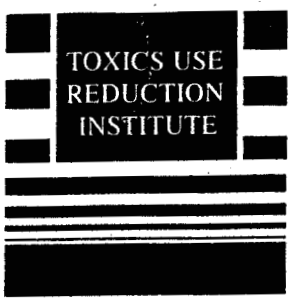

THE MASSACHUSETTS
TOXICS USE REDUCTION INSTITUTE

BENEFIT-COST ANALYSIS OF THE MASSACHUSETTS TOXICS USE REDUCTION ACT

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BENEFIT-COST ANALYSIS OF THE MASSACHUSETTS TOXICS USE REDUCTION ACT

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The Toxics Use Reduction Institute is a multi-disciplinary research, education, and policy center established by the Massachusetts Toxics Use Reduction Act of 1989. The Institute sponsors and conducts research, organizes education and training programs, and provides technical support to promote the reduction in the use of toxic chemicals or the generation of toxic chemical byproducts in industry and commerce. Further information can be obtained by writing the Toxics Use Reduction Institute, University of Massachusetts Lowell, One University Avenue, Lowell, Massachusetts 01854.

Notice

This study was funded by the Toxics Use Reduction Institute under contract number S963490 to Abt Associates Inc.. This report has been reviewed by the Institute and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the Toxics Use Reduction Institute, nor does the mention of trade names or commercial products constitute endorsement or recommendation for use.

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Executive Summary

The Massachusetts Toxics Use Reduction Act (TURA) was passed in 1989 with the objective of reducing toxic chemical use and byproduct generation in the Commonwealth. This report analyzes the benefits and costs of TURA to the Commonwealth for the period 1990 through 1997. *Based in part on a survey of facilities subject to TURA, the benefits of TURA to the Commonwealth were found to exceed the costs of TURA to the Commonwealth. Further, the conclusion that benefits exceed costs is reached exclusive of the human health and ecological benefits of the Act.* Figure ES-1 summarizes the monetized and non-monetized costs and benefits of the Act.

TURA establishes six goals, one of which is to reduce toxic or hazardous byproduct generation in Massachusetts by 50 percent from 1987 to 1997 using toxics use reduction (TUR) as the means of achieving this goal. Reductions in toxic chemical use are to be achieved by: input substitution, product reformulation, production unit redesign or modification, production unit modernization, improved operation and maintenance, and recycling, reuse or the extended use of toxics. TURA does not require that Massachusetts facilities implement TUR projects nor does it require that facilities meet specific reduction goals. Rather, the objectives of the Act are to be met by requiring facilities to report on their use of toxics and their generation of toxic byproducts as well as by requiring facilities to undergo a planning process to identify opportunities for toxics use reduction. Facilities are supported in their TUR efforts by the Office of Technical Assistance for TUR (OTA), the Toxics Use Reduction Institute (TURI), and the TUR Program Office of the DEP.

Approximately six-hundred Massachusetts facilities are subject to the planning and reporting requirements of TURA. Companies that employ the equivalent of 10 full-time employees, conduct any of the business activities defined within Standard Industrial Classification (SIC) codes 10-14, 20-39, 40, 44-51, 72, 73, 75, and 76, and process, manufacture, or otherwise use any of the toxic substances on the EPA EPCRA section 313 list as well as any chemicals on the EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) reportable quantities list are potentially subject to TURA.

Figure ES-1: Summary of the Costs and Benefits Attributable to TURA

Costs	Benefits
Monetized	
Compliance Costs: -Form S preparation -TUR plan preparation -Form S filing fees -Other TURA fees (TURP training, continuing education, certification) Capital investments	Savings in operating costs (=net operating cost changes) Federal grants to TURA program for TUR activities in Massachusetts
Non-Monetized	
	Human health and ecological benefits from: -reduced worker health and safety risks from exposure to toxic chemicals -reduced public health and safety risks from exposure to toxic chemicals -reduced environmental exposure to toxic chemicals Increased revenue from TUR improvements in processes and products Activities of TURA program agencies in other regulatory and non-regulatory programs Benefits to non-TURA firms in Massachusetts from TURA program resources Value of TURA data to public data users in the Commonwealth

This report monetizes benefits and costs to the extent that reliable estimates could be generated. Costs attributable to the requirements of TURA fall within two general categories: 1) compliance costs, including: Form S preparation, TUR plan preparation, Form S filing fees, and other TURA fees related to TURP training and certification; and 2) capital costs associated with the implementation of TUR projects. Because changes in operating costs resulting from TUR typically result in a net cost savings, net changes in operating costs are discussed as a benefit. Costs are estimated in this analysis for the period 1990 through 1997. Figure ES-2 summarizes the costs of the Act. Costs are presented in constant 1995 dollars (i.e., adjusted to account for inflation).

Figure ES-2 Summary of TURA Costs ($ 1995 - millions)

	1990	1991	1992	1993	1994	1995	1996	1997
Compliance Costs:								
Preparing Form S	0	2.0	1.4	1.3	1.2	1.1	0.9	0.9
Preparing TUR Plans	0	0	0	0	5.9	0.4	3.6	0
Form S Filing Fees	0	2.2	5.2	5.2	4.7	5.6	2.7	6.6
Other TURA Fees	0	0.001	0.03	0.05	0.08	0.08	0.06	0.04
Capital Costs:								
Capital Expenditures	0.4	1.0	1.5	2.2	4.0	4.3	6.5	7.2
Total	$0.4	$5.3	$8.1	$8.7	$15.9	$11.4	$13.8	$14.8

The primary purpose of TURA is to "promote industrial hygiene, worker safety, and protection of the environment and public health". Thus, the primary benefits of the Act are expected in these areas. Improved protection of human health and the environment is expected to result from TURA as facilities identify and implement toxics use and emission reduction opportunities through the TURA planning and reporting processes. These use and emission reductions will benefit society by reducing human exposure to toxics as well as lessening environmental contamination. The analysis does not, however, monetize the benefits of human health and ecological risk reduction due to the difficulty in isolating, measuring, and then monetizing impacts resulting from TUR. Instead, this analysis provides examples of chemicals for which quantitative data from Form S indicate use or emission reductions that would likely reduce human health and ecological risk.

Several other benefits are also generated for the Commonwealth as a result of TURA (see Figure ES-1), two of which are monetized in this report: net savings in facility operating costs and receipt of Federal grants used to fund TUR activities. Figure ES-3 summarizes the total changes in operating costs for 1990 through 1997 based on a survey of 1993 TURA filers. Again, costs are presented in constant 1995 dollars. Since the program's inception, TURA agencies have received 12 Federal grants, totaling $2,527,615 ($2,288,638 in 1995 dollars), to support TUR activities in the Commonwealth above-and-beyond those efforts funded directly by TURA fees. These grants are included in the analysis as benefits of TURA because they have been leveraged by the TURA program and have benefited the Commonwealth. The results of the monetized benefit-cost analysis should be considered in conjunction with the examples of human health and ecological benefits, as well as the other non-monetized benefits.

Figure ES-3 Net Changes in Operating Costs Resulting from TURA Activities
($ 1995- Positive values indicate reductions in costs)

	1990	1991	1992	1993	1994	1995	1996	1997
Total Operating Cost Changes Due to TURA (millions)	$6.0	$12.7	$9.1	$9.2	$9.7	$11.0	$10.2	$11.9

The report presents monetized costs and benefits in constant 1995 dollars (i.e., adjusted to account for inflation) for 1990 through 1997. Because the costs and benefits occur in different time periods, they must be discounted to a present value before comparison to determine overall net benefits. A present value can be calculated for any base year. For this report, 1995 is chosen as the base year. A real discount rate of seven percent was applied, which is the rate recommended by the Office of Management and Budget for analysis of federal regulations. The report estimates total costs of $77 million and total *monetized* benefits of $91 million, distributed as shown in Figure ES-4 below. Again, these monetized benefits should be considered only a partial picture of the benefits of the TURA Program because the value associated with the human health and ecological benefits of the Act, as well as certain other benefits, were not monetized.

Figure ES-4 Monetized and Non-monetized Costs and Benefits of TURA

(1990 through 1997 - millions of 1995 dollars)

Costs			Benefits	
Monetized				
Compliance Costs: -Form S preparation -TUR plan preparation -Form S filing fees -Other TURA fees (TURP training, continuing education, certification)	 $ 9.9 $ 10.1 $ 29.1 $ 0.3		Savings in operating costs (=net operating cost changes) Federal grants to TURA program for TUR activities in Massachusetts	$ 88.2 $ 2.3
Subtotal		$ 49.4		
Capital investments	$ 27.1	$ 27.1		
Total monetized TURA costs		$ 76.6	**Total monetized TURA benefits**	$ 90.5
Non-Monetized				
			Human health and ecological benefits from: -reduced worker health and safety risks from exposure to toxic chemicals -reduced public health and safety risks from exposure to toxic chemicals -reduced environmental exposure to toxic chemicals Increased revenue from TUR improvements in processes and products Activities of TURA program agencies in other regulatory and non-regulatory programs Benefits to non-TURA firms in Massachusetts from TURA program resources Value of TURA data to public data users in the Commonwealth	

1. Introduction

The Commonwealth of Massachusetts' Toxics Use Reduction Act (TURA - MGL 21I) was passed in 1989 with the objective of reducing toxic chemical use and byproduct generation in the Commonwealth. The Act establishes six goals, one of which is to reduce toxic or hazardous byproduct generation in Massachusetts by 50 percent from 1987 to 1997 using toxics use reduction (TUR) as the means of achieving this goal (MGL Ch.21I§13(A)). Reductions in toxic chemical use are to be achieved by: input substitution, product reformulation, production unit redesign or modification, production unit modernization, improved operation and maintenance, and recycling, reuse or the extended use of toxics. TURA does not require that Massachusetts facilities implement TUR projects nor does it require that facilities meet specific reduction goals. Rather, the objectives of the Act are to be met by requiring facilities to report on their use of toxics and their generation of toxic byproducts as well as by requiring facilities to undergo a planning process to identify opportunities for toxics use reduction. Facilities are supported in their TUR efforts by the Office of Technical Assistance for TUR (OTA), the Toxics Use Reduction Institute (TURI), and the TUR Program Office of the DEP.

Approximately six-hundred Massachusetts facilities are subject to the planning and reporting requirements of TURA. Companies that employ the equivalent of 10 full-time employees, conduct *any* of the business activities defined within Standard Industrial Classification (SIC) codes 10-14, 20-39, 40, 44-51, 72, 73, 75, and 76, and process, manufacture, or otherwise use any of the toxic substances on the EPA EPCRA section 313 list as well as any chemicals on the EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) reportable quantities list are potentially subject to TURA.

1.1 Overview of the Analysis

This analysis compares the social costs and benefits of the TURA program, considering both costs and benefits accruing directly to TURA firms (i.e., private or internal costs and benefits) and *benefits* accruing to other members of the Commonwealth (i.e., public benefits). Public *costs* are expected to be small and are not included in the analysis. The analysis monetizes costs and benefits to the extent that reliable estimates could be generated. Note that in the comparison of benefits and costs (see Chapter 4), a portion of the total Form S filing fees are excluded. The excluded amount represents funds that were diverted by the State legislature to entirely separate programs. Thus, the exclusion allows for a comparison of the costs and benefits of funds spent on toxics use reduction. Figure 1.1 summarizes the monetized and non-monetized costs and benefits considered in this analysis.

Figure 1.1 Monetized and Non-monetized Costs and Benefits Assessed in the Analysis

Costs	Benefits
Monetized	
Compliance Costs: -Form S preparation -TUR plan preparation -Form S filing fees -Other TURA fees (TURP training, continuing education, certification) Capital investments	Savings in operating costs (=net operating cost changes) Federal grants to TURA program for TUR activities in Massachusetts
Non-Monetized	
	Human health and ecological benefits from: -reduced worker health and safety risks from exposure to toxic chemicals -reduced public health and safety risks from exposure to toxic chemicals -reduced environmental exposure to toxic chemicals Increased revenue from TUR improvements in processes and products Activities of TURA program agencies in other regulatory and non-regulatory programs Benefits to non-TURA firms in Massachusetts from TURA program resources Value of TURA data to public data users in the Commonwealth

This analysis monetizes two general cost categories: compliance costs and capital investments. Compliance costs are those regulatory expenses and fees that TURA firms incur to comply with TURA regulations. Capital investments include expenditures on plant and equipment for implementation of TUR projects. It should be noted that TURA does not require that facilities implement toxics use reduction projects; activities motivated by TURA are voluntarily undertaken by facilities. Furthermore, toxics use reduction is often achieved without capital investment.[1]

[1] In particular, non-capital changes in operations and maintenance practices have led to significant reductions in chemical use or by-product generation in many firms. Data collected from TURA firms for this study contained numerous instances where changes in operating costs were reported without associated capital expenditures.

Two types of TURA program benefits are monetized: (1) operating cost savings resulting from implementation of TUR projects at TURA firms; and (2) federal grants to the TURA program. Operating savings are calculated as net changes in operating costs. Specific federal grants to the TURA program are included since they benefit the Commonwealth.

The analysis does not monetize the benefits of human health and ecological risk reduction due to the difficulty in isolating, measuring, and then monetizing impacts resulting from TUR. Therefore, the monetized benefits significantly underestimate the benefits associated with the reductions in toxic chemical use and by-product generation achieved as a result of the Act.[2] This analysis provides several examples of chemicals for which quantitative data from TURA Form S indicate use or emission reductions that would reduce human health and ecological risk. The results of the monetized cost-benefit analysis should be considered in conjunction with these examples of TUR benefits as well as other benefits of the TURA program that are considered qualitatively in this analysis (see lower right corner of Figure 1.1 and Chapter 3).

