Local Hazardous Waste
Management Program
in King County, Washington

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Final Report

Laboratory Waste Management Guide

Dave Waddell
Local Hazardous Waste Management Program in King County

This report was prepared by the Local Hazardous Waste Management Program in King County, Washington (LHWMP.) The program seeks to reduce hazardous waste from households and small quantity generator businesses in King County by providing information and technical assistance to protect human health and the environment.

This report is available for download at www.labwasteguide.org
For more information or to order printed copies of this report contact:

Local Hazardous Waste Management Program in King County, Washington

130 Nickerson Street, Suite 100
Seattle, WA 98109
206-263-3050 TTY Relay: 711
Fax 206-263-3070
www.lhwmp.org

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Voice: 206-263-3050 or TTY Relay: 711

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Principal contributors and editors to the 2011 and 2014 Lab Guides:

- Chris Antony – Infectious Disease Research Institute
- Steve Burke – LHWMP
- Alice Chapman – LHWMP
- Michelle Gaither – Pollution Prevention Resource Center
- Michael Jeffers – Seattle Public Utilities
- Alan Jones, Ph.D – Hospital Waste Management
- Bettye L.S. Maddux – University of Oregon SNNI
- Jim Neely – LHWMP
- Rob Rieck – Washington State Department of Ecology
- David E Simpkins – CellNetix
- Jill Stoddard Tepe – Mt. Baker Bio
- Bruce Tiffany – King County Industrial Waste
- Michelle Underwood – Washington State Department of Ecology
- Steve Whittaker, Ph.D. – LHWMP

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- Cathy Buller – Pollution Prevention Resource Center
- Jim Denovan – EIC Environmental Health and Safety
- Matthew Donelan – formerly of Berlex Corporation
- Arianne Fernandes – Washington State Department of Ecology
- Donna Hoskins – formerly of Berlex Corporation
- Shiela Lockwood – University of Washington Environmental Health and Safety
- Walt Loomis – formerly of City of Tallahassee, Florida
- Mike Radder – Fred Hutchinson Cancer Research Center
- Rick Renaud – formerly of King County Industrial Waste
- Bill Rowe – formerly of University of Washington Environmental Health and Safety
- Baz Stevens – formerly of King County Industrial Waste
- Don Wang – formerly of Zymogenetics
- Jenny Yoo – Washington State Department of Ecology

INTRODUCTION

The first edition of this management guide, published in 1994, was prepared by representatives from several groups: the King County Water and Land Resources Division, the LHWMP, the Northwest Laboratory Coalition, and the Washington Biotechnology and Biomedical Association. Baz Stevens from King County's Industrial Waste Section (formerly the Municipality of Metropolitan Seattle) was one of the original authors.

The management guide is part of a comprehensive program to reduce the amount of dangerous waste generated by businesses and the metals and chemical contaminants improperly disposed into waters and landfills.

The 2014 revision incorporates recent changes in Washington State's treatment by generator guidelines. The practices recommended in these guidelines will help analytical, medical, teaching, and biotechnology labs properly manage hazardous materials and reduce dangerous waste.

The guide also helps businesses and agencies in King County decide whether their waste may be acceptable for discharge to the sewer. For more help, see the contacts listed in the *For More Information* section of this report. Although the specific focus of this guide is King County, many of the recommendations are applicable to labs anywhere in the United States.

These guidelines were developed with the assumption that the wastes generated are from intermittent and small-scale operations originating from laboratory processes in educational, public, or private labs. Contact your local sewer utility with questions about the concentration and volume of a particular discharge that may be of concern,.

These guidelines do not provide authorization under Permit by Rule (WAC 173-303-802) to allow discharge of hazardous chemicals to the sewer. Rather, this handbook serves, in part, as a guide to assist businesses and agencies in King County in determining whether their waste may be acceptable for discharge to the sewer.

FACILITY MANAGEMENT

Drain Protection

Liquids discharged into the sewer system flow to wastewater treatment facilities that have limited capacity to remove chemical contaminants. Most areas in King County discharge to facilities that are maintained and operated by King County Department of Natural Resources and Parks. See **Local Sewer Districts**, page 41, for more information.

Rain and other runoff into storm drains usually flow directly to creeks and waterways that drain to Puget Sound with no treatment. It is important to protect both storm drains and the sewer system from chemicals and other pollutants. Consequently the best management practices in this handbook are intended to provide "drain protection" – or water quality protection.

Some commercial facilities in King County continue to discharge to on-site septic systems. No laboratory waste can be discharged to septic tanks. Recommended best management practices for maintenance and operation of on-site septic systems can be found at www.lhwmp.org/home/publications/publications_detail.aspx?DocID=kiricUGmzcs%3d

Reduce the risk of accidental discharges of chemicals into sinks and drains through use of spill and leak prevention techniques. Block floor drains in areas where chemicals are used or stored. Store chemical containers and carboys in secondary containment tubs and trays to help keep spills from traveling down nearby drains.

Cup sink drains in frequently used fume hoods are particularly difficult to protect from spills and leaks. Because these drains are seldom used, unobserved spilled liquids may remain concentrated and can react with incompatible chemicals that are spilled later.

Installing glass piping under these drains facilitates periodic inspection of the trap to determine whether chemicals have entered the drain unnoticed. Following inspection, flush the cup sink drain with water to prevent sewer gases from passing through a dry p-trap.

Keep enough material on hand to clean up spills. These supplies may include absorbents, drain plugs, acid and base neutralizers, goggles, gloves, respirators with chemical specific cartridges, and waste collection containers. Ensure that clean-up materials and copies of the emergency response plan and emergency phone numbers are readily available. Train your staff who will clean up chemical spills according to Washington's Emergency Response Standard (WAC 296-824.)

Safety Showers

The American National Standards Institute (ANSI/ISEA Z358.1-2009) recommends floor drains be installed for emergency showers. Do not store chemicals near these or other floor drains. Prevent spilled chemicals from reaching safety shower drains by covering or plugging the drain when not in use or by installing a temporary plug that opens automatically when the safety shower is turned on. The lever action that activates the shower may be linked to another lever that lifts the plug. See the *Spill Management* section, page 15, for information on preventing spilled chemicals from spreading.

Should contaminants washed off a person during emergency use of a safety shower be allowed in a drain? When hazardous chemicals are spilled on a worker, the first priority is to flush the contaminants off the person. Steps should be taken to limit the amount of hazardous chemicals entering the floor drain only if this does not interfere with the emergency response.

If hazardous chemicals enter the floor drain, notify the local sewer agency that there has been a release as soon as possible. Post the local sewer agency's phone number near the safety shower and in your spill response guide. Check in the Community Services section of your phone book for this phone number and look for the words "Sewer" or "Wastewater" under the name of your city or county. See **Local Sewer Districts**, page 41, for a list of sewer districts and links to their websites.

Chemical Storage

Laboratories generally use a variety of toxic, corrosive, reactive and flammable materials. If these are stored close together in fragile containers, there is a risk of breakage and spills that release materials to the environment. Proper storage of chemicals requires the use of prudent handling and storing practices and a well-constructed lab facility.

Components of a Safe and Effective Chemical Storage Area

Provide sufficient clearance for shelves and racks to allow removal and return of the largest container without tipping. Tipping containers when returning them to shelves, cabinets and refrigerators may cause the contents to drip or leak. Provide secondary containment made of material appropriate for chemicals stored on counters and near drains.

Provide separate corrosion-free cabinets for flammable liquids, concentrated inorganic acids and caustic liquid bases. Close and latch doors on chemical storage cabinets. Anchor these hazardous material storage cabinets to walls. See International Fire Code Chapter 34, Section 3404.3.2.1 for flammable liquid cabinet requirements and Chapter 27, Table 2703.1.1(1) for allowable volumes of hazardous materials stored.

Prepare for emergencies involving stored chemicals.

- Keep fire extinguishers near locations where chemicals are stored or used and train employees in their operation. Be sure to have extinguishers appropriate to the hazard class of chemical present (ABC for most chemicals, D for metals.)
- Have a stocked spill kit and train staff to the appropriate level according to the Emergency Response Standard (WAC 296-824.)
- Have a communications device, such as a telephone, or walkie-talkies, available in the room or area.

Dangerous waste accumulation requirements differ from hazardous material storage requirements. EPA and the Washington Department of Ecology (Ecology) regulate the former while local fire departments and code enforcement agencies oversee the latter.

A common area of confusion concerns the difference between waste accumulation areas and satellite accumulation areas.

- EPA answers common questions about hazardous waste satellite accumulation areas at this site: www.epa.gov/osw/hazard/generation/labwaste/memo-saa.htm.

- For information about Washington dangerous waste accumulation requirements, visit http://apps.leg.wa.gov/wac/default.aspx?cite=173-303-200.

Storing and Handling Chemicals

- Reduce the risk of bottle breakage. Whenever possible, order concentrated acids and flammable solvents in plastic-coated bottles. Small containers are more durable and less likely to break than large containers. Use rubber or plastic bottle carriers or bottle jackets when transporting glass containers.

- Keep containers closed with tight-fitting lids when not in use so contents cannot evaporate or escape a tipped container.

- Return chemicals to their proper place after use or at least before leaving the work station at the end of the day.

- Properly label containers with the chemical's name and its primary hazards. Chemical symbols alone are insufficient identification. This labeling is not required for portable containers that receive hazardous chemicals from labeled containers if the chemical is used and controlled by the same employee who performed the transfer within the same work shift.

- As a general rule, avoid storing chemical containers in fume hoods. Containers may interfere with the air flow, clutter work space, and could potentially spill into cup sink drains.

- Avoid storing chemicals on bench tops.

- Avoid storing chemicals under sinks.Moisture may cause labels to deteriorate and incompatible cleaning materials may be placed there unwittingly.

- Do not store flammable liquids in domestic refrigerators or freezers. Use only "lab-safe" equipment with external thermostats, manual defrosting, etc.

Incompatible Chemicals

Incompatible chemicals may react by releasing toxic or flammable gases, exploding or spontaneously igniting. Segregate and store chemicals by hazard class to minimize the risk of reactions between incompatible chemicals and label storage cabinets and cupboards with the hazard class of the stored materials. Material safety data sheets (MSDSs) should be available for all chemicals on site. Review them for information about incompatibilities. The following is a partial list of common incompatible chemicals that can react with each other.

Corrosives

Many acids can have additional hazards beyond corrosivity. Consequently, acids may require particular care when assigning a storage location to avoid incompatibilities.

- Store concentrated acids and bases separately in enclosures made of corrosion-resistant materials. Separate organic acids from oxidizing acids, such as sulfuric, nitric and perchloric. Glacial acetic acid and other combustible organic acids should be stored with flammable liquids.
- Concentrated sulfuric acid is a dehydrating acid and can release chlorine gas in contact with hydrochloric acid and fluorine gas in contact with hydrofluoric acid. Both chlorine and fluorine gases are highly toxic.
- Hydrofluoric acid is highly toxic, readily dissolves glass, and is quickly absorbed through the skin on contact. These unique characteristics create significant health risks during storage and handling. Special procedures must be developed to prevent accidental exposures and prepare for emergency response to hydrofluoric acid releases.

Oxidizing Chemicals

Oxidizers are materials that yield oxygen readily to stimulate the combustion of organic matter. When oxidizers come in contact with organic liquids, they can start or fuel fires.

Typical oxidizing agents found in labs include chromates and dichromates, halogens and halogenating agents, peroxides and organic peroxides, nitric acid and nitrates, perchloric acid, chlorates and perchlorates, permanganates, and persulfates.

- Store oxidizers away from alkalis, azides, nitrites, organic compounds (including concentrated organic acids), powdered metals, and activated carbon.
- Avoid contact between oxidizers and common combustible materials such as paper, cardboard, cloth, and wood.

Water-Reactive Compounds

Water-reactive compounds include alkali metals such as lithium, potassium and sodium, sodium borohydride, calcium carbide, and sodium peroxide. A more descriptive list of common water-reactive compounds can be found at the University of Georgia's website www.esd.uga.edu/chem/pub/waterreactivemat.pdf.

Solutions containing water, such as acids and alcohols, should be separated from these chemicals during storage and use.

- Store water-reactive compounds away from aqueous solutions, inorganic acids, base solutions and alcohols. Though some chemical storage systems recommend water-reactive solids be stored in flammable storage cabinets, this would not be prudent since these cabinets often contain containers of aqueous alcohol solutions.

- Keep a Class D fire extinguisher near storage and use areas for these compounds.
- Store these compounds in locations protected from automated sprinklers.
- Alkali metals should be stored in areas where they are free of moisture and contact with oxygen is prevented. In the case of lithium, prevent contact with nitrogen gas.
- Only the amount of water-reactive materials necessary to perform the work should be removed from storage. Spare materials should be returned to the appropriate storage container, and the closed container returned to its appropriate location.
- Storage containers should be labeled with their contents, hazardous properties, and type of oil or gas used to render the metal inert. Furthermore, these containers should be stored individually or in a manner that allows visual inspection for container integrity.
- Storage areas should be free of combustibles and of ignition sources.
- The portions of the building dedicated as storage area for alkali metals should not be equipped with automatic sprinklers. No other source of water (e.g., showers, sinks) should be in the immediate proximity of the metal.
- Storage areas should be prominently labeled to indicate the presence of alkali metals.

Waste Accumulation Containers in Fume Hoods

In some situations, chemical collection containers in fume hoods serve as satellite accumulation sites for wastes generated by instruments. These “working containers” are small waste containers (i.e., two gallons or less), managed under the control of key staff, used at a bench or work station, and emptied into “satellite” container(s) located at or near the point of generation at the end of every work shift. The following guidelines, developed by EPA Region I in collaboration with the Massachusetts Department of Environmental Protection, provide parameters for proper use of collection containers in fume hoods.

These working containers must be:

- Closed except during active use. Containers on bench tops or in fume hoods should be considered to be in active use during those parts of the work shift when they are being filled, but need to be covered when not in use.
- Managed in a manner so as to prevent spills and minimize releases.
- Emptied into a larger satellite container either when full or at the end of the work shift, whichever comes first.
- Marked and labeled as “hazardous waste” and with a description of the nature and hazard of the waste.

- Located on an impervious surface.
- Located at or near the point of generation.
- Under the control of staff directly responsible for the process generating the waste collected in the working container(s.)

