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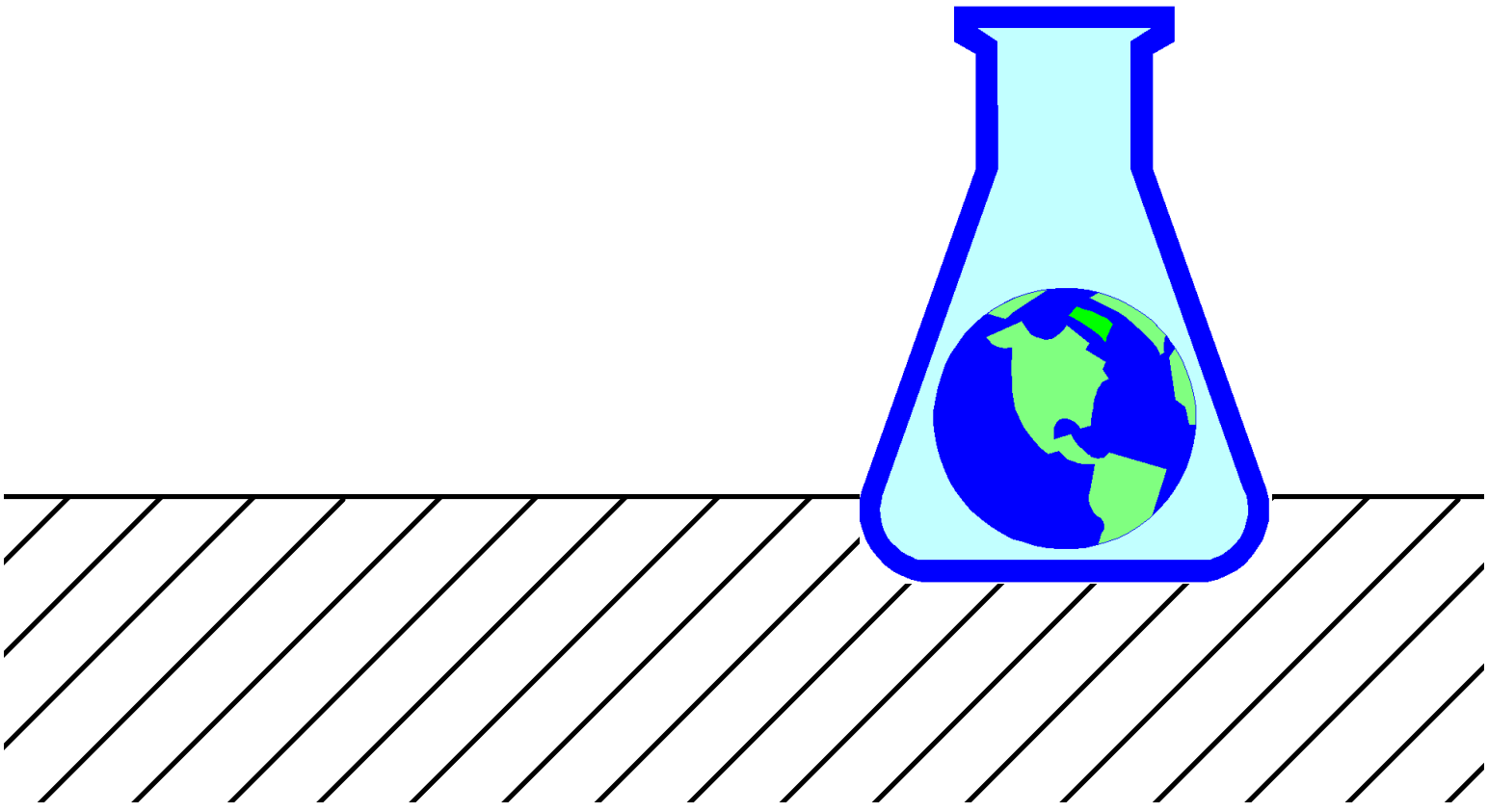
Environmental Management Guide for Small Laboratories



ENVIRONMENTAL MANAGEMENT GUIDE

for

SMALL LABORATORIES

Office of Small Business Ombudsman
U.S. Environmental Protection Agency
Washington, D.C. 20460

July 1998

NOTICE

This document has been prepared to assist those responsible for administering or improving environmental management programs at small laboratories. To do this, the document outlines management and Federal regulatory issues for small laboratory environmental management, but does not prescribe in detail all required factors and considerations. For example, many important state and local requirements are not addressed.

The U.S. Environmental Protection Agency (EPA) does not make any guarantee or assume any liability with respect to the use of any information or recommendations contained in this document. It is recommended that users of this document requiring additional information or advice consult a qualified professional.

ACKNOWLEDGEMENT

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SUGGESTED IMPROVEMENTS

Although every reasonable effort was made to make this document useful to small laboratories, it is recognized that improvements are always possible. Also, over time, environmental requirements and recommendations may change. Comments and suggested improvements on this document are welcome. Please direct these to:

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1.0 INTRODUCTION

This document provides information designed to help staff in small labs better understand their responsibility for good environmental management. Its purpose is to assist in development and implementation of environmental management programs which meet important Federal regulatory requirements. It is important to understand that for small lab programs to be fully responsive, the information provided here must be supplemented by knowledge of state and local regulations. This guide is designed to be a good starting source.

Environmental management issues associated with small laboratories present a unique challenge. This challenge stems from the fact that most of today's environmental management requirements are based on regulations which were designed for relatively simple processes in manufacturing (e.g. printing) and services (e.g. dry cleaning) entities. Small lab operations, in general, are very different from those in manufacturing and services as the following table indicates. The uniqueness of small lab operations means that traditional approaches to environmental management, which may work well with other operations, need careful consideration, and possibly adjustment, to work well.

WHAT MAKES LABS DIFFERENT?

Factor	Manufacturing/Services	Small Laboratories
Number of Chemicals Used	Low	High
Quantity of Chemicals Used	High	Low
Variability in Operations	Low	High
Staff Education/Knowledge of Chemicals	Mixed	High
Centralized Management Control	High	Mixed

With a focus on environmental management and emphasis on chemicals, it is important to understand that some critical related areas are not addressed by this document. For example, safety and health requirements administered by the Occupational Safety and Health Administration (OSHA) are not addressed nor are requirements for transporting hazardous materials (e.g. samples, supplies), which are implemented by the U. S. Department of Transportation (DOT). Both are very important to small labs. Also, neither the hazards of biologically-active nor radioactive materials are fully addressed in this document. However, Section 4.0 indicates reliable sources of information that should be helpful in these areas.

For the purpose of this document, a "small laboratory" is one that has no full-time position in environmental management. In small labs, environmental management is most likely a shared responsibility or administered by part-time staff or through collateral duty. Given this definition, most labs probably fall into this "small laboratory" category and will benefit from this document. Of course, many large labs, should benefit from the information contained in this document as well. However, large labs are likely to have additional environmental management responsibility that is not fully addressed here. Air emissions management is one example where large labs, especially those involved in research and development, may have additional responsibility.

Small labs are diverse in their settings and operations. Some small labs are affiliated with a larger organization, while others are independent operations. Given widespread use of the word "lab" many types of small labs exist; a few are listed below.

TYPICAL SMALL LAB TYPES	
Independent	• Contract Research in the Healthcare, Chemical, Natural Resources, Energy, or Manufacturing Industry • Commercial Testing Labs in the Environmental, Material Science, Healthcare, Industrial Hygiene, Food, and Engineering Sectors
Affiliated	• Teaching and Research Labs in Academia • Hospital Labs • Quality Assurance Labs in Manufacturing • Forensic Labs • Water and Wastewater Plant Labs • Government Research and Testing Labs • Research and Development Labs

All of these small lab types should benefit from the information in this Guide.

The remainder of this document is organized into three additional sections.

- Section 2.0 Key Environmental Management Issues - Presents information on: (1) environmental management systems; (2) the three most likely areas of environmental management risk, air emissions, water discharges, and waste management; and (3) pollution prevention.
- Section 3.0 Additional Environmental Management Issues - Presents information on important, but less common areas needing environmental management improvement in labs.
- Section 4.0 Reliable References - Lists additional information sources on small lab environmental, health, and safety management.

2.0 KEY ENVIRONMENTAL MANAGEMENT ISSUES

The environmental management issues presented in this section are considered "key" because they either: (1) represent traditional areas with the most environmental management risk for small labs, or: (2) are perceived to offer the greatest opportunity for improvement. Key environmental risk areas are those related to air emissions, water discharges, and waste management. Key opportunities for improvement are in environmental management systems and also in pollution prevention.

2.1 ENVIRONMENTAL MANAGEMENT SYSTEMS

Like any other important business activity in a small lab, environmental issues must be carefully managed. For example, other management systems occurring in small labs may address quality, finance, human resources, or safety. The collection of activities undertaken to ensure that environmental issues are managed is called an environmental management system (EMS). An EMS is essential to:

- Consistently comply with environmental laws and regulations;
- Improve overall environmental performance;
- Address environmental liability from current or past practices;
- Maximize the investment, no matter how small, in environmental affairs; and
- Integrate environmental objectives into overall business objectives.

Interest in environmental protection is growing steadily so small labs, like other organizations, may be increasingly challenged to demonstrate commitment to the environment. Implementing an EMS can help in a number of ways.

First, an EMS makes good business sense. By identifying the causes of environmental problems, and then eliminating them, an EMS can help save money. The following questions demonstrate the point:

- Is it better to conduct chemical analyses right the first time or perform a lot of re-work later?
- Is it cheaper to prevent a spill in the first place or clean it up afterwards?
- Is it more cost-effective to prevent pollution or to manage it after it has been generated?

Second, an EMS can be an investment in the long-term viability of a small lab. An EMS helps the organization become more focused and therefore, more effective in achieving environmental goals. This, typically, will result in higher staff job satisfaction and productivity. It also will help attract and retain new customers. More and more often, it is becoming necessary to prove a lab has an EMS to satisfy contract or other business terms.

The following elements are typically considered evidence of an effective EMS. Much of what is needed in many small labs may already be in place.

ELEMENTS OF AN ENVIRONMENTAL MANAGEMENT SYSTEM	
Policy	• Develop an Environmental Policy that describes the lab organization's commitment to the environment. • Use this policy as a framework for planning and implementation.
Planning	• Formulate objectives in line with the policy. • Plan actions to achieve objectives. • Ensure plan is in compliance with Federal, state, and local regulations.
Implementation	• Establish roles and responsibilities and provide resources. • Provide training to employees on their environmental responsibilities. • Institute processes for communicating both internally and externally environmental management issues. • Develop written procedures and policies and ensure that documentation is in place. • Identify potential emergencies and develop procedures for prevention and response.
Quality Control	• Monitor key activities and track performance. • Identify and correct problems. • Keep adequate records of EMS performance. • Conduct periodic environmental management systems audits to verify that the EMS is operating as intended.
Management Review	• Periodically review the EMS to evaluate overall program effectiveness and institute improvements where needed. • Annually review objectives to determine whether the lab is meeting them. Set new targets as needed.

Chances are that most small labs have already committed to a quality or safety program. In these cases, it is useful to think of an EMS as a value added component to these existing programs.

When first establishing an EMS, the process can seem overwhelming. However, because the EMS process encourages continual improvement, it doesn't matter how complete an EMS is, or isn't. It is important to get started now.

Small labs have some advantages over larger labs for establishing an EMS. For example, lines of communication are generally shorter, organizational structures are less complex, people perform multiple functions, and access to management is simpler. Also, time and resources are more scarce, which is an advantage because management and staff are motivated to spend time and resources wisely and an EMS promotes and sustains efficiency.

2.2 AIR EMISSIONS

Often, air emissions from small labs are subject to little or no regulation. Still, responsible lab staff should still take steps to minimize emissions because even small unregulated amounts of pollutants can be harmful to the environment. The good management practices presented in Section 2.5 should be helpful for minimizing quantities of air pollutants emitted from small labs.

This section presents information on applicable regulation at the Federal level. It is important to carefully review both state and local regulations for applicability. Some states have looked closely at labs as air pollution sources, but many have not.

2.2.1 Regulatory Considerations

Overview

The Clean Air Act Amendments of 1990 established broad-reaching programs dealing with issues such as auto emission standards, alternative fuels, and stratospheric ozone. But perhaps of greatest potential concern to laboratories, is in Section 112 addressing hazardous air pollutants (HAPs). Currently, 188 pollutants are listed as hazardous under Section 112 which also directs EPA to designate industry "source categories." HAP emission standards for many source categories have been developed and more are being added. Source categories include major industrial types (e.g., pharmaceutical manufacturing, synthetic organic chemical manufacturing) at which laboratories are often present. Interestingly, Congress also directed EPA to consider listing "research or laboratory facilities" as its own source category (CAA 112(c)(7)). EPA has not yet made a listing determination; but listing research or laboratory facilities as a separate source category would impact only very large stand-alone laboratory facilities which qualify as "major sources." Major sources are those with the potential-to-emit 10 tons per year of any single HAP or 25 tons per year of a combination of HAPs.

Although small laboratories are unlikely to meet EPA's definition of major source, they routinely emit air pollutants from fume hood stacks and vents and are often regulated by state air pollution control regulations. In some instances, small laboratories may be regulated under a state program because they are located in facilities with heating/cooling plants or pilot plants that are already regulated under a state program. Sometimes these operations qualify the entire site as a major source and, therefore, the small laboratory can be subject to these additional regulations.

Permits

State air pollution control regulations usually mandate that air pollution sources and control devices require permits to "construct" and permits to "operate." Laboratories may need to obtain permits for air pollution emissions, but state regulations governing permits for emissions from laboratory fume hoods vary drastically. Many states clearly exempt laboratory emissions from permitting requirements, while other states have no special exemption for laboratories. Further, some states have developed special registration requirements for lab fume hoods. Permits may also be required for air pollutant emissions from facility heating equipment such as boilers. Permits are typically required for the operation of boilers with heat input capacities equal to or exceeding 1 million Btu/hour; however, some states require permits for smaller boilers. Also, sources such as incinerators and paint spray booths, will most likely be subject

to air permitting requirements. Environmental staff in small labs need to carefully review their state's permitting requirements to determine if on-site air pollution sources require permits.