The analysis estimates the present value of the benefits and costs resulting from TURA during the period 1990-1997. This time period encompasses the seven years the Act has been in effect plus projections to 1997, the year corresponding to the goal of 50 percent by-product reductions stated in the Act. The time period covers both the program start-up as well as more recent years in which the requirements of the Act have become familiar to industry and administration of the Act has been consistently funded.

The next section focuses on sources of data used in estimating the costs and benefits of the Act. The remainder of the report is organized as follows: Chapter 2: Costs Attributable to the Act; Chapter 3: Benefits Attributable to the Act; and Chapter 4: Comparison of Costs and Benefits.

1.2 Data Sources

Several sources of data were used in estimating the benefits and costs attributable to TURA: 1) Annual Report of the Administrative Council on Toxics Use Reduction, 2) a fax survey and phone survey administered by Abt Associates Incorporated, 3) DEP TUR information system data files, 4) an in-depth survey of TURA filers, and 5) financial records from TURI's Program Income Account.

Annual Report of the Administrative Council on Toxics Use Reduction

The Annual Report of the Administrative Council on Toxics Use Reduction summarizes the accomplishments of each of the TURA agencies: the Council, the TUR Advisory Board, the

[2] For example, from 1990 to 1994, there was a 16 million pound reduction in by-product generation (a 26% reduction when normalized for changes in production) and a reduction in total chemical use of 36 million pounds (an 18% reduction when normalized) for the subset of TURA chemicals and industrial sectors that were reported on consistently from 1990 to 1994 (Source: The Massachusetts Toxics Use Reduction Institute, October 1996).

Office of Technical Assistance (OTA), the Toxics Use Reduction Institute (TURI), and the Massachusetts Department of Environmental Protection (DEP). In addition, the Annual Report presents the strategic plans for each of the TURA agencies and summarizes the expenditures from the TURA fund.

Phone and Facsimile Survey of TURA Filers

Abt Associates Incorporated administered a comprehensive survey of all 1993 TURA filers providing the basis for an evaluation of the Massachusetts Toxics Use Reduction (TUR) Program. The survey was conducted in three steps: an advance letter, a telephone interview, and a facsimile portion. The advance letter was sent to all 645 1993 TURA filers describing the evaluation project, the need for their participation, and notifying them that they would be receiving a phone call from an interviewer. Of the total survey population of 645, 434 phone surveys were completed. The result of the phone survey are contained in a separate report.

At the conclusion of the phone survey, participants were asked if they would be willing to participate in the fax portion of the survey. Of the 434 respondents that participated in the phone survey, 420 agreed to participate in the fax portion. The fax survey was administered with the objective of determining changes in operating and capital costs resulting from TURA activities, as well as the burden associated with TUR plan preparation and Form S preparation. Participants were allowed one week to respond before a follow-up call was made to verify that they had received the fax as well as to encourage them to return the fax. Of the 420 surveys administered, 215 were returned, with varying response rates for each of the five questions. A copy of the fax survey with question specific response rates is included in Appendix A.

Department of Environmental Protection (DEP) TUR Data System

Under TURA, the Massachusetts Department of Environmental Protection (DEP) has a number of responsibilities, including the management of planning and reporting data. The DEP data files provide information on the quantities of toxic chemicals manufactured, processed, or otherwise used as well as the amount generated as byproduct and shipped in/as product.

In-Depth Survey of TURA Filers

Greiner Environmental conducted in-depth investigations of 25 facilities covered by TURA to assess the effectiveness of the toxics use reduction (TUR) program in promoting toxics use reduction as well as to assess the effect of TURA on the competitive advantage of Massachusetts businesses. The in-depth interview process was designed to elicit information regarding: 1) the environmental management and toxics use reduction (TUR) history of the firm; 2) the approach to TUR planning and implementation; 3) project specific data regarding major TUR projects, material reductions, and the costs and benefits of TUR projects; and 4) the interaction with TUR agencies and the perceived value of that interaction.

Financial Records from TURI's Program Income Account

The financial records of TURI's Program Income Account include receipts for tuition-based programs, such as Toxics Use Reduction Planner (TURP) Training and continuing education courses.

Financial Records from DEP

The financial records of DEP contained information on dollars received for TURP certification and recertification.

Costs	Benefits	
	Monetized	Non-Monetized
✓		

2. Costs Attributable to the Toxics Use Reduction Act

Costs attributable to the requirements of the Toxics Use Reduction Act (TURA) fall within two general categories: 1) compliance costs including Form S preparation, TUR plan preparation, Form S filing fees and other TURA fees related to TURP training and certification; and 2) capital costs associated with the implementation of TUR projects.[3] These costs are discussed below.

2.1 Compliance Costs

2.1.1 Preparing and Filing Form S

Section 10 of TURA requires large quantity users of toxic chemicals to develop an inventory of such materials flowing in and out of each production process at their facility. These toxic use reports, known as Form S, supplement federal Form R reporting required under section 313 of the Emergency Planning and Community Right to Know Act (EPCRA). Massachusetts facilities are required to file Form S annually if they satisfy all of the following criteria during a given reporting year:

- employ the equivalent of at least 10 full-time employees; and
- conduct *any* of the business activities defined within Standard Industrial Classification (SIC) codes 10-14, 20-39, 40, 44-51, 72, 73, 75, and 76; and
- qualify as a large quantity toxics user (LQTU).

TURA defines an LQTU as any facility that manufactures or processes 25,000 pounds or more of a toxic substance or otherwise uses 10,000 pounds or more of a toxic substance. Facilities that satisfy either of these threshold quantities must report on every listed toxic substance that they manufacture, process or otherwise use at an amount equal to or greater than 10,000 pounds. As a result, certain manufactured or processed chemicals in the range of 10,000 - 25,000 pounds are reportable under TURA. Toxic substances subject to TURA reporting include any of the substances on the EPA section 313 EPCRA list as well as any chemicals on the EPA Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) reportable quantities list.

The estimated burden associated with Form S filing is based upon three components: 1) the number of labor hours required of each type of personnel to complete Form S, 2) the hourly wage rates for each type of personnel, and 3) external consulting fees. Estimates of the hours required to file Form S are based upon the responses to questions 5.a, 5.b, and 5.c of the facsimile portion

[3] Because changes in operating costs resulting from TUR typically result in a net cost savings, they are discussed in Chapter 3, Benefits Attributable to TURA.

of the TURA survey conducted by Abt Associates Inc. Estimated labor hours are divided into three categories: managerial, technical, and clerical. Figure 2.1 presents the questions used to estimate the burden associated with the preparation of initial and subsequent Form S submissions. The survey distinguished between initial and subsequent submissions because the burden was expected to be reduced after facilities had completed their initial Form S submission and were familiar with the requirements of the Rule.

Figure 2.1 Survey Questions Used to Estimate Form S Burden

5a. Estimate the in-house labor hours and external consulting fees (if any) required to prepare your first Form S.

In-house management: _____ Hours External consultant fees: $_____

In-house technical/production: _____ Hours

In-house clerical: _____ Hours

b. Estimate the average in-house labor hours and external consulting fees (if any) required per subsequent Form S submission.

In-house management: _____ Hours External consultant fees: $_____

In-house technical/production: _____ Hours

In-house clerical: _____ Hours

c. What percentage of the cost of completing Form S would you have incurred in the absence of TURA requirements (for example, to complete Federal Form R)?

_____ %

In addition, respondents were asked to estimate the percentage of Form S filing costs that would have been incurred in the absence of TURA planning requirements, most likely a result of Federal Form R reporting requirements. Based on the 187 companies that reported a value for question 5.c, an average of 39.6 percent of Form S filing costs would have been incurred in the absence of TURA requirements. Facility estimates were deducted from estimated burden hours to arrive at the *incremental* labor requirements to prepare Form S. Survey respondents that did not respond to question 5.c, were assumed to incur 39.6 percent (the average value based on facilities responding to this question) of Form S filing costs in the absence of TURA requirements.

According to survey responses, on average, preparation of a facility's first Form S requires 41 hours (19 management, 18 technical, and 4 clerical). Survey responses indicate that the average amount of time required of managerial level staff was reduced from 19.1 hours to 10.9 hours and the average amount of time required of technical level staff was reduced from 18.0 hours to 9.6 hours when preparing subsequent versus initial Form S submissions.

Estimates of the 1995 hourly wage rates (i.e., adjusted to account for inflation), fully loaded to include benefits, are based upon a methodology used for EPA's analysis of EPCRA section 313

reporting.[4] The loaded annual salaries were divided by 2,080 hours to derive the loaded, hourly wage rates for each labor category: $78.04 for managerial personnel, $58.67 for technical personnel, and $23.75 for clerical personnel. Appendix C presents the complete calculations used in estimating the 1995 loaded hourly rates for managerial, technical, and clerical personnel.

Based on 206 survey responses, the average per unit cost associated with the preparation of a facility's initial Form S submission is calculated to be $3,004 and is divided between in-house labor costs ($2,624) and external consulting fees ($380). The cost attributable to the preparation of subsequent Form S submissions is estimated at $1,708 based upon 201 survey responses. Roughly 90 percent of Form S preparation costs are incurred by in-house staff. External consultants are estimated to account for an average of $211 per subsequent Form S. Figure 2.2 summarizes the per unit costs associated with the preparation of a facility's initial Form S and subsequent Form S submissions.

[4] U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA Section 313*. June 1996.

Figure 2.2 Unit Costs of First and Subsequent Form S Completion

Unit Costs for First-time Form S Submissions					
Personnel	**Average In-house Labor Hours[1]**	**1995 Loaded Hourly Rate[2]**	**Total In-house Labor Costs (Rate x Hours)**	**External Consulting Fees[1]**	**Total Costs per Form S**
Management	19.1 (N=206)	$78.04	$1,493		
Technical	17.5 (N=206)	$58.67	$1,029		
Clerical	4.3 (N=207)	$23.75	$103		
Total			$2,624	$380 (N=206)	$3,004
Unit Costs for Subsequent Form S Submissions					
Personnel	**Average In-house Labor Hours[1]**	**1995 Loaded Hourly Rate[2]**	**Total In-house Labor Costs**	**External Consulting Fees[1]**	**Total Costs per Form S**
Management	10.9 (N=201)	$78.04	$848		
Technical	9.6 (N=201)	$58.67	$563		
Clerical	3.6 (N=201)	$23.75	$86		
Total			$1,497	$211 (N=200)	$1,708

Notes:
1. Toxics Use Reduction Act Survey - facsimile portion. Consulting fees were assumed to have been reported in 1995 dollars.
2. U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA Section 313*. June 1996.

In order to calculate the total costs attributable to TURA's reporting requirements from 1990 through 1997, the unit costs presented in Figure 2.2 were combined with the number of firms reporting in these years. DEP data indicate the total number of firms filing in 1991 through 1995 as well as the number of facilities that filed for the first time in each year. Form S was first filed July 1, 1991, therefore, no costs for Form S preparation were incurred in 1990. Because data for 1997 and the number of first time filers in 1996 were unavailable at the time of this analysis, it is assumed that: 1) the number of Form S submissions and the number of new filers in 1997 is equivalent to 1996; and 2) the number of first time filers in 1996 is equivalent to the number of first time filers in 1995. Figure 2.3 presents the estimated costs attributable to the preparation of Form S submissions from 1990 through 1997. For each year, total Form S preparation costs range between $0.9 million and $2 million ($1995).

Figure 2.3 Total Costs of Form S and Subsequent Form S Preparation ($1995)

Filing Year	Initial Form S Preparation	Subsequent Form S Submissions	Initial Form S Costs	Subsequent Form S Costs	Total Annual Costs
1991	678	0	678 x $3,004 = $2,036,699	0 x $1,708 = $0	$2,036,699
1992	147	577	147 x $3,004 = $441,585	577 x $1,708 = $985,758	$1,427,343
1993	50	655	50 x $3,004 = $150,199	655 x $1,708 = $1,119,015	$1,269,214
1994	43	602	43 x $3,004 = $129,171	602 x $1,708 = $1,028,469	$1,157,640
1995	20	581	20 x $3,004 = $60,080	581 x $1,708 = $992,592	$1,052,672
1996	20	515	20 x $3,004 = $60,080	515 x $1,708 = $879,836	$939,916
1997	20	515	20 x $3,004 = $60,080	515 x $1,708 = $879,836	$939,916

2.1.2 Preparing Toxics Use Reduction Plans

Section 11 of TURA requires that large quantity toxics users (LQTUs) develop a toxics use reduction (TUR) plan. Facilities that filed Form S by July 1, 1993, were required to complete their first TUR plans by July 1, 1994. The planning process is intended to help firms in identifying more efficient production methods that will both prevent pollution and save money. TURA does not require that facilities implement toxics use reduction projects, nor does it require that toxics be reduced by any set quantity. Section 11 requires that plans be certified by "Toxics Use Reduction Planners" or TURPs who have themselves passed a uniform certification examination developed by the Massachusetts Department of Environmental Protection (DEP). Because TUR planning is intended to be a continuous process, plans must be updated and recertified every two years. Facilities that completed their first TUR plan by July 1, 1994 were required to complete a plan update by August 1, 1996.