Systematic Storage of Lab Chemicals

We suggest following the storage and handling guidelines found in *Prudent Practices in the Laboratory* by the National Research Council's Committee on Prudent Practices in the Laboratory, Handling and Management of Chemical Hazards (National Academies Press, Washington, DC, 2011) available on-line at www.nap.edu/catalog.php?record_id=12654#toc

Many universities publish diagrams of their chemical storage system on their Web sites. These storage systems are often based on those published in the first edition of *Prudent Practices*. Flinn Scientific Inc. has a system for chemical storage that incorporate the concept of "related and compatible storage groups" found in *Prudent Practices* with a focus on secondary school laboratories.

These systems are based on a series of codes for functional classes of chemicals. Organic and inorganic chemicals are separated, with sub-groups further separated. The "related and functional storage groups listed in *Prudent Practices*" and the shelf storage codes often assigned to these groups are listed below. "I" refers to inorganic compounds and "O" refers to organic compounds.

I-1 Metals, hydrides

I-2 Halides, sulfates, sulfites, thiosulfates, phosphates, halogens

I-3 Amides, nitrates (except ammonium nitrate), nitrites, azides

I-4 Hydroxides, oxides, silicates, carbonates, carbon

I-5 Sulfides, selenides, phosphides, carbides, nitrides

I-6 Chlorates, perchlorates, chlorites, hypochlorites, peroxides

I-7 Arsenates, cyanides, cyanates

I-8 Borates, chromates, manganates, permanganates

I-9 Inorganic acids

I-10 Sulfur, phosphorus, arsenic, phosphorus pentoxide

O-1 Organic acids anhydrides, peracids

O-2 Alcohols, glycols, amines, amides, imines, imides

O-3 Hydrocarbons, esters, aldehydes

O-4 Ethers, ketones, ketenes, halogenated hydrocarbons, ethylene oxide

O-5 Epoxy compounds, isocyanates

O-6 Organic peroxides, hydroperoxides, azides

O-7 Sulfides, polysulfides, sulfoxides, nitriles

O-8 Phenols, cresols

O-9 Non-flammable stains, dyes, indicators

Flammable liquids must be stored in flammable storage cabinets or fire safety cans. Alphabetical storage is discouraged except within compatible groups.

Most guidelines have adapted this list to create a systematic shelf storage system. Unfortunately, this system is confusing to implement. For example, many of the listed chemicals are hazardous liquids that should be stored in specialized cabinets rather than on shelves. The system is also difficult to implement for secondary schools and other labs with limited storage space. Many stockrooms are too small to accommodate a system that has 19 separated shelves (plus storage cabinets.)

For labs with restricted storage spaces, compatible storage can be provided by grouping chemicals with similar hazards together. These labs could use a simplified system like that illustrated in Table 1.

TABLE 1 –SHELF STORAGE PATTERN FOR SMALL STOCKROOMS

Inorganic Shelves	Organic Shelves
I-1 & I-10 – Sulfur, phosphorus, arsenic, metals, hydrides (store all away from water!)	O-1 – Dry and dilute organic acids, anhydrides, peracids
I-2 – Halides, sulfates, sulfites, thiosulfates, phosphates, halogens	O-5 & O-7 – Organic peroxides, azides
I-5 & I-7 – Sulfides, selenides, phosphides, carbides, nitrides, arsenates, cyanides	O-6 & O-8 – Epoxy compounds, isocyanates, sulfides, sulfoxides, nitriles
I-4 – Dry hydroxides, oxides, silicates, carbonates	**Cabinets for Liquid Storage**
I-3, I-6 & I-8 – Nitrates, nitrites, borates, chromates, manganates, permanganates, chlorates, chlorites, inorganic peroxides	Flammable Storage Cabinet – O-2, O-3, O-4 Hydrocarbons, ethers, ketones, amines, halogenated hydrocarbons, aldehydes, alcohols, glycols, phenol, cresol, combustible organic acids, combustible anhydrides
	Corrosive Acid Storage Cabinet – I-9 Inorganic acids. Nitric acid stored separately in this or another cabinet
	Corrosive Base Storage Cabinet or Cupboard – I-4 liquids Inorganic hydroxides
***Notes**: Keep water reactive metals away from aqueous solutions and alcohols. Use secondary containers to separate yellow and white phosphorus, which are stored under water, from water-reactive metals.*	

The LHWMP maintains a School Chemicals List website at www.schoolchemlist.org that provides chemical hazard and storage information for over 1,100 chemicals. This resource provides storage codes for each chemical that correspond to those listed above.

The Department of Energy released an excellent technical paper titled Chemical Storage: Myths vs. Reality in 2007. It provides a thoughtful critique of many compatible chemical storage systems illustrated by photographs from laboratory settings. It is available at www.hss.doe.gov/healthsafety/wshp/chem_safety/chemicalstoragemythvrealityrevision6-27-07x.pdf

Preparing Your Laboratory for Earthquakes

- Lips on shelves provide some restraint for bottles in an earthquake, but are inadequate when there is violent shaking. Having doors on chemical storage cupboards is recommended. However, because unsecured cupboard doors can open during earthquakes, they should be fitted with locking latches.
- Shelf lips should be between one and two inches in height. Excessively high lips can make it difficult to remove bottles. Lips that are too low do little to prevent bottles from falling off shelves.
- Shelf anchors are recommended, although they can fail. Anchors should be designed to restrain full, rather than empty, shelves. Because many shelf clips become corroded over time (due to exposure to acid vapors), shelf anchors should be inspected annually. Shelf clips with more than a patina of rust should be replaced.
- Anchor large laboratory equipment to walls. Incubators, biosafety cabinets, corrosive and flammable storage cabinets, freezers and refrigerators, and storage shelves can fall over or collapse. In addition, these items also have "movement" potential, and can prevent emergency access to, and egress from, occupied spaces. Ensure that cylinders of compressed gas are secured.
- Small anchoring devices are available, from “thumb-locking” clips to industrial strength Velcro-like strips that anchor computer printers and other large equipment.
- Secure distillation apparatus and other elaborate glassware with straps.
- Install refrigerator door clasps.
- Following an earthquake, use caution when entering rooms with closed doors and when opening cabinets and cupboards. Containers may have broken, and toxic, flammable or corrosive vapors may be in the cabinet, cupboard or room. The first damage assessment should be performed by personnel trained in emergency response while wearing appropriate personal protective equipment.
- Develop a checklist to ensure your lab is prepared for earthquakes. A good template can be found at ohs.uvic.ca/emergency_management/eqpreplabs.pdf

Inventory Management

Managing the flow of chemicals through a laboratory is a key component of the Occupational Safety and Health Administration's (OSHA) Laboratory Standard (29 CFR § 1910.450.) This standard is administered in Washington State by the Department of Labor and Industries (L&I.) Prior to ordering any chemical for use in a laboratory, determine anticipated rate of use, shelf life, required personal protection and handling procedures, appropriate storage location and disposal method.

- The shelf life of a chemical may not be the same as its expiration date. Expiration dates are based on known instabilities when stored under normal conditions of temperature and humidity. Extended periods of storage, contamination during transfer of contents or exposure to high heat or humidity can cause degradation of even stable chemicals.
- Write the date received on each chemical container and the date opened on all containers of peroxidizable solvents.
- Maintain an inventory of chemicals stored in each lab. This inventory information should include the chemical name, CAS number, storage location, and the size and number of containers. Labs located within Seattle's city limits will typically be required by the Seattle Fire Department (SFD) to complete and submit a Hazardous Materials Inventory Statement: www.seattle.gov/fire/FMO/permits/applications/8002.pdf.
- The annual update of each lab's inventory is a logical time to review the on-going need for chemicals in storage. Many labs have accumulated stockpiles of old, unneeded chemicals as procedures have changed or research projects have completed. These "legacy chemicals" can degrade over time – both containers and contents – to a state that poses significant risks to employee's health and safety. Don't become a chemical hoarder!
- Limit quantities on site to those that can be used prior to the anticipated expiration or degradation date. Strive to purchase no more than a five-year supply of chemicals with stable shelf lives. If the smallest commercially available container of a needed chemical exceeds a five-year supply, purchase it.

Planning for Renovation and New Construction

- Avoid placing chemical storage shelves or cabinets over sinks. Accidental spills or breakage could release chemicals to the sewer.
- If you install a house vacuum system, use dry-seal or non-contact water pumps. Pumps that use contact water may discharge chemicals to the sewer.
- If available, select a sink that has a lip to provide spill protection.
- Contact a local plumbing inspector early in the process to clearly communicate to them where acidic wastes could accidentally enter drains. This could save time and costs associated with replacing cast-iron piping with acid-resistant materials.

- Passive acid-treatment tanks are often recommended by architects in classrooms and laboratory spaces. For most situations, these systems are very difficult to manage and maintain. Sulfuric acid creates a "slime" layer in contact with limestone that requires physical agitation or high pressure rinsing to remove. The slime layer prevents the limestone chips from neutralizing acidic wastewaters. Untreated acid could damage downstream side-sewer lines and lead to very expensive pavement-cutting and sewer repair projects.

Water Conservation

Structural measures, such as those listed below, can significantly reduce water use. In addition, well-trained lab workers can use their ingenuity to save water on the job.

- Install water-saving devices (such as flow restrictors) on sinks and rinse tanks.
- Reduce rinse times if possible (without affecting product quality.)
- Recycle water – for example, to air scrubbers and cooling towers.
- Eliminate one-pass or continuous flow cooling systems. Consider installing heat exchangers or re-circulating cooling water systems to conserve waste cooling water.
- Overhaul faulty steam traps on steam sterilizers.
- Reverse osmosis (RO) water is commonly used in lab experiments, but the RO process is very wasteful with as much as 90 percent of the water being discharged as wastewater. Some universities recirculate this water back through the RO system or use the discarded water as non-potable water in other areas. Possible uses of this non-potable water include flushing toilets, watering landscape plants or as cooling water for autoclaves.
- Proper steam sterilizer maintenance is an important part of many medical labs' infection control, energy conservation, and water conservation plans. A summary of the components of a proper sterilizer maintenance program can be found at www.24x7mag.com/issues/articles/2007-08_04.asp.

Nanotechnology

Materials of between 1.0 and 100 nanometers in size exhibit unique properties that can affect physical, chemical, and biological behavior.

The Centers for Disease Control and Prevention (CDC) provides excellent resources for working with nanomaterials at www.cdc.gov/niosh/topics/nanotech/. CDC's National Institute for Occupational Safety and Health (NIOSH) urges caution when working with these materials:

> "As with any new technology, the earliest and most extensive exposure to hazards is most likely to occur in the workplace. Workers within nanotechnology-related industries have the potential to be exposed to uniquely engineered materials with

> novel sizes, shapes, and physical and chemical properties. Occupational health risks associated with manufacturing and using nanomaterials are not yet clearly understood. Minimal information is currently available on dominant exposure routes, potential exposure levels, and material toxicity of nanomaterials.
>
> There are strong indications that particle surface area and surface chemistry are responsible for observed responses in cell cultures and animals. There are also indications that nanoparticles can penetrate through the skin or move from the respiratory system to other organs. Research is continuing to understand how these unique properties may lead to specific health effects."

NIOSH provides a cost-free field assessment program where they work with companies to develop safe working environments for nanoscale products. NIOSH has also published a comprehensive guide for working with nanomaterials, *Approaches to Safe Nanotechnology – Managing the Health and Safety Concerns Associated with Engineered Nanomaterials*. This document is available for download at www.cdc.gov/niosh/docs/2009-125/pdfs/2009-125.pdf.

Due to the rapidly emerging nature of nanomaterials research and production, specific regulatory guidance for proper disposal of nanomaterials was not available at the time this revision was published. Many university environmental health and safety websites recommend disposal of nanomaterials waste as a hazardous chemical waste.

Harvard University has posted an excellent set of guidelines for working safely with nanomaterials at http://www.uos.harvard.edu/ehs/ih/nanotech_control.shtml. These are their guidelines for disposal of nanomaterials waste:

- Never dispose of nanoparticle waste in regular trash or down the drain.
- When disposing of dry nanoparticle waste, use a sealable container that remains closed.
- Dispose of all nanoparticle waste, including contaminated debris, as you would the base material (i.e., carbon nanotubes should be disposed of as carbon, metallic particles consistent with the base metal.)
- If the nanoparticles are in solution, they should be managed as a solution of the solvent and the parent nanomaterial (e.g., flammable solvents are handled as flammable waste materials.)
- All nanoparticle waste must be labeled with the base metal or solute and identified as containing nanomaterial.

Though neither King County nor the State of Washington have adopted Harvard's disposal guidelines, they serve as a basis for prudent management of nanomaterials waste while state and local regulatory guidance is being developed.

Training

All laboratory staff should understand the importance of using best management practices for waste reduction and environmental protection. Training for new employees and refresher training for all staff are important.

- Keep your lab's Spill Response Plan updated and available to employees.
- Post emergency numbers.
- Train lab workers in the components of the Chemical Hygiene Plan covering proper chemical handling, storage and disposal.
- Emphasize a commitment to waste prevention and proper chemical management.
- Encourage employees to develop waste prevention and waste stream efficiency ideas and then to implement them.
- Provide regular training in water conservation.

Under Chapter 296-824 WAC, any business using hazardous chemicals must develop an emergency plan that anticipates and develops responses to emergencies. The plan must be written and must address pre-emergency planning and coordination with all potential responders. The plan must also define personnel roles and ensure that employees working with hazardous chemicals receive the minimum mandatory training required for awareness of chemical hazards and/or responding to spills. These requirements are enforced by L&I. For more information about these requirements, visit http://apps.leg.wa.gov/wac/default.aspx?cite=296-824-30005.

Labor and Industries has published a flow chart that helps define when training is mandated under Chapter 296-824 WAC at http://www.lni.wa.gov/wisha/rules/emergencyresponse/HTML/296-824-300.htm#WAC296-824-30005.

