Chemical Management in Schools

Solutions for Healthy School Environments

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Introduction

Protecting Michigan's environment through pollution prevention (P2) is a key element in preserving Michigan's natural resources for future generations. The state's P2 programs are administered by the Michigan Department of Environmental Quality (MDEQ) and a variety of areas are addressed in these programs.

The **Michigan Healthy Schools** initiative addresses waste reduction of school chemicals by not only cleaning out excess, legacy, unused, and improperly stored chemicals, but also by going a step further and implementing mechanisms in schools for minimizing the use of toxic chemicals and reducing accumulation of chemicals in the future. The School Chemical Grants Program funded schools to implement P2 projects that reduced chemical usage and encouraged proper chemical disposal and clean-up on school campuses. This training package was developed by Grand Valley State University through its MDEQ grant.

The **Chemical Management in Schools** training package includes this publication and a CD. The CD offers a compilation of resources from a variety of places such as the Michigan Department of Environmental Quality, other state programs, and federal agencies. It is the hope of the project team that these materials will be used to develop a chemical management system for your school or district.

The workbook leads you through:

- Chemicals in schools
- How to get started developing a chemical management system
- Assessment of current chemical management systems and conditions
- Chemical inventory procedures
- Chemical disposal considerations
- Design and implementation of a chemical management system

There are many tables in this publication that can be used to guide your efforts. Also, the CD has an array of resources relating to chemical management in schools.

What is the problem?

Help is needed for chemical management in schools!

Chemistry lesson one: Accidents happen, like the recent spill, when fumes in a lab class sent three students to the hospital and shut down the school for the day.

Chemistry lesson two: Adding unknowns to the mix – like improper storage and handling of toxic substances – can be a formula for disaster.

Firefighters responding to an alarm triggered by a chemistry experiment at a high school found a jar containing a potentially volatile material that is used to produce rocket fuel. Deemed unstable, the chemical – 2, 4-dinitrophenol – was detonated by the State Police Bomb Squad.

Chemicals that were 20 years old were found during a cleanup at another high school. 30-year-old species were discovered, preserved in large amounts of formaldehyde. Chemicals dating to the Depression were found at a high school.

While schools have long been aware of the dangers of working with chemicals such as 2, 4-dinitrophenol and mercury, these incidents show how easy it is to lose track of laboratory materials, sometimes decades old, according to area science teachers. Past practices, such as ordering chemical substances in bulk and keeping them in separate storage closets, fostered a system that sometimes allowed schools to become unwitting harborers of hidden hazards.

Old substances in science labs often aren't found until teachers do major cleanups, such as after the departure of a longtime teacher, or when school supplies have to be moved. Compounding the problem is a lack of guidelines from the state Department of Education instructing public schools on how to store and dispose of chemicals and how often to take inventory, according to science teachers.

Source: Boston Globe, April 10, 2005

A True Story

It is 1971 and a young teacher was informed in August that she was going to get a job teaching chemistry at a high school. The chemistry teacher had left suddenly and the principal was eager to fill the position.

The new teacher had only two college courses in chemistry, but she was up for the challenge thanks to an outstanding teacher's guide for the course.

The school was a typical suburban school built in the 1960s. She inherited a stock room full of chemicals all organized in alphabetical order. Among the chemicals was a pint of mercury – great for demonstrations according to her peers. There was a container of asbestos, but watch out – it flies out when the lid is opened. There were numerous organic solvents including benzene and carbon tetrachloride. Both were used in experiments in the laboratory manual. Heavy metal and cyanide compounds were part of the inventory as was a bottle of bromine.

In the mid 80s, the high school was invited by a local company to come and take some chemicals for free. What a bonanza! There were solvents, nickel compounds, chromates, and many more. Boxes of these chemicals ended up in a storage room in another part of the high school. Little did the teachers know that these chemicals were being "dumped" prior to the implementation of the federal hazardous waste management rules.

These and many other legacy problems continue to plague schools today. The morale of the story is that schools need to implement proactive and dynamic chemical management programs.

Elements of Chemical Management

"Science laboratories across the country use and store dangerous chemicals that are potentially hazardous to teachers and students. Many of these chemicals have been unused and stored on shelves and in cabinets for decades. New instructors inherit unfamiliar chemicals stored in original bottles or containers with faded and torn labels. Some containers are corroding and leaking not only due to age, but also due to improper storage practices (i.e., a reaction occurs between incompatible chemicals located next to each other because they were stored alphabetically). Some containers are broken. Some have crystals forming around them. Deteriorating metal clips or dried-out plastic clips that support chemical shelving add to these chemical management problems." (Rehab the Kansas Lab, 2005).

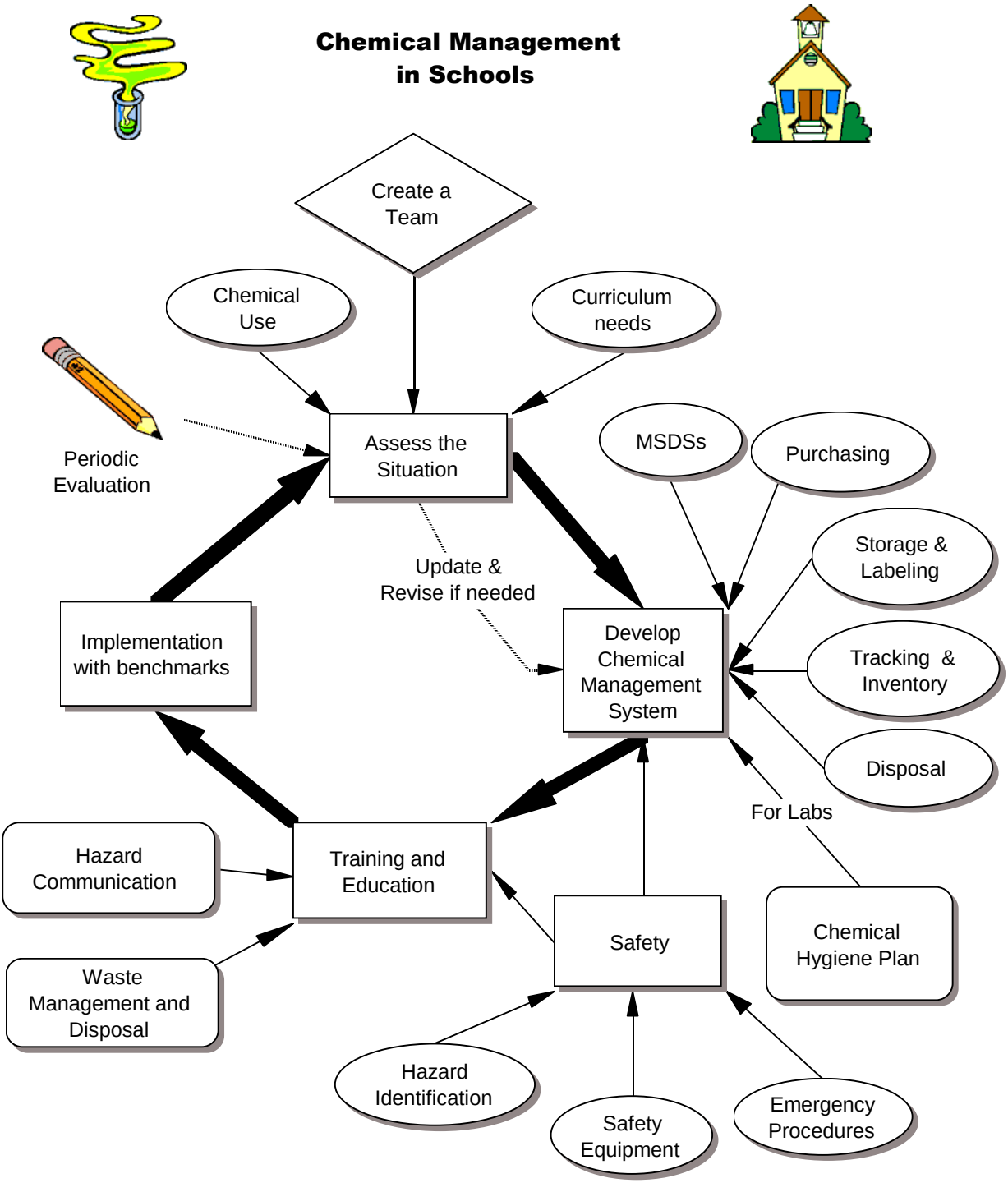
Is your school like this? Are there other chemical management issues in your school involving areas other than science labs? Chemical management has a broad scope and it should be a school or district-wide effort. It involves creating a system that tracks chemicals from purchase to disposal (Figure 1). Continuous improvement, as well as benchmarking to track progress, should be chemical management goals.

There are many components involved in chemical management. Some elements include:

- A chemical management team
- Assessment of current chemical management programs and conditions
- Chemical management system development

  - Curriculum adjustments
  - Chemical inventories
  - Chemical cleanout and disposal
  - Proper labeling, storage, and handling
  - Purchasing guidelines
  - Chemical safety
  - Training and education
- Implementation and periodic update

Figure 1
The big picture of chemical management



Chemicals in Schools

Chemicals in school are found in a variety of places (Table 1). You may have a whole shelf of chemicals but little idea about the properties of these chemicals. There may be no indication of how long the chemicals have been there. A spill happens – how should you clean it up? A student gets exposed to a chemical, what do you do? Do you know how hazardous the chemical may be?

On your Chemical Management in Schools CD, there are lists of hazardous chemicals and the NIOSH Pocket Guide to Chemical Hazards.

ToxTown
An interactive introduction to toxic chemicals and environmental health risks you might encounter in everyday life, in everyday places.
http://toxtown.nlm.nih.gov/

What is a Hazardous Chemical?

A hazardous chemical is defined by Michigan Occupational Safety and Health Administration (MIOSHA) as any chemical, chemical compound, or mixture of compounds which is a physical and/or health hazard.

A chemical is a physical hazard by MIOSHA definition if there is scientifically valid evidence that it is:

- A flammable or combustible liquid
- An explosive
- A pyrophoric (igniting spontaneously in air)
- An oxidizer
- An unstable material (reactive)
- A water reactive material
- An organic peroxide
- A compressed gas

A chemical is a health hazard by MIOSHA definition if there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Included are:

- Agents, which damage the lungs, skin, eye or mucous membranes
- Allergens
- Carcinogens
- Corrosives
- Embryotoxicants
- Hematopoietic system agents (blood)
- Hepatoxins (liver)
- Irritants
- Nephrotoxins (kidneys)
- Neurotoxins (nervous system)
- Reproductive toxicants
- Sensitizers
- Toxic or highly toxic agents

Routes of exposure include dermal, inhalation, and ingestion. The dose makes the poison! **Acute toxicity** is a large dose all at once. **Chronic toxicity** is a lower dose over time.

Table 1
Chemicals in Schools

Location	Product Type	Hazardous Ingredient Examples
Science Laboratories	Concentrated acids (undiluted)	Hydrochloric acid, Sulfuric acid Nitric acid, Acetic acid
	Concentrated bases (undiluted)	Sodium hydroxide, Ammonium hydroxide
	Solvents	Methanol Methylene chloride
	Oxidizers	Lead nitrate, peroxides
	Compressed gases	Oxygen
	Toxics	Cyanides Chromates (VI) Lead salts Mercury salts
Vocational and Trade Shops	Solvents (used in paints, paint thinners, lacquers, primers, and other products)	Petroleum naphtha, Xylene Turpentine, Toluene
	Cleaning Supplies/detergents	Phosphoric acid Sodium silicate
	Compressed gases	Acetylene Nitrogen
	Fuels, transmission, and brake fluids	Antifreeze, Acetone Gasoline
Visual and Performing Art Studio	Solvents (used in paints, thinners, adhesives, lacquers, primers, and other products)	Toluene Mineral spirits
	Pottery clear coating glaze	Lead Other heavy metals
	Pigments for paints and coatings	Cadmium Manganese Chromium
	Dry clay for ceramics and jewelry	Silica
	Acids for etching	Nitric acid Hydrochloric acid
Custodial/ Maintenance Areas	Cleaning supplies/detergents	2-Butoxyethanol Trisodium phosphate
	Drain cleaners (alkaline)	Potassium hydroxide
	Drain cleaners (acidic)	Sulfuric acid
	Pesticides (including disinfectants/sterilizers)	Permethrin Sodium hypochlorite
	Solvents (used in paints, thinners, adhesives, Lacquers, primers, and other products)	Toluene, Mineral spirits, Xylene
	Water treatment chemicals for swimming pools	Chlorine tablets

Location	Product Type	Hazardous Ingredient Examples
Kitchens/ Cafeterias	Pesticides (including disinfectants/sterilizers)	Permethrin Trisodium phosphate
	Refrigerants	CFCs Ammonia
	Cleaning supplies/detergents	Ammonium hydroxide
Nurses Office	Medical Equipment	Mercury thermometers and blood pressure manometers
Photography Laboratories	Intensifiers/reducers	Potassium dichromate Hydrochloric acid
	Developers	Hydroquinone Lactic acid
	Stop baths and fixer	Acetic acid Chrome alum (potassium chromium sulfate)
School Grounds/ Athletic Fields	Pesticides	2,4-D
	De-icers	Sodium chloride
	Fertilizers	Ammonium nitrate
Administrative Offices	Correction fluid	Ethylene glycol Trichloroethane
	Solvents (used in paints, paint thinners, lacquers, primers, and other products)	Methyl ethyl ketone Petroleum distillates
	Printer/copier toners	Carbon black

Source: Chemical Management Resource Guide for School Administrators (2006)

Material Safety Data Sheet (MSDS)

Material Safety Data Sheets (MSDS) contain the important information you need about hazardous chemicals. Michigan's Employee Right-To-Know Law requires that information about hazardous substances found in the work place be made available to exposed employees. Accordingly, employers must have a MSDS for every hazardous chemical in the work place and make these sheets available to their employees (MIOSHA, 2008). Examples of hazards are found in Table 2.

