strategy's efficient leveraging approach to monitoring, the Stratgey is considering existing tools developed under EPA's New Chemicals Program to help identify whether emerging chemicals are PBTs. For example, under its New Chemicals Program, EPA has defined a category, based on shared structural and toxicological properties, for chemical substances that meet the definition of a new PBT substance. The PBT Profiler is another tool that estimates persistence, bioaccumulation, and fish chronic toxicity based on chemical structure. While these tools and others can help identify whether emerging pollutants are PBTs, emerging PBTs may differ from current high-priority PBTs in other ways. The *Program* may not be able to detect new chemicals which have unexpected, novel pathways of exposure.

6.2 Current Recommendations

To provide flexibility in analyzing emerging pollutants, the Strategy recommends that the *Program* be designed with excess capacity and routinely archive samples. Excess capacity would allow analyte lists to be expanded when warranted to include emerging pollutants. For example, the Integrated Atmospheric Deposition Network (IADN) routinely archives extracts of the samples it collects. When it became clear that PBDEs were becoming widespread in the environment, yet little was known about the background concentrations of these compounds in the atmosphere, the archived IADN air samples were re-analyzed for PBDEs[8] . PBDEs were found in all of the samples analyzed from 1997-1999 near Lakes Michigan, Erie, and Superior as well as Chicago. In fact, PBDE concentrations were found to correlate well with PCB concentrations at these sites. Thus, by leveraging an existing network and analyzing archived samples for an emerging PBT, this study was able to demonstrate the widespread nature of PBDEs in the atmosphere while also presenting a regional picture of the behavior of these emerging PBTs in the Great Lakes basin. With archived samples, trends analyses could also be performed to reveal the history of environmental contamination (e.g., whether levels are increasing, decreasing, or leveling off). Specific recommendations for current programs are presented in Table 6-1 and discussed below.

Because the predominant pathway for human exposure to PBTs is fish consumption, the Strategy recommends focusing on the detection of emerging PBTs in fish and human tissues. To include monitoring of emerging PBTs, the Strategy recommends that the National Fish Tissue Study, described in detail in Appendix B, continue the current practice of archiving samples, so that retrospective analyses can be performed economically. In addition, it would be desirable to expand the list of compounds analyzed in the National Fish Tissue Study, or to perform analyses for emerging contaminants on a subsample of tissues. Similarly, the Strategy recommends that the CDC expand the list of analytes measured in NHANES to include more emerging pollutants, at least on a subsample of tissues, and to continue to archive samples.

To detect possible emerging PBTs that accumulate in other foods but not in fish, the Strategy recommends that the FDA undertake wide-spectrum monitoring on a small subsample of various foods. In cases where highly-exposed populations are monitored, the Strategy recommends that emerging PBTs be included, as opportunities allow.

Table 6-1. Recommendations for addressing emerging PBTs.

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[8]Strandberg, B.; Dodder, N. G.; Basu, I.; Hites, R. A. Concentrations and spatial variations of polybrominated diphenyl ethers and other organohalogen compounds in Great Lakes air, *Environmental Science and Technology*, **2001**, *35*, 1078-1083.

Environmental Medium	Current Program	Recommendations*
Food	National Fish Tissue Study	Continue or repeat survey, and expand to Alaska; Expand analyte list to include more emerging contaminants; Continue archiving samples
	FDA commercial food-supply monitoring	Undertake continuing, low-level monitoring of commercial food supply for emerging contaminants
Human Tissues	NHANES (general population)	Expand list of potential emerging contaminants
	Non-routine monitoring of highly-exposed populations	Pursue opportunities as they occur
All	All programs	Archive samples; allow excess capacity

*Shading indicates secondary recommendations. No shading indicates primary recommendations.

