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,

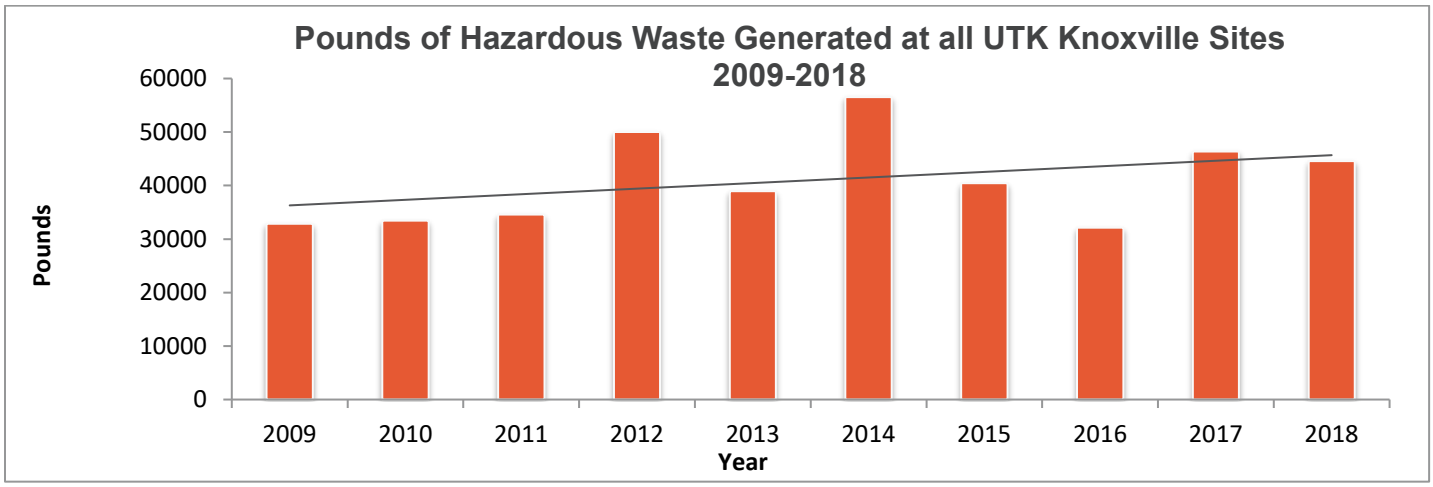
- **205 pounds was retorted (H010)**
- **16,961 pounds was incinerated (H040)**
- **21,966 pounds was fuel blended (H061)**
- **5,835 pounds was neutralized (H110)**

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

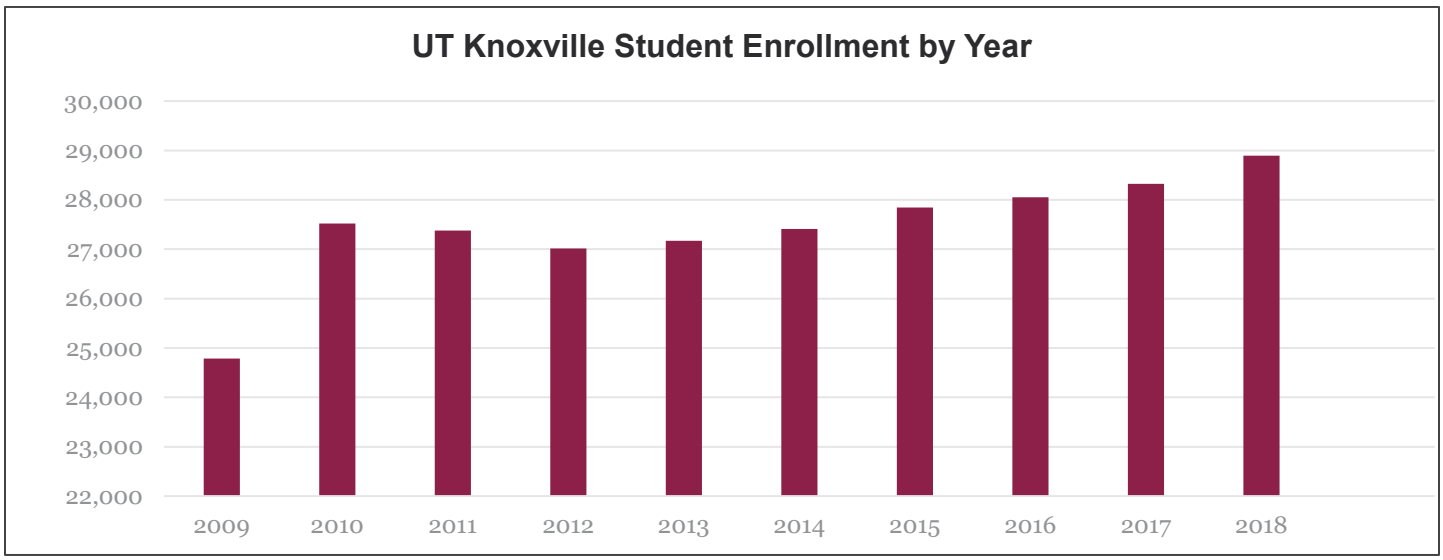
Hazardous Waste Disposal:

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.



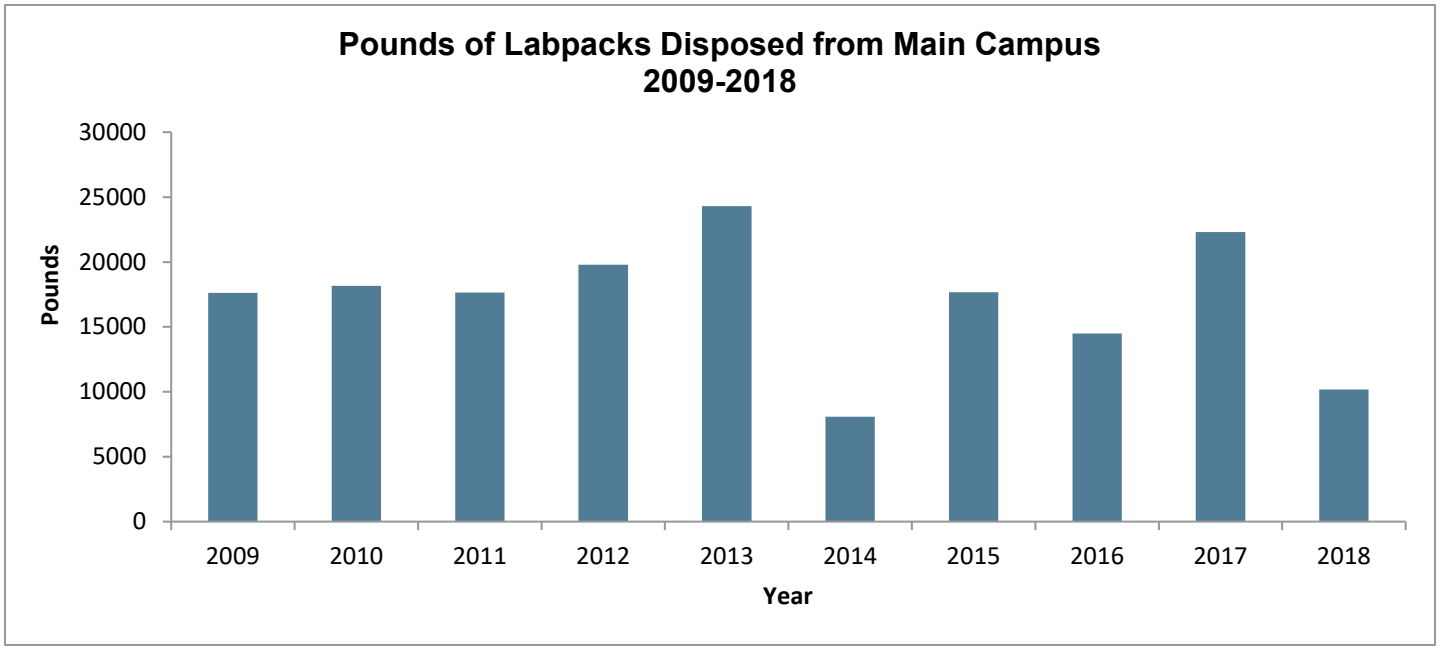
The graph below details student enrollment on the UT Knoxville campus from 2009-2018. The enrollment numbers correlate with the total amount of hazardous waste disposed on campus for the most part. There is a positive correlation between student enrollment and the volumes of hazardous waste generated.



