

# **POLLUTION PREVENTION PLAN**

**BOWDOIN COLLEGE  
OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY  
3800 COLLEGE STATION  
BRUNSWICK, MAINE 04011**

**August 2003**

**POLLUTION PREVENTION PLAN**

**BOWDOIN COLLEGE**  
**Office of Environmental Health and safety**  
**3800 College Station**  
**Brunswick, Maine 04011**

**Prepared by:**

**St.Germain & Associates, Inc.**  
**846 Main Street, Suite 3**  
**Westbrook, Maine 04092**

**August 2003**  
**Project No. 2479.1**

---

Patrick J. Coughlin  
Project Manager

---

Michael P. Rioux, CHMM  
Technical Review

## **BOWDOIN COLLEGE'S IMPLEMENTATION POLICY**

This Pollution Prevention (P2) Plan was developed in accordance with Section 2305 of Chapter 38 of the Maine Revised Statutes Annotated. This plan and the associated policies (specified within the plan) have been approved and implemented at Bowdoin College in Brunswick, Maine. The Environmental Health and Safety (EHS) Manager of Bowdoin has been assigned the role of Toxic Use Reduction (TUR) Coordinator, and is responsible for ensuring the policies and mandates within this plan will be implemented and maintained. The plan will be reviewed and updated periodically, at least every two years. A copy of the plan and backup data will be kept at the college for at least five years, and will be made available to the Commissioner of the Maine Department of Environmental Protection, or designee, upon request.

Bowdoin College

By

\_\_\_\_\_

Mark J. Fisher, CPG

Environmental Health and Safety Manager

## TABLE OF CONTENTS

### BOWDOIN COLLEGE'S IMPLEMENTATION POLICY

<u>1.0</u>	<u>INTRODUCTION</u> .....	<u>14</u>
<u>1.1</u>	<u>Extremely Hazardous Substances</u> .....	<u>22</u>
<u>1.2</u>	<u>Toxic Chemical Releases</u> .....	<u>22</u>
<u>1.3</u>	<u>Hazardous Waste</u> .....	<u>22</u>
<u>2.0</u>	<u>SUMMARY AND CONCLUSIONS</u> .....	<u>44</u>
<u>3.0</u>	<u>COLLEGE MANAGEMENT POLICY</u> .....	<u>55</u>
<u>4.0</u>	<u>EMPLOYEE AWARENESS, TRAINING, AND NOTIFICATION</u> .....	<u>66</u>
<u>4.1</u>	<u>Employee Awareness</u> .....	<u>66</u>
<u>4.2</u>	<u>Employee Training</u> .....	<u>77</u>
<u>4.3</u>	<u>Employee Notification</u> .....	<u>77</u>
<u>4.4</u>	<u>Municipality Notification</u> .....	<u>77</u>
<u>5.0</u>	<u>PRODUCTION UNIT ANALYSIS</u> .....	<u>99</u>
<u>5.1</u>	<u>Process Flow Diagrams and Chemical Pathways</u> .....	<u>99</u>
	<u>5.1.1 Ammonia Refrigeration System</u> .....	<u>99</u>
	<u>5.1.2 Academic Laboratories &amp; Studios</u> .....	<u>1242</u>
	<u>5.1.3 Facilities Management</u> .....	<u>1444</u>
	<u>5.1.4 Photography Darkrooms</u> .....	<u>1444</u>
<u>5.2</u>	<u>Identification of Unit of Product</u> .....	<u>1646</u>
<u>5.3</u>	<u>Identification of Production Units</u> .....	<u>1646</u>
	<u>5.3.1 Ice Arena Production Unit</u> .....	<u>1646</u>
	<u>5.3.2 Labpack Production Unit</u> .....	<u>1747</u>
	<u>5.3.3 Maintenance Production Unit</u> .....	<u>1747</u>
	<u>5.3.4 Darkroom Production Unit</u> .....	<u>1747</u>
<u>6.0</u>	<u>TRACKING AND REPORTING REDUCTIONS</u> .....	<u>1848</u>
<u>6.1</u>	<u>Baseline of EHS Usage Reductions</u> .....	<u>1848</u>
<u>6.2</u>	<u>Baseline of Hazardous Waste Generation Reductions</u> .....	<u>1848</u>
<u>6.3</u>	<u>Current Distribution of Hazardous Waste Generation</u> .....	<u>1949</u>
<u>6.4</u>	<u>Hazardous Waste Disposal Costs</u> .....	<u>1949</u>
<u>6.5</u>	<u>Reduction Goals</u> .....	<u>1949</u>
<u>6.6</u>	<u>Recordkeeping</u> .....	<u>2020</u>
<u>6.7</u>	<u>Reporting</u> .....	<u>2020</u>
<u>7.0</u>	<u>IDENTIFICATION, ANALYSIS, AND EVALUATION OF REDUCTION OPTIONS</u> .....	<u>2222</u>
<u>7.1</u>	<u>Past Reduction Options</u> .....	<u>2424</u>
	<u>7.1.1 Improved Inventory Control</u> .....	<u>2424</u>
	<u>7.1.2 Waste Segregation &amp; Characterization</u> .....	<u>2525</u>
	<u>7.1.3 Elimination of Degreasing Solvents</u> .....	<u>2525</u>
	<u>7.1.4 Installation of Silver Recovery Units</u> .....	<u>2526</u>
	<u>7.1.5 Development of Microscale Chemistry</u> .....	<u>2626</u>
	<u>7.1.6 Audit &amp; Organizational Changes</u> .....	<u>2626</u>
	<u>7.1.7 Beyond Hazardous Waste Reduction</u> .....	<u>2627</u>
<u>7.2</u>	<u>Current &amp; Future Reduction Options</u> .....	<u>2727</u>
	<u>7.2.1 Ice Arena Replacement</u> .....	<u>2727</u>
	<u>7.2.2 Evaluating Lab Experiments</u> .....	<u>2727</u>
	<u>7.2.3 Hazardous Chemical Substitution</u> .....	<u>2828</u>
	<u>7.2.4 Increased Use of Digital Photography</u> .....	<u>2828</u>
<u>8.0</u>	<u>SCHEDULE FOR IMPLEMENTING REDUCTION OPTIONS</u> .....	<u>2929</u>

## LIST OF FIGURES

FIGURE 1	Process Flow Diagram for Ammonia Refrigeration System.....	11
FIGURE 2	Procedural Flow Chart for Laboratory Wastes.....	13
FIGURE 3	Process Flow Diagrams for Photographic Developing.....	15
FIGURE 4	Toxic Use and Hazardous Waste Reduction Formulas.....	21

## LIST OF APPENDICES

APPENDIX A	Maine's Toxic Use and Hazardous Waste Reduction Law
APPENDIX B	MEDEP Biennial Pollution Prevention Progress Report

## 1.0 INTRODUCTION

St.Germain & Associates, Inc. (St.Germain) of Westbrook, Maine was retained by Bowdoin College (Bowdoin), located in Brunswick, Maine, to develop and update its Pollution Prevention Plan (P2 Plan). The P2 Plan was developed to meet the requirements of Maine's Toxic Use and Hazardous Waste Reduction Law (TUR Law), which is found in Title 38, Sections 2301 through 2313 of the Maine Revised Statutes Annotated (MRS). The P2 Plan was developed in accordance with the Maine Department of Environmental Protection's (MEDEP) "Toxics and Hazardous Waste Reduction Pollution Prevention (P2) Planning Guidebook" (January, 2003, herein referred to as "MEDEP's Reduction Guidelines").