7.0 COST ANALYSIS

Recommended Actions and Costs

- Leverage existing PBT monitoring programs to reduce contributions of EPA offices
- Share costs across offices and agencies
- Maintain current networks and enhance the *Program* incrementally with additional investments over a 10-20 year period

One of the priorities of this Strategy is to provide the framework, integration, and action steps necessary to implement the PBT monitoring program at a reasonable cost. This means making efficient use of current program funding and reducing the need for additional support by leveraging existing federal, state, and tribal programs and resources, where possible, and by establishing successful cross-program partnerships. These efforts would reduce the contribution of individual participants yet provide the foundation necessary to make the Strategy successful.

In past years, the CDC, FDA, EPA, the States, and others have, in most cases, supported PBT monitoring efforts independently. Under the *PBT Monitoring Strategy*, these organizations will continue to share the costs of collecting and analyzing PBT monitoring data. However, as described in previous chapters, the Strategy proposes to leverage each organization's monitoring investment. For EPA offices contributing to implementation of the Strategy, a multi-office proposal is offered to further distribute the responsibility placed on any one EPA office.

Recognizing the budgetary constraints of cross-office initiatives, EPA's share of implementing the Strategy is divided into potential budget options. Table 7-1 presents three potential options for the Strategy's recommended actions, along with an estimated cost range for each option. Option 1, further partitioned into Options 1a and 1b, is the highest priority for the Strategy. This option would establish a framework for the *National Multimedia Monitoring and Assessment Program for PBTs*, *2004-2020*, described in the Strategy, and begin periodic data assessments. Options 2 and 3 are also recommended since they are designed to address the gaps identified in the existing monitoring structure by adding incremental improvements to the base *Program*. Each option is described in further detail below.

It is assumed that EPA and other agencies and organizations will maintain current programs that monitor PBTs (i.e., the baseline). High priority programs for the Strategy include the Dioxin Inventory, IADN, MDN, NDAMN, NEI, the National Fish Tissue Study, TRI, and support for monitoring of PBTs in NHANES. This baseline investment is essential for the Strategy, which relies so heavily on leveraging, in particular, for meeting the Strategy's goals of understanding trends of PBTs in the environment and measuring the effectiveness of risk management actions. For EPA, the approximate cost to maintain current priority programs that monitor PBTs is $2.9 million per year.

Table 7-1. Potential options for implementing the PBT Monitoring Strategy recommendations.

Option	Activities Included	Benefits [a]	Cost Range (per year) [b]
Baseline Investments	Dioxin Inventory, IADN, MDN, NDAMN, NEI, National Fish Tissue Study, TRI, NHANES	Provides the foundation for our current understanding of PBT levels in critical media; Maintain ongoing, historical record for observing trends in critical media	$0K (no new investment; $2.9+M to maintain current programs)
1a) Ensure Compatibility and Accessability of Data in Various Monitoring Data Sets	Establish steering committee and information clearinghouse	Current monitoring efforts can be substantially integrated and availability of data can be improved	$20,000 - $120,000
1b) Improve Data Assessments	Conduct periodic multimedia assessments	Existing data can be used more fully (e.g., to understand whether source reductions translate into reduced exposure)	$50,000-$100,000
2) Conduct Research and Special Studies to Enhance Routine Monitoring	Improve modeling tools; Improve source characterization; Develop dry deposition method; Use Mexican NDAMN network to study transboundary flux	By filling specialized information gaps and/or developing methods for use in future routine monitoring, research studies can help improve the utility of existing monitoring networks.	$80,000 -$1.4 M
3) Improve Routine Monitoring via Additional Direct Investment	Establish new transboundary sites; Add MDN sites; Conduct biomonitoring of PBT levels in potentially high-end exposure subpopulations; Expand Dioxin/PCB analysis in ERAMs collected milk; Develop PCB Inventory; Expand soil survey; Initiate sediment survey; Add non-coplanar PCBs to NDAMN; Monitor PBTs in Air Toxics Monitoring Network	A number of currently identified PBT monitoring gaps and inefficiencies can be addressed by modest supplementation of existing programs	$40,000 - $2.1 M
TOTAL FOR FULL IMPLEMENTATION			$3.7 M

[a] Assuming full implementation.