CHEMICAL SPILL MANAGEMENT

Spill management plans are very dependent on the size and complexity of the facility and the diversity and comparative hazards of the chemicals being used in the lab. Excellent examples of spill management plans are available on the websites of several university environmental health and safety programs. A few key components should be part of every laboratory's spill response procedures:

- Differentiate between major (uncontrolled release) and minor (incidental) chemical spills.
  - Incidental Release – a release that can be safely controlled at the time of the release and does not have the potential to become an uncontrolled release. Limited response action is required.
  - Uncontrolled Release – a release where significant safety and health risks could be created. This includes large-quantity releases, small releases that are highly toxic, or airborne exposures that could exceed a published permissible exposure limit if employees aren't adequately trained or equipped to protect themselves.
- Prepare for major spills by working with your local emergency responders to develop a notification and evacuation plan. At some facilities, initial response to major spills may be by the facility's trained emergency response team. At many other labs, these spills may be beyond the capacity of their staff to handle.
- Minor spills are typically cleaned up by laboratory staff or facility-based emergency response teams.
- Only clean up minor spills when you can identify the chemical and are aware of the potential hazards. You should be wearing appropriate protective equipment and be equipped with appropriate spill kits
- Spill response training should be carefully designed to distinguish between major and minor spills and between similar chemicals with different hazards. Many lab staff can easily clean up a spill of 500 milliliters of 25 percent sodium hydroxide solution. Few lab staff can safely clean up a similar spill of ammonium hydroxide. Both are corrosive bases, but ammonium hydroxide's intensely irritating vapors pose a unique hazard.
- Small labs, such as a high school science lab, should have simple, easy-to-use spill kits. The kit should contain citric acid for spills of liquid bases, sodium carbonate for acids, and granular absorbent for organic solvents. Sand is sometimes applied to increase traction in spills of slippery compounds like sulfuric acid and sodium hydroxide.

Contact your local sewer agency to learn how and when they should be notified of a spill entering the sanitary sewer. See **Local Sewer Districts**, page 41, for a list of districts and links to their websites.

MANAGING HAZARDOUS CHEMICALS ON SITE

Potentially Explosive Chemicals

Several classes of chemicals may become explosive when they react with other compounds or may become unstable during storage. These include peroxidizable solvents, potentially explosive dinitro- and trinitro- organic compounds and elemental potassium. Question whether you need these compounds in your facility.

Metal Azides

Inorganic azide compounds, such as sodium azide, can react with metals and their salts to produce explosive metal azide crystals. For example, when azide solutions are poured down drains, the dilute solution can react with lead solder and copper pipes to produce explosive lead or copper azide salts.

- If you must use azide solutions, replace metal pipes with PVC or other non-metal piping materials.
- If sodium azide solutions have been discharged to drains having metallic pipes or solder, you should assume your pipes may be contaminated with metal azide salts. Contact the Business Waste Line at 206-263-8899 or Ecology at 425-649-7000 for assistance in determining the proper disposal procedures.

Ethers and Other Peroxide-forming Chemicals

Certain ethers are particularly susceptible to peroxide formation. Peroxides are formed by oxygen that reacts with ethers: R-O-R is ether; R-O-O-R is peroxide. The oxygen-to-oxygen (-O-O-) bond makes ether unstable. Generally, the larger the hydrocarbon chain (R), the more readily the ether will form peroxides. Ethyl ether and isopropyl ether can react with air to form explosive peroxide crystals. Other solvents such as tetrahydrofuran and dioxane can also produce peroxides.

Peroxides can explode when subjected to heat, friction, or shock. Do not disturb or open containers in which peroxides may have formed. Dispose of any container holding a peroxide-forming compound one year after the date it was opened. Label these containers with the words “DATE OPENED” and add the date.

To prevent the formation of peroxides:

- Avoid using peroxide-forming solvents if possible.
- Purchase ether with butylhydroxy toluene (BHT) or ethanol added as an anti-oxidant.
- Label ether containers with the dates they are opened.
- Purchase ether in containers small enough that it is used within six months.

- Check the MSDSs for your solvents to see if any are prone to creating peroxides.

Elemental potassium is a peroxide-former that is commonly used in school labs to demonstrate characteristics of period 1 earth metals. Potassium is a water-reactive earth metal that reacts with moisture in air to start the peroxidation process. This process can be observed by physical changes in the color of the potassium sticks. Originally a dull silver color, potassium will oxidize and form white crystals on its surface. As these crystals progressively turn yellow, orange, red and purple, the peroxidation process is advancing and the compound is increasingly at risk of exploding when handled. [Blair, 2000]

Metal Picrates and Picric Acid

Metal picrate compounds and picric acid can become dangerously unstable as a dry powder. Picric acid can dry out and form explosive picrate crystals when exposed to air, especially when contaminated with even minute amounts of metals.

To prevent the formation of explosive picrate crystals:

- Always keep picric acid wet or in solution.
- Avoid contact between picric acid and metals. Metal picrate salts are prone to explode when subjected to friction or shock.
- Never purchase or store picric acid in containers with metal lids.
- Avoid flushing picric acid solutions down drains at concentrations above 0.01 percent and below the lower pH limit of the local sewer utility.
- Dispose of more concentrated picric acid solutions as dangerous waste.
- If picric acid solutions have been discharged to drains with metallic pipes or soldered joints, assume the piping is contaminated with explosive metal picrate salts. Contact the Business Waste Line at 206-263-8899 or Ecology at 425-649-7000 for help in finding proper disposal procedures.

Perchloric Acid

Perchloric acid is highly corrosive and typically occurs as a 70 percent solution. When warmed above 150 degrees Fahrenheit, it is a powerful oxidizer. Perchloric acid can form explosive metal perchlorate crystals in combination with many metals. Any work with perchloric acid must be done in a specially-designed fume hood with a water wash-down system designed to prevent the buildup of metal perchlorates in the duct work. If you have been performing perchloric acid digestions in a fume hood not specifically designed for perchloric acid, contact Ecology immediately at 425-649-7000 for assistance in locating a contractor to evaluate the hood for perchlorate contamination.

- In the event of a perchloric acid spill, neutralize with soda ash (sodium carbonate) or another appropriate neutralizing agent. Soak up the spill with an inorganic absorbent. DO NOT use rags, paper towels, or sawdust and then set them aside to dry out; such materials may spontaneously ignite. Similarly, spills on wood may present a fire hazard after the liquid dries.

- If you must use perchloric acid solutions, replace metal pipes with PVC or other non-metal materials.
- If perchloric acid solutions have been discharged to drains with metallic pipes or solder, you should assume that your pipes are contaminated with metal azide salts. Contact the Business Waste Line at 206-263-8899 or Ecology at 425-649-7000 for assistance in determining the proper disposal procedures.
- Regularly inspect your containers of perchloric acid for discoloration. If the acid has turned a dark color and has crystals forming around the bottom of the bottle, there is a potential explosion hazard. Notify an emergency response agency such as Ecology at 425-649-7000 and secure the area.
- White crystals around the cap of perchloric acid containers are typically an ammonium salt, and small amounts may be washed off the bottle to the sewer using copious amounts of water.

Ammoniacal Silver Staining Solutions

Ammoniacal silver staining solutions are hazardous because they can form explosive silver salts. Whether disposed or deactivated, these wastes count toward your generator status. See *Appendix C* for information on these and other stains.

Safe use of these staining solutions includes the following procedures:

- Don't allow silver nitrate to remain in ammonium solutions for more than two hours. Use the staining solution or deactivate it.
- Keep silver nitrate solutions separate from ammonium hydroxide solutions.
- Deactivate these waste solutions by diluting 15:1 with water. Then, while stirring frequently, slowly add 5 percent hydrochloric acid to the solution until the pH reaches 2.
- Add ice if the solution heats up.
- Silver chloride will precipitate out when the pH reaches 2.
- Filter out the precipitate and dispose as dangerous waste, adjust the pH of the solution to 6 to 7 with sodium bicarbonate, then discharge to the sanitary sewer.

DANGEROUS WASTE REDUCTION AND DISPOSAL

Hazardous wastes are identified by federal regulation 40 CFR Part 261. In Washington State, “hazardous waste” is called “dangerous waste” and is primarily regulated by Ecology. Dangerous waste includes federally regulated hazardous waste and state-only dangerous wastes that meet Washington’s additional listed wastes and criteria for toxicity and persistence. Several other federal, state and local agencies may regulate a laboratory's hazardous materials and wastes. These include the federal Environmental Protection Agency (EPA), the Washington State Department of Labor & Industries (L&I), the local fire department, the local air quality authority, and the local sewer district.

In prior editions of this document, we used the words “hazardous” and “dangerous” interchangeably when defining materials that could pose dangers to human health or the environment. Because King County labs are regulated under the Washington Dangerous Waste Regulations, this guide will use the term “dangerous wastes”. The Dangerous Waste Regulations (Chapter 173-303 WAC) are found at www.ecy.wa.gov/biblio/wac173303.html

Failure to comply with the Dangerous Waste Regulations can result in significant fines and penalties. Laboratory managers must ensure that their lab complies with appropriate regulations.

- The manager of a laboratory should establish, follow and support a laboratory waste management policy.
- The policy should include written procedures and defined responsibilities.
- The policy should optimize reduction of dangerous waste and minimize the waste stream by diverting materials through recycling and other methods.
- Laboratory managers should assign a staff member responsibility for coordinating hazardous materials management and ensuring regulatory compliance. This individual should also assist the lab to maximize recycling opportunities and the use of biodegradable and compostable alternatives.

OSHA requires all labs to implement a written Chemical Hygiene Plan. These plans are monitored for compliance with OSHA requirements by L&I. In 29 CFR Part 1910 §191.1450, Appendix A, OSHA lists the National Research Council's recommendations concerning chemical hygiene in labs. Important topics that should be addressed include rules and procedures about:

- Chemical procurement, distribution and storage
- Environmental monitoring
- Housekeeping, maintenance and inspections
- Medical program

- Personal protective apparel and equipment
- Records
- Signs and labels
- Training and information
- Waste disposal

OSHA recommends that a laboratory's Chemical Hygiene Plan include a waste disposal program. The following are specific recommendations (29 CFR 1910 §191.1450):

- Comply with Department of Transportation regulations (CFR 49) when transporting wastes.
- Promptly dispose of unlabeled containers. Do not open if partially used.
- Remove waste from labs to a central waste storage area at least once a week and from the central waste storage area at regular intervals.
- Do not pour waste chemicals down the drain or add them to mixed refuse for landfill burial.
- Do not use fume hoods to dispose of volatile chemicals by allowing them to evaporate.
- Whenever possible, dispose of wastes by recycling, reclamation or chemical deactivation.

Before attempting to treat wastes for sewer or solid waste disposal, check with the regulating agency to ensure that the process is acceptable. Written documentation of chemical treatment activities may be required. Several resources are available to provide guidance in managing your laboratory wastes. The following sections provide guidance on specific waste streams that labs often find challenging to properly manage.

On-site Treatment of Laboratory Wastes

Laboratories are uniquely qualified to treat some of their wastes to eliminate their hazards or reduce the amount of waste needing disposal, thereby cutting costs. Unlike the situation in many other states, Ecology encourages on-site treatment of dangerous wastes by generators.

Ecology's Technical Information Memorandum (TIM) 96-412 (rev. February 2014) provides guidance for treating wastes on-site at https://fortress.wa.gov/ecy/publications/publications/96412.pdf

Specific Standards for On-site Treatment of Wastes

- Before initiating treatment, verify that the resulting wastes are acceptable for disposal as solid waste or discharge to the sewer. Ensure that the treatment process does not pose a risk to human health or the environment.

- The container in which treatment occurs must be marked with the date on which the waste was first accumulated and must be emptied every 180 days for medium quantity generators or 90 days for large quantity generators.
- The containers must be in good condition, compatible with their contents, properly labeled, kept closed, and inspected weekly.
- Secondary containment should be provided for wastes awaiting treatment.

2014 Changes to Requirements for On-Site Treatment of Wastes

In 2011, Ecology made a significant change to the TBG rules to bring their guidance into conformance with RCRA. That change impacted conditionally exempt small quantity generators of dangerous waste (CESQGs), called “small quantity generators” in Washington State. For the definition of a CESQG, visit either: www.lhwmp.org/home/BHW/sqg.aspx or www.ecy.wa.gov/programs/hwtr/manage_waste/rules_for_sqgs.html.

In response to feedback from generators and local governmental agencies, Ecology has expanded guidelines for the TBG rules (while still confirming to RCRA) that allow CESQGs to perform treatment of hazardous chemicals on-site. At the same time, Ecology added two new acceptable treatment methods.

The following criteria are condensed from Ecology’s Treatment by Generator (TBG) Fact Sheets. Visit Ecology, www.ecy.wa.gov/biblio/96412.html

Carbon Adsorption

- Works well with aromatic solvents, chlorinated organics, phenols, polynuclear aromatics, organic pesticides, chlorinated non-aromatics, high molecular weight aliphatics, chlorine, halogens, antimony, arsenic, bismuth, chromium, tin, silver, mercury and cobalt.
- Works poorly with alcohols, low molecular weight ketones, organic acids, aldehydes, low molecular weight aliphatics, nitrates, phosphates, chlorides, bromides, iodides, lead, nickel, copper, cadmium, zinc, barium and selenium.
- Is allowed when treated effluent and backwash are properly managed and disposed, spent carbon is regenerated or disposed properly, spills and releases are promptly cleaned, equipment is decontaminated as needed and sufficient time is provided for the carbon to adsorb contaminants.

Evaporation

- Allowed if only inorganic waste mixed with water is treated, all organic vapors from organic solutions are captured, some water content is left to prevent “over-cooking” of sludges, remaining sludges are properly disposed and secondary containment is provided for the evaporator.
- Many school science labs can evaporate water from waste copper sulfate and other metal solutions as a waste-reduction and cost-cutting technique. By lining the evaporation

container with a closable plastic bag, the waste sludge can be easily removed and placed in a small dangerous waste collection container for eventual removal.

Separation

- Separation processes must not change a chemical's structure, except to form a precipitate, and cannot generate toxic or flammable gases unless all vapors are captured.

Elementary Neutralization

- This process can only be used on wastes that are regulated solely because they exhibit the characteristic of corrosivity from having a pH of less than or equal to 2.0 or greater than or equal to 12.5.
- The neutralized waste must have a pH between 6 and 9 and meet the sewer discharge guidelines listed in Appendix A prior to discharge.
- Neutralizing large volumes of concentrated mineral acids is discouraged, since it generates significant heat and fumes which pose serious safety risks.
- Passive limestone acid-neutralization tanks are not recommended. Sulfuric acid significantly reduces the limestone's effectiveness unless it is frequently scrubbed clean. These tanks are hard to maintain, the chips are hard-to-reach, and sediments must be removed and characterized before disposal.