MSDSs are forms provided by chemical manufacturers to inform product users of toxicological information and physical properties for the specific chemical or substance.

Useful websites for MSDSs are:

MSDS Resource Library
www.reade.com/MSDS_Links.html

Household Products
www.householdproducts.nlm.nih.gov

This Workplace Covered by the Michigan Right To Know Law

Employers must make available for employees in a readily accessible manner, Material Safety Data Sheets (MSDS)* for those hazardous chemicals in their workplace.

Employees cannot be discharged or discriminated against for exercising their rights including the request for information on hazardous chemicals.

Employees must be notified and given direction (by employer posting) for locating Material Safety Data Sheets and the receipt of new or revised MSDS(s).

* When the employer has not provided a MSDS, employees may request assistance in obtaining MSDS from the:

Michigan Department of Labor & Economic Growth
Michigan Occupational Safety & Health Administration
General Industry Safety & Health Division
517-322-1831
Construction Safety & Health Division
517-322-1856

For further information visit our website at www.michigan.gov/miosha

MIOSHA/CET #2195 (Rev. 12/03)

MI SHA
Michigan Occupational Safety and Health Administration

MSDS(s) For This Workplace Are Located At

Location(s)

Location(s)

Person(s) responsible for MSDS(s)

Phone

- ✓ Does your school keep a file of MSDSs?
- ✓ Do you know where MSDSs are located?
- ✓ Are you familiar with the MSDSs that apply to the chemicals that you use?
- ✓ Can you quickly locate important information on a MSDS?
- ✓ Are you familiar with online resources for MSDSs?
- ✓ Do the chemicals that you order come with MSDSs?

Top chemicals of concern in schools are found in Table 3.

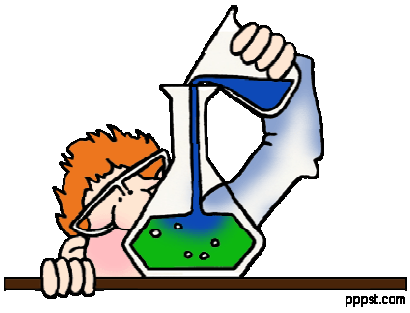
Table 2.
Chemical Hazards

Chemical Type		Description and Examples
Flammables/ Explosives		Chemicals that have the potential to catch fire rapidly and burn in the air. Liquids, gases, and solids (in the form of dusts) can be flammable and/or explosive. *Examples: paint thinner; laboratory solvents (acetone, alcohols, acetic acid, hexane); adhesives (some)*
Corrosives		Chemicals that can burn, irritate, or destroy living tissue or corrode metal through direct chemical action. This category includes strong acids and bases (alkalines), as well as dehydrating agents and oxidants. *Examples: sulfuric, nitric, and hydrochloric acids; potassium, ammonium, and sodium hydroxides (bases); hydrogen peroxide or chlorine (oxidants); acetic acid*
Oxidizers/ Reactives		Chemicals that react violently when combined with heat, light, water, or atmospheric oxygen, causing explosions or violent chemical reactions. *Examples: nitrates; chlorates; nitrites; peroxides; picric acid (crystallized); ethyl ether (crystallized); water reactive metals (e.g., sodium)*
Toxics		Any substance that, even in small amounts, can injure living tissue when ingested, inhaled, or absorbed into the skin. *Examples: mercury; arsenic; lead; asbestos; cyanide*
Compressed Gases		Gases stored under high pressure such that cracks or damage to the tanks and valves used to control these gases could cause significant physical harm to those in the same room. *Examples: acetylene; helium; nitrogen*

Source: Chemical Management Resource Guide for School Administrators (2006)

Table 3
Top 40 Chemicals of Concern in Schools

1. Acetic Acid
2. Acetyl Chloride
3. Adipoyl Chloride
4. Aluminum Chloride
5. Ammonium Hydroxide
6. Aniline
7. Antimony Pentachloride
8. Antimony Trichloride
9. Arsenic Trioxide
10. Benzene
11. Benzoyl Chloride
12. Benzoyl Peroxide
13. Benzyl Alcohol
14. Bromine
15. Butyric Acid
16. Cadmium
17. Calcium Carbide
18. Carbon Disulfide
19. Dioxane
20. Ether
21. Formaldehyde
22. Hydrochloric Acid
23. Hydrogen Peroxide
24. Lithium metal
25. Magnesium
26. Magnesium Perchlorate
27. Mercury
28. Nitric Acid
29. Perchloric Acid
30. Phosphorus
31. Picric Acid
32. Potassium
33. Potassium Cyanide
34. Potassium Permanganate
35. Sebacoyl Chloride
36. Sodium
37. Sodium Azide
38. Sodium Cyanide
39. Sodium Peroxide
40. Sulfuric Acid



Source: Conducting a Full Cleanout in Schools, Rachel Colella, NEMOA (2007)

Developing a chemical management system

The United States Environmental Protection Agency and various states have a variety of materials to get you started with development of a school chemical management system. The Massachusetts School Chemical Management Program manual provides basic elements:

U.S. EPA's School Chemical Cleanout (SC3) website at http://www.epa.gov/sc3/ has many helpful resources. Many states have SC3 programs.

Step 1: Get Started - Form a Team

Step 2: Assess Current Chemical Management Systems and Conditions

Step 3: Dispose of Unnecessary Chemicals

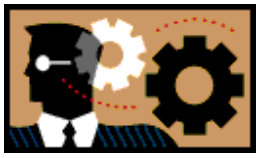
Step 4: Develop a Long Term Chemical Management System

Step 5: Evaluate and Update Your Chemical Management System

Source: Massachusetts School Chemical Management Plan (2006)

Step 1: Get started – form a team

A team approach to chemical management in schools has been found to be the most effective strategy for long term planning and implementation. A team creates institutional memory, and the success of the team's work continues even if one member leaves the school. Also, a team representing all aspects of chemical use in the school will develop a chemical management system that represents the entire school, and helps to coordinate common responsibilities across departments. The principal's or superintendent's support is critical.



Who do you think should be on your team?
See table 4.

The Team will coordinate the development and implementation of your school's Chemical Management System. It will:

- Conduct an initial investigation.
- Identify and prioritize systems to be developed.
- Recommend assignment of roles and responsibilities.
- Conduct research and exchange information.
- Develop long and short-term recommendations and plans.
- Identify and solicit resources necessary to develop the system.
- Develop and maintain an information and record keeping system.
- Provide long-term oversight including a reporting mechanism and auditing process.

Who will be the champion for the team?

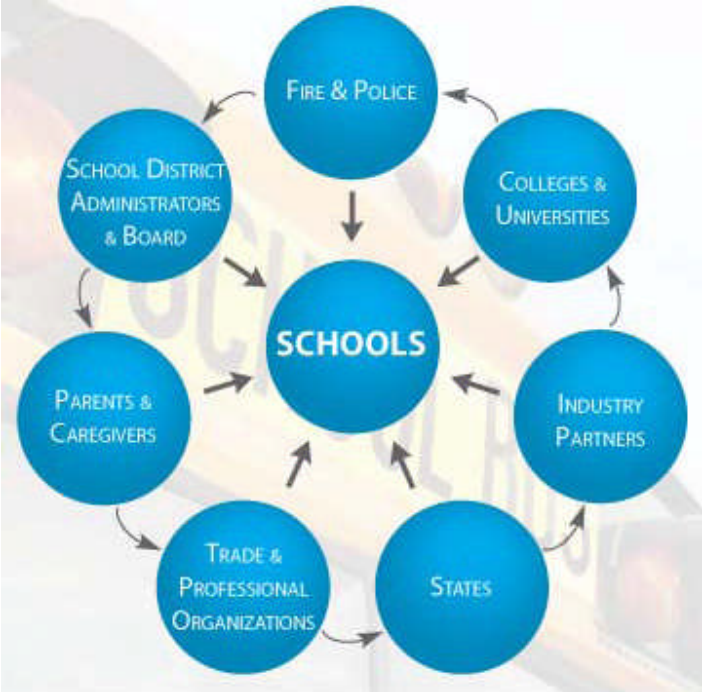
The Team should solicit involvement throughout the school and its community, identify and coordinate all department activities related to chemical management, provide technical assistance or referral to outside experts for school departments, and serve as a liaison to the school community.

Your team will have a lot of work to do and a champion will be needed to move things along. According to the U.S. EPA, collective knowledge is needed in

- School management practices, such as purchasing
- Curriculum development
- Chemical management and safety training
- Health concerns
- Legal and regulatory aspects, and
- Risk Management.

Important stakeholders for your team (Table 4) include:

- School principals
- Department heads
- Administrators
- Board members
- Science, art and vocational teachers
- Business managers
- Insurance representatives
- School legal counsel
- Facilities and custodial staff
- Office staff
- Partners (fire & police, colleges & universities, etc.)
- Parents



Source: U.S. EPA

Table 4
School Chemical Management Team

Name	Affiliation/Job Title	Expertise

Step 2: Assess current chemical management systems and conditions

How much does your team know about chemical management in your school or district? It may be that there are many elements of a system present, but coordination and communication may be lacking. Your team will need to do some detective work to frame the course of action.

The assessment involves several parts:

A. Gathering information on current practices

A questionnaire will help your team gather this information.

See Table 5: **School Chemical Management Assessment Questionnaire**

B. Conducting a safety prescreen

A safety prescreen will identify and resolve "imminent hazards." Dangerous situations are often found when schools start exploring the conditions of their chemicals. Identify areas to evaluate, but do not limit your evaluation to known storage and use areas, as chemicals are often used, left and forgotten in non–storage areas. Take notes for each location visited, and map the locations where chemicals are currently used and stored.

See Table 6: **Safety Prescreen Inspection Sheet**

C. Conducting a more detailed walk-through inspection

Conduct a full assessment of the school facility with respect to its storage of chemicals with your Team. Many of these items can be identified during the safety prescreen, although a second walk-through is often necessary. The work can be divided up between various team members.

See Table 7: **Walk-through Inspection Sheet**

Table 5
School Chemical Management Assessment Questionnaire

Yes	No	Conditions
		1. Does your school have a chemical management plan or system?
		2. Does your school have an individual or team responsible for chemical management or environmental health and safety? If so who? Do teachers know their responsibilities?
		3. Does the school have an inventory of the hazardous materials used in the school? If so is it electronic or paper? Where is it kept? How often is it updated and by whom?
		4. Are chemicals stored separated by hazard class and compatibility in a uniform storage system? Is there enough storage area?
		5. Has the school had a comprehensive school wide hazardous materials clean-out to rid the school of old unwanted chemicals? When?
		6. Do laboratories have a Chemical Hygiene Plan if required?
		7. Is chemical management or safety training available to staff? Is Right-To-Know training for all staff handling hazardous materials made available annually?
		8. Does the school have Material Safety Data Sheets (MSDS) for the hazardous materials used in the school? Where are they kept?
		9. Does the school have a chemical emergency response plan? Is the staff trained in chemical emergency response?
		10. Does the school have a chemical purchasing policy? Who is responsible for chemical purchasing?
		11. Is the school properly registered under its applicable generator status of hazardous waste with the Michigan Department of Environmental Quality?
		12. Does the school have a proper waste management system in place to assure proper management and disposal of chemicals?

Adapted from Massachusetts School Chemical Management Plan (2006)

Table 6
Safety Prescreen Inspection Sheet

Location: Date: Evaluated by:

General Storage Conditions	Comments
__Y __N Are storerooms too crowded? __shelves packed with chemicals __trip hazards __other_____	
__Y __N Are shelves or shelf supports attached to the walls or in cabinets corroded or at risk of collapsing?	
__Y __N Are there sources of ignition or heat that pose a risk? __Appliances __Exposed wires __ Light Sensor __Electrical Panel __Fan on a timer __ other_____	
Are chemicals stored: __Y __N overhead on high shelves where they cannot be observed? __Y __N, stacked on the floor? __Y __N, "stored" in the hood?	
Container Conditions	**Comments**
__Y __N Are there any "shock-sensitives" (explosive when disturbed)?	
__Y __N Is there evidence or signs of spilled materials or of vapors?	
Are there any containers: __ leaking ___corroded __weak __ broken	
__Y __N Do any chemicals have crystals or other material on container?	
__Y __N Are the elemental metals submerged in sufficient liquid?	
__Y __N Are there chemicals stored on incompatible shelving? __ acids on metal shelves __oxidizers on wooden shelves	
__Y __N Are there any chemicals stored in dangerous combinations? __nitric acid with other acids __ flammables and oxidizers __alphabetical order __acids and bases __other	
__Y __N Are water-reactives stored where there is a sprinkler system, water source, or under sink?	
Due to the presence of moisture, is there: __corroded pipes __corroded shelving __compromised chemicals	
Have container lids: __come loose __bulged __collapsed	
Are any container labels: __missing __unreadable __have insufficient information __other	
__Y __N Do the storage rooms have locking exit doors?	
__Y __N Is there adequate ventilation in the storage room?	

Adapted from Massachusetts School Chemical Management Plan (2006)

Table 7
Walk Through Inspection Sheet

Location: Date: Evaluated by:

√	General items to evaluate
	The types, conditions, quantities, and storage locations of chemicals. *Comments*:
	The types, conditions, quantities, and storage locations of hazardous waste. *Comments*:
	The condition and appropriateness of the chemical storage area, equipment and environmental controls, such as ventilation systems. *Comments*:
	Any chemical inventories for these storage areas, the status of these inventories, and who maintains them. *Comments*:
	The location, condition, amount and appropriateness of personnel protective equipment. *Comments*:
	The location, condition, amount and appropriateness of the emergency response supplies and equipment for the amount and type of chemicals stored. *Comments*:
	An effective system in place for chemical emergency response. *Comments*:
	The location, completeness and availability of Material Safety Data Sheets (MSDS) in each department using chemicals. *Comments*:
	Designation of the staff responsible for each of these locations. *Comments*:

Adapted from Massachusetts School Chemical Management Plan (2006)

Step 3: Conduct a chemical inventory.

