# From Cradle to Grave: Waste Management for Conservators

## A Special Insert Contributed by

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The moment you open and use a can of solvent you are a waste generator. Conservation laboratories might only produce 10–15 gallons of waste each year and private conservators only one quart, but the improper disposal of even small quantities may cause health, safety, and legal problems.

Although conservators are well aware of the dangers involved in working with chemicals on a daily basis and articles have been written suggesting methods for proper storage, most conservators do not know how to go about safely disposing of these chemicals after having used them. Some of these materials are highly toxic and many are incompatible when mixed together.

Proper disposal requires knowledge of federal and state regulations applying to the disposal of hazardous materials. It is incumbent upon conservators to contact their state and local officials to determine exactly what regulations apply in their instance, because the conservator, as a waste stream generator, bears the responsibility for ensuring that their waste is dealt with in a safe and environmentally sound manner. The regulations can be quite complicated; thus, this article is just a brief introduction into the issues of handling hazardous waste, and serves as a brief guide for the conservator.

The most important regulation governing hazardous waste is the Resource Conservation and Recovery Act (RCRA), whose primary goals are "to protect human health and the environment from the potential hazards of waste disposal, to conserve energy and natural resources, to reduce the amount of waste generated, and to ensure that wastes are managed in an environmentally sound manner." The basic tenet of this regulation is a "cradle-to-grave" tracking system, meaning that hazardous waste generators (users of hazardous materials who generate hazardous waste) must track waste from the moment it enters the site as a hazardous material to the eventual treatment or disposal of that material. This regulation requires hazardous waste generators to bear the responsibility of dealing with hazardous materials in a responsible way. Interesting to note is that the responsibility of hazardous waste may go beyond the grave, making the waste generator responsible (in part) for the waste handler's actions. Thus, if the handler does a poor job and pollutes the environment, the generator may be responsible for cleanup.

## AN OVERVIEW OF PERTINENT REGULATIONS

Congress has been concerned with the waste issue as far back as 1965 when it passed the Solid Waste Disposal Act. In 1976, Congress remodeled the Solid Waste Disposal Act, which dealt with nonhazardous waste, into RCRA. These environmental acts were then turned into federal regulations called the Code of Federal Regulations (CFRs) by the Environmental Protection Agency (EPA). All environmental regulations are found in the 40 CFRs. For the most part, the RCRA regulations are found in 40 CFR Parts 260 through 282.

In 1980, EPA issued regulations detailing the responsibilities for hazardous waste generators, transporters, and management facilities. Among these regulations were two broad exclusions: households and small businesses that generated less than 1,000 kilograms per month of hazardous waste. Amendments to RCRA in 1980 created three classes of generators, depending upon the amount of waste that one would produce per month. Please note that this discussion does not include "acutely hazardous waste" (see acutely hazardous list, under RCRA 40 CFR 261). Smaller quantities of "acutely hazardous waste" change the category for the generator. The three generator classes are:

1. large-quantity generators (LQG) that generate greater than 1,000 kilograms of hazardous waste per month

2. small-quantity generators (SQG) that generate between 100 and 1,000 kilograms of hazardous waste per month

3. very-small-quantity generators or conditionally small-quantity generators (CESQG) that generate less than 100 kilograms of hazardous waste per month.

Congress gave EPA the discretion as to whether they should issue regulations for the very-small-quantity generators. CESQGs are exempted from full regulation. This means they must follow only some of the regulations. The section defining the smallest amount of waste generated is of most concern to conservators and can be found in 40 CFR Part 261.5, "Special requirements for hazardous waste generated by conditionally exempt small-quantity generators."

The regulation, 40 CFR Part 261.5, is divided into ten paragraphs labeled (a) through (j). Paragraph (a) gives the definition of the conditionally exempt small-quantity generator (CESQG) that describes the amount of waste generated as less than 100 kilograms of hazardous waste in a month. Paragraph (b) gives the exemptions for the CESQG. Paragraphs (c) and (d) spell out the rules that a generator needs to follow when determining how much hazardous waste they generate in a month. Paragraphs (e) and (f) indicate the increasing restrictions on CESQGs that generate acutely hazardous waste. A generator is allowed to generate one kilogram of acutely hazardous waste in a month. If any more is generated, it becomes a SQG and subject to more stringent regulations. Paragraph (g) is a very important section and spells out the CESQG's requirements for handling its hazardous waste. Paragraphs (h) through (j) give rules for mixing hazardous waste with nonhazardous waste.

Individual states can either adopt the federal regulations as they are written in 40 CFR or can be authorized to run their own RCRA program. States can write their own regulations as long as those regulations are *at least as stringent* as the federal requirements. It must be noted that it is very difficult to stay current on state requirements. Sources concerning state requirements that were used for this article date back to 1993. Regulations for each state may have changed in the last eight years. Thus, if you are responsible for the waste at your place of work, check with your state's environmental regulatory agency for an update on the regulations that cover conditionally exempt small-quantity generators.

A comparison of the three categories for waste generators and their requirements can be found in Table 1, but some of the most salient differences are described here:

- EPA generator identification numbers are required by LQGs and SQGs. This generator identification number follows the hazardous waste from the point of generation to final disposal. Under federal regulations, the CESQG is not required to

obtain this EPA generator identification number.
• Hazardous waste manifest documents are required by LQGs and SQGs when shipping hazardous waste. This documentation provides information about the waste, where it is going when shipping, and must travel with the waste. Under federal regulations, CESQGs are not required to provide this manifest when shipping their hazardous waste.
• Permitted or interim status Subtitle C waste management facilities must be used by LQGs or SQGs. The federal government does not require CESQGs to use these Subtitle C waste management facilities.
• Reporting to the EPA on a biannual basis is a requirement for LQGs. Under federal regulations, CESQGs are exempt from this requirement.

