SUSTAINABLE DUKE: PROCUREMENT & WASTE

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Abstract

This report examines Duke University's Procurement Department and Waste Reduction & Recycling Department to identify opportunities for environmental improvement. With regard to waste reduction and recycling, we conducted two different waste reduction and recycling efforts to increase Duke's 39 % recycling rate, thereby lowering the amount of trash the University sends to the landfill. We conducted a series of waste audits to better understand Duke's to-landfill stream. Our audits revealed that 47% of the material sent to the landfill could have been recycled, and that 23% could have been composted. Second, we investigated whether Duke should consider switching to single-stream recycling (versus multiple-stream). We created models project potential impacts if Duke were to transition to single-stream recycling; the models predict that transitioning could: reduce Duke's annual tipping fee by up to$46,568 and reduce the commensurate CO_2e emissions by up to 281 tons CO_2e. With regard to Procurement, we evaluated the effectiveness of Duke's current sustainable procurement policies and practices through website information review and interviews. Additionally, we investigated the widely varying sustainable procurement approaches used by thirty other institutions of higher education to evaluate their relative merits. Our work resulted in a list of recommendations to improve upon Dukes already successful model.

Regarding waste management, we suggest that Duke implements single-stream recycling and post-consumer compost collection program simultaneously on campus. Regarding procurement, we recommend that Duke moves to a more centralized purchasing system and propose several suggestions to promote sustainable purchasing.

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Introduction

Our client, Sustainable Duke, was initiated in 2004 under the Office of the Executive Vice President at Duke University in Durham, North Carolina. It is the main office at Duke charged with reducing the campus environmental impact, strategic planning for sustainability, educating the campus community regarding Duke's footprint and developing programs to positively influence campus sustainability behaviors. More specifically this office works to:

- Assist in defining sustainability goals, strategies and performance metrics for long range campus planning
- Encourage and facilitate sustainability projects on campus initiated by students, faculty and staff
- Serve as the clearinghouse for sustainability programs at Duke – providing information and resources to campus community and beyond
- Ensure that Duke meets its goal of examining the actual and potential environmental impacts associated with campus activities and services in order to continually improve environmental performance

In 2007, Duke President Richard H. Brodhead signed the American College & University Presidents Climate Commitment (ACUPCC, described in *Background*), committing the University to developing an institutional plan to achieve climate neutrality. President Brodhead established the Campus Sustainability Committee (CSC) immediately afterwards to develop Duke's Climate Action Plan (CAP) (Duke University, Sustainable Duke 2012). To lead this effort, Brodhead designated Sustainable Duke. In conjunction with the CSC, Sustainable Duke drafted the CAP, which was approved by the CSC and the Board of Trustees in November 2009. The 2009 CAP primarily tackled Duke's carbon footprint and, using 2007 baseline data, created strategies to achieve the University's aggressive goal of becoming a climate-neutral (referring to Duke's carbon footprint from energy, transportation, and beyond) institution by 2024.

In 2011, the CSC began developing a Sustainability Strategic Plan (SSP), examining Duke's environmental stewardship beyond the CAP by investigating the University's water, waste and recycling, food, supply chain management, and land use programs. Sustainable Duke was again tasked with leading the development of the SSP, by collecting the University's current operating data in the aforementioned areas to guide aggressive but

attainable sustainability goals, and to design strategies accordingly. By following the strategies outlined by the 2009 CAP, Duke lowered its 2011 emissions by 11% from the 2007 baseline (Duke University, Sustainable Duke 2012); the SSP will become a vehicle by which CSC and Sustainable Duke can create strategies for environmental improvement, and hopefully, equally compelling results.

This Masters Project hopes to improve sustainability performance for Duke's Procurement Department and Sanitation (specifically Waste Reduction & Recycling (WR&R) Department; Tavey McDaniel Capps, Director of Sustainable Duke is our client and main contact for both the Purchasing and WR&R initiatives.

Objectives

Duke's WR&R and Procurement Departments are two distinct entities: WR&R operates under Duke's Facilities Maintenance Department, and Procurement operates under Duke's Financial Services department. Despite their intrinsic interrelatedness, because WR&R and Purchasing operate in two different departments, this project has two unique and separate objectives. The WR&R objectives of our project are:

1. To examine Duke's current trash and recycling programs and consumer habits to find opportunities to increase Duke's recycling rate and to increase Duke's landfill diversion rate.
2. To research what might happen if Duke transitioned from multiple-stream recycling to single-stream recycling.[1]

The Purchasing objective of our project is to assess Duke's current sustainable procurement practices and to recommend exemplary sustainable procurement practices found in sustainable procurement policies from other institutions of higher education (IHE).

[1] Multiple-stream recycling and single-stream recycling will be discussed in detail in the Background section. Briefly, multiple-stream recycling is a process where recycling consumers place glass in the glass bin, aluminum in the aluminum bin, and so on. Single-stream recycling allows consumers to place all of their recyclable items into one universal recycling bin.

Background

Universities are increasingly adopting sustainability initiatives (Dyer 2013). The Association for the Advancement of Sustainability in Higher Education (AASHE) began in August of 2006 as a the result of a realization of the Higher Education Associations Sustainability Consortium (HEASC) that universities needed a system to "address all the dimensions of sustainability (health, social, economic, and ecological) and all the sectors and functions of campus, including curriculum, facilities, operations, and collaboration with communities" (Unknown 2013a). In 2008, AASHE released the Sustainability Tracking, Assessment & Rating System (STARS) as a way for IHE to have a universal sustainability reporting system. As well as simply providing sustainability reporting metrics, AASHE and STARS were built to encourage management practices sharing and collaboration, as well as to inspire emulation of successful programs. At the time of this report, there were 288 institutions participating in STARS program (Unknown 2012)

The ACUPCC launched in 2007 as a "high-visibility effort to address global climate disruption undertaken by a network of colleges and institutions that have made institutional commitments to eliminate net greenhouse gas emissions from specified campus operations and to promote the research and educational efforts of higher education to equip society to re-stabilize the earth's climate" ("Mission and History | Presidents' Climate Commitment" 2012). When AUPCC officially launched, 284 institutions signed the pledge ("Mission and History | Presidents' Climate Commitment" 2012); now, more than 665 institutions have promised to engage in net-zero carbon emission goals (Dyer 2013).