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.

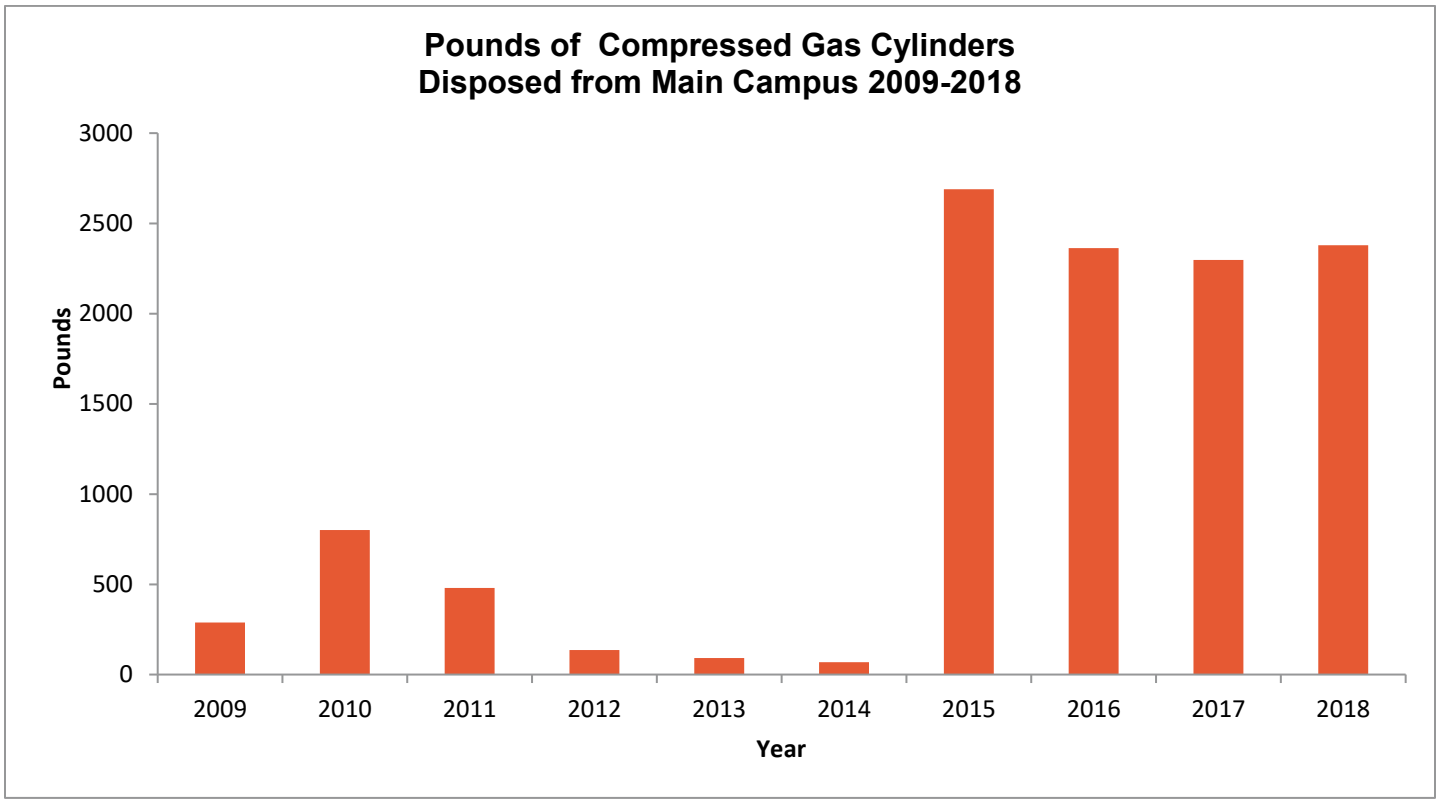


The volume of lab pack waste generated on the Main Campus has remained fairly consistent from 2009 through 2018. In 2014, lab packs decreased by over 66%. However, this was an artificial reduction due to how the waste was classified and does not reflect a true overall decrease. Much of what was previously 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

