Pilot Project: Chemical Waste Minimization in the Educational Laboratory

Illinois State University
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WMRC is a division of the Illinois Department of Natural Resources
Pilot Project:
Chemical Waste Minimization
in the Educational Laboratory

A Joint Project from:
Argonne National Laboratory- East
Waste Management & Research Center

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Executive Summary

During Calendar Year 1999, the Illinois Waste Management and Research Center (WMRC), a state agency, and Argonne National Laboratory-East (Argonne), a federal research facility, jointly conducted a pilot project entitled “Chemical Waste Minimization in the Educational Laboratory.” Four Chicago area secondary schools voluntarily participated in this Pilot Project. The purpose of the Pilot Project was to promote the integration of waste minimization and pollution prevention (WM&P2) strategies within secondary schools by presenting microscale chemistry lectures and demonstrations to high school chemistry teachers and by performing chemical vulnerability assessments within high school chemistry laboratories.

During the implementation of the Pilot Project, the project team identified three critical issues that appear to be common to secondary schools with active educational laboratories. These critical issues are:

1. The generation and accumulation of hazardous wastes within educational laboratories pose significant Environmental, Safety and Health (ES&H) risks within most secondary schools.

2. A significant amount of secondary school science teachers were found to have limited knowledge of current chemical and waste material storage, disposal and minimization requirements and strategies. These teachers would benefit greatly from the expertise and assistance provided from qualified external partners.

3. Internal and external funding is necessary for schools to adequately reduce existing ES&H risks caused by the continued generation and accumulation of hazardous wastes within educational laboratories.

Under the Pilot Project, Argonne's Division of Educational Programs (DEP) provided demonstrations and training on microscale chemistry techniques, and the WMRC performed chemical vulnerability assessments within each of the four participating high schools. The implementation of these activities helped address critical issues 1 and 2 (above) at the four participating schools.

Although the Pilot Project did not provide funding for chemical waste disposal, the Pilot Project was found to provide the schools with the tools (assessments and recommendations) needed to convince their school's administration that it is a priority to routinely address existing chemical material/waste concerns and issues (i.e. disposal).

Future implementation of this project is dependent upon the availability of funding opportunities locally, regionally, and nationally for the Chemical Waste Minimization in the Educational Laboratory Project activities. The project team is committed to bringing this project to more schools in the Chicagoland area and beyond. The team estimates that the cost for implementing the Chemical Waste Minimization in the Educational Laboratory
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Project within a typical Chicagoland secondary school to be between $1,500 to $2,500. Schools located further away from the Chicagoland area may incur additional costs.

For more information on how to implement the Chemical Waste Minimization in the Educational Laboratory Project within a secondary school of your choice, contact one of the following project team members:

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1.0 Introduction

During Calendar Year 1999, the Illinois Waste Management and Research Center (WMRC), a state agency, and Argonne National Laboratory-East (Argonne), a federal research facility, jointly conducted a pilot project entitled "Chemical Waste Minimization in the Educational Laboratory." Four Chicago area secondary schools voluntarily participated in this Pilot Project.

The purpose of the Chemical Waste Minimization in the Educational Laboratory Pilot Project was to promote the integration of waste minimization and pollution prevention (WM&P2) strategies within secondary schools by presenting microscale chemistry lectures and demonstrations to high school chemistry teachers and by performing chemical vulnerability assessments within high school chemistry laboratories. In addition, this pilot project provided technical guidance that focused on site-specific issues and concerns involving the use, management, storage, and disposal of chemicals within the participating school's educational laboratories.

The goal of this Pilot Program was to demonstrate the importance of integrating WM&P2 techniques and assessment strategies into the functions of the educational laboratory. The integration of these strategies can provide the following benefits for participating schools:

- A reduction in high school chemical waste generation;
- Minimization of health risks to students and teachers in school laboratories;
- Safer educational laboratories for both students and teachers;
- Continuance of schools' hands-on laboratory experiences for students - a practice that has been threatened by the increasing cost and difficulty of waste disposal; and
- Student knowledge of WM&P2 techniques that they will practice throughout their lives.
2.0 Background

The WMRC, which is headquartered on the University of Illinois Urbana-Champaign campus, is a division of the Office of Scientific Research and Analysis in the Illinois Department of Natural Resources. WMRC assists Illinois industries, businesses, and citizens to reduce and better manage generated solid and hazardous wastes released to air, water, and land. For more information, visit the WMRC's web site located at: http://www.wmrc.uiuc.edu/.

Argonne is one of the U.S. government's oldest and largest science and engineering research laboratories. For the past half-century, the University of Chicago has administered the operation of Argonne for the U.S. Department of Energy (DOE) and its predecessor agencies.

Argonne has four major mission areas, each of which fulfills important governmental and DOE responsibilities, as well as providing important benefits to society at large:

- Conduct of basic scientific research to further our understanding of the world we live in;
- Operation of national scientific facilities to help advance America's scientific leadership;
- Enhancement of the nation's energy resources to ensure America's energy future; and
- Development of better ways to manage environmental problems.

Argonne's web site is located at: http://www.anl.gov.
The Chemical Waste Minimization in the Educational Laboratory Pilot Program is comprised of three activities: Microscale Chemistry Training, Chemical Vulnerability Assessment, and Providing Guidance for Chemical and Waste Management Practices. These three activities are briefly described in the section below. For a more detailed breakdown of these components please read the Chemical Waste Minimization in the Educational Laboratory Pilot Program Workplan (Attachment 1).

3.1 Microscale Chemistry Training

The Chemical Waste Minimization in the Educational Laboratory Pilot Program provides chemistry teachers with the necessary training and tools for successful integration of microscale chemistry techniques and strategies into educational laboratories and secondary school chemistry curricula.