AASHE STARS and the ACUPCC are significant drivers in pushing IHE towards becoming sustainable institutions, and while their existence helps propel the greening of American campuses, they are not solely responsible for creating sustainable initiatives, practices, and departments at these IHE. As Dyer points out, universities are a lot like businesses; "a decent-size university manages the equivalent of office buildings, restaurants, hotels, laundry services, hospitals, auto-repair, retailers, waste haulers, and even small energy utilities" (2013). Dyer's thrust is that universities are creating sustainability initiatives "for the same reasons companies are: to reduce costs, improve

quality, foster innovation, attract talent, and generally demonstrate leadership in an increasingly competitive marketplace…. Colleges also face the same challenges as companies. They need to make the business case, inspire behavior change, and navigate bureaucracies… hundreds of campuses are taking on the hard but rewarding work of leading transformational change. In doing so they are creating learning environments that will inspire the next generation of CEOs, politicians, technicians, cultural icons, and professionals of all kinds to create a sustainable society" (Dyer 2013). Sustainable Duke's mission is to do just that; to create value by reducing Duke's footprint and improving inefficiencies, to inspire behavior change both on campus and beyond, to be a leader in sustainability.

Duke's community is made up of 64,045 students, employees, and professors (Duke University Office of News & Communications 2013), so reducing the footprint of the University is the same as reducing the impact of similarly sized cities.

WR&R

The Environmental Protection Agency (EPA) estimated that in 2008, Americans sent 135 million tons of waste to landfills (U.S Environmental Protection Agency; Office of Resource Conservation and Recovery 2009). This equals roughly 4.3 pounds of trash per person per day. The EPA further estimates that in 2008, Americans diverted 1/3 of their waste by recycling and composting. However, the EPA's data were created by taking limited data from landfill and Material Recovery Facilities (MRF), plants designed to receive, segregate and prepare recycled materials for downstream secondary processors, and projecting these data onto a state-by-state per-capita estimation of tons landfilled and recycled. A recent collaboration between Columbia University and *BioCycle* used actual data from landfills, and concluded that the EPA's estimation was significantly low. According to the Columbia University and *Biocycle* findings, in 2008, Americans generated 389.5 million tons of solid waste (roughly 7.1 pounds per person per day), of this 69% was landfilled, 24% was recycled and composted, and 7% was converted from waste to energy (van Haaren, Themelis, and Goldstein 2010). "This annual load of trash is roughly equivalent to the collective weight of the entire U.S. adult population – eighteen times over"

(Humes 2013). Humes calculates that, on average, one person generates 102 tons of trash over the course of their lifetime (Humes 2013).

Recycling is a cornerstone of landfill reduction programs. Not only does recycling lower the volume of waste landfilled, reusing discarded items to manufacture new goods preserves virgin materials, thus saving the commensurate energy and environmental impacts of collecting, transporting, and processing these virgin materials (Container Recycling Institution 2009). Table 1 describes the energy savings and greenhouse gas (GHG) avoidance of different recyclable materials.

Material	**Energy Savings** (MBTUs/ton)	**Avoided GHG emissions** (MTCE/ton of recovered material)
Aluminum cans	207	3.7
HDPE/LDPE	51-56	0.38-0.46
PET plastic	53	0.42
Steel cans	20	0.49
Newsprint	17	0.76
Corrugated	16	0.85
Phone books	12	0.72
Office paper	10	0.78
Glass containers	2.7	0.08
Aggregate	0.6	n/a

Table 1: Environmental Benefits from Recycling. Source: U.S. EPA, 2006)

Currently, more than 40 states have legislation forcing the recycling of municipal solid waste. Such legislation is driven by the concern of scarcity of landfill space (Highfill and Mcasey 1995).

Recycling collection is primarily accomplished in one of two methods, multiple-stream recycling or single-stream recycling. Multiple-stream recycling is the practice of sorting recyclables into bins with only similar components; glass in the glass bin, aluminum in the aluminum bin, and so on. Single-stream recycling allows people to place all recyclable items into one bin to be sorted at the MRF. These systems will be analyzed in more detail below, but one should realize that scholars, economists, and those in the waste

industry don't agree on which system is better. Single-stream is believed to increase recycling participation while lowering costs, but at the same time, single-stream contaminates recycling commodities in a way that multiple-stream recycling does not. Some argue that the contamination of recyclables from single-stream recycling compromises the commodities so much so that any cost savings and increased participation are significantly overshadowed by the economic and environmental losses in contaminated recyclable items (Morawski 2009; Phone Interview with Julie Muir, July 26, 2012). This report makes limited references to dual-stream recycling, which was created as a hybrid of single-stream recycling and multiple-stream recycling. Dual-stream recycling has two bins, one for mixed paper and one for other recyclables, aimed at reducing the contamination created by single-stream recycling while maintaining its user convenience

1. Recycling at Duke

Duke's recycling program began in 1989 when a group of students began collecting 7 recyclable items at 4 pickup locations, armed with only one truck (Unknown 2013b). Today, waste management at Duke is a robust and collaborative effort between several departments that service nearly 1,600 recycling bins around campus (Unknown 2013b). The Duke community actively participates in recycling programs such as Recycle-Mania, Recycle for Children, and Move Out for Charity, earning the University several awards including the Carolina Recycling Association Outstanding Collegiate Program award and Durham's Innovative Ventures Encouraging the Reduction of Trash award (Unknown 2013b). Arwen Buchholz is the current Recycling and Waste Reduction Coordinator at Duke.

Sustainable Duke and WR&R have been actively tracking landfill diversion and recycling rates at Duke since 2010. The following data represents waste and recycling from the University, Duke's Hospital and Duke's School of Medicine (SOM). In 2010, Duke sent 9,580 tons of waste to a landfill and had a 34.4% recycling rate. In 2011, Duke sent 9,056 tons of waste to a landfill and had a 39.02% recycling rate. In 2012, Duke sent 9,369.2 tons of waste to a landfill, and the 2012 recycling rate has yet to be calculated (Capps and Buchholz 2012). Duke currently pays $42.50 a ton to landfill its garbage (tipping fee), which means in 2012, the University spent $398,191 landfilling discarded items.