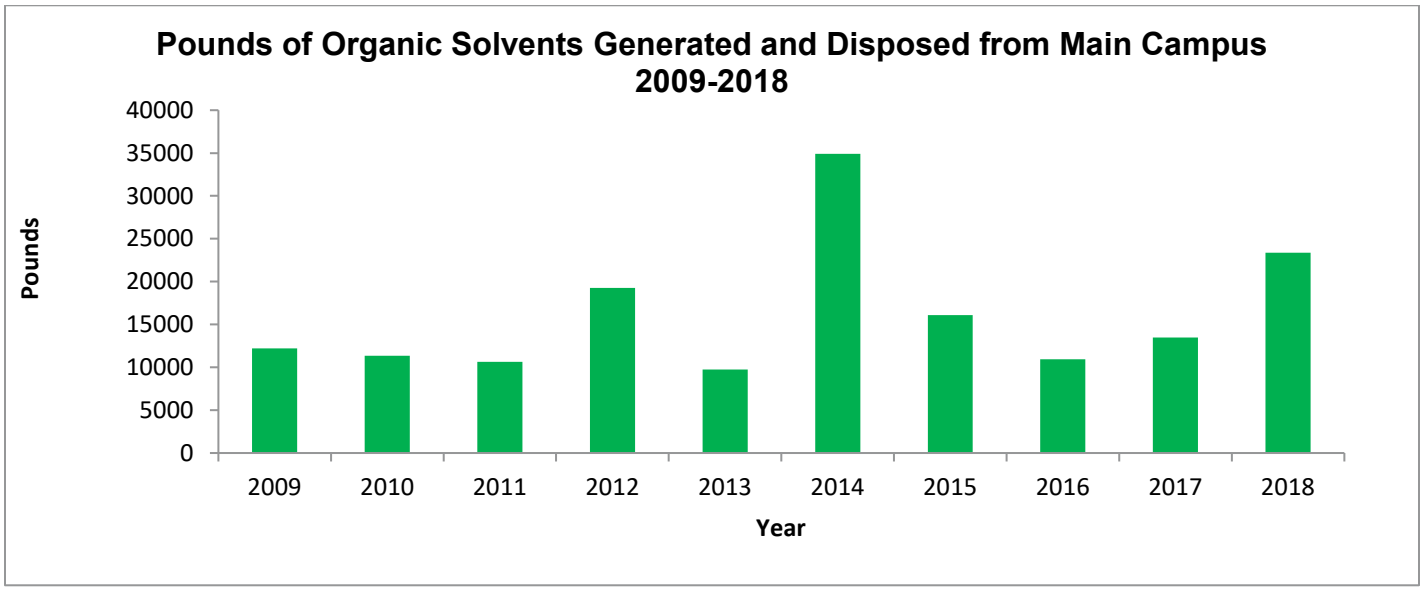
There are many serious safety concerns associated with compressed gas cylinders, including physical hazards associated with pressurized aging cylinders. In addition, inhalation of hazardous substances, or asphyxiation could occur from an unintentional release. Efforts are being made to encourage departments 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:

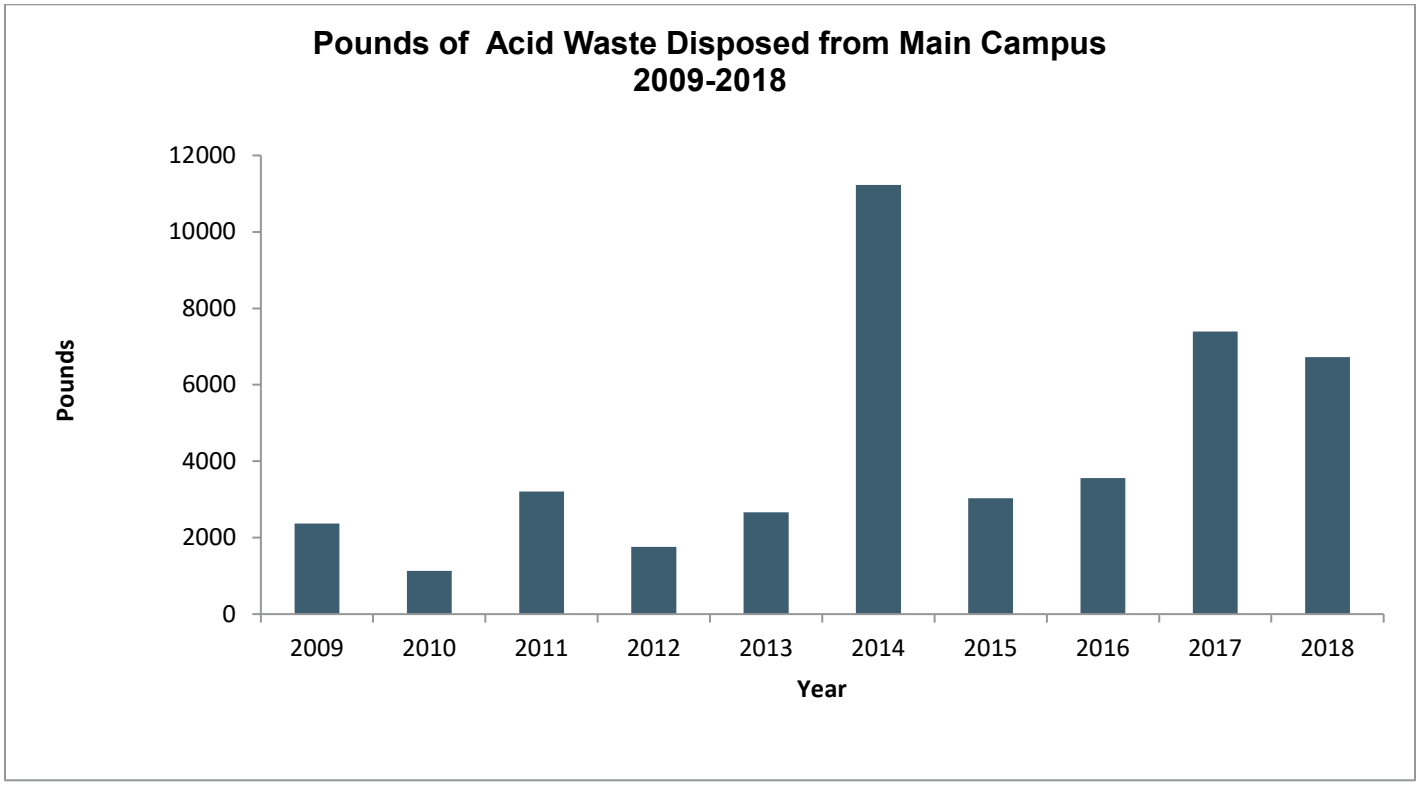
Examples of flammable liquids include acetone, methanol, ethanol, toluene, xylene and acetonitrile. Flammable liquids with high BTUs can typically be burned as a fuel in cement kilns, so disposal is relatively inexpensive, unless the flammable liquids are diluted with water, or mixed with heavy metals 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.