Other Potentially Important Air Pollution Control Regulations

In addition to the routine lab and building management operations which may be impacted by air pollution control regulations, labs may encounter the following non-routine or less common operations that will trigger air pollution control regulations:

- Demolition, renovation, and removal of asbestos-containing materials (ACMs) in existing structures on-site may be subject to the National Emission Standards for Hazardous Air Pollutants (NESHAPs). NESHAPs for asbestos are contained in 40 Code of Federal Regulations (CFR) Part 61, Subpart M, and in applicable state air pollution control regulations. Note that these requirements may change over time.
- Industrial facilities (e.g., chemical production plants, metal smelters, and manufacturing operations) often face stringent air pollution control regulations such as limitations on pollutant emissions, periodic or continuous emission monitoring, and installation of air pollution control equipment. Laboratories that are part of a large industrial facility may be subject to these more detailed requirements and will need to coordinate with the facility environmental, health, and safety staff.
- Pursuant to the Clean Air Act Amendments of 1990 (CAAA), EPA developed regulations that limit emissions of ozone-depleting chemicals such as chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). EPA regulations prohibit venting and require recycling of CFCs and HCFCs during the servicing, repair and disposal of air conditioning equipment, and require service personnel to be trained and certified by EPA or an EPA-approved organization. Owing to the CAAA and the Montreal Protocol, the production of CFCs was banned as of December 31, 1995. Some Heating Ventilation and Air Conditioning equipment may have needed to be upgraded or replaced to comply with phase-out schedules. Certain laboratory uses of CFCs have been permitted beyond the phase-out deadline since the Montreal Protocol, since EPA has declared laboratory analytical uses of CFCs to be an “essential use” in certain specific lab analyses.
- In response to the CAAA, EPA has developed regulations that establish requirements to prevent or respond to accidental releases of extremely hazardous air pollutants. Facilities storing above threshold quantities of extremely hazardous air pollutants will have to identify the possible hazards and develop risk management plans. Certain substances deemed extremely hazardous air pollutants may be present in labs (e.g., ammonia, chlorine, ethylene oxide, and vinyl chloride). However, EPA generally excludes chemicals stored in labs from the requirements (59 FR 4478, Jan. 31, 1994) because of small quantities stored.

2.2.2 Identifying and Quantifying Air Emissions

Air emissions of chemicals result from routine and non-routine lab operations. Examples of lab operations that result in air emissions of chemicals include:

- Exhaust from fume hoods, chemical storage cabinets and rooms;
- Breakage, spills, and leaks;
- Bench-top operations; and
- Glassware cleaning and rinsing.

In small labs, chemicals may seem to be everywhere so it is important to have an inventory to understand

and control their use. Although it may be difficult to maintain, an inventory is also important for identifying and quantifying potential air emissions.

Accurately quantifying small lab air emissions is very difficult. For example:

- Some non-routine lab processes may have little or no records on chemical usage.
- Chemicals can change phase in the course of laboratory work. A liquid can become a part of a solid or a solid reactant can become a volatile gas.
- Researchers may purchase and use chemicals that are outside of a centralized management system.
- Chemical volatility varies with temperature and pressure.

However, it is important to estimate maximum emission potential to understand if regulatory thresholds are likely to be exceeded. One way to estimate maximum air emission potential is based upon a simple mass balance model such as the one following. This model relies on accounting for all possible uses of the chemical so that the remainder, that can not be accounted for, is the maximum amount potentially emitted to the air.

MAXIMUM SMALL LAB AIR EMISSION CALCULATION

For a specific air volatile chemical, fill in quantities known or estimated.

Description	Quantity
(A) Amount of unused chemical in inventory today.	
(B) Amount of same unused chemical in a previous inventory. Note: A long period of time (i.e. one year) between (A) and (B) may yield more accurate results.	
(C) Subtract (A) from (B). This is the difference in inventory over the time period.	
(D) Amount of chemical purchased and received in the time period covered by the inventory records used in (A) and (B).	
(E) Add (C) and (D). This is the amount that needs to be accounted for.	
(F) Amount of chemical still in use in solutions and mixtures.	
(G) Amount of chemical disposed of as waste (all forms).	
(H) Amount (non-waste), shipped off-site, or other off premise use.	
Subtract (F) through (H) from (E). **This is the maximum amount potentially emitted to the air from the lab over the period of time between (A) and (B). Compare to regulatory thresholds.**	

A second approach centers upon evaluating a specific lab process instead of the entire lab. This approach will be easier and more reliable in labs where analyses are routine. For example, suppose a routine test mass balance calculation repetitively indicates a 10% “loss” of a chemical. “Loss” means the chemical is not part of the product or the solid waste stream. Thus, it may be assumed to be emitted to the air. This percentage can then be used to estimate the total mass of chemical potentially emitted by multiplying the loss per test by the total number of tests.

Although it might seem like an overwhelming task to make a calculation for all chemicals in a lab, this is probably not necessary. To start, the most air volatile and commonly used chemicals, such as organic solvents, should be addressed as well as any especially hazardous or stringently regulated chemicals. Thus, after making calculations for a small subset of chemicals, lab staff should have a good

understanding of potential air emissions. Quantifying air emissions is important because it can help : (1) determine lab status for permitting and regulatory compliance issues; and (2) identify and prioritize pollution prevention activities.

2.2.3 Air Emissions Program Checklist

The following checklist of actions will help small labs achieve and maintain a good air emissions program. Completing all of these actions does not necessarily mean all regulatory compliance requirements have been met. It is important to get updated information from Federal, state, and local authorities.

SMALL LAB AIR EMISSIONS PROGRAM CHECKLIST	
Action	**Notes**
1. If lab operations result in air emissions make sure they been identified, measured, and documented.	
2. Determine and record any changes in emission levels since the last inventory.	
3. Maintain an up-to-date site plan or blueprint showing all existing sources of air contaminants.	
4. If the lab emits air contaminants to the outdoor atmosphere (through stacks, vents, exhausts), make sure that a plan approval, operating permit, or exemption was obtained and documented if required.	
5. If an air emission permit is needed: • Ensure that all of the lab's permits to operate sources of air emissions are up-to-date, and	
• Ensure that there is a system for timely renewal of air permits and associated fees.	
6. Regularly observe and document emissions from emission points to determine whether smoke or odors are produced.	
7. If air emission control devices exist, ensure that inspections and maintenance (e.g., checking for belts) are performed on a regular basis.	
8. Ensure that chemical (including waste) containers are not left open on bench-tops or in fume hoods. Containers should be kept closed to eliminate fugitive emissions and evaporative losses.	
9. Maintain current copies of state and local air emission regulations.	

2.3 WATER DISCHARGES

As a convenient way to dispose of chemical lab waste, sink drains can be very tempting. Good laboratory practices, however, discourage disposal of chemicals in this manner since it may result in fire, chemical reactions, and corrosion within the plumbing system. In addition, drain disposal of chemicals may cause pH upsets and other environmental problems at the wastewater treatment plant. Consequently, Federal, state, and local regulations stipulate both acceptable, and prohibited, pollutants for discharge. This section reviews regulatory requirements, and indicates how laboratory staff can responsibly manage water discharges.

2.3.1 Regulatory Considerations

Overview

The primary objective of the Clean Water Act, as amended in 1972, is to limit uncontrolled discharge of pollutants to the nation's navigable waterways. To achieve this objective, EPA introduced several regulatory programs, many of which are implemented and enforced on a state and local level. Since most laboratories probably discharge wastewater to publicly-owned treatment works (POTWs), the first subsection following addresses this subject. Subsequently, other relevant sections of the Clean Water Act will be briefly discussed.

Discharges to POTWs

Where laboratories discharge wastewater to a POTW, lab staff must consider Federal, state and local water pollution control regulations before discharging pollutants down the drain. Regulations governing wastewater discharges to a POTW are sometimes referred to as "pretreatment standards," meaning that some wastes must be treated before being discharged to comply with the standards. The National Pretreatment Standards, found in 40 CFR Part 403.5 contain standards prohibiting all users from discharging the pollutants listed here into a sewer system.

- Flammable or explosive pollutants including, but not limited to, waste streams with a closed cup flash point of $< 140^{\S}$F.
- Pollutants which will cause corrosive structural damage to the POTW, but in no case discharges with pH lower than 5.0, unless the POTW is specifically designed to accommodate such discharges.
- Solid or viscous pollutants that may cause an obstruction of flow in the POTW.
- Pollutants capable of releasing fumes or vapors in sufficient quantities to detrimentally affect the safety and health of treatment works personnel.
- Pollutants, including oxygen demanding pollutants (high biological oxygen demand), at a concentration and flow which may cause interference with the POTW.
- Wastewater with sufficient heat to inhibit biological activity in the POTW (must not exceed $104^{\S}$F at the POTW).
- Petroleum, oil, non-biodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through.

Several states have imposed pretreatment standards that are more stringent than the Federal standards. Additionally, most POTWs have local sewer ordinances which usually set even more stringent standards.

Local sewer ordinances typically set discharge limits for metals, biological oxygen demand, and various organic pollutants. Many of these ordinances specify that an increase in the use of water in order to dilute pollutants to achieve compliance with the above limits is prohibited. Also, local ordinances often require "industrial users," as defined in the ordinance, to obtain discharge permits from the local wastewater authority. It is important to become familiar with the standards in state and local jurisdictions before discharging any substances to the sewer.

If, after careful consideration, small lab management determines that limited drain disposal of nonhazardous substances is acceptable, the following general guidelines should be followed:

- Use drain disposal only if the drain system flows to a wastewater treatment plant and not into a septic tank system or a storm water sewer system that flows directly into surface water. Note: Dye tracing can easily be done on all drains leading out of a laboratory to ensure that discharges affected by Federal, state, or local regulations go to the appropriate location (e.g., POTW).
- Make sure that the substances being disposed of are compatible with each other and with the piping system.
- Discharge only those compounds that are soluble in water such as aqueous solutions that are readily biodegrade and/or of low-toxicity solutions without metals that can make the sludge toxic.

National Pollutant Discharge Elimination System

Laboratories that discharge wastewater to surface water are likely to require a National Pollutant Discharge Elimination System (NPDES) permit. NPDES programs are usually maintained and enforced by state water pollution control agencies. Even effluents such as non-contact cooling water are often subject to NPDES requirements. Laboratories with their own wastewater treatment system that discharges to a nearby lake or stream would be subject to NPDES requirements.

In the early 1990s, EPA implemented a program requiring NPDES permits for storm water runoff. In general, offices and the associated parking areas are not included by NPDES storm water requirements. However, some light industrial activities, such as outside storage of materials, may cause NPDES storm water runoff requirements to apply. Check with appropriate wastewater authorities to be sure.

Septic System

In most areas, laboratories no longer discharge wastewater to septic systems. Where public sewer systems are available, septic systems may be prohibited. Laboratory managers in facilities that discharge wastewater to a septic system, should caution all personnel that any pollutant discharged down the drain has the potential to contaminate the environment. Facilities discharging to septic systems may be required to obtain a permit for discharge to ground water.

Reportable Discharges of Oil and Hazardous Substances

Discharges of oil to a navigable waterway that cause a sheen or discoloration of the surface of the water must be reported to the National Response Center (NRC: 800/424-8802) or the U.S. Coast Guard (40 CFR 110). Navigable waters are defined broadly by EPA and include most lakes, rivers and streams. Discharges of hazardous substances, as designated in 40 CFR 116, to navigable waterways must be reported if they exceed the reportable quantities established in 40 CFR 117. Any person in charge of a vessel or an onshore facility shall, as soon as he/she has knowledge of any discharge of a designated hazardous substance, immediately notify the appropriate agency of the discharge.

Spill Prevention, Control and Countermeasure (SPCC)
In accordance with 40 CFR 112, an SPCC plan is required of facilities storing oil, which due to their location, could reasonably be expected to discharge oil in harmful quantities to navigable waters. SPCC requirements apply to facilities storing more than 42,000 gallons of oil underground, 1,320 gallons total above ground, or any single container above ground exceeding 660 gallons. For example, SPCC planning activities would likely be triggered for a lab having an outdoor, aboveground heating oil tank with a capacity of 1,000 gallons.

It is important to remember that many water discharge regulations that affect laboratories are implemented and enforced at the state and local level; therefore, regulations will vary from state to state and sometimes by localities within a state. Whether you are connected to a septic system, on-site wastewater treatment system, or local publicly owned treatment works (POTW) will also determine the specific regulations that you must follow, so be sure to check with your local wastewater authority.

2.3.2 Hazardous Waste Mixed with Domestic Sewage

In most cases, lab staff should avoid discharging regulated hazardous waste down the drain (see Section 2.4 for the Federal regulatory definition of hazardous waste) even though EPA's hazardous waste management regulations excludes from the definition of hazardous waste any wastes mixed with domestic sewage that enters a POTW (40 CFR 261.4(a)(1)). Generally, any laboratory that discharges down the drain more than 15 kg of hazardous waste per monthly (40 CFR 403.12(p)(2)), or acutely hazardous waste in any amount, is required to notify the EPA Regional Office, the state hazardous waste authorities, and the POTW of such discharges. (Check with local authorities first.) Notification usually must include the following information.

- Name of the hazardous constituents contained in the wastes.
- Estimates of the masses and concentrations of constituents in the waste-stream discharges during that calendar month.
- Estimate of the masses of such constituents which may be expected to be discharged during the following twelve month period.

Although it may be allowed, discharging limited amounts of hazardous waste with domestic sewage may not always be an environmentally sound choice.

Lab staff should never allow hazardous waste discharges to drains leading to septic tanks or storm sewers.

2.3.3 Neutralization

In most states, it is acceptable to neutralize acid and caustic solutions and then dispose the neutralized solution down the drain if there are no other hazardous characteristics. Check with state and local authorities first however. Where it is permissible, it is important that only elementary neutralization is occurring and that it is under a Resource Conservation and Recovery Act (RCRA) exemption for hazardous waste treatment without a permit. Non-exempted treatment, without a RCRA permit, is a serious RCRA violation. A neutralized solution should have a final pH value between 6 and 9 (check

with your local POTW to make sure this pH range meets their requirements). Although many labs are equipped with neutralization tanks, problems can result from their usage. For example, a limestone chip bed is commonly used as a passive in-line acid neutralization system. In theory, these systems should work but they often do not in practice because: (1) they are flow dependent; and (2) system maintenance (e.g., cleaning) is often neglected. Also, limestone, though an aid for neutralizing acid discharges, is not helpful in neutralizing caustic discharges. In general, it is not wise to rely on an in-line system until its effectiveness has been proven and can be monitored.

2.3.4 Spill Containment

A discussion of water discharge would not be complete without mentioning spill containment. The need for spill protection applies to all areas where materials can be potentially damaging to the POTW or enter storm water systems. The following are some suggestions to prevent spills from entering drains.

- Floor drains should be eliminated from new construction. Where floor drains presently exist, they should be covered with properly fitting drain covers. Note that a lack of floor drains may make it more difficult to test emergency showers.
- Fume hood cup sinks should be guarded or closed off. If the sink does not need to be used, then it should be sealed off. If the sink must remain in service, it can be protected from spills by installing a perimeter guard ring. A simple cup sink guard can be made by encircling it with a line of non-reactive caulk.
- Have spill kits available where required (e.g., by SPCC plans) or where spills are likely to enter drains. Make sure appropriate spill kits are available. For example, there are special kits for acids, caustics, organics, and mercury. They are not interchangable.

2.3.5 Water Discharge Checklist

The following checklist of actions will help small labs achieve and maintain a good water discharge program. Completing all of these actions does not necessarily mean all regulatory compliance requirements have been met. It is important to get updated information from Federal, state, and local regulators.