The specific guidelines for conducting TUR planning are somewhat flexible, leaving companies free to use whatever process and format is most useful and efficient; however, all TUR plans must contain the following elements:

- *Management policy statement* describing company policies regarding toxics use reduction;
- *Scope of plan* describing the production units and chemicals included in the plan and the types of TUR techniques evaluated;
- *Employee notification* to solicit ideas on increasing the efficiency of chemical use and reducing waste from every member of the company;
- *Process characterization*, including a discussion of the purpose of the chemical in the process, unit of product, process flow diagram, and materials accounting;
- *Costs of toxics* describing the total costs of using a toxic chemical in each production unit;
- *Options identification, evaluation, and implementation*;

- *Certification* by the senior plant manager and a DEP approved Toxics Use Reduction Planner (TURP);
- *Plan summary* to be submitted to DEP.

The estimated burden of preparing TUR plans and plan updates is based upon three components: 1) the number of labor hours required of each type of personnel to complete their portion of the plan; 2) the hourly wage rates for each type of personnel; and 3) external consulting fees. Labor hours required to prepare a TUR plan and plan update are based upon a survey of TURA filers administered by Abt Associates. Survey respondents were asked to estimate the in-house labor hours and external consulting fees associated with the preparation of their 1994 TUR plan and 1996 TUR plan update. Figure 2.4 presents questions 4.a, 4.b, and 4.c, used to estimate the burden associated with the preparation of TUR plans and plan updates.

Figure 2.4 Survey Questions Used to Estimate TUR Plan Burden

4a. Estimate the in-house labor hours and external consulting fees (if any) required to prepare your 1994 TUR plan:

In-house management:	_____ Hours	External consultant fees: $_____
In-house technical/production:	_____ Hours	
In-house clerical:	_____ Hours	

b. Estimate the in-house labor hours and external consulting fees (if any) that will be required to prepare your 1996 TUR plan update:

In-house management:	_____ Hours	External consultant fees: $_____
In-house technical/production:	_____ Hours	
In-house clerical:	_____ Hours	

c. What percentage of TUR planning costs would you have incurred in the absence of TURA requirements?

_____ %

Estimated labor hours are divided into three categories: managerial, technical, and clerical. In addition, respondents were asked to estimate the percentage of TUR planning costs that would have been incurred in the absence of TURA planning requirements, which were deducted from each facility's estimated burden hours to arrive at the incremental labor requirements to prepare the TUR plan. Based on the 181 companies that reported a value for question 4.c, an average of 21 percent of TUR plan preparation costs would have been incurred in the absence of TURA requirements. Survey respondents that did not respond to question 4.c, were assumed to incur 21 percent (the average value based on 84 percent of fax respondents) of TUR plan costs in the absence of TURA requirements.

Hourly wage rates for managerial, technical, and clerical staff are based upon a methodology used

for EPA's analysis of EPCRA section 313 reporting.[5] Appendix C presents the complete calculations used in estimating the 1995 loaded hourly rates for managerial, technical, and clerical personnel. The loaded annual salaries were divided by 2,080 hours to derive the loaded, hourly wage rates for each labor category: $78.04 for managerial personnel, $58.67 for technical personnel, and $23.75 for clerical personnel.

The average per unit cost associated with the preparation of a TUR plan was calculated, based on 206 survey responses, to be $9,782 and is divided between in-house labor costs ($7,917) and external consulting fees ($1,865). The cost attributable to the preparation of a TUR plan update is estimated at $5,714 based upon 202 survey responses. Roughly 80 percent of total TUR plan update costs (or $4,510) are incurred by in-house staff. External consultants are estimated to account for an average of $1,204 per TUR plan update. Figure 2.5 summarizes the per unit costs associated with the preparation of a TUR plan and TUR plan update.

[5] U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA Section 313*. June 1996.

Figure 2.5 Unit Costs of TUR Plan and TUR Plan Update Preparation

Unit Costs for TUR Plan Preparation					
Personnel	**Average In-house Labor Hours[1]**	**1995 Loaded Hourly Rate[2]**	**Total In-house Labor Costs (Rate x Hours)**	**External Consulting Fees[1]**	**Total Costs per Plan**
Management	59.6 (N=206)	$78.04	$4,649		
Technical	49.4 (N=206)	$58.67	$2,901		
Clerical	15.4 (N=206)	$23.75	$367		
Total			$7,917	$1,865 (N=204)	$9,782
Unit Costs for TUR Plan Update Preparation					
Personnel	**Average In-house Labor Hours[1]**	**1995 Loaded Hourly Rate[2]**	**Total In-house Labor Costs**	**External Consulting Fees[1]**	**Total Costs per Plan**
Management	31.5 (N=202)	$78.04	$2,461		
Technical	29.8 (N=202)	$58.67	$1,748		
Clerical	12.7 (N=202)	$23.75	$300		
Total			$4,510	$1,204 (N=201)	$5,714

Note: 1.Toxics Use Reduction Act Survey - facsimile portion. Consulting fees were assumed to have been reported in 1995 dollars.
2.U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA Section 313*. June 1996.

In order to calculate the total costs attributable to TURA's planning requirements, the unit costs presented in Figure 2.5 were combined with estimates of the number of TUR plans and TUR plan updates prepared between 1994 and 1997. Facilities that filed Form S by July 1, 1993 were required to complete their first TUR plans by July 1, 1994. DEP data indicate that 705 facilities reported to TURA in 1993 and were therefore potentially subject to TURA planning requirements. Of the 705 facilities that filed in 1993, 602 filed again in 1994 and are therefore assumed to have prepared a TUR plan.[6,7]

[6] This provides a rough estimate because companies that eliminate the use of a chemical reported in 1993 are allowed to submit a certification statement to DEP stating that the chemical has been eliminated, thereby exempting them from preparing a plan for that chemical.

[7] Of the 645 facilities that filed in 1994, 43 were first time filers and were not assumed to have prepared a TUR plan in 1994.

Facilities that completed their first TUR plan by July 1, 1994 must complete a plan update by August 1, 1996.[8] All facilities that prepared a TUR plan in 1994 are assumed to have prepared a TUR plan update in 1996. Facilities that submitted their first plans in 1995 (an estimated 43 facilities) need not update until 1998 since planning is not required in odd years after 1995. Based on DEP data, 20 facilities filed Form S in 1995 that did not file in 1994, and would therefore prepare a TUR plan by July 1, 1996. No plans will be submitted in 1997 because planning no longer occurs in odd years. Figure 2.6 presents the estimated costs attributable to the preparation of TUR plans and TUR plan updates from 1994 through 1997.

Figure 2.6 Total Costs of TUR Plan and TUR Plan Update Preparation ($1995)

Filing Year	TUR Plans	TUR Plan Updates	TUR plan Costs	TUR Plan Update Costs	Total Annual Costs
1994	602	0	602 x $9,782 = $5,888,578	0 x $5,714 = $0	$5,888,578
1995	43	0	43 x $9,782 = $420,613	0 x $5,714 = $0	$420,613
1996	20	602	20 x $9,782 = $195,634	602 x $5,714 = $3,439,584	$3,635,218
1997	0	0	$0	$0	$0

Note: Numbers may not calculate due to rounding.

2.1.3 Form S Filing Fees

Pursuant to Section 19 of TURA, Form S filers are assessed a two-tiered, annual fee based upon the number of employees at their facility as well as the number of chemicals reported. The base fee establishes a minimum payment which varies according to the number of full-time employees working at a facility. In addition to the base fee, Form S filers are assessed a fee of $1,100 per chemical reported (i.e., per Form S filed). Maximum fees are set according to the number of full-time employees and range from $5,550 to $31,450 per facility. Figure 2.7 presents the 1996 fee schedule as it appears in the *1996 Reporting Package*.

Figure 2.7 Toxics Use Fee Schedule

10-49 full-time employees*	$1,850 plus $1,100 per Form S, not to exceed a total combined fee of $5,550.
50-99 full-time employees*	$2,775 plus $1,100 per Form S, not to exceed a total combined fee of $7,400.
100-499 full-time employees*	$4,625 plus $1,100 per Form S, not to exceed a total combined fee of $14,800.
500 + full-time employees*	$9,250 plus $1,100 per Form S, not to exceed a total combined fee of $31,450.

* TURA defines full-time employees as working 2,000 work hours per year.

[8] This date coincides with the 1996 extended reporting deadline for EPA's federal Form R.

Section 19 allows the Administrative Council to adjust the base fees, fees per chemical, and maximum fees to reflect changes in the Producer Price Index; however, fees have not been adjusted since the fee schedule was originally established in 1990. In addition, any toxic user who employs the equivalent of fewer than one hundred full-time employees may in instances of severe financial hardship apply to the secretary of environmental affairs for a waiver of the toxics use fee for that year. If good cause is shown, the secretary may waive in whole or in part the fee for that year or extend the time for paying any part of the fee. A total of six requests for fee waivers based on severe financial hardship were received by the Administrative Council in FY 1995. Five of the six applicants were granted full waivers and/or payment plans.

Revenues generated by the Toxics Use Reduction Fund are primarily used to fund the Office of Technical Assistance for TUR (OTA), the Toxics Use Reduction Institute (TURI), as well as the TURA Program Office within the Department of Environmental Protection (DEP). In addition, monies from the Toxics Use Reduction Fund have been diverted to partially fund a number of different programs. In 1994, $1.4 million was diverted for the 21E program (the Massachusetts Superfund Law), with $1.5 million transferred to 21E in 1995. A sum of $125,000 was diverted to the Cape Cod Community College job training program in 1995, 1996, and 1997. Also, each year beginning with FY 1991, $200,000 of the TURI budget has been diverted to the Microscale Chemistry Program at Merrimack College. Figure 2.8 presents the filing fees collected for the Toxics Use Reduction Fund (TURA Fund #149) for FY 1991 through FY 1997. Funds diverted from the TUR Fund are not reflected in Figure 2.8. Current year dollars are presented along with the values adjusted for inflation to 1995 dollars using the Bureau of Labor Statistics' Producer Price Index (PPI) for intermediate materials, supplies and components.[9]

[9] BLS, Bureau of Labor Statistics. Producer Price Index for Intermediate Materials, Supplies and Components (Series ID: wpusop2000) downloaded from URL: http://stats.bls.gov/eag.table.html.

Figure 2.8 Filing Fee Revenues	Fees Received	Inflation Adjusted 1995 Dollars
FY'91	$1,849,163	$2,018,885
FY'92	$4,557,499	$4,962,787
FY'93	$4,613,679	$4,959,109
FY'94	$2,878,911	$3,034,396
FY'95	$3,787,471[1]	$3,787,471[1]
FY'96	$2,392,047[1,2]	$2,380,611[1,2]
FY'97	$6,275,000[1,2]	$6,245,000[1,2]
Total	$26,353,770	$27,388,259

1. Estimated quantity.
2. The 1996 filing date was changed from July 1, 1996, the first day of Massachusetts' 1997 fiscal year, to August 1, 1996. A portion of the fees that ordinarily would have been received prior to the filing deadline, and thus credited in FY 1996, were received in FY 1997. This delayed filing date resulted in unusually low FY 1996 revenues and unusually high FY 1997 revenues.

Source: Executive Office of Environmental Affairs (EOEA)

2.1.4 Other TURA Fees

There are three additional costs associated with the TURA program that are borne by TURA firms: 1) fees for the TUR planner course, 2) application fees for TUR planner (TURP) certification and recertification, and 3) fees for continuing education conferences and workshops. Individuals from TURA firms are charged $200 for the 48 hour TUR planner course. (Individuals from non-TURA firms are assessed a fee of $1,200.) The planner course is required prior to application for general practice TUR planner certification, as is a passing grade on DEP's certification exam and pre-requisite experience. General practice TUR planners can certify TUR plans at any TURA facility. Limited practice planners, those who apply to DEP for certification based on experience, are not required to take the 48 hour course, although many choose to do so. Limited practice planners are qualified to certify only the plan for the facility at which they are employed.

The application fees for TURP certification and recertification are $100 for limited practice TUR planners and $500 for general practice planners. Revenues generated from certification fees are placed in the TURA fund. TURP certification is valid for 2 years. In order to be recertified, a TUR planner must complete a minimum of 30 credits of course work, seminars, or any other educational or professional program approved by the DEP related to TUR. Fees for continuing education events vary. TURP course and continuing education fees cover the cost of delivering these programs.

Figure 2.9 summarizes the payments made by TURA filers to TURI for TURP courses and

continuing education, and to DEP for certification and recertification. Fees were inflated to 1995 dollars using the Bureau of Labor Statistics' Producer Price Index (PPI) for intermediate materials, supplies and components.[10]

Figure 2.9 Costs Attributable to TUR Planner Training and Continuing Ed. Courses ($1995)

	DEP Certification and Recertification Costs[1]	TURP Course Fees, TURA filers only[2]	Continuing Education Course Fees, TURA filers only[2]	Total Annual Cost
1991	$0	$655	$0	$655
1992	$0	$31,361	$0	$31,361
1993	$19,563	$31,042	$0	$50,605
1994	$65,981	$15,916	$0	$81,896
1995	$27,900	$5,600	$45,890	$79,390
1996	$39,013	$7,726	$10,638	$57,376
1997[3]	$17,914	$7,726	$10,638	$36,278
Total	$170,370	$100,026	$67,166	$337,562

1. DEP TURP Database.
2. TURI Program Income Account.
3. Estimated based on 1996 costs.

2.2 Implementation of Toxics Use Reduction (TUR) Projects - Capital Expenditures

TURA facilities may implement toxics use reduction projects as a result of the TUR planning process, TURI workshops or continuing education courses, chemical reporting activities, or OTA consultations. Because TURA does not require that facilities implement toxics use reduction projects, activities motivated by TURA are voluntarily undertaken by facilities. Many are implemented on the expectation of net financial benefits, improvements in worker health and safety, and improved environmental performance. In order to estimate the capital expenditures motivated by TURA, the TURA fax survey asked facilities to estimate such capital expenditures (see Figure 2.10):

[10] BLS, Bureau of Labor Statistics. Producer Price Index for Intermediate Materials, Supplies and Components (Series ID: wpusop2000) downloaded from URL: http://stats.bls.gov/eag.table.html.