In preparing this plan, St.Germain and Bowdoin completely revised the original P2 plan and program for the college. Original hazardous waste documents (manifests, inspection records, etc.) were reviewed to accurately reflect hazardous waste generation from the late 1980's to the present. This waste stream information was then combined into production units that better reflect current college operations, and provide a more useful tool for pollution prevention. As the underpinnings to previous MEDEP submittals have been changed by this approach, a revised version of the biennial P2 progress reports has been created and is included as an appendix to this plan.

The Maine TUR Law (see Appendix A) requires facilities that are subject to the reporting of Extremely Hazardous Substances (EHS) and releases of Toxic Chemicals under the Superfund Amendments and Reauthorization Act (SARA) Title III, Section 312 and 313, respectively, and facilities that generate 2,640 pounds or more of hazardous waste per calendar year, to set voluntary two-year numeric reduction goals. These voluntary goals consist of reducing the aggregate amount of each of the above chemical categories by a predetermined amount, established by the facility, by January 1<sup>st</sup> of 2002, 2004 and 2006. Reductions are calculated from the established baseline years. Baseline years can vary for each facility, and are typically:

- the amount of EHS used during 1990
- the average Toxic Chemical released during 1990 and 1991; and
- the average quantity of hazardous waste generated during 1987 and 1989

A facility can use alternate years if those years represent the first years of full operation and reporting thresholds were exceeded for each of those years. The original TUR Law required mandatory reduction goals of 10, 20 and 30 percent of EHS usage and hazardous waste

generation by January 1<sup>st</sup> of 1994, 1996 and 1998.

### **1.1 Extremely Hazardous Substances**

Bowdoin stores 1,200 pounds of anhydrous ammonia, an EHS, on site, which is in excess of the 500-pound reporting threshold and therefore is subject to the EHS reduction requirements of the TUR Law. In accordance with the definition of Toxic User (38 MRSA, Section 2301 (19)), **Bowdoin is required to report EHSs under SARA Title III, Section 312, and therefore is not exempt from the TUR Law reduction requirements (38 MRSA Section 2304-A(1)(A)). Bowdoin is required to develop the P2 Plan, set voluntary 2-year numeric goals for reducing the amount of anhydrous ammonia used on campus by January 1<sup>st</sup> of calendar years 2002, 2004, and 2006, and file biennial pollution prevention (P2) progress reports.** In order to become exempt from this reduction requirement, Bowdoin would be required to reduce the amount of anhydrous ammonia that is present on site below 500 pounds. As the 1,200 pounds of ammonia are used as an inherent part of the sealed cooling system for Dayton Ice Arena (see Section 5.1.1), reduction of ammonia would require replacing or eliminating this cooling system.

### **1.2 Toxic Chemical Releases**

Bowdoin is exempt from reporting Toxic Chemical releases because their Standard Industrial Classification (SIC) code (8221) is not included in the types of facilities that are required to report Toxic Chemicals under the Toxic Chemical Release Inventory Report (Form R Report). Therefore, in accordance with the definition of Toxic Releaser (38 MRSA Section 2301(17)), **Bowdoin is not required to report Toxic Chemical releases under SARA Title III, Section 313, and therefore is exempt from the TUR Law toxic release reduction requirements (38 MRSA, Section 2304-A(1)(B)).**

### **1.3 Hazardous Waste**

Bowdoin is currently a Large Quantity Generator (LQG) of hazardous waste under Maine regulations, generating 2,640 pounds or more of hazardous waste in a calendar year. **Therefore, in accordance with 38 MRSA, Section 2304-A(1)(C), Bowdoin is not exempt from the TUR Law reduction requirements and is required to develop the P2 Plan, set voluntary 2-year numeric goals for reducing the amount of hazardous waste generated at the campus by January 1<sup>st</sup> of calendar years 2002, 2004, and 2006, and file P2 progress reports.** To become exempt (as it pertains to the generation of hazardous waste) from the TUR Program, Bowdoin must demonstrate that it has not shipped hazardous waste off-site for a full

calendar year in quantities of 2,640 pounds or more.

The P2 Plan has been designed for use as a planning tool to reduce EHS and hazardous waste on site. It describes the operations and equipment that are involved in their use and generation as well as the reduction options that have and will be evaluated and implemented to achieve Bowdoin's reduction goals. The actual reduction progress is reported biennially in the MEDEP P2 progress reports.

## **2.0 SUMMARY AND CONCLUSIONS**

Bowdoin has directed its efforts on reducing the usage of EHS as well as reducing the quantity of hazardous waste generated at the campus in order to reach its voluntary reduction goals.

Bowdoin continues to evaluate reduction options for the usage of ammonia in the refrigeration system of Dayton Arena located on the campus. Since the system stores a fixed volume of ammonia, the only reduction option is replacement with a non-toxic alternative. Since the track record of these refrigeration systems have been proven to be safe, few cost-effective alternatives can be found on today's market.

Bowdoin has been successful in reducing its hazardous waste generation by an overall average of 74% from its baseline years, exceeding the previously set 2002 reduction goal of 5% by 69%. The majority of reductions have occurred in laboratory wastes. These reductions were achieved through the implementation of microscale laboratories, and improvements in inventory control, waste segregation and waste characterization. Training employees directly involved in these operations played a major role in the success of the program. Other significant reductions occurred with ignitable solvent degreasing wastes. Two solvent degreasers (parts cleaners) in Facilities Management were eliminated and a third was replaced with a non-toxic, citrus-based degreasing unit. Hazardous waste generated from these two units during 2002 represented 6% of the total hazardous waste generated that year. Based on Bowdoin's past reduction efforts and planned future reduction evaluations, Bowdoin anticipates it will be able to meet its 2004 and 2006 reduction goals of 75 and 76%, respectively.

### **3.0 COLLEGE MANAGEMENT POLICY**

The P2 Plan will become an integral part of Bowdoin's policy, product development, operational procedures and training. Bowdoin is committed to excellence and leadership in protecting the environment and improving the workplace. In keeping with this policy, Bowdoin's objective is to reduce toxic chemical use and hazardous waste generation and to minimize their potential adverse impacts on air, water and land. By successfully implementing source reduction, cost savings can be achieved and a safe and healthy workplace for Bowdoin's employees and student body can be maintained, resulting in an overall improvement in the environment.

Bowdoin's Environmental Management Mission Statement includes the following points:

- Environmental protection is everyone's responsibility. It is valued and displayed as a commitment by Bowdoin.
- Bowdoin is committed to toxic use reduction and energy conservation in the design of all new services.
- Reducing the use of toxics and the generation of hazardous by-products at the source is a prime consideration in research, process design, and operations. Bowdoin is committed to identifying and implementing reduction opportunities by encouraging and involving every employee.
- Innovative technologies, and methods that substitute non-hazardous materials and utilize other source reduction approaches, will be given top priority in addressing all environmental issues.
- Bowdoin seeks to demonstrate its responsible citizenship by adhering to all environmental regulations. Bowdoin promotes cooperation and coordination among industry, government, and the public toward the shared goal of preventing pollution at its source.