SMALL LAB WATER DISCHARGE PROGRAM CHECKLIST	
Action **To evaluate or improve the lab water discharge program, ensure that:**	**Notes**
1. The discharge meets with general pretreatment prohibitions for: • Fire or explosion hazards. • Corrosivity. • Viscous obstructions which could plug sewer. • Sludge discharges. • Heat sufficient to inhibit biological activities (> 104§F).	
2. The POTW is aware of the discharge.	
3. The lab has a sewer use discharge permit or letter of acknowledgment from the POTW.	
4. The lab has a copy of the POTW's sewer use discharge requirements.	
5. There a system in place to routinely monitor the discharge to the POTW.	
6. If samples are taken: • They are handled by a certified sampling/analytical lab. • Proper sample containers, preservation techniques, holding times, and quality control are used. • There is a designated employee responsible for making sure that sampling is performed according to permit requirements. • Sampling results are reviewed and compared with permit requirements. Ensure that deviations noted and investigated. • Reports are maintained on site for three years.	
7. All laboratory personnel have been trained to understand the types of pollutants prohibited from discharge to the POTW.	
8. Direct discharges to surface water are permitted.	
9. Discharges to on-site waste disposal systems are permitted.	
10. Copies of state and local water pollution regulations are available.	

Note: Actions 1-7 are for discharges to POTWs.

2.4 HAZARDOUS AND NON-HAZARDOUS WASTES

Managing the generation and disposal of hazardous and nonhazardous wastes is one of the most difficult environmental management challenges for staff in small labs. Common issues to address include classification, storage, labeling, treatment, and disposal of laboratory wastes as well as identifying opportunities to minimize the generation of wastes. This section will review these areas and indicate some practical ways to help manage waste. Only the Federal requirements, which set forth minimum requirements, are outlined here. It is important to check with relevant state and local authorities to find out if there are any stricter regulations or requirements which apply. Often there are.

2.4.1 Regulatory Considerations

Overview

The Resource Conservation and Recovery Act (RCRA), enacted in 1976, was written to provide "cradle to grave" tracking of hazardous waste. Pursuant to RCRA, EPA developed hazardous waste management regulations applicable to generators and treatment, storage and disposal facilities (TSDFs). In 1984, Congress expanded the scope of RCRA with passage of the Hazardous and Solid Waste Amendments (HSWA). HSWA allowed EPA to pass regulations governing small quantity hazardous waste generators (SQGS; those generating <1,000 kg hazardous waste/month). Therefore, HSWA had a substantial impact on small labs. Through RCRA and HSWA, EPA developed regulatory programs for hazardous waste and nonhazardous waste.

Most laboratories routinely generate hazardous waste and, therefore, are subject to RCRA hazardous waste management regulations (40 CFR Parts 260 to 270). As hazardous waste generators, laboratories are subject to requirements governing waste classification and, depending on quantities generated, waste accumulation, disposal, recordkeeping, and emergency preparedness.

State Delegation

EPA has delegated authority to implement and enforce hazardous waste management programs to states with regulations that are at least as stringent as EPA's hazardous waste regulations. Still, it is important to keep up with the EPA regulations since EPA regularly publishes new hazardous waste management regulations that are enforceable in the states even though they may not yet be included in a given state's hazardous waste regulations.

Hazardous Waste Defined

EPA defines hazardous waste in 40 CFR 261. In order for a waste to be hazardous waste it must meet the EPA definition of "solid waste," since hazardous waste is considered a subset of solid waste. The term "solid waste" is used very broadly in RCRA and refers to both nonhazardous and hazardous waste including not only solids, but also liquids, semi-solids, sludges, and compressed gases. A solid waste determination depends on the type of material and how it will be recycled or disposed of. Therefore, chemicals from a laboratory may or may not be a solid waste, depending on their final disposition. Certain solid wastes are considered hazardous wastes since they may cause an increase in mortality or illness or pose substantial hazard to human health or the environment when improperly managed. A waste is considered hazardous if it is: (1) listed on one of the lists of hazardous wastes; or (2) it exhibits

one or more of the four hazardous characteristics. Listed and characteristic hazardous wastes are identified using codes consisting of one letter followed by three digits. For listed wastes, the first letter in the code corresponds to the list designation (e.g., F-List, P-List, U-List, K-List). The first letter in the codes of characteristic wastes is D. Generators must identify their wastes with all applicable codes; therefore, it is common for several codes to be associated with a single waste container.

To determine if a waste is a regulated hazardous waste, generators can use either knowledge or testing (40 CFR 262.11). Wastes such as expired chemical stocks will not require testing to determine if they are hazardous waste; rather, knowledge of the chemicals' origins and characteristics can be applied in the determination. (Note: Material Safety Data Sheets (MSDSs) can be useful for this purpose).

Listed Wastes

There are four lists of hazardous wastes. To determine if a waste is listed, one must have knowledge of the waste's origin. The lists are described briefly below, but complete copies of the hazardous waste lists are included in 40 CFR 261.

- F-List [40 CFR 261.31] - The F-list (F001-F039), frequently referred to as the non-specific source list, contains spent solvents, electroplating wastes, wastes related to the production or treatment of chlorinated hydrocarbons, wood preserving wastes, and certain landfill leachates. Spent solvents on the F-list are designated by the codes F001, F002, F003, F004 and F005. The F001 code only applies to certain chlorinated solvents used in degreasing operations. Spent solvents represented by the codes F002 through F005 are presented alphabetically in a table on the next page. Often, laboratories generate F-listed spent solvents. For example, in an organic prep lab, listed solvents such as methylene chloride and carbon disulfide are used in the extraction processes: methylene chloride wastes (e.g., waste extracts) are denoted by the code F002, and carbon disulfide wastes are denoted by the code F005. Note that there is a special “ignitability” provision for some of these wastes. This provision states that if a F-listed waste was originally listed for ignitability (solely), and that waste is no longer ignitable, then the waste is no longer a listed hazardous waste.
- K-List [40 CFR 261.32] - The K-list, frequently referred to as the specific source list, contains solid hazardous wastes from certain industries including, but not limited to, chemical manufacturing, ink formulating, petroleum refineries and metal smelting. Laboratories may generate K-listed waste if they accept waste samples from a K-listed industrial process.
- P-List [40 CFR 261.33(e)] - The P-list applies to unused, discarded, commercial chemical products with a sole-active ingredient on the P-list. In laboratories, the P-list is often assigned to expired chemicals or unused chemicals that are thought to be contaminated. For example, a container of carbon disulfide, that for some reason is thought to be contaminated, would be disposed of as P022 waste. The P-list can also be applied to discarded chemical solutions that were made in the laboratory in lieu of purchasing a commercial product. For example, excess (e.g., unused) Aldrin standard that was prepared in the laboratory (e.g., in methanol) would be disposed of as P004 waste if Aldrin was the sole-active ingredient (methanol is not "active" in this case). The P-list is not applied to waste standards with several active ingredients (e.g., a mixed pesticide standard), but only to waste standards with a sole-active ingredient. P-listed wastes are acutely hazardous wastes. To avoid generation of unnecessary quantities of P-listed waste, all P-listed waste should be segregated from other hazardous waste.

F-LISTED SOLVENTS	
Solvent	**F-Code**
Acetone	F003
Benzene	F005
n-Butyl Alcohol	F003
Carbon Disulfide	F005
Carbon Tetrachloride	F001
Chlorobenzene	F002
Chlorinated Fluorocarbons	F001
Cresols	F004
Cresylic Acid	F004
Cyclohexanone	F003
2-Ethoxyethanol	F005
Ethyl Acetate	F003
Ethyl Benzene	F003
Ethyl Ether	F003
Isobutanol	F005
Methanol	F003
Methylene Chloride	F002
Methyl Ethyl Ketone	F005
Methyl Isobutyl Ketone	F003
Nitrobenzene	F004
2-Nitropropane	F005
ortho-Dichlorobenzene	F002
Pyridine	F005
Tetrachloroethylene	F002
1,1,1-Trichloroethane	F002
1,1,2-Trichloroethane	F002
Trichloroethylene	F002
1,1,2-Trichloro-1,2,2-Trifluoroethane	F002
Trichlorofluoromethane	F002
Toluene	F005
Xylene	F003

- U-List [40 CFR 261.33(f)] - The U-list applies to unused, discarded, commercial chemical products that contain a sole-active ingredient that appears on the U-list. In laboratories, the U-list is often assigned to expired chemicals or unused chemicals that are thought to be contaminated. For example, a container of methylene chloride, that for some reason is thought to be contaminated, would be disposed of as U080 waste. [Note: Actually dichloromethane, not its synonym methylene chloride appears on the U-list. When reviewing the P- and U-lists, one must carefully check for synonyms.] Unlike the P-list, which have been identified as acute hazardous wastes, the U-listed wastes have been identified as toxic wastes.
- State Listed Wastes - State hazardous waste regulators often add wastes, such as waste oils and polychlorinated biphenyls, to their state lists of hazardous wastes.

Characteristic Wastes

There are four hazardous waste characteristics: ignitability, corrosivity, reactivity and toxicity. Generators may use testing or knowledge to determine if their waste exhibits one or more of the characteristics. Below are key descriptors of each characteristic. Actual definitions can be found in the CFR at the citations given.

- Ignitability [40 CFR 261.21] - Ignitable wastes, denoted by the code D001, are generally liquids with flash points below 60°C (140°F). Non-chlorinated solvent wastes are usually ignitable wastes. (Note: These solvent wastes may also be F-listed.) A non-liquid is considered ignitable if it is capable of causing fire through friction, absorption of moisture, or spontaneous chemical changes, and burns in a manner that creates a hazard.
- Corrosivity [40 CFR 261.22] - Corrosive wastes, denoted by the code D002, are generally aqueous solutions with a pH $2 \leq$ or ≥ 12.5.
- Reactivity [40 CFR 261.23] - Reactive wastes, denoted by the code D003, are those wastes that are generally unstable, explosive, capable of detonation when heated under confinement, or react violently with water. Also, wastes are reactive if they generate toxic cyanide or sulfide fumes when subjected to pH between 2 and 12.5.
- Toxicity [40 CFR 261.24] - Toxic wastes, denoted by the codes D004 through D043, are certain wastes containing the regulated constituents shown in the table on the next page. To determine if wastes are toxic, they are subjected to the toxicity characteristic leaching procedure (TCLP). It should be noted that some states now require other metals to be analyzed under TCLP. As indicated throughout this document, you must check with your state agency to see if there are any additional requirements. TCLP identifies wastes that are likely to leach hazardous concentrations of regulated constituents in simulated landfill conditions. Wastes leaching contaminants above the regulated concentrations exhibit the toxicity characteristic and must be assigned the appropriate EPA hazardous waste code. Liquid wastes (e.g., containing less than 0.5% filterable solids) exhibit the toxicity characteristic if the waste itself contains contaminants above the regulated levels (the TCLP does not need to be performed).

EPA TOXICITY CHARACTERISTIC CONSTITUENTS

EPA ID Number	Regulated Constituent	Regulatory Level (mg/l)
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon tetrachloride	0.5
D020	Chlordane	0.03
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	200.0
D024	m-Crsol	200.0
D025	p-Cresol	200.0
D026	Cresol (total)	200.0
D016	2,4-D	10.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13
D012	Endrin	0.02
D031	Heptachlor (and itsæpoxide)	0.008
D032	Hexachlorobenzene	0.13
D033	Hexachlorobutadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D013	Lindane	0.4
D009	Mercury	0.2
D014	Methoxychlor	10.0
D035	Methyl ethylketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D015	Toxaphene	0.5
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D017	2,4,5-TP (Silvex)	1.0
D043	Vinyl chloride	0.2

Exclusions

Certain substances are excluded from the regulatory definitions of solid and hazardous wastes. For example, household waste (no matter how hazardous) is excluded from the regulatory definition of hazardous waste. Three exclusions that are particularly important to many laboratories are highlighted below:

- Wastewater - Under the Federal RCRA regulations, mixtures of untreated sanitary waste and other (i.e. hazardous) waste discharged to a publicly-owned treatment works (POTW) are excluded from the definition of solid waste and, therefore, not regulated hazardous waste (40 CFR Part 261.4(a)). This exemption also applies to on-site waste water treatment systems with an NPDES permit. The discharges are subject to stringent water pollution control requirements instead of hazardous waste requirements (see Section 2.3.2).
- Samples - Samples that are sent to the laboratory for analyses are not considered regulated waste while awaiting testing, while stored after testing for a specific purpose, or while being transported back to the sample collector (40 CFR 261.4(d)). For example, samples are not yet waste if QC of analytical results has not been completed and re-testing may be necessary. Once a sample is no longer being held for a specific purpose, then it must be managed as waste, and hazardous waste if appropriate (e.g., if it is listed or displays a characteristic).
- Empty Containers - Empty containers that once held hazardous materials are not regulated as hazardous waste if they meet the definition of "empty." A container is empty if all waste has been removed (e.g., by pouring or pumping) and less than one inch of residue remains on the bottom of container. Containers that held acutely hazardous waste are considered empty only after being triple rinsed with a solvent capable of removing the acutely hazardous waste residue. The solvent rinsate then must be managed as acutely hazardous waste.

2.4.2 Mixtures of Chemical Wastes

It is not uncommon for laboratories to generate waste streams that contain several chemicals mixed together. If this is the case, there are additional rules that affect treatment, storage, and disposal practices. It is important to understand that a mixture of a hazardous waste and a nonhazardous waste is hazardous if the mixture exhibits the above noted characteristics and/or if the hazardous waste component is a listed hazardous waste. Dilution is not allowed as treatment.

2.4.3 Determining Generator Status

If lab wastes are found on any of the hazardous waste lists or exhibit any of the characteristics mentioned previously, the waste is considered hazardous and must be stored, treated or otherwise managed in accordance with the requirements specified in RCRA. Once wastes are determined to be hazardous, it is necessary to quantify the amount of hazardous waste generated per month.

Hazardous waste generators are subject to varying requirements depending on how much hazardous waste they generate monthly. Under the Federal rules, there are three classes of generators: large quantity generators (LQGs), small quantity generators (SQGs), and conditionally-exempt small quantity generators (CESQGs). Often, states define generator status differently and set more stringent

requirements, especially upon SQGs and CESQGs. Therefore, it is imperative that lab staff understand state generator requirements.

SQGs and LQGs must obtain EPA generator identification numbers. Hazardous waste must be labeled, stored, and disposed of in accordance with state hazardous waste regulations. Organizations generating less than 100 kilograms of hazardous waste per month are CESQGs and are subject to very minimal regulation (in most states).

The table on the next page presents an overview of generator status requirements that apply to laboratories depending upon their generator status.