Figure 2.10 Survey Question Used to Estimate Capital Expenditures Due to TURA

3. Estimate total capital expenditures (i.e., investment in fixed assets) incurred to implement all projects identified as a result of TURA activities for the years 1990 through 1997. If none, please enter zero. If you are unable to estimate the costs, enter "N.A." *Do not annualize the capital costs.*

1990	1991	1992	1993	1994	1995	1996	1997
$	$	$	$	$	$	$	$

Because the question explicitly requested capital expenditures that *resulted from TURA activities,* all reported changes are included in the calculation of TURA costs. Capital expenditures reported by survey respondents were inflated to 1995 dollars using the Bureau of Labor Statistics' Producer Price Index (PPI) for Capital Equipment.[11] Capital costs were then annualized assuming a 15 year lifespan of capital and a seven percent discount rate. By converting capital expenditures to annualized values, the benefits and costs of TURA could be compared within the time period of the analysis (1990-1997). The following formula was used in converting capital costs to annual costs:

$$Annual\ Cost = \frac{Capital\ Cost}{PVF}$$

Where PVF is equal to:

$$PVF = \sum_{i=1}^{15} \frac{1}{(1.07)^i}$$

The average capital expenditures are shown in Figure 2.11 for 1990 through 1997. To estimate the total capital expenditures for all TURA facilities, average capital expenditures were multiplied by the number of Form S filers in each year. Capital expenditures range from $360,000 in 1990 to a projected $7.2 million in 1997.

[11] BLS, Bureau of Labor Statistics. Producer Price Index for Capital Equipment (Series ID: wpusop3200) downloaded from URL: http://stats.bls.gov/eag.table.html.

Figure 2.11 Capital Costs of Implementing TUR Techniques ($ 1995)

	1990	1991	1992	1993	1994	1995	1996	1997
Average Annualized Costs Per Facility	$530 (N=99)	$1,410 (N=102)	$2,096 (N=105)	$3,475 (N=109)	$6,720 (N=120)	$7,945 (N=134)	$12,078 (N=127)	$13,479 (N=121)
Number of TURA filers	678	724	705	645	601	535	535	535
Total Annualized Costs for all TURA Facilities	$360 k	$1,021 k	$1,478 k	$2,241 k	$4,039 k	$4,250 k	$6,462 k	$7,211 k

2.3 Summary of Costs

As described above, costs attributable to TURA fall under five general categories: costs associated with the preparation of Form S, costs associated with the preparation of TUR plans, Form S filing fees, other TURA fees, and capital expenditures incurred as a result of TURA activities. Total costs range from $0.4 million in 1990 to $14.8 million in 1997. The largest contributor from each of the five categories varies from year to year. In 1991, 1992, 1993, and 1995 the greatest costs resulted from Form S filing fees. In 1994, the first year of TUR planning, plan preparation resulted in the highest costs. In 1996 and 1997, as well as in 1990, capital expenditures exceeded all other cost categories.

Figure 2.12 Summary of TURA Costs ($ 1995 - millions)

	1990	1991	1992	1993	1994	1995	1996	1997
Compliance Costs:								
Preparing Form S	0	2.0	1.4	1.3	1.2	1.1	0.9	0.9
Preparing TUR Plans	0	0	0	0	5.9	0.4	3.6	0
Form S Filing Fees	0	2.2	5.2	5.2	4.7	5.6	2.7	6.6
Other TURA Fees	0	0.001	0.03	0.05	0.08	0.08	0.06	0.04
Capital Costs:								
Capital Expenditures	0.4	1.0	1.5	2.2	4.0	4.3	6.5	7.2
Total	$0.4	$5.3	$8.1	$8.7	$15.9	$11.4	$13.8	$14.8

Costs	Benefits	
	Monetized	Non-Monetized
	✓	✓

3. Benefits Attributable to the Toxics Use Reduction Act (TURA)

The primary purpose of TURA is to "promote industrial hygiene, worker safety, and protection of the environment and public health". Thus, the primary benefits of the Act are expected in these areas. Improved protection of human health and the environment is expected to result from TURA as facilities identify and implement toxics use and emission reduction opportunities through the TURA planning and reporting processes. These use and emission reductions will benefit society by reducing human exposure to toxics as well as lessening environmental contamination.

In addition to providing human health and environmental benefits, the reductions in toxics use and emission may also benefit industry directly by decreasing operating costs. Because TURA does not require that facilities implement toxics use reduction projects, TUR projects motivated by TURA are voluntarily undertaken by facilities, generally on the expectation of net financial benefits. For example, a facility may investigate, identify, and implement a solvent reduction opportunity and, as a result, save money on future purchases of solvent. Toxic use reduction techniques - such as input substitution, product reformulation, and in-process recycling/reuse of chemicals - may, however, result in increased operating costs. For example, a facility may substitute a more expensive, less toxic chemical for a currently-used chemical. Other toxics use reduction activities may involve an initial investment with payback over a period of time from reductions in chemical use, waste treatment costs, water use, or other factors. Investment in fixed assets (i.e., capital investments) were discussed in cost Section 2.1 above. Because changes in operating procedures credited to TURA typically result in a net cost savings, they are discussed in this benefits section.

3.1 Monetized Benefits

Benefits, in the form of reduced operating costs, are presented as quantified values based upon a survey of 1993 TURA filers. Also, TURA agencies have received a number of Federal grants to support TUR activities in the Commonwealth above-and-beyond those efforts funded directly by TURA fees. Benefits in the form of grants are also monetized. The analysis does not quantify the benefits of human health and ecological risk reduction due to the difficulty in isolating, measuring, and then monetizing impacts resulting from TUR. Additional, non-quantified benefits are also discussed in Section 3.2.

3.1.1 Economic Productivity Benefits: Reductions in Operating Costs

The TURA survey requested information on changes in annual operating costs for 1990 through 1997 via the question shown in Figure 3.1. Because the survey question explicitly requested the changes in costs that *resulted from TURA activities* all reported changes are included in the calculation of TURA costs and benefits. Of the 215 respondents to the fax survey, 40 percent

indicated a change in costs as a result of TURA activities, with 64 percent of these reporting reductions in costs, 28 percent reporting cost increases, and 8 percent indicating a mix of reductions and increases. On average, however, operating costs were reported as *decreasing* as a result of TURA in each of the eight years included in this study. The greatest number of facilities (115) indicated a cost change in 1995 and 1996 while the highest average cost reduction was projected to occur in 1997 ($22,000 average per facility).

Figure 3.1 Survey Question Used to Estimate Reductions in Industry Operating Costs

2. **Estimate the change in annual operating costs due to all projects implemented as a result of TURA activities. Enter the operating cost change in the first year that the change occurred. If none, enter zero. If you are unable to estimate changes, enter "N.A." Indicate net savings as a positive value and a net cost increase as a negative value. Please estimate 1996 and 1997 costs.**

You may have considered these costs in developing your 1994 or 1996 TUR plans.

1990	1991	1992	1993	1994	1995	1996	1997
$	$	$	$	$	$	$	$

The survey requested that facilities indicate the operating cost change *in the first year that the change occurred.* This format was selected with the expectation that facilities could readily recall the year of operating changes and estimate associated cost changes. This analysis assumes that the cost changes indicated by a facility continue within the time frame of this analysis (1990 through 1997). For example, if a facility reported that it first achieved a reduction in costs due to TURA in 1995, the analysis assumes that the savings are also realized in 1996 and 1997.

To assess the validity of the assumption that operating cost changes are continual within the study time-frame, the analysis first considers operating cost changes resulting from capital expenditures. According to TUR experts, an average life of capital equipment that might result in toxics use/emission reduction, such as a modernized production line, is about fifteen years. Because the scope of this analysis is only eight years, any operating cost changes resulting from capital investments are expected to continue through 1997 (and beyond). TUR techniques that do not require a capital investment, such as input substitution or product reformulation, may either increase or decrease operating costs. If costs decrease, the facility would be expected to continue the TUR technique to improve profitability. If costs increase, the facility may or may not choose to continue the TUR technique. This analysis assumes that cost increases are continual and thus may overestimate the costs of TURA.

As part of the data quality assurance process, responses were assessed for patterns that might indicate that the respondent provided total cost changes due to TURA projects in each year rather

than savings only for the *initial year* a TUR project was implemented. If a respondent provided cumulative savings but the analysis treated these values as first year savings, benefits would be overestimated. The analysis checked for two specific patterns: (1) facilities that entered cost changes for four or more sequential years; and (2) facilities that entered *the same value* for three sequential years. Limited call-backs to selected respondents indicating substantial changes in operating costs confirmed that: (1) it was reasonable to assume that responses following either of the two specified patterns resulted from a misinterpretation of the question and should be included as *total* annual cost changes due to TURA; and (2) other responses were appropriately included as *initial year* cost changes.

The average change in operating costs are shown in Figure 3.2 for 1990 through 1997. Operating costs reported by survey respondents were inflated to 1995 dollars using the Bureau of Labor Statistics' Producer Price Index (PPI) for intermediate materials.[12] To estimate the total change in operating costs for all TURA facilities, average cost changes were multiplied by the number of Form S filers in each year. Net operating cost savings ranged from $6.0 million in 1990 to $11.9 million in 1997.

Figure 3.2 Average Annual Net Changes in Operating Costs Resulting from TURA Activities
($ 1995- Positive values indicate reductions in costs)

	1990	1991	1992	1993	1994	1995	1996	1997
Mean total cost changes due to TURA (thousands)	8.9	17.6	12.9	14.3	16.1	20.5	19.1	22.3
Number of TURA filers	678	724	705	645	601	535	535	535
Total Operating Cost Changes Due to TURA (millions)	$6.0	$12.7	$9.1	$9.2	$9.7	$11.0	$10.2	$11.9

3.1.2 Grants to the TURA Program

Since the program's inception, TURA agencies have received 12 Federal grants, totaling $2,527,615 ($2,288,638 adjusted for inflation to 1995 dollars), to support TUR activities in the Commonwealth above-and-beyond those efforts funded directly by TURA fees.[13] These grants are included in the analysis as benefits of TURA because they have been leveraged by the TURA

[12] BLS, Bureau of Labor Statistics. Producer Price Index for Intermediate Materials Less Food and Feeds (Series ID: wpusop2700) downloaded from URL: http://stats.bls.gov/eag.table.html.

[13] BLS, Bureau of Labor Statistics. Producer Price Index for Intermediate Materials, Supplies and Components (Series ID: wpusop2000) downloaded from URL: http://stats.bls.gov/eag.table.html.

program and have benefited the Commonwealth.[14] The grants are listed in Figure 3.3 below:

Figure 3.3 Grants Received by the TURA Program for TUR Activities

Grant Title[1]	Yr. Awarded	Grantor	Grantee	Grant Amt.
Critical Parameter Grant	1991	U.S. EPA	OTA	$100,000
Merrimack River Grant	1991	U.S. EPA	OTA	$120,000
Buzzards Bay Pollution Prevention Grant	1992	U.S. EPA	OTA and Mass. Coastal Zone Mgmt. Office	$ 65,000
TUR for Dry Cleaners	1992	U.S. EPA	TURI	$ 50,000
Clean Alternatives Project	1993	U.S. EPA	TURI	$140,765
Clean States Incentive Grant	1994	U.S. EPA	OTA	$100,000
Chemical use Reduction for Improved Indoor Air in School	1994	U.S. EPA	OTA	$ 60,000
Reducing Discharges from Business and Homes	1994	U.S. EPA	OTA	$ 20,000
Alternative Clothes Cleaning: Training Curriculum Development	1994	U.S. EPA	TURI	$110,000
Pollution Prevention Education and Assistance in Low Income Area Schools	1995	U.S. EPA	OTA	$ 40,000
Demonstration of "Near Zero" VOC Lithographic Ink Blanket Wash Systems	1995	U.S. EPA New England	TURI	$ 52,850
NICE[3] -- 3 Grants at $425,000 each[2] -Erving Paper -Brittany Printing and Dyeing -TermoTrex	 1995 1996 1996	Dept. of Energy	OTA	$1,275,000
Autobody Grant	1996	U.S. EPA	OTA	$105,000
Total Grants:				$2,238,615

Notes: 1. For a description of these grants, see The Commonwealth of Massachusetts, Executive Office of Environmental Affairs, "Massachusetts Administrative Council on Toxics Use Reduction, Fiscal Year 1995 Annual Report," December 14, 1995.
2. OTA reviewed and selected projects for grant proposals and assisted companies in preparing grant applications. Awards were made to companies.

[14] These Federal grants are presumably funded at least in part by federal taxes and fees. The portion of funding resulting from taxes/fees paid by Massachusetts firms/residents results in a transfer payment rather than a benefit to the Commonwealth.