Microscale chemistry is a teaching methodology wherein laboratory chemistry training is provided to students while utilizing very small amounts of reagents and correspondingly small apparatus. The use of microscale techniques would enable a school to significantly reduce the cost of reagents, the cost of waste disposal, and the dangers associated with the manipulation of chemicals. These cost reductions would be achieved while still providing students with the hands-on laboratory experience that is vital to those who might choose to pursue careers in the sciences. A typical microscale experiment consumes less than 10% of the quantity of reagent used in the corresponding traditional macroscopic experiment. The fire hazards are greatly diminished, exposure to vapors is reduced, and the quality of laboratory air is improved. The smaller apparatus that is used in a microscale chemistry laboratory is less prone to breakage, and should breakage occur, the safety hazard is considerably less. Microscale laboratories are much easier to assemble and take less time to run than their macroscale counterparts, which allows for better time management in the high school science curriculum. Many universities and colleges have already begun to switch from macroscale to microscale chemistry in their educational laboratories. The introduction of these techniques at the secondary education level would lead to freshmen being better prepared for the type of experimentation that they will encounter in college.

Argonne's Division of Educational Programs (DEP) and its Pollution Prevention Program presented microscale chemistry lectures and demonstrations, and provided equipment kits, instructional manuals, and other supplies to the four participating high schools. Argonne has conducted similar workshops for over 300 high school teachers in the Chicago area since 1995.

Argonne's DEP serves as the interface among DOE, Argonne, and the academic community. DEP collaborates with universities, colleges, technical institutes, informal educational centers, consortia, and the precollege community in an effort to promote,
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develop, and facilitate educational and research interactions among Argonne and interested institutions, organizations, and agencies. Argonne's Pollution Prevention Program has funded DEP's microscale chemistry program since 1995.

3.2 Chemical Vulnerability Assessment

The WMRC performed chemical vulnerability assessments at each of the participating schools. By observing current practices, the WMRC was able to assess each school's generation, storage, and management of laboratory chemicals and wastes. The WMRC used its Chemical Vulnerability Assessment Report Outline as a guide to performing these assessments (see Attachment 2). The WMRC routinely performs similar assessments at Illinois businesses and institutions as part of its function of assisting Illinois industries, businesses, and citizens to reduce and better manage generated wastes.

3.3 Guidance for Chemical and Waste Management Practices

In response to observations made during the chemical vulnerability assessments, the WMRC provided each participating school with a guidance letter containing information, recommendations, and suggestions to improve the school's chemical management practices. Attachment 3 contains the guidance letters provided to the four participating schools.
### 4.0 Profiles of Participating Schools

#### School A

| General Location:                      | Far Southwest Suburban Chicago Area |
| Public/Private:                        | Public                               |
| Age of School:                         | >70 years                            |
| Enrollment:                            | 900                                  |
| Number of Chemistry Laboratories:      | 2                                    |
| Number of Chemical Storage Areas:      | 1 main, 3 ancillary                  |
| Number of Chemistry Faculty:           | 1.5                                  |
| Number of Chemistry Students (per year):| ~160                                 |
| Number of Chemistry Experiments performed (per year): | ~3,000

**Key Information:** Head of Chemistry Department “inherited” Chemical Inventory in 1982. There has not been any disposal of chemical inventory since that time.

#### School B

| General Location:                      | West Suburban Chicago Area           |
| Public/Private:                        | Public                               |
| Age of School:                         | >70 years                            |
| Enrollment:                            | 6,000                                |
| Number of Chemistry Laboratories:      | 1                                    |
| Number of Chemical Storage Areas:      | 1 large storage room                 |
| Number of Chemistry Faculty:           | 3                                    |
| Number of Chemistry Students (per year):| 350 to 400                          |
| Number of Chemistry Experiments        | ~8,000                               |
| performed (per year):                  |                                      |

#### School C

| General Location:                      | Far South Suburban Chicago Area      |
| Public/Private:                        | Private                              |
| Age of School:                         | 36 years                             |
| Enrollment:                            | 1,200                                |
| Number of Chemistry Laboratories:      | 3                                    |
| Number of Chemical Storage Areas:      | 3 main, 3 ancillary                 |
| Number of Chemistry Faculty:           | 2.5                                  |
| Number of Chemistry Students (per year):| ~390                                |
| Number of Chemistry Experiments        | ~7,000                               |
| performed (per year):                  |                                      |
School D

General Location: Far Southwest Suburban Chicago Area
Public/Private: Public
Age of School: 26
Enrollment: 1,700
Number of Chemistry Laboratories: 2
Number of Chemical Storage Areas: 1
Number of Chemistry Faculty: 2
Number of Chemistry Students (per year): ~250
Number of Chemistry Experiments performed (per year): ~5,000
5.0 Pilot Program Activities

5.1 Microscale Chemistry Training Sessions

The first phase of implementing the Chemical Waste Minimization in the Educational Laboratory Pilot Project was to provide the participating chemistry teachers with the necessary training and tools for successful integration of microscale chemistry techniques and strategies into educational laboratories and secondary school chemistry curricula. Argonne's DEP provided microscale chemistry demonstration training, equipment kits, and corresponding instructional manuals to the four participating high schools. The instructional manuals and equipment kits enabled participants to immediately incorporate laboratory exercises into the school curriculum.

Argonne's DEP provided individual training to the participating Chemistry faculty. The Chemistry faculty from each school ranged from two to four members. The microscale chemistry training/demonstration sessions were two to three hours in length and were held at Argonne, although the training could be performed at individual schools with little difficulty and at a reasonable cost. It is important to note that in the past Argonne's DEP has performed similar Microscale Chemistry training/demonstration sessions for larger groups, ranging from 20 to 50 people, at one central location.

The instruction manuals that are provided to the teachers contain descriptions of each microscale chemistry experiment, a list of required materials, procedures, and necessary guidance, such as hints, concerns, or suggestions on how to teach each experiment. Below is a listing of the experiments provided in the instruction manuals that were demonstrated or reviewed during the training/demonstration sessions.