Aldehyde Deactivation

- Visit https://fortress.wa.gov/ecy/publications/publications/1404003.pdf for access to Ecology's Fact Sheet 14-04-003 for detailed guidance.
- This guideline only applies to chemical treatment of waste formalin, glutaraldehyde, and ortho-phthalaldehyde (OPA) in accumulation tanks or containers.
- Deactivation only includes chemical treatment of *spent* aldehyde solutions for purposes of removing the state-only toxicity characteristic. *Unused* formalin cannot be treated using this guidance because it is listed waste U122.
- Approval must be obtained in advance from the local sewer authority prior to discharge to the sewer. Discharge to storm drains or septic tanks is not allowed.

On-site Polymerization

- Visit https://fortress.wa.gov/ecy/publications/publications/1404002.pdf for access to Ecology's Fact Sheet 14-04-002 for detailed guidance.
- On-site polymerization is appropriate for treating ignitable resin wastes originally intended for commercial manufacture of plastics. This treatment method is limited to only those reactions initiated by a polymerizing component or catalyst.
- Other methods of polymerization, such as thermal processes, do not qualify.

Small Quantity Generators Treating Dangerous Waste

- Visit https://fortress.wa.gov/ecy/publications/publications/1404004.pdf for access to Ecology's detailed guidance on TBG for CESQGs.
- CESQGs must treat wastes only in containers and tanks that meet Ecology's specified standards,
- A written log must be maintained that includes date of treatment and the amount of each dangerous waste treated.
- Containers and tanks must be labeled or marked with the words "Dangerous Waste" or "Hazardous Waste" and must identify the major risk posed by the contents.
- The CESQG must establish an emergency coordinator, post emergency response information and respond to any emergencies.
- SQGs are only allowed to use the eight treatment methods published by Ecology

Treatment by Generator Counting Requirements

- Prior to conducting TBG activities, regulated generators and CESQGs with active RCRA ID numbers must notify Ecology of their plans. Visit www.ecy.wa.gov/programs/hwtr/waste-report/notification.html for instructions and forms.
- TBG activities will not reduce a lab's dangerous waste generator status, but can significantly reduce disposal costs. For annual reporting and generator status determinations, the total quantity (as wet weight) of waste generated prior to treatment and the weight of any remaining material that designates as dangerous waste after treatment must be counted. The waste before treatment and materials remaining after the process must be designated and managed properly.
- All generators must maintain a written log of the quantity of each dangerous waste managed on site, the treatment method and the date treatment occurred.
- All TBG activities for the year must be reported to Ecology by regulated generators and CESQGs with active RCRA ID numbers in their Dangerous Waste Annual Report, found at www.ecy.wa.gov/programs/hwtr/waste-report/index.html.

Permit by Rule

Permit by rule (WAC 173-303-802) is a second regulatory allowance for on-site treatment of dangerous wastes before disposal. One of the common areas of regulatory confusion regards the difference between "permit by rule" and "treatment by generator." Both are available options for labs wishing to manage wastes on site. For a full description, refer to the Permits by Rule regulation at http://apps.leg.wa.gov/wac/default.aspx?cite=173-303-802.

There are two primary benefits derived from receiving a permit or written authorization that qualifies a process for permit-by-rule exemption.

- The waste that is treated under Permit by Rule is exempt from being counted toward your generator status.
- Waste disposal costs are reduced because your waste is not hauled off-site

Conditions to Qualify for Permit by Rule (PBR) Exemption

- You must have written permission to discharge the waste to the sewer from the Publicly Owned Treatment Works (POTW.) Acceptable forms of permission include National Pollution Discharge Elimination System (NPDES) permit, state waste discharge permit, or a pretreatment permit or written discharge authorization. The permit must cover the specific waste stream and constituents being discharged.

NOTE: This document does not constitute permission under the PBR guidance in WAC 173-303-802.

- The permit application must include the waste stream as a source of wastewater with an estimate of flow; its chemical characteristics; whether it is batch or continuous discharge and the specific treatment it will receive.
- Wastes must be properly designated at the point of generation before mixing with any other waste streams.
- If treatment will be in an elementary neutralization unit, wastes must designate as hazardous only because of the corrosivity characteristic.
- In order to qualify as an elementary neutralization unit, treatment must take place in a tank or container.
- The waste must be treated immediately upon being generated. An example of this is a "hard-piped" system connecting the process that generated the waste to the treatment tank.
- The generator must notify Ecology that wastes are being treated on-site and indicate on the annual report that PBR activity is being conducted.
- The facility must have a contingency plan and emergency procedures.
- Weekly inspections of the treatment tank's integrity must be done and good housekeeping practiced in the area.
- Staff training must be documented.
- Activities must comply with the permit requirements as well as those of the Dangerous Waste Regulations for management of wastes prior to treatment.

Example: PBR for Lab Sample Destruction

- You must meet all the requirements listed above under **Conditions to Qualify for Permit by Rule (PBR) Exemption**.

- Laboratory samples are kept under chain-of-custody protocols for an established length of time before being disposed. Some of these samples are of water that has been acidified before analysis to preserve the sample.
- When the protocol no longer requires a sample to be stored, it can be disposed. If the sample is hazardous only for the corrosivity characteristic, it can be neutralized and discharged to the sewer. This neutralization can be viewed as treatment by generator or permit by rule depending on the circumstances.
- When treated in batches by adding a neutralizing solution to the sample, it is considered treatment by generator (TBG) and the waste must be counted towards the lab's generator status. This is because the sample becomes a waste as soon as it begins to be treated and the treatment is done in a batch process. For larger labs doing water quality analyses, this could cause them to become large quantity generator.
- It is considered immediate treatment under PBR if an entire acidified liquid sample is poured or siphoned directly into a neutralization tank that already contains a basic neutralizing solution. This is considered PBR, and does not count as generated dangerous waste, because the liquid is a viable reference sample until it comes into contact with the neutralizing liquid via a continuous "hard-piped" system.

Example: PBR for Managing Acidic Glass-Washing Solutions

- You must meet all the general requirements listed above to qualify for PBR consideration.
- Laboratory glassware is often acid-washed in tubs. This acidic wastewater must be neutralized before discharge to the drain. This wastewater is subject to regulation as dangerous waste if its pH is less than 2.0.
- This waste stream, which can also be a significant portion of a lab's entire generated waste, can be viewed as treatment by generator or permit by rule depending on the circumstances.
- If the wastewater from the glass washing tub is directly piped to an elementary neutralization tank, neutralized, then directly piped to the sewer, it will qualify as immediate treatment under PBR and not be counted as generated waste.
- If the glass washing wastewater is treated in batches by adding a neutralizing compound, the process is considered TBG and counts towards the lab's generated dangerous waste.

Determining Solvent Distillation and Recycling Opportunities

Additional guidelines to assist in determining if a hazardous solvent waste can be recycled:

- Most onsite systems can separate solvents from solids (like in a paint shop) but are less able to separate different solvents. Be aware of product guidelines at purchase.
- The higher the concentration of solvent the more likely a reclaim option is acceptable.

- The higher the value of the virgin solvent the more likely there is a reclaim option.

Acetone Used in Glassware Cleaning

Analytical labs often use acetone when cleaning glassware. Acetone is ignitable and is a listed dangerous waste (waste code F003.) Acetone may not be rinsed off glassware into a drain because flammable liquids are prohibited from sewer disposal. Acetone rinsate should be collected and disposed as ignitable dangerous waste.

High Pressure Liquid Chromatography Waste

High pressure liquid chromatography (HPLC) analyses are typically done with a mixture of water, acetonitrile and methanol. Both acetonitrile and methanol are flammable solvents. Some methods add 0.1 percent trifluoroacetic acid to the mixture. Acetonitrile concentrations in the resulting liquid waste range from 10 to 40 percent and are prohibited from discharge to the sewer.

There are a number of methods to reduce the volume of solvent waste from HPLC analyses. Such methods include modifying the size of columns used in the process, distilling and reusing acetonitrile, and separating water from the solvent waste. If the water remaining after separation contains <100 milligrams/liter of acetonitrile, it may be discharged to the sewer in King County. This separation technique falls under the guidance found in TIM 96-412, *Treatment by Generator*.

If possible, avoid using trifluoroacetic acid or other halogenated hydrocarbons in HPLC mixtures. These compounds designate as a persistent dangerous waste in Washington State at a concentration of 100 ppm or more.

Ethidium Bromide Management

Ethidium bromide (EtBr) is commonly used in molecular biology research and teaching labs. While it is not regulated as dangerous waste, the mutagenic properties of this substance may present a hazard when poured down the drain or placed in the trash.

Alternatives to Ethidium Bromide

Since the publication of the first edition of the Lab Guide, many alternatives to EtBr have been developed for detection of nucleic acids. The Massachusetts Institute of Technology's (MIT's) Green Chemistry/Pollution Prevention Program provides an excellent summary of the characteristics of ethidium bromide and eight commercially available alternatives at https://ehs.mit.edu/site/sites/default/files/files/BCS_etbr_alts_apr2k9.pdf.

MIT provided the information in their Green Chemistry publication to help their laboratories evaluate alternatives. At the time of this printing, the listed disposal methods have not been evaluated; therefore, the disposal column in the chart is not King County guidance and Massachusetts Water Resource Authority (MWRA) approval may **not** be used as a basis for permission to discharge those materials to the King County sewer system.

Alternatives to UV light for transillumination include expansion into other wavelengths for detection. For example, Blue Light transilluminators using LED lights have longer bulb lives.

Disposal of Pure Ethidium Bromide

Unused EtBr should be collected for disposal with a hazardous waste vendor.

Disposal of Electrophoresis Gels

Trace amounts of EtBr in electrophoresis gels should not pose a hazard. Higher concentrations (i.e., when the color of the gel is dark pink or red) should not be placed in laboratory trash. The disposal recommendations for gels are:

- Less than 0.1 percent EtBr: dispose as solid waste with clearance from the waste characterization program at Public Health – Seattle & King County www.kingcounty.gov/healthservices/health/ehs/toxic/SolidWaste.aspx#wc
- More than or equal to 0.1 percent EtBr: place in sealed bags and label for disposal similar to dangerous wastes

Disposal of Contaminated Gloves, Equipment and Debris

Gloves, test tubes, paper towels, etc., that are contaminated with more than trace amounts of EtBr should be placed in sealed bags and labeled for disposal similar to dangerous wastes.

Disposal of Ethidium Bromide Solutions

Aqueous solutions with <10 µg/L (<10 ppb) EtBr can be discharged to the sewer.

Aqueous solutions containing >10 µg/L (>10 ppb) EtBr must be chemically treated using the decontamination procedures listed below and disposed to the sewer or collected for disposal similar to dangerous wastes or nonhazardous waste (depending on concentration.) All aqueous solutions released to the sewer must meet local sewer discharge requirements for metals, pH, etc.

Solvent solutions containing any amount of EtBr should be disposed as ignitable dangerous waste. Ethidium bromide mixed with a radioactive isotope is restricted from discharge to the sewer and should be disposed as mixed waste. More information on mixed radioactive and hazardous waste requirements can be found at http://apps.leg.wa.gov/rcw/default.aspx?cite=70.105E&full=true.

Treatment of Ethidium Bromide Waste

Ethidium bromide waste solutions can be treated to reduce their volume before disposal, thereby reducing disposal costs. These solutions may also be deactivated to eliminate their hazardous characteristics before discharge to the sewer. Most universities recommend filtration over deactivation. Filtration and neutralization of EtBr falls under the guidance found in TIM 96-412, *Treatment by Generator*.

Filtering aqueous EtBr waste solutions through activated charcoal is simple and effective. The filtrate may then be poured down the drain. Commercially available filtration systems include FluorAway™, the S&S Extractor™ and The Green Bag® Kit.

- Filter the EtBr solution through charcoal filter.
- Pour filtrate down the drain.
- Place charcoal filter in a sealed bag (e.g., Ziplock™) and collect for disposal similar to dangerous wastes.

A safety note: if using a residential vacuum to speed filtration, do not use a standard Erlenmeyer or side-arm filtering flask. A filtration flask capable of withstanding vacuum must be used to prevent implosion.

Deactivating EtBr Solutions

Deactivated EtBr solutions should be neutralized and poured down the drain with copious amounts of water. Treatment may be confirmed using ultraviolet (UV) light to detect fluorescence. Continue treatment until fluorescence is no longer detected in the deactivated solution. There are two recognized methods for deactivation, the Lunn and Sansone Method [Lunn and Sansone, 1994, p. 185] using hypophosphorus acid and sodium nitrate, and the Armour Method using household bleach. [Armour, 1996, p. 214] Although the Armour Method is the simplest, traces of mutagenic reaction mixtures were found using this method. [Lunn and Sansone, *Analytical Biochemistry*, 1987, vol. 162, p. 453]

Decontamination of EtBr Spills

EtBr spills can be decontaminated with a solution of 20 ml of hypophosphorus acid (50 percent) added to a solution of 4.2 g of sodium nitrate in 300 ml water. Prepare fresh solution the day of use in a fume hood. Wear rubber gloves, lab coat, and safety glasses. Turn off electrical equipment before decontamination to reduce the risk of electrocution.

- Soak a paper towel in decontamination solution, then place the towel on the contaminated surface and scrub.
- Scrub five more times with paper towels soaked in water, using a fresh towel each time.
- Place all towels in a container and soak in fresh decontamination solution for one hour.
- Test liquids squeezed from the final towel scrub and mixture for fluorescence; repeat procedure with fresh decontamination solution if fluorescence is present.
- Neutralize with sodium bicarbonate and discard as nonhazardous aqueous waste.
- This procedure has been validated for EtBr-contaminated stainless steel, Formica, glass, vinyl floor tile surfaces and filters of transilluminators.

Disposal of Alcohols

Alcohols, such as ethanol, methanol and isopropanol, are common organic solvents used in labs. All are flammable liquids and are regulated as ignitable dangerous waste at concentrations above 24 percent in water. Additionally, methanol and isopropanol are category D toxic dangerous wastes under the Dangerous Waste Regulations at a concentration above 10 percent in water.