For the most part these exemptions were established so as not to put an undue financial burden on the small business population; however, the CESQG is not exempt from all regulations. Thus we have paragraph (g):

In order for the hazardous waste generated by a conditionally exempt small-quantity generator in quantities of less than 100 kilograms of hazardous waste during a calendar month to be excluded from full regulations under this section, the generator must comply with the following requirements (40 CFR Part 261.5.g).

There are three requirements that all waste generators must follow:

**1. Identify Your Hazardous Waste**

Any generator who is responsible for determining if their waste is hazardous according to 40 CFR Part 262.11, must ask three questions:

(i) Is my waste excluded under 40 CFR 261.4?

(ii) Is it listed as a hazardous waste in Subpart D of 40 CFR Part 261?

(iii) Does it show any hazardous characteristics as identified in Subpart C of 40 CFR Part 261?

Many materials used in the conservation studio can be considered hazardous. Common materials such as acetone, alcohol, xylene, adhesives, and their mixtures are all considered hazardous, and the level of hazard can often be found in the materials safety data sheet for the product (MSDS).

Wastes are classified by EPA terminology. Lists of wastes that are hazardous under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, the regulations governing the cleanup of hazardous waste sites) can be found in 40 CFR 302. Wastes that are hazardous under RCRA are listed in 40 CFR 261 or are classified as hazardous according to one or more of the following characteristics:
• Ignitable: a material that burns readily (applies to liquids with specific flash points, oxidizers, a material that can cause spontaneous chemical change, or ignitable compressed gases)
• Corrosive : an aqueous material of specified acidic or basic nature, or a liquid that can corrode steel at a particular rate
• Reactive : explosive, violently, or vigorously active
• Toxic: a waste that contains one of a specified group of heavy metals, organic toxicants, and pesticides at a particular level (by EPA-approved methods).

There are more than 500 specific hazardous wastes, some of which the conservator is quite familiar, such as asbestos, benzene, arsenic, lead and mercury. However, a material is not considered a hazardous waste unless it has been designated so by the person or entity holding that material.

**2. Comply with Storage Quantity Limits**

As seen above, storage quantity limits vary for the type of generator, as well as for the type of chemical waste under consideration. The CESQG may accumulate its hazardous waste on-site indefinitely provided the total amount of waste accumulated does not exceed 1,000 kilograms at any one time. The CESQG must move its hazardous waste to an acceptable waste management facility before it exceeds the 1,000 kilogram limit or face more stringent requirements set for SQGs. Please note that these accumulation rules depend upon state and local regulations (see section on Exceptions by State).

Many hazardous wastes are liquids and are measured in gallons or liters, not pounds. In order to measure the amount of liquid wastes, gallons or liters must be converted to pounds or kilograms. A rough guide is that 30 gallons (about half of a 55-gallon drum) of waste with a density similar to water weighs about 220 pounds (100 kilograms). Of course, small quantities can simply be weighed on a balance.

The generator must keep track of the amount of waste generated each month. There are occasions when the generator may change its generator class depending upon the amount of waste generated for each month. In many cases, small businesses that fall into different generator categories at different times choose to satisfy the more stringent requirements to simplify compliance. Other details such as smaller quantities of "acutely hazardous waste" will place the generator in the next higher category. Thus it is very important to

## Federal Regulations and Their Acronyms

- Clean Air Act (CAA)
- Clean Water Act (CWA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Department of Transportation (DOT)
- Environmental Protection Agency (EPA)
- Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
- Hazardous and Solid Waste Amendments (HSWA)
- Resource Conservation and Recovery Act (RCRA)
- Superfund Amendments and Reauthorization Act (SARA)
- Toxic Substances Control Act (TSCA)