- Boyles Law
- Charles Law I
- Charles Law II
- Acids and Bases I
- Acids and Bases II
- Copper to 'Silver' to 'Gold'
- Electrolyte or Nonelectrolyte
- Electrolytic Cell
- Redox/Electrochemistry
- Empirical Formulas
- Esters
- Generating Gases
- Heat of Fusion
- Analysis of a Hydrate
- Kinetics
- Column Chromatography
- Microstir Bar
- Solubility of a Salt
- Precipitation Reactions
- Specific Heat of Lead
- Stoichiometry
- Triple Point of Dry Ice
- Analysis of Vinegar
- Titrations for Vitamin C

5.2 Microscale Chemistry Training Session Results
As part of the microscale chemistry demonstration training, the participating teachers were asked to complete an exit survey designed to provide Argonne's DEP with feedback on the quality and content of the training. Attachment 4 contains a copy of the exit survey that was completed by representatives from each of the four schools. Representatives stated that they were very satisfied with the Argonne DEP microscale chemistry demonstration training. As a whole, the four schools found the microscale chemistry demonstration training to be very useful and understandable. All of the schools stated that they have incorporated, and will continue to incorporate, information from the training into course curricula. In addition, all of the schools communicated the importance of the microscale chemistry demonstration training and recommended that Argonne's DEP continue to develop and promote this program. Below are some quotes taken from the surveys:

- "(Argonne's DEP) did a good job! We know you are there if we need you."
- "The information (Argonne's DEP) provided justifies the implementation of microscale techniques."
- "I am incorporating the (microscale) lessons, and I have been able to expand the curriculum."

5.3 Chemical Vulnerability Assessments

The WMRC performed chemical vulnerability assessments at each of the participating schools. By observing current practices, the WMRC was able to assess each school's generation, storage, and management of laboratory chemicals and wastes. The WMRC performed a site visit at each of the participating schools, performing a walk-through of chemistry laboratories and chemical storage facilities. The WMRC used its Chemical Vulnerability Assessment Report Outline as a guide to performing these assessments (see Attachment 2). Each site visit was approximately three to four hours in duration. During the site visits, the WMRC provided each school with verbal recommendations based on site observations. In addition, the WMRC generated a guidance letter to each school, providing written recommendations on the best practices for managing each school's chemical inventory. In all, the WMRC dedicated approximately eight hours of effort to perform the site visit and generate a guidance letter for each school. Attachment 5 provides photographs containing examples of observed conditions at the participating schools. Examples of conditions observed by the WMRC include the following:

- Incompatible groupings of stored chemicals.
- Storage of excessively old or outdated chemicals. All of the participating schools were observed to possess various quantities of outdated chemicals.
- Stockpiled obsolete chemicals awaiting disposal. For example, School C had stored chemical waste but did not possess funding for disposal. The estimated cost for
disposal of the stockpiled chemical waste was $8,000. In addition, School C's "sister school" possessed an equal quantity of chemical waste.

- Insufficient laboratory class space.
- Mercury containing thermometers and stored mercury on shelves.

As part of the vulnerability assessment, the participating teachers were asked to complete a survey that was designed to provide the project team with feedback on the quality and content of WMRC's vulnerability assessment. Attachment 6 contains a copy of the survey that was completed by representatives from each of the four participating schools.

The site visits, coupled with the surveys, provided the project team with a clearer picture of how chemicals and wastes are commonly managed within typical secondary level educational laboratories. The following are some of the major observations made by the project team:

- **Chemical waste generation and disposal is a concern at all of the schools.**

Together, the 4 participating schools perform over 23,000 individual chemistry experiments per year. If each experiment were to generate 50 milliliters (ml) of liquid waste, these 4 schools would generate over 1,150 liters of liquid hazardous waste per year, or over 280 liters per school (per year). Incorporating microscale chemistry into the curriculum can reduce the generation of waste by more than 90%. However, there will always be some waste generated from experiments, in addition to outdated or excess chemicals that will need to be disposed. The WMRC's Chemical Vulnerability Assessments provide the needed information and contacts to assist the participating schools in developing a chemical management and disposal program.

- **Teachers need site specific information and guidance to properly manage chemicals and wastes within the educational laboratory.**

In all cases, the participating schools stated that the WMRC was able to provide them with useful information and/or recommendations relating to the management of laboratory chemicals. All of the participating schools communicated the importance of having an external resource (such as the WMRC) to provide useful chemical management and disposal information (and contacts).

- **Teachers need external assistance in order to make internal change.**

Several participating schools stated that the recommendations and guidance letters provided by the WMRC are an excellent means of communicating chemical management concerns/issues to co-workers and school administration. The teachers are able to use the guidance letters in their efforts for funding/resources to improve chemical management procedures or provide disposal of chemical wastes.
• Funding for chemical waste disposal is not budgeted at many schools.

Of the participating schools, 2 had not disposed of waste chemicals in over 10 years, 1 had not disposed of waste chemicals in 8 years, and the remaining school had not disposed of waste chemicals in 3 years. Hopefully, the WMRC’s Chemical Vulnerability Assessments will assist the participating schools in developing a chemical management and disposal program that can justify requests for future funding and resources.

• Alternative sources of funding for chemical waste disposal must be sought.

Based on observations made during the WMRC’s Chemical Vulnerability Assessments and information provided in the surveys, there appears to be a shortage of funding for the disposal of chemical wastes generated from educational laboratories. Representatives from the participating schools stated that they must maintain collections of chemical wastes due to lack of funds for disposal (see above). The representatives from the participating schools also inquired about the existence of local, regional, state, or federal funding sources, or programs, that can assist in the disposal of educational laboratories chemical wastes.
6.0 Conclusions

6.1 Pilot Project Findings

The goal of the Chemical Waste Minimization in the Educational Laboratory Pilot Project was to demonstrate the importance of integrating WM&P2 techniques and assessment strategies into the functions of the educational laboratory. During the implementation of the Pilot Project, the project team was able to identify three main issues, that if addressed, would lead to reductions in high school chemical waste generation, the minimization of health risks to students and teachers in school laboratories, and safer educational laboratories for both students and teachers. These three main issues are:

1. The generation and accumulation of hazardous wastes within educational laboratories pose significant Environmental, Safety and Health risks within most secondary schools.

   Of the 4 participating schools, 2 had not disposed of waste chemicals in over 10 years, 1 had not disposed of waste chemicals in 8 years, and the remaining school had not disposed of waste chemicals in 3 years. In addition to the existing waste, each school will continue to generate new waste from chemistry experiments performed during the school year. It is believed that this same scenario exists in the majority of secondary schools throughout the country. The implementation of microscale chemistry techniques would significantly reduce the generation of additional hazardous waste within secondary schools.