Alcohol solutions that characterize as dangerous wastes are prohibited from discharge to the sewer. Dilution of waste alcohol solely to bring its concentration below these levels is prohibited. Dilution of alcohol **as part of the "industrial process"** at the lab is allowed and its concentration is not evaluated for waste characterization until the process is complete.

For example, in teaching labs, "waste" ethanol can be mixed with water to demonstrate the Particle Theory. The final volume of the solution is less than the predicted sum of the volumes of the separate solutions because the alcohol and water molecules arrange in a different geometry that is more closely packed. At the point the demonstration is completed, the ethanol concentration is determined. If the final ethanol concentration is below 24 percent, it will not be considered an ignitable waste and is acceptable for discharge to the sewer.

Technologies are available for removing stains, dyes and cell debris from reagent grade ethanol, methanol, and isopropanol used in Cytology and Histology stain lines, thus permitting the same alcohol to be reused indefinitely. In addition, these systems will remove lipids (fats) and marker inks commonly found in tissue processor waste alcohol. Commercially available systems include the filtration-based Benchtop Alcohol Recycling System™ from Creative Waste Solutions and fractional-distillation-based systems from B/R Instruments, CBG Biotech and CMT Environmental Services. Suncycle Systems has also developed an alcohol cartridge recycling system for tissue processors.

Descriptions of these systems can be found by visiting the Sustainable Hospitals website at www.sustainablehospitals.org/cgi-bin/DB_Report.cgi?px=W&rpt=Cat&id=30. Carefully review the On-site Treatment of Laboratory Wastes section of this guide to determine if the system you are using falls under Ecology's TBG guidelines or is an exempt solvent recovery method.

Isopropanol is often used as a disinfectant in medical labs. Surfaces are wiped down with a cloth or paper towel holding isopropanol, with much of the isopropanol evaporating off the cloth and counter. When the cloth wiper is no longer useful, put the rag in your shop towel collection container for laundering, or wring out the free liquids into an ignitable dangerous waste collection container. The remaining cloth or paper wiper will typically be acceptable for disposal as solid waste. See *Appendix E, Solid Waste Disposal – Common Questions*, for important information on receiving clearance for disposal of solid waste in King County.

Disposal of 3,3-Diaminobenzidine (DAB)

3,3-Diaminobenzidine is a potent mutagen and should be handled with care. Contact with the skin causes burning pain and itching and inhalation can cause cyanosis. Because it poses a serious risk to health on contact, DAB is restricted from discharge to the sewer or septic tank. DAB should be be disposed similar to dangerous wastes or detoxified prior to discharge to the sewer.

Any detoxification procedure must result in a final DAB concentration below 10 µg/L (ppb) for the waste to be acceptable for discharge to the sewer. Detoxification of DAB falls under the guidance found in TIM 96-412, *Treatment by Generator*.

Do not try to detoxify DAB with chlorine bleach (sodium hypochlorite) because the products remain toxic. One method is described as follows: [Dapson, 1995, p. 162]

1. Prepare the following aqueous stock solutions:

- 0.2 M potassium permanganate (31.6 g $KMnO_4$ /liter)
- 2.0 M sulfuric acid (112 ml concentrated acid/liter)

2. Dilute the DAB solution until its concentration does not exceed 0.9 mg/ml.

3. For each 10 ml of DAB solution, add:

- 5 ml 0.2 M potassium permanganate
- 5 ml 2.0 M sulfuric acid

4. Allow the mixture to stand for at least 10 hours. It is now considered non-mutagenic.

5. Adjust the pH to meet local sewer limits

6. Submit a sample to an analytical laboratory to test the final DAB concentration

7. If results show that DAB is below 10 µg/L, the solution can be discharged to the sanitary sewer.

Disposal of Wastes Containing Sodium Azide

Some commonly used laboratory reagents contain sodium azide. Sodium azide is a category-B toxic dangerous waste due to oral-rat LD_{50} data, so in a waste mixture it will designate at a concentration of 0.1 percent. Any waste containing over 0.1 percent sodium azide must be disposed as a dangerous waste.

If sodium azide is unused and is the sole active ingredient (dilute solution) or discarded chemical product (unusable or spill cleanup) it cannot be treated for disposal to the sewer and must be disposed as a dangerous waste. In this case, sodium azide would designate as a discarded chemical product with dangerous waste number P105. Sodium azide can also form explosive metal azides, as discussed in the *Managing Hazardous Chemicals On-site* section.

Enterococcus Agar

Although enterococcus agar contains sodium azide as a preservative, the remaining sodium azide concentration is below 0.1 percent after use. Consequently, it does not have to be counted or disposed as dangerous waste.

Alkaline Iodide Azide (AIA) Reagent for the Winkler Dissolved Oxygen Titration

Here is a common list of constituents and concentrations in the AIA reagent before being added to a water sample for dissolved oxygen analysis:

Water .... 50 percent

Potassium Hydroxide................................. 40 percent

Potassium Iodide .... 9 percent

Sodium Azide .... 0.6 percent

Because the sodium azide concentration is greater than 0.1 percent with a pH greater than 12.5, expired or unused stock reagent will be regulated as a corrosive, Washington-state-only toxic dangerous waste. When used as a titrant, the sodium azide is sufficiently diluted during the analytical process to fall below the 0.1 percent concentration limit. Although the waste solution generated by the Winkler Method must be counted as a corrosive dangerous waste if the final pH is over 12.5, it may then be neutralized under the treatment-by-generator guidelines.

Because aqueous azide solutions can form potentially explosive metal azide crystals when in contact with laboratory drainage systems that contain metal components (e.g., copper pipes or lead solder), King County Industrial Waste has placed specific restrictions on sanitary sewer discharges, depending on the composition of the laboratory drainage system:

- Glass or PVC Drainage System Components and Verified Metal-Free: must be <0.05 percent (<500 mg/L) sodium azide.
- Unknown Composition of Drainage System Components: must be <0.01 percent (<100 mg/L) sodium azide.

Management of Aldehyde Wastes

The most common aldehyde wastes coming from labs are ten-percent buffered formalin. two-to-four percent glutaraldehyde solutions and 0.5 percent ortho-phthalaldehyde (OPA) solutions (typically Cidex® OPA.) Ten-percent buffered formalin is a tissue preservative containing 3.7 percent formaldehyde in a mixture of water and methanol with sodium phosphate dibasic. Glutaraldehyde and OPA are used as cold sterilants.

Buffered Formalin

Spent formalin solutions are regulated in Washington State as toxic category C dangerous waste. Based on equivalent concentration criteria, spent formalin solutions designate as dangerous wastes at concentrations of 1.0 percent or more formaldehyde. However, due to concerns about worker exposure to formaldehyde vapors, the discharge limit to the King County sewer system is 0.1 percent formaldehyde. Formaldehyde solutions may not be discharged to septic systems or storm drains. Solutions that are more than 1.0 percent formaldehyde must either be disposed as dangerous waste or chemically treated to reduce the formaldehyde concentration to acceptable levels for sewer discharge.

Unused buffered formalin should not be treated for disposal to the sanitary sewer. Unused formalin contains formaldehyde (waste code U122) as a sole active ingredient, which is a listed dangerous waste. Treatment of a listed waste results in a treatment residue that is still a listed dangerous waste and is prohibited from sanitary sewer disposal.

Chemical Treatment of Formalin

Spent buffered formalin found in histology labs is readily treatable. Deactivation of formalin falls under the guidance found in TIM 96-412, *Treatment by Generator*.

Some commercially available chemical treatment products that will "detoxify" formalin are listed below:

- Neutralex™
- VYTAC™ 10F
- Aldex®
- D-Formalizer®

According to product data, these compounds will reduce the concentration of a treated sample of formalin to under 0.1 percent formaldehyde, although the times required for this vary. According to product literature, both "Neutralex™" and "D-Formalizer®" will reduce the concentration to less than 25 parts per million (ppm) formaldehyde in 15 minutes.

For Neutralex™, one packet is described as treating one gallon of buffered formalin to 15 ppm. However, because the sewer limit is 1000 ppm formaldehyde, the packet can actually treat 50 times as much formalin and still have the resulting solution meet the local sewer limit. Therefore, both "Neutralex™" and "D-Formalizer®" can be pre-diluted up to 50:1 with water before being mixed with waste formalin. Because formalin treatment is covered under the treatment by generator guidelines, log sheets must be kept indicating the amount of formalin treated and the dates the treatment occurred. The amount of formalin generated before treatment must continue to be counted toward your generator status. Please review the Treatment by Generator section of this guide prior to undertaking treatment activities for chemical wastes generated in your lab.

One laboratory in King County has reported using technical grade sodium sulfite to deactivate spent formalin solutions. Based on the lab’s test data, a ratio of 35 grams sodium sulfite/liter of formalin, when mixed, will consistently reduce the residual formalin concentration well below the sewer limit of 1000 ppm. The lab also reports a 75 percent reduction in treatment costs per liter of formalin using these bulk reagents rather than the much more expensive commercial products.

The required quantity of commercial product or sodium sulfite used to treat formalin can vary greatly depending on the amount of secondary wastes in waste formalin. Inks, dyes, and tissue decomposition by-products, may impede treatment. For formalin that is particularly "dirty", it is suggested that the treatment mixture sits 10 to 12 hours prior to treatment.

There are commercial products that employ the Purpald® test to assay formalin (waste) for content prior to disposal. The efficacy of the Purpald® test has been called into question when utilized in a variety of conditions. When formalin has a high level of secondary wastes and no longer is opaque, it is suggested that a target of zero ppm is appropriate using a qualitative Tollen’s test for formaldehyde.

Alternatives to Formalin

Another option is to request less hazardous preservatives from suppliers. Safer substitutes for formaldehyde can reduce the risk of harmful exposures and potentially eliminate disposal problems. Review the MSDS for products before purchasing a "safer substitute" to ensure that it is less hazardous.

Propylene glycol is often the primary ingredient in soaking solutions for specimens that have been preserved in formalin. In histology settings, Prefer® or Safe-Fix® have been used as effective substitute preservatives to formalin on small specimens. However, these products are less effective on larger tissues due to their slower penetration rate.

Glutaraldehyde

Glutaraldehyde solutions are regulated in Washington State as category C dangerous waste. Based on equivalent concentration criteria, glutaraldehyde solutions designate as dangerous wastes at concentrations of 1 percent in water. However, 2-to-4 percent glutaraldehyde sterilant solutions have been shown to break down readily to nonhazardous by-products in the sewer system. [Balogh, 1997] Therefore, cold sterilant solutions containing less than 4 percent glutaraldehyde are acceptable for discharge to the King County sewer system. Glutaraldehyde solutions may not be discharged to septic systems or storm drains. Solutions of over 4 percent glutaraldehyde must either be disposed as dangerous waste or chemically treated to reduce the glutaraldehyde concentration to acceptable levels for sewer discharge.

Chemical Treatment of Glutaraldehyde

Glutaraldehyde is readily treatable using the same methods described above for formalin. Deactivation of glutaraldehyde falls under the guidance found in TIM 96-412, *Treatment by Generator* www.ecy.wa.gov/biblio/96412.html.

Ortho-Phthalaldehyde

Ortho-phthalaldehyde is commonly used as a substitute for glutaraldehyde in sterilization. It works more quickly, remains bioactive longer and is much less of an irritant to the eyes and nasal passages. OPA solutions are regulated in Washington State as category A toxic dangerous waste due to aquatic toxicity (Keith Holtze, 2002.) Based on equivalent concentration criteria, OPA solutions designate as dangerous wastes at concentrations of 0.01 percent in water. Therefore, cold sterilant solutions containing more than 0.01 percent OPA are not acceptable for discharge to the King County sewer system. O-phthalaldehyde solutions can never go into septic systems or storm drains.

A commonly used OPA-based cold sterilants is Cidex® OPA. Cidex® OPA contains 0.55 percent OPA which exceeds the allowable discharge limit.

Chemical Treatment of Ortho-Phthalaldehyde

O-phthalaldehyde is readily treatable by adding the amino acid glycine to it at a rate of 7 grams per gallon of waste o-phthalaldehyde (half a tablespoon per gallon.) Once OPA has been deactivated, typically after five minutes contact with glycine, it is acceptable for discharge to the King County sanitary sewer.

Deactivation of OPA falls under the guidance found in TIM 96-412, *Treatment by Generator*.

Aldehyde Spill Management

Glutaraldehyde and formalin spills can be deactivated with one of the commercially-available treatment chemicals listed above. O-phthalaldehyde spills can be deactivated by adding glycine to the spilled material as described above. A spill of unused formalin is listed waste (U122), so it and the contaminated cleaning materials must be disposed as dangerous waste.

Management of Scintillation Fluid Wastes

Scintillation fluids are used to detect weak alpha and beta-emitting radionuclides. This is typically done by mixing the fluid with the radionuclide, which causes the fluid to become radioactive.

If the stock fluid contains hazardous materials, the waste produced is by definition mixed waste (both hazardous and low-level radioactive waste.) If the radioactive material concentration is sufficiently low, the fluid can be disposed as a hazardous waste.

In guidance published between 1993 and 1995, the Department of Ecology approved three spent scintillation fluids for discharge to the sewer:

- Packard / Perkin Elmer (PE) Microscint™ O
- Packard / PE Optifluor™
- National Diagnostic's Ecoscint™ Original

At this time, no other spent scintillation fluids have been approved by Ecology for discharge to the sewer. Generally, if the samples are radioactive, they are disposed as either a mixed waste or a radioactive waste. Those samples with no detected radioactivity (or very low levels of radioactivity) would be disposed in the sewer if non-hazardous or disposed as a hazardous/dangerous waste or if toxic.

For radionuclide sewer disposal acceptance criteria within the King County sewer system, see the Washington State Department of Health regulation WAC 246-221-290 – Appendix A – Table III. Discharge restrictions are provided per radionuclide in units of micro-curie per milliliter (µCi/mL) on a monthly average concentration basis. Proper recordkeeping of the concentration and volume of radionuclides in sewer discharges is essential in order to remain compliant with the monthly average requirement,

Caution: scintillation wastes may be expensive to dispose even if the material is not considered radioactive by a regulatory agency. Even slightly higher radiation levels can cause a substantial problem at a hazardous waste disposal facility and greatly increase waste disposal costs if the waste is rejected at the gate. Work closely with your hazardous waste vendor to assure waste acceptance in advance of any shipments.