#### **4.0 EMPLOYEE AWARENESS, TRAINING, AND NOTIFICATION**

Section 2305 (4) of Title 38 MRSA states: "An employee awareness and training program consistent with the requirements of section 2306 is to involve employees in toxics use, toxics release, and hazardous-waste reduction planning and implementation to the maximum amount feasible." The Environmental Health and Safety Manager (EHS Manager) of Bowdoin is designated as the TUR Coordinator. In that role, the EHS Manager leads the Environmental Action Team (EAT) on campus. The function of the EAT is to assist the EHS Manager in pollution prevention planning and achieving program objectives. The objectives of Bowdoin are to make employees aware of: (1) the TUR Law and how it impacts Bowdoin; (2) the targeted usage of EHS and hazardous waste generation requiring reductions; (3) the benefits of employee health that can be experienced from reducing the releases of these chemicals to the environment; (4) the processes that use EHS and generate hazardous waste; (5) the existence and membership of the EAT; and (6) the notification method for any ideas, substitutes, or process redesign that could assist in the reduction of EHS usage and hazardous waste generation on campus. Bowdoin's EAT consists of the following employees:

- EHS Manager
- Laboratory Support Manager
- Assistant Director for Housekeeping Services
- Visual Arts Technician
- Coordinator for a Sustainable Bowdoin
- Director of Safety & Security
- Director of Facilities Operations
- Director of Facilities Administration

#### **4.1 Employee Awareness**

Bowdoin's EHS Manager is responsible for implementing the employee awareness and training requirements stated previously. The tasks to be undertaken by the EHS Manager to publicize the TUR program are as follows:

- a posted notice will appear on the Bowdoin web site outlining the commitment to EHS usage and hazardous waste reduction goals;
- semiannual updates of reduction progress will be provided by the EHS Manager and to all department heads by email; and
- the EAT members will oversee the reduction goals of the program within their respective departments, and report any concern (that would require extra attention) in meeting these goals to the EHS Manager. The EAT represents areas on the campus where EHS are used and/or hazardous waste is generated.

#### **4.2 Employee Training**

The EHS Manager will meet with the EAT semiannually (Spring & Fall Semesters) to discuss the reduction goals of the program. During these meetings the EHS Manager will inform the EAT of the current status of each reduction goal and solicit any reduction ideas or recommendations. The EAT Members will then discuss the assigned reduction goals with employees, and solicit comments on ways of achieving or maintaining these reduction goals. Opportunity for employee communication, comment and input, to planning and revision of the program is afforded by the EAT and Department heads. Biennial training of impacted employees by the EHS Manager will be accomplished by describing the contents of the P2 Plan and associated reduction goals in Bowdoin's daily electronic newsletter, *Faculty/Staff Digest*. The article will describe the following:

- the requirements of the TUR Law (i.e., 38 MRSA, Sections 2301 through 2313) and how it impacts Bowdoin,
- identifying the targeted usage of EHS and hazardous waste streams, the processes that use EHSs and generate waste streams, the characteristics or chemicals within each waste stream that cause it to be classified as a hazardous waste and efforts that have been made to reduce usage of EHSs and generation of hazardous wastes,
- the safety, health, and environmental benefits that can be realized from reduction of EHS usage and hazardous waste generation and
- the reduction goals for the targeted EHS usage and hazardous waste streams, the current strategies that have been developed to help maintain these reductions and how employees can help achieve reduction goals.

#### **4.3 Employee Notification**

In accordance with 38 MRSA, Section 2306, Bowdoin will utilize the employee awareness techniques described in Section 4.1, and:

- notify department heads in writing six months before the P2 Plan is scheduled to be updated of the requirements of the P2 Plan, the targeted EHS usage and hazardous waste streams, and the associated production units for which the plan must be maintained;
- solicit comments or suggestions from employees on EHS usage and hazardous waste generation reduction options; and
- once a year, the EHS Manager will convey department heads in writing the progress achieved in meeting the voluntary reduction goals of the P2 Plan.

#### **4.4 Municipality Notification**

In accordance with 38 MRSA, Section 2306, the EHS Manager will notify the municipal officers of the Town of Brunswick of its pollution prevention efforts, and will provide a copy of the biennial Progress Report to the Town Clerk. A cover letter summarizing the report will

accompany each copy of the biennial report.

The Progress Report will include:

- reduction goals set by Bowdoin;
- progress achieved in reaching these goals;
- reduction techniques implemented to meet these goals;
- description of employee involvement;
- list of pollution prevention methods to be used during the following two years;  
and
- a certification statement with the reports signed by a senior management official.

## **5.0 PRODUCTION UNIT ANALYSIS**

Production Unit Analysis represents the heart of the reduction planning process. It incorporates process flow diagrams, chemical pathway analyses and descriptions of operations utilizing targeted toxic chemicals and generating hazardous wastes. It provides the EAT with an in-depth understanding of each operation that contributes to the use and generation of EHS and hazardous waste.

### **5.1 Process Flow Diagrams and Chemical Pathways**

Process flow diagrams for the operations at Bowdoin are illustrated in Figures 1, 2 and 3. The diagrams include the major operations that use EHS or generate hazardous waste. Whenever possible, these diagrams illustrate the chemical pathway of the targeted chemicals. Universal waste has not been included in this P2 Plan because it is managed and recycled under the MEDEP Universal Waste regulations, and is not included in the college's hazardous waste generation that is targeted for reduction.

Figures 1 through 3 in this section will be used by the EHS Manager and EAT members, to assist them in meeting the requirements of Section 4.0, and during their quarterly reduction planning meetings.

#### **5.1.1 Ammonia Refrigeration System**

Figure 1 is a process flow diagram of the ammonia refrigeration system used in Dayton Ice Arena. The figure represents a simple illustration of the ammonia refrigeration system and the chemical pathway of anhydrous ammonia through the system. The refrigeration system is based on the principle that absorption of heat by a fluid (refrigerant) takes place when it changes from the liquid phase to a vapor phase. This absorption of heat by the fluid lowers the temperature of the surrounding objects. The mechanical refrigeration system employs a compressor, which exerts pressure on vaporized ammonia forcing it to pass through a condenser located in the cooling tower of the ice arena, where it loses heat and liquefies. The liquefied refrigerant is then pumped through the coils of the refrigeration compartment and vaporizes, drawing heat from the brine solution circulating through the pipes within the refrigeration compartment. The vaporized refrigerant is then pumped to the compressor and the cycle is repeated. The pipes containing brine solution extend through the refrigeration compartment and under the ice surface in the arena. The brine solution is cooled in the refrigeration compartment and flows through the pipes under the ice rink, removing heat from the ice surface. The brine solution flows from the ice rink and returns to the refrigeration