**Table 1**

| CESQGs | SQGs | LQGs |
|---|---|---|
| **Hazardous Waste Determination:** Identify all hazardous wastes generated. Measure the amount of hazardous waste generated per month to determine your generator category. | **Hazardous Waste Determination:** Identify all hazardous wastes generated. Measure the amount of hazardous waste generated per month to determine your generator category. | **Hazardous Waste Determination:** Identify all hazardous wastes generated. Measure the amount of hazardous waste generated per month to determine your generator category |
| **Comply with Storage Quantity Limits:** No more than 2,200 pounds (1,000 kilograms) of hazardous waste on-site at any time. | **Comply with Storage Quantity Limits:** No more than 13,228 pounds (6,000 kilograms) of hazardous waste on-site for up to 180 days without a permit. | **Comply with Storage Quantity Limits:** Accumulate waste for no more than 90 days without a permit. |
| **EPA Identification Number:** No federal requirement (check with state requirements) | **EPA Identification Number:** Obtain a copy of EPA Form 8700–12, fill out the form, and send it to the contact listed with the form. An EPA identification number will be returned to you for your location. | **EPA Identification Number:** Obtain a copy of EPA Form 8700–12, fill out the form, and send it to the contact listed with the form. An EPA identification number will be returned to you for your location. |
| **Managing Hazardous Waste On-Site:** No federal requirement (check with state requirements) | **Managing Hazardous Waste On-Site:** Accumulate waste in:<br>• Containers;<br>• Tanks;<br>and comply with specified technical standards for each unit type.<br>Comply with Preparedness and Prevention requirements. Prepare safety guidelines for emergencies. | **Managing Hazardous Waste On-Site:** Accumulate waste in:<br>• Containers;<br>• Drip pads;<br>• Tanks;<br>• Containment buildings;<br>and comply with specified technical standards for each unit type.<br>Comply with Preparedness and Prevention requirements. Prepare written Contingency Plan. Train employees in hazardous waste management and emergency response. |
| **Recordkeeping and Biennial Report:** No federal requirement (check with state requirements) | **Recordkeeping and Biennial Report:** No federal requirement (check with state requirements) | **Recordkeeping and Biennial Report:** Retain specified records for three years. Submit biennial report by March 1 of even numbered years covering generator activities for the previous year. |
| **Prepare Hazardous Waste for Shipment Off-Site:** No federal requirement (check with state requirements) | **Prepare Hazardous Waste for Shipment Off-Site:** Package, label, mark, and placard wastes following Department of Transportation requirements. Ship waste using hazardous waste transporter. | **Prepare Hazardous Waste for Shipment Off-Site:** Package, label, mark, and placard wastes following Department of Transportation requirements. Ship waste using hazardous waste transporter. |
| **The Manifest:** No federal requirement (check with state requirements) for a manifest. You must ensure proper treatment and disposal of your waste. | **The Manifest:** Ship waste to hazardous waste treatment, storage, disposal, or recycling facility. Ship hazardous waste off-site using the manifest system (EPA Form 8700–22) or state equivalent. | **The Manifest:** Ship waste to hazardous waste treatment, storage, disposal, or recycling facility. Ship hazardous waste off-site using the manifest system (EPA Form 8700–22) or state equivalent. |
| **Comply with Land Disposal Restrictions:** No federal requirement (check with state requirements) | **Comply with Land Disposal Restrictions:** If you choose to treat on-site, ensure that wastes meet treatment standards prior to land disposal. Send notifications and certifications to TSDF as required. Maintain waste analysis plan if treating on-site. | **Comply with Land Disposal Restrictions:** Ensure that wastes meet treatment standards prior to land disposal. Send notifications and certifications to TSDF as required. Maintain waste analysis plan if treating on-site. |
| **Export/Import Requirements:** No federal requirement (check with state requirements) | **Export/Import Requirements:** Follow requirements for exports and imports, including notification of intent to export and acknowledgement of consent from receiving country. | **Export/Import Requirements:** Follow requirements for exports and imports, including notification of intent to export and acknowledgement of consent from receiving country. |

check the regulations and state contacts for more details that may apply to specific situations.

Measurement of hazardous waste must occur as waste is accumulated, before disposal or recycling. Some examples of wastes that are specifically exempted from counting include

- all quantities hazardous wastes that are packaged and transported away from your business
- wastes that might be left in the bottom of containers that have been thoroughly emptied through conventional means such as pouring or pumping
- all quantities hazardous wastes that are placed directly in a regulated treatment or disposal unit at your place of business
- wastes that are reclaimed continuously on site without storing prior to reclamation, such as dry-cleaning solvents
- wastes that are discharged directly to publicly owned treatment works (POTWs) without being stored or accumulated first
- wastes that have already been counted once during the calendar month, and are treated on site or reclaimed in some manner, and used again

### 3. Ensure Proper Treatment

The waste generator must manage their hazardous waste either in an on-site or off-site waste management facility that is permitted or in interim status under the Subtitle C hazardous waste management facility standards; a state permitted, licensed, or registered municipal or industrial solid waste facility; or a facility that beneficially uses, reuses, or legitimately recycles or reclaims waste, or treats waste prior to beneficial use, reuse, or legitimate recycling or reclamation. Requirements for the type of waste management facility vary by generator type and state regulations.

If you treat or dispose of your hazardous waste on-site, your facility must also be

- a state or federally regulated hazardous waste management treatment, storage, or disposal facility
- a facility permitted, licensed, or registered by a state to manage municipal or industrial solid waste.
- facility that uses, reuses, or legitimately recycles the waste (or treats the waste prior to use, reuse, or recycling)
- a universal waste handler or destination facility subject to the universal waste requirements of 40 CFR Part 273 (Universal wastes are wastes such as certain batteries, recalled and collected pesticides, or mercury containing thermostats.)

It is important to call the appropriate state agency to verify that the treatment, storage, and disposal facility (TSDF) you have selected has the necessary permits to ensure that the facility fits into one of the above categories. Such telephone calls should be documented.

### Exceptions by States

Again, some states have additional requirements for CESQGs, and a thorough check of state requirements is in order. For example, some states require CESQGs to follow some of the small quantity generators (SQG) requirements such as obtaining an EPA identification number, or compliance with specific with storage standards. Please note that these regulations change regularly and it is best that those responsible for the hazardous waste at each workplace check with each state's environmental regulatory agency for an update on the regulations that cover CESQG's. The following summarizes some of these more stringent requirements.

**CESQG Generator Size Categories:** As noted previously, federal regulations characterize hazardous waste generators of less than 100 kilograms per month as conditionally exempt. Most states use the same exclusion level; however, the District of Columbia, Kansas, Rhode Island and Maine have adopted lower exclusion levels. These state rules have important implications for waste generators. For example, Kansas has established an exclusion level of 25 kg/mo. Thus a generator is considered a CESQG only if it generates less than this amount. Rhode Island and Maine fully regulate all hazardous waste generators and do not provide any conditional exemption. Thus, generators of less than 100 kg/mo must meet state requirements that equal federal requirements for LQGs.