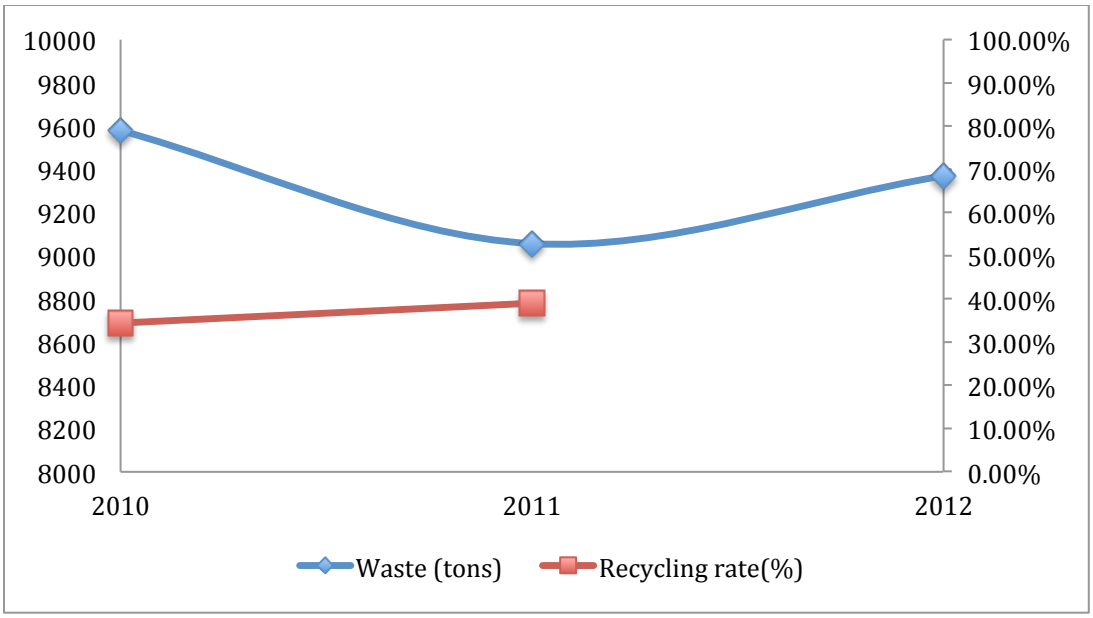

Figure 1: Waste to landfill and recycling rate at Duke University

Themelis et al (2011) discovered that in 2008, 85.5% (28.8 million tons) of plastics generated in the United States were landfilled, not recycled. "The chemical energy contained in this material was 807 million Btu, the energy equivalent of 36.7 million tons of coal, or 139 million barrels of oil, or 783 billion cubic feet of natural gas" (Themelis et al. 2011). Lastly, Themelis et al. (2011) suggest that if all of this non-recycled plastic (NRP) was "converted by pyrolysis to a fuel oil, they would produce an estimated 87 million barrels of oil per year (3.6 billion gallons), enough to power six million cars for one year". As this data suggests, society is landfilling valuable items, and that recycling our waste can translate into recovering financial, material, and energy investments.

2. Compost

As well reducing waste streams through reuse and increased recycling rates, universities are beginning to explore the impact of the biodegradable material in their waste streams. Forty percent of food purchased in the U.S. goes uneaten, more than 20 pounds of food per person per month, totaling roughly $165 billion of purchased and trashed food annually (Gunders 2012). "Americans send more food to landfills than any other material in the municipal solid waste stream - 33 million tons per year to be exact!... When excess food, leftover food and food scraps are put in a landfill they decompose and become a significant source of methane with 21 times the global warming potential of

carbon dioxide" (Wagner 2012). Further, landfills are estimated to be the second largest source of anthropogenic methane emissions in the U.S." (Levis and Barlaz 2011). Buried in landfills, organic waste isn't exposed to oxygen and "these materials degrade anaerobically to form methane and carbon dioxide" (Levis and Barlaz 2011), whereas oxygen exposed organic waste decomposes into humus and CO_2. (Michel 2010). In the United States, decomposing emits roughly 10 million metric tons of methane annually, and composting can remove 55% of this methane emission making composting a compelling and needed waste reduction strategy (P. 2004). Our masters' project will not address the upstream consumer end of the organic waste problem such as purchasing more food than one can consume, but this project will address the end of life of organic materials that are placed in trashcans to be landfilled. Specifically, we will focus on post-consumer compost; organic items such as apple cores, or meals/snacks purchased but not completely consumed.

A number of IHEs are having success with composting programs on campus. Purdue collects post-consumer compost in campus wide dining facilities as well as in university residence halls. The University sends its organic waste to the West Lafayette Wastewater Treatment Utility that uses Purdue's organic waste to fuel an anaerobic digester that creates energy for the wastewater plant. Through this program, Purdue diverts an average of 20 tons of food waste a month, and saves roughly $10,000 annually in landfill tipping fees (Purdue University 2010). Stanford offers post-consumer food composting in all of their dining facilities, and in 2007, they collected over 1,300 tons – all of which returns to the University as fertilizer for the Stanford Farm, and campus landscaping (Sustainable Stanford 2011). Allegheny College received a grant from the Pennsylvania Department of Environmental Protection to purchase a $247,000 composting unit. Allegheny offers post-consumer compost collection in all dining facilities, which diverts 800 to 1,000 pounds, daily, from the landfill. Allegheny has not recorded the savings in landfill tipping fees because their waste hauler charges by cubic yard, not weight, but the College estimates that the composter saves $20,000 annually in topsoil and mulch (Spencer 2008).

3. Multiple-Stream Recycling Versus Single-Stream Recycling

Multiple-stream recycling was once the standard recycling collection method. In 1987 only 4 single-stream programs existed in the United States (Morawski 2009), in 1995, only 5 single-stream systems existed (Jamelske and Kipperberg 2006); however since 2000, "hundreds of communities throughout North America" have transitioned from multiple-stream system to the trendy single-stream collection system because of the convenience single-stream offers (Morawski 2010). Single-stream recycling collection started in California as an opportunity to reduce costs and to increase state legislated landfill diversion targets (Morawski 2010). Obstacles of multiple-stream system include low participation rate and high collection and processing costs. Single-stream recycling systems are convenient and simple, have created higher participation rates, and therefore, theoretically divert more recyclable items from the landfill (Morawski 2010). However, successfully transitioning from a dual-stream system demands a robust educational component to properly instruct the consumers how to dispose of waste. Single-stream systems create potential savings in transportation costs, because trucks collecting multiple-stream recycling must end a collection mission when, for example, the truck's aluminum compartment fills up despite more room in the other streams' compartments. In single-stream recycling, the truck's mission ends only when the truck's full capacity is totally realized, saving the number of trips a truck must make. Additionally, the large cart and comingled loads from single-stream allows for an automated truck to collect the recycling, eliminating the need for laborers jumping off of the truck to empty each recycling stream bin into the appropriate compartment on the truck, thus saving the amount of human labor needed in collection. Further, single-stream has realized lower injury rates, resulting in significantly lower insurance and worker compensation costs (Container Recycling Institution 2009).