There are several options for conducting an inventory, depending on your goals:

- Short Term Inventory for disposal purposes
  - You can work with your staff to collect information on only products you need to price for disposal, or
  - You can have staff collect information on all products to enable you or a vendor or specialist to screen and flag items that are overstocked or particularly hazardous for disposal.

- Long Term Inventory System
  - Select an electronic inventory system (your school chemical vendor may have one available or you may develop your own data base or spreadsheet) or printed form that can be used and maintained for long-term tracking.
  - Inventory all of the chemicals in the school to identify the name of the chemical, hazard class, container size and percent full, locations of containers, and dates on which solutions were prepared or expiration date, if applicable.

An example from the Massachusetts School Chemical Management Program of conducting a school chemical inventory is found on the resource CD.

A chemical inventory spreadsheet from the State of Florida can help to organize the inventory (Table 8). Special features are the storage category numbers, color code, Chemical Abstract Service (CAS) registry number, NFPA hazard ratings, and personal protective equipment (PPE). Other examples and spreadsheets are on the resource CD.

Important Note:
The Michigan Department of Environmental Quality takes no responsibility for the accuracy, content or completeness of the inventory procedures in the CD, nor for the safety of those following these procedures. Conducting a chemical inventory may be hazardous and those who do so should proceed with extreme caution. A school should consider contracting a licensed Hazardous Waste disposal firm experienced in management of small quantities of laboratory chemicals to conduct the inventory and dispose of any hazardous waste.

Table 8 Chemical Inventory Form

Source: Florida School Chemical Cleanout Campaign (2008)

Name	Storage Cat.	Fisher 5 C	CAS #	NFPA-H	NFPA-F	NFPA-R	NFPA-O	PA-O Expo	PPE	PEL	TLV	Other Names, Synonyms	Quantity	Storage S	ate Recei	Exp.Date	Shelf Life
Acetaldehyde	Org. 3	BLUE	75-07-7	3	4	2			GOG, APRON, HOOD, GLO	200PPM	25 PPM	Ethanal, Acetic aldehyde, Ethyl aldehyde					
Acetamide	Org. 2	GRAY	60-35-5	2	1	0			GOG, APRON, HOOD,	15 MG/M3	10 MG/M3	Acetic acid amide					
Acetanalide	Org. 2	GRAY	103-84-4	1	1	0						Antifebrin					
Acetic acid	Org. 1	WHITE	64-19-7	3	2	2			GOG, APRON, HOOD, GLO	10PPM	10PPM	Glacial acetic acid, Ethanoic acid, Vinegar					
Acetic anhydride	Org. 1	WHITE	108-24-7	3	2	1			GOG, APRON, HOOD, GLO	5PPM	5PPM	Acetyl oxide, ethanoic anhydride, acetic oxide					
Acetocarmine Stain	Org. 1	WHITE															
Aceto-Orcein Solution	Org. 1	WHITE	1400-62-0	3	1	0			GOG, APRON	25 MG/M3	25 MG/M3	Orcein-Aceto Solution					
Acetone	Org. 4	RED	67-64-1	1	3	0		GOG, APRON, HOOD, GLO		1000PPM	750PPM	Dimethyl ketone, 2-Propanone					
Acetylsalicylic Acid	Org. 1	GRAY	50-78-2						GOG, APRON			Asprin					
Acrylonitrile	Org. 2	RED	50-78-2					GOG, APRON, GLOVES			4.3 MG/M3, 2 pp	Cyanoethylene, Vinyl cyanide, 2-PROPENENITRILE					
Adrenaline	Org. 2	BLUE	51-43-4					GOG, APRON, GLOVES				ADRENISOL					
Adenosine Triphosphate	Org. 2	GRAY	987-65-5	1	0	0			GOG, APRON			ATP					
Adiptic Acid	Org. 1	GRAY	124-04-9	1	1	0			GOG, APRON								
Adrenaline Solution	Org. 2	BLUE	51-43-4	1	0	0			GOG, APRON			Epinephrine					
Agar	Misc.	GRAY	9002-18-0	0	1	0			GOG, APRON			Polysaccharide complex					
Alizarin yellow R	Misc.	GRAY	1718-34-9	1	0	0			GOG, APRON			Sodium salt, Salicylic acid					
Alum	Inorg. 2	GRAY	10043-67-1	1	0	0			GOG, APRON	2 MG/M3	2 MG/M3	Potassium Alum, Aluminum potassium sulfate, Kalinite					
Aluminon	Inorg. 2	GRAY	569-58-4	1	0	0			GOG, APRON			Aurin Tricarboxylic Acid					
Aluminum	Inorg. 1	RED	7429-90-5	0	0	0			GOG, APRON	15 MG/M3	10MG/M3						
Aluminum chloride	Inorg. 2	GRAY	7784-13-6	1	0	0			GOG, APRON		2 MG/M3	aluminum choride hexahydrate					
Aluminum hydroxide	Inorg. 4	GRAY	21645-51-2	1	0	0			GOG, APRON			Aluminium hydrate, hydrated alumina					
Aluminum nitrate	Inorg. 3	YELLOW	13473-90-0	1	0	0	OX	OXIDIZER	RON, HOOD,	2 MG/M3	2 MG/M3	Nonahydrate, Nitric acid, Alumnum salt					
Aluminum oxide	Inorg. 3	GRAY	1344-28-1	1	0	0			GOG, APRON	15 MG/M3	10MG/M3	Alumina					
Aluminum Sodium Sulfate	Inorg. 2	GRAY	10102-71-3						GOG, APRON								
Aluminum sulfate	Inorg. 2	GRAY	7784-31-8	2	0	0			GOG, APRON	2 MG/M3	2MG/M3	Cake aluminum, Patent aluminum					
Ammonia	Inorg. 4	WHITE	1336-21-6	2	0	0			GOG, APRON								
Ammonium acetate	Inorg. 2	GRAY	631-61-8	1	1	0			GOG, APRON			Acetic acid, Ammonium salt					
Ammonium bicarbonate	Inorg. 4	GRAY	1066-33-7	1	0	0			GOG, APRON			Ammonium hydrogen carbonate					
Ammonium bromide	Inorg. 2	GRAY	12124-97-9	2	0	0			GOG, APRON			Hydrobromic acid monoammoniete					
Ammonium carbonate	Inorg. 4	GRAY	506-87-6	2	0	2			GOG, APRON			Diammonium carbonate, crystal ammonia					
Ammonium chloride	Inorg. 2	GRAY	12125-02-9	2	0	0			GOG, APRON		10MG/M3	Sal ammoniac, Ammonium muriate					
Ammonium chromate	Inorg. 8	BLUE	7788-98-9									Neutral ammonium chromate, Diammonium chromate					
Ammonium dichromate	Inorg. 8	GRAY	7789-09-5	3	1	1	OX	OXIDIZER	RON, HOOD,	0.1 MG/M3	0.05 MG/M3	Ammonium bichromate					
Ammonium Hydroxide (<35%)	Inorg. 4	WHITE	1336-21-6	3	1	0		GOG, SHIELD, APRON, HO		50PPM	25PPM	Ammonia water, Aqueous ammonia					
Ammonium iodide	Inorg. 2	GRAY	12027-06-4	1	0	1			GOG, APRON	15 MG/M3	10 MG/M3						
Ammonium molybdate	Inorg. 8	GRAY	12027-67-7	1	0	0		GOG, APRON, GLOVE		5 MG/M3	5 MG/M3	Molybdic acid hexammonium salt, ammonium heptamolybdate					
Ammonium nitrate	Separate	YELLOW	6484-52-2	2	0	3	OX	OXIDIZER	GOG, APRON								
Ammonium oxalate	Inorg. 2	WHITE	6009-70-7	4	1	0		GOG, APRON, HOOD, GLOVES				Ammonium oxalate monohydrate					
Ammonium persulfate	Inorg. 6	YELLOW	7727-54-0	2	0	1	OX	OXIDIZER	RON, HOOD, GLOVES		5 MG/M3	Ammonium peroxydisulfate, Peroxydisulfuric acid, diammonium salt					
Ammonium phosphate, monobasic	Inorg. 2	GRAY	7783-28-0	2	0	1			GOG, APRON			Ammonium phosphate dibasic, Ammonium Dihydrogen Phosphate					
Ammonium phosphate, dibasic	Inorg. 2	GRAY	7722-76-1	2	0	0			GOG, APRON			Dammonium Hydrogen Phosphate, Phosphoric Acid Diammonium Salt					
Ammonium sulfate	Inorg. 2	BLUE	7783-20-2	2	0	0			GOG, APRON			Mascagnite, sulfuric acid diammonium salt, Ammoniium Hydrogen Sulfate					
Ammonium sulfide	Inorg. 5	WHITE	12135-76-1	3	3	0		GOG, SHIELD, APRON, HOOD,		10PPM	10PPM	Ammonium sulfide solution,					
Ammonium tartrate	Inorg. 2	GRAY	3164-29-2	2	0	0			GOG, APRON			tartaric acid, Diammonium salt					
Ammonium thiocyanate	Inorg. 7	GRAY	1762-95-4	2	1	1			GOG, APRON			Ammonium sulfocyanate, Ammonium rhodanide					
Amyl acetate	Org. 3	RED	628-63-7	1	3	0		GOG, APRON, HOOD, GLO		100PPM	100PPM	Banana Oil, Pear Oil, n-pentyl acetate					
n-Amyl Alcohol	Org. 2	GRAY	71-41-0	1	3	0		GOG, APRON, HOOD, GLOVES				n-Pentanol, 1-Pentanol					
Aniline	Org. 2	BLUE	62-53-3	3	2	2				19MG/M3,5PPN	0MG/M3,2PPN	Aminoacetic Acid, Aminobenzene, Phenylamine, aniline oil					
Aniline blue	Org. 2	GRAY	8004-91-9	2	1	1		GOG, HOOD, GLOVES				Aniline blue					
Anthracene	Org. 3	GRAY	120-12-7	1	1	0			GOG, APRON	0.2 mg/m3	0.2 mg/m3	Paranaphthalene, Green oil					
Antimony	Inorg. 1	GRAY	7440-36-0					GOG, APRON, GLO		0.5 MG/M3	0.5MG/M3						
Antimony potassium tartrate	Inorg. 2	BLUE	28300-74-5	2	0	0			GOG, GLOVES								
Antimony pentachloride	Inorg. 2	WHITE	7647-18-9	3	0	1		GOG, SHIELD, APRON, HO		0.5MG/M3	0.5MG/M3	Antimony(V) chloride, antimony perchloride					
Antimony trichloride	Inorg. 2	WHITE	10025-91-9	3	0	1			GOG, APRON, HOOD,	0.5MG/M3	0.5MG/M3	Butter of antimony, antimony(III) chloride					
Ascorbic acid	Inorg. 1	GRAY	50-81-7	1	0	0			GOG, APRON	15 MG/M3	10 MG/M3	Vitamin C, L-ascorbic acid					
L-Aspartic acid	Inorg. 2	GRAY	56-84-8	1	0	0		GOG, APRON, GLOVES									
Balsam	Org. 3	GRAY	8007-47-4	1	2	0			GOG, APRON								
Barium acetate	Inorg. 2	BLUE	543-80-6	3	0	0			GOG, APRON, HOOD,	0.5MG/M3	0.5MG/M3	Acetic acid, Barium salt, Barium diacetate					
Barium carbonate	Inorg. 4	BLUE	513-77-9	2	0	0			GOG, APRON, HOOD,	0.5 MG/M3	0.5 MG/M3						
Barium chlorate	Inorg. 6	YELLOW	13477-00-4						GOG, APRON, HOOD,	0.5 mg/m3	0.5 mg/m3	Barium chlorate monohydrate					
Barium chloride	Inorg. 2	BLUE	10361-37-2	3	0	0			GOG, APRON, HOOD,	0.5 MG/M3	0.5MG/M3						
Barium hydroxide	Inorg. 4	WHITE	12230-71-6	3	0	0			GOG, APRON, HOOD,	0.5 ppm	0.5ppm	Barium Hydroside, Octahydrate					
Barium nitrate	Inorg. 3	YELLOW	10022-31-8	3	0	0	OX	OXIDIZER	RON, HOOD,	0.5 MG/M3	0.5MG/M3	Nitrobarite					
Barium peroxide	Inorg. 6	YELLOW	1304-29-6	1	0	0			GOG, APRON, HOOD,	0.5 MG/M3	0.5 mg/m3	Barium dioxide, Barium superoxide, Barium binoxide					
Barium sulfate	Inorg. 2	BLUE	7727-43-7	0	0	0			GOG, APRON, HOOD,	15 MG/M3	10 MG/M3	Blanc fixe, Barite, barytes					
Benedict's solution	Inorg. 2	BLUE	68-04-2						GOG, APRON	0.1 mg/m3		Benedict's Reagent					
Benzaldehyde	Org. 3	GRAY	100-52-7	2	2	0		GOG, APRON, HOOD, GLO		PPM - 8 HOURS		benzoic aldehyde, benzenecarbanal					
Benzene	Org. 3	RED	1076-43-3	2	3	0		GOG, SHIELD, APRON, HOOD,		10PPM	10PPM	Benzol, Coal naphtha					
Benzoic acid	Org. 1	GRAY	65-85-0	2	1	0			GOG, APRON			Dracylic acid, phenyl formic acid, benzene carboxylic acid					
Benzyl alcohol	Org. 2	GRAY	100-51-6	2	0	1			GOG, APRON			Phenyl methanol					
Benzoyl peroxide	Org. 6	YELLOW	94-36-0	1	4	4	OX	OXIDIZER	ER,PROTECT	5MG/M3	5MG/M3	Benzoic acid, Peroxide, Dibenzoyl peroxide					
BHT		GRAY	128-37-0	2	1	0			GOG, APRON			2,6-Di-tert-butyl-p-cresol , 2-6-Di-t-Butyl-4-Methylphenol					
Bile salts	Org. 1	GRAY							GOG, APRON			Sodium salts of glycolic and tautorocholic acids					
Bizmuth	Inorg. 1	GRAY	7440-69-9					GOG, APRON, GLOVES									
Bismuth nitrate	Inorg. 3	YELLOW	10035-06-0	2	0	1	OX	OXIDIZER	, APRON, GLOVES								
Bismuth trichloride	Inorg. 2	GRAY	7787-60-2					GOG, APRON, HOOD, GLOVES				Bismuth (III) Chloride					
Biuret solution	Misc.	WHITE	108-19-0									Carbamylurea, indodicarbonic diamine					
Boiling chips, marble		GRAY															
Boric acid	Inorg. 9	GRAY	10043-35-3	1	0	0		GOG, APRON, HOOD,		15 mg/m3	10 mg/m3	Orthoboric acid, Boracic acid					
Bouin's solution		GRAY							GOG, APRON	0.016 PPM	0.016PPM						
Brilliant cresyl blue	Org. 9	GRAY	81029-05-2						GOG, APRON								
Bromcresol green	Misc.	GRAY	76-60-8	1	1	0			GOG, APRON								
Bromocresol purple	Org. 9	GRAY							GOG, APRON								
Bromine	Inorg. 2	WHITE	7726-95-6	4	0	0	OX	OXIDIZER	, APRON, HO	0.1PPM	0.1PPM						
Bromophenol blue	Misc.	GRAY	115-39-9	1	1	0		GOG, APRON, HOOD, GLOVES									
Bromothymol blue indicator	Org. 9	YELLOW	34722-90-2						GOG, APRON								