**State Hazardous Waste Identification Number:** Unlike the federal government, at least eight states require all generators to obtain a state hazardous waste identification number. They are California, Illinois, Louisiana, Maine, Michegan, Minnesota, Rhode Island, and West Virginia. In addition, other states, such as Texas have special rules for industrial CESQG's. To further complicate matters, sometimes a state requires the generator to use a licenced transporter, and the transporter in turn requires a waste manifest and waste identification number.

**State Storage Time Limits and On-site Waste Accumulation Limits:** The storage time limit is the maximum amount of time a generator can hold hazardous waste on-site without a storage permit. Federal regulations allow CESQGs to store waste on-site indefinitely, provided that the maximum amount stored does not exceed 1,000 kg at any given time. Once the 1,000 kg limit is exceeded, all waste accumulated is subject to federal requirements for SQGs, which include a maximum storage time limit of 180 days, a maximum on-site accumulation limit of 6,000 kg, and other storage requirements.

Some states have adopted a limited storage time and/or a lower maximum storage limit. For example, five states (California, District of Columbia, Louisiana, Mississippi, and Rhode Island) restrict storage time for all CESQGs. California, Louisiana, and Mississippi, each require a maximum storage period of 365 days. Rhode Island restricts the storage period for all generators to a maximum of 90 days (the LQG restriction).

**State Licenses Required for Hauling Wastes and Generator Self-Transport Limits:** At least eleven states (Arkansas, District of Columbia, Louisiana, Maine, Minnesota, New Hampshire, Ohio, Rhode Island, Texas, West Virginia, and Wisconsin) require all generators of less than 100 kg/mo to use a licensed commercial hazardous waste hauler or to obtain a license if they self- transport the waste. In addition, Michigan and New Jersey require CESQGs to use a licensed hauler or obtain a license only for the transport or self-transport of liquid industrial waste and waste oil, respectively. In Massachusetts, CESQGs who wish to self-transport their waste need only to register with the State. Also, in 1993, twelve states (California, Colorado, Florida, Kentucky, Maryland, Massachusetts, Missouri, Nebraska, New Jersey, New York, South Carolina, and Washington) had limits on the amount of waste that CESQGs may self-transport. Self-transport limits ranged from

23 kg in California to 999 kg in Colorado.

**State CESQG Manifest Requirements**: Under federal regulations, CESQGs are exempt from using a manifest. But, at least ten states (California, Delaware, Louisiana, Idaho, Maine, Minnesota, New Hampshire, North Dakota, Pennsylvania, and Rhode Island) require all generators of less than 100 kg/mo to use a manifest. Michigan requires a manifest only for liquid industrial waste.

**States mandating CESQG Waste Management in a Permitted Subtitle C Treatment, Storage, Disposal Facility (TSDF) only**: Federal regulations allow CESQGs to manage their hazardous waste in one of three general types of waste management facilities [(1) Subtitle C TSDFs; (2) municipal or industrial solid waste facilities; or (3) a recycler]. At least seventeen states (California, Colorado, Connecticut, Illinois, Kentucky, Louisiana, Maine, Massachusetts, Minnesota, New Hampshire, New Mexico, North Carolina, Ohio, Pennsylvania, Rhode Island, West Virginia, and Wisconsin) require these generators to manage their hazardous waste in a permitted Subtitle C TSDF, thus prohibiting disposal in a municipal or industrial waste landfill or other municipal, industrial facility. Also, at least six states ( Georgia, Michigan, Nebraska, New Jersey, North Dakota and Tennessee) require CESQGs to manage specifically liquid industrial and ignitable wastes in a permitted Subtitle C TSDF.

**State CESQG Reporting Requirements**: Federal regulations do not require CESQGs to submit annual or biannual reports. However, at least six states (Arizona, California, Louisiana, Minnesota, Rhode Island, and Washington) have reporting requirements for all generators of less than 100 kg/mo. California and Rhode Island require CESQGs to report every two years. Arkansas, Arizona, Louisiana, Minnesota, and Washington have annual reporting requirements. Texas requires that CESQG's report monthly, but only submit a copy of the manifest if the waste is sent out of state. In addition, there may be other requirements. For example, Nebraska requires that CESQG's who self transport their waste receive DOT training.

Since state requirements are at least as stringent as federal ones, it is incumbent upon the generator to properly check with their state for details needed in proper waste management. (See "State Agencies" on page 9.)

Further information and guidance on classification of waste generators can be found in *Hazardous Waste from Small Quantity Generators* (1990). Also called the SQG book, this source gives guidance for businesses and governments on the proper management of hazardous waste from small-quantity generators. *Hazardous Waste from Conditionally Exempt Small Quantity Generators in the Municipal Solid Waste Stream: A Literature Review* (1993) covers several state and local studies that have characterized CESQG waste generation and management practices.

## MANAGING HAZARDOUS WASTE

There are three groups or units responsible for managing hazardous waste. They include the laboratory professional (i.e., the conservator), the waste manager, and the waste handling operator. The conservator is involved in planning the use of hazardous materials. (S)he is the decision maker in considering the use of alternative materials that may be less hazardous or in establishing a program of minimization of the amount of hazardous materials kept in stock in the studio.

## SOME INFORMATION ON CHEMICAL COMPATIBILITIES WITH REGARD TO WASTE

The materials used by most conservators can be broadly grouped into chemical classes. These classifications are solvents (including paints and varnishes), detergents, acids and alkalies, bleaches, and ethyl ether. As a general rule these classes should not be mixed together in a waste container. The possibility of chemical reaction between incompatible materials is a genuine fire and safety hazard.