2. A significant amount of secondary school science teachers were found to have limited knowledge of current chemical and waste material storage, disposal, and minimization requirements and strategies. These teachers would benefit greatly from the expertise and assistance provided from qualified external partners.

   Although some of the school's chemical management procedures were found to be more advanced, all of the chemistry teachers that participated in the pilot project were interested in acquiring chemical and waste material storage/disposal assistance and information. Some were more interested in receiving contacts and information regarding chemical waste disposal, while others were more focused on receiving information on chemical storage and management. In all cases, the WMRC and Argonne National Laboratory were found to be invaluable sources of information, contacts, and resources, that prior to this pilot project, were not easily accessible for the school teachers. The continued implementation of this project will provide greater exposure of much needed chemical material/waste information to secondary school chemistry teachers.
3. Internal and external funding is necessary for schools to adequately reduce existing Environmental, Safety and Health risks caused by the continued generation and accumulation of hazardous wastes within educational laboratories.

All of the schools participating in the pilot program possessed collections of stored chemical wastes. These collections of chemical wastes ranged from 3 years to over 10 years. In addition, none of the schools possessed an established funding mechanism for chemical waste disposal. Three of the four participating school representatives expressed their concern over lack of funding support from their Administration for the disposal of chemical waste. It is believed that this same scenario exists in the majority of secondary schools throughout the country. The representatives were eager to receive any information on possible chemical waste disposal programs or funding sources. The project team was unable to provide the schools with substantive information in this area. However, the Pilot Project was found to provide the schools with the tools (assessments and recommendations) needed to convince their school's administration that it is a priority to routinely address existing chemical material/waste concerns and issues (i.e., disposal).

6.2 Future Implementation

Future implementation is dependent upon availability of funding opportunities locally, regionally, and nationally for the Chemical Waste Minimization in the Educational Laboratory Project activities. The project team would like to continue to expand this project to more schools in the Chicagoland area and beyond. The project team estimates that the cost for implementing the Chemical Waste Minimization in the Educational Laboratory Project within a typical Chicagoland secondary school to be between $1,500 to $2,000. Schools located further away from the Chicagoland area may incur additional costs.

In the future, the project team will continue to promote the use of chemical waste minimization in the educational laboratory through the distribution of this report, and through the continued implementation of project activities by Argonne's DEP and the WMRC (funding dependent). The project team will continue its search for funding opportunities within individual schools, school districts (systems), school boards, and local, county, state, and federal agencies and/or organizations.
Attachment 1

Work Plan
Pilot Project: Chemical Waste Minimization in the Educational Laboratory

Argonne National Laboratory
and
the Illinois Waste Management and Research Center

1 Introduction

The Illinois Waste Management and Research Center (WMRC) and Argonne National Laboratory-East (Argonne) jointly are conducting a pilot project entitled Chemical Waste Minimization in the Educational Laboratory. This pilot project is a partnership between a state agency, WMRC, and a federal research facility, Argonne National Laboratory-East.

WMRC, which is headquartered on the University of Illinois Urbana-Champaign campus, is a division of the Office of Scientific Research and Analysis in the Illinois Department of Natural Resources. WMRC helps Illinois industries, businesses, and citizens to reduce and better manage generated solid and hazardous wastes released to air, water, or land.

Argonne is one of the U.S. government's oldest and largest science and engineering research laboratories. For the past half-century, the University of Chicago has administered the operation of Argonne for the U.S. Department of Energy (DOE) and its predecessor agencies.

Argonne has four major mission areas, each of which fulfills important governmental and DOE responsibilities, as well as providing important benefits to society at large:

- Conduct of basic scientific research to further our understanding of the world we live in,
- Operation of national scientific facilities to help advance America's scientific leadership,
- Enhancement of the nation's energy resources to ensure America's energy future, and
- Development of better ways to manage environmental problems.

2 Purpose

The purpose of the Chemical Waste Minimization in the Educational Laboratory Pilot Project is to promote the integration of waste minimization and pollution prevention (WM&P2) strategies within secondary schools by presenting microscale chemistry lectures and demonstrations to high school chemistry teachers and by performing chemical vulnerability assessments within high school chemistry laboratories. In addition, this pilot project will provide technical guidance that focuses on site-specific issues and concerns involving the use, management, storage, and disposal of chemicals within the participating school’s educational laboratories.
This pilot program will be implemented in five secondary schools located in the Chicago area. The five schools will be asked to voluntarily participate in the pilot project.

The integration of WM&P2 techniques and assessment strategies into the functions of the educational laboratory could provide the following benefits to participating schools:

- Reduction of high school chemical waste generation;
- Minimization of health risks to students and teachers in the school laboratories;
- Safer educational laboratories for both students and teachers;
- Continuance of schools' hands-on laboratory experiences for students, a practice that has been threatened by the increasing cost and difficulty of waste disposal; and
- Student knowledge of minimization techniques that they will practice throughout their lives.

3 Pilot Project Description

The Chemical Waste Minimization in the Educational Laboratory Pilot Program consists of the following three components:

1. Microscale Chemistry Training - Provide teachers with the necessary training and tools for successful integration of microscale chemistry techniques and strategies into educational laboratories and secondary school chemistry curricula.

   NOTE: Microscale chemistry is a teaching methodology wherein laboratory chemistry training is provided to students while utilizing very small amounts of reagents and correspondingly small instruments. The use of microscale techniques would enable a school to reduce significantly the cost of reagents, the cost of waste disposal, and the dangers associated with the manipulation of chemicals. The cost reductions would be achieved while still providing students with the hands-on laboratory experience that is vital to those who might choose to pursue careers in the sciences. A typical microscale experiment consumes 1% of the quantity of reagent used in the corresponding traditional macroscopic experiment. The fire hazards are greatly diminished, exposure to vapors is reduced, and the quality of laboratory air is improved. The smaller instruments that are used in a microscale chemistry laboratory are less prone to breakage, and should breakage occur, the safety hazard is considerably less. Microscale laboratories are much easier to assemble and take less time to run than their macroscale counterparts, which would allow for better time management in the high school science curriculum. Many universities and colleges have already begun to switch from macroscale to microscale chemistry in their educational laboratories. The introduction of these techniques at the secondary education level would lead to freshman being better prepared for the type of experimentation that they will encounter in college.

