Hazardous Waste Reduction Plan

University of Tennessee Safety Plan

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Statement of Commitment

It shall be the policy of the University of Tennessee to conduct a program that will reduce the volume and risks associated with the generation of hazardous waste to the minimum levels that are economically and technically feasible. This program shall be in full compliance with the requirements of all applicable federal, state and local regulations. The reduction efforts shall extend beyond the minimum regulatory expectations so that the potential for environmental pollution is minimized with health and safety protection maximized.

The university administration shall support this endeavor by committing human and financial resources to the successful implementation of this plan. Each employee who has involvement in a waste generating operation shall consider waste reduction as an integral component of their job and shall be committed to successful implementation of the program. It shall be the responsibility of each department head or manager to support and enforce the policies and procedures written in the waste management plan.

Troy Lane
Associate Vice Chancellor Public Safety
University of Tennessee - Knoxville

6/10/2019
Date

Purpose

The main objective of this plan is to reduce or eliminate the generation of hazardous waste to the extent that is economically and technically feasible. In research, teaching, testing and many other operations on campus, generating chemical waste cannot be avoided. However, chemical waste can be managed as efficiently as possible to minimize the amount that is generated. The Director of Environmental Health and Safety (EHS) will be primarily responsible for coordinating the waste minimization plan.

The Pollution Prevention Act of 1990 requires all hazardous waste generators to reduce or eliminate the generation of hazardous waste whenever feasible. The University of Tennessee must report its efforts towards waste minimization to the Tennessee Department of Environment and Conservation (TDEC) on an annual basis. As a result, the university sets waste reduction goals for each waste stream. These goals are outlined in detail in Appendix A.

Scope and Applicability

This waste minimization plan meets all of the requirements of the Tennessee Hazardous Reduction Act of 1990 (TCA 68-212-301), and encompasses all chemical waste operations conducted on the Knoxville campus and all off-campus activities that are part of the Knoxville campus's mission. The plan requires all individuals on campus who generate any type of hazardous waste to implement this plan by using resources that are economically and technically feasible to reduce or eliminate waste generation. Waste in any form represents lost money, lost resources, and lost labor.

Implementing a waste minimization program benefits everyone at UT Knoxville and the community by:

- Lowering waste disposal and compliance costs
- Reducing long-term liability for disposal
- Reducing costs of chemical purchases
- Reducing health and safety hazards
- Promoting environmental awareness
- Preventing pollution and conserving resources

Abbreviations and Definitions

EPA: Environmental Protection Agency

RCRA: Resource, Conservation and Recovery Act

TDEC: Tennessee Department of Environmental Quality

Procedures

Methods to Minimize Hazardous Waste Generation:

Waste reduction should be considered during all phases of a process including project/process design, purchasing, and use. The most effective location to minimize the amount of waste generated is at the point of waste generation. The policy of the University is to maintain an open-minded attitude towards application of any waste reduction option. Therefore, all faculty and staff are encouraged to constantly search for ideas that can be implemented to improve waste reduction efforts. The following methods should be considered to reduce the amount of hazardous waste produced on campus and the university will encourage use of these methods to meet its waste reduction goals.

Process modifications
This involves the use of micro-chemistry or using reduced volumes in an experiment. Procedures to switch to micro-chemistry include:

- Switching from conventional to fast microprocessor-based, top loading balances that are sensitive to 0.1 mg.
- Use of chromatographic techniques, such as high performance and ion exchange that can clearly separate and purify milligram quantities of a substance.
- Use of microscale glassware, including pipettes, burettes, syringes, reactors and stills for handling reagents and their products.
- Switching from conventional to sensitive spectrometers that can analyze milligram quantities of substance.

Chemical waste exchange:
Laboratories should check with other departments on campus, with EHS or on the chemical waste exchange list on-line before ordering a specific chemical. It costs 20-40 times the original purchase price of a chemical to dispose of that same chemical. In fact, the American Chemical Society estimates that 40% of the chemical waste generated by labs consists of unused chemicals. This could be reduced if labs checked with other departments or their own stock before ordering chemicals. Do not accept any chemicals from another department or outside organization unless you are sure these substances will be used.

Product substitution with a non-hazardous or less hazardous material.
Examples of product substitution include:

- Using a biodegradable non-toxic preservative, such as ethanol, in lieu of formaldehyde-based substances (formalin).
- Replacing flammable scintillation fluid with non-hazardous biodegradable scintillation fluid.
- Replacing hazardous solvents or cleaning solutions in parts washers with non-hazardous solutions.