3.2 Non-monetized Benefits

The analysis identified, but was unable to monetize, five additional categories of benefits of TURA. The most significant of these benefits is human health and ecological risk reduction resulting from TUR. Other non-monetized benefits include: increased revenue from TUR improvements in processes and products; activities of TURA program agencies in other regulatory and non-regulatory programs; benefits to non-TURA firms in Massachusetts from TURA program resources; and the value of TURA data to public data users in the Commonwealth. These benefits are discussed below.

3.2.1 Benefits to Human and Ecological Health

As discussed above, the primary purpose of TURA is to "promote industrial hygiene, worker safety, and protection of the environment and public health". The results of the Abt Associates telephone survey indicate that 89 percent of respondents felt that the TUR planning process contributed to the implementation of TUR. These TUR techniques will reduce the risks associated with exposure to toxic chemicals for workers, the public, and the environment.

However, in many cases, toxics use/emission reductions cannot be attributed solely to TURA. TURA is only one of several initiatives within the past decade that have encouraged reductions in the use and release of toxic chemicals. Other major initiatives include the federal Toxics Release Inventory (EPCRA, section 313), the federal "33/50" program, and the "Montreal Protocol".

- The *Toxics Release Inventory* is a database, created under the authority of the Emergency Planning and Community Right-to-Know Act, containing a national inventory of the release and transfer of toxic chemicals from manufacturing facilities.

- The *"33/50" Program* is an EPA voluntary pollution prevention initiative that derives its name from its overall goals - an interim goal of a 33% reduction in 1992 and an ultimate goal of a 50% reduction in 1995 in releases and transfers of 17 high-priority toxic chemicals using 1988 TRI reporting as a baseline.

- The *Montreal Protocol on Substances that Deplete the Ozone Layer,* as amended in 1990, commits the 24 signatory nations to phase out the production of chlorofluorocarbons (CFCs) completely by the year 2000. The agreement also includes a longer-run schedule for phasing out hydrochlorofluorocarbons (HCFCs).

Each of these programs has been documented as reducing the emissions of toxic chemicals from some facilities. In addition, factors unrelated to government programs may influence facilities' decisions about toxic chemical use and release such as increased costs of waste disposal, public preference for environmentally-friendly products, and industry-initiated pollution prevention programs. For purposes of this report, it is desired to distinguish reductions in use and/or emissions of toxics *that are attributable to TURA*. In many cases, however, it may be the

existence of multiple initiatives and multiple advocacy groups that, in combination, result in toxics use/emission reductions. In recognition of the difficulty of ascribing toxics use/emission reductions to a single cause, the TURA reporting form (Form S) is not structured to distinguish reductions due to TURA.

While this report does not attempt to credit specific toxics use/emission reductions to TURA, an examination of the differences between TURA and the three major toxics reduction initiatives listed above indicates TURA's unique niche and the likelihood that TURA's contributions to the reductions achieved in Massachusetts have been significant. The phone survey conducted by Abt Associates Incorporated to evaluate the TURA program found that 88.7 percent of respondents felt that the TUR planning process contributed to the implementation of TUR. In addition, 70 percent of respondents indicated that they identified TUR opportunities in preparing their 1994 TUR plan.

Key differences between TRI and TURA

TURA builds on the federal TRI program in at least three important ways. First, TURA includes a requirement that facilities develop a TUR plan. The planning process is designed to reveal to companies opportunities for TUR that make economic sense and, thus, are implemented. The planning component of TURA ensures that facilities do not engage solely in an accounting exercise and that potential TUR techniques are identified and evaluated. TURA does *not*, however, require facilities to implement any TUR techniques.

Second, in addition to the chemical release data required under TRI, under TURA, Massachusetts facilities must report the amounts of each listed chemical (over a threshold amount) *used* at the facility, including the amounts manufactured, processed, otherwise used, generated as by-product, and shipped in product. This attention to chemical use may improve targeting of both government and industry pollution prevention programs.

A third difference between TRI and TURA is the expanded industry and chemical coverage under TURA. Currently TRI requires reporting for facilities with primary operations in manufacturing SIC codes 20-39.[15] TURA requires reporting for facilities in manufacturing SIC codes 20-39 plus facilities in SIC codes 10-14 (mining), 40 (railroad transportation), 44 (water transportation), 45 (transportation by air), 46 (pipelines), 47 (transportation services), 48 (communications), 49 (electric, gas, and sanitary services), 50 and 51 (wholesale), 72 (personal services), 73 (business services), 75 (automotive repair), and 76 (miscellaneous repair services).

[15] EPA has proposed expanding the industries covered under TRI to include facilities with primary operations in SIC codes 10 (except 1081), 12 (except 1241), 4911 (limited to facilities that combust coal and/or oil), 4931 (limited to facilities that combust coat and/or oil), 4939 (limited to facilities that combust coal and/or oil(4953 (limited to facilities regulated under the Resource Conservation and Recovery Act, subtitle #), 5169, 5171, and 7389 (limited to facilities primarily engaged in solvent recovery services on a contract fee basis).

TRI includes a list of over 600 chemicals subject to reporting. TURA reporting is required for the TRI chemical list plus chemicals on the EPA Comprehensive Environmental Response, compensation, and Liability Act (CERCLA or "Superfund") reportable quantities list.

The time-phasing of TRI and the TURA reporting and planning processes may also provide insight into the programs' influence on TUR. TRI data was first collected in 1988 for calendar year 1987. For most chemicals and industries, TURA chemical use reporting was first required in 1991 for calendar year 1990. For companies that were required to file TUR reports in 1993, the first TUR plan was required in 1994. Toxics use/emission reduction subsequent to 1990, and particularly in 1994 and 1995, are the most likely to be related to TURA.

Key differences between TURA vs. the "33/50" Program and the Montreal Protocol

While the "33/50" Program and the Montreal Protocol were both widely publicized pollution prevention initiatives, their limited chemical scope sharply differentiates them from TURA. The Montreal Protocol covers only ozone-depleting chemicals (e.g., CFCs, halons) and mandates their phase-out. The "33/50" Program, a voluntary program initiated by EPA, covered only ten individual organic chemicals (benzene, carbon tetrachloride, chloroform, dichloromethane, methyl ethyl ketone, methyl isobutyl ketone, tetrachloroethylene, toluene, 1,1,1,-trichloroethane, trichloroethylene) xylenes, and six groups of inorganic chemicals and their compounds (cadmium, chromium, cyanide compounds, lead, mercury, and nickel). Given the toxic and hazardous nature of these chemicals, they are high priorities for the TURA program as well and have been the target of technical assistance, outreach, and research.

3.2.2 Assessing Human Health and Ecological Risk Reduction

The magnitude of the changes in human health and ecological health resulting from TURA can, in theory, be assessed by a series of steps that combine estimates of changes in chemical exposure with dose-effect data to characterize changes in risk to the exposed population. However, a risk assessment is not feasible because there is no means by which to isolate changes in chemical exposure that result from TURA as opposed to other causes. Thus, rather than conducting a risk assessment, this analysis examines benefits in occupational health and safety and public and environmental health by providing examples of indicator chemicals for which reductions in use or emissions are likely to have resulted, at least in part, from TURA. For these indicator chemicals, the analysis examines quantitative data from Form S and federal Form R to determine actual use or emission reductions and then provides some economic data on the impacts of these chemicals on human and ecological health. The examples provide a framework for the reader to consider the process by which toxics use/emission reductions translate to quantifiable benefits from improvements in occupational health, public health, and ecological health.[16] However, the health

[16] Note that TURA and TRI filings were accessible for analysis only for filing years 1990 through 1994. This benefit-cost analysis covers 1990 through 1997. Additional human health and ecological benefits accruing in the last three years of the time frame are not evident from this analysis.

and ecological benefits of TURA can not be fully assessed from the examples.

Occupational Health and Safety

Chemical Release

Workers are put at risk both from chronic exposure to toxic chemicals and from acute exposure resulting from accidental spills and releases. A primary route of chronic exposure is inhalation. Worker exposure to volatilized chemicals or to particulates results, largely, from "fugitive emissions". Fugitive emissions are chemical releases to air that are *not* released through a confined air stream, such as a vent. For example, fugitive emissions result from equipment leaks and evaporative losses.

This analysis draws on data available from TURA to identify reductions in fugitive emissions that result from TUR. Fugitive emission reductions are presented for a single chemical - ethyl acetate - that serves as a case study of TURA benefits. Ethyl acetate was chosen for two reasons. First, it is not subject to reporting under the 33/50 program or TRI and was not phased out under the Montreal Protocol. The fact that these other major government programs do not apply to ethyl acetate allows for segregation of the effects of TURA from these programs. Second, ethyl acetate is a volatile chemical, with relatively high levels of reported fugitive emissions.

Ethyl acetate is used as a general solvent in coatings and plastics and in smokeless powders, pharmaceuticals, and synthetic fruit essences. It is toxic by inhalation and skin absorption as well as an irritant to eyes and skin. The National Institute for Occupational Safety and Health (NIOSH) has set a recommended exposure limit of 400 ppm for ethyl acetate.

This analysis evaluated reductions in fugitive emissions of ethyl acetate due to TUR in four steps:

(1) Select facilities that reported fugitive emissions of ethyl acetate in Federal Form R.

(2) From the facilities selected in Step 1, choose those that reported use of a TUR technique (Form S, Section 3.3) for ethyl acetate. Exclusion of records not indicating a TUR technique narrows the analysis to reductions in fugitive emissions that are potentially related to TURA.

(3) For each of the facilities selected in Step 2, calculate the fugitive emissions of ethyl acetate on a production-normalized basis in each reporting year as:

$$PFE = FE/FPI$$

where:

PFE = Production-normalized fugitive emissions of ethyl acetate;
FE = Total fugitive emissions of ethyl acetate (from Form R, Section 5.1); and
FPI = Facility production index for ethyl acetate (from Form R, Section 8.9).

(4) For each year, determine the number of facilities that indicated a TUR technique *and* decreased fugitive emissions of ethyl acetate on a production normalized basis.

Reductions in fugitive emissions are evaluated on a production normalized basis to address the question of the *benefits of TURA*. Changes in emissions that track changes in production quantity are likely to result from economic forces unrelated to TURA. TURA techniques generally alter the production process, and are reflected in emissions per unit. Note, however, that in some cases, TURA may also result in reduced production of goods produced using toxic chemicals in favor of more "environmentally-friendly" goods.

Also, note that this method of evaluating reductions in fugitive emissions does not capture cases of complete substitution for ethyl acetate. Facilities that substituted a less toxic chemical for ethyl acetate would no longer be subject to TURA reporting for ethyl acetate. Therefore, such facilities would not be included in this assessment of benefits.

Forty-four facilities in Massachusetts filed a Form S for ethyl acetate in reporting years 1990 through 1994. Thirty-nine of the 44 reported fugitive emissions between 1990 and 1994. Twenty-three of these facilities reported using a TUR technique for ethyl acetate in at least one year. As shown in Figure 3.4, most of the TUR techniques affected processing operations and involved input substitution, improved operation and maintenance, or product reformulation.

Figure 3.4 TUR Techniques Implemented to Reduce Ethyl Acetate Use

TUR Techniques	Materials Handling/Storage	Processing Operations	Finished Goods Handling
Input Substitution	1	9	1
Product Reformulation	2	7	0
Product Unit Redesign or Modification	0	1	0
Production Unit Modernization	1	3	0
Improved Operation and Maintenance of Production Unit Equipment and Methods	1	8	0
Recycling, Reuse, or Extended Use of Toxics	0	1	0
Management Technique of Using Byproduct as Product	0	0	1
Miscellaneous	2	6	0

Of the twenty-three facilities indicating a TUR technique, six did not report sufficient production data to calculate production-weighted emissions. Of the remaining seventeen facilities, nine indicated a reduction in production-weighted fugitive emissions for a year the facility listed a related TUR technique (See Figure 3.5). These emission reductions may reduce worker exposure

to ethyl acetate.

Figure 3.5 Production Weighted Emission Reductions of Ethyl Acetate (1990-1994)
For 9 of the 23 facilities indicating a TUR technique for Ethyl Acetate

Year	Percent Reduction of Fugitive Air Emissions per Year					# of Unique Facilities
	1-20	21-40	41-60	61-80	81-100	
1990-1994	2	5	1	1	2	9

In addition to the benefits associated with reductions in the quantity of ethyl acetate emitted per unit of production, benefits will result from facilities substituting entirely for ethyl acetate. Seven of the 44 facilities that filed a Form S for ethyl acetate between 1990 and 1994 fell below TURA reporting thresholds for ethyl acetate by 1994. These facilities cannot, however, be distinguished between those experiencing production shut downs and those implementing TUR techniques.

Chemical Use

Workers may also be exposed to toxic chemicals as a result of accidental releases and dermal absorption of minute doses of chemical. The chemical use data reported in Form S can be used to gauge these risks. Data on chemical use indicates the chemicals to which a worker is *potentially* exposed on the shop floor. Actual exposure depends on process controls and exposure controls as well as the frequency and nature of chemical accidents. Neither the federal Occupational Safety and Health Administration nor the Massachusetts Department of Labor and Industries require firms to report annually on chemical use in such a way that government authorities might be able to predict potential worker exposure to chemicals of concern.

Data from TURA and TRI can be used to estimate reductions in toxic chemical use that result from TUR. In this analysis, use reductions are presented for sulfuric acid, as an example of TUR progress. Sulfuric acid was chosen for two reasons: (1) it is one of the most widely used industrial chemicals in Massachusetts; and (2) the TURA program offices have provided assistance to numerous facilities in reducing the use of sulfuric acid.