2. Chemical Vulnerability Assessment - Perform a chemical vulnerability assessment at each participating school and develop a report that contains findings, recommendations, and
guidance regarding the generation, storage, and management of laboratory chemicals and wastes at each school.

3. Chemical Waste Options and Guidance - Provide each participating school with a list that includes the types and quantities of chemical wastes recommended for disposal and the options and estimated costs for disposing of these wastes.

Argonne’s Department of Educational Programs (DEP) and its Pollution Prevention Program will present microscale chemistry lectures and demonstrations and provide equipment kits, instructional manuals, and other supplies for participating schools. Argonne has conducted similar workshops for over 300 high school teachers in the Chicago area since 1995.

Argonne’s DEP serves as the interface among DOE, Argonne, and the academic community. The DEP collaborates with universities, colleges, technical institutes, informal educational centers, consortia, and the precollege community in an effort to promote, develop, and facilitate educational and research interactions among Argonne and interested institutions, organizations, and agencies. Argonne’s Pollution Prevention Program has funded DEP’s microscale chemistry program since 1995.

WMRC will conduct a chemical vulnerability assessment at each of the participating schools. WMRC routinely performs similar assessments at Illinois businesses and institutions as part of its function of assisting Illinois industries, businesses, and citizens to reduce and better manage generated wastes.

4 Program Administration (Argonne - Pollution Prevention Program)

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4.1 Pilot Project Development
4.2 Record Keeping and Documentation
4.3 Public Relations
4.4 Development of Funding Resources
4.5 Project Management
4.6 Coordination of Formal Correspondence with Participating Schools
5 Microscale Chemistry Lectures and Demonstrations (Argonne - DEP)

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5.1 Provide appropriately trained personnel to present microscale chemistry lectures and demonstrations at the five designated pilot program high schools in the Chicago area.

5.2 Provide microscale chemistry equipment kits, corresponding instructional manuals, and any other supplies at the five designated pilot program high schools in the Chicago area. The instructional manuals and equipment kits will enable participants to immediately incorporate lab exercises into the school curriculum.

5.3 Maintain documentation of microchemistry lectures and demonstrations at the five designated pilot program high schools. This documentation should include the name and address of each participating school, the number of participants at each school, the names and positions of participants, the number of students enrolled in chemistry classes, and feedback from participants.

6 Chemical Vulnerability Assessments (WMRC)

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Oak Brook, IL 60523  
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6.1 Provide appropriately trained personnel to conduct chemical vulnerability assessments at the five designated pilot program high schools in the Chicago area.

6.2 The chemical vulnerability assessments should include a review of the following: existing waste generating practices; pollution prevention opportunities; existing waste materials; and current practices and activities related to chemical waste generation, storage, and disposal.

Att 1-5
6.3 A Chemical Vulnerability Assessment Report will be prepared for each of the five designated pilot program high schools. These reports (see the attached outline) will contain the following: a description of observed conditions; recommendations for addressing identified chemical waste generation, storage, or disposal concerns; and cost estimates for the packaging and disposal of identified chemical waste materials.

6.4 The Chemical Vulnerability Assessment Reports will be submitted to the Argonne Project Manager for review no later that two weeks following the assessment. (The Argonne Project Manager will formally provide the Chemical Vulnerability Assessment Report to each of the five designated pilot program high schools.)

7 Project Closeout (Argonne and WMRC)

7.1 Argonne and WMRC will provide guidance to the five designated pilot program high schools in addressing concerns or issues identified during workshops and/or assessments. This guidance will primarily involve providing information and access to resources relating to the proper use, storage, and disposal of chemicals in an educational laboratory.

7.2 Argonne's Project Manager will develop a Chemical Waste Minimization in the Educational Laboratory Pilot Project Final Report. This final report will document the findings from all five designated pilot program high schools. The information gathered during the microscale chemistry lectures and demonstrations and the chemical vulnerability assessments will be incorporated into the final report.
Illinois Waste Management and Research Center
CHEMICAL VULNERABILITY ASSESSMENT REPORT OUTLINE

I. General Information
   A. School name:
   B. Address:
   C. Phone:
   D. Fax:
   E. Contact person:
   F. County Board District:
   G. School District:
   H. WMRC participants in assessment:

II. General School Description
   A. Types of laboratory(s)
   B. Support facilities (maintenance, chemical suppliers, chemical disposal)
   C. Receiving and storage areas
   D. Physical layout - provide diagram if possible
   E. Laboratory operating schedule (class schedules, sizes, etc.)

III. School Management Structure
   A. Private or Public
   B. Grade Levels

IV. Current Environmental/P2 Programs in place
   A. Policy Statement(s)/level of commitment
   B. Program components
   C. Designated participants (teams?)
   D. Faculty involvement
   E. Training programs
   F. Hazards communication
   G. Opportunity identification process
   H. Current successes - what activities have been conducted

V. Waste Description
   A. Type, origin, and quantity of all waste streams
      1. What makes hazardous wastes hazardous
      2. What causes materials to transform from a useful state to a waste
   B. Waste collection and handling procedures
   C. Waste tracking procedures
   D. Relationship between wastes and classes
   E. Efforts to separate/avoid mixing of wastes

Att 2-1
F. Waste treatment procedures
   1. equipment and materials
   2. treatment costs

G. Explanation of waste handling accounting procedures

H. Off-site waste transportation and disposal arrangements
   1. performed by?
   2. shipped where?
   3. qualifications of contractors/vendors

I. Waste storage procedures

J. Records handling of waste related information
   1. Manifests or documentation

VI. Pollution Prevention Opportunities

A. Laboratory Information
   1. Description
   2. Quality requirements
   3. Raw materials usage for each class (types, quantities, purities)
   4. Equipment used in each class
   5. Labor requirements including maintenance and clean-up
   6. Solid waste generation including off-spec product, scrap material, packaging,
      trash, etc.