Solvents: Solvents, as a class, present a known fire and health hazard and accordingly also present disposal and storage problems. Included in this category are paint, varnish and polymer residues, as well as true solvents like toluene and naptha. (Diethyl ether is categorized with ether.) Solvent waste should be collected in glass bottles for future removal from the lab. Glass is inert and unlike metal, will not rust through if water is mixed in with the waste.

It must be emphasized that dumping even water soluble solvents down the drain is not an acceptable practice. Flammable vapors can collect in traps and stand pipes creating a fire hazard.

Solvents must be collected separately, and mixtures must be labeled appropriately with all known component parts.

Detergents: Only some detergents can be safely and legally disposed of down the drain without prior treatment. With the exception of triethanolamine, sewage plants are designed to accommodate this waste. Triethanolamine should be disposed of as the waste solvents are. Do not collect this material in a metal can if it has been mixed with water.

Acids and Alkalies: Acids and alkalies may be disposed of in the sewer system under certain conditions. If the acid or base contains no dissolved heavy metals, it may be neutralized and then washed down the drain with plenty of water (neutralization with strong acids is a potentially very dangerous activity and should only be attempted with a thorough understanding of good practice addition, the following list of web and paper based resources and references can provide further information to augment this article.

Please note that waste containing dissolved heavy metals should not be disposed of in the sewer system under any conditions. Metals such as copper, zinc, lead, cadmium, and mercury are toxic and can kill the bacteria that is introduced at the treatment plant to work on the sewage. This reaction requires the plant to initiate a new treatment cycle.

If neutralization is not possible, the waste must be containerized for removal.

Bleaches: The very mild and dilute bleaches used in conservation treatments should be neutralized before disposal in the

In a larger conservation laboratory or studio, the conservator may, especially if using large volumes of a hazardous material, recycle or treat hazardous waste. No matter what programs are instituted by the conservator in private practice, as long as hazardous waste is being generated, she or he must handle that hazardous waste. This practice includes proper labeling of the waste and once accumulated, the proper storage of this waste. In larger facilities, there may be a designated manager, but in the private studio, the conservator will often carry out the duties of the waste manager. The conservator in private practice may opt to subcontract this management to a trained individual who can provide oversight, training, auditing, interpretation of regulations, and collect the waste. Waste collection includes the storage, labeling, packaging, manifesting, and removing hazardous waste. The waste handling operator is the person who is familiar with and responsible for making sure that Department of Transportation (DOT) regulations are followed. Waste handling operators must have a permit from RCRA that allows them to transport, treat, store, or dispose of hazardous waste. This is a responsibility that must be contracted to a highly trained professional organization or company.

### Self Inspection and Compliance

One of the best ways to ensure compliance with hazardous waste regulations is to set up a visit by an inspector from a state or local hazardous waste agency. These visits can help identify and correct problems. During the visit, one can ask the inspector questions and receive advice on effective ways to manage hazardous waste. The best way to prepare for a visit from an inspector is to conduct your own self inspection. Self inspection involves a review of one's own laboratory practices and protocols for waste management. The following steps serve as a guide for this process.

### 1. Plan Chemical Use

Inventory chemicals present in the laboratory or studio. The inventory should include an estimate of quantities of materials and a confirmation that an MSDS for each material is on hand. In planning upcoming projects, it is important to consider the type and amount of waste they might produce. In addition, think of any methods or techniques that you can employ to limit or reduce your inventory of hazardous materials as well as your future waste accumulation.

- consider use of alternative materials
- order only what you need
- use only what you need
- reuse what you can

### 2. Inventory Waste and Label It Properly

- All bottles of waste must be properly labeled with any known chemical components and contaminants. Proper labels can be obtained from safety suppliers. Containers should also be dated.
- Used chemicals should not be mixed because they may be incompatible. Mixing complicates reclamation and adds to disposal costs for the conservator.
- Depending upon the generator classification, an EPA generator identification number might needed. There is no cost to obtain an identification number and the correct forms for this can be obtained directly from the RCRA hotline, (800) 424–9346).

sewer system. Many of the bleaches self-neutralize with time. Sodium perborate, hydrogen peroxide, sodium borohydride, and chlorine dioxide generating baths—each in dilute aqueous solution—should stand for an hour in order to avoid complications in the sewer system, and then be discarded. Chloramine T may be diluted and washed down the drain, as it is often used in water treatment plants. Other bleaches must be neutralized before disposal. Consult with local water treatment facilities before disposal in a sewer system.

Ether: Ether, diethyl ether, and ethyl ether all refer to the same material. Petroleum ether (pet ether) is not the same chemical and is handled like the solvents. Ether is terribly dangerous because it is highly flammable and a terrific explosion hazard. Its vapor is heavier than air and creeps along the floor. If it finds an open flame, the fire can flash back to the container. No one should ever smoke or have an open flame near an open can of ether.

Ether is also a very serious hazard because it reacts with air to form shock sensitive explosive peroxides. For this reason it should always be kept in a metal container which will inhibit the formation of peroxides. Ether must never be stored in glass jars. Bottles of ether contaminated with peroxides have been known to explode from unscrewing the lid.

As a general rule, ether stored without refrigeration should not be used longer than three months after it is opened. Close attention should be paid to the expiration date on the can. Very old cans of ether often must be disposed of by bomb squads rather than disposal agencies.

It is not wise to save ether for lengths of time while waiting for a scheduled removal of other waste. Close attention should be paid to the expiration date on the can. Very old cans of ether often must be disposed of by bomb squads rather than disposal agencies.