2.4.4 Hazardous Waste Accumulation in the Laboratory

Storage requirements for hazardous waste are specified under Federal (RCRA) and state requirements. At a minimum, lab staff should be aware of the following Federal regulations. The quantity and type of waste generated will determine what specific requirements need to be followed. Hazardous waste accumulating in laboratories are usually considered to be in "satellite accumulation areas" and are subject to minimal regulatory requirements (262.34(c)). Satellite accumulation areas must be at or near the process that generates the waste and under the control of the operator of that process. Generators may accumulate up to 55 gallons of hazardous waste, or 1 quart of acutely hazardous waste, at a satellite accumulation area. If the waste is moved to a nearby room, then it is not considered in satellite accumulation and is subject to more stringent requirements. Waste in satellite accumulation areas must be managed as discussed below:

- All hazardous waste containers in the laboratory must be kept closed during storage except when it is necessary to add or remove waste. Evaporation of wastes in fume hoods is prohibited.
- Federal satellite area rules only require labels listing the container's contents, but many states require that the contents, the hazard and the actual words, "Hazardous Waste," be on the container. Prudent practice would be to mark all hazardous waste containers in the laboratory with the words "Hazardous Waste" and other words that identify the containers' contents (e.g., "waste hexane with trace pesticide contamination").
- Hazardous waste must be stored in containers that are in good condition and are compatible with the wastes they contain.

RCRA REQUIREMENTS FOR LABS AS A FUNCTION OF GENERATOR STATUS*

Requirement (40CFR)	CESQG**	SQG	LQG
Waste Determination (262.11)	Applicable	Applicable	Applicable
Generation Rate Limits (261.5 and 262.34)	<100 kg/mo	100-1,000 kg/mo	1,000 kg/mo or greater
Accumulation Quantity Limit w/o Permit (261.5 and 262.34)	not to exceed 1,000 kg at any time not to exceed 1 kg acute at any time	not to exceed 6,000 kg at any time	No limit
Accumulation Time (261.5 and 262.34)	No limit	180 days, or 270 if waste is to be transported over 200 miles.	90 days
EPA ID Number (262.12)	Not required***; possible state requirement	Required	Required
Mark Containers with Start Date (262.34)	Not applicable	Applicable	Applicable
Mark Containers "Hazardous Waste" (262.34(a))	Not applicable	Applicable	Applicable
Air Emission Standards 40 CFR 265 Subpart CC	Not applicable	Not applicable	Applicable
Satellite Accumulation (262.34(c))	Not applicable	Applicable	Applicable
Use Manifests (262, Subpart B)	Not required***; possible state requirement	Required	Required
Exception Reporting (262.42)	Not required	Required after 45 days	Required after 35 days
Biennial Report (262.41)	Not required	Not required; possible state requirement	Required
Contingency Plan (265, Subpart D)	Not required, but OSHA (29 CFR 1910.38) requires emergency planning	Basic planning required in accordance with the standards in 262.34(d)(4) and (5) and 265, Subpart C as well as OSHA regulations	Full written plan in accordance with 265 Subpart D, is required by 262.34(a)(4) and OSHA regulations
RCRA Personnel Training (262.34 and 265.16)	Not required, but recommended	Basic training required by 262.34(d)(5)(iii)	Full compliance with the training requirements in 265.16 is required by 262.34(a)(4)
Storage Requirements (without permit) (262.34 and 265)	None, but OSHA regulations under 29 CFR 1910, Subparts H and N, apply, particularly 29 CFR 1910.106	Compliance with technical standards in Part 265, Subparts I and J; for containers and tanks is required by 262.34(d)(2) and (3) and OSHA regulations	Compliance with technical standards in Part 265, Subparts I, J, W, and DD, is required by 262.34(a)(1) and OSHA regulations
Recordkeeping Requirements (262.40)	Waste determinations and generation log required (notification of regulated waste activity, training records, manifests, and land disposal restriction notifications recommended)	Notification of regulated waste activity, waste determinations, generation log, manifests, land disposal restriction notifications, exception reports, and correspondence with local emergency responders (written contingency plan, weekly container inspection & periodic equipment maintenance logs, and RCRA training records recommended)	Notification of regulated waste activity, waste determinations, generation log, manifests, land disposal restriction notifications, exception reports, biennial reports, correspondence with local emergency responders, RCRA training records, and written contingency plan required (weekly container inspection is required & periodic equipment maintenance logs is recommended)
Waste "Designated Facility"	state-approved or RCRA permitted facility or legitimate recycler	RCRA-permitted facility or legitimate recycler	RCRA-permitted facility or legitimate recycler
Land Disposal Restrictions (268.7)	Possible state requirement	Applicable	Applicable

* From *Laboratory Safety & Environmental Management,* Vol. 5, No. 6.
** As of January 1, 1998, landfills accepting CESQG waste must be in compliance with portions of 40 CFR Part 258.
*** Although these items are not legally required under RCRA, most transporters and TSDFs will not handle hazardous waste without them.

- Up to 55 gallons of hazardous waste, or 1 quart of acutely hazardous waste, may be stored at each satellite accumulation area. Note: Although EPA regulations allow up to 55 gallons of hazardous waste to be stored at each satellite accumulation area, this is often not a safe practice. Also, standards such as those specified by the National Fire Protection Association (e.g., NFPA 45) limit the quantities of flammable materials that can be stored in one laboratory room. Therefore, lab staff should limit the quantity of hazardous waste permitted to be stored in each room to a more reasonable quantity (e.g., five gallons).

Once hazardous waste leaves the satellite accumulation areas and enters a different location, referred to herein as a central accumulation area, additional regulations take effect.

Hazardous Waste in a Designated Accumulation Area

Once hazardous waste leaves the satellite accumulation areas and enters a different location, referred to herein as an accumulation area, it is subject to more stringent management standards.

When waste leaves the satellite accumulation area, "the clock starts." From this date, a laboratory must ship the waste off-site to a permitted hazardous waste treatment, storage or disposal facility (TSDF) within 90, 180, or 270 days depending on its generator status and distance from the TSDF. If waste is not sent off-site within the required time frame, then the laboratory is subject to fines and in some cases very cumbersome and costly RCRA storage permit requirements.

All waste containers entering an accumulation area must be clearly marked with the date they entered the area. All containers must be clearly marked "Hazardous Waste."

The following emergency equipment must be maintained at the accumulation area and periodically tested to ensure it is in working order:

- A communications device or alarm system capable of informing facility personnel and local emergency response authorities in the event of an emergency;
- A portable fire extinguisher, spill control equipment, and decontamination equipment; and
- Water at adequate volume and pressure to supply water hose streams, or foam producing equipment, or automatic sprinklers.

Waste containers must be arranged in the accumulation area so that there is adequate aisle space to allow for the flow of emergency personnel and equipment. Incompatible wastes must be separated to the extent possible using distance, berms, or containment pans. The area must be inspected weekly for all waste containers in the shed for leaks and deterioration on a weekly basis.

2.4.5 Storage Requirements for Chemicals and Wastes

Laboratory staff should ensure that both hazardous wastes and stock chemicals are stored properly in order to prevent spills and uncontrolled reactions. Chemicals should be segregated according to chemical classes. For example, acids should be kept separate from bases, oxidizers from organics, and cyanides from acids. The table on the next page provides additional examples of segregation principles for various chemical classes.

PARTIAL LIST OF INCOMPATIBLE CHEMICALS (REACTIVE HAZARDS)*

Substances in the left hand column should be stored and handled so that they cannot accidentally contact corresponding substances in the right hand column.

Acetic acid	Chromic acid, nitric acid, peroxides, permanganates
Acetic anhydride	Hydroxyl-containing compounds such as ethylene glycol, perchloric acid
Acetone	Concentrated nitric and sulfuric acid mixtures, hydrogen peroxide
Acetylene	Chlorine, bromine, copper, silver, fluorine, mercury
Alkali and alkaline earth metals, such as sodium, potassium, lithium, magnesium, calcium, powdered aluminum	Carbon dioxide, carbon tetrachloride, other chlorinated hydrocarbons (also prohibit the use of water, foam, and dry chemical extinguishers on fires involving these materials—dry sand should be employed)
Ammonia (anhydrous)	Mercury, chlorine, calcium hypochlorite, iodine, bromine, hydrogen fluoride
Ammonium nitrate	Acids, metal powders, flammable liquids, chlorates, nitrites, sulfur, finely divided organics, combustibles
Aniline	Nitric acid, hydrogen peroxide
Bromine	Ammonia, acetylene, butadiene, butane, other petroleum gases, sodium carbide, turpentine, benzene, finely divided metals
Calcium oxide	Water
Carbon, activated	Calcium hypochlorite, other oxidants
Chlorates	Ammonium salts, acids, metal powders, sulfur, finely divided organics, combustibles
Chromic acid and chromium trioxide	Acetic acid, naphthalene, camphor, glycerol, turpentine, benzene, finely divided metals
Chlorine	Ammonia, acetylene, butadiene, butane, other petroleum gases, hydrogen, sodium carbide, turpentine, benzene, finely divided metals
Chlorine dioxide	Ammonia, methane, phosphine, hydrogen sulfide
Copper	Acetylene, hydrogen peroxide
Fluorine	Isolate from everything
Hydrazine	Hydrogen peroxide, nitric acid, and other oxidant
Hydrocarbons (benzene, butane, propane, gasoline, turpentine, etc.)	Fluorine, chlorine, bromine, chromic acid, peroxides
Hydrocyanic acid	Nitric acid, alkalis
Hydrofluoric acid (anhydrous) Hydrogen fluoride	Ammonia (aqueous or anhydrous)
Hydrogen peroxide	Copper, chromium, iron, most metals or their salts, any flammable liquid, combustible materials, aniline, nitromethane
Hydrogen sulfide	Fuming nitric acid, oxidizing gases
Iodine	Acetylene, ammonia (anhydrous or aqueous)
Mercury	Acetylene, fulminic acid, ammonia
Nitric acid (concentrated)	Acetic acid, acetone, alcohol, aniline, chromic acid, hydrocyanic acid, hydrogen sulfide, flammable liquids, flammable gases, nitratable substances
Nitroparaffins	Inorganic bases, amines
Oxalic acid	Silver and mercury and their salts
Oxygen	Oils, grease, hydrogen, flammable liquids, solids, gases
Perchloric acid	Acetic anhydride, bismuth and its alloys, alcohol, paper, wood, grease, oils (all organics)
Peroxides, organic	Acids (organic or mineral), also avoid friction, store cold)
Phosphorus (white)	Air, oxygen
Phosphorus pentoxide	Alcohols, strong bases, water
Potassium chlorate	Acids (see also chlorates)
Potassium permanganate	Glycerol, ethylene glycol, benzaldehyde, sulfuric acid
Silver and silver salts	Acetylene, oxalic acid, tartaric acid, fulminic acid, * ammonium compounds
Sodium	See alkali metals (above)
Sodium nitrite	Ammonium nitrate and other ammonium salts
Sodium peroxide	Any oxidizable substance, such as ethanol, methanol, glacial acetic acid, acetic anhydride, benzaldehyde, carbon disulfide, glycerol, ethylene glycol, ethyl acetate, methyl acetate, furfural
Sulfuric acid	Chlorates, perchlorates, permanganates

* From *Prudent Practices in the Laboratory, Handling and Disposal of Chemicals*, National Academy Press, 1995.

Laboratories that use highly reactive chemicals should take measures to ensure that these substances are handled properly. Due to the volatile and explosive nature of this class of chemicals, it warrants special attention. The following guidelines should be followed when using and storing highly reactive substances:

- Consider the storage requirements of each highly reactive chemical prior to purchase and make sure that staff are trained to store it safely.
- Obtain and review the Material Safety Data Sheet or other chemical safety information to ensure that staff are aware of the hazards and storage requirements.
- Purchase small quantities of the chemical that staff will need for the short term. Try not to exceed a three month supply.
- Label, date, and inventory all highly reactive materials as soon as they are received. If staff must transfer the chemical from its original container into another container, make sure it is labeled with the name of the chemical, and the words DANGER! HIGHLY REACTIVE MATERIAL. Note: OSHA may require special labels disclosing all hazards on repackaged containers.
- Do not open a container of highly reactive material that is past its expiration date.
- Do not open a liquid organic peroxide or peroxide former (e.g., picric acid) if crystals or a precipitate are present.
- Segregate the following highly reactive materials:
  - Oxidizing agents from reducing agents and combustibles.
  - Powerful reducing agents from readily reducible substrates.
  - Acids from reducing agents.
- Store highly reactive liquids in trays large enough to hold the contents of the bottles.
- Store peroxidizable materials away from heat and light.
- Do not use metal spatulas to handle peroxides because contamination by metals can lead to explosive decomposition. Use ceramic, Teflon®, or wooden spatulas.
- Avoid friction, grinding, and all forms of impact near peroxides, especially solid peroxides and diazomethane solution (used in methylation of some pesticides). Glass containers that have screw-cap lids or glass stoppers should not be used. Instead, use polyethylene bottles with screw-cap lids.
- Store materials that react vigorously with water away from possible contact with water.
- Store thermally unstable materials in a refrigerator. Use a refrigerator with these safety features:
  - Alarm to warn when temperature is too high.
  - Spark-proof controls on the outside.
  - Magnetic, locked door.
- Store liquid organic peroxides at the lowest possible temperature consistent with the solubility or freezing point. Liquid peroxides are particularly sensitive during phase changes.
- Inspect and test peroxide-forming chemicals periodically.
- Store containers in cabinets that are designed to hold that type of waste.

2.4.6 Hazardous Waste Manifests and Related RCRA Provisions

Hazardous Waste Manifests

In accordance with 40 CFR 262, all hazardous waste shipments being sent off-site to be managed at a TSDF must be accompanied by hazardous waste manifests. Wastes may only be manifested to appropriate designated facilities, such as permitted TSDF or a recycler. Often, manifests are completed by a hazardous waste contractor. However, laboratory personnel must review the manifest to ensure it is completed accurately and sign the manifest certifying that it is accurate. The designated TSDF must sign the manifest and send a copy to the laboratory within 30 to 45 days (depending upon your generator status) of the waste shipment. If a signed copy is not received by the laboratory within the appropriate time frame, the laboratory is subject to exception reporting requirements in 40 CFR 262.42. Note: As of August 12, 1997, labs in campus settings (i.e. labs in multiple buildings located on contiguous properties divided by roads) the Military Munitions Rule (62 FR 6621) exempted some RCRA manifest requirements. Specifically, to allow generators to consolidate waste in a central accumulation area, EPA now allows transportation of hazardous waste on public or private right-of-ways, or along the border of contiguous properties under the control of the same person without a manifest.

Land Disposal Restriction (LDR) Notices

EPA regulations require that nearly all hazardous waste be treated prior to land disposal (40 CFR 268). Hazardous waste generators are required to notify the receiving TSDF when they ship land disposal restricted wastes. LDR notices accompany the hazardous waste manifest and include the generator's identification number, the appropriate treatment standards, and the accompanying manifest number.