Step 4: Dispose of unnecessary chemicals

After conducting the chemical inventory, it is time for the team to review the lists generated to determine the next steps. No doubt there will be many chemicals that are no longer used, outdated, in poor condition, or otherwise in line for disposal. A triage approach is helpful at this point:

1. Which chemical containers are:

   - Unlabeled?
   - In poor condition?
   - Expired?
   - Not essential?

These are candidates for disposal and should be tagged and noted on your inventory sheet.

2. Approximately how much of each chemical is used each year?

   - Check order records.
   - Look at what is required for the curriculum.

A composite spreadsheet format is helpful for generating the amounts for the entire school.

3. Given the amounts above, how many years worth of a chemical do you currently have?

   - Subtract the chemicals that will be disposed.
   - Consider the total amounts of all of the chemicals in various areas of the school.

If the team determines that chemical cleanout plus disposal is in order, then there are four activities to consider:

1. Create a list of chemicals for disposal (Table 9).
2. Identify a qualified professional to assist in the chemical cleanout and disposal process.
3. Prepare for the chemical cleanout and disposal.
4. Take steps to reduce the need for future chemical cleanouts (i.e., purchasing controls, inventory management, microscale chemistry).

The Disposal List

Completing the disposal list will help you to:

- Identify chemical management problems or cleanout issues that need immediate attention or action (e.g., situations that might pose health and safety concerns to students and staff, such as potential explosions or fires).
- Rank and prioritize schools and areas of the school(s) needing cleanout.
- Estimate the types and quantities of chemicals for removal in the cleanout.
- Identify chemicals needing special handling (e.g., radioactive or explosive, shock sensitive, unknown).
- Identify activities that need the expertise of a qualified professional (e.g., removing and disposing of chemicals).

Example of a completed disposal list.

Storage Date/ Initial	Chemical Name	CAS	Conc	Exp. Date	Amt. or container size	Cont. Type	Amount (est.)	Storage Location
4/2/08 JS	**1-Propanol**	**71-23-8**	**100%**	**N/A**	**2 x 500 mL**	**Poly**	**750 mL**	**Flammable cabinet Room 202**
6/5/08 MA	**Aluminum**	**7429-90-5**	**100%**	**N/A**	**500 g**	**Glass**	**200 g**	**Chemical Shelf Room 110**

Unlike small businesses such as printers, auto shops, and dry cleaners, which tend to generate large quantities of a few pollutants, labs typically generate small quantities of a wide variety of pollutants. This characteristic requires careful attention in dealing with labs on compliance and on pollution prevention issues. In fact, because of this characteristic, the term "lab pack" was coined years ago by hazardous waste firms to describe a typical method of waste handling. In a "lab pack" a number of small containers (i.e. jugs and bottles) of hazardous waste are individually packaged in a traditional 55 gallon drum. Although "lab packs" appear inefficient compared to combining all materials, they make sense because it is unwise, for safety and legal reasons, to encourage mixing different lab wastes in a single container. Companies exist that specialize in the preparation and disposal of lab packs. (U.S.EPA, 2008)

Table 9
Chemical Disposal List

Storage Date and Initials*	Chemical Name	CAS	Conc.	Exp. Date	Amt. or container Size	Cont. Type	Amount (est.)**	Storage Location

*Initials = who stored the items **Keep track of the accumulated amount
Source: Adapted from U.S. EPA SC3 Program (2008)

Identification of qualified cleanout professionals

How do I find a professional?

> Check the MDEQ website for listings (Hazardous & Liquid Industrial Transporters)
> Check with your school or district business manager for companies that may have helped in the past
> Contact a college, university or business partner for help.
> Look for contacts at conferences such as that of the Michigan Science Teachers Association.

Remember that only qualified personnel should be involved with chemical handling, packing, removal, and transport to bring about a safe and successful cleanout.

Disposal of chemicals and chemical waste must be done in compliance with local and state regulations as well as with the federal Resource Conservation and Recovery Act. A qualified professional will be aware of the proper cleanout and disposal techniques and applicable regulatory requirements.

In addition, using qualified personnel will help to minimize chemical exposure to students and staff, environmental damage, and the likelihood of accidents and their associated costs.

One way to evaluate and competitively select a qualified hazardous waste disposal contractor is to issue a request for proposal (RFP*). Building Successful Programs to Address Chemical Risks in Schools* from the U.S. EPA has a section on drafting RFPs and looking at vendor qualifications.

Be clear about the scope of work for the contractor. Estimates for work may include:

- Classification and marking each container.
- Segregating materials by compatibility, hazard class and disposal requirements.
- Lab packing materials into drums or Department of Transportation (DOT) approved containers.
- Completion of needed documentation, manifest and shipping documents.
- Transportation to treatment and/or disposal site.

Examples of cost savings techniques for hazardous waste disposal are found in Table 10.

Table 10
Examples of Cost Savings Techniques

Technique	Type of Cost Savings	Real World Example
Leveraging a household hazardous waste (HHW) collection event for chemical disposal.	Transportation and labor.	The Tennessee Department of Environment and Conservation used an existing contract to do HHW collection and facilitate simultaneously cleanouts of school labs.
Use a knowledgeable partner to help identify substance(s) that can be safely disposed of without a hazardous waste contractor.	Packing, labor, transportation, and disposal.	The Northwest Tri-County Intermediate Unit in Pennsylvania leveraged the State environmental agency to review inventories and denote items that could be safely disposed.
Work with a partner organization to take advantage of an existing disposal contract.	Disposal (lower rates)	In Iowa, in early stages of their chemical management efforts, the Metropolitan Waste Authority partnered with EPA Region 7 to use existing chemical management services.
Incorporate performance-based contracting in your RFP.	Disposal, chemical purchasing, future chemical management.	A pilot program in Lansing, Michigan incorporated performance-based contracting clauses to encourage cleanout professionals to find ways to minimize costs while providing other chemical and resource lifecycle services.
Negotiate disposal rates by combining multiple cleanouts.	Lower disposal rates and reduce cost for lab packing, labor, and transportation.	Qualified school personnel in the Fort Worth, Texas Independent School District collected smaller amounts of waste from all district schools prior to one large consolidated disposal to save on transportation costs and negotiate a lower disposal rate per drum of hazardous waste.
Research your chemical management regulations to identify potential ways to lower costs.	Reduced packing and transportation costs.	Rochester City School District, NY environmental personnel talked to regulators about the amounts and types of chemicals that could be legally and safely transported by the school district to a proper disposal facility.

Source: U.S. EPA SC3 Program (2008)

Step 5: Design and Implement a school chemical management system

Now that the chemical inventory is under control and hopefully a chemical cleanout has taken place, the team should focus on the design and implementation of an overall chemical management plan.

U.S. EPA's School Chemical Cleanout campaign provides a strategy for planning:

1. Evaluate chemical management practices and identify program goals.
2. Decide what your chemical management system will look like.
3. Publicize your program.
4. Put your chemical management system into action.
5. Sustain your program.

An effective chemical management system should include the five following elements:

- Administrative Systems
- Chemical Emergency Response
- Chemical Purchasing Controls
- Chemical Management and Storage
- Hazardous Waste Management

At minimum, the following should be considered:

A. Develop procedures for managing chemicals, storing chemicals, and keeping the chemical inventory list current.
B. Plan and budget for chemical purchases, management and disposal.
C. Review curriculum for opportunities to use the smallest amount of the least hazardous chemicals.
D. Offer chemical management and safety training to staff.
E. Practice continuous improvement and evaluation.

Examples of tasks to be accomplished in designing a chemical management system are found in Table 11.

Source: Massachusetts School Chemical Management Program Manual (2006)

Table 11

Chemical Management in Schools Checklist

Task	Point Person or Group	Timeline
1. Establish a leadership team (teachers, maintenance staff, etc.)		
2. Appoint a chemical hygiene (safety) officer.		
3. Establish and communicate a chemical management policy.		
4. Implement pollution prevention in classrooms and on the grounds.		
5. Incorporate green chemistry and safe science into the curriculum.		
6. Conduct and maintain a chemical inventory.		
7. Properly dispose of excess and obsolete chemicals.		
8. Establish a chemical storage and handling policy.		
9. Provide policies for purchase of chemicals.		
10. Establish an environmentally preferable purchasing policy.		
11. Develop a Chemical Hygiene plan for labs.		
12. Develop a hazard communication plan.		
13. Create an emergency response and spill clean-up plan.		
14. Establish a training program for chemical management and safety.		
15. Establish a hazardous waste training program.		
16. Develop a budget for clean-outs and the overall program.		
17. Review and update plans, inventories, policies, etc. yearly.		

A. Develop procedures for managing, storing and inventorying chemicals.

Most schools do not evaluate the health and safety criteria, or storage requirements before purchasing a chemical product. Thus, schools often end up with chemicals that are very toxic, reactive and even explosive, which they are not adequately prepared to use and store. Schools often purchase more chemicals than they need to obtain lower bulk pricing. Surplus stock also results from changes in staff and curricula, as well as the availability of better substitutes. Also, chemicals received as free donations often end up not used, and incur costs for disposal. The unanticipated cost of disposal can be 5 to 10 times more than the purchase price. (Massachusetts School Chemical Management Program Manual, 2006)

Software to Track Activities

U.S. EPA provides a valuable software tool that gives school districts the ability to evaluate and manage different aspects of their school safety and health issues, including chemical management. The Healthy Schools Assessment Tool (Healthy SEAT) is downloadable. See the Healthy SEAT website at: http://www.epa.gov/schools/healthyseat/index.html

To address these issues (Table 12), a school should

- Conduct a school-wide inventory to identify where chemicals are located.
- Designate a centralized place for chemical storage and another for waste storage, with spill containment.
- Organize chemical and waste storage systematically to keep like chemicals together.
- Adopt a standard labeling procedure for chemicals and waste, using labels that are colorfast and permanent.
- Designate who is responsible for labeling and inventory control.
- Use tags, bar codes, or some other system to establish a computer tracking of chemicals.
- Use a first-in/first-out policy.
- Perform regular inventory audits to identify chemicals that aren't being used.
- Provide a simple regular listing to chemical users of available chemical stocks, location, and point-of-contact.

Items to Do List

- Organize chemicals first by COMPATABIILTY, not alphabetically. (Tables 13 and 14)
- Chemicals can be arranged alphabetically within their compatibility group.
- Store chemicals inside a closable cabinet with sturdy shelves with front edge lips.
- Store chemicals in locked cabinets.
- Keep chemical storage areas off limits for students.
- Provide adequate ventilation in storage areas.
- Secure storage shelves to the floor or wall.

- Store acids in a dedicated acid cabinet.
- Store highly toxic chemicals in a lockable poison cabinet.
- Store volatile chemicals in a ventilated cabinet.
- Store flammable chemicals in an approved flammable liquid storage cabinet.
- Make sure all containers are properly closed.
- After each use, carefully wipe down the outside of the container with a paper towel before returning it to the storage area. Properly dispose of the paper towel after use.

Items Not to Do List

- Do not store chemicals on top of cabinets.
- Do not store chemicals on the floor, even temporarily.
- Do not store chemicals on bench tops or in hoods, except when in use.
- Do not store chemicals on shelves above eye level.
- Do not store chemicals with food and drink.
- Do not store chemicals in staff refrigerators, even temporarily.
- Do not expose stored chemicals to direct heat or sunlight, or highly variable temperature.
- Do not store chemicals in food containers.
- Do not place heavy materials, liquid chemicals and large containers on high shelves.