B. Laboratory teaching information
   1. Class schedules
   2. Operating procedures - including waste handling
   3. Chemical inventory information (including ordering procedures, shelf-life of
      material)
   4. Chemical usage - lab. analysis, cleaners, etc.
   5. MSDS's for materials used

C. Maintenance/Housekeeping
   1. Facility maintenance schedule
   2. Maintenance products - cleaners, etc.
   3. MSDS's for maintenance products
   4. Labeling of chemicals

D. Economic information
   1. Chemical, utility, water, sewer, and disposal costs
   2. Laboratory teaching and maintenance costs
   3. Waste disposal costs-how are waste costs accounted for?

E. Purchasing strategy
   1. Quantity requested, Quantity purchase
   2. Inventoried package sizes

F. Inventory control
   1. Kinds of chemicals
   2. Quantities
   3. Location
   4. Status

Att 2-2
VII. Current Pollution Prevention/Waste Minimization Activities
   A. Source Reduction (material substitution or reduction)
   B. Raw material and/or product re-use or in-lab recycling (solvent distillation)
   C. Off-site recycling
   D. Recycling programs for non-hazardous waste (on and off-site)
   E. Equipment/technique modification or substitution
   F. New technology development
   G. Faculty awareness and training/participation
   H. Pollution Prevention Program or Comprehensive Chemical Management System
   I. Other

VIII. Barriers to Pollution Prevention Activities
   A. Economic
   B. Technical
   C. Regulatory
   D. Research needs

IX. Identify current needs and/or problem areas
   A. Testing of innovative technology/technique
   B. Pollution prevention training
   C. Identification of opportunities
   D. School policy/management commitment
   E. Faculty involvement
   F. Specific waste problems
   G. Establishing priorities for pollution prevention/waste reduction

Att 2-3
Sir/Madam,

Michael Springman and I would like to thank you for your cooperation in reviewing High School A’s chemical management practices. We are part of the Illinois Waste Management and Research Center (WMRC), a Division of the Illinois Department of Natural Resources, and are working with high schools in evaluating school inventory and storage practices. The cleanliness and neatness of both the storage room, storage cabinets, and the classroom were very impressive. The enthusiastic responses to our questions and suggestions gave us a good feeling that our suggestions would be given considerable thought.

During our visit, we made several observations about the chemicals on hand, the quantities stocked, and the method of storage. Some recommendations are presented below.

a. Bottles with small quantities of like chemicals or materials should be consolidated into one container or bottle. We recommend combining the contents of like chemicals into one container and discarding the empty bottles.

b. We recommend color coding your storage shelves, segregating chemicals (organic, inorganic), and storing the chemicals according to the storage patterns and compatibility groups identified in “School Science Laboratories a Guide to Some Hazardous Substances,” U.S. Consumer Product Safety Commission, 1984. We left two copies of this document. You are free to copy the document or parts of it for your use.
c. Incompatible chemicals should not be stored next to each other. We recommend reviewing the compatibility charts in the literature that we left, ("School Science Laboratories a Guide to Some Hazardous Substances"), to ensure that incompatible groups are not stored with each other. We also recommend that nitric acid be stored in an enclosure by itself.

d. Some old or outdated chemicals were observed on the storage shelves. We recommend reviewing lesson plans for the past three years to identify those chemicals that are used for instructional purposes. Those chemicals that are not used should be packaged according to compatibility codes. Keep the boxed chemicals for a year. If they are not used in the year time frame, dispose of them properly. It is a good idea to post an inventory of content on the outside of each box.

e. During the visit, we discussed disposal options for mercury (Hg). One local company that accepts mercury is:

   D.F. Goldsmiths
   909 Pitner Avenue
   Evanston, IL 60202-1550
   voice: (847) 869-7800       fax: (847) 869-2531

Please contact them for particulars for disposing of the mercury. With the small quantity you have, we may be able to transport the Hg to Evanston for you.

f. Flammable materials should be stored in flammable materials storage cabinets. We recommend storing all flammable materials in the flammable material’s cabinet when not in use. We also recommend combining the contents of small containers into one larger container.

If you have any questions or if we can be of assistance, please feel free to contact myself at (630) 472-5028 or Michael Springman at (217) 761-3632.

Sincerely,

Malcolm Boyle
Manager, WMRC Oak Brook Office
June 11, 1999

Chemistry Department Representative
High School B

Sir/Madam,

Michael Springman and I would like to thank you for your cooperation in reviewing High School B's chemical management practices. We are part of the Illinois Waste Management and Research Center (WMRC), a Division of the Illinois Department of Natural Resources, and are working with high schools in evaluating school inventory and storage practices. The cleanliness, organization, and neatness of both the storage room, storage cabinets, and the classroom were very impressive. The best we have seen for a high school. The enthusiastic responses to our questions and suggestions were very encouraging.

During our visit, we made several observations about the chemicals on hand, the quantities stocked, and the method of storage. You have already inventoried, segregated, labeled, and stored the chemicals as recommended by Flinn (for reference see “School Science Laboratories a Guide to Some Hazardous Substances,” U.S. Consumer Product Safety Commission, 1984). This is a major step in maintaining a safe laboratory and you should be commended for your efforts.

Some recommendations are presented below.

a. Enclosed is a copy of the State of Illinois Industrial Material Exchange Service. They may be of assistance in getting rid of your no longer used chemicals.

b. Enclosed is a copy of Bowling Green State University Orphan Chemical List and Information. This program is a clearinghouse for chemicals. If you need any of the chemicals, contact Dave Heinlen (419) 372-2173. Like you, these are schools with chemicals which they no longer use, but would like to give to someone who can use
them. There may be a transportation charge, but you would have to contact them to find out.

c. Definitely contact your State representatives and Tom Skinner at the Illinois Environmental Protection Agency (IEPA) to let them know that some type of assistance is needed by the high schools of Illinois for the safe disposal and management of chemicals.

d. Bottles with small quantities of like chemicals or materials should be consolidated into one container or bottle. We recommend combining the contents of like chemicals into one container and discarding the empty bottles.

e. If you want to dispose of mercury (Hg), one local company that accepts mercury is:

D.F. Goldsmiths
909 Pitner Avenue
Evanston, IL 60202-1550
voice: (847) 869-7800 fax: (847) 869-2531

Please contact them for particulars for disposing of the mercury. With the small quantity you have, we may be able to transport the Hg to Evanston for you, if disposal is needed.

