XIII. Chemical Disposal

Federal, state/provincial, and local regulations govern the disposal of hazardous waste generated by school laboratories. In order to control this hazardous waste, schools must develop and implement waste minimization procedures. As defined in *Section II - Purchasing Your Chemicals*, effective waste minimization begins with smart and efficient purchasing. Make sure to buy only the amount of chemicals you need.

School chemistry classroom/laboratory experiments and demonstrations result in chemical hazardous waste. Initial disposal information is found on the chemical Safety Data Sheets (SDS's) for when it comes time to dispose of this waste. Since specific disposal requirements are government mandated and regulated, be sure to research specific requirements before any chemicals are even brought into your school. If you are not absolutely clear on these hazardous waste disposal requirements, call your local, provincial, or state government.

This section provides some useful guidelines on how to handle chemical and hazardous waste, and provides examples on how generate less waste in your laboratory. Waste minimization is not only good for the environment, but also reduces costs associated with chemical waste disposal.

All chemical waste should be disposed of through a central channel of responsibility. For example, a school with multiple chemistry laboratories and science teachers should set up a central waste disposal process, designating one individual to track, label, and handle all waste.

Chemical wastes include but are not limited to:

- Used or unneeded laboratory chemicals.
- Glassware and laboratory supplies contaminated with chemical residue.
- Contaminated materials resulting from chemical spill response.
- Paints, oils, pesticides, cleaners, etc.

Guidelines for Reducing Chemical Waste

<u>During Purchasing</u>

- Purchase chemicals in smaller container sizes. The contents of smaller containers are more likely to be utilized and would result in a less significant loss if subjected to degradation or contamination.
- Do not purchase chemicals in quantities that result in a long period if storage before depletion. This can jeopardize the chemical properties over time and create hazardous storage conditions.
- See *Section II – Purchasing Your Chemicals* for detailed information.

<u>Storage Concerns</u>

- Store chemicals according to manufacturers' recommendations. Following the manufacturers' special storage requirements will maximize the shelf life of the chemical.
- Date and store new chemicals in a manner that enables the older chemicals to be used first.
- Label all containers that contain or will contain chemicals. Use the complete common chemical name to identify each container's contents.
- Replace damaged caps and lids, and make sure they are on securely at all times. This will limit air and moisture contamination to the contents.

- Inventory the chemicals in your laboratory every month. Replace worn and damaged labels. Be sure chemicals are stored by compatibility rather than alphabetically. Dispose of chemicals that are no longer needed.
- Dispose of chemicals that tend to form peroxides, become more reactive with time, or are approaching the end of their shelf lives.
- See *Section VI – Storing Your Chemicals* for detailed information on chemical storage.

Unused Chemicals and Hazardous Waste Disposal

1. All leftover materials and washings from an experiment should be considered hazardous waste unless clearly identified otherwise.
2. Only non-contaminated paper towels should be placed in the regular trash. Paper towels that were used to wipe up solid chemical waste are considered hazardous solid waste and should be disposed of accordingly. Used filter paper is also hazardous waste unless clearly proven otherwise.
3. It is the responsibility of the teacher to instruct his or her students on the handling of chemical waste.
4. Teachers should provide each student with a beaker for all liquid waste, which includes aqueous solutions, reaction products, and washings.
5. Students should inform the teacher when the beaker becomes full, and never dispose of any hazardous waste themselves.
6. If the object being disposed of has precipitated solids, decant the solvent into a liquid waste flask so only the solids remain. Dispose of the hazardous solid separately from the solution.
7. Poisonous and reactive compounds, such as concentrated organic peroxides, should be disposed of in individual containers.
8. Label containers specifically for solid waste.
9. Provide containers for recyclable and used paper products when needed.
10. Provide a separate container for glass trash.

Getting Rid of Your Hazardous Waste and Residual Chemicals

Waste chemicals can be disposed of in a number of ways, depending on the specific substance. These include disposal in sanitary landfills; hazardous waste landfills; sewer systems; or by incineration, recycling, or reuse. Chemicals can also be treated by chemical, physical, or biological processes, including neutralization, oxidation, precipitation, and solidification. The process for disposal must be in compliance with requirements as regulated by the Environmental Protection Agency (EPA), Environment Canada, local/provincial regulations, and as recommended by the American Chemical Society (ACS).