Source: Michigan Department of Environmental Quality and U.S. EPA

Table 12
Chemical Storage

Science Lab: Chemical Storage	Yes	No
GENERAL:		
1. Written Chemical Hygiene Plan and Standard Operating Procedures updated and available to employees. Required by OSHA Laboratory Standard.		
2. Written Hazard Communication Program updated and available. Including: MSDS sheets for all chemicals on premises, information on proper labeling, chemical inventory, training documentation, emergency planning etc. Required by OSHA Hazard Communication Standard.		
3. National Fire Protection Association Code used as guideline for proper storage, handling and use of chemicals in the school.		
4. All biological hazards identified, labeled, stored and disposed of according to OSHA Blood Borne Pathogen Standard.		
5. Written Exposure Control Plan and universal precaution procedures completed as required by OSHA Blood Borne Pathogens Standard.		
6. Chemical storage area separate and secure from other areas and off limits to students.		
7. Chemicals locked during non-class periods.		
8. Storage areas/cabinets labeled to identify the hazardous nature of the products.		
9. Storage cabinets anchored to a fixed entity.		
10. All chemical storage shelves equipped with anti-roll lips.		
11. All chemicals stored at or below eye level but off of floor.		
12. No chemicals stored in fume hoods.		
13. Clearance of at least 18 inches between chemicals and sprinkler heads.		
14. Chemicals never stacked. Labels always visible.		
15. All containers clearly labeled with chemical name, expiration date, hazards and storage requirements (see labeling checklist for details).		
16. Chemicals stored in class-appropriate containers designed for chemical storage.		
17. Chemicals stored according to chemically compatible families (chemical class/ reactive group). Compatibility on shelves vertical as well as horizontal.		
18. Chemical storage area equipped with functioning smoke detectors.		
19. Sources of ignition kept away from chemical storage area.		
20. Two unobstructed, clearly visible exits/evacuation routes available from storage room.		
21. Fire extinguisher easily accessible and annually inspected.		
22. Personal protective equipment provided and used properly when handling chemicals.		
23. Chemical storage rooms fire-resistant and vented via mechanical exhaust system with at least four air changes/hour.		
24. Chemicals stocked only in small quantities for use that year.		
25. Chemicals used on first-in, first-out basis to prevent accumulation of expired materials.		
26. Recommended shelf life of chemicals followed.		
27. Chemical storage areas (including refrigerators) free of food/drink. "No Food" signs posted.		
28. Chemical containers checked regularly for rust, corrosion and leakage.		
29. Chemical containers capped and sealed except when adding or removing chemicals.		
30. Emergency eye wash station and fire blanket available within 25' of storage area.		
31. Wastes accumulated for disposal. Documentation kept to determine generator status.		
32. All unusable, unneeded, deteriorated, out-dated and excessive amounts of chemicals eliminated from storage.		
33. All contaminated sharps/glass discarded immediately in puncture-resistant containers, capped, labeled and eliminated from storage.		

Science Lab: Chemical Storage	Yes	No
34. Comprehensive chemical inventory list/disposal log on hand and updated annually.		
35. Annual safety review performed for chemical storage area.		

CLASS SPECIFIC:

36. Flammable and corrosive liquids stored separately in approved cabinets (except acetic acid - store with flammables.)		
37. Acids stored separately from bases.		
38. Organic acids stored separately from inorganic acids (nitric acid from formic acid, acetic acid, and anhydrides.)		
39. Ignitables stored separately from oxidizers or sources of ignition, especially solvents.		
40. Oxidizing agents stored separately from reducing agents & flammables.		
41. Halogenated solvents stored separately from non-halogenated solvents.		
42. Water reactives stored separately from aqueous sources. Not stored under sinks.		
43. Chemical containers free of the formation of peroxides.		
44. Peroxide-forming chemicals stored in airtight containers, routinely checked for formations and disposed within 6-12 months of opening.		
45. Flammable chemicals stored in explosion-proof/safe refrigerators.		
46. Flammable storage cabinets free of combustible materials and odors.		
47. Less than 10 gallons of flammable chemicals stored outside flammable storage cabinets.		
48. Pyrophorics stored separately from flammables and corrosives.		
49. Strong bases stored in separate corrosive resistant cabinets.		
50. Safety caps in place on all stored compressed gas cylinders.		
51. Operational fume hood provided where noxious or toxic chemicals prepared/tested.		
52. Ventilated cabinets available for storage of highly toxic or odorous chemicals.		
53. Sufficient secondary containment provided for solvents/wastes/acids/bases.		
54. Concentrated acids and bases limited to maximum of two pints of each.		
55. Ether cans drained after opening and not stored unless absolutely necessary.		
56. Water-reactive products stored under dry oil.		

Source: Chemical Cleanout Toolkit for Utah Schools (2008)

Table 13

Organization of Storage Categories in the Science Department

Chemicals should be stored according to hazard class and chemical compatibility, not in alphabetical order! Check the MSDS sheet for chemical incompatibilities.

The following Chemical Storage Pattern is recommended by Flinn Scientific, Inc. The numbers are specific to their products, and other suppliers may not use these reference numbers. The storage categories are still applicable, and are in order of the chart from top shelf to bottom shelf:

Organic

# 2 Alcohols, Glycols, Amines, Amides, Imines, Inides	# 8 Phenol, Cresols
# 3 Hydrocarbons, Esters, Aldehydes	# 6 Peroxides, Azides, Hydroperoxides
# 4 Ethers, Ketones, Ketenes, Halogenated Hydrocarbons, Ethylene Oxide	# 1 Acids, Anhydrides, Peracids (Store in an Acid Cabinet)
# 5 Epoxy Compounds, Isocyanates	Miscellaneous
# 7 Sulfides, Polysulfides, etc.	Miscellaneous

Inorganic Acids

# 9 Acids – except Nitric (Store in an Acid Cabinet)	Nitric Acid (Store in a separate acid cabinet)

Inorganic

# 10 Sulfur, Phosphorus, Arsenic, Phosphorus Pentoxide	# 7 Arsenates, Cyanides, Cyanates (store away from water)
# 2 Halides, Sulfates, Sulfites, Thosulfates, Phosphates, Halogens, Acetates	# 5 Sulfides, Selenides, Phosphides, Carbides, Nitrides
# 3 Amides, Nitrates (not Ammonium Nitrate), Nitrites, Azides	# 8 Borate, Chlorates, Manganates, Permanganates
# 1 Metals and Hydrides (store away from water)	# 6 Chlorates, Perchlorates, Chlorites, Perchloric Acid, Peroxides, Hypochorites, Hydrogen Peroxide
# 4 Hydroxides, Oxides, Silicates, Carbonates, Carbon	Miscellaneous

Table 14

Incompatibility of Common Laboratory Chemicals

The following list in not all inclusive. It is a general guideline. Check your Material Safety Data Sheets for more details.

Chemical	Incompatible Chemicals
Acetic acid	aldehyde, bases, carbonates, hydroxides, metals, oxidizers, peroxides, phosphates, xylene
Acetone	acids, amines, oxidizers, plastics
Alkali and alkaline earth metals	acids, chromium, ethylene, halogens, hydrogen, mercury, nitrogen, oxidizers, plastics, sodium chloride, sulfur
Ammonia	acids, aldehydes, amides, halogens, heavy metals, oxidizers, plastics, sulfur
Ammonium nitrate	acids, alkalis, chloride salts, combustible materials, metals, organic materials, phosphorus, reducing agents, urea
Aniline	acids, aluminum, dibenzoyl peroxide, oxidizers, plastics
Azides	acids, heavy metals, oxidizers
Bromine	acetaldehyde, alcohols, alkalis, amines, combustible materials, ethylene, fluorine, hydrogen, ketones (acetone, carbonyls, etc.), metals, sulfur
Calcium oxide	acids, ethanol, fluorine, organic materials
Carbon (activated)	alkali metals, calcium hypochlorite, halogens, oxidizers
Carbon tetrachloride	benzoyl peroxide, ethylene, fluorine, metals, oxygen, plastics, silanes
Chlorates	Powdered metals, sulfur, finely divided organic or combustible materials
Chromic acid	acetone, alcohols, alkalis, ammonia, bases
Chromium trioxide	benzene, combustible materials, hydrocarbons, metals, organic materials, phosphorus, plastics
Chlorine	Alcohols, ammonia, benzene, combustible materials, flammable compounds (hydrazine), hydrocarbons (acetylene, ethylene, etc.), hydrogen peroxide, iodine, metals, nitrogen, oxygen, sodium hydroxide
Chlorine dioxide	hydrogen, mercury, organic materials, phosphorus, potassium hydroxide, sulfur
Copper	Calcium, hydrocarbons, oxidizers
Flammable liquids	ammonium nitrate, chromic acid, hydrogen peroxide, nitric acid, sodium peroxide, halogens
Fluorine	alcohols, aldehydes, ammonia, combustible materials, halocarbons, halogens, hydrocarbons, ketones, metals, organic acids
Formaldehyde	Strong oxidizing agents, caustics, strong alkalis, isocyanates, anhydrides, oxides, and inorganic acids. Formaldehyde reacts with hydrochloric acid to form the potent carcinogen, bis-chloromethyl ether. Formaldehyde reacts with nitrogen dioxide, nitromethane, perchloric acid and aniline, or peroxyformic acid to yield explosive compounds. A violent reaction occurs when formaldehyde is mixed with strong oxidizers.
Hydrocarbons (e.g. butane, propane, benzene)	acids, bases, oxidizers, plastics
Hydrofluoric acid	metals, organic materials, plastics, silica (glass), (anhydrous) sodium
Hydrogen peroxide	acetylaldehyde, acetic acid, acetone, alcohols, carboxylic acid, combustible materials, metals, nitric acid, organic compounds, phosphorus, sulfuric acid, sodium, aniline
Hydrogen sulfide	acetylaldehyde, metals, oxidizers, sodium
Hypochlorites	acids, activated carbon
Iodine	acetylaldehyde, acetylene, ammonia, metals, sodium
Mercury	Acetylene, aluminum, amines, ammonia, calcium, fulminic acid, lithium, oxidizers, sodium

Chemical	Incompatible Chemicals
Nitrates	acids, nitrites, metals, sulfur, sulfuric acid
Nitric acid	acetic acid, acetonitrile, alcohols, amines, ammonia, aniline, bases, benzene, cumene, formic acid, ketones, metals, organic materials, plastics, sodium, toluene
Oxalic acid	oxidizers, silver, sodium chlorite
Oxygen	acetaldehyde, secondary alcohols, alkalis and alkalines, ammonia, carbon monoxide, combustible materials, ethers, flammable materials, hydrocarbons, metals, phosphorus, polymers
Perchloric acid	acetic acid, alcohols, aniline, combustible materials, dehydrating agents, ethyl benzene, hydriotic acid, hydrochloric acid, iodides, ketones, organic material, oxidizers, pyridine
Peroxides, organic	acids (organic or mineral)
Potassium	Acetylene, acids, alcohols, halogens, hydrazine, mercury, oxidizers, selenium, sulfur
Potassium chlorate	acids, ammonia, combustible materials, fluorine, hydrocarbons, metals, organic materials, sugars
Potassium perchlorate (also see chlorates)	alcohols, combustible materials, fluorine, hydrazine, metals, organic matter, reducing agents, sulfuric acid
Potassium permanganate	benzaldehyde, ethylene glycol, glycerol, sulfuric acid
Sodium	acids, hydrazine, metals, oxidizers, water
Sodium nitrate	acetic anhydride, acids, metals, organic matter, peroxyformic acid, reducing agents
Sodium peroxide	acetic acid, benzene, hydrogen sulfide metals, oxidizers, peroxyformic acid, phosphorus, reducers, sugars, water
Sulfides	Acids
Sulfuric acid	Potassium chlorates, potassium perchlorate, potassium permanganate

Source: Incompatibility of Common Laboratory Chemicals, http://www.sefsc.noaa.gov/HTMLdocs/appendix-G.html (2008)

B. Plan and budget for chemical purchases, management, disposal.

Does your school or district have a purchasing and disposal policy for chemicals? Do you know what you can and cannot order? Are there any guidelines on accepting chemical donations? Anticipated use and need as well as ultimate disposal of chemicals are important considerations. Creating an approved chemicals list and a tracking system can take the guess work out of purchasing decisions and future disposal costs. There may be excess chemicals in another school that can meet your needs. The goal of a purchasing policy is to reduce the risk, liability and cost to students and staff through eliminating the purchase of unnecessary hazardous products (Table 15).

Steps to Developing a Chemical Purchasing Policy

1. Identify a Purchasing Coordinator

Ideally this should be someone from the business office or another designated administrator who can oversee budget issues and approve purchases across all departments and has an understanding of the chemical issues. To save money, chemicals could be purchased at the District or ISD-level. This allows for more purchasing power than by individual teachers or schools.

2. Identify Department Representatives to Participate in Review Process

This group will participate in the development and implementation of the purchasing policy and purchase review criteria. Identify a representative from each department where chemicals are purchased who has the skills and authority to review their department's purchase requests.

3. Review Current Purchasing Procedures

Identify how chemical purchasing is currently done within each department, the individual school buildings, and within the district. Explore how to integrate the review of chemical purchase requests with the existing purchasing system.

4. Assess Chemical Inventory System

Determine if there is an existing chemical inventory system in the school. If not, initiate the development of a school wide or district wide chemical inventory system. This will enable departments to screen purchase orders against what already is in stock at the school.

Source: Massachusetts School Chemical Management Program Manual. (2006)

Chemical Swap System

Consider developing a system for sharing inventory that is available in another department or school building. Issues to be addressed include:

Transporting the chemicals within a building and between buildings

Transport of chemicals between buildings involves risks that need to be taken seriously. Consider the health and safety issues and related liability issues of having staff transport hazardous products. It involves:

• understanding how to pack chemicals safely in compatible groupings,

• having staff trained in chemical management and emergency response, and

• having proper unloading and storage of the materials on the receiving end.