Avoid mixing hazardous waste with non-hazardous waste.
Do not mix water, or other non-hazardous substances with hazardous waste. This will generate even more hazardous waste, which increases disposal cost. In the case of flammable solvents, the more water mixed with the hazardous waste, the more expensive the disposal costs. Flammable liquids with a high BTU content are typically sent for fuel blending and water mixed with the flammables lowers the energy contents thereby requiring more expensive disposal techniques. Also, do not mix used oil with solvents or heavy metals, or the used oil cannot be recycled.

Spill prevention:
Care should be taken when weighing or transferring chemicals to minimize spills. Containers should be sealed when not in use and processes should be contained (i.e. fume hoods) to prevent the escape of fumes or leaks into the environment.

Limiting quantities purchased.
Purchase chemicals in the smallest volumes needed. Consider buying pre-weighed or pre-measured reagent packets where waste generation is high.

Inventory management and control
Laboratories should constantly monitor their chemical inventory and dispose of any unwanted or expired chemicals through EHS. New containers should be dated when they are received so that older products will be used first.

Good housekeeping practices:
This includes properly labeling all containers with their hazardous contents and keeping an up-to-date chemical inventory.

Training:
Include waste minimization practices in student and employee training sessions. All employees and students who generate hazardous waste should take the hazardous waste management and waste minimization training and quiz.

Segregation:
Waste should be properly segregated once they are generated and stored in chemically compatible containers. For example, acid waste should not be stored together with caustics and oxidizers should not be stored with flammables. Hydrofluoric acid waste should not be stored in glass containers. Waste should be stored in secondary containment (i.e. tubs) when appropriate to ensure proper segregation during storage.

Eliminating unknown chemicals
Chemicals that are unlabeled cost up to 10 times more for disposal than properly labeled chemicals. In fact, in 2001 UT Knoxville spent roughly $75,000.00 to identify unknown chemicals (that price does not include disposal fees). At the very minimum, containers need to be labeled with the chemical/product name and primary hazard. Lab checkouts are conducted by EHS when an employee is leaving the university to ensure they are not leaving behind unlabeled chemicals.

Recycling.
There are many good reasons to recycle. Some of these reasons include:

- Conserves energy
- Protects the environment
- Reduces the need to build new landfills and incinerators
- Saves money and energy
- Stimulates the development of green technologies
- Provides valuable raw materials to industry

Examples of current recycling programs at UT Knoxville are:

- Universal waste, such as rechargeable batteries, fluorescent lamps and used oil, are sent to commercial recyclers.
- Solvents with high BTU values are reclaimed and burned as fuel in incinerators.
- Mercury from thermometers and equipment is collected for retorting.
- Any used photographic fixer that is generated is processed for silver recovery.
- Old computer equipment is sent for electronics recycling.

Distillation:
Some solvents can be re-distilled and reused. Currently, the Chemistry Department re-distills acetone for reuse.

Elementary neutralization and reclamation.
- Acids and bases can be neutralized, as long as they don't contain any heavy metals or organics.
- Gels can be directly injected with ethidium bromide to eliminate large volumes of liquid waste.

The following methods of disposal are ***not*** acceptable and are considered a violation of state and federal environmental regulations.

- evaporation
- dilution
- combustion
- storm sewer
- sanitary sewer
- sharps container
- regular trash
- biohazard waste containers

Mixture Rule:
In 1982, the EPA adopted the mixture rule **40 CFR § 261.3a) (2) (IV)**, which states that hazardous waste, when mixed with a non-hazardous substances remains hazardous. This rule does not apply when mixing occurs during a process, only when waste is being mixed. Combining wastes to render them nonhazardous is considered treatment. Intentional mixing of waste to change the characteristic is a direct violation of the US EPA Resource Conservation and Recovery Act (RCRA) land disposal treatment standards. A permit is generally required to treat hazardous waste. There are some exceptions to this rule, however, please call EHS before attempting any method of disposal.

Implementation:
EHS shall characterize the waste stream from each area that generates hazardous waste. Generators of hazardous waste will be queried about the availability and feasibility of waste reduction. EHS shall work with all departments to implement waste reduction efforts.

Performance Measures:
- Document hazardous waste minimization efforts. These records will be kept as part of Appendix A that is available in the EHS office for review and inspection.
- Review hazardous waste reduction results from the Annual Hazard Waste Report that is filed with the Tennessee Department of Solid Waste.
- Statutory limits as defined by the Tennessee Department of Environment and Conservation.