Sulfuric acid is used to manufacture a wide variety of chemicals and materials including fertilizers, paints, detergents, and explosives, and is used in wastewater treatment. Health hazards resulting from acute exposure to sulfuric acid by exposure route are:

- inhalation: eye, nose, throat irritation;
- ingestion: pulmonary edema, bronchitis;
- direct skin or eye contact: emphysema, conjunctivitis, stomatis, dental erosion, tracheobronchitis, skin or eye burns, dermatitis.

This analysis evaluated reduction in use of sulfuric acid in four steps analogous to those presented above for fugitive emissions:

(1) Select facilities that reported processing or "otherwise using" sulfuric acid in Form S.

(2) From the facilities selected in Step 1, choose those that reported use of a TUR technique (Form S, Section 3.3) for sulfuric acid.

(3) For each of the facilities selected in Step 2, calculate the amount of sulfuric acid processed/otherwise used on a production weighted basis in each reporting year as:

$$PU = U/FPI$$

where:

PU = Production-normalized process/use of sulfuric acid;
U = Total quantity of sulfuric acid processed/used (from Form S, Section 1, 1.2b and 1.2c); and
FPI = Facility production index for sulfuric acid (from Form R, Section 8.9).

(4) For each year, determine the number of facilities that indicated a TUR technique and decreased use of sulfuric acid on a production normalized basis.

Two hundred thirty-six unique facilities in Massachusetts filed a Form S for sulfuric acid process/otherwise use in reporting years 1990 through 1994. Ninety-four of these facilities reported using a TUR technique for sulfuric acid in at least one year. As shown in Figure 3.6, most of the TUR techniques affected processing operations and involved improved operation and maintenance, recycling/reuse, or product unit modernization.

Figure 3.6 TUR Techniques Implemented to Reduce Sulfuric Acid Use

TUR Techniques	Materials Handling/ Storage	Processing Operations	Finished Goods Handling
Input Substitution	1	15	0
Product Reformulation	1	5	0
Product Unit Redesign or Modification	1	13	0
Production Unit Modernization	2	23	0
Improved Operation and Maintenance of Production Unit Equipment and Methods	10	65	2
Recycling, Reuse, or Extended Use of Toxics	1	29	0
Management Technique of Using Byproduct as Product	0	8	0
Miscellaneous	3	22	0

Of the 94 facilities indicating a TUR technique, 9 did not report sufficient production data to calculate production-normalized use. Of the remaining 85 facilities, 74 decreased their production-normalized use of sulfuric acid for a year the facility listed a related TUR technique. These use reductions lessen the risk to workers associated with exposure to sulfuric acid. Figure 3.7 indicates the distribution of the percent, production normalized reductions in chemical use experienced by the 74 facilities that listed a TUR technique. For example, in 12 cases between 1990 and 1994 production normalized use of sulfuric acid was reduced by greater than 60 percent. These reductions may have occurred at separate facilities or at the same facilities but in separate years.

Figure 3.7 Production Normalized Use Reductions of Sulfuric Acid (1990-1994)

Year	Percent Reduction of Total Use					# of Unique Facilities
	1-20	21-40	41-60	61-80	81-100	
1990-1994	62	35	14	10	2	74

In addition to the benefits associated with reductions in the quantity of sulfuric acid used per unit of production, benefits will result from facilities substituting entirely for sulfuric acid. Fifty-two of the 236 facilities that filed a Form S for sulfuric acid process/otherwise use between 1990 and 1994 fell below TURA reporting thresholds for sulfuric acid by 1994. These facilities cannot, however, be distinguished between those experiencing production shut downs and those implementing TUR techniques.

As mentioned above, a risk assessment linking changes in use and emissions to reductions in adverse health effects was not possible. However, data on the cost of avoiding illnesses related to

sulfuric acid exposure provide evidence of the potential economic benefits associated with reductions in sulfuric acid use. Valuation of the benefit of sulfuric acid use reduction can be based on society's willingness-to-pay to avoid the risk of related illnesses.

For example, the National Institute of Occupations Safety and Health indicate that one symptom of contact with sulfuric acid is emphysema. The direct medical costs of treating a case of emphysema have been estimated by the U.S. Environmental Protection Agency (see *The Medical Costs of Five Illnesses Related to Exposure to Pollutants*, EPA, 1993.) The results of this analysis suggest that avoiding one case of emphysema would result in the avoidance of an average lifetime cost of treating emphysema of $24,000 ($1995, 7 percent discount rate). This estimate excludes non-medical direct costs (e.g., child care, housekeeping expenses) and indirect costs of illness (e.g., decreased productivity of patients, pain and suffering of patient and family/friends). Thus, an estimate of all benefits of avoiding a single case of emphysema from exposure to sulfuric acid is likely to substantially exceed the $24,000 estimate.

In summary, reduced exposure to sulfuric acid is expected to reduce cases of emphysema and other occupational health and safety impacts. To the extent that TUR reduces worker exposure to sulfuric acid, benefits will accrue to society. While this analysis estimates the medical cost of a single case of emphysema, the number of avoided cases and types of illness are unknown and therefore the total benefits of TUR for this chemical and outcome are not monetized.

Public Health

Populations neighboring industrial facilities may be exposed to toxic chemicals as a result of planned chemical releases, accidental spills and releases, or the release of chemicals as part of the facility's manufactured product. To the extent that TURA reduces the release of toxic chemicals to the environment, benefits will accrue to society. In this section we use an analogous approach to that used for considering improvements in worker health and safety to assess the benefits of TURA to public health. We examine reductions in emissions of a single TURA reportable chemical - in this case, trichloroethylene (TCE). TCE was selected because: (1) OTA and TURI have focused on reductions of TCE in cleaning processes and substitution of aqueous-based solvents for toxic solvents; and (2) there is sufficient evidence in animals to classify TCE as a carcinogen (Class B2). However, unlike the chemicals evaluated above, TCE is a 33/50 chemical and a Clean Air Act (CAA) standard for TCE used in vapor degreasing has been established by the U.S. EPA, which may have motivated use and by-product reductions. Emissions considered in this analysis include the amount of TCE that: 1) goes to the sewer or public wastewater treatment facility; 2) leaves the facility as fugitive or stack air emissions; 3) leaves the facility as solid or hazardous waste; and 4) leaves the facility to be treated, disposed of, or recycled off-site.

Changes in the risk to public health per unit of production were evaluated based on the emission reduction index (ERI) reported in Form S. The steps are similar to those described above for occupation risk changes.

(1) Select facilities that reported TCE emissions in Federal Form R.

(2) From the facilities selected in Step 1, choose those that reported use of a TUR technique (Form S, Section 3.3) for TCE.

(3) For these facilities, count those that indicated a positive emission reduction index (ERI) in Form S for the production unit with a TUR technique (i.e., indicated decreasing emissions on a production-normalized basis).

Where:

$$Emissions\ Reduction\ Index\ (ERI) = 100 \times \frac{EQ_{BY} - EQ_{RY}}{EQ_{BY}}$$

and:

EQ_{BY} = Emissions quantity in the base year divided by the number of units of product produced in the base year; and

EQ_{RY} = Emissions quantity in the reporting year divided by the number of units of product produced in the reporting year.

Seventy-two facilities in Massachusetts filed a Form S for TCE in reporting years 1990 through 1994. Thirty-seven of the 72 facilities reported using a TUR technique for TCE in at least one year. Figure 3.8 summarizes the frequencies of reported TUR techniques implemented for TCE. Most techniques changed processing operations by means of improved operations and maintenance, recycling/reuse, or production unit modernization.

Figure 3.8 TUR Techniques Implemented to Reduce TCE Use

TUR Techniques	Materials Handling/Storage	Processing Operations	Finished Goods Handling
Input Substitution	0	5	1
Product Reformulation	1	3	0
Product Unit Redesign or Modification	1	9	0
Production Unit Modernization	0	12	1
Improved Operation and Maintenance of Production Unit Equipment and Methods	5	30	2
Recycling, Reuse, or Extended Use of Toxics	0	13	0
Management Technique of Using Byproduct as Product	0	3	0
Miscellaneous	0	4	0

Of the thirty-seven facilities indicating a TUR technique, 34 indicated a reduction in production-normalized emissions of TCE for a year the facility listed a related TUR technique (See Figure 3.9). For example, in 1994, normalized emissions of TCE were reduced by greater than 40 percent for 20 production units at 11 facilities.

Figure 3.9 Production Normalized Emission Reductions of TCE (1990-1994)

Year	Percent Reduction per Prod. Unit					Total Production Units	Facility Count
	1-20	21-40	41-60	61-80	81-100		
1990	0	0	1	2	4	7	6
1991	2	0	6	9	13	30	23
1992	1	4	8	13	15	41	21
1993	2	5	8	12	5	32	20
1994	2	7	12	7	1	29	20

In addition to the benefits associated with reductions in the quantity of TCE emitted per unit of production, benefits will result from facilities substituting entirely for TCE. Thirty-one of the 72 facilities that filed a Form S for TCE between 1990 and 1994 fell below TURA reporting thresholds for TCE by 1994. These facilities cannot, however, be distinguished between those experiencing production shut downs and those implementing TUR techniques.

As mentioned above, a risk assessment linking changes in emissions to reductions in adverse

health effects was not possible due to the difficulty in isolating changes in chemical exposure resulting from TURA as opposed to other causes. However, data on the cost of avoiding illnesses related to TCE indicate the magnitude of potential benefits associated with reductions in TCE emissions. In particular, valuation of benefits of TCE emission reductions would be based on society's willingness-to-pay to avoid the risk of cancer-related premature mortality. EPA's Office of Policy Analysis (OPA) has recommended a range of $2.1 to $11.3 million (1995 dollars) for valuing an avoided event of premature mortality.[17] This range is based on hedonic wage studies and contingent valuation analyses in labor markets to estimate the amounts that individuals would be willing to pay to avoid slight increases in risk of mortality or would need to be compensated to accept a slight increase in risk of mortality (i.e., the question analyzed in these studies is: how much more must a worker be paid to accept an occupation with a slightly higher risk of mortality?).[18] The resulting estimates of the value of a "statistical life saved" are used in analyses such as this benefit-cost analysis to value regulatory effects that are expected to reduce the incidence of mortality.

Reductions in the quantity of toxic chemicals *used* at a facility also reduce public health risks by reducing the risk of accidental release in transporting the chemical to the facility, in using and storing the chemical on site, and in transporting the chemical off-site for treatment or disposal. As discussed above, using sulfuric acid as the case study (see Occupational Health Risk section), TUR has been used by multiple facilities between 1990 and 1994 to reduce the use of toxic chemicals and, hence, the risk of accidental release.

To the extent that TUR reduces public exposure to TCE and the associated risk of premature mortality, benefits will accrue to society. In addition, reductions in the use of TCE decrease public health risks by reducing the risk of accidental releases. While this analysis estimates society's willingness-to-pay to avoid premature mortality, the avoided risk resulting from the implementation of TUR techniques is not known. Without this information, the total benefits of TUR for this chemical and outcome cannot be calculated.

Ecological Health

Ecological benefits stem from improvements in habitats or ecosystems that are affected by releases of toxic chemicals, whether releases occur as accidental spills, routine releases, or

[17] Values were converted to 1995 dollars using the GDP implicit price deflators, available from the Bureau of Economic Analysis (BEA) web site: http://www.bea.doc.gov/beahome.html.

[18] The willingness-to-pay values estimated in these studies are associated with small changes in the probability of mortality. To estimate a willingness-to-pay for avoiding certain or high probability death, they are extrapolated to the value for a 100 percent probability event. The estimates, however, do not represent the willingness-to-pay to avoid the certainty of death.

releases as a component of the manufactured product.[19] For example, spawning grounds for important recreationally or commercially caught fish species may be restored by reducing toxic chemicals discharged to water. Assessment of ecological benefits of TURA is subject to the same constraints as discussed above for assessment of human health benefits. In addition, the difficulty of risk assessment is compounded by the requirement to define assessment endpoints (e.g., nesting and feeding success of piping plovers). Also, it is difficult to attach monetary values to ecological benefits because they often do not occur in markets in which prices or costs are readily observed. As such, ecological benefits may be loosely classified as non-market benefits. This classification can be further divided into non-market *use* benefits, and non-market, *non-use* benefits.

Non-market, *use* benefits stem from improvements in ecosystems and habitats that, in turn, lead to enhanced human use and enjoyment of the affected areas. For example, reduced discharges may lead to increased recreational use and enjoyment of affected waterways in such activities as fishing, swimming, boating, hunting or birdwatching.[20] Non-market, *non-use* benefits include benefits that are not associated with current use of the affected ecosystem or habitat but arise from the realization of the improvement in the affected ecosystem or habitat resulting from reduced emissions. For example, people may be willing to pay to assure the survival of the bald eagle, even though they never expect to see one.

While it is often extremely difficult to quantify the relationship between reductions in toxic emissions, ecological improvement, and advancements in societal well-being, there is indisputable evidence that society values ecological improvements. The evidence includes, for example, society's willingness to contribute to organizations whose mission is to protect endangered species or purchase lands to avert development.

A large number of use and non-use ecological benefits may arise from reductions in toxics use and emissions. Reductions in toxics *use* may benefit the environment by reducing the risk of accidental releases as well as decreasing the quantity of chemicals eventually disposed as components of a product. Disposal of products that are composed of toxic chemicals may lead to environmental exposure through routes such as leaching from landfills or airborne emissions from incinerators. Reductions in toxic *emissions* may directly decrease stress on plant and animal species.