Training

Lab staff should be trained annually in hazardous waste management and emergency procedures relevant to their positions. Other staff may need to be trained in proper building evacuation procedures in the event of an emergency. The training must teach personnel to perform their duties in a way that ensures compliance with hazardous waste management regulations. Obviously, since hazardous waste management responsibilities differ for various staff, so do training requirements. RCRA training regulations also require that hazardous waste generators maintain written job titles and descriptions for all employees with positions relating to hazardous waste management. Lab staff who pack hazardous waste for transport or prepare and/or sign manifests must be trained in accordance with DOT regulations. Also, OSHA's Lab Standard (29 CFR 1900.1450) requires a plan, including training, addressing lab staff who work with chemical hazards. Oddly, though, not all labs (e.g., QA labs in manufacturing) are included.

Reporting and Record-keeping

Generators must file EPA Form 8700-12 (Notification of Hazardous Waste Activity) with their state hazardous waste agency to obtain an EPA identification number. Generators should retain a copy of this form. In addition, generators must also retain weekly inspection logs for the accumulation area, data relating to hazardous waste determination, training records, job descriptions, hazardous waste manifests, and LDR notices. Many laboratories (especially SQGs and LQGs) are subject to annual reporting requirements imposed by their state hazardous waste agency.

2.4.7 Medical and Infectious Wastes

In addition to generating chemical waste, laboratories that perform biological and medical research may also generate medical and infectious waste. Although there are no Federal EPA requirements for the management and disposal of medical waste (other than regulations for medical waste incinerators and chemical treatment systems) most states do define and regulate this waste stream. Medical waste is generally defined as any solid waste generated in the diagnosis, treatment, immunization of human beings or animals, in related research, or in the production or testing of "biologicals" including cultures and stocks, human blood and blood products, human pathological wastes, sharps, animal waste, and wastes from isolated patients.

It is important to consult with the state office of environmental management to obtain the current requirements in the lab location. Additionally, it is important to understand that other Federal agencies such as DOT, OSHA, and the Nuclear Regulatory Commission (NRC) have regulations that address various aspects of medical waste management. Information on how to contact these agencies for more information are in Section 4.0.

Proper management ensures that infectious waste is handled in accordance with established procedures from the time of generation through treatment of the waste. The following elements of an infectious waste management program should be in place to reduce exposure to employees and the public:

- Segregate infectious waste from the general trash.
- Use the universal biological hazard symbol on infectious waste containers.
- Select the packaging material that is appropriate for the type of waste handled:
  - Plastic bags for solid or semisolid infectious waste.
  - Puncture resistant containers for sharps.
  - Bottles, flasks, or tanks for liquids.
- Use packaging that maintains its integrity during storage and transportation.
- Do not compact infectious waste or packaged infectious waste before treatment.
- Minimize storage time.
- Select the most appropriate treatment option for your waste. Consider steam sterilization, incineration, thermal inactivation, and chemical disinfection. Note that in most cases, it is acceptable to discharge blood and blood products to the sanitary sewer, but check first with your local POTW.
- Contact state and local authorities to identify approved treatment disposal options.

An effective infectious waste program not only protects workers and the environment, it can also lead to cost savings from waste reduction or prevention.

2.4.8 Multi-hazardous Wastes

Laboratories may generate waste streams that contain a combination of chemical, biological, or radioactive substances. Multi-hazardous wastes are defined as those that contain both chemical and biological hazardous substances, while "mixed wastes" will contain radioactive, chemical, and/or biological hazardous substances. Any waste-stream that presents more than one type of hazard requires special management consideration because the selected treatment technology appropriate for one type of

waste may not be appropriate for the other types. Some examples of laboratory mixed wastes include:

- Used flammable (e.g., toluene) liquid scintillation cocktails.
- Phenol-chloroform mixtures from extraction of radiolabeled nucleic acids.
- Aqueous solutions containing chloroform and radioactive material typically found in solutions generated by the neutralization of radioactive trichloracetic acid solutions.
- Certain gel electrophoresis waste (e.g., methanol or acetic acid containing radionuclides).
- Lead contaminated with radioactivity.

To minimize the generation of multi-hazardous waste streams, consider the following points:

- Use pollution prevention strategies to reduce multi-hazardous waste to a waste that presents a single hazard. By taking measures to limit the types of hazard in a specific waste-stream the waste may be managed by standards methods only for that category.
- When possible select a single management option. Some waste management methods are appropriate for more than one waste hazard. For example low-level radioactive animal tissue (radioactive-biological waste) can often be incinerated on-site in compliance with NRC regulations, which may be a satisfactory disposal option for both the radioactive and the biological characteristics of the waste. Some multi-hazardous waste can be disposed of safely in the sanitary sewer when allowed by the local POTW (see Section 2.4).

The problems presented by managing mixed wastes can be reduced by applying waste minimization techniques such as:

- Substitution of nonignitable liquid scintillation fluid (LSF) for toluene-based LSF to reduce a chemical-radioactive waste to a radioactive waste.
- Substitution of shorter half-life radionuclides such as ^{32}P for ^{33}P and ^{131}I for ^{125}I to shorten the hazard period.
- Use of 2.5 mL scintillation vials (minivials) instead of 10 mL vials to reduce waste scintillation fluid.
- Elimination of the methanol/acetic acid and radioactive mixed hazards in gel electrophoresis work by skipping the gel fixing step if it is not required.
- Prevention of radioactive contamination of lead by lining lead containers with disposable plastic or by using alternative shielding materials.

2.4.9 Sealed Radioactive Sources

Sealed radioactive sources are commonly used in measuring devices and other laboratory instrumentation. For example, gas chromatographs use ^{63} Nickel and static eliminators use ^{210} Polonium. Leakage and proper disposal are infrequent, but major concerns associated with radioactive sealed sources. Leak tests are required for beta and gamma sources emitting 100 microcuries or greater and for alpha sources that emit 10 microcuries or greater. Leak tests should be conducted every six months. This can be accomplished by wiping the source with a filter paper or a medical swab and then sending it to a certified testing lab. Consideration should also be given to the proper disposal method for radioactive sealed sources. When taking the equipment out of service, it is advisable to follow the manufacturer's instructions. Generally, manufacturers advise returning the equipment to them and they in turn, will dispose of the radioactive source. The manufacturer should be your first contact to learn about handling, shipping and disposal options prior to shipment.

2.4.10 General Hazardous Waste Recycling and Disposal Considerations

Once specific waste streams and quantities have been determined, it is important to decide on the best recycling or disposal method for that waste. Reputable hazardous waste transporters or hazardous waste management facilities can provide advice on the options that are most cost-effective and environmentally preferred to specific situations. Note, however, that it is always the generator's responsibility to understand and be in compliance with the regulations. Typical disposal options for chemical wastes include incineration for toxic materials, and landfill for nonhazardous materials. Hazardous waste transporters can also assist labs meet DOT shipping and RCRA transportation requirements and help prepare hazardous waste manifest forms.

Because laboratory wastes typically include a diverse array of chemicals in small quantities, they present special disposal concerns. In general, chemicals can either be consolidated into bulk waste streams that meet specific characteristics or "lab-packed." The term "lab-pack" describes the most common method for packaging small quantities of laboratory waste. Small containers of compatible waste materials are placed intact into a larger packaging unit, usually a steel or fiber drum that contains an absorbent material, such as vermiculite, to cushion the containers and absorb spilled or leaked waste. An inventory is made as the containers are added to the drum. The drum is then sealed and a copy of the inventory sheet is attached to the drum. The drum is then shipped off-site for disposal accompanied by a Hazardous Waste Manifest.

There are advantages and disadvantages to lab-packing. This packaging method eliminates the need to transfer wastes and also reduces the occurrence of dangerous reactions resulting from mixing incompatible materials. However, this method is often the most expensive. The decision to consolidate or lab-pack should be made by those who are knowledgeable about the makeup of each waste stream and in consultation with the selected hazardous waste contractor. Note that only individuals who have successfully completed DOT "Hazmat" training can prepare lab-packs.

2.4.11 Nonhazardous Waste

In addition to hazardous waste, RCRA regulates nonhazardous waste, sometimes simply referred to as solid waste. Solid waste disposal facilities typically must be permitted by a state agency and must meet certain design and operating requirements. Most laboratory facilities arrange to have solid waste hauled to a permitted waste disposal facility (e.g., landfill or incinerator). On-site landfills or incinerators are stringently regulated by state agencies governing waste management and, in the case of incinerators, air pollution control.

Many state and local regulations include requirements for segregating and recycling certain materials (e.g., glass, newspapers, aluminum). Laboratory managers should ensure that personnel comply with local recycling codes.

2.4.12 Hazardous Waste Management Checklist

The following checklist of actions will help small labs achieve and maintain a good hazardous waste management program. Completing all of these actions does not necessarily mean all regulatory compliance requirements have been met. It is important to get updated and more complete information from Federal, state and local authorities.

HAZARDOUS WASTE MANAGEMENT PROGRAM CHECKLIST	
Action **If it has been determined that the lab generates hazardous waste, ensure that:**	**Notes**
Hazardous Waste Identification	
1. Waste has been properly characterized to determine that (1) it is hazardous waste and (2) proper EPA identification code numbers have been assigned.	
Generator Status	
2. The facility has a system to determine generation rate and quantity of hazardous waste accumulated on-site and uses this data to ascertain generator status	
3. If required (e.g., SQG or LQG), the facility has an EPA identification number.	
Satellite Accumulation	
4. Each satellite accumulation area (SAA) is at or near the point of waste generation for each waste and is under the control of the operator of the process that generated the waste.	
5. Waste containers are labeled “Hazardous Waste” and/or with words to indicate their contents.	
6. Waste containers are kept closed and are in good condition.	
7. Wastes are compatible with containers.	
8. Wastes in any given SAA do not exceed 55 gallons of hazardous waste or one quart of acutely hazardous waste.	
Central Accumulation Area	
9. Every hazardous waste container is marked “Hazardous Waste” and with its accumulation start date.	
10. Waste is stored $\leq$90 days for LQGs and $\leq$180 days for SQGs, or 270 days if transported more than 200 miles.	
11. Incompatible wastes and/or materials are separated or protected by physical means (wall, cabinet).	
12. Internal communications equipment is available (e.g., two-way radio, telephone).	
13. Floor drains are covered to prevent a spill from entering a drain.	
14. Fire extinguishers and a water supply are available.	
15. Decontamination equipment is available (emergency shower, eyewash).	
16. Aisle spaces are unobstructed.	
17. Containers are inspected for leakage and/or corrosion at least weekly and inspections are recorded.	
18. The storage area provides secondary containment.	
19. Personal safety equipment is available and usable.	
20. Ignitable and reactive wastes are handled and stored in a manner to prevent fires and/or explosives.	
21. Containers are arranged on shelving so that the heavy containers are on the lower shelves and smaller containers on higher shelves.	
22. Shelving supporting hazardous wastes is in good condition and sturdy enough to support the load.	

Hazardous Waste Disposal	
23. Any hazardous waste treated or disposed on-site (e.g., neutralized and/or discharged down the drain) is done so in accordance with all applicable regulations.	
24. Any hazardous waste leaving the site is sent to an appropriately permitted TSDF.	
25. The hazardous waste transporter/broker is licensed, insured and reputable.	
26. Employees responsible for shipping hazardous waste have been trained in accordance with DOT regulations.	
Recordkeeping and Reporting	
27. The following records are retained on-site for at least three years: • Manifests • Waste analyses results • Inspection records • Training records • Land disposal restrictions notifications	
28. Hazardous waste manifests, signed by the transporter and designated TSDF, have been received by the facility within the appropriate time period (e.g., 35 days for LQG and 60 days for SQG).	
Emergency Preparedness	
29. An emergency coordinator who is familiar with response procedures at the facility has been designated and is on site or on call at all times.	
30. Emergency phone numbers (Fire Department, Police Department and Local Hospital) have been posted.	
31. The Fire Department is aware of the types and quantities of hazardous materials stored in the facility.	
32. For LQGs, a written contingency program has been developed and distributed.	
33. Spill cleanup materials and equipment (e.g., absorbents, neutralizers, and personal protective equipment) are available.	
Management System	
34. Copies of current Federal, state and local hazardous waste management regulations are available.	
35. An individual has been designated to manage hazardous waste at the facility (e.g., tracking, accumulation, disposal, minimization and recordkeeping).	
36. A formal training program (e.g., waste management, emergency response) is in place.	
37. A system to track the quantities of chemicals and hazardous wastes on-site is in place.	
38. The laboratory has investigated and, where feasible, implemented pollution prevention opportunities.	

2.5 POLLUTION PREVENTION AND WASTE MINIMIZATION

Pollution prevention and waste minimization are terms that refer to practices that reduce or eliminate the amount and/or toxicity of pollutants which would have entered any waste stream or that would have been released into the environment prior to recycling, treatment, or disposal. Pollution prevention applies not only to the management of all types of waste, but also to the management of releases to air, water, and land. Some common pollution prevention practices include equipment or process modifications, reformulation, substitution with less toxic materials, and inventory control procedures. EPA has developed a hierarchy for waste management alternatives which lists source reduction as the preferred option, followed by on-site and off-site recycling, treatment, and land disposal.

Implementing a comprehensive pollution prevention program can benefit a lab organization in a number of ways. It may cut expenses by reducing waste treatment and disposal costs, raw material purchases, and other operating costs, and it also may reduce potential environmental liabilities and help protect the environment.

Laboratories have unique waste disposal issues that are different from manufacturing operations because of the broad variety and small quantities of chemicals used and the rapid frequency in which processes can change. This section presents proven pollution prevention opportunities applicable to laboratory operations. The information contained in this section is not exhaustive, but serves as a resource to help lab staff begin or expand a pollution prevention program.

There are various methods you can employ to minimize the generation of hazardous wastes. To be effective, a pollution prevention program should include the key elements outlined below:

1. Obtain management support: Top management should instill and foster support by communicating the importance for such a program to staff. Management participation and compliance with the program is critical to its success.
2. Conduct a waste stream assessment: Evaluate each waste stream from every laboratory and process to generate ideas and options for reducing waste.
3. Conduct a feasibility analysis: This will help prioritize the order in which waste minimization options are selected and carried out. When performing a feasibility analysis, consider regulatory issues, costs, staffing, space requirements, and company policies.
4. Implement the selected waste minimization options: Develop and disseminate a memo or policy to educate and train staff who will ultimately be involved in performing and/or implementing the selected options.
5. Evaluate the program: Periodically evaluate the program's performance to determine overall effectiveness. Then implement recommended changes for improvement.

Pollution prevention and waste minimization opportunities in use at labs are listed below.

- Establish a centralized purchasing program to ensure full utilization of chemical products.
- Order reagent chemicals only in amounts needed.
- Maintain a limited inventory of chemicals on hand so that chemicals do not expire or deteriorate and necessitate disposal.