Many other scintillation fluids are available, as presented in this list at The University of Illinois at Chicago (UIC) website:
www.uic.edu/depts/envh/RSS/Radwaste.html#Biodegradable_and_Nontoxic_Fluids

Please note that the UIC guidance on acceptability for discharge to the sanitary sewer is based on EPA hazardous waste regulations, rather than Washington State's Dangerous Waste Regulations. Unless listed above, these fluids have NOT been approved for discharge to the sanitary sewer by King County Industrial Waste.

The compounds listed below designate as dangerous waste and are prohibited from discharge to the sewer. The surfactants in many scintillation cocktails contain alkyl phenoxy ethoxylates (APEs) or tergitol. Both of these compounds are Category D toxic dangerous wastes. Other cocktails contain xylene, pseudocumene, or other solvents that cause them to be regulated as ignitable dangerous wastes.

- Packard / Perkin Elmer: *Microscint™ 20, Ultima Gold, OptiPhase HiSafe, OptiPhase HiSafe 2* and *OptiPhase PolySafe*
- National Diagnostics: *Ecoscint™ A, Ecoscint™ O* and *Ecoscint™ H, Uniscint BD*
- Beckman Coulter: *Ready Safe, Ready Protein+, Ready Gel, Ready Value, Ready Organic, Ready Flow III* and *Ready Solv HP*

Management of Lab Consumables Waste

Many laboratory plastics can be recycled if they are not contaminated with dangerous waste. Diverting plastics to recycling can greatly reduce a lab's solid waste disposal rate. Tracking of these waste diversion savings helps labs demonstrate their program's effectiveness.

Labs in some areas recycle sharps, pipet tip boxes, media bottles, reagent bottles and jars, conical tubes, sample tubes, round-bottom tubes, transfer pipets, plastic packaging materials and even polystyrene (Styrofoam) shipping containers.

- Initiating a comprehensive on-site recycling program can be daunting. Consider hiring consultants to help institute the program in a way that allows tracking waste reductions and reporting the benefits. An internet search may lead you to university or healthcare pages that describe their waste reduction programs. Contact them to see if they can offer tips to help your program get up and running.

- Choose vendors with reduced shipping packaging options or reusable packaging materials. Companies that deliver locally often use less packaging material. Use insulated shipping containers that can be easily reused by the receiving entity, such as a cushioned polyethylene insulated shipper (e.g., Thermosafe Insulated Shipper, the Greenbox, and Bio ReBox, etc.)

Preparing Contaminated Empty Containers for Recycling

Lab glass and plastic contaminated with biohazardous materials can be prepared for recycling in some cases, once they have been sterilized and dried in accordance with the CDC's *Guideline for Disinfection and Sterilization in Healthcare Facilities, 2008*: www.cdc.gov/hicpac/disinfection_sterilization/20_00reference.html.

Pollution Prevention (P2)

Activities that reduce waste and prevent pollution are strongly encouraged. Reducing use of chemicals reduces chemical waste. Basic pollution prevention techniques include product substitution, reduced product usage, recycling and reuse of chemicals, modified operations, careful inventory tracking, and water conservation.

These are some pollution prevention best management practices for labs:

- When possible, use analytical methods and science classroom experiments that do not require hazardous chemicals.
- Substitute hazardous chemicals with less toxic alternatives. Although this can be a challenge, an excellent summary has been published by EPA's Design for the Environment Program at http://pubs.acs.org/doi/full/10.1021/es1015789.
- Use the least amount of chemical required for each experiment or process so that there is less to dispose of as waste.
- Ask if your suppliers offer chemicals in small volumes and buy them in small lots. This can reduce waste and leftover materials in case procedures are changed, expiration dates pass or spills occur.
- Reduce the scale of your experiments and analyses through use of microscale equipment or small scale chemistry techniques. Many resources are available on-line to assist in this process.
- Mark the arrival date on containers so you can see how quickly they are used (if at all.) Bar coding systems are now available to track inventory.

- Consolidate or coordinate purchasing authority to reduce duplicate purchases of chemicals and improve inventory tracking.
- Check with suppliers of your laboratory standards. Some will allow you to ship standards back for reuse after the expiration dates have passed. If yours does not, dispose of them properly.
- Avoid stocking over 2.2 pounds or 1.0 kilograms of "P-listed" chemical products (WAC 173-303-9903.) This could help you stay below "large quantity generator" status.
- Limit the size of samples you accept and guarantee your ability to return samples to the supplier.

P2 Example: Liquid Chromatography

Solvent recycling in liquid chromatography (LC and HPLC) can be done by the microprocessor controlled S^3 Solvent Saver System®. This system uses a sensitive level sensing circuit to shunt the eluant to waste whenever the output from the system detector exceeds a user set level. After the contaminant (normally a component from the sample) has passed and the output from the system detector drops below the programmed level, the uncontaminated solvent will be returned to the solvent reservoir to be used again, reducing both solvent disposal and purchasing costs.

P2 Example: Western Blotting

Western blotting is a technique used by biochemists to electrophoretically transfer proteins from polyacrylamide gels onto a more stable membrane substrate, such as nitrocellulose. The standard conducting solution used during western blotting contains 20 percent methanol, resulting in the generation of a listed dangerous waste. For many protein transfer applications, particularly those involving high molecular weight proteins, it is possible, and even helpful, to replace 20 percent methanol (a dangerous waste) with 20 percent ethanol (a nonhazardous waste) in the conducting solution.

- For isolation and purification of DNA, replace chloroform-phenol extractions with techniques developed by Promega, Stratagene (Lambda DNA Purification Kit), or green kits that exclude toxic materials like guanidinium salts and utilize biodegradable plastics like Mt. Baker Bio's SeqJack GreenGene Kits.
- PVC produces dioxins during manufacture and incineration and may contain lead and phthalates as stabilizer and plasticizer, respectively. Substitute PVC plastic labware with a polypropylene or polystyrene alternative. Replace PVC with dust-free latex or nitrile gloves.
- The Pollution Prevention Resource Center (PPRC) has an on-line topic hub titled *Biotechnology Labs: P2 Opportunities* that describes techniques for source reduction, green chemistry, energy and water efficiency, and materials reuse and recycling at http://pprc.org/hubs/index.cfm?page=subsection&hub_id=1005&subsec_id=13

- Label waste and recycling collection containers so it is unmistakably clear which waste or recycling streams go in which container. Train staff and enforce proper segregation.
- Locate waste and recycling tubs and containers to follow work flow and improve accessibility.

Wastewater and Solid Waste Disposal Guidelines

All wastewater discharged to the sewer system must comply with local, state and federal standards. These are designed to protect surface waters and to maintain the quality of biosolids from wastewater treatment plants. Because discharge to a septic tank system is regulated as if the discharge was directly to groundwater, virtually no wastes may be discharged to a septic tank. Laboratory operations often generate dangerous wastes that contain dilutions and mixtures of chemicals in very low concentrations or in small quantities. See Appendix A for King County guidelines for disposal of liquid wastes to the sewer system.

Solid waste guidelines are designed to protect local and regional landfills, transfer stations, their customers and their employees. Appendix B lists King County guidelines for solid waste disposal. In general, each component of a waste stream must meet all criteria listed in the relevant appendix to be accepted for discharge to the King County sewer system or disposal as a solid waste.

The guidelines in the appendices are offered as a starting point for proper sewer and solid waste disposal and should not be considered definitive. Many aspects of the Dangerous Waste Regulations, Chapter 173-303 WAC (listed wastes, off-spec chemicals, mixtures, formulations, etc.), are not covered in Appendices A and B. Please refer to WAC 173-303-070 through 173-303-110 for waste designation procedures. The generator has full responsibility for waste characterization and regulatory compliance.

Certain wastes that fail the criteria listed in Appendix A may be suitable for discharge to the sewer under special rules. Under all conditions, obtain written authorization from the King County Industrial Waste Program at 206-263-3000 or Info.KCIW@kingcounty.gov, or a local sewer utility to discharge wastewater that falls outside these criteria. For information on solid waste disposal, call the Waste Characterization Program at Public Health – Seattle & King County at 206-263-8528 or wc@kingcounty.gov.

Again, these guidelines do not provide authorization under Permit by Rule to allow discharge of hazardous chemicals to the sewer. They serve, in part, as a guideline to assist businesses and agencies in King County in determining whether their waste may be acceptable for discharge to the sewer.

Ecology provides two on-line resources to help waste generators better understand waste designation:

- Ten Designation Steps:
  www.ecy.wa.gov/programs/hwtr/demodebris/pages2/designat_steps.html

- Dangerous Waste Designation Tool: www.ecy.wa.gov/programs/hwtr/manage_waste/des_intro.html

FOR MORE INFORMATION

Industrial Materials Exchanges

For materials management alternatives, contact the Industrial Materials Exchange (IMEX) at 206-263-8465 or imex@kingcounty.gov. IMEX is a free service designed to help businesses find markets for industrial by-products and surplus materials. Through IMEX, businesses with materials they can no longer use can be matched with others who may need the materials. Materials are advertised at no cost. www.lhwmp.org/home/IMEX/index.aspx

Dangerous Waste Management – In King County

The Local Hazardous Waste Management Program in King County provides on-site consultation services to businesses in King County. The services are at no charge to the customer and do not have the regulatory authority of enforcement. Information is kept strictly confidential. Call 206-263-8899 or 800-325-6165 extension 3-8899 for information or to schedule a visit.

The Business Waste Line provides answers to questions about dangerous waste management and provides referrals for on-site technical assistance or investigation of problem situations with hazardous materials. The caller may remain anonymous. Call 206-263-8899 or e-mail bwl@kingcounty.gov

The Waste Characterization Program at Public Health – Seattle & King County provides answers about what can go into the landfills. Call 206-263-8528 or e-mail wc@kingcounty.gov

Dangerous Waste Disposal Options in King County

The Local Hazardous Waste Management Program in King County provides dangerous waste management information for conditionally exempt generators at www.lhwmp.org/home/BHW/index.aspx.

The Washington State Department of Ecology provides dangerous waste management information for regulated generators at www.ecy.wa.gov/programs/hwtr/managewaste.html

Vendors that manage dangerous waste in King County can be found at www.lhwmp.org/home/Yellowbook/material_detail.aspx?ItemID=zZk%2bT93STcw%3d

Dangerous Waste Management – Outside King County

The Northwest Regional Office of the Washington Department of Ecology provides technical and regulatory assistance to businesses throughout northwestern Washington State. In the northwest part of the state, they can be reached at 425-649-7000. Ask to speak to a hazardous waste technical assistance staff person. www.ecy.wa.gov/programs/hwtr/index.html

King County Industrial Waste Program

For more information on sewer guidelines in King County, call the King County Industrial Waste Program at 206-263-3000 or Info.KCIW@kingcounty.gov, or your local sewer utility. www.kingcounty.gov/environment/wastewater/IndustrialWaste.aspx

Air Quality Management

For more information on air quality guidelines in the Puget Sound region, call the Puget Sound Clean Air Agency at 800-552-3565. www.pscleanair.org/contact/

Health and Safety Programs

For more information on health and safety regulations, contact the Washington State Department of Labor and Industries. They can provide your company with no-charge safety & health or risk management consultation**.** All information is kept strictly confidential. Program description is at www.lni.wa.gov/Safety/Basics/Assistance/Consultation/default.asp Contact information is at www.lni.wa.gov/Safety/Basics/Assistance/Consultation/consultants.asp.

Specific guidelines for laboratories are found at http://www.lni.wa.gov/wisha/rules/labs/HTML/296-828-200.htm.

UW Field Research and Consultation Group

For more than 30 years, the University of Washington Field Research and Consultation Group (Field Group) has provided consultation services without charge to Washington state businesses to promote the safety and health of Washington's workplaces. Their services are made possible by funding from the Washington State Industrial Insurance Medical Aid and Accident funds. Visit http://depts.washington.edu/frcg/services.html or call (206) 543-9711 for more information about their consultation and research services.

Resources for Reducing the Scale of Experiments and Analyses

Microscale and small scale chemistry resources and equipment are readily found through an internet search. Many colleges and chemistry instructors have posted resources, including descriptions of experiments and needed equipment on their websites.

The National Small-Scale Chemistry Center is located at Colorado State University with regional centers across the United States. The focus of small-scale chemistry is the teaching lab. It is currently in use at secondary schools, community colleges and universities. Small scale differs from microscale in its use of inexpensive plastic materials in place of traditional glass apparatus. Both the volumes and concentrations of chemicals are reduced with these substantial benefits:

- Lower costs of materials and chemicals
- Increased safety from use of unbreakable plastic and nonhazardous solutions
- Reduced lab set-up and clean-up times, which allows more hands-on chemistry education

Visit their website at http://www.smallscalechemistry.colostate.edu/ for more information and free videos demonstrating the benefits of small-scale chemistry.

Resources for Recycling Lab Plastics

Many labware plastics can be recycled instead of going in to the waste stream. It is often helpful to have a consultant visit your site to look for opportunities to recycle lab plastics or substitute biodegradable plastics for those that must be disposed.

An internet search using the words *Laboratory Plastic Recycling Consultation* will bring up several informative websites and service providers to choose from.

Local Sewer Districts in King County

King County provides wholesale wastewater treatment services to 17 cities and 17 local sewer utilities in King, Snohomish and Pierce counties. These local agencies own and operate independent collection systems, which include pipelines and pump stations to collect and carry wastewater flows in their service area to King County's regional system for treatment and disposal. The local agencies have 30-year agreements with King County for this service. King County owns and operates the regional treatment plants, pipelines, pump stations and other related facilities.