Program Review:
This program shall be reviewed annually and amended as necessary. When it becomes apparent that the plan is deficient, it shall be revised.

Performance measures shall be monitored at least annually.

Training:

Employees who generate or handle hazardous waste shall be trained to reduce hazardous waste generation. The hazardous waste management and waste reduction training may be presented during the annual training for hazardous waste generators. In addition, a self-study course is available by contacting the Environmental Health and Safety department at 865-974-5084.

Waste Minimization Efforts:

Specific Examples of waste minimization efforts that were made but EHS during 2017.

- EHS is packaging non-hazardous lab pack waste separately from hazardous waste, which saves money and reduces reportable quantities on our State year-end report.
- EHS eliminated >600 unknowns at a cost savings of $20.00 per sample plus eliminating an addition $1,400.00 in disposal costs by performing testing and consolidating compatible waste streams together. The unknowns originated from Walter Life Science building.
- EHS personnel poured off solvent materials campus-wide, which saved UT $2,500.00 in disposal costs.
- EHS punched over 50 empty propane cylinders during 2018 and shipped the empty cylinders to metals recycling. A cost savings of $1,000.00
- EHS was able to find a re-use option for 50% of the hazardous waste that was collected on-site.
- EHS is managing the non-hazardous waste on-site through a “Waste to Energy” program that converts the waste to electricity thereby providing a greatly reduced carbon footprint for that material into a beneficial re-use product.

Recordkeeping

EHS shall keep a record of the waste minimization plans for at least three years.

References

40 CFR 239-282 (RCRA Regulations)

Tennessee State Regulations 0400-12-01

Appendices

Appendix A Hazardous Waste Reduction Analysis

Disclaimer

The information provided in these guidelines is designed for educational use only and is not a substitute for specific training or experience.

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Appendix A

Hazardous Waste Reduction Analysis

Hazardous Waste: UTK Campus

The UTK Main Campus has three E.P.A. ID numbers assigned to it. An additional E.P.A. ID number is assigned to the Agricultural Campus/Vet School and they are treated as a separate entity. The Agricultural Campus hazardous waste management is the responsibility of UTIA Safety Office. Table 1 lists the amount of hazardous waste disposed for each of the three departments on the UT Knoxville campus possessing an E.P.A. ID# from 2007-2017

Table 1: Totals (in pounds) of all hazardous waste disposed on UTK campus

Year	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Weight (pounds)	32854	33441	34605	49993	38959	56496	40439	32134	46350	44547

In 2018, we disposed of 44,547 pounds of hazardous waste. Of that,

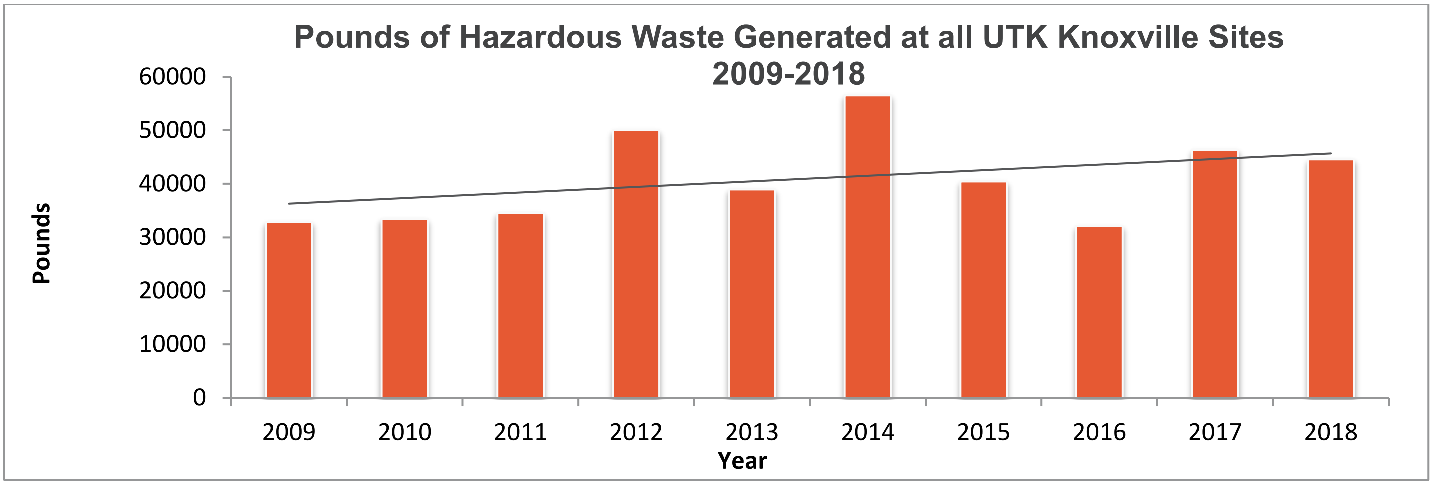
- **205 pounds was retorted (H010)**
- **16,961 pounds was incinerated (H040)**
- **21,966 pounds was fuel blended (H061)**
- **5,835 pounds was neutralized (H110)**