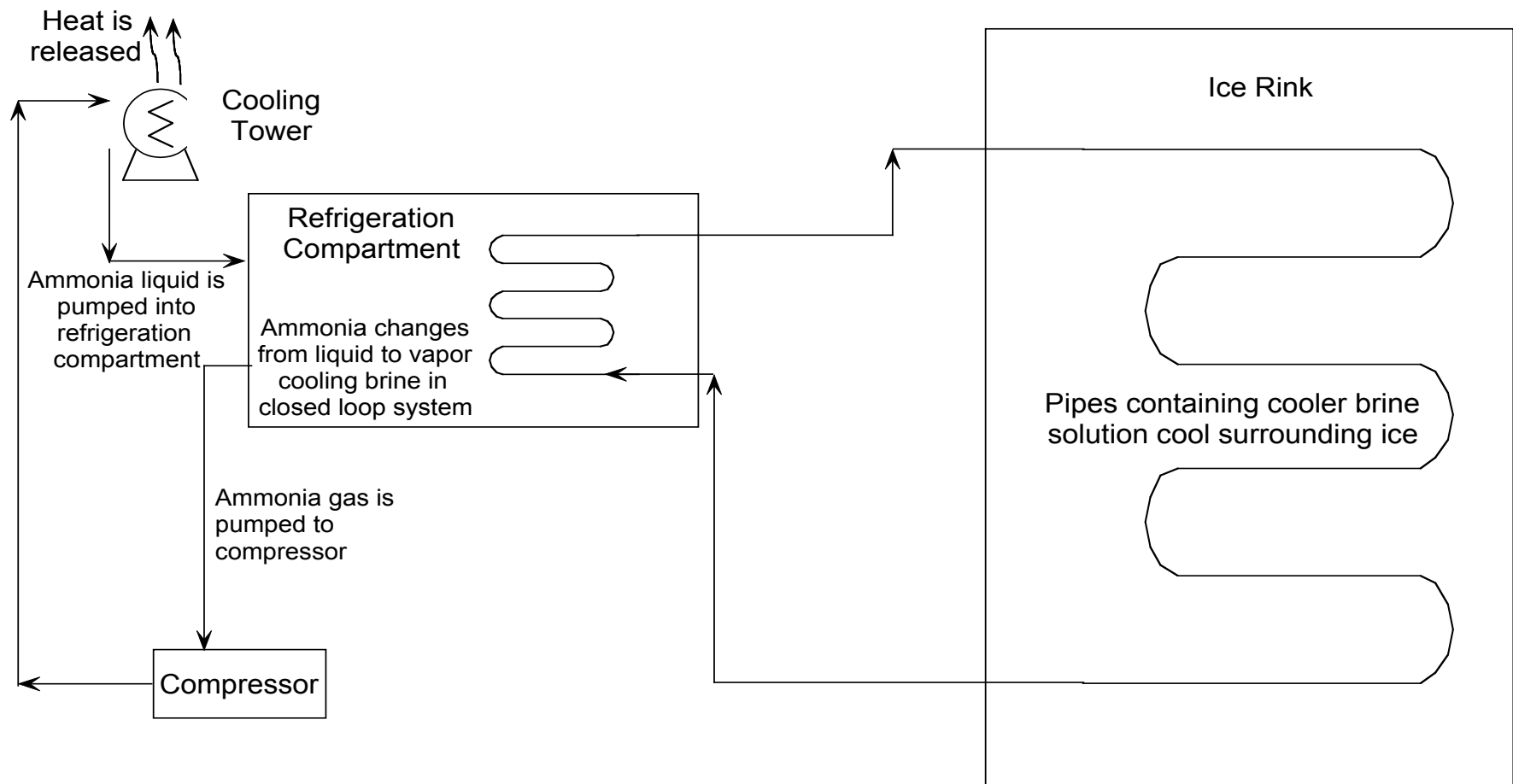
compartment where the cycle is repeated.

Since the refrigeration system consists of these two loops, the anhydrous ammonia never comes in contact with the brine solution, and is fully contained within the refrigeration compartment and pipes leading to the compressor and condenser. No releases to the air or water were included in the diagram because there are no significant discharges to either of these media. As ammonia is an EHS, it is targeted for reduction by this plan.

The brine solution contains residual chromium (as sodium dichromate) from a solution that was previously added to the brine to inhibit corrosion. The inhibitor solution now added no longer contains chromium but analytical testing indicates the remnant chromium concentration in the solution exceeds the 5 ppm hazardous waste toxicity level (6.2 ppm). Maintenance to this system periodically generates amounts of this hazardous waste (most recently in 2001) and is, therefore, targeted

Figure 1

### Process Flow Diagram for Ammonia Refrigeration System



### **5.1.2 Academic Laboratories & Studios**

A large percentage of hazardous waste generated at Bowdoin is from Druckenmiller Hall, where the Chemistry, Biology, Geology, Neuroscience and Environmental Studies Departments are located. The majority of hazardous waste streams generated in these departments are generated in small amounts (less than one liter per student) during student laboratory classes. A much smaller amount is generated in art studios in the Visual Arts Department.

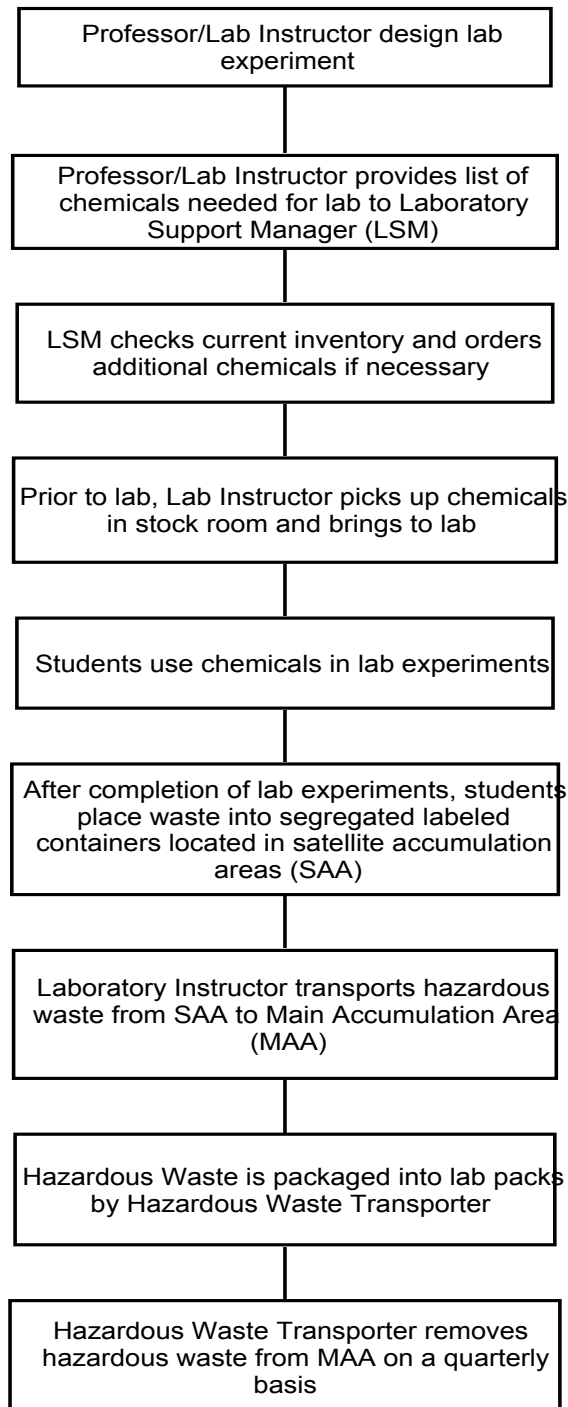
The type of chemical waste generated varies depending on the type of experiment being performed. Figure 2 is a procedural flow diagram that illustrates the typical procedures involving the procurement and management of chemicals and resultant chemical wastes that take place prior to, during and upon completion of a student lab. A procedural flow chart was developed in place of a process flow chart due to the variety of chemicals used during a student lab and the larger reductions of waste that can be achieved when analyzing the procedures instead of the types of chemicals in the process. By analyzing the path of chemicals used in a student lab from design to procurement to use and collection of waste, significant reductions of expired and overstocked chemicals and unsafe supplies of highly reactive chemicals can be avoided, thereby increasing the level of safety in student labs and reducing the quantity of waste being generated.