For information on specific local sewer districts and a map of their boundaries, visit www.kingcounty.gov/environment/wtd/About/SewerAgencies.aspx#agencies

APPENDIX A

KING COUNTY GUIDELINES FOR SEWER DISPOSAL

King County Guidelines for Sewer Disposal		
Characteristic or Criteria	**Acceptable to sewer if meets ALL of these criteria**	**Unacceptable to sewer if exhibits ANY of these criteria**
1. Flash Point	>60 degrees C or 140 degrees F	<60 degrees C or 140 degrees F
2. Heat	<65 degrees C or 150 degrees F	>65 degrees C or 150 degrees F
3. Corrosivity (pH)	5.5 to 12.0	<5.5 or >12.0
4. Solubility	Water soluble	Water insoluble
5. Reactivity	Non-reactive	Water or air reactive; explosive; polymerizer Creates toxic gas or nuisance stench
6. Radioactivity	Meets WA Dept. of Health limitations[1]	Does not meet Dept of Health limits[1]
7. Persistence (WAC 173-303-100)	Halogenated organic compounds <0.01% Polycyclic aromatic hydrocarbons <1.0%[2]	Halogenated organic compounds ≥0.01% PAH concentration ≥1.0%[2]
8. Toxicity (WAC 173-303-100)	Category X <0.001% Category A <0.01% Category B <0.1% Category C <1.0% Category D <10 % No evidence or Category E =100%	Category X ≥0.001% Category A ≥0.01% Category B ≥0.1% Category C ≥1.0% Category D ≥10%
9. Toxic Mixtures (WAC 173-303-100)	Equivalent concentration <0.001%[3]	Equivalent concentration ≥0.001%[3]

Important Note: These guidelines for sewer disposal are not definitive. Many aspects of Chapter 173-303 WAC (e.g., listed wastes, off-specification chemicals, mixtures, formulations, etc.) could not be covered in this table. Please refer to WAC 173-303-070 through -110 for waste designation procedures. These guidelines are offered as a starting point for proper sewer disposal. The discharger must take full responsibility for waste characterization and regulatory compliance. Certain wastes that fail the criteria listed in the above table may be suitable for discharge to the sewer under rules promulgated by the Washington State Department of Ecology. Under all conditions, obtain written authorization from King County's Industrial Waste Program to discharge wastewater that falls outside these criteria.

[1] Chapter 246 WAC. For specific guidance, contact the Washington Department of Health at 425-576-8945. See WAC 246-221-290 – Appendix A – Table III.

[2] Polycyclic aromatic hydrocarbons (PAHs) include acenaphthene, acenaphthylene, fluorene, anthracene, fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno (1,2,3-c,d)pyrene, benzo(g,h,l)perylene, dibenzo [(a,e), (a,h), (a,i), and (a,l)] pyrenes, and dibenzo (a,j) acridine. Also, carcinogens are not separately regulated.

[3] Small quantity generators of dangerous waste should contact their sewer agency to see if they are partially exempt from the Toxic Mixtures discharge requirements

Toxic Category Table (WAC 173-303-100)

Data can be found in the Registry of Toxic Effects of Chemical Substances (RTECS), NIOSH

Category	Fish LC_{50} (mg/L)	Oral (rat) LD_{50} (mg/kg)	Inhalation (rat) LC_{50} (mg/L)	Dermal (rabbit) LD_{50} (mg/kg)	Example Compounds
X	<0.01	<0.5	<0.02	<2	Organophosphate Insecticides
A	0.01 - <0.1	0.5 - <5.0	0.02 - <0.2	2 - <20	Fuming Nitric Acid, Aflatoxin
B	0. 1 - <1.0	5 - <50	0. 2 - <2.0	20 - <200	Phenol, Sodium Azide Sodium Cyanide
C	1.0 - <10	50 - <500	2.0 - <20	200 - <2000	Stannic Chloride, Sodium Fluoride
D	10 - 100	500 - 5000	20 - 200	2000 - 20,000	Methanol, Stannous Chloride

King County Local Sewer Limits[4]

Substance	Grab Sample Max (mg/L)	Daily Average Max (mg/L)[5]
Arsenic	4.0	1.0
Cadmium	0.6	0.5
Chromium	5.0	2.75
Copper	8.0	3.0
Cyanide	3.0	2.0
Lead	4.0	2.0
Mercury	0.2	0.1
Nickel	5.0	2.5
Silver	3.0	1.0
Zinc	10.0	5.0
Temperature	<150°F	------------
Hydrogen sulfide (atmospheric)	10.0 parts-per-million-volume	------------
Polar fats, oil and grease (FOG)[6]	No visible FOG floating on surface	------------
Nonpolar FOG[6]	100	100

[4] **Important note**: Your sewer district may have local limits that are different than those listed above. Contact your local sewer district to learn their limits

[5] Daily average is calculated from three samples taken at least five minutes apart. Businesses discharging over 5,000 gallons a day must meet the standards for daily average maximum and grab sample maximum.

[6] Polar FOG is from animal or vegetable sources. Nonpolar FOG is from mineral or petroleum sources. **Important note**: Many sewer districts will have FOG limits that are lower than 100 mg/L. Contact your local sewer district to learn their limits and to verify whether their FOG limits are for Total FOG (polar + nonpolar) or for only nonpolar FOG.

Additional King County Sewer Guidelines	
Substance	**Discharge Limits**[7]
Glutaraldehyde[8]	1.0% in water[8]
Formaldehyde	0.1% in water[9]
Formalin (treated)[10]	None once formaldehyde concentration is under limit and pH is adjusted as necessary
Ethanol	24% in water
Methanol	10% in water
Isopropanol	10% in water
Barium	100 mg/L
Beryllium	10 mg/L
Selenium	1.0 mg/L
Thallium	10 mg/L

[7] **Important note**: These guidelines are designed for small discharges of under 50 gallons. Your sewer district may have local limits that are different than those listed above. Contact your local sewer district to learn their limits

[8] Cold sterilant solutions containing no more than 4 percent glutaraldehyde may be discharged to the King County sewer provided appropriate BMPs are followed. Contact King County Industrial Waste for a copy of the "Policy regarding discharge of 2-4% glutaraldehyde disinfectant solutions to King County Sanitary Sewer".

[9] Formaldehyde is a category B toxic compound and therefore designates as a dangerous waste at concentrations above 0.1 percent.

[10] See section on formaldehyde treatment options.

APPENDIX B

SEATTLE & KING COUNTY GUIDELINES FOR SOLID WASTE DISPOSAL

Characteristic or Criteria	**Unacceptable** for solid waste disposal at sites in King County
1. Physical State	Liquid
2. Corrosivity (pH)	≤2.0 or ≥12.5
3. Reactivity	Water or air reactive; explosive; polymerizer. Creates toxic gas or nuisance stench
4. Radioactivity	Does not meet Department of Health limits[1]
5. Toxicity Characteristic Leaching Procedure (WAC 173-303-090)	Must be less than Dangerous Waste limits for TCLP-listed metals and organics.
6. Persistence (WAC 173-303-100)	Halogenated organic compounds ≥0.01% PAH concentration ≥1.0%[2]
7. Toxicity[3] (WAC 173-303-100)	Category X ≥0.001% Category A ≥0.01% Category B ≥0.1% Category C ≥1.0% Category D ≥10%
8. Formalin Preserved Tissues & Specimens	Residual formaldehyde concentration >1.0 %
9. Toxic Mixtures (WAC 173-303-100)	Equivalent concentration ≥0.001%

IMPORTANT NOTE: These guidelines for solid waste disposal are not definitive. Many aspects of Chapter 173-303 WAC (e.g., listed wastes, off-spec chemicals, mixtures, formulations, etc.) could not be covered in this table. Please refer to WAC 173-303-070 through –110 for waste designation procedures. The guidelines provided here are offered as a starting point for proper solid waste disposal. The generator must take full responsibility for waste characterization and regulatory compliance. Under most conditions you should obtain a written clearance from Public Health Seattle & King County prior to disposal of contaminated or questionable solid waste. Call 206-263-8528 or e-mail wc@kingcounty.gov for more help.

[1] Chapter 246 WAC. For specific guidance, contact the Washington Department of Health at 425-576-8945

[2] Polycyclic aromatic hydrocarbons (PAHs) include acenaphthene, acenaphthylene, fluorene, anthracene, fluoranthene, benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, pyrene, chrysene, benzo(a)pyrene, dibenz(a,h)anthracene, indeno (1,2,3-c,d)pyrene, benzo(g,h,l)perylene, dibenzo [(a,e), (a,h), (a,i), and (a,l)] pyrenes, and dibenzo (a,j) acridine. Carcinogens are not separately regulated.

[3] Concentration limits based on equivalent concentration calculations found in WAC 173-303-100(5)(b)(ii)

Toxic Category Table (WAC 173-303-100)					
Data can be found in the Registry of Toxic Effects of Chemical Substances (RTECS), NIOSH					
Category	**Fish** LC_{50} **(mg/L)**	**Oral (rat)** LD_{50} **(mg/kg)**	**Inhalation (rat)** LC_{50} **(mg/L)**	**Dermal (rabbit)** LD_{50} **(mg/kg)**	**Example Compounds**
X	<0.01	<0.5	<0.02	<2	Organophosphate Insecticides
A	0.01 - <0.1	0.5 - <5.0	0.02 - <0.2	2 - <20	Mercuric chloride
B	0. 1 - <1.0	5 - <50	0. 2 - <2.0	20 - <200	Arsenic, Sodium Cyanide
C	1.0 - <10	50 - <500	2.0 - <20	200 - <2000	Phenol, Sodium Fluoride
D	10 - 100	500 - 5000	20 - 200	2000 - 20,000	Sodium Chloride, Stannous Chloride

APPENDIX C

PROPER DISPOSAL OF FIXATIVES & STAINS

Stain Solutions	Constituents	Disposal Option
Acid Fast Stain (for Mycobacteria)		
• Solution 1	Ethanol, basic fuchsin	Ignitable Dangerous waste
• Solution 2	Organic cleaner	Not regulated as HW
• Working solution	Mix of solution 1 and 2	Ignitable HW
• Decolorizing solution	Ethanol, hydrochloric acid	Ignitable HW, check pH for corrosivity
• Methylene blue counterstain	Methylene blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
Alcian Blue Pas Stain		
• 1% Alcian blue solution	Alcian blue, acetic acid, thymol	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• IN Hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Shiff reagent	Basic fuchsin, sodium metabisulfate, IN hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.55% Potassium metabisulfate solution	Potassium metabisulfate	Not regulated as HW
Alcian Blue Stain, pH 2.5		
• 3% Acetic acid solution	Acetic acid	Corrosive HW
• 1% Alcian blue solution	Alcian blue, acetic acid, thymol	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Nuclear fast red counterstain solution	Nuclear fast red, aluminum sulfate	Not regulated as HW
Bluing Solution for Hematoxylin Stain		
• Ammonia solution	Ammonium hydroxide	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Lithium carbonate solution	Lithium carbonate	Toxic HW
• Celloidin	Ethanol, ethyl ether, celloidin (nitrocellulose, parlodion)	Ignitable HW as a liquid, Flammable Solid HW or Explosive IF DRY
• Glycerin water mounting medium	Glycerin, phosphate buffered solute	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Congo Red Stain (Amyloid)		
• 80% Alcohol & sodium chloride (saturated)	Sodium chloride, ethanol	Ignitable HW
• Alkaline salt solution	80% alcohol, sodium hydroxide	Ignitable HW, check pH for corrosivity
• Stock Congo red staining solution	Congo red, 80% alcohol	Ignitable HW
Elastic Van Gieson Stain		
• Acid fuchsin - 1%	Acid fuchsin	Not regulated as HW
• Picric acid, saturated solution	Picric acid	Corrosive, Flammable Solid HW
• Van Gieson's solution	Acid fuchsin, picric acid	Corrosive, Flammable Solid HW
Fite's Acid Fast Stain		
• Ziehl-Neelsen carbol-fuchsin solution	Phenol, absolute alcohol, basic fuchsin	Toxic HW
• Decolorizing solution	70% Ethanol, hydrochloric acid	Ignitable HW
• Methylene blue counterstain	Methylene blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
Fontana-Masson Stain		
• 10% Silver nitrate	Silver nitrate	Oxidizer HW
• Fontana's silver solution	Silver nitrate, ammonium hydroxide	Corrosive, Oxidizer HW
• 0.2% Gold chloride solution	Gold chloride	Not regulated as HW (but reclaim the gold if possible)
• 5% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Nuclear fast red counterstain solution	Nuclear fast red, aluminum sulfate	Not regulated as HW
Giemsa (Modified Max-Gruenwald) Stain		
• Stock Jenner solution	Jenner dye, methanol	Ignitable and Toxic HW
• Working Jenner Solution	Stock Jenner solution	Ignitable and Toxic HW
• Stock giemsa solution	Giemsa powder, glycerin, methanol	Ignitable, Toxic and Persistent HW
• Working giemsa solution	Stock giemsa solution	Not regulated as HW
• 1% Acetic water solution	Glacial acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit

Stain Solutions	Constituents	Disposal Option
Gram (Modified Brown-Brenn) Stain		
• 1% Crystal violet solution	Crystal violet	Toxic HW
• Grams iodine solution	Iodine, potassium iodide	May be regulated as tissue corrosive
• Stock basic fuchsin solution	Basic fuchsin	Persistent HW
• Working basic fuchsin solution	Stock basic fuchsin solution	Not regulated as HW
Gridley's Ammoniacal Silver Nitrate Solution[1]		
• Ammoniacal silver nitrate solution	Sodium hydroxide, silver nitrate, ammonium hydroxide,	Corrosive, Oxidizer HW. Potentially Explosive HW, can deactivate prior to disposal
• 1% Periodic Acid	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• 2% Silver Nitrate	Silver nitrate	Toxic, Oxidizer HW
• Formalin Solution	Formaldehyde	Toxic HW
• 0.2% Gold Chloride	Gold chloride	Not regulated but reclaim gold if possible
• 5% Sodium Thiosulfate	Sodium thiosulfate	Not regulated as HW
Grocall's Methenamine Silver (GMS) Stain		
• 5% Chemical acid solution	Chromium trioxide	Toxic HW, test for oxidizer, check pH for corrosivity
• Silver nitrate solution	Silver nitrate	Toxic Oxidizer HW
• 3% Methenamine solution	Hexamethylenetetramine	Flammable Solid HW
• 5% Borax solution	Sodium borate	Not regulated as HW
• Stock Methenamine-silver nitrate solution	3% Methenamine, 5% silver nitrate solutions	Toxic Flammable Solid HW
• Working methenamine-silver nitrate solution	5% Borax solution, methenamine-silver nitrate stock	Toxic Flammable Solid HW
• 1% Sodium bisulfite solution	Sodium bisulfite	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.1% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible
• 2% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Stock light green solution	Light green SF (yellowish), glacial acetic acid	Not regulated as HW
• Working light green solution	Stock light green solution	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Hypo (Sodium Thiosulfate)		
• 3% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Lugol's iodine for mercury removal	Iodine, potassium iodide	Corrosive HW
• 2% Hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Nuclear-fast red solution	Nuclear-fast red, aluminum phosphate, thymol	Not regulated as HW
Iron Stain (Prussian Blue)		
• 2% Potassium ferricyanide solution	Potassium ferricyanide	Not regulated as HW but not allowed to sewer
Jones Silver Stain		
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• 3% Methenamine solution	Hexamethylenetetramine	Flammable Solid HW
• Borate buffer solution	Boric acid, sodium borate	Check pH for corrosivity
• 5% Silver nitrate solution	Silver nitrate	Toxic, Oxidizer HW
• Working methenamine silver solution	3% Methenamine solution, 5% silver nitrate solution, borate buffer solution	Test for oxidizer, then test for toxicity
• 0.2% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible
• 3% Sodium thiosulfate	Sodium thiosulfate	Not regulated as HW
Mucicarmine Stain		
• Mucicarmine stock solution	Carmine alum lake, aluminum hydroxide, ethanol, aluminum chloride	Ignitable HW, check pH for corrosivity
• Mucicarmine working solution	Mucicarmine stock solution	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Weigert's iron hematoxylin, solution A	Hematoxylin, ethanol	Ignitable HW
• Weigert's iron hematoxylin, solution B	Hydrochloric acid, ferric chloride	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Weigert's iron hematoxylin solution	Hematoxylin solution A and solution B	Ignitable HW, check pH for corrosivity
• 0.25% Metanil yellow solution	Metanil yellow, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit

Stain Solutions	Constituents	Disposal Option
Oil Red O Stain		
• Oil red O stock solution	Oil red O, 98% isopropanol	Toxic, Ignitable HW
• Oil red O working solution	Oil red O stock solution	Toxic, Ignitable HW
Periodic Acid Schiff Stain (PAS)		
• 0.5% Periodic acid solution	Periodic acid	Test for oxidizer, otherwise not regulated as HW
• IN hydrochloric acid	Hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Schiff reagent	Basic fuchsin, sodium metabisulfite, IN hydrochloric acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 0.55% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
Periodic Acid Shiff Digested Stain (PAS-D)		
• 0.55% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
• Malt diastase solution	Diastase of malt, pH 6.0 phosphate buffer	Not regulated as HW
• Phosphate buffer	Sodium chloride, sodium phosphate monobasic	Not regulated as HW
Phosphotungstic Acid Hematoxylin (PTAH)		
• PTAH working solution	Hematoxylin, phosphotungstic acid, potassium permanganate	Test for corrosivity & oxidizer, otherwise not regulated as HW. Must meet sewer limits
• Eosin Y working solution	Eosin Y, 95% ethanol , glacial acetic acid	Ignitable HW
Reticulin Stain (Gomori's Method) [1]		
• 10% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 10% Potassium hydroxide solution	Potassium hydroxide	Corrosive HW
• Ammoniacal silver solution	Sodium hydroxide, silver nitrate, ammonium hydroxide,	Corrosive, Oxidizer HW. Potentially Explosive HW, can deactivate prior to disposal
• 0.5% Potassium permanganate solution	Potassium permanganate	Test for oxidizer, otherwise not regulated as HW
• 2% Potassium metabisulfite solution	Potassium metabisulfite	Not regulated as HW
• 2% Ferric ammonium sulfate solution	Ferric ammonium sulfate	Not regulated as HW
• Formalin solution	Formaldehyde	Toxic HW
• 0.2% Gold chloride solution	Gold chloride	Not regulated but reclaim gold if possible

Stain Solutions	Constituents	Disposal Option
Reticulin Stain (Gomori's Method) - continued		
• 2% Sodium thiosulfate solution	Sodium thiosulfate	Not regulated as HW
• Nuclear-fast red (Kernechtrot) solution	Nuclear-fast red, aluminum sulfate	Not regulated as HW
Spirochete Stain (Steiner & Steiner Method)		
• 1% Uranyl nitrate solution	Uranyl nitrate	Not regulated as HW or radioactive waste. Meets DOH guidelines for sewer discharge.
• 1% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 0.04% Silver nitrate solution	Silver nitrate	Toxic HW. Test for oxidizer.
• 2.5% Gum mastic solution	Gum mastic, absolute alcohol	Ignitable HW
• 2% Hydroquinone solution	Hydroquinone	Toxic HW
• Reducing solution	Gum mastic solution, hydroquinone solution, absolute alcohol	Ignitable HW
Trichrome Stain – Masson's Method		
• Bain's solution	Picric acid, glacial acetic acid, formaldehyde	Toxic HW, test pH for corrosivity
• Weigert's iron hematoxylin, solution A	Hematoxylin, 95% alcohol	Ignitable HW
• Weigert's iron hematoxylin, solution B	Ferric chloride, glacial acetic acid	Corrosive HW
• Weigert's iron hematoxylin, working solution	Solution A, solution B	Ignitable HW, test pH for corrosivity
• Biebrich scarlet – acid fuchsin solution	1% Biebrich scarlet solution, 1% acid fuchsin, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Phosphomolybdic – phosphotungstic acid solution	Phosphomolybdic acid, phosphotungstic acid	Test for oxidizer, test pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Aniline blue solution	Aniline blue, acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• 1% Acetic acid solution	Glacial acetic acid	Check pH for corrosivity, otherwise not regulated as HW, must meet sewer limit
• Toluidine blue stain solution (for mast cells)	Toluidine blue	Not regulated as HW

Stain Solutions	Constituents	Disposal Option
Vonkossa Stain for Calcium		
• 5% Silver nitrate solution	Silver nitrate	Oxidizer HW
• 5% Sodium thiosulfate	Sodium thiosulfate	Not regulated as HW
• Nuclear-fast red solution	Nuclear-fast red, aluminum sulfate	Not regulated as HW
Fixative	**Constituents**	**Disposal Option**
Miscellaneous Fixatives		
• Alcohol fixatives	Methanol, ethanol	Methanol is Toxic Ignitable HW, Ethanol is Ignitable HW
B-5 Fixative		
• Stock solution	Mercuric chloride, sodium acetate (anhydrous)	Toxic HW
• Working solution	B-5 stock solution, formaldehyde solution	Toxic HW
• Bouin's fixative solution	Picric acid (saturated), 37% formaldehyde solution, acetic acid	Toxic HW, check for corrosivity
Formalin Fixatives		
• 10% Aqueous formalin solution	Formaldehyde	Toxic HW
• 10% Aqueous saline formalin solution	Formaldehyde, sodium chloride	Toxic HW
• 10% Neutral buffered formalin	Formaldehyde, sodium phosphate monobasic, sodium phosphate dibasic	Toxic HW
• Formalin alcohol solution	Formaldehyde, ethanol	Ignitable Toxic HW
• Hollande's fixative solution	Copper acetate, picric acid, formaldehyde, acetic acid	Toxic HW
Zenker's Fixative Solutions		
• Stock solution	Mercuric chloride, potassium dichromate, sodium sulfate	Toxic HW, test to see if oxidizer or corrosive
• Working solution	Zenker's stock solution, acetic acid	Toxic HW, test to see if oxidizer or corrosive

[1] Ammoniacal silver staining solutions are hazardous due to their potential to form explosive silver salts. Whether disposed or deactivated, these wastes are counted against your generator status.

- Don't allow silver nitrate to remain in ammonium solutions for more than two hours.
- Keep silver nitrate solutions separate from ammonium hydroxide solutions.
- Deactivate these waste solutions by diluting 15:1 with water. Then, while stirring frequently, slowly adding 5 percent hydrochloric acid to the solution till the pH reaches 2.
- Add ice if the solution heats up. Silver chloride will precipitate out when the pH reaches 2.
- Filter out the precipitate and dispose as dangerous waste, adjust the pH of the solution to 6 to 7 with sodium bicarbonate, then discharge to the sewer.

APPENDIX D

SOLID WASTE DISPOSAL - COMMON QUESTIONS

What is "Solid Waste?"

- "Solid Waste" refers to materials allowed in local municipal collection systems for garbage and recycling.

Who do I call to find out if my waste is acceptable for disposal as solid waste?

- Contact the Public Health – Seattle & King County Waste Characterization Program at 206-263-8528 or e-mail wc@kingcounty.gov .

Who do I call to get my waste cleared for disposal as solid waste?

- Contact the Waste Characterization Program at 206-263-8528 or e-mail wc@kingcounty.gov.

What are the guidelines for disposal of biomedical wastes? Who do I call for info?

Untreated medical wastes are NOT allowed in the landfill. For more information on biomedical waste disposal, contact the medical waste coordinator for Public Health – Seattle & King County at 206-205-4394. See http://www.kingcounty.gov/healthservices/health/ehs/toxic/biomedical.aspx

Where does my solid waste go for disposal?

- Wastes generated within the Seattle city limits are disposed at Columbia Ridge Landfill, Oregon.
- Wastes generated in King County, outside the Seattle city limits, go to Cedar Hills Landfill near Issaquah

What process must I go through to get a clearance for questionable solid waste?

- Contact the Waste Characterization program at 206-263-8528 or e-mail wc@kingcounty.gov , describe your waste and ask for instructions about the information needed to determine its acceptability.
- They will answer your questions and send you a two-page Waste Characterization Form. Download the form at http://www.kingcounty.gov/healthservices/health/ehs/toxic/SolidWaste.aspx#wc. Complete the form and submit it with the appropriate data (typically material safety data sheets and/or results of laboratory analyses.)
- If the waste is from Seattle, they'll review the information and, if it is acceptable, issue a permit.
- If the waste is from King County, outside Seattle, they'll review the information and issue a technical report. If the waste is acceptable, King County Solid Waste will issue a permit.

Can I dispose of 'Special Wastes' at King County or Seattle solid waste facilities?

Some of these wastes can be taken to King County's landfill in Issaquah. They have to be solids and be dangerous wastes in Washington State only, aka: State-only wastes. Generally these are Toxic Category D wastes or persistent wastes that are not extremely hazardous, e.g. Paint booth filters. Contact the Waste Characterization program at 206.263.8528 or wc@kingcounty.gov for more information.

What common solid wastes from labs may not be acceptable?

- Buffers consisting of more than 10 percent toxic category D substances (e.g., potassium hydroxide)
- Drier packages with over 10 percent potassium chloride, sodium chloride or copper chloride
- Soil samples with these characteristics:
  A. Contains 3 percent or more total petroleum hydrocarbons;
  B. Contains contaminants which occur at concentrations at or above a dangerous waste threshold in the toxicity characteristics list (see WAC 173-303-090 [8] [c])
- Many lab stains and dyes can designate because they are halogenated organic compounds (e.g., bromophenol blue.)

APPENDIX E

COMMON ACRONYMS & ABBREVATIONS

Abbreviation	Meaning
AIA	Alkaline Iodide Azide
BHT	Butylhydroxy toluene
BMBL	Biosafety in Microbiological and Biomedical Laboratories [Handbook from CDC/NIH]
BMP	Best Management Practices
BSC	Biological Safety Cabinets
BSL	Biosafety Level [Laboratories]
CAV	Constant Air Volume
CFR	Code of Federal Regulations
CHP	Chemical Hygiene Plan
DAB	3,3 Diaminobenzidine
DNA	Deoxyribonucleic Acid
DW	Dangerous Waste [WA State]
DWS	Drinking Water Standards of the *Safe Drinking Water Act*
EATOS	Environmental Assessment Tool for Organic Syntheses
EHSs	Extremely Hazardous Substances
EHW	Extremely Hazardous Waste[{WA State]
EIA	Enzyme Immuno Assays
ELISA	Enzyme-Linked Immunosorbant Assays
EPA	Environmental Protection Agency
EPCRA	Emergency Planning & Community Right-to-Know Act
EtBr	Ethidium Bromide
FDA	Food and Drug Administration
FOG	Fats, oil, and grease
GHS	Globally Harmonized System [Hazard Communication replacing HCS by 2013]
GMP	Good Management Practices
GMS	Grocall's Methenamine Silver
HCS	Hazard Communication Standard [an MSDS is example of this]
HEPA	High Efficiency Particulate Air [Refers typically to air filters]
HMIS	Hazardous Material Identification System [Similar to NFPA Symbols]
HMIS	Hazardous Material Inventory Statement [Seattle Fire Dept reg. 2701.5.2]
HPCL	High Performance Liquid Chromatography
HVAC	Heating, Ventilation, and Air Conditioning
HW	Hazardous Waste
HWTR	Hazardous Waste and Toxics Reduction [WA State Dept of Ecology Program]
IBC	Institutional Biosafety Committee

IMEX	Industrial Materials Exchange
KCLWMG	King County Lab Waste Management Guide
LC	Liquid Chromatography
LQG	Large Quantity Generator [WAC 173-303]
MQG	Medium Quantity Generator [WAC 173-303]
MSDS	Material Safety Data Sheets
NaOCl	Sodium Hypochlorite
NaOH	Sodium Hydroxide
NFPA	National Fire Protection Association [Usually refers to ***NFPA*** Symbols]
NIH	National Institutes of Health
NIOSH	National Institute for Occupational Safety and Health
OPA	Ortho-phthalaldehyde
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic aromatic hydrocarbons
PAPR	Positive Air-Purifying Respirator
PAS	Periodic Acid Schiff
PAS-D	Periodic Acid Schiff Digested
PBR	Permit by Rule
PCB	Polychlorinated Biphenyls
PEL	Permissible Exposure Limit
POTW	Publicly Owned Treatment Works
PPE	Personal Protective Equipment
PPM	Parts Per Million
PTAH	Phophotungstic Acid Hematoxylin
PVC	Polyvinyl chloride
RCRA	Resource Conservation and Recovery Act [WA State refers to ID #]
RIA	Radioimmunoassays
RO	Reverse Osmosis
RTECS	Registry of Toxic Effects of Chemical Substances
SQG	Small Quantity Generator [WAC 173-303]
TBG	Treatment by Generator [WAC 173-303]
TCLP	Toxicity characteristic Leaching Procedure
TSD	Treatment, Storage, or Disposal facility
TSS	Total Suspended Solids
USDA	US Department of Agriculture
UV	Ultraviolet
VAV	Variable Air Volume
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety & Health Act

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