[b] Values are estimated annual costs averaged over a five year monitoring period. In some cases, start up costs in the initial year will be greater than the ongoing investments in subsequent years.

Options 1a and 1b propose improving the integration of current monitoring programs and conducting periodic assessments of the data collected for a modest new investment of approximately $370,000 to $420,000 per year. Option 1a includes establishing a cross-Agency steering committee and an information clearinghouse. Option 1b includes conducting multimedia and other data assessments; encouraging other federal agencies to monitor the commercial food supply, particularly enhancing fish monitoring; encouraging continued monitoring of PBTs in NHANES; and improving modeling tools for supporting assessments. A summary of activities under Options 1a and 1b and the range of costs to support them is presented in Table 7-1.

Option 1a is recommended, as a minimum, to begin to address the need for a coordinated PBT monitoring and assessment program. By implementing Option 1a, the current lack of integration among monitoring efforts can be remedied and existing data can be used more fully. A steering committee would be established to coordinate PBT monitoring programs. An information clearinghouse would make PBT monitoring data more readily available and thus more likely to be used for research and analysis. Option 1b is also viewed as highly critical to beginning the implementation of the Strategy. This option includes periodic multimedia assessments of the data to utilize data collected from PBT monitoring programs to better inform decision makers. For example, data assessments could analyze whether risk management actions result in reduced emissions as well as reduced levels of PBTs in fish tissue, a primary exposure pathway. Also, improved modeling tools would be developed under Option 1b to provide more useful data assessments, for example, by being better able to apportion sources of PBTs or predict concentrations where there are no monitors. A more detailed discussion of these activities is included in Chapter 5.

Once the framework for a coordinated multimedia monitoring program has been established, incremental improvements to the *Program* can be made through research and special studies (Option 2). For an estimated $1.2 million, Option 2 proposes improving PBT source characterization; establishing a dry deposition method (for mercury); and using the Mexican NDAMN network to study transboundary fluxes of PBTs. Likewise, Option 3 proposes to improve routine monitoring further by supplementing existing routine monitoring networks for an additional investment of approximately $2.1 million. This investment would address a number of already identified PBT monitoring gaps and inefficiencies, for example, by expanding geographic coverage or adding analytes to existing networks. A summary of activities under Options 2 and 3 and the range of costs to support them is presented in Table 7-1. A more detailed discussion of recommended activities is included in Chapter 5.

Figure 7-1 illustrates the estimated costs for Options 1 (a and b) through 3 and current baseline programs over the next ten years. The Strategy expects to routinely leverage nearly $3 million in existing programs, i.e., baseline investments. A new investment of approximately $4.3 million is recommended in FY05 and FY06 to implement Options 1 through 3. This commitment will drop to $3.6 million in FY07 through FY09, and remain at a sustained level of $3 million in FY10 and beyond. A more modest investment of $0.85 million to $1.1 million over FY05 - FY09, followed by similar investments in subsequent five-year periods (e.g., FY10 - FY14) for future data assessments, would support Options 1a and 1b and is viewed as a top priority.