For the past 15 years, single-stream recycling has experienced steady growth ("2011 Report on Postconsumer PET Container Recycling Activity" 2011); forty U.S. cities, towns and counties adopted single-stream programs in 2008 alone. According to a series of surveys conducted by R.W. Beck, in 2005, 29% of the communities with recycling had access to single-stream recycling program, but in 2010, 64% of recycling communities had

access to single-stream programs. Figure 2 shows the growth (from 2005 to 2010) of percentage of population using single-stream recycling (Morawski 2011). The percentage of population using multi-stream recycling decreased from 70% to 34%, from 2005 to 2010. While that percentage of using single-stream recycling increased from 29% to 65% during the same period of time.

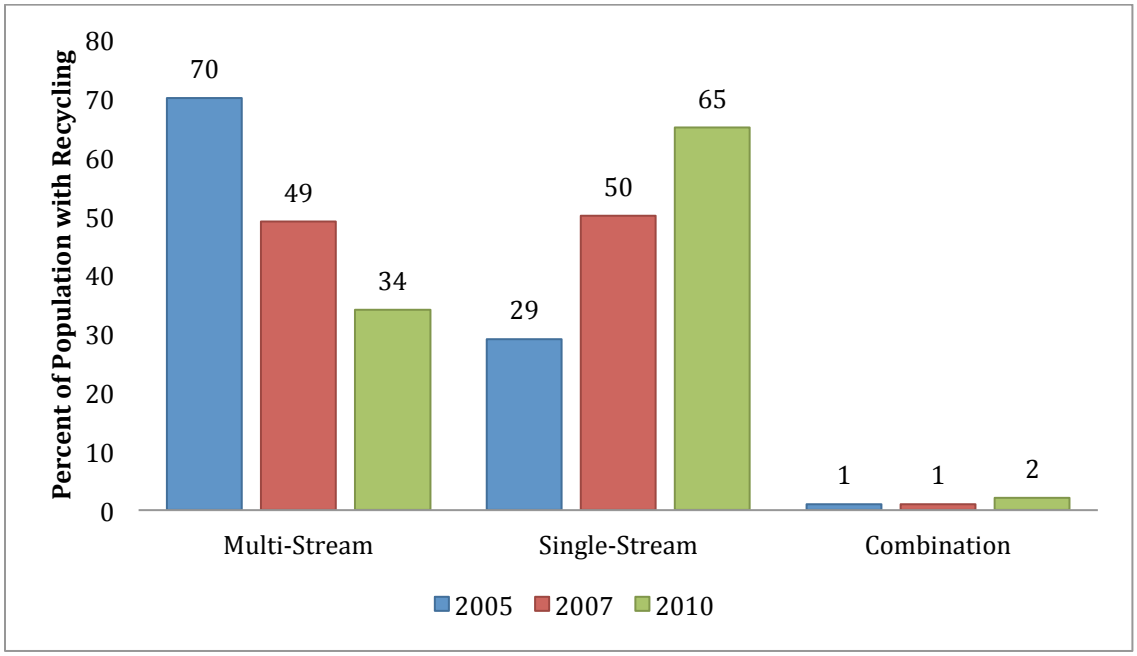

Figure 2: 2005, 2007 and 2010 Comparisons: Percentage of Population Using Multi-Stream Recycling vs. Single-Stream Recycling Source Morawski 2010 (* Combination means some combination of both single and multiple stream collection)

Accordingly, single-stream material recovery facilities (MRFs) have increased drastically as well. In the United States, the number of single-stream MRFs more than doubled from 2006-2011, with 160 single-stream MRFs operating in 2011 (Morawski 2011). Despite the fact of rapid growth, single-stream recycling is not universally accepted as the best way to recycle, and its true effectiveness is a subject of controversy and debate. Opponents argue that single-stream recycling produces higher contamination rates than multiple-stream collection, and therefore, higher processing costs too. Contaminated recyclables can sometimes be recycled, but generally they're down-cycled, or even landfilled. Contaminated recyclables also affect secondary processors forcing them to absorb the costs and effort of further processing the contaminated goods. Companies that

purchase MRF separated recyclables are questioning the claimed cost benefits of single-stream recycling, and questioning if single-stream can really divert more waste with less money.

a. Contamination in single-stream recycling

Single-stream recycling is often critiqued for increasing the contamination rate of recyclable materials collected (Collins 2012; Morawski 2010). If true, single-stream can increase the likelihood that recyclables will be down-cycled rather than recycled, or directed into landfills because of the lack of a market for low quality, contaminated recyclables (Wang 2006). Consequently, increases in recycling collection may not truly improve landfill diversion commensurately. Collins' study revealed that in single-stream systems, 73-78%, by weight, of recyclables are actually utilized into new products, while the remaining 27-22% are landfilled (2012). On average, these single-stream systems landfill 5%-10% more incoming recyclable materials than their multiple-stream counterparts (Morawski 2009). Collins' study further discovered that high contamination rates may also cause higher recovering cost. Table 2 shows average recycling rates for different recyclable commodities at MRFs, and secondary processing facilities (recycled-paper paper mills, aluminum recycling facilities, etc.); contamination rate depends largely on materials accepted, public education, incentive designs and demographics of each community (Collins 2012).

	Composition per 100 tons, as sorted at the MRF (%)	Percent loss at secondary processing facility	Remaining amount that is actually recycled (%)
Glass	17	21 – 40	10.2 – 13.43
Paper	55	15 – 18	45.1 – 46.75
Plastic	10	32.2	6.78
Steel	4	0	4
Aluminum	3	2 – 11	2.67 – 2.94
Other (recyclables)	4	Unknown	4
Residual	8	100	0
TOTAL	**101**	**22.1 to 27.255**	**72.75 – 77.90**

Table 2: Losses through single-stream recycling in states without container deposit programs. Source Collins 2012

Below is a description of contamination issues related to traditional recyclable items:

Paper: Paper, especially white office paper, is significantly impacted and degraded by single-stream recycling. Liquids adversely affect paper, and in single-stream systems paper is generally exposed to liquid from beverage containers that are not empty (Skumatz and Null 2004). The study further indicates that comingling of streams requires more chemicals, water, and bleach in creating recycled white office paper.