There are a number of options to relieve your school of unneeded and waste chemicals. Residual waste resulting from experiments and demonstration can be handled using one of the listed disposal methods. This information is also valid for surplus chemicals that are still usable.

Before using a method, clearly identify your disposal options, and if needed, consult the various available resources. Some of these include:

- Local, or provincial/state department of education, or an officer of your province/state's science teacher's professional association. Many areas have resources to supply information on successful existing programs.
- The chemistry department of a nearby college or university. They can inform you about the disposal processes they use, and may even be able to use your surplus chemicals.
- Contact other local chemistry teachers for advice on the correct compliance methods for disposal

in your area and double-check sources of their information.
- Contact the American Chemical Society (ACS) for information.
- Information on the Internet is plentiful. Start with federal requirements and work your way down to local and municipal requirements. All the information identified above can be found using the Internet. Using it wisely can answer most of your questions very effectively.

Based on your chemical and waste, select an option for handling these residual chemicals.

- Always check the local regulations before determining which of the disposal methods is best for you. If you are unsure if a method is permitted, positively verify it before proceeding.
- Consider the cost of your options, but never determine a disposal method for cost or convenience at the price of safety.
- Pay a certified, approved hazardous waste disposal firm to remove these materials. There is a cost associated with this, but its safety benefits to you and the school cannot be overstated.
- Find out if there are any other schools in your district, or organizations in your area, that need to dispose of laboratory chemicals and suggest a partnership with them to share the expenses.

Taking Care of Disposal Yourself

If you decide to dispose of the chemicals yourself, use the following information to do so safely. Ward's Science is providing this information for your convenience. These options are viable ONLY if they fall within the guidelines defined by the regulatory agencies in your area. If you decide to handle disposal yourself, it is important to do it safely. Provisions for the safely disposing of your hazardous chemicals include:

- Wearing personal safety gear including gloves, safety glasses/goggles, etc.
- Working under a fume hood.
- Making sure a fire extinguisher and response materials are present at all times.
- Working with an assistant at all times. Never dispose of chemicals by yourself!
- Gaining a full knowledge of the disposal process procedures, from beginning to end, before you start. (If you are completing chemical elimination through chemical methods, such as neutralization, first practice the procedure with small amounts to verify knowledge of the process, to ensure reactions (i.e., heat generation) and final results. Once knowledge of process is verified and can be completed without any surprises, the balance of the waste product can be processed.)

Disposing of Non-Hazardous Waste Chemicals as Trash

The following guide was prepared by Cornell University Environmental Health and Safety (EH&S) and adapted for the school chemistry teacher. Keep in mind that these references were approved by the NY DEC and regulatory authorities for Cornell University, and are provided in this manual as alternatives for your school. The guide lists solid chemicals that are not considered hazardous and that can disposed with regular trash. You should securely package waste for disposal, and personally transport it to the dumpster. Always check with your local municipality for rules and regulations in your area.

Not Considered Hazardous and can be properly disposed in the trash.

A. *Organic Chemicals*

Enzymes
Sugars and sugar alcohols
Starch
Naturally occurring amino acids and salts

Citric acid and its Na, K, Mg, Ca, NH_4 salts
Lactic acid and its Na, K, Mg, Ca, NH_4 salts

B. ***Inorganic Chemicals***

Silica
Sulfates: Na, K, Mg, Ca, Sr, NH_4
Phosphates: Na, K, Mg, Ca, Sr, NH_4
Carbonates: Na, K, Mg, Ca, Sr, NH_4
Oxides: B, Mg, Ca, Sr, Al, Si, Ti, Mn, Fe, Co, Cu
Chlorides: Ca, Na, K, Mg, NH_4
Borates: Na, K, Mg, Ca

C. ***Laboratory Materials Not Contaminated with Hazardous Chemicals***

Chromatographic adsorbent
Glassware
Filter papers
Filter aids
Rubber and plastic protective clothing

Other examples of non-hazardous biochemicals include polysaccharides, nucleic acids and naturally occurring precursors, and dry biological media.