PCBs: Another disposal problem nearly unique to the conservator is the handling of small amounts of PCBs (polychlorinated biphenyls), Arochlor mounting medium. It is absolutely illegal to throw Arochlor into the garbage. Even materials contaminated with PCB, a well-documented carcinogen, must never be thrown into the garbage. All materials including contaminated tissues, microscope slides, swabs, and so on, should be segregated and disposed of by a registered contractor.

Dry Waste: Disposal of solid or dry waste is difficult to discuss in general terms, but as a rule, solid or dry materials should be kept in that state and not mixed in with liquid waste for disposal. Seek advice from a professional on particular disposal methods especially for toxic and reactive materials.

for handling chemicals ). Consult with local water treatment facilities before deciding on this course of action. Municipalities may wish to test the stock solution before allowing you to proceed with neutralization prior to disposal.

3. Waste Containerization

It is always safest and most cost effective to keep wastes in separate containers. Store waste containers properly by segregating them according to the categories defined by federal regulations. Follow the same compatibility rules in storing waste materials as one would in storing fresh chemicals. Also, see the box, "Some Information on Chemical Compatibilities with Regard to Waste" for specific information on containerization and disposal of particular classes of chemicals.

Ask the contracted waste management company or waste hauler about the type of container they prefer and how it should be labeled. In most cases, reusing the glass bottles in which the chemical was purchased is a convenient solution. This approach postpones the problem of disposing of empty bottles. The original labels should be obliterated or removed and the bottles clearly and properly labeled as waste. Glass or plastic is preferable to metal because small amounts of water in the waste will not cause rusting. An advantage to glass or plastic is that it is transparent and you can see what is inside. Teflon or polyethylene containers are good and are less apt to break than glass. Waste bottles should be kept closed. Ether should be kept in a metal container only. Most importantly, make sure that your waste is compatible with the composition of the container.

Also ask your waste hauler how they would like your containers packaged. For example, waste containers may be kept in cardboard boxes. For maximum safety these boxes can be lined with polyethylene and filled in with vermiculite around the bottles. This fill is an absorbent material which becomes a contained slush if waste leaks or is spilled. Even though waste has been containerized, incompatible materials must not be put in the same box. As a final precaution, place a small tray under each bottle.

The following is short list of some specific incompatibilities:

- alcohols with strong mineral acids;
- nitric acid with acetic acid, sulfuric acid, alcohols and most organic chemicals;
- ammonia with hypochlorite bleach;
- n-Butylamine with copper and copper alloys;
- n,n-Dimethyl formamide with halogenated hydrocarbons;
- Ethyl acetate with strong alkalies and acids;
- Ethylene dichloride with oxidizing materials;
- Ethylene glycol with sulfuric acid;
- MEK peroxide (hardener for polyester casting resin) with anything flammable;
- 1,1,1-Trichloroethane with caustic soda and caustic potash.

4. Removal

Removal of waste from the site depends upon what arrangements have been made for transport and final disposal. There are two options: the conservation staff can prepare the waste for direct transport to a disposal site, or an intermediate receiver can pack or prepare the waste in some way for transport and/or final disposal. These arrangements depend upon the type and size of the conservation laboratory in question.

Disposal of waste may mean filling out a hazardous waste manifest which indicates what kind of waste is in the container, who produced the waste, the name of the transporter and manner of disposal. By signing these forms the generator, the transporter and the disposal site all share some responsibility for the waste, however the government always views the

## Some Examples of Procedures That Are Not Acceptable

- Most chemicals may not be put into the sewage system. Untreated bleaches (oxidizers) can react with organic material in the sewers. Sodium chlorate, for example, when mixed with automobile brake fluid, will burst into flames in 30 seconds. Solvents, heavy metals, poisons, and strong acids and bases can damage a sewer system.

- Most chemical waste may not be disposed of in common garbage. Oxidizers can react with organic waste in the garbage truck and spontaneously combust. Disposing of waste solvents, paints, varnishes, or other chemicals in the back yard or in an empty lot is against federal law.

- Burning waste solvents is also illegal. Some chemical compounds (most notably chlorinated hydrocarbons) form very persistent intermediate products when incinerated. These can compound air pollution problems and can be toxic.

- It is not advisable to allow solvents to evaporate in a vent hood, just to get rid of the solvents. The Clean Air Act covers emission standards and the use of vent or fume hoods. Emission standards are beyond the scope of this article, but suffice to say that they will be more highly regulated in the future. In recent RCRA regulations, Subpart CC deals with the venting of volatile organic chemicals from waste areas. Evaporation of waste solvents is only acceptable if a special permit is written and accepted by the government to allow solvents to evaporate from a fume hood.

- "Dilution is not the Solution to Pollution" (WAAC 1984). The law says that chemicals must be handled as though they retain their original strength. Some classes of chemicals may be neutralized and then disposed of down the drain with large amounts of water. Only persons familiar with the chemistry of neutralization reaction should attempt to neutralize their waste. In addition, federal, state and local laws will dictate the pH at which solutions may safely enter the local water system

- Swabs, rags, wipes, or other chemically soaked substrates are considered hazardous waste. By law, they cannot be disposed of as regular or household trash. Such materials should be containerized to prevent solvent evaporation.

waste as belonging to the generator ("cradle"). This manifest tracks the chain of custody for hazardous waste shipments. Although CESDQs are not required to fill out a manifest, state regulations and local regulations may be more stringent.