- Only mix what is needed.
- Rotate chemical stock.
- Develop a running inventory of unused chemicals for use by other departments.
- Reduce or eliminate the use of highly toxic chemicals in laboratory experiments.
- Centralize the waste management function to better track waste generation rates and management costs.
- Establish waste minimization goals.
- Educate staff on the benefits of waste minimization.
- Perform routine self-audits and pollution prevention opportunity assessments.
- Scale down experiments/procedures by using smaller labware and chemical quantities.
- Increase use of instrumentation that requires less reagents or smaller or fewer samples.
- Include in the experiment plan the reaction work-up-steps that deactivate hazardous materials or reduce toxicity.
- Treat or destroy hazardous waste products as the last step in experiments. Be careful, a RCRA permit may be needed.
- Complete reactions to eliminate hazardous waste.
- Reuse/recycle spent solvents.
- Recover metal from catalyst.
- Use procedures to recover metallic mercury. Note that except for physical separations, most mercury procedures are not safe at lab scale and won't work well in small batches.
- Recover silver from silver chloride residue waste.
- Investigate silver recovery or recycling with an outside vendor for photo processing wastes.
- Investigate mercury recovery and recycling with outside vendor.
- Keep individual hazardous waste streams segregated: segregate hazardous from nonhazardous, segregate recyclable waste from non-recyclable waste.
- Assure that the identity of all chemicals and wastes is clearly marked on all containers.
- Use less solvent to rinse equipment. For example, rinse several times with small volumes of solvent, rather than using only one or two rinses with larger volumes.
- Use citrus based solvents instead of xylene.
- Use biodegradable aqueous or detergent cleaners instead of chemical cleaners.
- Substitute red liquid thermometers for mercury thermometers where possible.
- Use biodegradable scintillation cocktail.
- Seek alternatives to phenol extractions.
- Review the use of highly toxic, carcinogenic, reactive, or mutagenic materials to determine if safer alternatives are feasible.
- Review procedures periodically to determine if quantities of chemicals and/or chemical waste could be reduced.
- Develop experiments in teaching labs that can use the same waste containers from week to week or that use less and fewer chemicals while still relaying concepts to the class.
- When preparing a new protocol, consider the kinds and amounts of waste products and see how they can be reduced or eliminated.
- Examine your waste/excess chemicals to determine if there are other uses within your organization before discarding.
- Consider using computer simulation/modeling to replace wet chemistry.

- Use solid phase extractions instead of column chromatography.
- When solvent is used for cleaning purposes, use spent solvent for initial cleaning and fresh solvent for final cleaning.
- When cleaning substrates or other materials by dipping, process multiple items in one day.
- Store and reuse developer in photo labs.
- Polymerize epoxy waste to a safe solid.
- Consider using solid-phase extractions for organics.
- Reuse hexane (or other solvent) after rotary evaporation.
- Keep containers closed except when in use.

2.5.1 In-Lab Treatment Of Hazardous Waste

Although not pollution prevention or waste minimization, there are many benefits to undertaking appropriate waste treatment techniques in the lab. Generators of hazardous wastes may treat their wastes on-site provided they treat in tanks and containers, and they are not conducting thermal treatment. If it is acceptable to incorporate treatment steps, suitable options for waste minimization (e.g., In-lab treatment) should be considered when planning experiments. Often steps can be added at the end of the experiment or procedure to eliminate hazardous byproducts and wastes. Some typical examples include oxidizing organic chemicals with sodium hypochlorite to produce nonhazardous waste, using phase separation of organics from aqueous solutions and liquids from solids. Other in-lab treatment methods include precipitation of toxic metals, oxidation of inorganic cyanides and sulfides, and treatment of organic peroxides and hydro-peroxides. Ideally, every laboratory procedure should be reviewed to determine whether acceptable waste treatment steps should be developed and included. Some specific recommendations include:

- Destroy ethidium bromide using $NaNO_2$ and hydrophosphorus acid.
- Treat sulfur and phosphorus wastes with bleach before disposal.
- Treat organolithium waste with water or ethanol.
- Consider including detoxification and/or waste neutralization steps in lab experiments.

2.5.2 Pollution Prevention and Waste Minimization Checklist

There are many opportunities for preventing pollution and minimizing waste in small labs. Acting on these usually results in cost savings. The following short list is designed to help a small lab begin or expand a pollution prevention and waste minimization program.

POLLUTION PREVENTION AND WASTE MINIMIZATION CHECKLIST	
Action	**Notes**
1. Offer unused chemicals to other departments or organizations before disposing as a hazardous waste.	
2. Contact suppliers to determine if they will accept unused materials (e.g., compressed gases).	
3. Mix compatible wastes together to reduce costs associated with shipping multiple containers. (Note: Its imperative to be certain the wastes are compatible. If unsure, don't do it.)	
4. Scale down experiments or production batches by using smaller sized labware and quantities of chemicals.	
5. Consider reaction work-up steps that deactivate hazardous materials for each procedure.	
6. Reduce the amount of solvent needed to rinse equipment.	
7. Use terpene or citrus based cleaners to replace organic solvents like acetones.	
8. Reuse or recycle spent solvents when feasible, before disposing.	
9. Identify less hazardous chemicals identified as substitutes for hazardous chemicals.	
10. Substitute red liquid thermometers for mercury ones.	
11. Develop and implement a laboratory pollution prevention program.	

Note: On May 28, 1993, EPA published its Interim Guidance to Hazardous Waste Generators on the Elements of a Waste Minimization Program (58 FR 31114). In this guidance, EPA stated that an effective waste minimization program should include each of the general elements: top management support; characterization of waste generation; periodic waste minimization assessments; cost allocation system; technology transfer; and program evaluation. Also, EPA emphasized the need for each generator to have a written waste minimization plan.

3.0 ADDITIONAL ENVIRONMENTAL MANAGEMENT ISSUES

The following section describe areas of environmental management responsibility that are important, but do not affect all small laboratories. Information is provided to make lab staff aware of these issues. If relevant, additional information should be sought from the references listed in the next chapter.

3.1 HAZARDOUS SUBSTANCE RELEASES

In 1980, Congress passed the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) in response to the growing concern about releases of hazardous substances to the environment. CERCLA was intended to provide for response to, and cleanup of, environmental problems not adequately addressed by other environmental statutes. Under CERCLA, provisions were made to establish a trust fund to finance environmental cleanups -- this resulted in CERCLA's nickname "Superfund."

CERCLA has been amended over ten times since its passage in 1980. Two important amendments are the Superfund Amendments and Reauthorization Act (SARA) of 1986 (see next section), and the Pollution Prevention Act of 1990.

Past Disposal Areas

The primary purpose of CERCLA is to provide for liability, compensation, cleanup, and emergency response for hazardous substances released to the environment. If lab personnel discover or have knowledge of an area that may be contaminated with hazardous substances (e.g., an abandoned landfill), they should consult with environmental professionals prior to disturbing the area. Such areas may require historical investigation and environmental sampling and analyses.

Releases of Hazardous Substances

EPA has designated hazardous substances and established reportable quantities (RQs) for releases (40 CFR 302) of these substances. The regulation mandates notification of a National Response Center (NRC) for releases of hazardous substances in quantities exceeding the associated RQ. It is unlikely that RQs of hazardous substances will be present at most small laboratories. However, lab managers should be familiar with the substances and RQs listed in 40 CFR 302 to make their own determination. If hazardous substances are present on-site in quantities exceeding the RQs, then lab staff should be prepared to make the required notifications in the event of a regulated release.

Pollution Prevention

In 1990, Congress passed the Pollution Prevention Act as an amendment to CERCLA. The act sets a priority for preventing pollution at the source over recycling, treatment, or disposal of waste. Since 1990, EPA has examined its regulations to ensure that they encourage pollution prevention. Many states have developed regulations requiring businesses to establish pollution prevention programs. Pollution prevention can be achieved by substituting nonhazardous products for hazardous products, improving operating practices to reduce the quantity of hazardous substances consumed, and educating employees as to the benefits of pollution prevention.

3.2 EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 is actually Title III of the Superfund Amendments and Reauthorization Act (SARA) which was mentioned previously (Section 3.1). EPCRA allows individuals access to information regarding chemicals used and emitted in their communities. Laboratories storing hazardous substances above regulatory thresholds are required to participate in the local emergency planning process.

Emergency Planning and Notification

In 40 CFR 355, EPA codified a list of extremely hazardous substances and associated threshold planning quantities (TPQs). Labs storing extremely hazardous substances in amounts exceeding the TPQs must notify state and local emergency response authorities and participate in the community's emergency planning process. Lab management should review and compare inventories of chemicals on site with EPA's list extremely hazardous substances to determine if these substances are present in amounts exceeding the TPQs.

Inventory and Material Safety Data Sheet (MSDS) Reporting

EPCRA establishes reporting requirements that provide the public with important information on hazardous chemicals in their community (40 CFR 370). Specifically, laboratories storing chemicals may be required to submit material safety data sheets (MSDSs) and inventories of the chemicals on site to the state and local emergency response authorities (e.g., the local fire department). Submissions are only required for hazardous substances present in amounts exceeding 10,000 pounds and extremely hazardous substances present in amounts exceeding their TPQs or 500 pounds (whichever is less).

3.3 PESTICIDES

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) was originally enacted in 1948, then amended substantially in 1972 and amended again in 1988 and 1996. The aim of the statute is primarily to safeguard public health and the environment against misuse of pesticides. Before being sold, distributed, transported, used or stored in the U.S., pesticides must be registered by EPA. Laboratories may be subject to FIFRA regulations if storing, applying, or disposing of pesticides. Pesticides used and stored on-site must be managed in accordance with label directions (40 CFR 162). Pesticide storage areas should be well-ventilated, secure, and away from food and beverages (40 CFR 165). Pesticides and pesticide containers should be disposed of in accordance with 40 CFR 165 and, if appropriate, hazardous waste regulations. Finally, laboratories testing pesticides in support of the registration process are subject to FIFRA Good Laboratory Practice Standards (40 CFR 160). Additionally, chemicals being used to treat medical waste must be registered under FIFRA if they make any antimicrobial claims.

3.4 DRINKING WATER

The Safe Drinking Water Act, as amended, establishes national drinking water standards applicable to public drinking water systems. Generally the standards apply to municipalities operating a public drinking water system. However, a laboratory with an on-site drinking water system (e.g., on-site wells) that has 15 or more service connections and supplies water to an average of at least 25 people daily, at least 60

days per year is operating a "public water system" as defined by EPA. Laboratories operating a public water system face stringent sampling and analyses requirements specified in 40 CFR 141 and their state regulations.

3.5 TOXIC SUBSTANCES

Under the Toxic Substances Control Act (TSCA) of 1976 (40 CFR 720.36), EPA is given broad authority to issue regulations designed to gather health/safety and exposure data on, require testing of, and control exposure(s) and/or use(s) of, new and existing industrial chemical substances and mixtures. (Drugs, cosmetics, foods and food additives, pesticides and nuclear medicine are exempt from TSCA coverage and are subject to control under other Federal statutes). All laboratories, including “small” laboratories, must adhere to the TSCA Good Laboratory Practice Standards (TSCA GLPS) found at 40 CFR 792 when performing studies relating to health effects, environmental effects and chemical fate testing issued under Section 4 of TSCA.

Using its authority provided under TSCA, EPA has implemented stringent requirements pertaining to polychlorinated biphenyls (PCBs). In laboratories, PCBs can often be found in samples, microscopy fluids, standards, electrical equipment (e.g., transformers, ballasts), or hydraulic systems. PCB-containing equipment and materials must be labeled, stored and disposed of in accordance with EPA's PCB management requirements in 40 CFR 761. Although PCB-containing ballasts (such as those found in fluorescent lights) may still be in service, most PCB transformers were to have been removed from service or retrofilled with a non-PCB oil by October 1991. Facilities with more than 45 kg (99.4 lb.) of PCB containing materials (not just waste) on site, at any time during the calendar year, must prepare an "annual document" as described in 40 CFR 761.180.

Wastes containing PCBs are regulated by the EPA in 40 CFR Part 761. Many laboratories generate PCB wastes including liquid and solid excess samples, solvents containing PCBs (e.g., extracts) and standards. Wastes containing 50 ppm PCBs are regulated under TSCA. However, EPA interprets the 50 ppm to apply to the "starting concentration" of the PCB material if any dilution took place. Therefore, if a 10 ppm PCB solution is prepared from a 1000 ppm standard >50 ppm, then upon disposal the 10 ppm solution must be managed as if it contains over 50 ppm PCBs. Obviously, this interpretation further confuses the management of PCB laboratory wastes. It is important to segregate PCB waste from other lab wastes since management of PCB wastes is complex and disposal of PCB regulated waste is especially costly.

In many states, the management of PCB laboratory wastes is especially complex since they are often subject to both EPA's TSCA regulations and state hazardous waste regulations. PCB wastes are not regulated as a hazardous waste under the Federal RCRA regulations. PCB waste generators must be sure to comply with the following PCB management requirements:

- Generators of PCB waste must submit a "Notification of PCB Activity," EPA Form 7710-53, to EPA's Office of Toxic Substances (40 CFR 761.205).
- PCB waste containers and entrances to PCB waste storage areas must be marked with a PCB warning label (40 CFR 761.40).
- PCB waste containers must be marked with the date the waste was first generated [40 CFR 761.65(c)(8)]. PCB waste containers in the laboratory must be marked with the date the first drop of

waste enters the container. [Note: If the waste is also hazardous waste, this date will probably differ from the hazardous waste accumulation start date.]

- PCB waste containers must be inspected for leaks every 30 days [40 CFR 761.65(c)(5)]; even if the containers are stored in the laboratory. The inspections should be documented in a log book.
- PCB wastes must be placed in special containers as required by 40 CFR 761.65(c)(6).
- PCB wastes must be stored in an area with a roof, walls and an impervious floor with six-inch curbing and a containment capacity equal to twice the volume of the largest PCB container or 25% of the total volume of all the PCB containers, whichever is greater [40 CFR 761.65(b)].

PCB waste must be incinerated within one year from the date the waste was generated [40 CFR 761.65(a)]. To be sure the disposal facility has adequate time to incinerate wastes, all PCB wastes should be shipped off-site within nine months of generation. PCB waste shipments must be accompanied by a waste manifest.

There are also TSCA regulations applicable to laboratory analysis of asbestos. Regulations applicable to asbestos sampling and analysis are 40 CFR 763, Subparts E and G (Subpart E, 783.87(a)(b); 763.90(i), Appendix A, Appendix E; Subpart G, 763.121(f), Appendix A.) TSCA also specifies requirements applicable to the importation of chemicals.

3.6 UNDERGROUND STORAGE TANKS

Underground storage tanks (USTs) are stringently regulated by state environmental agencies and sometimes also by local fire departments. State and local UST regulations are often more stringent than EPA's regulations which are contained in 40 CFR 280. State and local authorities must be aware of the presence of USTs on site. USTs were required to have leak detection devices no later than December 1993 and corrosion protection and spill/overfill prevention are required to be operable by December 1998. Newly installed USTs are required to be equipped with corrosion protection, automatic release detection, and overfill prevention devices. Most USTs must be leak tested annually and product in the tanks must be inventoried regularly. In some areas, where both storage of heating oil in UST’s and use is in the same location, exemption from regulation may apply. Regardless, USTs that contain heating oil should be leak tested regularly since they are just as likely to cause environmental impairment as regulated USTs.