With regard to paper recycling, single-stream recycling may cost more per ton than multiple stream-collected materials. The American Forest & Paper Association (AFPA) and Skumatz Economic Research Associates Inc. (SERA) released a report in 2004 stating that although single-stream recycling collection can save $10-$20 a ton in collection costs, it creates an increase in MRF processing of $5-$15, and increases paper mill operation, maintenance, and repair costs by $5-$13 a ton. Their findings indicate that single-stream collected paper creates a system-wide net increase of $3 a ton. Table 3 describes the single-stream driven cost savings and increases with regard to paper mills. The report mentions an anonymous paper plant in Ohio has discontinued purchasing paper pulp from single-stream MRFs because of this contamination. Some major Canadian newspapers have given up on recycled paper and have switched back to virgin fiber because of low quality papers from single-stream recycling. One newspaper that used 100% single-stream paper reported a rapid increase in manufacturing contamination, from 3.5% in 2003 to 15% in 2010 (Morawski 2010).

The AFPA & SERA study also found contamination rates at single-stream MRFs as high as 18 percent, higher than those at multiple stream facilities. However, contamination also depends on the age and technological sophistication of these processing facilities. The study revealed that newer single-stream MRFs have lower contamination rates than older multiple stream facilities. It further indicated that if older multiple stream facilities were retrofitted, they would have better quality productions compared to new single-stream MRFs.

	Collection	Processing	Pulping/Papermaking	System Net
Cost savings with SS	$15 (10-20)			
Cost increases with SS		$10 (5-15)	$8 (5-13)	$3 (0-8)

Table 3: Average Cost Differences by Value Chain Segment -- US $/ton of ONP/RMP. Source Morawski 2010

Plastics: The material yield rate of plastics from single-stream MRFs is typically 68% to 70% while multiple-stream systems' rate is usually 75% to 78%. The NAPCOR/APR 2011 Report on Postconsumer PET Container Recycling Activity concluded that the quality of PET bales from curbside collection programs worsened due to rising single-stream recycling implementation (Morawski 2010). Figure 3 below shows the increase in yield losses from curbside material since 2006, and industry experts suggest 2011 level (35%) has reached crisis level.

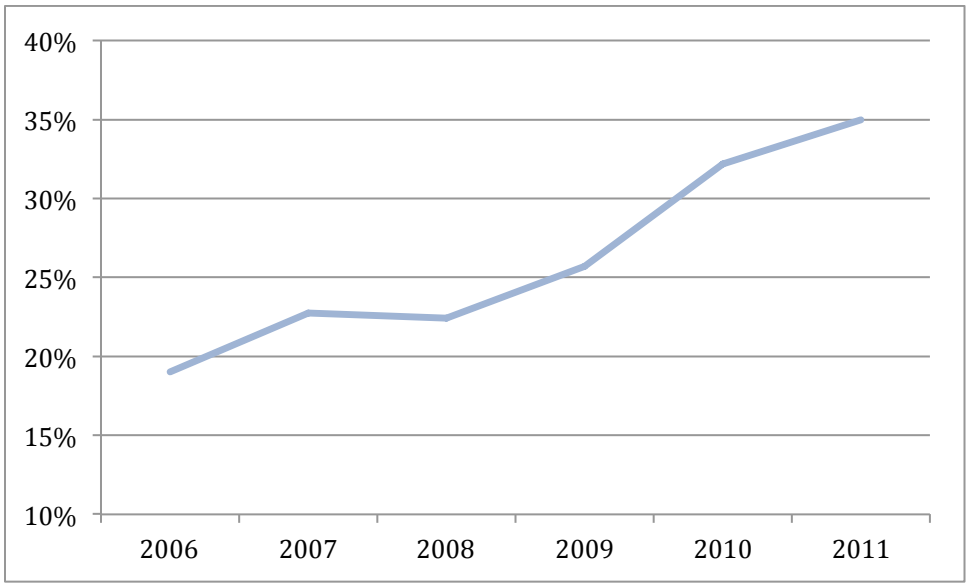

Figure 3: Yield losses at MRFs from curbside material. Source NAPCOR/APR 2011

Aluminum: Single-stream recycling creates between 2%-11% contamination in aluminum and this contamination in aluminum is reportedly increasing. Single-stream plastic is the primary contaminator of aluminum, which can have safety implications if not properly removed before recycling/reprocessing aluminum. Because of this, aluminum recyclers are installing post-MRF pretreating facilities to clean single-stream generated plastic from their aluminum.

Glass: Single-stream recycling systems have the greatest influence on glass, because glass is very vulnerable during various collection stages in single-stream collection system(Morawski 2010). Glass is tossed into containers with other recyclables, dumped into trucks, poured onto the conveyor belts of sorting facilities. These physical disturbances break the glass making it harder to recycle. Further, broken glass shards lodge into cardboard and paperboard, which creates complications if not impossibilities in recycling them as well. In a single-stream system, about 40% of the glass is recycled into containers and fiberglass, 20% becomes low-end applications (down-cycled) such as road base and landfill cover, and 40% is landfilled (Morawski 2010). Conversely, multiple-stream recycling enables 90% of the glass to be recycled into glass bottles, and container deposit programs boasts a container-recycling rate of 98% (Morawski 2010).

b. Overseas Shipping:

High contamination rates in materials from single-steam collection causes rejections at local secondary processing facilities, which leads to shipping recyclables to overseas markets such as China and India (Morawski 2011). Cheap labor in these countries means that the imported recyclables are sorted manually rather than automatically (Jaquiss 2008). Further, Morawski reported that the low quality recyclables exported by the US end up being landfilled in China and India (2011). The existence of these markets in developing countries has maintained a relatively high market value for low-quality scrap materials, thus keeping the market alive (Jaquiss 2008). While these developing countries create a market for low-quality co-mingled recyclables, the fact that some of the exported goods are simply landfilled abroad creates a problem when estimating true landfill diversion. Furthermore, shipping our recyclables overseas creates an additional carbon footprint to the process (Morawski 2011).

In a period of rapid economic growth, demand for recycled materials increases as well. However, since the economic downturn of 2009, higher labor costs plus stricter quality control import regulations in China have severely impacted the market for low-quality recyclables (Morawski 2009).

c. Empirical studies of single-stream

Many studies have been conducted on the effectiveness and efficiency of single-stream recycling versus to multi-stream recycling programs. A study by Jennifer Wang (2006) examined three cities: Fremont, Livermore and San Leandro in the San Francisco Bay area. Resulting regression models showed a statistically significant increase in the amount of recyclables collected in all three cities, in both total tonnage and per capita. The study also suggests that education about single-recycling is crucial in enhancing its efficacy (Wang 2006).

Daniel Lantz, the director of environmental and engineering services at Metro Waste Paper Recovery (Toronto), examined costs of seven large-scale recycling programs (3 single-stream and 4 multiple-stream) in Ontario in Canada. Table 4 shows that single-stream costs are even higher than multiple-stream programs, opposite to the predominant understanding of cost differences between the two systems.