If you have any questions or if we can be of assistance, please feel free to contact Michael Springman at (217) 761-3632 or I at (630) 472-5028.

Sincerely,

Malcolm Boyle
Manager, WMRC Oak Brook Office

*Att 3-4*
Sir/Madam,

I would like to thank you for your cooperation in reviewing High School C’s chemical management practices. We are part of the Illinois Waste Management and Research Center (WMRC), a Division of the Illinois Department of Natural Resources, and are working with high schools in evaluating school inventory and storage practices. The overall laboratory management is very good. The enthusiastic responses to my questions and suggestions show a commitment to making your facility a safe environment for students and faculty.

During our visit, I made several observations about the chemicals on hand, the quantities stocked, and the method of storage. You should continue to inventory, segregate, label, and store the chemicals as recommended by Flinn (for reference see the document I supplied: "School Science Laboratories a Guide to Some Hazardous Substances," U.S. Consumer Product Safety Commission, 1984). This is a major step in maintaining a safe laboratory and you should be commended for your efforts.

Some recommendations are presented below.

a. Enclosed is a copy of the State of Illinois Industrial Material Exchange Service. They may be of assistance in getting rid of your no longer used chemicals.

b. Definitely contact your State representatives and Tom Skinner at the Illinois Environmental Protection Agency (IEPA) to let them know that some type of assistance is needed by the high schools of Illinois for the safe disposal and management of chemicals.

c. I will inform you when, and if, the Illinois Environmental Protection Agency (IEPA)

July 19, 1999

Chemistry Department Representative
High School C
starts a program to take back mercury containing thermometers. If you want to
dispose of mercury (Hg), one local company that accepts mercury is (but it has to be
free, elemental mercury and has to be delivered to the company):

D.F. Goldsmiths
909 Pitner Avenue
Evanston, IL 60202-1550
voice: (847) 869-7800 fax: (847) 869-2531

Contact them for particulars.

d. Some safety issues should be evaluated, they are the size of the labs (number of
students), lab furniture, and the adequacy of safety showers.

Size of Labs: The labs are small and crowded, I would recommend that student
enrollment be limited to 30 or less students. This would facilitate an evacuation in
case of an emergency.

Lab. Furniture: The counter surfaces and counters look to be well worn. The
possibility of upgrading or refurbishing the lab. furniture should be evaluated. This
may also make the lab. easier to evacuate in case of an emergency.

Safety Showers: The present safety showers in the labs. should be evaluated for
adequacy. If they are not adequate for use in an emergency, they should be upgraded
or replaced. There are specific requirements for industrial safety showers and required
monthly testing. If you need more information on safety showers, let me know.

If you have any questions or if I can be of assistance, please feel free to contact me at
(630) 472-5028.

Sincerely,

Malcolm Boyle
Manager, WMRC Oak Brook Office
September 1, 1999

Chemistry Department Representative
High School D

Sir/Madam,

I would like to thank you both for your cooperation in reviewing High School D’s chemical management practices. I am part of the Illinois Waste Management and Research Center (WMRC), a Division of the Illinois Department of Natural Resources, and work with high schools in evaluating school inventory and storage practices. The overall laboratory chemical management is very good. The enthusiastic responses to my questions and suggestions show a commitment to making your facility a safe environment for students and faculty.

During my visit, I made several observations about the chemicals on hand, the quantities stocked, and the method of storage. You should continue to inventory, segregate, label, and store the chemicals as recommended by Flinn (for reference see the document I supplied: “School Science Laboratories a Guide to Some Hazardous Substances,” U.S. Consumer Product Safety Commission, 1984). Your efforts are a major step in maintaining a safe laboratory and both of you should be commended for these efforts. Some recommendations are presented below.

a. Definitely contact your State representatives and Tom Skinner at the Illinois Environmental Protection Agency (IEPA) to let them know that some type of assistance is needed by the high schools of Illinois for the safe disposal and management of chemicals.

b. An alternative to mercury containing thermometers are alcohol containing thermometers. These may be a suitable replacement for mercury containing thermometers in laboratory experiments. I will inform you when, and if, the Illinois Environmental Protection Agency (IEPA) starts a program to take back mercury
containing thermometers. If you want to dispose of mercury (Hg), one local company that accepts mercury is (but it has to be free, elemental mercury and has to be delivered to the company):

D.F. Goldsmiths  
909 Pitner Avenue  
Evanston, IL 60202-1550  
voice: (847) 869-7800  
fax: (847) 869-2531

c. The present chemical storage area does not have sufficient ventilation. There needs to be a supply of outside air to the storage area and an exhaust of the storage room air to the outside. OSHA recommends a complete room air change out six times per hour. Egress from the present chemical storage room may not be sufficient.

d. The budget for procuring chemicals should also contain an appropriation for the disposal of outdated or waste chemicals. The chemicals not used for a three-year period should be disposed of.

e. A central location should be provided for the display of Material Safety Data Sheets (MSDSs) by anyone using the chemicals.

f. Some literature and references are included to assist in the design of the new laboratory facility.