Presently, above ground storage tanks (ASTs) are only regulated by EPA under the Clean Water Act if they have the potential to release oil to navigable water ways. Many state environmental agencies and local fire departments have developed regulations applicable to nearly all ASTs.

4.0 RELIABLE RESOURCES

Of the numerous sources of information on environmental management, the following list provides information most relevant to small lab environmental programs. Included are reference materials, organizations, world wide web (www) site addresses, toll-free hotlines, waste exchanges, governmental resource centers, EPA Regional Offices, and state Small Business Assistance Programs. In addition, lab staff should consult with the relevant state and/or local agencies for specific questions regarding air emissions and hazardous waste management, and contact the local POTW for information regarding wastewater discharge issues.

4.1 PUBLICATIONS

Topic	**Source**
Comprehensive Lab EHS Coverage	• **Laboratory Safety & Environmental Management (LS&EM).** A newsletter published by PRIZIM Inc. covering the full spectrum of lab environmental, health, and safety issues. 316 E. Diamond Avenue, Gaithersburg, MD 20877.
Environmental Management Systems	• **Environmental Management Systems: An Implementation Guide for Small and Medium- Sized Organizations**. EPA 832-B-96-007, November 1996. • **Environmental Management in Healthcare Facilities**. K.G. Wagner, Ph.D. (ed). W.B. Saunders Co. 1998.
Chemical Safety	• **Prudent Practices in the Lab: Handling and Disposal of Chemicals**. National Research Council, National Academy Press, Washington, DC. 1995. • **Chemical Health & Safety**. A journal published by the American Chemical Society, Washington, DC 20036. • **Chemical Safety in the Laboratory**. Stephen K. Hall, CRC Press, Inc. 1994.
Pollution Prevention	• **Pollution Prevention and Waste Minimization in Laboratories**. P. A. Reinhardt, K. Leigh Leonard, and P. C. Ashbrook, CRC Press, Inc. 1996. • **Facility Pollution Prevention Guide**. EPA/RREL Publication EPA/600/92/088. May 1992. • **EPA Guide to Pollution Prevention - Research and Educational Institutions**. EPA/RREL Publication, EPA/625/7-90/010. June 1990.

Safety

- **Handbook of Laboratory Safety**. K. A. Furr, Ph.D. (Ed.). CRC Press. 1996.
- **Laboratory Waste Management - A Guidebook**. American Chemical Society, Washington, DC. 1994.

Waste Management

- **Hazardous Laboratory Chemicals Disposal Guide**. M. Armour, 2nd Edition, CRC Press, Inc. 1996.
- **Destruction of Hazardous Chemicals in the Laboratory**. G. Lunn, and E. B Sansone, John Wiley & Sons. 1992.
- **Step-by-Step Guide to Better Laboratory Management Practices**. Publication No. 97-431, Washington State Department of Ecology, Hazardous Waste and Toxics Reduction Program. July 1997. Department of Ecology, Publications Distribution Center, P.O. Box 47600, Olympia, WA 98504-7600).
- **RCRA Orientation Manual**. EPA 530-R-98-004.

4.2 PRIVATE ORGANIZATIONS

American Chemical Society, 1155 16th Street, NW, Washington, DC 20036. 202-872-4600.
Offers journals, training, and information on lab waste management and chemical health and safety.

American Institute for Pollution Prevention, 1616 P Street, Suite 100, Washington, DC 20036. 202-797-6567.

American Institute of Chemical Engineers' Center for Chemical Process Safety, 345 East 47th Street, New York, NY 10017. 292-705-7319.

National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02269. 617-770-3000.
Develops and offers standards on flammable chemical storage in labs.

PRIZIM Inc. sponsors national and regional meetings and training titled, "Laboratory Safety & Environmental Management (LS&EM)," publishes the LS&EM newsletter, and offers environmental, health, and safety management consulting services for laboratories. 316 E. Diamond Avenue, Suite 201, Gaithersburg, MD 20877. 301-840-9316.

4.3 GOVERNMENT RESOURCE CENTERS

U.S. EPA Small Business Ombudsman Clearinghouse/Hotline, 401 M Street, SW, Washington, DC 20460. 1-800-368-5888.
Helps private citizens and small businesses with questions on all program aspects within EPA.

EPA National Center for Environmental Publications and Information. 1-800-490-9198.

Provides access and information about EPA publications.
U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Health and Safety (NIOSH). NIOSH 1-800-356-4674.
Provides information about occupational safety and health issues.

U.S. Environmental Protection Agency (U.S. EPA) Clean Air Technology Center (CATC), U.S. EPA, Research Triangle Park, NC 27711. 919-541-0800. World Wide Web (www) Home Page: http://www.epa.gov/ttn/catc.
Serves as a resource on all areas of emerging and existing air pollution prevention and control technologies.

U.S. EPA Pollution Prevention Information Clearinghouse, 401 M Street, SW, Washington, DC 20460. 202-260-1023. E-mail: PPIC@epamail.epa.gov.
Provides a library and electronic bulletin board dedicated to information on pollution prevention.

U.S. Nuclear Regulatory Commission, One White Flint North, 11555 Rockville Pike, Rockville, MD 20852-2738. 301-415-7000. http://www.nrc.gov/

4.4 INTERNET SITES

4.4.1 Government Agencies

U.S. Environmental Protection Agency: http://www.epa.gov. Also see http://www.epa.gov/ttm/nelac for information on environmental lab business opportunities.

U.S. Environmental Protection Agency Small Business Ombudsman: http://www.epa.gov/sbo/. Also see the Small Business Environmental Home Page: http://www.smallbiz-enviroweb.org/

U. S. Department of Labor, Occupational Health and Safety Administration (OSHA): http://www.osha-slc.gov

U. S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention (CDC), National Institute for Occupational Safety and Health (NIOSH): http://www.cdc.gov/niosh/homepage.html

4.4.2 Other

These listservs can be helpful for solving unique problems. All have lab oriented participants.

- SAFETY list. A general discussion of environmental, health, and safety. Contact Ralph Stuart at the University of Vermont (email: rstuart@esf.uvm.edu) for information on how to subscribe.

- LAB-XL. A discussion of performance oriented environmental regulation of laboratories. Contact Ralph Stuart at the University of Vermont (email: rstuart@esf.uvm.edu) for information on how to subscribe.
- The National Association of Chemical Hygiene Officers (NACHO) list. Participants discuss all aspects of laboratory chemical hygiene. Contact Dr. Jim Kaufman at the Laboratory Safety Workshop (email: Labsafe@aol.com) for information on how to subscribe.

4.5 HOTLINES

EPA Small Business Ombudsman Hotline: 1-800-368-5888
Provides environmental management assistance information to small businesses, including labs.

EPA RCRA Hotline: 1-800-424-9346; (703) 412-9810
Provides information related to hazardous waste regulations and Resource Conservation and Recovery Act (RCRA), Superfund-related matters.

TSCA Hotline: 202-554-1404
Provides information concerning the Toxic Substances Control Act (TSCA)-related regulations and policies.

CHEMTREC: 1-800-262-8200
The Chemical Transportation Emergency Center provides technical information related to chemical exposure, spills, leaks, and fires, including Material Safety Data Sheets (MSDS).

Department of Transportation: 1-800-467-4922
Provides information on matters related to the U.S. Department of Transportation (DOT) hazardous materials transportation regulations.

National Response Center: 1-800-424-8802
For reporting spills of hazardous substances.

OSHA: 1-800-321-6742
Provides information regarding matters related to the Occupational Health and Safety Administration (OSHA) programs and standards.

4.6 WASTE EXCHANGES

Northeast Industrial Exchange
90 Presidential Plaza
Syracuse, NY 13202
(315) 422-6572

Southern Waste Information Exchange
P.O. Box 6487
Tallahassee, FL 32313
(904) 644-5516

California Waste Exchange
Department of Health Services
Toxic Substances Control Division
Alternative Technology & Policy Development Section
714 P Street
Sacramento, CA 95814
(916) 324-1807

4.7 U.S. EPA REGIONAL OFFICES

Region 1 (VT, NH, ME, MA, CT, RI)
John F. Kennedy Federal Building
Boston, MA 02203-0001
(617) 565-3420

Region 2 (NY, NJ, PR, VI)
290 Broadway
New York, NY 10007-1866
(212) 637-3000

Region 3 (PA, DE, MD, WV, VA)
841 Chestnut Street
Philadelphia, PA 19107
(215) 566-5000

Region 4 (KY, TN, NC, SC, GA, FL, AL, MS)
61 Forsyth Street
Atlanta, GA 30303
(404) 562-9900

Region 5 (WI, MN, MI, IL, IN, OH)
77 West Jackson Boulevard
Chicago, IL 60604-3507
(312) 353-2000

Region 6 (NM, OK, AR, LA, TX)
1445 Ross Avenue
Dallas, TX 75202-2733
(214) 655-6444

Region 7 (NE, KS, MO, IA)
726 Minnesota Avenue
Kansas City, KS 66101
(913) 551-7000

Region 8 (MT, ND, SD, WY, UT, CO)
999 18th Street
Denver, CO 80202-2466
(303) 312-6302

Region 9 (CA, NV, AZ, HI)
75 Hawthorne Street
San Francisco, CA 94105
(415) 744-1305

Region 10 (AK, WA, OR, ID)
1200 Sixth Avenue
Seattle, WA 98101
(206) 553-1200

4.8 STATE SMALL BUSINESS ASSISTANCE PROGRAMS

Small Business Ombudsman (SBO) and Small Business Assistance Program (SBAP) offices are located in each state. These are an excellent and free source of environmental management assistance. These sources are also familiar with local environmental requirements.

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Blake Roper, Ombudsman Administrative Division Department of Environmental Management P.O. Box 301463 Montgomery, AL 36130-1463 334-213-4308 334-213-4399 800-533-2336 (national) rbr@adem.state.al.us	James Moore Air Division Department of Environmental Management P.O. Box 301463 Montgomery, AL 36130-1463 334-271-7861 334-271-7950 (F) 800-533-2336 (national)
David Wigglesworth Small Business Advocate AK DEC 555 Cordova Street Anchorage, AK 99501 907-269-7582 907-269-7600 (F) 800-510-2332 (state) dwiggles@envircon.state.ak.us	Scott Lytle Small Business Assistance AK DEC 555 Cordove Street Anchorage, AK 99501 907-269-7571 907-269-7600 (F) 800-510-2332 (state) slytle@envircon.state.ak.us
Dual role SBO and SBAP	Gregory Workman AZ DEQ - Compliance Assistance 3033 N. Central Avenue Phoenix, AZ 85012 602-207-4337 602-207-4872 (F) 800-234-5677 (state) workman.gregory@ev.state.az.us
	Richard Polito Maricopa County SBEAP 1001 N. Central, Suite 200 Phoenix, AZ 85004 602-506-5102 602-506-6669 (F) rpolito@estrp.maricopa.gov
Robert Graham Department of Pollution Control & Ecology P.O. Box 8913 Little Rock, AR 72219-8913 501-682-0708 501-682-0707 (F) 888-233-0326 (national) grahamr@adeq.state.ar.us	

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
James Schoning Small Business Ombudsman California EPA Air Resources Board 2020 L Street P.O. Box 2815 Sacramento, CA 95814 916-323-6791 916-323-2393 (F) 800-272-4572 (state)	Peter Venturini California EPA Air Resources Board Stationary Source 2020 L Street P.O. Box 2815 Sacramento, CA 95814 916-445-0650 916-327-7212 (F)
La Ronda Bowen Public Advisor South Coast Air Management District Small Business Assistance Office 21865 E. Copley Drive Diamond Bar, CA 91765 909-396-3235 909-396-3335 (F) 800-388-2121 (national) lbowen@aqmd.gov	Natalia Porche SCAQMD/SBAP 21865 E. Copley Drive Diamond Bar, CA 91765 909-396-3218 909-396-3335 (F) 800-388-2121 (national)
Cathy Heald CDPHE OCS-INF-A1 4300 Cherry Creek Drive, South Denver, CO 80246-1530 303-692-2034 303-691-1979 (F) 800-886-7689 (state) cathy.heald@state.co.us	Nick Melliadis CDPHE APCD/55/B-1 4300 Cherry Creek Drive, South Denver, CO 80246-1530 303-692-3175 303-782-5493 (F) 800-333-7798 (national) nick.melliadis@state.co.us
Tracy Babbidge, Ombudsman Small Business Assistance Program Department of Environmental Protection 79 Elm Street Hartford, CT 06106-5127 860-424-3382 860-424-4063 (F) 800-760-7036 (state) tracy.babbidge@po.state.ct.us	Glen Daraskevich Small Business Assistance Department of Environmental Protection Environmental Quality Division 79 Elm Street Hartford, CT 06106-5127 860-424-3545 860-424-4063 (F) 800-760-7036 (state) glen.daraskevich@po.state.ct.us
George Petitgout Small Business Ombudsman DE DNRC P.O. Box 1401 Dover, DE 19903 302-739-6400 302-739-6242 (F) gpetitgout@dnrec.state.de.us	George Petitgout Dual Role as SBAP Director

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Carol Baker Air Quality Division EHA/Department of Health 2100 Martin Luther King Avenue, SE Washington, DC 20020 202-645-6093 x3082 202-645-6102 (F)	Olivia Achuko Air Quality Division EHA/Department of Health 2100 Martin Luther King Avenue, SE Washington, DC 20020 202-645-6093 x3071 202-645-6102 (F)
Elsa Bishop Small Business Ombudsman Department of Environmental Protection 2600 Blair Stone Road Tallahassee, FL 32399-2400 904-488-0114 904-922-6979 (F) 800-722-7457 (state) bishop_e@dep.state.fl.us	Currently dual role as SBAP Principal and Small Business Ombudsman Tom Ledew FL SBAP-MS5505 Dept. of Env. Protection 2600 Blair Stone Road Tallahassee, FL 32399-2400
Marvin Lowry GA SBAP 4244 International Parkway, Suite 120 Atlanta, GA 30354 404-362-2656 404-363-7100 (F) marvin_lowery@mail.dnr.state.ga.us	Anita Dorsey-Word GA SBAP 4244 International Parkway, Suite 136 Atlanta, GA 30354 404-362-4842 404-363-7100 (F) anita_dorsey-word@mail.dnr.state.ga.us
	Robert Tam HI Department of Health Clean Air Branch 919 Ala Moana Boulevard Honolulu, HI 96814 808-586-4200 808-586-4359 (F)
Doug McRoberts ID DEQ/PL&E statehouse Mail 1410 North Hilton Boise, ID 83706 208-373-0497 208-373-0169 (F) dmcrober@deq.state.id.us	
Donald Squires Illinois EPA/DAPC Small Business Ombudsman 2200 Churchill Road P.O. Box 19276 Springfield, IL 62794-9276 217-785-1625 217-782-9039 (F) 888-372-1996 (state) epa813@epa.state.il.us	Mark Enstrom Illinois Department of Commerce and Community Affairs 520 East Adams Springfield, IL 62701 217-524-0169 217-785-6328 (F) 800-252-3998 (state) menstrom@commerce.state.il.us