Value of traded materials

Some staff may want compensation for the materials that they are swapping. This could be done as a credit system. It could also be thought of as a reduction in disposal fees, thus saving the department money.

Tracking the swap on the inventory system

A major problem with the inventory systems is keeping them updated. Be sure to track any changes in inventory.

Source: Massachusetts School Chemical Management Program Manual (2006)

Chemical Purchasing Policies

Tracking of chemicals in schools is easier if there are purchasing policies in place (Table 15). Things to consider are to:

Tighten purchasing controls.

Institute procedures that are designed to restrict hazardous chemical purchases to those needed for the current instructional or research programs and in minimal amounts that reflect short term use.

Do not buy extra chemicals in bulk for supposed “savings.” A centralized purchasing system can be used to monitor requests for chemicals, implement policies such as staggered deliveries, ensure sharing of chemicals among common users, and develop plans for leftover chemicals.

Consider disposal cost at time of purchase.

Many chemicals deteriorate with time. When they must be removed, the disposal cost may be 20 to 50 times the original purchase price. The real cost of chemicals should be regarded as the initial purchase price plus any ultimate disposal costs. Reduced disposal costs can often offset savings from buying in quantity.

Consider handling and disposal requirements.

If the facility does not have adequate storage and safety provisions for a chemical, its purchase should be discouraged. Try to use nonhazardous chemicals or those that are suitable for reuse.

Reduce expired stock.

Negotiate expiration dates of chemicals with suppliers based on their intended use. Order reagents in amounts needed and stock smaller containers of chemicals. This helps prevent waste due to surplus or shelf life expiration.

Use up old stock.

Rotate chemical stocks to avoid expiration of their shelf life. Note expiration dates. Use a “first in, first out” policy to keep chemicals from becoming outdated.

Avoid donations of chemicals.

Do not accept donated chemicals or “free samples” unless they meet a specific need, as they can become a future waste problem. Create a policy for acceptance of donations (Table 16).

Source: Research and Educational Laboratory Waste Reduction (1997)

Table 15
Guidelines for a Chemical Purchasing Policy

Guideline	Person(s) Responsible	Date Completed
Create a Standard Use Chemical Lists, by Department or grade level.		
Develop a process to consider exceptions to Standard Use Chemical List.		
Develop a Chemical Health and Safety Cap for chemical purchase and use.		
Explore toxics use reduction opportunities.		
Determine allowable quantities that can be purchased.		
Develop a receiving protocol that links to the chemical inventory.		
Form a review committee for purchases.		
Coordinate Staff Order Forms.		
Develop a review schedule for order requests.		
Provide an orientation to relevant staff.		
Conduct periodic evaluation of the guidelines.		

Modified from Massachusetts School Chemical Management Program Manual (2006)

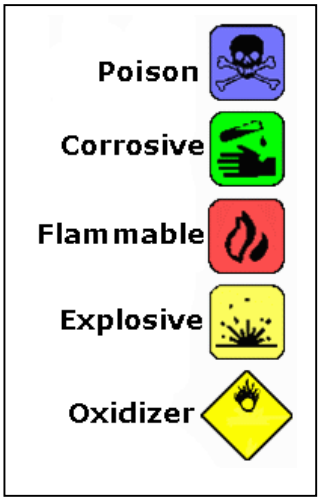
Table 16
Evaluation of Donation Acceptance

Criteria	Answer	Comments
Is the chemical needed?	Yes ❑ No ❑	
Do we need the quantity that they are offering?	Yes ❑ No ❑	
Is it what they say it is?	Yes ❑ No ❑	
Is the container opened?	Yes ❑ No ❑	
Is it contaminated?	Yes ❑ No ❑	
Is it in the original container?	Yes ❑ No ❑	
Is it in a used or new container relabeled properly?	Yes ❑ No ❑	
Is it in an intact container that is compatible with the product inside?	Yes ❑ No ❑	
What are the disposal costs?		
Do you have the storage facilities, staff training, safety and emergency response systems, and disposal system to manage it safely (hidden costs)?	Yes ❑ No ❑	
Have you checked the MSDS?	Yes ❑ No ❑	

Source: Massachusetts School Chemical Management Program Manual (2006)

Ordering Chemicals for educational use

Before ordering chemicals, teachers and other personnel should:



- Make sure the chemical is on the school system's list of approved chemicals if there is a list.
- Be capable of assessing the hazards of chemicals.
- Be sufficiently knowledgeable to recognize requests from others for nonessential chemicals.
- Have a current inventory of existing chemicals.

For each chemical used, ask the following questions:

- Can proper storage be provided for the chemical?
- Are the facilities appropriate for the use of the chemical?
- Will the chemical or its end products require disposal as hazardous waste?
- Is appropriate personal protective equipment available for safe use of the chemical or its end product?
- Have persons who will handle and use the chemical been trained in handling these chemicals? Are they aware of the hazards?

Chemicals should be ordered in quantities consistent with the rate of use. Order in polyethylene bottles or plastic coated bottles, if available, to minimize breakage, corrosion, and rust.

Chemicals Not on the List

Before making a request to use a chemical not on the school system's approved list or if there is doubt about its value, the requestor should read and research the appropriate MSDS to determine whether the chemical can be safely used with students.

The requestor also should consider the:

- Relative hazard level of the chemical.
- Educational value of using the chemical.
- Teacher's experience or lack of experience in using the substance.
- Degree to which the laboratory is equipped for the safe use of the chemical.

A requestor who wishes to use a substance not on the appropriate list should seek the permission of the science

supervisor or other person by submitting a written request. The request should include the following:

1. A copy of the lesson plan for the proposed demonstration or laboratory exercise.

2. Information supporting the following assertions:

- ✓ Use of the substance is pedagogically sound.
- ✓ The demonstration or laboratory exercise using the substance is an effective way to illustrate an important property, process or concept.
- ✓ No satisfactory substitute for the substance is readily available.
- ✓ Adequate safeguards are in place to ensure proper use of the substance.
- ✓ Students will be instructed in the proper handling of the substance (as indicated in the lesson plan).

3. Information on the following to enable the supervisor to make an informed decision:

- ✓ the extent of exposure of students and the teacher to the chemical (including estimate of time to the nearest minute).
- ✓ the age or maturity level of the students who will be exposed.

4. In considering a substance for use in the laboratory, teachers are advised to check hazardous materials lists available in print and on the Internet.

These general guidelines can be modified for chemicals used in the maintenance department, auto shop, office area, and other areas of the school.

Tables 17 through 20 provide tools for making decisions about ordering chemicals.

Source: School Improvement in Maryland (2008)

Table 17
Checklist For Purchasing Chemicals

To be completed by _____

Science Lab: Purchasing	Yes	No
1. Chemicals purchased in a manner consistent with the District's purchasing policy.		
2. One person or department designated with the responsibility of purchasing chemicals. (Basic knowledge of chemistry required).		
3. Purchasing procedure for personnel in place (i.e. purchase request forms etc.).		
4. Chemicals purchased in quantities needed for current school year only. Rate of use and and shelf-life considered in order to minimize purchase quantity.		
5. Chemicals not purchased if hazardous properties exceed educational value.		
6. Proper storage and ventilation requirements of chemical confirmed/met before purchase.		
7. Appropriate means of disposal for chemical determined before purchase (i.e. Is disposal as a hazardous waste required?).		
8. Adequate funds for appropriate and legal disposal of the chemical, or its end product, confirmed before purchase.		
9. Required safety precautions associated with chemical known before purchase.		
10. Proper protective/safety equipment necessary for chemical on hand before purchase.		
11. Environmental impact of chemical considered before purchase, (including manufacturing, use, disposal etc.). Alternatives considered if warranted.		
12. Reagents ordered in polythylene bottles or plastic coated glass bottles to minimize breakage, corrosion, and rust.		
13. A check is made of the chemical inventories in other locations for duplication or excess .		

Certification: I hereby certify that I have completed all of the above activities in fulfillment of my responsibilities as the Chemical Management Representative for my department.

_____ _____
Date School

_____ _____
Signature Name (print)

_____
Date Completed

Source: Modified from Chemical Cleanout Toolkit for Utah Schools (2008)

Table 18
Health and Safety Cap Criteria

It is recommended that the following chemicals or types of chemicals should NOT BE ALLOWED for purchase or use in your school (note that many chemicals will fall into more than one of these categories):

Chemicals with a flammability or reactivity rating of 4

Ratings are based on the MSDS, or the HMIS or NFPA rating system.

Chemicals that are explosive or that become unstable ("shock sensitive") as they age. This includes peroxidizable compounds (such as ethyl ether and picric acid).

Chemicals with a health rating of 4

Ratings are based on the MSDS, or the HMIS or NFPA rating system. Chemicals with a health rating of 4 are generally fatal at very low exposure levels. All mercury and mercury compounds are strong neurotoxins. Most salts of mercury are fatal at less than one gram.

Chemicals with a health rating of 3

These should be carefully reviewed before purchase. It may not be possible to totally eliminate use of these chemicals because some common laboratory acids are in this category, but many cancer-causing and other highly toxic materials have a rating of 3. Examples include lead and lead compounds which are strongly neurotoxic, and most, such as lead acetate, are suspected cancer-causing agents.

Chemicals that require use of a respirator

Respirator use requires a formal respirator program including medical monitoring and fit testing. This is not going to reasonably occur in the school environment for staff and students. Also, if the respirator fails, the student or teacher receives an exposure.

Chemicals with special storage requirements

Examples include elemental sodium and phosphorus, which must be stored under mineral oil; some chemicals must be stored in an explosion-proof refrigerator, etc. These storage requirements are usually not met due to financial and time constraints.

Gas Cylinders

Cylinders can be dangerous for two reasons: the compressed nature of the gas creates a handling hazard as well as an "explosive" hazard in storage, and the gas itself can be hazardous.

Chemicals with a regulatory designation of "Acutely Hazardous Substances"

If your school has any amount of "Acutely Hazardous Substance", your hazardous waste generator status is automatically classified at a minimum as a "Small Quantity Generator" (even if the total amount of your hazardous waste would normally classify you as a "Conditionally Exempt Small Generator"). Thus, you invoke the more stringent level of regulations.

Source: Massachusetts School Chemical Management Program Manual (2006)

Table 19

Hazardous Chemicals

Chemicals that may have a greater hazard than usefulness

(Not all-inclusive)

Acrylonitrile	Dichlorobenzene	Nickel, metal & oxide	Sodium, metal
Ammonium chromate	Dichloroethane	Nicotine	Sodium ferrocyanide
Aniline	Dimethylaniline	Osmium tetroxide	Sodium nitrate
Aniline hydrochloride	p-Dioxane	Oxygen, tank	Sodium sulfide
Anthracene	Ethers	Paris green	Sodium thiocyanate
Antimony trichloride	Ethylene dichloride	Phenol	Stannic chloride
Arsenic	Ethylene oxide	Phosphorus, red, white	Stearic acid
Arsenic chloride	Gunpowder	Phosphorus pentoxide	Strontium
Arsenic pentoxide	Hexachlorophene	Phthalic anhydride	Strontium nitrate
Arsenic trioxide	Hydrobromic acid	Picric acid	Sudan IV
Asbestos	Hydrofluoric acid	Potassium, metal	Sulfuric acid, fuming
Ascarite	Hydrogen	Potassium oxalate	Talc*
Benzene	Hydriodic acid	Potassium sulfide	Tannic acid
Benzoyl peroxide	Indigo carmine	Pyridene	Tetrabromoethane
Calcium cyanide	Lead arsenate	Pyrogallic acid	Thermite & compounds
Calcium fluoride	Lead carbonate	Saccharin	Thioacetamide
Carbon tetrachloride	Lead (IV) chromate	Selenium	Thiourea
Chlorine	Lithium (metal)	Silver cyanide	Titanium trichloride
Chloral hydrate	Lithium nitrate	Silver oxide	o-Toluidine
Chloretone	Magnesium powder	Silver nitrate	Uranium
Chloroform	Mercury	Sodium arsenate	Uranyl acetate
Chloropromazine	Mercuric chloride	Sodium arsenite	Uranyl nitrate
Chromium	Mesitylene	Sodium azide	Urethane
Chromium oxide	Methyl iodine	Sodium chromate	Vinylite
Chromium potassium sulfate	Methyl methacrylate	Sodium cyanide	Wood's metal
Chromium trioxide	Methyl orange*	Sodium dichloroindophenol	
Colchicine	Methyl red*	Sodium dichromate	

*Suggested alternatives: Methyl orange & Methyl red >>> Bromophenol blue & Bromothymol blue
Talc >>> Starch talc

Source: Dr. John Moody, Indiana University Southeast, derived from www.cs.ius.indiana.edu

Table 20
“Red Flag” Chemical List

H = This chemical is a regulated hazardous waste when discarded.
E = Explosion/fire hazard C = Carcinogen T = Toxic R = Reactive