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[19] Much of this section is drawn from *Regulatory Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Metal Products and Machinery Industry (phase 1)*, U.S. EPA, Office of Water, April, 1995.

[20] In some cases, it may be possible to quantify and attach partial economic values to ecological benefit events on the basis of market values (e.g., an increase in tourism activity associated with improved recreational fishing opportunities); in this case, these benefits might better be classified as economic productivity related events. These events, however, are often not able to be fully valued using information from economic markets. In this case, they are more appropriately classified as non- market use benefits since economic markets will only capture related expenditures made by recreationists such as food and lodging and will not capture the value placed on the experience itself.

In summary, by reducing the discharge of toxic chemicals to the environment, TUR techniques result in improved ecosystems, generating benefits for the Commonwealth. However, it is difficult to attach monetary values to ecological benefits because they are not traded in readily observable markets. Economists have developed indirect measures to estimate the economic value associated with non-market benefits and have found that people attach *use* and *non-use* values to ecological health; however, total benefits were not estimated in this analysis due to the difficulties in estimating changes in exposures to toxic chemicals resulting from TURA, as well as the imperfect understanding of the link between use/emission reductions and environmental benefits.

3.2.3 Increased Revenue to TURA Firms from TUR

Firms may realize a second type of financial benefit from TUR beyond reductions in operating costs (discussed in Section 3.1): revenue increases. TUR can create a strategic advantage for firms through enhanced product quality, new product development, increased market share, reduced and competitive pricing, increased customer responsiveness, and reduced time to market.[21] These benefits of TUR were not quantified in this analysis.

3.2.4 Benefits to Non-TURA Firms

Many of the services provided by TURA program agencies are utilized by, and benefit, firms not subject to compliance with TURA. In particular, technical assistance, information transfer, and educational services of the TURA program are utilized by non-TURA firms. Approximately 50% of the OTA-assisted firms are non-TURA filers. The benefits to these firms are expected to be considerable and are not quantified in the analysis. Furthermore, the discussion of human and ecological health benefits of TURA in Section 3.3 is focused on TURA firms. These benefits are also expected to result from non-TURA firms that have implemented TUR with the assistance of TURA program resources. These benefits are not quantified in this analysis.

3.2.5 Value of Activities of TURA Program Agencies in other Regulatory and Non-Regulatory Programs

Since the program's inception, the TURA agencies have been engaged in a number of activities designed to incorporate toxics use reduction in permitting, compliance, and enforcement within other regulatory programs and through non-regulatory initiatives. For example, the OTA and DEP have worked with EPA New England to allow the state to structure an air program exemption intended to promote the use of aqueous cleaners in place of more toxic solvent cleaners, zero wastewater discharge systems, use of lower air polluting chemicals by printers, and use of penalty mitigations to reward firms that choose pollution prevention as their remedy.

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[21] Meninger, M., Jeanne Wirtanen, "Case Studies of Strategic Benefits Realized by Selected Participants in the Toxic Use Reduction Program," University of Massachusetts/Boston, MBA Program-Environmental Management Specialization and the Environmental Business Council of New England, Inc., July 1996.

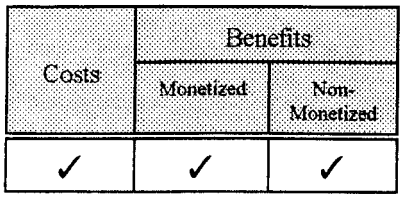
TURI, DEP and OTA have developed and delivered training on TUR and facility-wide permitting and enforcement to DEP personnel outside of the TURA program.

The TURA agencies have been instrumental in a new Massachusetts initiative aimed at promoting the competitive advantage of Massachusetts business through the advancement of home-grown innovative TUR and other environmental technologies. The STrategic Envirotechnology Partnership (STEP) is an effort to use the state's resources to promote new technologies. TURA agencies play a pivotal role in coordinating research, conducting technology demonstrations, and transferring technology to potential users.[22] The benefits of these activities are not quantified in this analysis.

3.2.6 Value of TURA Data to Public Users

As discussed in Section 3.2.1, Form S requires that Massachusetts facilities report chemical use data not reported under EPCRA section 313. In addition, TURA requires additional industries and chemicals to be reported that are not reported to section 313. This information allows more informed decisions to be made by society, consumers, and corporate lenders, purchasers, and stockholders. For example, TURA data enhances the ability of corporate lenders, purchasers, and stockholders to more accurately gauge a facility's potential environmental liabilities, resulting in better informed decisions making. TURA data also provide information for the efficient design and targeting of enforcement and regulatory programs, including voluntary programs and grants. The benefits of TURA data to public data users were not quantified in this analysis.

[22] A description of these and other activities can be found in the *Massachusetts Administrative Council on Toxics Use Reduction, Fiscal Year 1995 Annual Report.*



4. Comparison of Benefits and Costs

The value of TURA to the Commonwealth can be assessed by weighing the benefits achieved as a result of the Act against its associated costs. The categories of costs and benefits assessed in this analysis are summarized below in Figure 4.1.

As shown in Figure 4.1, this report monetizes two major cost categories associated with TURA. In contrast, only two of at least seven benefit categories are quantified. Most importantly, the benefits from reductions in risk to human health and to the environment are not monetized. This report was unable to quantify these benefits because of the difficulty in estimating changes in exposures to toxic chemicals due to TURA, the imperfect understanding of the link between use/emission reductions and human health and environmental benefits, and lack of evidence regarding society's valuation of some of these benefits. Therefore, the monetized benefits are expected to represent only a portion of the total benefits of the TURA program.

For the monetized cost and benefit components, the above sections of this report presented annual values in constant 1995 dollars (i.e., adjusted to account for inflation) for 1990 through 1997. Because the costs and benefits occur in different time periods, they must be discounted to a present value before comparison to determine overall net benefits. A present value can be calculated for any base year. For this report, 1995 is chosen as the base year. A real discount rate of seven percent was applied, which is the rate recommended by the Office of Management and Budget for analysis of federal regulations. Present value costs and benefits for the monetized components of the analysis are shown in Figure 4.2.

Figure 4.1 Monetized and Non-monetized Costs and Benefits Assessed in the Analysis

Costs	Benefits
Monetized	
Compliance Costs: -Form S preparation -TUR plan preparation -Form S filing fees -Other TURA fees (TURP training, continuing education, certification) Capital investments	Savings in operating costs (=net operating cost changes) Federal grants to TURA program for TUR activities in Massachusetts
Non-Monetized	
	Human health and ecological benefits from: -reduced worker health and safety risks from exposure to toxic chemicals -reduced public health and safety risks from exposure to toxic chemicals -reduced environmental exposure to toxic chemicals Increased revenue from TUR improvements in processes and products Activities of TURA program agencies in other regulatory and non-regulatory programs Benefits to non-TURA firms in Massachusetts from TURA program resources Value of TURA data to public data users in the Commonwealth

Diverted Funds from the TURA Program

As discussed in Section 2.1.3, a portion of funds generated from Form S filing fees were diverted from the TURA program in FY 1991 - 1997 by the state legislature to support non-TURA related activities. In FY 1994, $1.4 million was diverted for the 21E program (the Massachusetts Superfund Law), with $1.5 million transferred to 21E in 1995. Also, $125,000 was diverted to the Cape Cod Community College job training program in 1995, 1996, and 1997. In addition, each year beginning with FY 1991, $200,000 of the TURI budget has been diverted to the Microscale Chemistry Program at Merrimack College. Any benefits deriving from the expenditure of these funds are outside the scope of this analysis. To evaluate the value of TURA, these unrelated expenditures are excluded. The 1995 present value of diverted funds is $5.0

million.

Conclusion

The analysis estimated a total 1995 present value cost of $77 million, with monetized benefits of $91 million. Thus, the monetized values indicate that TURA has resulted in a *net benefit* to the Commonwealth for the period 1990-1997. This conclusion is reached despite the exclusion of several benefits of TURA. Improvements to human and environmental health were not monetized due to the difficulty in isolating, measuring, and monetizing impacts resulting from TUR. In addition, four other benefit categories were not monetized. In summary, comparison of the costs to the monetized and non-monetized benefits indicates that TURA provides a substantial net benefit to the Commonwealth of Massachusetts.

Figure 4.2 Monetized and Non-monetized Costs and Benefits of TURA

(1990 through 1997 - millions of 1995 dollars)

Costs			Benefits	
Monetized				
Compliance Costs:			Savings in operating costs (=net operating cost changes)	$ 88.2
-Form S preparation	$ 9.9			
-TUR plan preparation	$ 10.1			
-Form S filing fees	$ 29.1		Federal grants to TURA program for TUR activities in Massachusetts	$ 2.3
-Other TURA fees (TURP training, continuing education, certification)	$ 0.3			
Subtotal		$ 49.4		
Capital investment costs	$ 27.1	$ 27.1		
Total monetized TURA costs		$ 76.6	**Total monetized TURA benefits**	$ 90.5
Non-Monetized				
			Human health and ecological benefits from: -reduced worker health and safety risks from exposure to toxic chemicals -reduced public health and safety risks from exposure to toxic chemicals -reduced environmental exposure to toxic chemicals Increased revenue from TUR improvements in processes and products Activities of TURA program agencies in other regulatory and non-regulatory programs Benefits to non-TURA firms in Massachusetts from TURA program resources Value of TURA data to public data users in the Commonwealth	

Appendix A: TURA Facsimile Survey

FAX TRANSMITTAL COVER SHEET

Date:

PLEASE DELIVER THE FOLLOWING PAGES TO:

Name: _____

Organization: _____

Fax Number: _____

Number of Pages including this cover page: 3

Thank you for your participation in the Toxics Use Reduction Act (TURA) telephone survey. As we discussed, this short questionnaire is the final piece of the survey. Your response is important to help the Commonwealth of Massachusetts evaluate the costs and benefits of TURA. Please provide your best estimate of the information requested even if exact data are unavailable.

Please return your response via fax to:
Abt Associates Inc.
Fax #413-584-2330

Please respond by _____

If you have questions call Josh Kanner at 617-349-2485.

We will treat all information provided as confidential and will not use the data in any way that may reveal your company identity.

TOXICS USE REDUCTION ACT SURVEY

Facility Name: _____ **DEP ID #:** _____ **AAI #** _____

- **Please indicate whether your facility had a *net* change in annual operating costs in any of the following areas due to all TUR projects implemented as a result of TURA activities.** *(TUR projects may include: solvent or chemical substitution, product reformulation, productivity improvements, process improvements, improved housekeeping, recycling, chemical inventory control, etc.)*

	Increase	Decrease	No Change
• Labor (e.g., record keeping, manifesting, wastewater treatment operation, material handling)	1 (N=79)	2 (N=22)	3 (N=96)
• Waste Disposal (e.g., hazardous waste, wastewater treatment operation)	1 (N=19)	2 (N=65)	3 (N=115)
• Chemicals (e.g., purchases, inventory, and storage)	1 (N=22)	2 (N=81)	3 (N=96)
• Energy Use (e.g., conservation, process changes, treatment operation)	1 (N=25)	2 (N=16)	3 (N=155)
• Water Use (e.g., conservation, process modifications, recycling)	1 (N=12)	2 (N=41)	3 (N=145)
• Compliance Costs (e.g., pollution control equipment, permitting fees, safety training, protective equipment, monitoring, fines)	1 (N=83)	2 (N=31)	3 (N=85)
• Insurance Premiums (e.g., workers compensation, fire and liability insurance)	1 (N=1)	2 (N=6)	3 (N=187)
• Other _____	1 (N=4)	2 (N=1)	3 (N=0)

[IF YOU INDICATED A CHANGE FOR ANY OF THE CATEGORIES IN Q.1, CONTINUE. OTHERWISE, SKIP TO Q.4.]

2. **Estimate the change in annual operating costs due to all projects implemented as a result of TURA activities. Enter the operating cost change in the first year that the change occurred. If none, enter zero. If you are unable to estimate changes, enter "N.A." Indicate net savings as a positive value and a net cost increase as a negative value. Please estimate 1996 and 1997 costs.**

You may have considered these costs in developing your 1994 or 1996 TUR plans.