22,171 pounds, approximately 50% of our waste had a beneficial use, or was eliminated from leaving a waste footprint in our environment.

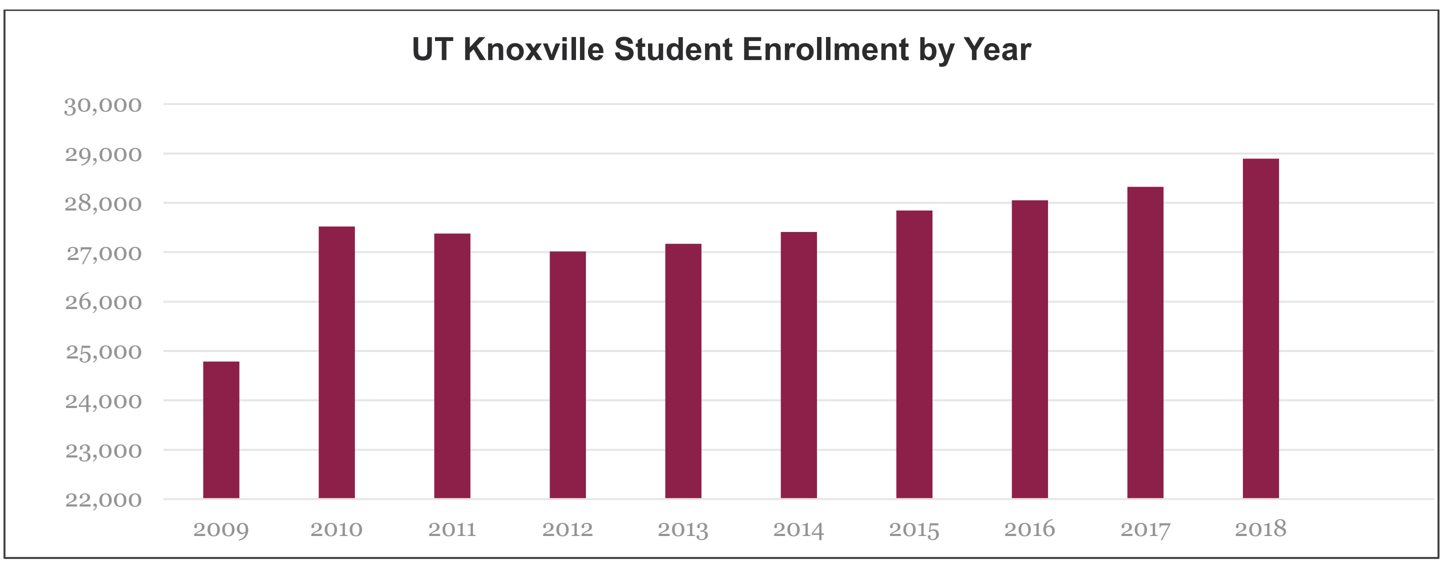
Hazardous Waste Disposal:

Total Pounds Disposed at University of Tennessee Knoxville Campus

The following graph illustrates the total pounds of hazardous waste disposed by each department or division at UTK from 2009-2018). Fluctuation in the amount of hazardous waste generated on the UTK is expected due to the nature of the activities producing hazardous waste. Increases in research often correspond to increases in waste. Additionally, spikes in waste production are associated with laboratory moves resulting in cleanouts of legacy materials. With the addition of several new science buildings, increases in hazardous waste are probable for the next several years.