Chemical waste generation by students in art studios is infrequent and limited to very small volumes of organic solvents and weak acids used in painting and printmaking activities, such as cleaning of paintbrushes and printmaking plates. These wastes, when generated, are typically packaged and stored with laboratory wastes for disposal.

Due to the small quantity and large variety of chemical waste generated in each student lab, most waste is packaged in labpacks prior to shipment offsite. Labpacks consist of regulated packaging of small quantities of varying types of chemical waste. Each waste is generally packaged in accordance with compatibility and disposal characteristics. However, when waste is packaged in a labpack, the disposal cost rises dramatically due to the extra labor involved in packaging and unpacking (at the disposal facility) the waste.

Figure 2

## Procedural Flow Chart for Laboratory Wastes



### **5.1.3 Facilities Management**

Hazardous waste is generated in smaller quantities by Bowdoin's Facilities Management Department. Typical wastes include spent paint thinner and paints generated from maintenance activities. Given the successful waste reduction programs in the past, very little hazardous waste is currently generated by this department. Due to the small amount of waste and sporadic generation rate, no process flow diagram is provided for this waste stream.

### **5.1.4 Photography Darkrooms**

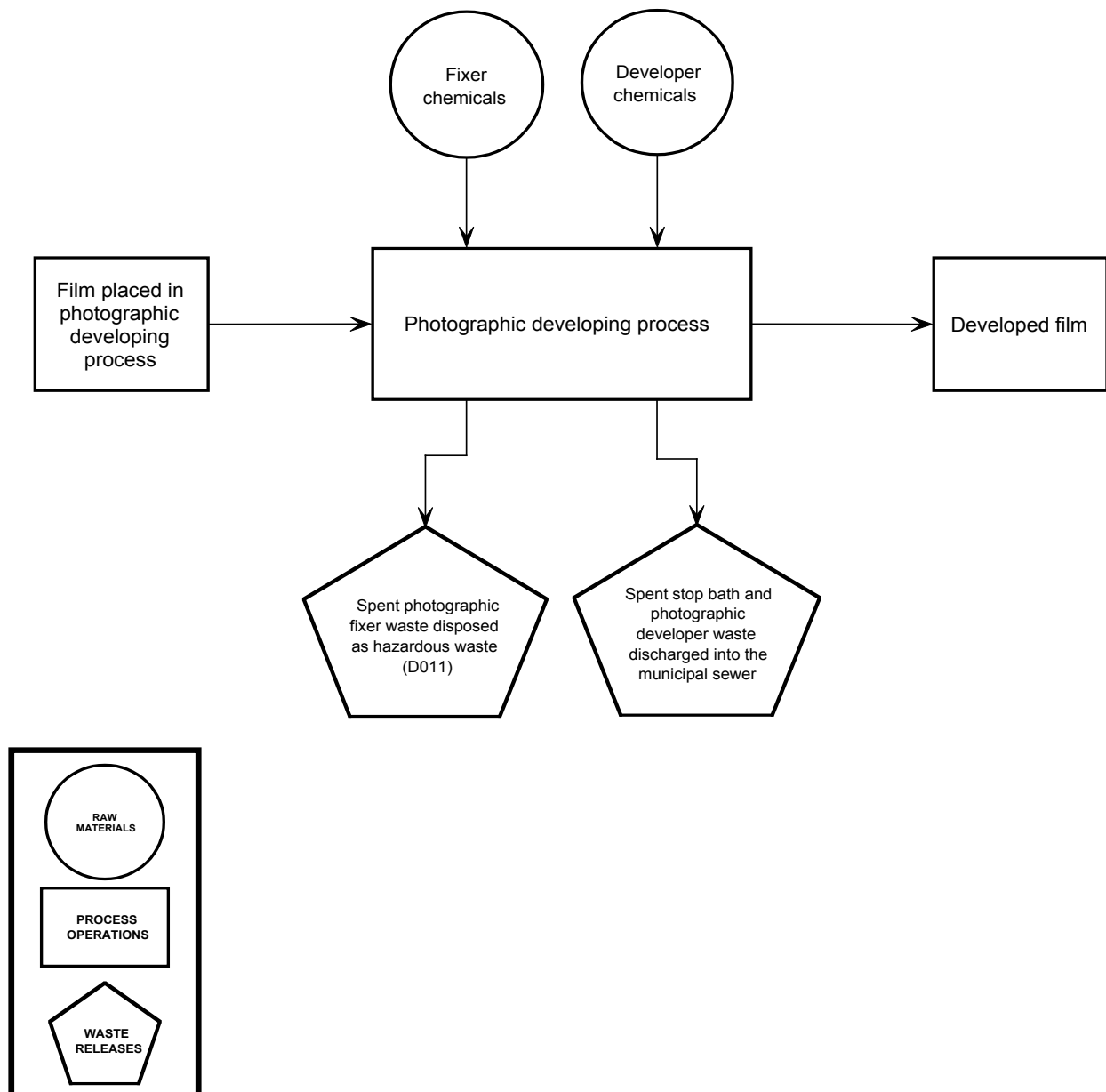
Beginning in the Fall of 2002, Bowdoin began separate tracking of silver-containing wastes generated from on-campus photographic developing. These liquid wastes are generated from Photography classes in the darkroom located in the McLellan Building, and at a less frequent rate from student activities in the darkroom of the Craft Center.

Figure 3 illustrates the typical process flow of photographic developing. Photographic paper and film is coated with a light sensitive emulsion containing silver halide. Once the paper or film is exposed to an image and ready for developing, it is placed in a developer solution that converts the silver halide crystals (within the emulsion) that have been exposed to light into metallic silver. The print or film is transferred to a chemical stop bath that halts the conversion process. The print or film is then moved into a fixer solution that removes the undeveloped and unexposed silver crystals.

The spent stop bath and spent developer solutions are discharged as non-hazardous waste into the Town of Brunswick's sewer system. The spent fixer solution contains silver and is disposed as a hazardous waste with a waste code of D011.

Figure 3

### Process Flow Diagram for Photographic Developing



## **5.2 Identification of Unit of Product**

As defined in the MEDEP's Reduction Guidelines, a unit of product is "a measure that reflects the level of production or activity associated with the use of a toxic or the generation of a hazardous waste." Since Bowdoin is an educational institution, the level of many of its activities and operations is dependent upon the number of students attending Bowdoin each year. For example, in photography courses, the amount of photographic developing is directly proportional to the number of students in the course. Therefore, the unit of product that has been chosen is Bowdoin's student enrollment for any given year. This number is used in reference to a baseline year to normalize the amount of waste produced by the college. This normalization ratio is referred to by MEDEP as the Activity Production Index, or API.

## **5.3 Identification of Production Units**

In accordance with the TUR Law, a production unit is defined as "a process, line, method, activity or combination thereof to make a product." Production units have been developed in accordance with the MEDEP's Reduction Guidelines in order to define the amount of reduction that has occurred, future reduction planning that may be necessary and to be used to meet the "Employee Awareness, Training and Notification" requirements specified in Section 4 above. Figures 1 through 3 will aid the employees and the EAT in clearly identifying the operations that are involved in the usage of EHS and the generation of hazardous waste within Bowdoin's operations. The name given to each production unit is identical to the names of production units used in the MEDEP P2 progress report. The four production units – Ice Arena, Labpack, Maintenance, and Darkroom – are described as follows.