HET	Acetaldehyde	HEC	Ethylene oxide
C	Acetamide	HCT	Formaldehyde
HE	Acetic acid (glacial)	HCT	Formic acid
HR	Acetic anhydride	HEC	Gasoline
HCT	Acrylamide	HTR	Hydrochloric acid (12M)
T	Adrenaline	HTR	Hydrofluoric acid
HR	Aluminum chloride	HER	Hydrogen peroxide (30%)
HTR	Amide compounds	HER	Hydride compounds
HETR	Ammonia gas	C	Hydroquinone
HR	Ammonium hydroxide (14.8M)	HTR	Iodine
HC	Aniline (or its salts)	TR	Iodate compounds
CT	Antimony compounds	HETR	Lead compounds
HCT	Arsenic powder & compounds	HER	Lithium metal
C	Asbestos	HT	Mercury & compounds
HETR	Azide compounds	HCT	Methylene chloride
HT	Barium & compounds	HE	Methyl ethyl ketone
HEC	Benzene	HE	Methyl isobutyl ketone
C	Benzidine	T	Napthalene
E	Benzoyl peroxide	CT	Nickel powder & compounds
HER	Benzyl alcohol	HCT	Nicotine
HC	Beryllium & compounds	HER	Nitrate & nitrite compounds
HTR	Bromine	HTR	Nitric acid (15.8M)
HTR	Bromate compounds	HECR	Nitro & nitroso compounds
HCT	Cadium powders & compounds	HER	Perchlorate compounds
T	Caffeine	HER	Perchloric acid
HER	Calcium carbide	HER	Peroxide compounds
HR	Calcium oxide	HT	Pesticides
HET	Carbon disulfide	HT	Phenol
HCT	Carbon tetrachloride	HR	Phosphoric acid (14.8M)
HER	Carbonyl compounds	HETR	Phosphorus (yellow/white)
HER	Chlorate compounds	HETR	Phosphorus pentoxide
HTR	Chlorine	E	Picric acid
HCT	Chloroform	HER	Potassium metal
HCT	Chromium powder & compounds	HR	Potassium permanganate
CT	Cobalt powder & compounds	HET	Pyridine
T	Colchicine	C	Pyrogallic acid
HER	Collodion (nitrocellulose)	HT	Selenium compounds
HT	Cresols	HCT	Silver compounds
HTR	Cyanide compounds	HT	Strychnine
HET	Cyclohexane & cyclohexene	HER	Sodium metal
HT	Dichlorobenzene	HR	Sulfide compounds
HC	Dichloroethane	HR	Sulfuric acid (18M)
HER	Diisopropyl ether	HCT	Tetrachloroethylene
HEC	1,4 Dioxane	HET	Toluene
HET	Ethyl ether	HCT	Trichloroethylene
HT	Ethylene glycol	HCT	Urethane (Ethyl carbamate)

Source: Modified from School Science Laboratory Chemical and Mercury Clean-out Project (2002)

Table 21

Request to Procure and Use a High Hazard Chemical

Please complete this form and give it to the Chemical Management Officer (CMO) for review. The CMO with the assistance of the Chemical Management Committee will make a final determination as to whether the chemical requested may be purchased. Incomplete response will automatically be denied. (Source: School Science Laboratory Chemical and Mercury Clean-out Project, 2002)

Faculty Name_____

Name of chemical requested_____

Common name, if any_____

Is this chemical on the "red flag" list? ☐ Yes ☐ No

Quantity requested_____

Name of supplier_____

Purpose of ordering this chemical:

Special handling or storage requirements?_____

Will the chemical be used by: ☐ Instructor only ☐ Whole class

Chemical will be used completely by:

☐ End of current semester ☐ End of next semester

☐ End of next school year ☐ In 2 years

What type of waste will be produced by this chemical?

☐ Hazardous waste: amt. vol._____
(to be stored for proper disposal)

☐ Non-hazardous waste (to be disposed of in trash)

☐ Non-hazardous waste (to be disposed of down the drain)

_____ _____

Faculty Signature CMO Signature (If Approved)

Date_____ Date_____

Environmentally Preferable Purchasing (EPP)

Environmentally Preferable Purchasing (EPP) is the practice of purchasing products that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose.

For EPP details, consult the MDEQ publication *The Green Industry Guide to Environmental Purchasing*.

MDEQ's EPP Website
(Environmentally Preferred Purchasing)
www.michigan.gov/deqp2initiatives

EPA's EPP Website
www.epa.gov/opptintr/epp/documents/labeling.htm
This website has guides for purchasing carpet, copiers, food serviceware, cleaning products, electronics, and other links.

Guide to Green Cleaning in Schools
http://healthyschoolscampaign.org/campaign/green_clean_schools/guide.php

Procurement can be the front line of defense against pollution and wasteful practices. It is simpler and less costly than end of pipe practices. Operations can be centralized so you have some control over what products are purchased. Large purchasers can drive national, even global markets.

The link between environment and procurement is:

- Recycled aluminum cans require 95% less energy to manufacture
- Using 1 ton of recycled paper saves 20 trees and 7000 gallons of water
- 100 Energy Star computers and monitors can save $10,000 in energy costs over 5 years

What are environmentally preferable products?

EP Products can include:

- Recycled content products
- Less toxic products
- Water conserving products
- Energy conserving products
- More durable products
- Biodegradable products
- Products with less packaging
- Renewable materials

Definitions:

- Post-consumer waste: generated by consumer after product has served its use
- Remanufactured product: has been made from existing product materials to meet normal specifications
- Recyclable product: can be recycled

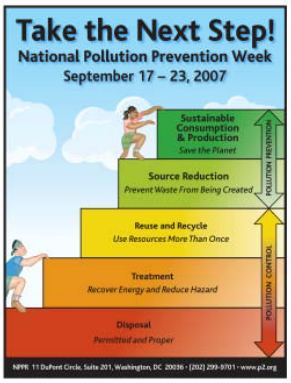
Why use EP Products?

- Greater demand will drive down prices.
- Many municipal recycling programs have periodic trouble selling collected materials.
- Buying recycled-content products will support these markets.
- Many vendors do not carry EP products because their customers have not asked for them.

Questions to consider when purchasing:

- Is the product non-hazardous or less hazardous when compared with competing goods?
- Is it reusable compared with competing goods and services?
- Is it made from recycled materials?
- Do we really need to buy a virgin product when the recycled version is just as good?
- What happens to it at the end of its life? Can it be recycled?
- Will the manufacturer take the product back?
- Will it require special disposal considerations?
- Does it conserve energy or water or result in saving money?
- Is it manufactured from plant-based or otherwise renewable raw materials?

Why is environmentally preferable purchasing important?



The purchase and use of environmentally preferable products can have a profound impact on the environment. Here are just a few of the many benefits:

- Buying less hazardous products will keep hazardous chemicals out of the soil, air, and water. It also reduces regulatory, environmental, and personal liabilities; improves worker safety; and can reduce disposal costs.
- Using energy-efficient and water-conserving products can save money.
- Products that are reusable, refillable, repairable, or more durable create less waste and are more cost-effective in the end than disposable or short term-use products.
- Buying recycled products help “close the loop” by supporting the recycled materials markets and more importantly conserves our natural resources.
- Using products made with renewable resources reduces our dependence on non-renewable resources.

Source: Michigan Department of Environmental Quality (2008)

Disposal Policies

Does your school or district have a disposal policy for school chemicals? Have funds been budgeted for proper disposal? It is important to realize that you may be held legally liable for your hazardous waste and any damage it creates even after it leaves your school and is transported to a treatment, storage, or disposal facility (Table 22). Under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as Superfund, you can be required to contribute to the costs of cleaning up any contamination resulting from your wastes wherever they may end up. Michigan has its own set of rules for hazardous waste management. With the public's ever-increasing concern about protecting the environment and the need for schools to serve as model global citizens, school laboratories must be careful to comply with all federal, state, and local regulations.

Where can I get more information?

Contact the MDEQ Waste and Hazardous Materials Division and your local wastewater treatment plant.

Assistance in determining your regulatory requirements can be found in the Michigan Guide to Understanding Hazardous Waste Management at www.michigan.gov/deq/0,1607,7-135-3312_4118_4240-10188--,00.html or by contacting the MDEQ Environmental Assistance Center at 1-800-662-9278.

For more disposal details, refer to references like the Flinn Catalog/Reference Manual and the American Chemical Society publications. University websites also may have valuable information.

DO:

DO maintain accurate records from the point of waste generation to waste disposal & final disposition. This is best done by using a manifest form and keeping an accurate filing system for these documents.

DO treat/neutralize wastes when permitted by meeting certain requirements.

DO store your wastes properly prior to disposal or recycling:

- Use containers in good condition and compatible with the wastes.
- Keep containers closed at all times except when adding or removing wastes.
- Place hazardous waste containers in a covered, secure storage area without floor drains and with secondary containment.

DO follow storage limits and permissible accumulation times.

DO segregate individual and incompatible hazardous waste streams.

DO keep nonhazardous wastes separate from hazardous wastes.

DO store recyclable wastes – like recoverable metals and solvents – separately from each other, as well as apart from nonrecyclable wastes.

DO store or package waste in small containers to prevent or reduce:

- decomposition of reactive compounds
- breakage and potential volume spilled
- exposure to hazardous materials
- area required for storage

DO package severe hazardous wastes (extreme poisons or toxins, severe flammable, corrosive or stench characteristics, strong oxidizers, or carcinogens) in 3 layers:

- place each chemical container in a clear heavyweight, sealable plastic bag;
- place the bag & contents on a thin layer of cat litter in the bottom of a sealable, compatible container;
- fill the remaining portion of the container with cat litter;
- and place the lid on the container and label the container clearly with the chemical name, chemical formula and hazard risk.
- add a proper label and date.

Students at North Star Academy in Marquette, Michigan learned about chemical waste, including the best way to store and dispose of it, and they are spreading their lessons to other area school districts. The students made an inventory of all the chemicals in the school, for instance those used in chemistry and science classes, and implemented a plan to dispose of the chemicals when no longer needed.

DO NOT:

DO NOT dispose any wastes in sinks or drains without prior approval from the local wastewater treatment department.

DO NOT dispose any wastes in sinks and drains that discharge to a septic tank system.

DO NOT dispose of any chemicals in the trash without assurance from your regulatory authority and solid waste disposal service.

DO NOT dispose of any chemicals by evaporation in a fume hood or other location unless authorized.

DO NOT mix incompatible wastes (e.g. ignitables and oxidizers).

DO NOT move any chemicals that have crystallized! Crystallized chemicals may explode if not handled with extreme care. Contact local officials and arrange for a disposal contractor to remove the crystallized chemicals.

Source: Chemical Cleanout Toolkit for Utah Schools (2008)

Table 22
A Waste Management Decision Tree

Check with the Michigan Department of Environmental Quality about hazardous waste management issues.

I have a waste

Is it hazardous? → Liquid or solid – it must be disposed as a hazardous waste

Is it non-hazardous? → Solid – it can go in the trash
Liquid – It might get approved to go down the drain of a municipal sewer.

Practices for Lab Chemical Waste Handling

1. Non-hazardous liquid wastes may be dried down – hazardous wastes may not.
    - Only the water, not the chemical, may be evaporated.

2. Chemical wastes awaiting proper disposal should be stored in a secure designated space.
    - Don't mix with virgin stock chemicals.
    - Don't store in the classroom.
    - Don't store in a hood.

3. Containers of waste awaiting proper disposal should be:
    - Kept in good condition and not leaking.
    - Kept closed, except for adding or removing waste.
    - Labeled to identify what they contain and an accumulation date.
    - Stored only with compatible wastes.
    - Stored inside and protected from freezing.

4. Avoid mixing hazardous and non-hazardous wastes.

Source: School Science Laboratory Chemical and Mercury Clean-out Project (2002)

C. Review curriculum for opportunities.

Laboratory Pollution Prevention

Pollution prevention (P2) means reducing or eliminating waste at the source by modifying processes, promoting the use of non-toxic or less-toxic substances, implementing conservation techniques, and re-using materials rather than putting them into the waste stream (Table 23).

Online videos can show a variety of chemical reactions.

Kent's Video Chemical Demonstrations
http://www.kentchemistry.com/KentsDemos.htm

Helpful Hints on Chemical Procedure and Chemical Demonstrations
http://www.csudh.edu/oliver/demos/index.htm

Lecture Demonstration Movie Sheets
http://chemed.chem.purdue.edu/demos/

Bob Becker's demonstrations
http://chemmovies.unl.edu/chemistry/beckerdemos/bd000.html

An interesting middle school unit:

Chemicals, the Environment, and You—developed with the National Institute of Environmental Health Sciences (NIEHS)—is a creative, inquiry-based instruction program.
http://science.education.nih.gov/supplements/nih2/chemicals/guide/guide_toc.htm

Pollution prevention accomplishes the following:

- Reduces the students' exposure to hazardous chemicals.
- Virtually eliminates fire or explosive hazards.
- Sharply reduces laboratory costs.
- Reduces the use of chemicals and promotes waste reduction at the source.
- Makes recycling easier (less material to recycle).
- Vastly improves laboratory safety.
- Improves laboratory air quality.
- Reduces the amount of spills and accidents.
- Teaches excellent laboratory techniques.
- Saves storage space.
- Provides a clean and productive environment.
- Teaches awareness of chemicals and their impact on the environment.

THE BOTTOM LINE: P2 is a cost-effective and safe strategy that any teaching institution can adopt. It is the best and easiest way to reduce costs, improve safety, and eliminate wastes. Elements include:

- Practice spill prevention. Provide secondary containment in the lab and in the classroom.
- Use hazardous chemicals and solvents sparingly or have only the instructor performing such experiments.
- Implement conservation practices in the lab. Use electricity, water, and chemicals sparingly.
- Establish a chemical exchange program within your facility or with area institutions.
- Make sure all chemical containers are properly covered and lids are tightly closed.
- Scale down your experiments.
- Consider using non-hazardous chemical alternatives.
- Conduct experiments that recycle and reuse chemicals.
- Purchase equipment to reclaim solvents and metals, etc.
- Separate hazardous waste from non-hazardous waste.

Source: Michigan Department of Environmental Quality (2008)

Table 23

Twenty-four Ideas to Help Reduce Your Hazardous Waste

The Chemical Waste Management section of the Division of Environmental Health and Safety at the University of Illinois at Urbana-Champaign (UIUC) has developed a list of ways to reduce hazardous waste in university research and teaching labs.