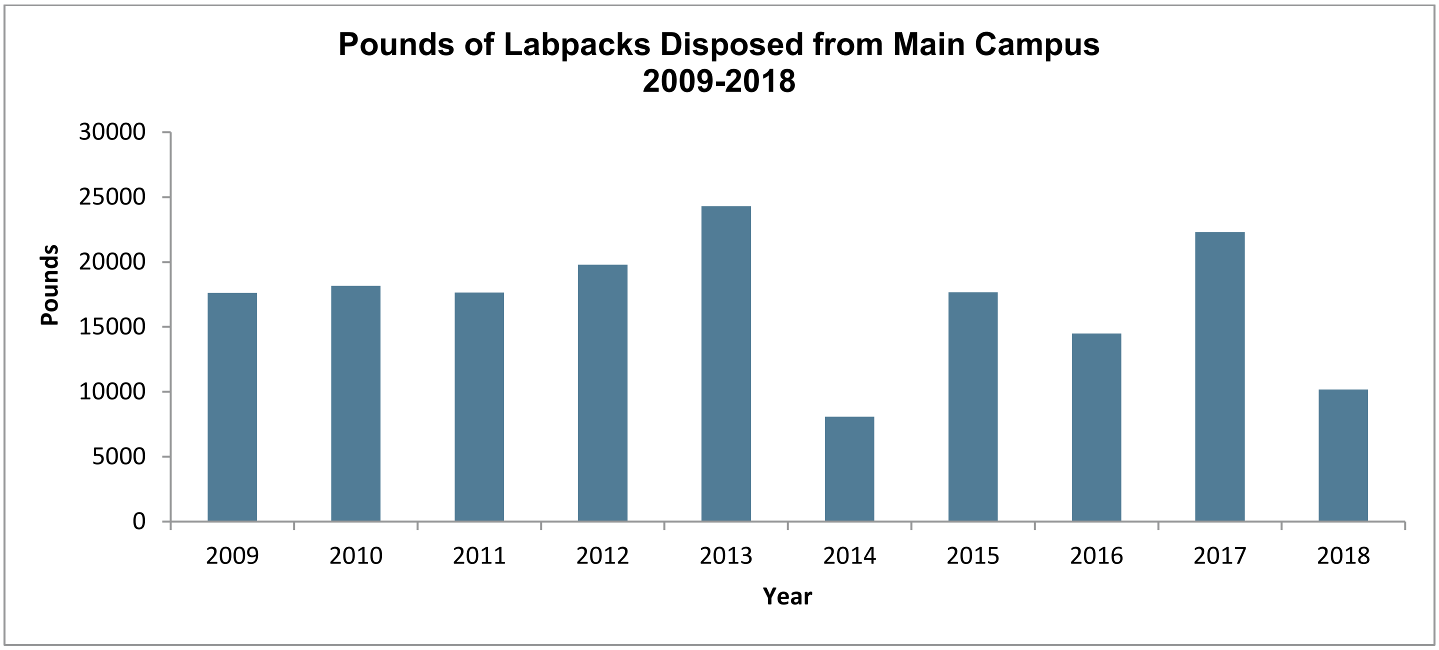
The graph below details student enrollment on the UT Knoxville campus from 2009-2018. The enrollment numbers correlate with the total amount of hazardous waste disposed on campus for the most part. There is a positive correlation between student enrollment and the volumes of hazardous waste generated.



Specific Waste streams

Mixed Waste Lab packs:

Due to the nature of research and teaching, a university produces small amounts of a diverse group of chemicals, which are defined by DOT 49 CFR as lab pack quantities. In order to reduce the amount being generated EHS encourages laboratories to limit quantities of chemicals they order, use the oldest dated chemicals first, discard expired chemicals, and check with other departments on campus to see if they can use discarded chemicals before disposing of as waste. However, it is very difficult to gain control of lab pack generation, because this waste stream is generated in varying quantities by different processes in several dozen locations. We have been encouraging labs to clean out and dispose of old, chemicals. However, if there is an increase in research, sometimes that can increase the amount of hazardous waste generated. Efforts should be made to examine specific laboratories to determine which waste minimization efforts would meet their specific needs.