### **5.3.1 Ice Arena Production Unit**

The Ice Arena production unit consists of the ammonia refrigeration system and the piping system with the brine solution containing residual chromium in Dayton Arena. No hazardous wastes were generated by this production unit in 2002. Some chromated waste has been generated in the past by maintenance conducted on the brine solution piping, but this generation is infrequent. As the ammonia system is a closed loop, no ammonia is released from the system. Note that the waste generation rate for this production unit, unlike the other production units, is only indirectly dependent on student enrollment (see also Section 6.7).

### **5.3.2 Labpack Production Unit**

The Labpack production unit consists of the student labs and chemical stockrooms located in Druckenmiller Hall, where the Chemistry, Biology, Geology, Neuroscience and Environmental Studies Departments are located. These operations are included in this production unit because the majority of hazardous waste is generated in student labs and in chemical stockrooms having outdated or expired chemicals. This unit also includes the infrequent small quantities generated in the Visual Arts Center, which is also shipped for disposal in labpacks. During 2002, a total of 2,623 pounds of hazardous waste in the form of labpacks were generated at Bowdoin. This represents 71% of all hazardous waste generated in 2002. The types of hazardous waste shipped include flammable, corrosive, toxic and oxidizer wastes and cover a wide variety of chemicals.

### **5.3.3 Maintenance Production Unit**

The Maintenance production unit consists of Facilities Management waste generated in the course of maintenance activities at the college. These wastes include solvents from painting and degreasing operations. A total of 325 pounds of hazardous waste were generated by this production unit in 2002, representing 9% of the total hazardous waste stream for 2002. In the Fall of 2002, two parts washers that generated hazardous waste were eliminated and a non-toxic citrus-based alternative was substituted in a third, eliminating the generation of additional hazardous waste.

### **5.3.4 Darkroom Production Unit**

The Darkroom production unit consists of silver-containing waste fixer solutions generated from photography developing in the darkrooms of the McLellan Building and the Craft Center. Approximately 730 pounds of hazardous waste were generated by this production unit in 2002, representing 20% of the total hazardous waste stream for 2002. Tracking of these wastes as a production unit began in 2002 when silver recovery units were purchased to remove silver from these waste solutions. The silver recovery units were eliminated in 2003, as they were found to increase administrative and maintenance costs without significantly reducing hazardous waste generation, and replaced with satellite collection containers.

## **6.0 TRACKING AND REPORTING REDUCTIONS**

It is imperative that any campus involved in reductions of EHS usage and hazardous waste generation maintain effective and thorough recordkeeping in order to track the status of all reduction efforts and to produce accurate biennial P2 progress reports. The EHS Manager is responsible for obtaining the reduction information from the annual Maine Chemical Inventory Reports and hazardous waste manifests. Through the use of tracking forms discussed in this section, the EHS Manager keeps the EAT informed of the reduction levels for each production unit.

### **6.1 Baseline of EHS Usage Reductions**

The TUR Law requires a facility to use the average amount present onsite of the EHS that was reported on the Maine Chemical Inventory Report during the years 1990 and 1991 or during the first year reporting is required, whichever is earlier. In 1990 and continuing through the present, the Dayton Ice Arena refrigeration system contains approximately 1,200 pounds of ammonia. Therefore, 1,200 pounds represents the baseline amount on which all future reductions of ammonia will be based.

### **6.2 Baseline of Hazardous Waste Generation Reductions**

MEDEP's Reduction Guidelines allow Large Quantity Generators of hazardous waste to use as a baseline year either the average amount of hazardous waste generated during 1987 and 1989, or a baseline year that is more representative of the hazardous waste generation activity. Bowdoin selected 1990 for the baseline year, as this was the first year that Bowdoin qualified as a Large Quantity Generator. The amount of hazardous waste generated in this year is used in the reduction formula to calculate past and present reductions for the Labpack and Maintenance production units. For the other two production units, Ice Arena and Darkroom, no wastes were generated in 1990 so the first year of waste generation following 1990 was used. The baseline year for the Ice Arena is 1992 (the year the current refrigeration system was refitted). The baseline year for the Darkroom production unit will be 2003, as this represents the first full year of separate tracking of this production unit.

The baseline quantities of each of these categories are listed in Table 1. These quantities were taken from the hazardous waste manifests that accompanied each shipment of hazardous waste during the respective baseline year.

**Table 1.0 – Baseline Quantities of Hazardous Waste Generated**

Waste Category	Waste Code(s)	Baseline Year	Quantity (Pounds)
Labpack	Various	1990	3,790
Maintenance	Various	1990	531
Ice Arena	D007	1992	17,000
Darkroom	D011	2003	1,805 <sup>a</sup>

<sup>a</sup>As 2003 has not ended, the baseline year quantity provided is an estimate based on the Fall 2002 and Spring 2003 amounts combined.

### 6.3 Current Distribution of Hazardous Waste Generation

Table 2.0 illustrates the distribution of hazardous waste generated during 2002 from the production units on campus. This table is used to perform the employee training and notification requirements specified in Section 4.0, and to assist the EAT in current and future reduction strategies.

**Table 2.0 – Hazardous Waste Generation Distribution During 2002**

Waste Category	Waste Code(s)	Quantity (Pounds)	Percentage of Total (%)
Labpack	Various	2,623	71
Maintenance	Various	325	9
Ice Arena	D007	0	0
Darkroom	D011	730	20
	<b>Total:</b>	<b>3,678</b>	<b>100</b>

### 6.4 Hazardous Waste Disposal Costs

During its 2002 calendar year, Bowdoin expended approximately \$7,000 for the disposal of hazardous waste. This year, the amount is estimated to be \$5,000. The amount will decrease for 2003 as the 2002 figure included disposal of waste generated in the previous year. Savings in disposal of degreasing solvents in the Maintenance production unit will likely be offset by disposal costs attributed to the Darkroom production unit. The implementation of the reduction options listed in Section 7 will continue to reduce hazardous waste disposal costs.

### 6.5 Reduction Goals

No reduction goals for ammonia have been established since there is no safer, cost-effective alternative for ammonia in the refrigeration system of the ice arena. The ammonia is in a closed-loop system and is typically not released during normal operations. The EAT will continue to evaluate other options as they become available.

Bowdoin has established 76% and 77% hazardous waste generation reduction goals for

January 1<sup>st</sup> of 2004 and 2006, respectively. By January 1<sup>st</sup> of 2002, Bowdoin was successful in reducing its hazardous waste generation by 74% from its baseline years of 1990 and 1992. This reduction surpassed the 5% reduction goal that was established by the campus in its original 2002 report.

## **6.6 Recordkeeping**

Information from the Maine Chemical Inventory Report and the hazardous waste manifests are tracked by the EHS Manager in a dedicated database, and used to complete the progress reports. The average amount of ammonia that is reported in the Maine Chemical Inventory Report is not expected to change from year to year. This amount is tracked by communicating with Facilities Management personnel responsible for maintenance of the system.

Information from hazardous waste manifests are summarized semiannually into the four hazardous waste categories (listed in Table 2.0), which are analyzed by the EHS Manager in order to determine the reduction status of each waste category. At the end of calendar years 2003 and 2005, the information from this database will be used to complete the biennial P2 progress reports.

## **6.7 Reporting**

The MEDEP requires facilities that are subject to the TUR Law to report its reduction progress in the progress reports. Bowdoin is required to submit a progress report for reductions in EHS usage and for reductions in hazardous waste generation. Bowdoin completes the report biennially in a software file that is supplied by the MEDEP. A copy of the revised 2002 report is included in Appendix B.