The following are excerpts adapted for high school chemistry laboratories:

1. Evaluate experiments and demonstrations to see if less hazardous or nonhazardous reagents could be used.
2. Purchase chemicals in smallest quantities needed.
3. Date chemical containers when received so that older ones will be used first.
4. If possible, establish an area for central storage of chemicals.
5. Establish an area for chemical waste.
6. Write a waste management/reduction policy.
7. Inventory chemicals at least once a year.
8. Centralize purchasing of chemicals through one person in the school.
9. Include waste reduction as part of student training.
10. Use manuals such as the American Chemical Society (ACS) "Less is Better" or "ACS Waste Management for Lab Personnel" as part of your training. Label all chemical containers as to their content so that they don't become "unknowns".
11. Develop procedures to prevent and/or contain chemical spills: purchase or make spill clean-up kits, use secondary containment in areas where spills are likely.
12. Segregate your wastes to reduce volume and cost for disposal:
    - Keep recyclable waste/excess chemicals separate from nonrecyclables.
    - Keep nonhazardous chemical wastes separate from hazardous waste.
    - Keep organic wastes separate from metal-containing or inorganic wastes.
    - Keep halogenated solvents separate from nonhalogenated solvents.
    - Keep highly toxic wastes (cyanides, etc.) separated from above.
13. Use the least-hazardous cleaning method for glassware. Use detergents such as Alconox, Micro, or Pierce RBS-35 on dirty equipment rather than/or before using KOH/ethanol bath, acid bath, or No Chromix.
14. Substitute red liquid (spirit-filled), bimetal, digital, or thermocouple thermometers for mercury thermometers.
15. Avoid the use of reagents containing barium, arsenic, cadmium, chromium, lead, mercury, selenium, and silver.
16. Consider the quantity and type of waste produced when purchasing reagents.
17. Purchase equipment that enables the use of procedures that produce less waste.
18. Review your procedures regularly (e.g., annually) to see if quantities of chemicals and/or waste could be reduced.
19. Look into the possibility of including detoxification and/or waste neutralization steps in laboratory experiments.
20. Scale down experiments producing hazardous waste wherever possible.
21. Use preweighed or premeasured reagent packets where waste costs are high.
22. Encourage orderly and tidy behavior in the lab.
23. Be wary of chemical "gifts" from outside the school. Chemical gifts can very easily become your "hazardous waste."
24. Use demonstrations or video presentations to replace experiments that produce large amounts of hazardous waste

Microscale Chemistry

Microscale chemistry is an environmentally safe pollution prevention method of performing chemical processes using small quantities of chemicals without compromising the quality and standard of chemical applications (Table 24). Instituting microscale laboratory techniques in chemistry teaching laboratories is one of the best ways to minimize the quantity of waste generated. It provides a means of source reduction and therefore waste reduction, increases the safety of students and provides for decreased purchasing costs of chemicals.

David Brook's website has microscale chemistry labs and movies.
http://dwb4.unl.edu/Chemistry/chemmovies.html

The National Microscale Chemistry Center
http://www.microscale.org/

ChemCollective
Online labs
http://ir.chem.cmu.edu

Colorado State University, National Small-Scale Chemistry Center,
http://www.smallscalechemistry.colostate.edu

State of Tennessee: School Lab Chemical Cleanout Campaign: Green Chemistry Experiments
http://www.state.tn.us/environment/sc3/greenchemistry.shtml

Microscale Chemistry offers many benefits in that it:

- Reduces chemical use and promotes waste reduction at the source.
- Offers vastly improved laboratory safety by
  - improving laboratory air quality.
  - reducing exposure to toxic chemicals.
  - preventing fire and explosion hazards.
  - minimizing spills and accidents.
- Sharply reduces laboratory cost.
- Requires shorter experiment time.
- Implements excellent laboratory manipulative techniques.
- Lowers glass breakage cost.
- Saves storage space.
- Improves laboratory skills.
- Provides a clean and productive environment.
- Promotes the principle of 3Rs: Reduce, Recover and Recycle.
- Creates the sense of 'Green Chemistry'.
- Changes the psychology of people using chemicals.
- Is user friendly to people with physical disabilities.

Source: Michigan Department of Environmental Quality

Table 24
Reduced Scale Chemistry

Science Lab: Alternative Options (Reduced Scale Chemistry)	Yes	No
1. Hazardous chemicals substituted with less toxic alternatives.		
2. Microscale experiments utilizing smaller quantities of chemicals frequently used.		
3. Chemicals recycled by performing cyclic experiments (i.e. product of reaction becomes starting material).		
4. Interactive teaching software, demonstration videos or classroom demonstrations used in lieu of experiments that generate large amounts of chemical waste or utilize hazardous chemicals		
5. Premeasured chemical packets used to reduce bulk chemical disposal problems.		
6. Containers dated upon arrival to track rate of use.		
7. Older chemicals used before opening new containers of same compound.		
8. Suppliers utilized that offer "chemical take back" system to annually dispose unused chemicals.		
9. Chemicals purchased in smallest quantity needed, reducing waste and leftover materials.		
10. Detoxification or waste neutralization steps utilized.		
11. Accurate inventory of all chemicals kept on-site to prevent expiration or loss of product and accumulation of chemical stockpiles.		

Source: Chemical Cleanout Toolkit for Utah Schools (2008)

Green Chemistry

Green chemistry consists of chemicals and chemical processes designed to reduce or eliminate negative environmental impacts. The use and production of these chemicals may involve reduced waste products, non-toxic components, and improved efficiency. In order for green chemistry to be incorporated effectively into chemical product and process designs, it first must be incorporated into the chemistry education system. For green chemistry to enter widespread practice, chemists must be educated about green chemistry during their academic and professional training.
U.S. EPA, Green Chemistry www.epa.gov

The basic principles of green chemistry are found in Table 25. Below are some resources on this topic.

American Chemical Society Green Chemistry Educational Resources
Green laboratory exercises.
http://www.acs.org

Green Chemistry Network
The GCN promotes awareness and facilitates education, training and practice of Green Chemistry in industry, commerce, academia and schools.
http://www.rsc.org/chemsoc/gcn/

Chemical Industry Education Centre
Introduces the themes of sustainable development and provides case studies from the chemical industry. The website is aimed at 11-16 year olds and the general public.
http://www.sustain-ed.org/

Greener Education Materials for Chemists
GEMs is an interactive collection of chemistry education materials focused on green chemistry.
http://greenchem.uoregon.edu/gems.html

Illinois Green Schools Website
Ideas and activities about how to green your lesson plan.
http://www.greeningschools.org/

Greening Across the Chemistry Curriculum
Modules on green chemistry.
http://academic.scranton.edu/faculty/CANNM1/dreyfusmodules.html

Recipe for Sustainable Science Curriculum
This curriculum, based on the 12 Principles of Green Chemistry, is designed to be a simulation of actual business methodology in which students are challenged to manufacture a crayon.
http://www.beyondbenign.org/outreacheducation/middleschool.html

Green Cleaning Pollution Prevention Calculator
http://www.ofee.gov/janitor/index.asp

Great Lakes Pollution Prevention Roundtable Sector Resources
Sector Resources are collections of records for both online and hard copy material related to a particular sector or a topic of interest across a wide variety of sectors.
http://www.glrppr.org/sectors/

Table 25
Principles of Green Chemistry

1. Prevent waste. Design chemical syntheses to prevent waste, leaving no waste to treat or clean up.

2. Design safer chemicals and products. Design chemical products to be fully effective, yet have little or no toxicity.

3. Design less hazardous chemical syntheses. Design syntheses to use and generate substances with little or no toxicity to humans and the environment.

4. Use renewable feedstocks. Use raw materials and feedstocks that are renewable rather than depleting. Renewable feedstocks are often made from agricultural products or are the wastes of other processes; depleting feedstocks are made from fossil fuels (petroleum, natural gas, or coal) or are mined.

5. Use catalysts, not stoichiometric reagents. Minimize waste by using catalytic reactions. Catalysts are used in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and work only once.

6. Avoid chemical derivatives. Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.

7. Maximize atom economy. Design syntheses so that the final product contains the maximum proportion of the starting materials. There should be few, if any, wasted atoms.

8. Use safer solvents and reaction conditions. Avoid using solvents, separation agents, or other auxiliary chemicals. If these chemicals are necessary, use innocuous chemicals.

9. Increase energy efficiency. Run chemical reactions at ambient temperature and pressure whenever possible.

10. Design chemicals and products to degrade after use. Design chemical products to break down to innocuous substances after use so that they do not accumulate in the environment.

11. Analyze in real time to prevent pollution. Include in-process real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts.

12. Minimize the potential for accidents. Design chemicals and their forms (solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

Source: Green Chemistry, U.S. EPA (2008)
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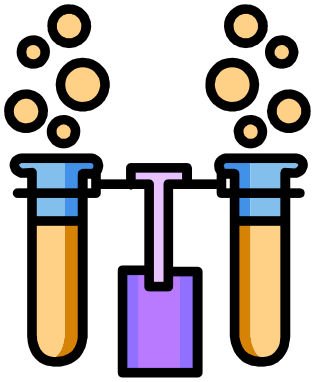
D. Offer chemical management and safety training to staff.

Chemical management and safety training are critical to maintaining healthy school environments. Teachers need to know about the chemicals that they and their students use, how to handle them safely, and ways to minimize their use.



Elements of this training could include information on the following topics:

- Chemical Management Plan for the school or district
- Hazard Communication Standard compliance
- Chemical spill response
- Hazardous waste handling
- Safety
- Curriculum considerations

Of particular interest on the resource CD for *Chemical Management in Schools* are:

- *School Chemistry Laboratory Safety Guide*
- Administrator guides
- *NIOSH Guide to Chemicals*
- Chemical management plan examples
- Template spreadsheets
- Curriculum materials

A qualified person from your school or district could use this publication, resources on the CD, websites, and your site specific plans to customize training for your school or district.

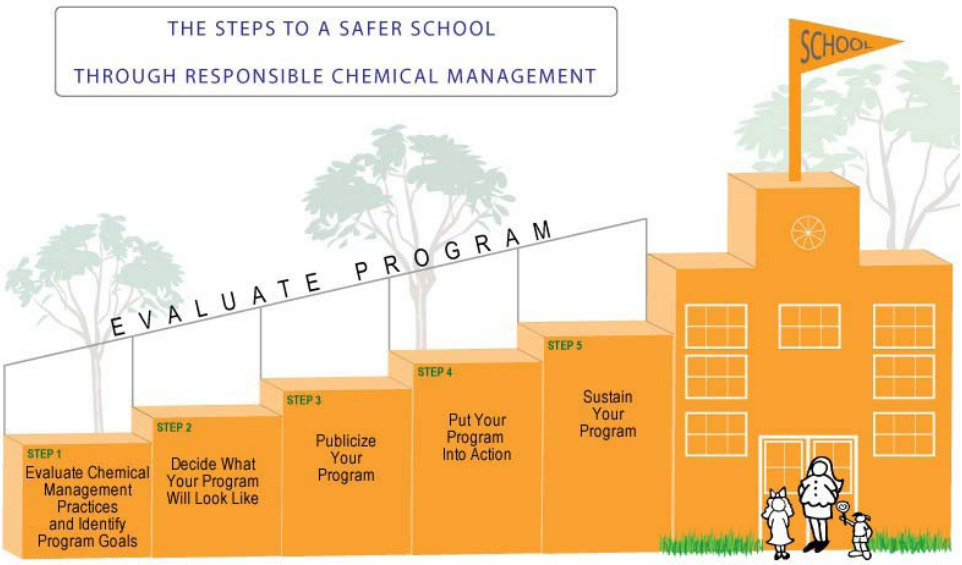
E. Periodically evaluate your progress and update your chemical management system as needed.

Chemical management in schools is an ongoing process. At minimum, the chemical management team should review progress each year. New staff should be encouraged to join the team. It is particularly important that there be a champion for the chemical management system who will make sure that the programs and practices are sustained. This champion should be in close contact with top administrators and decision-makers.

Continuous improvement should be a goal. An example of this would be to:

- Plan – Develop a plan for improving and predict the results.
- Do – Execute the plan, first on a small scale.
- Study/check – Evaluate feedback to confirm or to adjust the plan.
- Act – Make the plan permanent or make adjustments.

In summary, your Chemical Management Plan should be dynamic and sustainable. There should be short term and long term goals that are evaluated on a regular basis. Benchmarks for progress should be formulated and successes celebrated. Sound chemical management involves funding for initial chemical disposal, planning and implementation time, follow-through, training, and commitment from the entire school or district. The pay offs are healthy schools, cost savings and satisfaction that the right things are being done.



Source: U.S. EPA

Table 26
Chemical Management System Review

Chemical Management Plan	Questions to Consider	Comments	Date & Initial
Policy	Are we meeting our goals and objectives? Are there new goals & objectives?		
Roles & Responsibilities	Have people followed through with tasks? Are there changes in roles & responsibilities?		
Purchasing	Are purchasing requests done and tracked properly? Are "high hazard" chemical requests minimized? Were MSDSs obtained? Are surplus supplies redistributed?		
Storage	Are proper storage patterns for chemicals used? Is hazardous waste stored correctly?		
Inventory	Was an inventory of each chemical storage area conducted this year? Is the inventory on file and accessible?		
Use	Is chemical use tracked? Is it minimized?		
Curriculum	Did faculty review curricula for ways to minimize waste and chemical use? Are up-to-date-reference materials on microscale/green chemistry available?		
Waste Disposal	Are wastes inventoried? Are proper waste disposal methods followed?		
Chemical Spill Response	Are operational safety equipment and chemical spill materials available in the appropriate areas? Are safety signs posted? Are MSDSs readily accessible?		
Training	Have faculty and staff been made aware of the management plan? Has other training (e.g., chemical spill response, handling hazardous materials, MSDSs, etc.) been provided?		
Legal Requirements	Is the chemical management officer staying current on all legal requirements concerning storage, handling and disposal of chemicals?		

Adapted from School Science Laboratory Chemical and Mercury Clean-out Project (2002)

Chemical Management in Schools

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