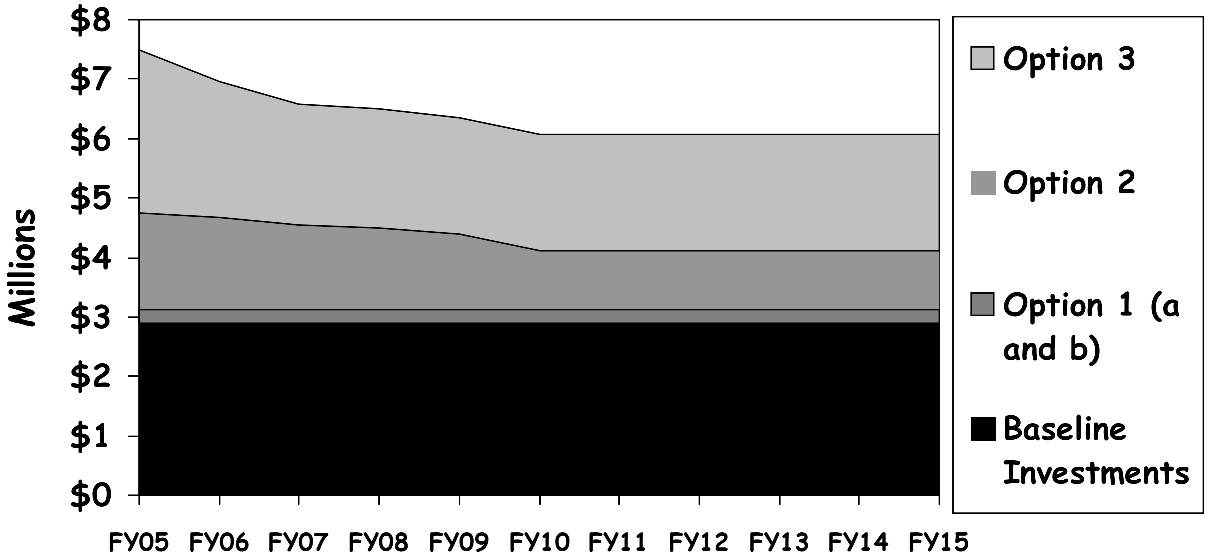

Figure 7-1. Anticipated multi-year expenditures for recommended options.

Table 7-2 presents the itemized actions for each potential option and their associated costs. The current baseline investments for existing monitoring programs are also given to demonstrate the extent to which the Strategy leverages current programs. Note that the values in Table 7-2 are estimated average yearly costs for a five year monitoring program. Also note that start up costs in the initial year will be greater than the investments in subsequent years to maintain the program, as shown in Figure 7-1.

Table 7-2. Costs of recommended Strategy actions (New Dollars), by option, as well as baseline monitoring contributions (Base Dollars) (dollars in thousands).[a]

Action	New Dollars [a]	Base Dollars
BASELINE INVESTMENTS		
Dioxin Inventory	$0	$200
TRI (existing program)	$0	NA [b]
NEI (existing program)	$0	NA [b]
IADN (existing program)	$0	$650
NDAMN (existing program)	$0	$650
MDN (existing program)	$0	NA [b]
National Fish Tissue Study (Analysis of PBTs)	$0	$1,000
Continued support for NHANES	$0	$400
TOTAL BASELINE INVESTMENTS	$0	$2,900
OPTION 1a		
Intra-Agency Steering Committee	$20	$0
Establish Information Clearinghouse	$100	$0
TOTAL FOR OPTION 1a	$120	$0
OPTION 1b		
Conduct Periodic Multimedia Assessments	$50-100	$0
TOTAL FOR OPTION 1b	$50-100	$0
OPTION 2		
Improve modeling tools for assessments	$200	$0
Improve PBT source characterization	$1,000	$0
Develop Dry Deposition Method (for mercury)	$80	$0
Mexican NDAMN network - transboundary flux	$140	$0
TOTAL FOR OPTION 2	$1,420	$0
OPTION 3		
Additional Transboundary sites (for mercury)	$400	$0
Additional MDN sites	$400	$0
Expand Dioxin/PCB analysis in ERAMS collected milk	$110	$0
Develop PCB Inventory	$40	$0
Expand National Soil Survey (for D/F/PCBs)	$70	$0
Initiate sediment survey (for D/F/PCBs)	$70	$0
Add non-coplanar PCBs to selected NDAMN sites	$50	$0
Conduct biomonitoring of PBT levels in potentially high-end exposure subpopulations	$1,000	$0
TOTAL FOR OPTION 3	$2,140	$0
TOTAL	$3,730 - $3,780	$2,900

[a] Values are estimated annual costs averaged over a five year monitoring period. In some cases, start up costs in the initial year will be greater than the ongoing investments in subsequent years.
[b] Highly leveraged program; direct EPA support has not been estimated.