The numbers included in the progress report are calculated using MEDEP equations, which are shown in Figure 4. The percent reduction achieved is calculated by computing the API and using that index to normalize the production unit figures over the course of the reporting year. The API is equal to the student enrollment during that year divided by the baseline year enrollment (see Section 5.2). The API accounts for years where Bowdoin's enrollment may be below or above the typical level. It is used to adjust the EHS usage and hazardous waste generation in relation to the baseline year enrollment. Note that the Ice Arena production unit is not directly related to student enrollment, and therefore uses an API of 1.

The Adjusted Amount (AU) calculation is the normalization of the campus' EHS usage and hazardous waste generation with its API. The Reduction formula utilizes these normalized

amounts in the calculation of the final reduction figures. A negative reduction number indicates a decrease in the amount of EHS used or hazardous waste generated, where a positive number indicates an increase.

The EHS Manager is responsible for completing the biennial progress reports and sending them along with the associated fees to the MEDEP. The EHS Manager is also responsible for sending a copy of these reports to the Town Clerk for the Town of Brunswick.

### **Figure 4**

#### **Toxic Use Reduction Formulas**

##### **Toxic Use API**

$$\text{API} = \frac{\text{reporting year production}}{\text{baseline year production}}$$

##### **Toxic Use Adjusted Amount (AU)**

$$\text{AU} = \frac{\text{pounds of toxic used in report year}}{\text{API report year}}$$

##### **Toxic Use Reduction**

$$\% = \frac{\text{AU - pounds of toxic used in base year}}{\text{pounds of toxic used in base year}} \times 100$$

#### **Hazardous Waste Reduction Formulas**

##### **Hazardous Waste Generated API**

$$\text{API} = \frac{\text{reporting year production}}{\text{baseline year production}}$$

##### **Hazardous Waste Generated Adjusted Amount (AU)**

$$\text{AU} = \frac{\text{pounds of waste generated in report year}}{\text{API report year}}$$

##### **Hazardous Waste Generated Reduction**

$$\% = \frac{\text{AU - pounds of waste generated in base year}}{\text{pounds of waste generated in base year}} \times 100$$

## **7.0 IDENTIFICATION, ANALYSIS, AND EVALUATION OF REDUCTION OPTIONS**

In accordance with Section 2305 (2) of the TUR Law, Bowdoin identifies, analyzes, and evaluates any technology, process, procedure or equipment change necessary to achieve reductions with the following hierarchy of reduction options:

- improved operational controls;
- input substitution;
- process redesign;
- reuse and on-site recycling of hazardous waste;
- waste minimization;
- waste segregation;
- improved waste characterization;
- treatment of hazardous waste to reduce volume and/or toxicity; and
- off-site recycling of hazardous waste.

Typically, Bowdoin attempts to utilize those reduction options that provide the greatest amount of reduction with the smallest amount of impact to academic activities. Each of the above reduction options as it relates to Bowdoin is described below.

### Improved Operational Controls

Improved operation controls can include many reduction techniques, ranging from better purchasing and inventory controls to the adoption of good-housekeeping techniques. This is the first and one of the easier reduction options implemented by Bowdoin because many times it involves little additional effort to implement and does not reduce the efficiency of Bowdoin's operations. Training is key in the success of this chosen reduction option.

### Input Substitution

Input substitution is the replacement of a hazardous chemical with a less hazardous chemical. The EAT is continually assessing less hazardous chemicals that can be substituted in the chemical labs and maintenance operations. Input substitution not only reduces the risks associated with exposure to chemicals, but also can reduce the generation of hazardous waste.

### Process Redesign

Process redesign consists of changing the way the product is produced to achieve an overall reduction in the use, release, and waste generation during the process. Laboratory experiments are an example of a process that can be redesigned to reduce the amount or type of chemicals used and change the waste generated by an experiment.

### Reuse and On-site Recycling

Reuse and on-site recycling of EHSs and hazardous materials can be a cost-effective reduction option because it can increase the life of these materials, thereby reducing the amount of raw material purchased for the process or activity as well as decrease the quantity of EHSs and hazardous materials requiring disposal. The recycling of ammonia in the closed-loop refrigeration system at the Ice Arena is an example of a toxic chemical being reused within a process.

#### Waste Minimization

Waste minimization is the process of examining systems closely for excess waste generation. Improved procedures, more efficient equipment, and training are all options that can minimize the amount of waste being generated. During the early years of the MEDEP TUR Program, it became evident that waste minimization was an area where significant reductions in waste generation could occur.

#### Waste Segregation

Waste segregation is the process of separating different waste streams to avoid the commingling of incompatible wastes or wastes of different disposal destinations. It is a reduction option that can be applied to most facilities generating more than one waste stream. Proper segregation of incompatible wastes results in the avoidance of any potentially dangerous chemical reactions that could cause human injury or damage to the environment. Whenever wastes of different disposal destinations become commingled in a container, Bowdoin will pay the disposal cost for the most expensive component of the wastes. A higher degree of waste recycling can be achieved when waste is properly segregated.

#### Improved Waste Characterization

This reduction option, which involves the proper disposal characterization of each waste stream, minimizes the occurrence of hazardous waste becoming mixed with non-hazardous waste and improperly shipped to a disposal facility that is not licensed to receive it. Proper waste characterization identifies the correct classification of a waste stream based on its source of generation, chemical composition and characteristics, and MEDEP and EPA solid and hazardous waste disposal regulations.

Significant penalties and long-term liabilities can result from the improper characterization of hazardous waste. Not only could Bowdoin be subject to significant environmental penalties for the improper labeling, shipping, and disposal of hazardous waste, it also could experience third-party lawsuits if the final destination location of the waste caused damage to human health or

the environment.

### Treatment of Hazardous Waste to Reduce Volume and/or Toxicity

The Environmental Protection Agency defines “treatment of hazardous waste” as:

*“Treatment means any method, technique, or process, including neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, or so as to recover energy or material resources from the waste, or so as to render such waste non-hazardous, or less hazardous; safer to transport, store, or dispose of; or amenable for recovery, amenable for storage, or reduced in volume.”*

The definition of treatment is very broad and general and can apply to many process activities that are associated with hazardous waste. Some forms of treatment are not allowed by the MEDEP, such as evaporation of hazardous waste. For most treatment activities, licenses or abbreviated permits are required by the MEDEP prior to the initiation of treatment. Some of these can be very time consuming and expensive to acquire. In some cases, the amount of reductions achieved and cost savings realized far out weigh the effort and cost expended. Examples of treatment include: solvent distillation, silver recovery, elementary neutralization, aerosol can depressurization, and chemical precipitation.

### Off-site Recycling of Hazardous Waste

Recycling of hazardous waste is considered low on the hierarchy of reduction techniques, because the waste is still generated on-site and must be shipped offsite to be recycled. More efficient recovery of hazardous waste is more likely to occur at the point of generation rather than off-site. Off-site recycling increases the amount of waste handling and costs of waste management.

## **7.1 Past Reduction Options**

The following section summarizes activities undertaken by the College and represents a considerable commitment to implementing pollution prevention. These summaries are important for tracking historical successes and can serve as a basis of discussion for future reduction options.