	Average	Net cost (average)	
	Quantity (tons)	Low	High
Single stream costs	110,126	$141.84	$141.84
Multiple stream costs	47,709	$138.35	$138.35
Adjustment for capital		$4.00	$6.00
Adjustment for additional labor		($7.00)	($3.00)
Adjustment for premium fiber revenues		($7.00)	($6.00)
Adjustment for economies of scale		($8.50)	($5.00)
Adjustment for collection efficiencies		$0.00	$3.00
Adjustment for two-stream program costs		$119.85	$133.35
2007 single-stream to dual-stream difference		($21.99)	($8.49)
Dual-stream percentage less than single-stream		-15.5%	-6.0%

Table 4: Comparison of single-stream to multiple-stream costs, with adjustments. Source: Metro Waste Paper Recovery, 2008.

Our information thus far has robustly captured and illustrated the challenges facing single-stream recycling. However, the aforementioned challenges and problems portray an important, but narrowly focused shortcoming – primarily, they describe the degradation of materials and the resulting costs. Thus far, our analysis has neglected single-stream

recycling's impact on all of the stakeholders, and is therefore not complete. SERA Inc.'s analysis states that single-stream recycling benefits more of the stakeholders than not (Skumatz 2012). Table 5 describes the advantages and disadvantages of single-stream recycling with relationship to all of the stakeholders affected. Table 5 shows that despite the shortcomings of single-stream recycling (down-cycling, contamination, increased maintenance costs to paper-mills), it benefits more stakeholders than it adversely affects, which helps explain the continued growth of single-stream MRFs.

Stakeholder	Pros	Cons	Net
Households	*Easier, more space for recyclables *Cheaper		Pro
Commercial Businesses	*Easier, takes less dumpster and in-house space, more flexible system, easier training/implementation		Pro
Elected Officials	*Citizens happier *Recycling Increases		Pro
Cities	*Citizens happier *Programs cheaper *Recycling increases, and more participation *Lower GHG	*Concerns about markets/mills	Pro
Haulers	*Significantly higher tonnages per household stop *Increase in commercial recycling accounts from more flexible option. *Cheaper, more efficient collection *Higher productivity, automated collection improves jobs, satisfaction, and decreases insurance costs; can use large carts with less frequent collection *Customers satisfied *Higher net revenues and business growth	*Reduced revenues per ton	Pro
MRF Operators	*More material *Mechanized	*More residuals, higher tech/cost facilities	Pro
Brokers	*More material *No difference in price for SS vs. DS once it meets specs (many use photos)	*Questions from buyers	Neutral to Pro
Paper mills/users	*Benefits from more material to provide stream for mills with recycled input capacity	*Reported higher)&M costs; pre-cleaning sometimes needed	Con

Stakeholder	Pros	Cons	Net
		*Lowers yields in bales	
Other end users	*More material captured/available	*Some lower yields; now expected	Neutral/positive

Table 5: Summary of Pros and Cons of Single-Stream by Stakeholder Perspective. (This table is directly borrowed from SERA Inc. 2012 report, *The Latest Nationwide on Single-Stream… Pros, Cons, How is it Performing?)*

Procurement

Sustainable procurement, also known as environmentally preferable purchasing, is defined as a purchasing process that will not only benefit purchasers in terms of meeting their needs for goods, services and utilities, but also be beneficial to society and the economy, while lowering the impact on environment (The Marrakech Process 2008). It is specifically important for broader environmental issue because it is closely related to and can directly contribute to energy consumption reduction, waste reduction, and strategic sourcing (McCarty 2011). To adopt sustainable procurement, purchasers, organizations or individuals, should make their buying decisions based on three criteria: economic, social, and environmental, known as the "triple bottom line" criteria.

Sustainable purchasing can be beneficial in the following ways:

1) Reduction of greenhouse gas (GHG) emissions: Choose energy efficient products and services. These energy efficient products and services produce lower carbon footprints in their cradle-to-gate life-cycle (sourcing, production, and transportation) (Sustainable procurement resource center 2013).

2) Reduction of other negative environmental impacts beyond GHGs: Choose products that have lower affect on natural resources, such as air and water, quality, that use less natural resources, and that generate less waste.

3) Creating social benefits: address key issues such as working conditions, labor rights, trade equality.

Increasing awareness and need for sustainable products necessitates developing and adopting consumer information tools of sustainable products, which are transparent, verifiable, non-misleading and non-discriminatory (United Nations Global Marketplace

2002). After the Earth Summit held in Rio in 1992, eco-labeling was identified as a way to facilitate consumption of sustainable products that are energy or resource efficient (Horne 2009). Programs that provide sustainability criteria and identify sustainability products are crucial to sustainable purchasing because they can provide the general public the information about the sustainability of a product or a company. These programs include, but are not limited to, Energy Star, Electronic Product Environmental Assessment Tool (EPEAT) criteria, Green Seal Certification, EPA Design for the Environment program, and EcoLogo Certification. Energy Star is a program operated by the U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy to help customers identify energy efficient products (ENERGY STAR 2013). EPEAT criteria, Green Seal Certification and the EcoLogo Program (founded by the Government of Canada) include various types of environmental aspects that consider the full lifecycle of electronic products(EPEAT 2008; Green Seal 2012; Ecologo Program 2012). EPA Design for the Environment is primarily designed to identify sustainable cleaning products (Design for the Environment (DfE) 2013).

Currently, both public and private sectors, including governments, private businesses and universities, are developing strategies to improve their sustainability, through using some of the above programs or other sustainable criteria. Through sustainable procurement, they can use their purchasing power to contribute to a more sustainable patter of development and lower the impact on environment (United Nations Global Marketplace 2013).

Regarding the public sector, governments implement sustainable public purchasing strategies to improve their procurement activities by lowering environmental impacts and increasing social benefit (International Institute for Sustainable Development 2013). Government purchasing represents 20% of Gross Domestic Product and multi-year contracts in the U.S. ("Environmentally Preferable Purchasing - Buy Green, Save Green" 2011). Federal government alone spends more than $350 billion each year in purchasing goods and services ("Basic Information | Environmentally Preferable Purchasing | US EPA" 2013). Therefore, government purchasing has the power to push manufactures and vendors to provide more sustainable products and drive down the price ("Environmentally Preferable Purchasing - Buy Green, Save Green" 2011). For instance, price of 100%

recycled content paper has been driven down significantly due to government purchasing ("Environmentally Preferable Purchasing - Buy Green, Save Green" 2011). People's awareness of limited landfill space and need for recycling drove the movement to buy recycled content paper (Kobrin 2011). U.S. Congress passed the Resource Conservation and Recovery Act (RCRA) in 1976, under which agencies were required to purchase recycled content products whereas possible. Meanwhile, governments also began to encourage the general public to buy recycled products. President Clinton issued Executive Order 12873, which was the first comprehensive federal policy that encourages agencies to buy recycled content products and environmentally preferable products (Kobrin 2011). Since then, many local governments have implemented sustainable procurement policies to facilitate environmental preferable purchasing within local region (Kobrin 2011).