1990	1991	1992	1993	1994	1995	1996	1997
$ V28	$ V32	$ V36	$ V40	$ V44	$ V48	$ V52	$ V56

Analysis Variable : V28

N	Mean	Std Dev	Minimum	Maximum
82	8108.54	73799.33	-10000.00	668000.00

Analysis Variable : V32

N	Mean	Std Dev	Minimum	Maximum
89	15942.70	111494.39	-8000.00	1010000.00

Analysis Variable : V36

N	Mean	Std Dev	Minimum	Maximum
93	11654.84	71883.46	-50000.00	611000.00

Analysis Variable : V40

N	Mean	Std Dev	Minimum	Maximum
92	13074.46	76700.67	-50000.00	676000.00

Analysis Variable : V44

N	Mean	Std Dev	Minimum	Maximum
100	16278.50	88832.90	-63000.00	797000.00

Analysis Variable : V48

N	Mean	Std Dev	Minimum	Maximum
111	21178.83	96954.10	-60000.00	910000.00

Analysis Variable : V52

N	Mean	Std Dev	Minimum	Maximum
100	16098.00	86985.05	-65000.00	800000.00

Analysis Variable : V56

N	Mean	Std Dev	Minimum	Maximum
87	19227.59	93742.17	-60000.00	800000.00

3. **Estimate total capital expenditures (i.e., investment in fixed assets) incurred to implement all projects identified as a result of TURA activities for the years 1990 through 1997. If none, please enter zero. If you are unable to estimate the costs, enter "N.A."** ***Do not annualize the capital costs.***

1990	1991	1992	1993	1994	1995	1996	1997
$ V60	$ V64	$ V68	$ V72	$ V76	$ V80	$ V84	$ V88

Analysis Variable : V60

N	Mean	Std Dev	Minimum	Maximum
99	4343.43	30840.00	0	300000.00

Analysis Variable : V64

N	Mean	Std Dev	Minimum	Maximum
102	7558.82	47909.69	0	450000.00

Analysis Variable : V68

N	Mean	Std Dev	Minimum	Maximum
105	6247.62	27075.32	0	180000.00

Analysis Variable : V72

N	Mean	Std Dev	Minimum	Maximum
108	12862.96	46962.28	0	330000.00

Analysis Variable : V76

N	Mean	Std Dev	Minimum	Maximum
116	32939.66	199410.97	0	2000000.00

Analysis Variable : V80

N	Mean	Std Dev	Minimum	Maximum
129	18224.81	59168.09	0	500000.00

Analysis Variable : V84

N	Mean	Std Dev	Minimum	Maximum
111	38963.96	240017.35	0	2450000.00

Analysis Variable : V88

N	Mean	Std Dev	Minimum	Maximum
94	9515.96	34249.59	0	250000.00

4a. Estimate the <u>in-house</u> labor hours and external consulting fees (if any) required to prepare your <u>1994</u> TUR plan:

In-house management: V092 Hours [92-94] External consultant fees: $ V101 [101-109]

In-house technical/production: V095 Hours [95-97]

In-house clerical: V098 Hours [98-100]

Analysis Variable : V092

N	Mean	Std Dev	Minimum	Maximum
206	74.3058252	183.3867795	0	2360.00

Analysis Variable : V095

N	Mean	Std Dev	Minimum	Maximum
206	62.2718447	108.9905965	0	600.0000000

Analysis Variable : V098

N	Mean	Std Dev	Minimum	Maximum
206	20.7184466	58.0686587	0	624.0000000

Analysis Variable : V101

N	Mean	Std Dev	Minimum	Maximum
204	2409.42	4363.78	0	35000.00

b. Estimate the <u>in-house</u> labor hours and external consulting fees (if any) that will be required to prepare your <u>1996</u> TUR plan <u>update:</u>

In-house management: V107 Hours [107-109] External consultant fees: $ V116 [116-121]

In-house technical/production: V110 Hours [110-112]

In-house clerical: V113 Hours [113-115]

Analysis Variable : V107

N	Mean	Std Dev	Minimum	Maximum
202	39.6287129	69.6198331	0	500.0000000

Analysis Variable : V110

N	Mean	Std Dev	Minimum	Maximum
202	38.1534653	73.0576084	0	546.0000000

Analysis Variable : V113

N	Mean	Std Dev	Minimum	Maximum
202	16.5643564	57.0916895	0	624.0000000

Analysis Variable : V116

N	Mean	Std Dev	Minimum	Maximum
201	1596.94	2938.47	0	20000.00

c. What percentage of TUR planning costs would you have incurred in the absence of TURA requirements?

V122 % [122-124]

Analysis Variable : V122

N	Mean	Std Dev	Minimum	Maximum
181	21.0552486	29.0037783	0	100.0000000

5a. Estimate the <u>in-house</u> labor hours and external consulting fees (if any) required to prepare your <u>first</u> Form S.

In-house management: V125 Hours [125-127] External consultant fees: $ V134 [134-139]

In-house technical/production: V128 Hours [128-130]

In-house clerical: V131 Hours

Analysis Variable : V125

N	Mean	Std Dev	Minimum	Maximum
206	31.9368932	55.9003547	0	500.0000000

Analysis Variable : V128

N	Mean	Std Dev	Minimum	Maximum
206	29.6601942	59.7160032	0	500.0000000

Analysis Variable : V131

N	Mean	Std Dev	Minimum	Maximum
207	7.9613527	16.3676941	0	120.0000000

Analysis Variable : V134

N	Mean	Std Dev	Minimum	Maximum
206	628.8834951	1947.65	0	15000.00

b. Estimate the <u>average</u> in-house labor hours and external consulting fees (if any) required per <u>subsequent</u> Form S submission.

In-house management: V140 Hours External consultant fees: $ V149

In-house technical/production: V143 Hours

In-house clerical: V146 Hours

Analysis Variable : V140

N	Mean	Std Dev	Minimum	Maximum
201	18.8905473	42.8989273	0	500.0000000

Analysis Variable : V143

N	Mean	Std Dev	Minimum	Maximum
201	16.6417910	32.8534784	0	300.0000000

Analysis Variable : V146

N	Mean	Std Dev	Minimum	Maximum
201	6.2736318	11.5883455	0	60.0000000

Analysis Variable : V149

N	Mean	Std Dev	Minimum	Maximum
200	408.3000000	1715.46	0	20000.00

c. What percentage of the cost of completing Form S would you have incurred in the absence of TURA requirements (for example, to complete Federal Form R)?

V155 %

Analysis Variable : V155

N	Mean	Std Dev	Minimum	Maximum
187	39.5668449	34.1015178	0	100.0000000

PLEASE FAX YOUR RESPONSE TO:
ABT ASSOCIATES INC.
413-584-2330

THANK YOU FOR YOUR INPUT.

Appendix B: TURA Fax Survey Analysis

Abt Associates Incorporated administered a comprehensive survey of all 1993 TURA filers providing the basis for an evaluation of the Massachusetts Toxics Use Reduction (TUR) Program. The survey was conducted in two parts: (1) a phone portion, and (2) a fax portion, used to support this benefit-cost analysis. The survey population consisted of the 645 TURA filers in 1993. Of this population, a total of 434 phone surveys were completed. At the conclusion of the phone survey, participants were asked if they would be willing to participate in the fax portion of the survey. Of the 434 respondents that participated in the phone survey, 420 agreed to participate in the fax portion. The fax survey was administered with the objective of determining changes in operating and capital costs resulting from TURA activities, the burden associated with TUR plan preparation, the burden associated with preparation of TUR plan updates, the burden associated with first Form S preparation, and the burden associated with subsequent Form S preparation. Participants were allowed one week to respond before a follow-up call was made to verify that they had received the fax as well as to encourage them to return the survey. Of the 420 surveys administered, 215 were returned, with varying response rates for each of the five questions.

Bias associated with nonresponse

The effect of nonresponse on survey estimates depends on the percentage of the population that does not respond as well as the extent to which those not responding are systematically different from the whole population. Surveys that capture a large percentage of a given population will provide good estimates even if nonrespondents are distinctive. Of the 420 fax surveys administered, 215 were returned, representing approximately 30 percent of the total population of 1993 TURA filers. However, many surveys were only partially complete and response rates for individual questions varied. To the extent that non-respondents are different from the sample population, biased estimates may result.

In order to determine the extent of potential bias in the fax survey population, the respondent and non-respondent populations were compared on the following criteria: total chemical use, and TRI reporting. The respondent and non-respondent populations were found to be almost identical when compared on total chemical use and TRI reporting. Figure B.1 presents the distribution of chemical use for the fax survey population compared to the total survey population.[23] The percentage of TRI reporters in the respondent and non-respondent populations were almost identical; 85% of the non-respondent survey population, 87% of the respondent population, and 86% of the total survey population report to TRI. The effect of non-respondent bias on the survey results is assumed to be negligible for the purposes of this analyses.

[23] The number of facilities does not equal the entire survey population due to the absence of chemical use data for 1993 filers.

Figure B.1 Total 1993 Chemical Use of Survey Population		
*Range of Chemical Use (pounds)**	% of Facilities in Range	
	Total Survey Pop.	*Fax respondents*
1 - 50,000	23%	21%
50,001- 100,000	13%	14%
100,001 - 150,000	9%	8%
150,001 - 200,000	6%	4%
200,001 - 250,000	5%	5%
250,001 - 1,200,000	25%	23%
>1,200,000	19%	24%
Total %	100%	100%
Number of Facilities**	631	209

*Total TURA Chemical Use (Pounds) = Amount Processed + Amount Manufactured + Amount Otherwise Used
** Total number of facilities=Number of facilities in population for which chemical use data were available.
Toxics Use Reduction Institute Data, 1996

Correlation Analysis

In determining how to extrapolate the survey results to the total population, an analysis was conducted to measure the relationship between the number of employees at each facility and the burden estimates and costs estimates provided. If the variables were found to be related, a basis would exist for weighting the results prior to extrapolation, given a knowledge of the distribution of facility size across the total population. The analysis was based on the hypothesis that larger facilities make larger capital expenditures as a result of their TURA activities and incur a greater burden in preparing their Form S submissions compared to smaller facilities.

Pearson correlation coefficients were generated in order to measure the strength of the linear relationship between each pair of variables. A correlation value of zero indicates that each variable has no linear predictive ability for the other, a value of +1 indicates complete correlation, and a value of -1 indicates complete inverse correlation.[24] The results of the analysis found that estimates of operating cost changes, capital expenditures, and burden estimates for plan preparation and Form S submissions were weakly correlated to facility size. Figure B.2 and B3

[24] Note that strong correlation does not imply causality. For example, although x and y may be correlated, it cannot be assumed that x causes y (or y causes x).

present the Pearson correlation coefficients for each of the analysis variables. Based upon these results, the estimated values were not weighted prior to extrapolation.

Figure B.2 Pearson Correlation Coefficients I

	1990	1991	1992	1993	1994	1995	1996	1997
Operating Cost Savings								
Emp. number	0.07923	0.11331	0.13937	0.12866	0.16466	0.16593	0.17625	0.20841
Capital Expenditures								
Emp. number	0.14798	0.23632	0.18549	0.16975	0.15755	0.23089	0.19260	0.16680

Figure B.3 Pearson Correlation Coefficients II

	In-house management	In-house technical	In-house clerical	External consulting fees
1994 TUR Plan Preparation Burden				
Emp. number	0.06463	0.06637	-0.00099	0.02727
TUR Plan Update Preparation Burden				
Emp. number	0.05563	0.04228	-0.01255	0.06264
First Form S Preparation Burden				
Emp. number	0.04127	0.10591	0.02834	-0.00805
Subsequent Form S Preparation Burden				
Emp. number	0.01873	0.06055	-0.00938	-0.05987

Appendix C: Calculations of Loaded Hourly Wage Rates by Labor Category

Managerial and technical level wage rates are composite estimates of wage rates for several occupation categories and levels from the Bureau of Labor Statistics' *Occupational Compensation Survey*. The managerial level wage rate is a composite of the wage rates of engineers (levels VI-VIII), accountants (levels V-VI), and attorneys (levels IV-VI). The technical level wage is a composite of the wage rates of engineers (levels III-VIII) and accountants (levels III-VI). The clerical wage rate is an average of all the clerical wage levels (I-V). Weighting factors used to generate the composite managerial and technical wage rates are based on information provided by the chemical industry and chemical industry trade associations on the typical fraction of total reporting effort required of each occupation category for completion of Form R. The distribution of effort across occupation categories is assumed to be the same for TUR plan preparation (i.e., primarily allocated to managerial level and technical level engineers). Figure B.1 presents a break out of the allocation of time across occupation categories.

The 1993 composite annual salary estimates were adjusted to 1995 dollars using the Employment Cost Index (ECI) for white-collar occupations in private industries. The ECI is reported for March, June, September, and December. Values were averaged across the four months to generate 1993 and 1995 values. The 1995 adjusted, composite salary for each labor category was then multiplied by benefits and overhead factors to estimate the 1995 loaded salaries. Detailed benefits data for white-collar occupations in private, goods-producing industries were used to account for the cost of benefits for managerial, technical, and clerical labor. The overhead factor of 17 percent is based on information provided by the chemical industry and chemical industry trade associations. Figure C.1 summarizes the calculations of the 1995 loaded, hourly wage rates for managerial, technical, and clerical level staff

Figure C.1 Calculation of 1995 Loaded, Hourly Wage Rates for Managerial, Technical, and Clerical Level Staff

Labor Category	Occupation (levels)	Avg. Salary	Weighting Factor	1993 Comp. Salary	ECI Ratio 93:95	1995 Adjusted Salary	1995 Benefits (% salary)	1995 Overhead (% salary)	1995 Loaded Annual Salary	1995 Loaded Hourly Rate
Managerial	Engineer (6-8)	$93,981	10/17	$55,283						
	Attorney (4-6)	$111,263	5/17	$32,724						
	Accountant (5-6)	$73,528	2/17	$8,650						
	Composite		17/17	$96,658	1.062	$102,730	41.0%	17.0%	$162,314	$78.04
Technical	Engineer (3-8)	$74,802	5/6	$62,335						
	Accountant (3-6)	$59,436	1/6	$9,906						
	Composite		6/6	$72,241	1.056	$76,270	43.0%	17.0%	$122,031	$58.67
Clerical	Clerical (1-5)	$28,850	1/1	$28,850						
	Composite		1/1	$28,850	1.063	$30,681	44.0%	17.0%	$49,396	$23.75

Source: U.S. EPA, Office of Pollution Prevention and Toxics. *Economic Analysis of the Proposed Rule to Add Certain Industries to EPCRA section 313.* June 1996.