### **7.1.1 Improved Inventory Control**

Since the late 1980's, Bowdoin has recognized the importance of improved inventory control in its science laboratories and has implemented improvements to the programs. Similar to other

institutions, Bowdoin disposed of expired and unused chemicals in significant quantities from its chemical stockrooms, laboratories and classrooms. Major cleanouts of chemicals from these areas occurred in 1990, 1992, 1993, 1995 and 1997. As an action to prevent future overstock of chemicals for disposal, Bowdoin implemented a multi-departmental computerized chemical inventory system in 1998. This, in conjunction with the establishment of a single point-of-control for the receiving, storage, and issuance of chemicals in Druckenmiller Hall, has significantly reduced the amount of hazardous waste generated and resulted in the following benefits:

- greater utilization of chemical inventories prior to the purchase of new chemicals, which has resulted in fewer expired or off-specification chemicals being discarded as hazardous waste;
- fewer chemicals being stored in stockrooms, resulting in safer working conditions;
- disposal of expired, highly reactive chemicals;
- reduced hazardous waste disposal costs; and
- fewer unknown chemicals being discarded, resulting in a reduction in analytical costs and easier waste stream characterization.

The effect of implementing of this reduction option is difficult to quantify, but has played a role in reducing labpack waste by an average of 60% from its 1990 baseline year.

### **7.1.2 Waste Segregation & Characterization**

In addition to improved inventory control, Bowdoin has instituted a program of waste collection, identification and segregation in Druckenmiller Hall that maintains strict controls over the waste chemicals. This control has reduced the amount of hazardous waste generated through proper characterization and by preventing the commingling of hazardous wastes with non-hazardous wastes.

### **7.1.3 Elimination of Degreasing Solvents**

Two parts washers were eliminated in Facilities Management during the past several years. In a third unit, the toxic material used for degreasing was replaced with a non-toxic, citrus-based material. These actions have reduced hazardous waste generation and improved health and safety conditions for workers. Prior to implementing these options, solvent degreasers represented as high as 14% of Bowdoin's total hazardous waste stream. The elimination of degreasing solvents has contributed to the 73% reduction in maintenance wastes since the baseline year.

### **7.1.4 Installation of Silver Recovery Units**

In the Fall of 2002, Bowdoin purchased two silver recovery units for removing silver from the

waste fixer solutions from darkrooms in the McLellan Building and the Craft Center. These units were used through the spring semester of 2003, and then their use was discontinued. This reduction option was found not to be feasible for several reasons. The units could not be “hard-piped” into the development process (totally enclosed treatment) and, therefore, their use requires a hazardous waste treatment license. As licensing requires the amount of waste treated through the unit be reported as part of Bowdoin’s hazardous waste generation, there is no resulting reduction in hazardous waste generation. Without a reduction in hazardous waste generation or an improvement for the environment, Bowdoin could not justify the additional administrative cost associated with this option. If regulations change that allow for wastes treated through silver recovery units not to be reported, this option should be re-evaluated at that time.

#### **7.1.5 Development of Microscale Chemistry and Laboratory Substitutions**

Starting in the 1980’s, Bowdoin’s Chemistry professors developed microscale laboratory procedures, techniques and equipment that have significantly decreased the amount of chemicals used in chemistry laboratories and subsequently have reduced associated chemical exposure and disposal costs. The microscale approach allows student lab experiments and research to be carried out on a greatly reduced scale as compared to previous methodologies.

In addition, Bowdoin has greatly reduced the use of formaldehyde in its science laboratories since the construction of the new Science Center in 1992 by substitution of less toxic alternatives.

#### **7.1.6 Audit & Organizational Changes**

Bowdoin has undertaken several environmental audits in the past few years, contracting with experienced environmental professionals to identify areas for improving compliance and reducing waste disposal on campus. Bowdoin also formed the EAT, charged with acting as an advisory group to the EHS Office, providing a means of communication with employees, and reducing the impact the college has on the environment through the implementation of sound waste management practices and encouraging employee participation. Most recently in 2002, Bowdoin incorporated the EHS Manager position into the Facilities Management Department, which will result in better coordination between the program manager and waste generators.

#### **7.1.7 Beyond Hazardous Waste Reduction**

In addition to the many steps taken in the area of hazardous waste reduction, Bowdoin has also extended its reduction efforts as follows:

- the replacement of hazardous cleaning chemicals with non-toxic alternatives in 2003;
- reduction in non-hazardous waste disposal, providing incentives for recycling, and creation of a full-time position dedicated to enacting environmental sustainability in 2001; and
- replacement of bulk-storage pool treatment chemicals (one 500-gallon aboveground storage tank of chlorine, and 30-gallon drums of muriatic acid, located at the Farley Field House) with commercially-available 5-gallon units in 1998-1999.

While not directly related to hazardous waste reduction, these actions reflect a commitment by Bowdoin to reduce the environmental footprint of the college to the greatest extent practical.

## **7.2 Current & Future Reduction Options**

In addition to revisiting and improving upon past reduction options, the EAT is constantly evaluating reduction options that are suggested by faculty, students and employees. During semiannual meetings, the EAT discusses each reduction option and evaluates its potential application at the college. Not only are the potential hazardous waste reductions evaluated, but also the cost-effectiveness, degree of difficulty in implementing the option and its overall impact on the safety and health of employees, students and the environment. The following reduction options are currently being evaluated by the EAT.

### **7.2.1 Ice Arena Replacement**

Bowdoin has begun planning for the replacement of Dayton Arena with a new ice rink facility. While the new refrigeration system would likely still use ammonia, the new system would be more efficient and therefore likely use less ammonia. In addition, the new system would not contain chromated brine solution. The EHS Manager will coordinate with the Department of Planning and Development to address EHS and hazardous waste issues in both designing the new facility, and decommissioning the existing facility.

### **7.2.2 Evaluating Lab Experiments**

The EHS Manager will be working with science departments that generate laboratory wastes to evaluate ways of further reducing hazardous waste generation. Options for consideration include, but are not limited to: substitution of less hazardous chemicals; switching lab experiments to ones that produce less toxic waste; and incorporating waste destruction procedures into the experiment plan, as appropriate.

### **7.2.3 Hazardous Chemical Substitution**

Bowdoin has historically replaced many hazardous chemicals with alternatives that produce less toxic waste and will continue to pursue this reduction option. Examples in the past include the degreasing solvents and formaldehyde discussed above. The EHS Manager will continue to assess opportunities for hazardous chemical substitution in campus activities, such as in maintenance areas and art studios in addition to science labs.

### **7.2.4 Increased Use of Digital Photography**

Members of the EAT will be discussing with professors that use film photography in their classes the possibility of increased utilization of digital techniques to reduce the hazardous waste generated from traditional developing techniques. During 2002, spent fixer solutions made up 20% of the hazardous wastes being generated at Bowdoin.

## **8.0 SCHEDULE FOR IMPLEMENTING REDUCTION OPTIONS**

Bowdoin has achieved significant reductions in hazardous waste generation through its past achievements. As such, identifying and scheduling new activities to promote reduction are becoming increasingly difficult. However, Bowdoin is committed to taking all practical actions to prevent pollution and will continue to look for reduction opportunities. With an overall reduction in hazardous waste generation of 74% over the baseline years in the 2002 reporting year, Bowdoin has set future reduction goals of 75% and 76% in 2004 and 2006, respectively. Bowdoin will strive to exceed those goals and continue towards elimination of pollution from the campus.

**APPENDIX A**

**Maine's Toxic Use and Hazardous Waste Reduction Law**

## **APPENDIX B**

### **MEDEP Biennial Pollution Prevention Progress Report**