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Maggie McShane IDEM/OBR 100 N. Senate P.O. Box 6015 Indianapolis, IN 46206-6015 317-232-8598 317-232-6647 (F) 800-451-6027 (state)	Cheri Storms IDEM/OPP & TA/VOC 100 N. Senate, Room 1320 P.O. Box 6015 Indianapolis, IN 46206-6015 317-233-1041 317-233-5627 (F) 800-451-6027 cstor@opn.dem.state.in.us
Linda King IA Department of Development Small Business Liaison 200 E. Grand Street Des Moines, IA 50309 515-242-4761 515-242-4749 (F) 800-358-5510 (state) lking@ided.state.ia.us	John Konefes IA Waste Reduction Center University of Northern Iowa 1005 Technology Parkway Cedar Falls, IA 50614-0185 319-268-3733 (F) 319-273-8905 800-422-3109 (state) konefes@uni.edu
Janet Neff Environmental Ombudsman Office of Pollution Prevention KS DH&E Forbes Field, Building 283 Topeka, KS 66620 913-296-0669 913-291-3266 (F) 800-357-6087 (national)	Frank Orzulak, Director Continuing Education Building University of Kansas Lawrence, KS 66045 785-864-3978 785-864-5827 (F) 800-578-8898 (state) forzulak@falcon.cc.ukans.edu
Rose Marie Wilmoth Air Quality Representative Office of Commissioner Department for Environmental Protection 14 Reilly Road Frankfort, KY 40601 502-564-2150, x128 502-564-4245 (F) 800-926-8111 (national) wilmoth@nrdep.nr.state.ky.us	Gregg C. Copley, Director Kentucky Business Environmental Assistance Program Gatton College of Business and Economics University of Kentucky Lexington, KY 40506-0034 606-257-1131 606-323-1907 (F) 800-562-2327 (national) gccopl1@pop.uky.edu
Jim Friloux, Small Business Ombudsman LA DEQ P.O. Box 82263 Baton Rouge, LA 70804 504-765-0735 504-765-0746 (F) 800-259-2890 (state) jim_f@deq.state.la.us	Dick Lehr LA Department of Environmental Quality (Air) 7290 Bluebonnet P.O. Box 82135 Baton Rouge, LA 70884-2135 504-765-2453 504-765-0921 (F) 800-259-2890 (state) richard_l@deq.state.la.us

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Ron Dyer Department of Environmental Protection Office of Innovation and Assistance Station 17 state House Augusta, ME 04333 207-287-4152 207-287-2814 (F) 800-789-9802 (state) ron.e.dyer@state.me.us	Brian Kavanah Department of Environmental Protection Office of Innovation and Assistance Station 17 state House Augusta, ME 04333 207-287-6188 207-287-2814 (F) 800-789-9802 (state)
John Mitchell MD Department of the Environment Office of Community Assistance 2500 Broening Highway Baltimore, MD 21224 410-631-3003 410-631-3936 (F) 800-633-6101, x3003 (state)	
	George Frantz Executive Office of Environmental Affairs Office of Technical Assistance/#2109 100 Cambridge Street Boston, MA 02202 617-727-3260 x631 617-727-3827 (F) george.frantz@state.ma.us
Dana Cole MI Jobs Commission Victor Center, 4th Floor 201 N. Washington Lansing, MI 48913 517-335-1847 517-335-0198 (F)	Dave Fiedler MDEQ Environmental Assistance Division P.O. Box 30457 Lansing, MI 48909 517-373-0607 517-335-4729 (F) 800-662-9278 (national)
Charlie Kennedy MPCA/OEA 520 Lafayette Road St. Paul, MN 55155-4194 612-297-8615 612-297-8324 (F) 800-985-4247 (state)	Troy Johnson SBAP Coordinator Air Quality Division MN Pollution Control Agency 520 Lafayette Road St. Paul, MN 55155 612-296-7767 612-297-7709 (F) 800-657-3938 (state) troy.johnson@pca.state.mn.us
Jesse Thompson Small Business Ombudsman MS DEQ P.O. Box 10385 Jackson, MS 39289-0385 601-961-5171 601-961-5742 (F) 800-725-6112 (national)	

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Brad Ketcher state of Missouri Office of the Governor P.O. Box 720 Jefferson City, MO 65102 573-751-3222 573-751-1495 (F)	Byron Shaw, Jr. DNR Technical Assistance Program Jefferson state Office Building Box 176 Jefferson City, MO 65102 573-526-5352 573-526-5808 (F) 800-361-4827 (national)
Mark Lambrecht Department of Environmental Quality Small Business Ombudsman 1520 E. 6th Avenue Helena, MT 59620 406-444-2960 406-444-6836 (F) 800-433-8773 (national) malambracht@mt.gov	Warren Norton Department of Environmental Quality Air Quality Division 1520 E. 6th Avenue Helena, MT 59620 406-444-5281 406-444-1499 (F) 800-433-8773 (national)
Dan Eddinger Public Advocate Department of Environmental Quality P.O. Box 98922 Lincoln, NE 68509-8922 402-471-3413 402-471-2909 (F) edh@nccibm.rtpnc.epa.gov	Dan Eddinger Dual Role as Ombudsman and SBAP Principal
Marcia Manley Small Business Ombudsman NV Department of Environmental Protection 333 West Nyle Lane Carson City, NV 89706-0851 702-687-4670, x3162 702-687-5856 (F) 800-992-0900, x4670 (state) mmanley@ndep.carson-city.nv.us	Janet Goodman Small Business Program Manager NV Department of Environmental Protection 333 West Nyle Lane Carson City, NV 89706-0851 702-687-4670, x3164 702-687-5856 (F) 800-992-0900, x4670 (state)
Rudolph Cartier Dual Role as Ombudsman and SBAP Principal	Rudolph Cartier Air Resources Division Department of Environmental Services 64 North Main Street, 2nd Floor Concord, NH 03301-2033 603-271-1379 603-271-1381 (F) 800-837-0656 (state) cartier@desarsb.mr.com

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
John Serkies Office of Business Advocacy Department of Commerce and Economic Development 20 West state Street CN 823 Trenton, NJ 08625-0823 609-633-7308 609-777-3106 (F) 800-643-6090 (national) jserkies@commerce.state.nj.us	Chuck McCarty Pollution Prevention-Permit Coordinator SBAP NJ DEPE P.O. Box 423 Trenton, NJ 08625-0423 609-292-3600 609-777-1330 (F) cmccarty@dep.state.nj.us
Robert Horwitz NM ED/AQB Harold Runnels Building P.O. Box 26110 Santa Fe, NM 87502 505-827-9685 505-827-0045 (F) 800-810-7227 (national)	Cecilia Williams NM ED/AQB Harold Runnels Building P.O. Box 26110 Santa Fe, NM 87502 505-827-0042 505-827-0045 (F) 800-810-7227 (national)
Tria Case Supervisor, Division of Small Business Environmental Ombudsman Unit Empire state Development, 32nd Floor 633 3rd Avenue New York, NY 10017 212-803-2282 212-803-2309 (F) 800-782-8369, x157 (national) tcase@empire.state.ny.us	Marian Mudar Environmental Program Manager NYS Environmental Faciliites Corporation 50 Wolf Road, Room 598 Albany, NY 12205 518-457-9135 518-485-8494 (F) 800-780-7227 (state only) mudar@nysesc.org
Edyth McKinney Office of the Small Business Ombudsman Department of Environment, Health, and Natural Resources P.O. Box 29583 Raleigh, NC 27626 919-733-0823 919-715-6794 (F) 800-829-4841 (national) edythe_mckinney@owr.ehnr.state.nc.us	Fin Johnson Office of Small Business Ombudsman Department of Environment, Health and Natural Resources P.O. Box 29583 Raleigh, NC 27626 919-733-0824 919-715-6794 (F) 800-829-4841 (national) fin_johnson@owr.ehnr.state.nc.us
Jeff Burgess ND SDH&CL P.O. Box 5520 Bismark, ND 58506 701-328-5153 701-328-5200 (F) 800-755-1625 (state)	Tom Bachman ND SDH&CL Division of Environmental Engineering P.O. Box 5520 Bismark, ND 58506 701-328-5188 701-328-5200 (F) 800-755-1625 (state)

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Mark Shanahan Clean Air Resource Center 50 West Broad Street, Room 1901 Columbus, OH 43215-5985 614-728-3540 614-752-9188 (F) 800-225-5051 (state) mark.shanahan@aqda.state.oh.us	Rick Carleski Ohio EPA Division of Air Pollution 1600 Watermark Drive Columbus, OH 43215 614-728-1742 614-644-3681 (F) rick.carleski@epa.state.oh.us
Steve Thompson Deputy Executive Director Department of Environmental Quality 1000 NE 10th Street Oklahoma City, OK 73117-1212 405-271-8056 405-271-8425 (F)	Alwin Ning Small Business Program Department of Environmental Quality 1000 NE 10th Street Oklahoma City, OK 73117-1212 405-271-1400 405-271-1317 (F) 800-869-1400 (national)
Paul Burnet OR DEQ 811 SW 6th Avenue Portland, OR 97204-1390 503-229-5776 503-229-6945 (F) 800-452-4011 (state)	Jill Inahara OR DEQ Air Quality Division 811 SW 6th Avenue Portland, OR 97204 503-229-6147 503-229-5675 (F) 800-452-4011 (state)
Greg Czarnecki Office of P2 & Compliance Assistance PA DEP RCSOB, 13th Floor P.O. Box 8772 Harrisburg, PA 17105-8468 717-772-8951 717-783-2703 (F)	Scott Kepner Bureau of Air Quality Control PA DEP P.O. Box 8468 Harrisburg, PA 17105-8468 717-787-1663 717-772-2303 (F) Kepner.Scott@a1.dep.state.pa.us
Tomas DeLeon Administrator, Commercial Development Administration Office P.O. Box 4275 San Juan, PR 00902 787-724-1451 787-722-8477 (F)	Maria Rivera PREQB - SBAP IIC - 91, Box 9197 Vega Alta, PR 00692-9607 787-767-8025, x296 787-756-5906 (F)
Roger Greene RI Department of Environmental Management 235 Promenade Street Providence, RI 02908 401-277-2771 401-277-4546 (F)	Pam Annarummo RI Department of Environmental Management 235 Promenade Street Providence, RI 02908 401-222-6822, x7204 401-277-3810 (F) 800-253-2674 (state)

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Donna H. Gulledge, SBO SC Department of Health & Environmental Control 2600 Bull Street Columbia, SC 29201 803-734-5909 803-734-9196 (F) 800-819-9001 (national) gulleddh@columb30.dhec.state.sc.us	Rose Stancil SBAP Technical Engineer Assistant Department of Health & Environmental Control 2600 Bull Street Columbia, SC 29201 803-734-2765 803-734-9196 (F) stancirr@columb30.dhec.state.sc.us
Joe D. Nadenicek Small Business Ombudsman Department of Environment & Natural Resources Joe Foss Building 523 East Capitol Pierre, SD 57501 605-773-3151 605-773-6035 (F) 800-438-3367 (state)	Bryan Gustafson Department of Environment & Natural Resources Joe Foss Building 523 East Capitol Pierre, SD 57501 605-773-3351 605-773-6035 (F)
Ernest Blankenship TN Department of Environment & Conservation L&C Tower, 8th Floor 401 Church Street Nashville, TN 37243-1551 615-532-0731 615-532-0614 (F) eblankenship@mail.state.tn.us	Linda Sadler Small Business Assistance Program L&C Annex, 8th Floor 401 Church Street Nashville, TN 37243-1551 615-532-0779 615-532-0614 (F) 800-734-3619 (national) lsadler@mail.state.tn.us
Tamra Shae-Oatman Small Business Advocate TX NRCC (Mail Code 106) P.O. Box 13087 Austin, TX 78711-3087 512-239-1062 512-239-1065 (F) 800-447-2827 (national) toatman@smtpgate.tnrcc.state.tx.us	
Stephanie Bernkopf UT Department of Environmental Quality Office of the Small Business Ombudsman 168 North 1950 West Salt Lake City, UT 84114-4810 801-536-4479 801-536-4099 (F) sbernkop@deq.state.ut.us	Frances Bernards UT Department of Environmental Quality Division of Air Quality P.O. Box 144820 Salt Lake City, UT 84114-4820 801-536-4056 801-536-4099 (F) 800-270-4440 (state) fbernard@deq.state.ut.us

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
	Judy Mirro VT Environmental Assistance Division Laundry Building 103 South Main Street Waterbury, VT 05671 802-241-3745 802-241-3273 (F) 800-974-9559 (state)
John Daniel, Air Division Director VA Department of Environmental Quality P.O. Box 10009 Richmond, VA 23240 804-698-4311 804-698-4510 (F) 800-592-5482 (state)	Richard Rasmussen Manager, Small Business Assistance Program VA Department of Environmental Quality P.O. Box 10009 Richmond, VA 23240 804-698-4394 804-698-4510 (F) 800-592-5482 (state) rgrasmusse@deq.state.va.us
Dual role SBO/SBAP Principal.	Marylyn A.Stapleton VI Department of Planning & Natural Resources Division of Environmental Protection 8000 Nisky Center, Suite 231 Charlotte Amalie, St. Thomas, VI 00802 340-777-4577 340-774-5416 (F)
Leighton Pratt Department of Ecology P.O. Box 47600 Olympia, WA 98504-7600 360-407-7018 360-407-6802 (F)	Bernard Brady WA Department of Ecology Air Quality Program P.O. Box 48600 Olympia, WA 98504-7600 360-407-6803 360-407-6802 (F) bbra461@ecy.wa.gov
Kenneth Shaw Small Business Ombudsman WV Office of Air Quality 1558 Washington Street, SE Charleston, WV 25311 304-558-1218 304-558-1222 (F) 800-982-2474 (state)	Fred Durham WV Office of Air Quality 1558 Washington Street, SE Charleston, WV 25311 304-558-1217 304-558-1222 (F) 800-982-2474 (state)
Hampton Rothwell Small Business Ombudsman Department of Development WI SBAP, 6th Floor 201 West Washington Avenue Madison, WI 53703 608-267-0313 608-267-0436 (F) 800-435-7287 (national) hrothwell@commerce.state.wi.us	Pam Christenson Technical Assistance Director Department of Commerce WI SBAP, 6th Floor 201 West Washington Avenue Madison, WI 53703 608-267-9214 608-267-0436 (F) 800-435-7287 (national) pchristenson@commerce.state.wi.us

OMBUDSMAN	SMALL BUSINESS ASSISTANCE PROGRAM
Dan Clark Department of Environmental Quality OA/Small Business Ombudsman 122 W. 25th Street Cheyenne, WY 82002 307-777-7388 307-777-3773 (F) dclark@missc.state.wy.us	Charles Raffelson Department of Environmental Quality Division of Air Quality 122 W. 25th Street Cheyenne, WY 82002 307-777-7347 307-777-5616 (F) craffe@missc.state.wy.us