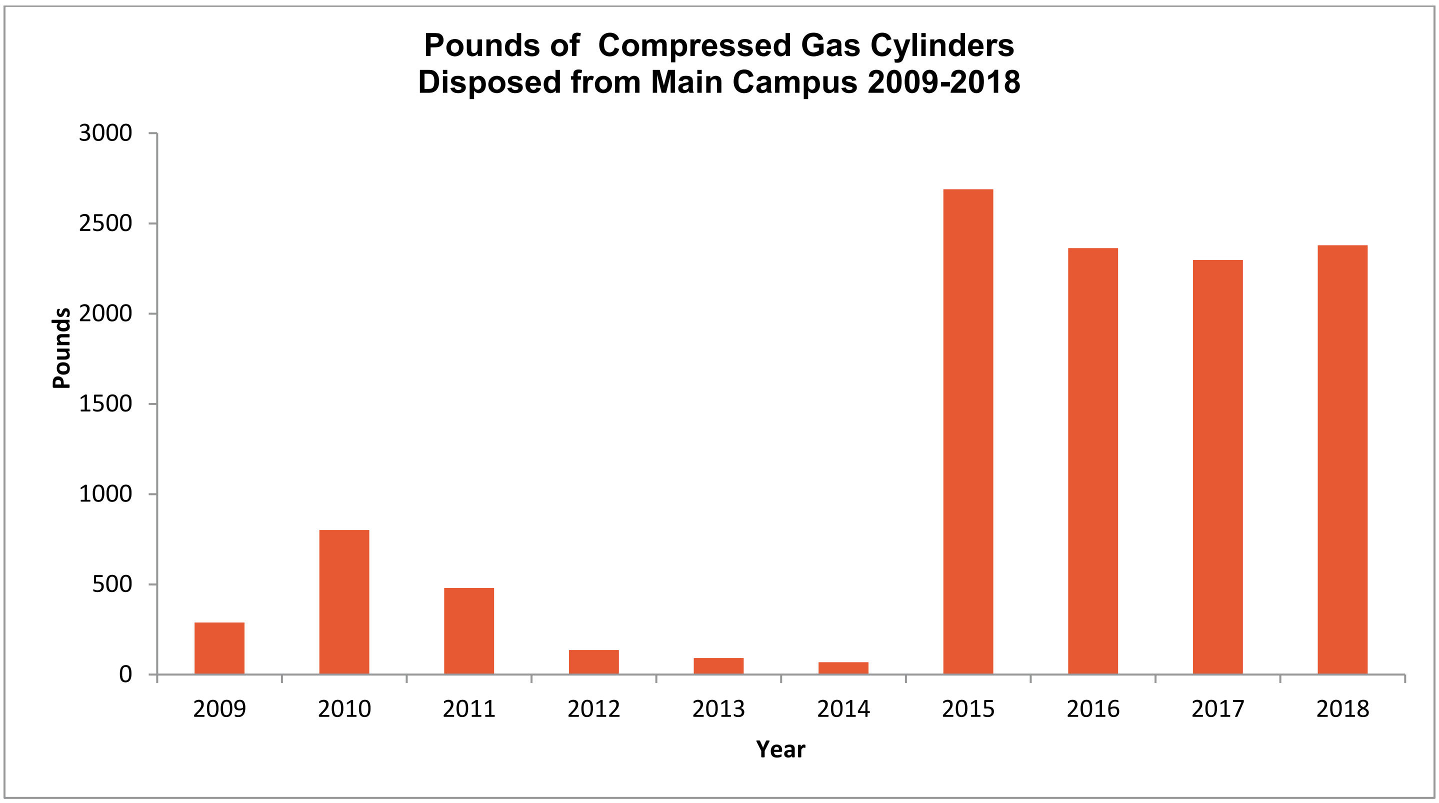


The volume of lab pack waste generated on the Main Campus has remained fairly consistent from 2009 through 2018. In 2014, lab packs decreased by over 66%. However, this was an artificial reduction due to how the waste was classified and does not reflect a true overall decrease. Much of what was previously considered lab pack waste was classified as either organic solvents or acid waste so those waste streams spiked in 2014 as those graphs demonstrate. In 2015 we returned to the classification system previously used which accounts for the return to approximately the same level seen prior to 2014. It is very difficult to control this waste generation. The decrease in volume last year directly corresponds to our effort to consolidate compatible material; thereby reducing volume and costs.