Information about where to find a waste hauler, an intermediate receiver and a final disposal site will be specific to each county and state. Contact local waste haulers, waste management companies, or other small waste generators, health services department, or local fire stations to ask how disposal is handled in your community. Organizations which function under the auspices of state or federal agencies should be able to give some guidance. Smaller or non-affiliated conservation laboratories can contact waste management companies and haulers. Larger companies and haulers may find it too expensive or cumbersome to handle the typically small quantities that conservation laboratories generate, but sometimes arrangements can be made if the containers are properly labeled and if it is understood how the to fill out the manifest forms which record the disposal. If it is not possible to locate a company which can handle small quantities, contact nearby organizations that generate small quantities of varied waste to find out how they manage their waste. Note that generator may not piggyback waste into the waste stream of a local institution unless the work is performed on site at that institution. Any waste company or hauler must be registered with the state and the EPA.

### 5. Costs

The cost of managing hazardous waste is an important issue for the conservator. While these costs cannot be avoided, they can be reduced. For example, in finding a company to remove accumulated hazardous waste, it is best to comparison shop. With multiple quotes for the cost of removal, the conservator can search for the most economical vendor. However, be wary of quotes that are significantly lower than the majority of vendor's quotes. This could signal a vendor who is unscrupulous in their waste management practices. Since the responsibility of the generator goes with the waste to the "grave," the conservator may find that they will share the costs of a site cleanup if the vendor illegally dumps any of the conservator's waste. The more waste generated by the conservator and/or the more acute the hazard, the more it will cost for its removal.

### 6. Resources for Further Information

There are may resources available to the conservator for hazardous waste management. These include the state EPA office, local fire department, the AIC Health and Safety Committee, the local health department, the local sewage disposal system or waste management company, the Internet, local library, safety catalogs or even the client's safety officer. In addition, the following list of web and paper based resources and references can provide further information to augment this article.

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White, M. 1998. Health and safety annex CESQGs. *WAAC Newsletter* 20(3).

Black, C., and C. Stavroudis. 1984. Hazardous waste disposal. *WAAC Newsletter* 6(2).

# References and Resources


40 Code of Federal Regulations (CFR) 260–267. Hazardous Waste Management Regulations. Washington, D.C.: Government Printing Office.

ACS. 1990. Waste management manual for laboratory personnel: Department of government relations and science policy. ACS, Washington D.C.

ACS. 1993. Less is better—laboratory chemical management for waste reduction: Department of government relations and science policy. ACS, Washington, D.C.

Armour, M.A. 1991 *Hazardous laboratory chemicals: Disposal guide*. Boca Raton, Florida: CRC Press.

Babin, A., and M. McCann. 1992. Waste management and disposal for artists and schools, Center for Safety in the Arts, New York.

Committee on Hazardous Substances in the Laboratory/Assembly of Mathematical and Physical Sciences/National Research Council. 1981. *Prudent practices for handling_hazardous chemicals in laboratories*. Washington, D.C.: National Academy Press.

Cuthbertson, B. 1990. The federal hazardous waste regulations for household hazardous waste collection programs. *Proceedings of the Fifth National Conference on Household Hazardous Waste Management*, San Francisco.

EPA. 1993. Hazardous waste from conditionally exempt small quantity generators in the municipal solid waste stream: a literature review. EPA, Washington D.C.

EPA. 1994. Generation and Management of CESQG Waste. EPA, Washington, D.C.

Furr, A. K. 2000. *CRC handbook of laboratory safety*. 5th ed. Boca Raton: CRC Press.

Phifer, R. W., and W. R. McTique, Jr. 1988. *Handbook of hazardous waste management for small quantity generators*. Chelsea, MI: Lewis Publishers.

*Safety in Academic Chemistry Laboratories*. 1995. Washington, DC: The American Chemical Society.

Schwartz, S. I., and W. B. Pratt. 1990. *Hazardous waste from small-quantity generators*. Washington, D.C.: Island Press.


## Websites

1. www.epa.gov

2. www.epa.gov/epaoswer/general/risk/risk.htm

3. http://oaspub.epa.gov/webimore/aboutepa.ebt4?search=WASTES, HAZARDOUS WASTE

4. www.osha.gov

5. www.epa.gov/epaoswer/hazwaste/sqg/index.htm. This page has several helpful links for the Small Quantity Generator. Found on this page are two links that can be helpful to any of us who generate hazardous waste:
   - http://www.epa.gov/epaoswer/general/manag-hw/manag-hw.htm, "Managing Hazardous Waste in Your Community." This site has several fact sheets concerning hazardous waste management in PDF format.
   - http://www.epa.gov/epaoswer/hazwaste/sqg/sqghand.htm. This page has links to several formats of an EPA handbook, *Understanding the Hazardous Waste*.

# State Agencies

**Alabama**
Land Division
Alabama Department of
Environmental Management
334 271–7730

**Alaska**
Division of Air and Water
Hazardous Waste Section
Alaska Department of Environmental
Conservation
907 465–5158

**American Samoa**
American Samoa Environmental
Protection Agency
Government of American Samoa
Overseas Operator: 684 663–2304

**Arizona**
Hazardous Waste Compliance Unit
Arizona Department of Environmental
Quality
602 207–4108

**Arkansas**
Hazardous Waste Division
Arkansas Department of Pollution
Control and Ecology
501 562–6533

**California**
Hazardous Waste Management
Program
Department of Toxic Substances
Control
916 324–1781; 800 61–TOXIC (CA
only)

**Colorado**
Hazardous Materials and Waste Management Division
Colorado Department of Health
303 692–3320

**Commonwealth of Northern Mariana Islands**
Division of Environmental Quality
Department of Public Health and Environmental Services
Overseas Operator: 670 234–6114
Cable Address: Gov. NMI Saipan