Packaging Instructions:

1. **Package securely for the dumpster** by using at least two layers of packaging so that material cannot spill during collection.
2. Leave label on innermost container.
3. Label outer container "Non-hazardous" waste.
4. **Place containers in the dumpster yourself**. Custodians should not handle even non-hazardous laboratory chemicals.

Sanitary Drain Disposal of Laboratory Waste Chemicals

The following guide was also prepared by Cornell University Environmental Health and Safety (EH&S) and adapted for the school chemistry teacher. Keep in mind that these references were approved by the DEC and regulatory authorities for Cornell University, and are provided in this manual as alternatives for your school. Verify compliance with your local regulations and wastewater treatment facility before initiating disposal of any amounts of identified chemicals.

It is the responsibility of the school chemistry teachers to make sure that chemical waste generated from their activities is disposed of properly. Some materials can be safely discharged into the sanitary sewer, while others can cause significant health problems for people or have adverse effects on the environment. If the amount of discharge is considerable, it could affect the functioning of the servicing wastewater facility. Such chemicals can form sludge to the point that it has to be reclassified as a hazardous waste where otherwise it might have been recycled.

Chemistry teachers should reference the following information before undertaking drain disposal of any lab

chemicals.

- Only the materials found on the safe list can be discharged down the SANITARY drain.
- Drain disposal must only be used when the drain flows to a sanitary sewer system that eventually goes to the wastewater treatment plant. Storm drain systems flow directly into surface water and should ***NEVER*** be used for chemical disposal. *Floor drains may flow to storm sewers and should never be used for disposal.* Only use laboratory sinks for disposal of chemicals on the safe list as discussed below.
- Quantities of chemical waste for drain disposal should be limited generally to a few hundred grams or milliliters or less per day. Larger amounts should have prior approval from your local authorities and waste water treatment facility. Only materials listed in this document as safe for drain disposal are approved for drain disposal in quantities up to 100 grams or 100 milliliter per discharge. Disposal should be followed by flushing with at least 100-fold excess of water.
- **Note:** Sulfuric, hydrochloric, acetic, and phosphoric acids may be discharged in larger quantities only if they are neutralized to a pH of between 5.5 and 9.5 before they can be drained to the sanitary sewer.
- Understand the hazards and toxicity of the materials you work with by consulting Safety Data Sheets. Work slowly to avoid splashes and wear the proper protective equipment (lab coat, goggles, face shield, gloves) during drain disposal.

Safe for Drain Disposal

The following materials are examples of chemicals that are safe for laboratory sink drain disposal as long as they do not contain any materials that are prohibited from drain disposal.

- Aqueous solutions with 5.5 > pH <9.5
- Neutralized acids and bases with 5.5 > pH < 9.5
- Enzymes
- Proteins
- Sugars
- Citric acid
- Lactic acid
- Sodium, potassium, magnesium, calcium or ammonium salts
- Autoclaved or disinfected biological liquids
- Starches
- Naturally occurring amino acids

Check with your local municipality for a list of materials that may be safe for drain disposal in your area.

Inorganics

Dilute solutions of inorganic salts, where both cation and anion are listed below, are suitable for drain disposal. Materials listed are considered to be relatively low in toxicity. Compounds of any of these ions that are strongly acidic or basic should be neutralized before drain disposal.

Cations	**Anions**
Al^{+3}	BO_3^{-3}
Bi^{+3}	$B_4O_7^{-2}$
Ca^{+2}	Br^-
$Cu^{+, +3}$	CO_3^{-2}
$Fe^{+2,+3}$	Cl^-
H^+	HS^-
K^+	HSO^{-3}
Li^+	I^-
Mg^{+2}	OCN^-
Na^+	OH^-
NH_4^+	NO_3^-
Sn^{+2}	PO_4^{-3}
Sr^{+2}	SCN^-
$Ti^{+3, +4}$	SO_3^{-2}
Zn^{+2}	SO_4^{-2}
Zr^{+2}	

- Mineral acids and bases should be neutralized to a pH level in the 5.5-9 range before disposal.
- Copper and zinc have specific discharge limits set by sewage treatment plants. Contact your local wastewater facility prior to discharging any copper or zinc.