Compressed Gases

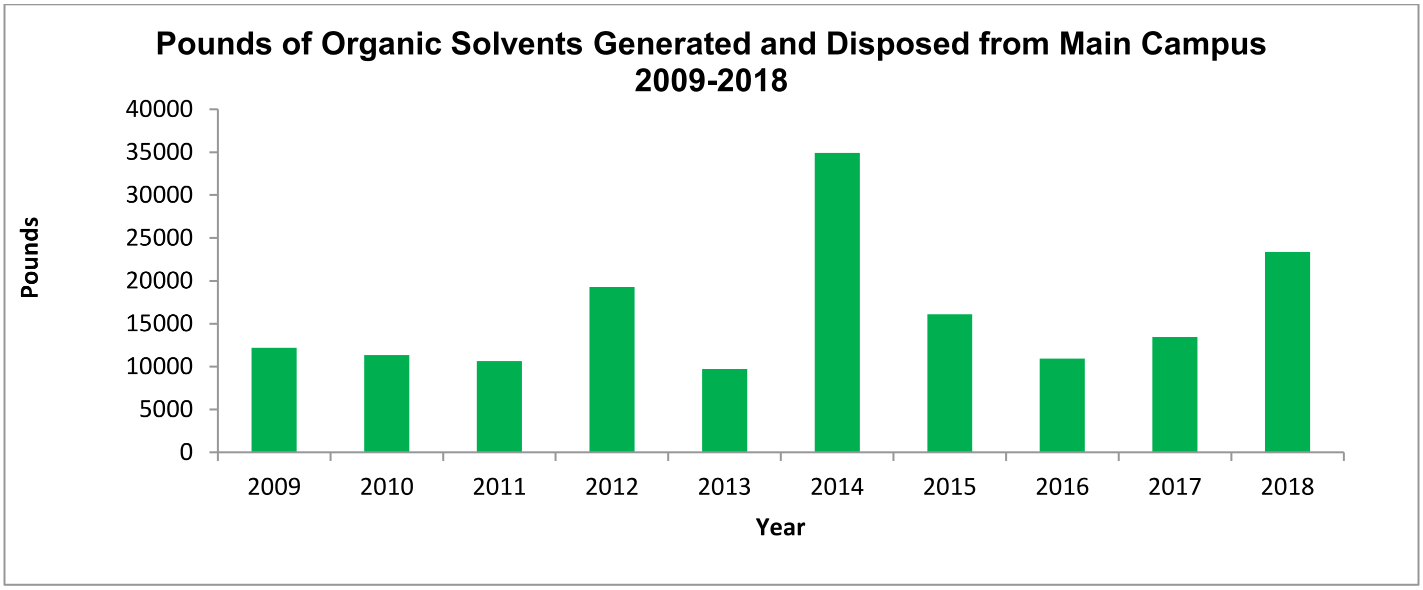
There are many serious safety concerns associated with compressed gas cylinders, including physical hazards associated with pressurized aging cylinders. In addition, inhalation of hazardous substances, or asphyxiation could occur from an unintentional release. Efforts are being made to encourage departments to purchase cylinders from manufacturers that will accept empty or partially full cylinders or checking with other departments to see if there is an existing cylinder available for use. It is very important that cylinders are properly labeled based on the fact that disposal of "unknown" cylinders is very expensive.

Historically, there has been a relatively low volume of this waste stream produced during most years. Spikes in 2010 and 2011 were primarily due to lab cleanouts where compressed gas cylinders were present. The volume of gas cylinders disposed has continued to decrease steadily since 2010. EHS has been educating people to dispose of cylinders before they become old and must be handled by a high hazard contractor. We also discourage departments from buying their own cylinders. Labs should always rent cylinders, if possible. The large increase seen since 2015 - 2018 results from including aerosol cans in this waste stream. Previously, EHS punctured aerosol cans and recovered the contents for disposal. This was a labor intensive process which was deemed to be inefficient.



Flammable Liquids:

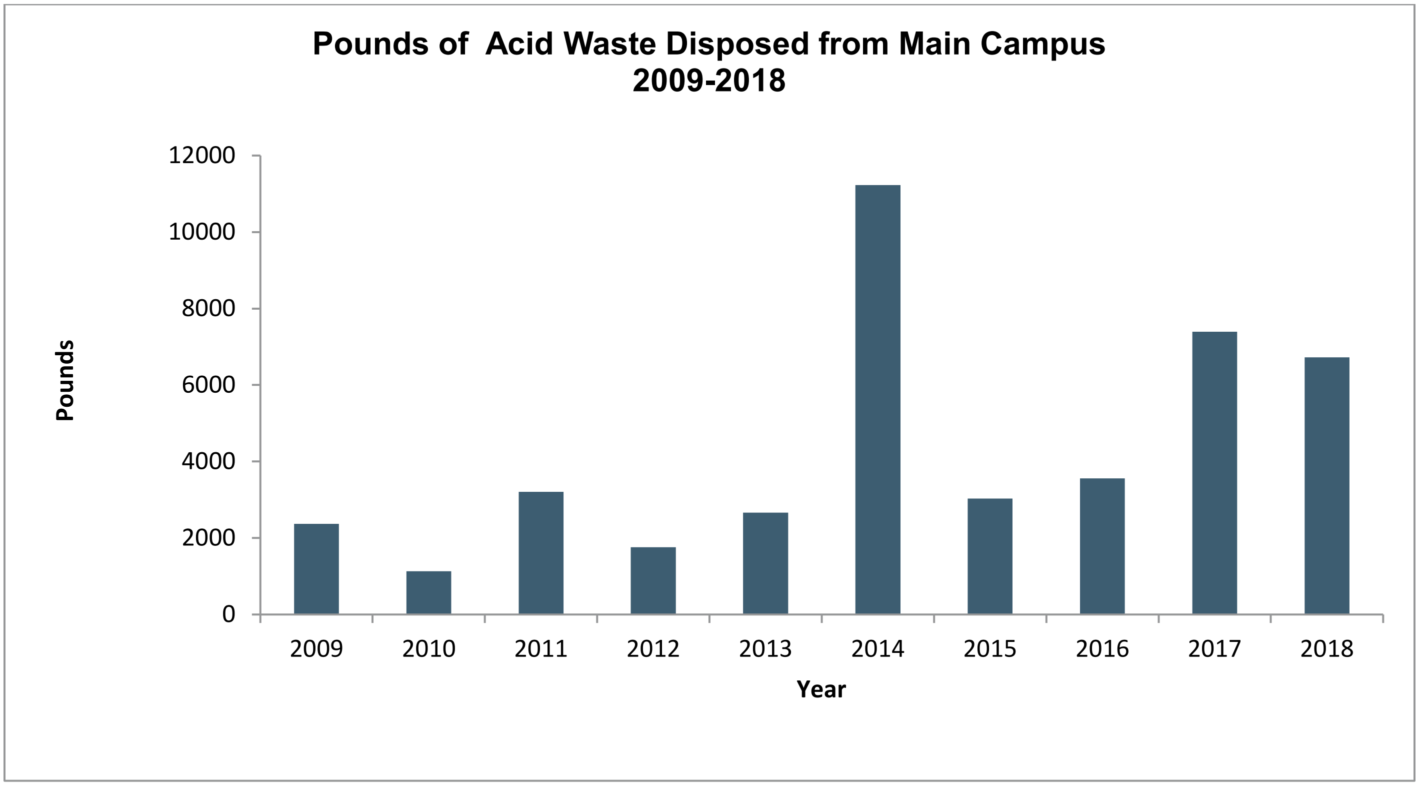
Examples of flammable liquids include acetone, methanol, ethanol, toluene, xylene and acetonitrile. Flammable liquids with high BTUs can typically be burned as a fuel in cement kilns, so disposal is relatively inexpensive, unless the flammable liquids are diluted with water, or mixed with heavy metals or halogenated solvent waste which will increase disposal costs. The best way to minimize the volumes of flammable liquid waste generated is to redistill solvents or find a non-flammable, biodegradable alternative.



There was almost a 50% increase in the volume of flammable organic solvents that were generated and disposed on main campus from 2011-2012, due to an increase in research. The volumes steadily decreased from 2009-2011. We were able to reduce the volume of flammable liquids disposed by 24% from 2008 to 2009, by another 15% from 2009-2010, and by a total of 40% from 2009-2011. Since 2009, the volumes have remained consistent until 2012. There was a decrease of approximately 50% between 2013 and 2012. In 2014, there was a dramatic increase. However, as described in the section of this report summarizing the lab pack waste stream, much of this increase was due to classifying organic solvents that were previously reported as lab pack waste because of container size in this waste stream based on chemical type. In 2015 we reverted back to our previous classification system. Consequently, the volume of this waste stream declined closer to levels seen prior to 2014. The volumes generated in 2017 were consistent with previous years. The increase in 2018 directly corresponds to the effort to “bulk” solvents rather than lab pack them. Most of this waste was fuel blended, which is a very desirable form of disposal (re-use).

Aqueous Metals/Acid Waste:

The cost to treat and dispose of heavy metals aqueous solutions containing metals such as barium, mercury, lead, selenium, cadmium, varies depending upon the type of metal and the concentration present.



*The volume of acid waste generated and disposed remained relatively constant from 2009-2013. The spike seen in 2014 is largely attributed to the way waste was classified. Much of this waste had previously been reported on the lab pack waste stream. Returning to the classification system used prior to 2014 resulted in the levels of acid waste decreasing to levels similar to those seen before 2014. There was an increase in the volumes of hazardous waste generated in 2017 & 2018 due to Chemistry labs bulking their waste rather pouring it down the drain. An increase in research and teaching that resulted in an increase in waste generation. Most of this waste is neutralized for disposal, which reduces the waste footprint.