Regarding the private sector, Environmentally Preferable Purchasing Guidelines (EPPs) are fairly common in universities and businesses. EPPs are important because, if written and followed correctly, EPPs can lessen consumer created environmental degradation, create social justice through responsible supply chain management, as well as adding value through eliminating inefficiencies in the products' packaging, transportation, and end of life.

Environmentally preferable purchasing at Duke

In 2004, Duke's Procurement Department created a University EPP (**Error! Reference source not found.**), aimed at thoughtful purchasing, focusing on: source reduction, forest conservation, recycled content, energy & water, local sourcing, vendor diversity, and toxics & pollution.

Besides the EPP guideline, Duke has implemented several practices to encourage sustainable purchasing. Specifically for office supplies, Duke has a Staples Advantage website. Customers using this website have the ability to filter for environmentally preferred items by selecting an "eco-office" button, but this filter is not the default. Customers have to click the "eco-office" button to find environmentally friendly products such as recycled printer paper. Although Duke does not have a recycled paper mandate, a list of recycled paper is available on the Staples Advantages website to provide recycled paper information and encourage users to purchase.

Duke also encourages purchasers to buy Energy Star products when available (Duke University Computer Store 2013).Duke employees wishing to purchase computers must do so through Duke's Computer Store. Duke Computer Store has three tiers of computer performance options depending on the needs of the purchaser. "The Duke Computer Purchasing Program offers standardized computer models to get better pricing and extended warranties through our preferred vendors, Dell, Lenovo, and Apple. In addition to better pricing, we have selected the most energy efficient computer options to choose from as rated by EPEAT" (Duke University Computer Store 2013).

Sustainable Duke has established various green certifications, in which green purchasing checklist are available, including Green Classroom Certification, Green Workplace Certification, Green Lab Certification, Green Event Certification, and Green Dorm Room (Duke Sustainability). Green Classroom Certification encourages faculties to reduce their paper use, energy use and also other classroom supplies, by using other teaching strategies. These strategies include electronic submission of homework, providing reading materials online and turning off lights and other electronic appliances after use. Checklists are designed for Green Lab Certification, Green Workplace Certification, and Green Event Certification to provide recommended actions and standards to reduce the environment impact under each specific circumstance. These actions and standards cover various areas, including energy conservation, water conservation, green purchasing, recycling, food purchasing and transportation.

Procurement has created the Buy@ Duke website/portal, which is a web-based procurement tool aimed at centralizing purchasing at the University. It is a tool to integrate Duke's purchasing from different departments and individuals, thus granting Duke better bargaining power against suppliers. Additionally, it helps Duke better manage procurement financial information and also lower related costs. Currently, Buy@ Duke only contains catalogs from 25 scientific supply vendors (Green 2011). The website will expand the vendor list to include more merchandise categories in the future. Buy@ Duke began its pilot programs in February in the following departments: Immunology, Biology, and the Neonatology Division of the Department of Pediatrics (Green 2011). It will further expand while pilot departments provide feedback to help improve the website. Though Buy@ Duke

does not incorporate sustainability functions into the system right now, it is saving University's paper by transferring purchasing activities online.

Methods

We familiarized ourselves with the IHE sustainability landscape by reading the CAPs, SSPs, and Environmental Progress Reports of other IHEs beyond Duke. Further, both Shepherd and Liu joined the RECYC-L and Green School email list servs. These documents and email threads helped orient us with best management practices and showed us examples from which we could suggest that Duke borrow. Some of these documents/reports had been previously collected by Sustainable Duke's summer 2011 intern Kelly Marie Jones, and were shared with the team. During John Shepherd's 2012 summer internship with Sustainable Duke, he collected and researched CAPs, SSPs, and Progress Reports from various IHEs including some suggested by Capps, some from the Ivy Plus Sustainability Working Group member IHEs, and some discovered by typing "university sustainability strategic plan" into Google. As Shepherd read these documents he created two research journals (one for procurement and one for WR&R) describing "highlights" from these SSPs, CAPs, and Progress reports that were shared with team-member Liu. IHEs that were researched in this manner include:

Auburn	North Carolina State University	The University of Colorado, Colorado Springs
Baylor	Notre Dame	The University of North Carolina, Chapel Hill
Brown	Princeton	The University of North Carolina, Greensboro
Columbia	Purdue	The University of Oregon
Cornell	Rutgers	The University of Pennsylvania
Dartmouth	The University of California, Davis	The University of Wisconsin, Oshkosh
Davidson	The University of California, Santa Barbara	Yale
Harvard	The University of California, Santa Cruz	
Johns Hopkins	The University of Chicago	

Below, we will describe our methods specific to our WR&R activities and procurement/purchasing activities objectives

Waste Reduction & Recycling

1. **Interviews**

During the summer of 2012, John Shepherd had several telephone interviews with the people listed below.

a. Robert Gogan, Associate Manager of Recycling Services, Harvard University

b. Thomas Jones, Director of Recycling Services, Clemson University

c. Julie Muir, Community Relations Manager, PSSI/Stanford University

d. Larry Cook, Recycling Coordinator, University of South Carolina

e. Patrick McDonald, Plant Manager, Sonoco (Raleigh, NC)

f. Lisa Skumatz, President of Skumatz Economic Research Associates (Superior, CO)

g. Spring Buck, Coordinator of Recycling, Cornell University.

Each interview was unstructured, because each interviewee had a different specialty or case study from which to speak; all of the interviewees worked in waste reduction and/or recycling. They were asked questions to discover their opinions on multiple-stream recycling versus single-stream recycling. Those at universities were asked about successes lessons learned, and failures of transitioning to single-stream recycling. Patrick McDonald was asked about contamination at his MRF in Raleigh where Duke's recycling is sent.

2. **Survey of Peer Institutions**

During the summer of 2012, John Shepherd worked with Duke Recycling & Waste Reduction and Sustainable Duke in creating a 34 question Qualtrics based survey that was emailed to 49 universities to help inform Duke's waste & recycling goals. Specifically, the survey collected data regarding:

- Recycling rates and items included in recycling program
- Diversion rate and items included in diversion reporting
- Collection crews, methods, and reporting
- Are they multiple-stream recycling or single-stream recycling? Why? If they're multiple-stream, are they considering transitioning?