Materials *Prohibited* From Drain Disposal

- Ashes, cinders, sand, mud, straw, shavings, metal, glass, rags, plastics, wood, paint residues, and solid or viscous substances capable of causing obstruction to the flow of sewers.

- Some chemicals that are ***not safe*** for drain disposal include:
    - Halogenated hydrocarbons
    - Mercury and mercury compounds
    - Nitrocompounds
    - Mercaptans
    - Flammables (immiscible in water)
    - Explosives such as azides and peroxides
    - Water soluble polymers (potential to form gels that block sewers)
    - Water reactive materials
    - Malodorous materials
    - Toxic chemicals such as carcinogens, mutagens, and teratogens
    - Radioactive materials
    - Materials with pH < 5.5 or pH > 9.5 (Neutralized acids and bases may be eligible for drain disposable if there are no other restrictions on the material)

- Grease, oil
- Animal products (tissue, blood, hair, bones, etc.)
- Non-aqueous solutions with a flashpoint < 60° Celsius (140° Fahrenheit) such as gasoline, benzene, xylene, bromates, etc.
- Mixtures that have a component not found on the safe list.
- Any other material not found on the safe list.

This list is by no means exhaustive. If you are not certain about drain disposal for a particular material, dispose of it as hazardous waste or contact your local municipality for instructions.

Materials That Are Not Legally Disposable

As a prerequisite to shipping chemical waste, the identity of the material must be established. A potential problem in any laboratory is "orphan" waste. Orphan waste is unidentified material left behind by students and/or a teacher. Contact your local municipality for proper disposal methods in your area. The best method of dealing with such "orphan" waste is to prevent its occurrence by removing as much chemical waste as possible at the time of its creation.

Heavy Metals Disposal

Heavy metals have been banned from land disposal. Alternate methods of treatment and disposal are under investigation; however, none of these have received final federal approval. Disposal should be subcontracted to a certified and approved waste disposal organization. Only the teacher should separate mercury from glassware (such as thermometers and manometers), using proper precautions. All heavy metal compounds should be kept separate from other materials to facilitate proper disposal.

- **Non-Chemical Paraphernalia Disposal**
  Plasticware, disposable gloves, glassware, paper towels, and tools that are contaminated with chemical waste, must be disposed of through a certified and approved waste disposal organization. Such items should be decontaminated and reused if possible. The appropriate method of decontamination is based on the chemical waste and information found on the SDS. When washing these items, *the resulting rinsing solution will be considered chemical waste.* For disposing of empty bottles, regulations require that they be rinsed three times, with a 30-second drain time between rinses, before being discarded or reused.

The Five Most Common Laboratory Waste Handling Errors

It is the science teacher's responsibility to manage laboratory hazardous waste. This task does not need to be overwhelming. Clearly understanding the hazards involved, being persistent in your maintenance, and instituting safe and effective control measures should establish an effective routine. But remember: never become complacent in your handling of chemical wastes. The five most common mistakes in handling hazardous waste in the laboratory are listed below.

1. **Improper Labeling of Waste Containers**
    - Failing to label a waste bottle.
    - Storing waste in a bottle labeled inappropriately or only as "Waste". Per regulatory requirements, waste containers must always be clearly labeled as "Hazardous Waste".

2. **Improper Isolation of Waste**
    - Mixing incompatible chemicals in a single waste container.

3. **Improper Storage of Waste**
    - Storing waste in a fume hood where experiments are being performed.
    - Using metal cans for waste. Depending upon the pH of a substance, the metal container can easily be corroded. Use only glass or polyethylene containers for waste.
    - Storing flammable waste containers on a bench or floor. Store your flammable waste containers in an approved flammable storage cabinet.
    - Storing waste bottles in or near a sink or floor drain. This could allow hazardous waste to enter the sewer.

4. **Failure to Securely Cap Waste Bottles**
    - Leaving the cap off a waste bottle. The only time a cap should be off a waste bottle is when you are putting waste into it.
    - Leaving a funnel in the waste bottle. The funnel can easily be removed and used in another waste bottle, resulting in an accident.

5. **Accumulation of Excessive Waste**
    - You should have no more than ONE bottle of each kind of waste in your laboratory**.**

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