**Connecticut**
Bureau of Waste Management
Department of Environmental Protection
203 424–3023

**Delaware**
Hazardous Waste Management Branch
Department of Natural Resources and Environmental Control
302 739–3689

**District of Columbia**
Hazardous Waste Management Branch
Pesticides and Hazardous Materials Division
Environmental Regulatory Administration
202 645–6080

**Florida**
Bureau of Solid and Hazardous Waste MS4560
Division of Waste Management
Department of Environmental Protection
904 488–0300

**Georgia**
Hazardous Waste Management Branch
Environmental Protection Division
Department of Natural Resources
404 656–7802

**Guam**
Solid and Hazardous Waste Management Program
Guam Environmental Protection Agency
Overseas Operator: 671 646–8863

**Hawaii**
Solid and Hazardous Waste Branch
Office of Solid Waste Management
Department of Health
808 586–4226

**Idaho**
Hazardous Materials Bureau
Division of Environmental Quality
Department of Health and Welfare
208 334–5898

**Illinois**
Division of Land Pollution Control
Illinois Environmental Protection Agency
217 785–8604

**Indiana**
Hazardous Waste Management Branch
Office of Solid and Hazardous Waste
Indiana Department of Environmental Management
317 232–4417

**Iowa**
Environmental Protection Division
Department of Natural Resources
515 281–4968

**Kansas**
Bureau of Waste Management
Department of Health and Environment
913 296–1608

**Kentucky**
Hazardous Waste Branch
Division of Waste Management
Department of Environmental Protection
502 564–6716

**Louisiana**
Office of Solid and Hazardous Waste
Hazardous Waste Division
Louisiana Department of Environmental Quality
504 765–0249

**Maine**
Division of Oil and Hazardous Materials Facilities
Bureau of Hazardous Materials Control and Solid Waste Control
Department of Environmental Protection
207 287–2651

**Maryland**
Hazardous Waste Program
Hazardous and Solid Waste Management Administration
301 631–3345

**Massachusetts**
Division of Hazardous Waste
Massachusetts Department of Environmental Protection
617 292–5574

**Michigan**
Hazardous Waste Permit Section
Waste Management Division
Department of Natural Resources
517 373–0530

**Minnesota**
Hazardous Waste Division
Minnesota Pollution Control Agency
612 297–8512

**Mississippi**
Division of Hazardous Waste Management
Office of Pollution Control
Department of Environmental Quality
601 961–5052

**Missouri**
Hazardous Waste Management Program
Division of Environmental Quality
Department of Natural Resources
314 751–3176

**Montana**
Solid and Hazardous Waste Bureau
Department of Health and Environmental Sciences
406 444–1430

**Nebraska**
Air and Waste Management Division
Department of Environmental Quality
402 471–4217

**Nevada**
Waste Management Bureau
Division of Environmental Protection
Department of Conservation and Natural Resources
702 784–1717 or 800 882–3233 (NV only)

**New Hampshire**
Waste Management Compliance Bureau
Waste Management Division
Department of Environmental Services
603 271–2942

**New Jersey**
Bureau of Advisement and Manifest
Department of Environmental Protection
609 292–8341

**New Mexico**
Hazardous and Radioactive Waste Bureau
Environmental Department
505 827–4308

**New York**
Division of Hazardous Substances Regulation
Department of Environmental Conservation
518 485–8988

**North Carolina**
Hazardous Waste Section
Division of Solid Waste Management
Department of Environment, Health, and Natural Resources
919 733–2178

**North Dakota**
Division of Hazardous Waste Management
Department of Health Management and Special Studies
701 328–5166

**Ohio**
Division of Hazardous Waste Management
Ohio Environmental Protection Agency
614 644–2944

**Oklahoma**
Division of Hazardous Waste Management
Department of Environmental Quality

**Oregon**
Hazardous Waste Program
Waste Management and Cleanup Division
Department of Environmental Quality
503 229–5913

**Pennsylvania**
Bureau of Waste Management
Pennsylvania Department of Environmental Resources
717 787–6239

**Puerto Rico**
Environmental Quality Board
Office of the Governor
Banco Nationale Plaza Building
809 767–8056

**Rhode Island**
Division of Waste Management
Department of Environmental Management
401 277–2797

**South Carolina**
Division of Hazardous and Infectious Waste Management
Department of Health and Environmental Control
803 896–4000

**South Dakota**
Division of Environmental Regulation
Department of Environment and Natural Resources
605 733–3153

**Tennessee**
Division of Solid Waste Management
Tennessee Department of Environmental Conservation
615 532–0780

**Texas**
Industrial and Hazardous Waste Division
Texas Natural Resources Conservation Commission
512 239–6592

**Utah**
Hazardous Waste Compliance Section
Division of Solid and Hazardous Waste Management
Department of Environmental Quality
801 538–6170

**Vermont**
Hazardous Waste Management Division
Department of Environmental Conservation
Agency of Natural Resources
802 241–3888

**Virgin Islands**
Division of Environmental Protection
Department of Planning and Natural Resources
809 773–0565

**Virginia**
Office of Waste Resource Management
Waste Division
804 527–5145

**Washington**
Division of Hazardous Waste and Toxics Program
Department of Ecology
206 407–6758

**West Virginia**
Hazardous Waste Management Section
Division of Environmental Protection
Bureau of Environment
304 558–5929

**Wisconsin**
Hazardous Waste Management Section
Division of Environmental Quality
Department of Natural Resources
608 266–2111

**Wyoming**
Solid and Hazardous Waste Division
State of Wyoming Department of Environmental Regulation
307 777–7752