Literature:
- “Article 2: Thermometers –What’s Hot and What’s Not”
- “OSHA Regulations: 29 CFR 1910.106 (d)”
- “Prudent Practices in the Laboratory: Handling and Disposal of Chemicals”
- “Laboratory Inspection Form Guidelines”
- “Laboratory Design Guidelines”
- “Fume Hoods”
- “Emergency Eyewash and Shower Equipment”

References:

The new storage area should be designed to allow for:

- segregation of chemicals to reduce accidental combination of incompatible
Final Report

chemicals
• proper ventilation, at least six room air changes per hour
• fume hood for solution preparations
• proper grounding of chemical storage cabinets to reduce potential spark sources
• fire extinguishers at appropriate locations
• egress out of the area in case of an emergency
• storage shelving with lips or raised edges to reduce the chance of bottles sliding over the edge off of the shelf
• the storage room should be liquid tight where the walls meet the floor
• solid chemical storage
• liquid chemical storage
• laboratory equipment storage
• proper gas cylinder storage and restraints (if applicable)
• waste collection and storage
• broken glassware collection
• chemical preparation area, in the chemical storage room or in close proximity, to reduce transporting chemicals through classrooms
• spill kits and absorbents for emergency spill clean up
• eyewash and emergency shower facilities
• first aid stations
• appropriate lighting
• MSDS central library and display

These are some of the issues which should be considered in the design of the new laboratory and classroom facility. If you have any questions or if I can be of assistance, please feel free to contact me at (630) 472-5028.

Sincerely,

Malcolm Boyle
Manager, WMRC Oak Brook Office
Exit Survey

Microscale Chemistry for High School Teachers
A Hands-On Workshop
1999

Name (optional) ________________________________

I. Overall - As a result of your experience at Argonne, please respond to the following questions. Circle the number that best reflects your opinion.

<table>
<thead>
<tr>
<th>To what extent:</th>
<th>Great Extent</th>
<th>Large Extent</th>
<th>Little Extent</th>
<th>Some Extent</th>
<th>Not At All</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. did you gain further theoretical knowledge through this workshop?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>b. did you gain the further practical experience that you desired from this workshop?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>c. have you had prior interactions with Argonne staff members?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>d. do you expect to have further interactions with Argonne?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>e. do you intend to incorporate materials or information acquired at the workshop in your course curricula?</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

II. Please rate each of the following sessions as to how useful the activity was to you in terms of incorporating what was learned into your classroom and how well you understood what occurred during the activity.

a. Charles's Law

<table>
<thead>
<tr>
<th>Activity</th>
<th>Very useful</th>
<th>Understandable</th>
<th>Not useful</th>
<th>Not understandable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charles's Law</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Boyle's Law

<table>
<thead>
<tr>
<th>Activity</th>
<th>Very useful</th>
<th>Understandable</th>
<th>Not useful</th>
<th>Not understandable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boyle's Law</td>
<td>5 4 3 2 1</td>
<td>5 4 3 2 1</td>
<td></td>
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</tr>
<tr>
<td>c. Stoichiometry</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>d. Analysis of a Hydrate</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Empirical Formulas</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
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<tr>
<td>f. Redox/Electrochemistry</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
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<tr>
<td>g. Electrolytic Cell</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
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<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
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</tr>
<tr>
<td>h. Vitamin C Analysis</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
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</tr>
<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>i. Triple Point of Dry Ice</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td>Understandable</td>
<td>5</td>
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<tr>
<td></td>
<td>Not Applicable</td>
<td></td>
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</tr>
<tr>
<td>j. Heat of Fusion</td>
<td>Very useful</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Understandable</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Not Applicable</td>
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</tbody>
</table>

**k. Copper to Silver to Gold**

<table>
<thead>
<tr>
<th>Very useful</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Not useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>Not understandable</td>
</tr>
<tr>
<td>Not Applicable</td>
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</tbody>
</table>

**l. Generating Gases in Microscale**

<table>
<thead>
<tr>
<th>Very useful</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Not useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandable</td>
<td>5</td>
<td>4</td>
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</tbody>
</table>

**m. Solubility of a Salt**

<table>
<thead>
<tr>
<th>Very useful</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Not useful</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understandable</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>Not understandable</td>
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<tr>
<td>Not Applicable</td>
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</tr>
</tbody>
</table>

III. Argonne is committed to making this program a success and to that end we want to assist you in whatever way you think necessary to implement this program in your school.

a. What do you see are the barriers to implementation in your school?

b. Should we conduct a special seminar for administration or school board members?
c. What assistance would you like Argonne to provide you in order to implement this program?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

IV. If offered in the future, how might this workshop or others we organize be improved?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

V. Please indicate how you think you could incorporate what you learned at the workshop in the courses you teach.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
VI. Do you feel it is important for Argonne to continue having workshops such as the one you attended?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

VII. Are there any other topics you would like to suggest for future workshops?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Attachment 5

Click to view photographs containing examples of observed conditions at participating schools.
Chemical Waste Minimization in the Educational Laboratory Pilot Project
Chemical Management Assessment Survey Form

*The names of specific schools and teachers will remain confidential and will not be used in the Pilot Program final report.*

*Name of School:*

*Name of Teacher:*

Date:

1. On a scale from 1 to 10 (10 being the highest level of satisfaction), please rate your level of satisfaction with the Waste Management & Research Center (WMRC) Chemical Management Assessment performed at your school.

2. Did WMRC personnel provide you with useful information?
   - Yes  
   - No

3. Did WMRC personnel accurately identify potential hazards and issues in the school's chemical storage areas?
   - Yes  
   - No

4. Did WMRC personnel provide you with useful information, recommendations or suggestions relating to your schools chemical management practices?
   - Yes  
   - No

*Att 6-1*
5. Please provide examples of information, recommendations, or suggestions received from the WMRC, that have been incorporated into your school's chemical management program.

6. Of the chemicals that are currently being stored at the school, what percentage do you estimate to be obsolete or waste?

7. Please quantify the amount of chemicals that are currently being stored at the school that you estimate to be obsolete or waste? (i.e., # of bottles, boxes, shelves, pounds, liters, etc.)

8. Please estimate the number of years since your school has formally identified and disposed of obsolete or waste chemicals.
9. Does your school's Administration provide funding for the identification and disposal of obsolete or waste chemicals?

   Yes               No

   If yes, how much funding has been set aside this school year for the identification and disposal of obsolete or waste chemicals?

10. Do you have any recommendations to improve the chemical management assessment?

11. Please provide any additional comments or questions.

Fax completed form to Keith Trychta at 630-252-3153, or return via email at ktychta@anl.gov.
The Photographs below show examples of general conditions observed within participating schools during the implementation of the Chemical Waste Minimization in the Educational Laboratory Pilot Project.