- If the university has a hospital, do they coordinate recycling and recycling reporting with the hospital? If so, how?

These data are summarized in Appendix 1.

Both authors of this paper analyzed data, and results are described in the results section of this report. Forty-six of the 49 universities responded to the survey – a response rate of 94 percent. Respondents were notified that their responses will be anonymous.

Though the survey was primarily interested in assessing the recycling collection and reporting of other universities, a single-stream component was added to the survey. In the single-stream component, the survey probed to see how much, if any, recycling rates increased in universities that transitioned to a single-stream system.

3. Waste Audits

Waste audits are a tool for institutions to better understand the components of the stream sent to landfill; how much of the 'trash' could have been recycled, composted, or even reused? Harvard University and the University of North Carolina performed waste audits (2012 and 2010, respectively) to better understand their waste stream. Harvard's audit revealed that 38% of their waste could be composted, and UNC discovered that 55% of their waste could be composted (Allen et al. 2010; A. Powell 2012b).

The authors of this paper worked with Duke's Campus Sustainability Fellows to conduct waste audits to better understand the composition of the discarded items Duke sends to the landfill; specifically, the percentage of material that could have been either recycled or composted.

> "The Campus Sustainability Fellows (CSF) program supports upper-class undergraduate and second year masters or graduate student internships to provide assistance to individual Duke schools with sustainability initiatives and assessment. Fellows will work with Sustainable Duke to identify, collaborate with and provide resources to staff and students who are interested and engaged in sustainability and workplace greening. Specific tasks could include conducting departmental level GHG inventories, connecting with existing green teams (if applicable), assisting departments with completion of the Green Workplace Certification, conducting waste audits, evaluating water usage, as well as other sustainability initiatives. Projects will be centered on a theme for each year, such as waste reduction, that is connected to the priorities of the Campus Sustainability Committee (CSC) for that particular year. Fellows report school assessments and progress to the CSC to better connect their efforts with campus sustainability priorities.

> "FY13 – Pilot program will include three Fellows with a fourth Fellow from the Nicholas School Assistantship program that will assist the Sustainability Director with coordination of the program. Fellows work an average of 10 hours per week at $10/hr. FY13 theme – Waste Reduction – will address topics such as recycling, reuse, composting, source reduction, supply chain management, etc. all related to decreasing the impact of the campus waste streams" (Capps 2012).

Because of the assistance from the Campus Sustainability Fellows, "we" in the waste audit section of this paper refers to the waste audit team, including Duke's Campus Sustainability Fellows and both authors of this paper.

Our waste audit team collected tailgating trash from the October 20th, 2012 UNC at Duke football game, and once at four buildings on Duke's West campus: Fuqua School of Business, Sanford School of Public Policy, French Family Science Center (FFSC), and School of Nursing. Further, Esi Waters and Britta Victor (Nicholas School students) audited the November 28th, 2012 Ohio State at Duke Basketball game, and gave us the authority to cite their data and use in our analysis. To get a better understanding of consumer habits in the buildings, as well as to make our audit more robust, we created 4 distinct zones from which we audited the waste: dining, classroom/study areas, common areas/lounges, offices. We did not have zones for the athletic events. All of the areas on which we performed waste audits had recycling bins close to the trashcans. Housekeeping was asked to collect at least 8 full bags of garbage from each zone in the aforementioned buildings, keeping the bags separated by zone and building. These trash-bags were taken to an FMD sanitation and recycling warehouse to be inspected and analyzed.

We designated 6 bins to reflect Duke's and Sonoco's 6 current recycling streams/capabilities, and also added a bin/stream for compost and "other plastics i.e. lab plastic, film plastic, and Styrofoam despite the fact that Sonoco cannot process Styrofoam. We also included a bin for traditional trash. Our 9 categories of 'trash' were:

1. Aluminum, Steel, Tin
2. Glass
3. Plastics
4. Other Plastics (Styrofoam and plastic film)
5. White Office Paper
6. Mixed Paper
7. Cardboard
8. Compostable
9. Trash

Our waste audit team placed each bag on a table, and sorted its contents, placing items into the appropriate bins. After our waste audit team had emptied and sorted all of the contents of a bag, our waste audit team then weighed the contents of each stream to determine the mass of each stream, revealing a mass percentage total for each stream relative to the bag of trash from which it came.

Our waste audit team then totaled the mass of each stream for each zone and building, to calculate the total waste stream percentages for each building, the basketball game and the football game. This gave our waste audit team quantifiable illustration of the waste streams of these 4 buildings and the football and basketball games.

We performed waste audits on only 4 of Duke's 175 West Campus buildings. The University of North Carolina (Chapel Hill) and Harvard waste audits that inspired our waste audit did not examine residence halls. Further, the authors of this paper, the CSF, Capps, and Buchholz determined that our audits should focus on buildings used by the entire Duke community (students, faculty, and staff) whereas dorms exclude 2 out of the 3 stakeholders, and don't represent the Duke Community as well as other buildings. We realize that not having residence halls data limits our ability to fully understand Duke's entire waste stream and recycling vs. trash habits. However, we calculated our waste audit data as a rough estimation of the composition of Duke's overall waste-stream and we feel justified in assuming this because, borrowing from the 2010 UNC waste audit, our selected buildings provide an accurate description of consumer recycling habits because the buildings all have offices, classrooms, dining facilities, and conference rooms (Ciliberti, Pontrandolfo, and Scozzi 2008; Lyons 2000). As will be revealed in the Results section of this paper, all four buildings had similar numbers in terms of stream composition percentage, leading us to assume that they're consistent with current University consumer trash disposal habits. Lastly, because our audits included special events and athletics, as well as 'every day' offices, labs, classrooms, and common areas, Buchholz agreed that our sampling was broad enough to be roughly representative of the entire trash stream on campus.

For analysis, we separated our data into 3 categories. The first was athletic events. The second and third were both related to academic buildings 1) a normal day in the

building and 2) a special event in the building because our waste audits serendipitously coincided with three special events (an election night party at the Sanford School of Public Policy, a Holiday party at the SON, and networking party at Fuqua). Normal day trash, the aforementioned special event trash, and athletic event trash data were analyzed independently to give our waste audit team a more refined breakdown of waste streams generated by all three categories of waste production. As well as analyzing these three categories separately, we combined all of the data to give an overall understanding of the waste we audited. We used this overall waste composition, more specifically the percentages it created (percentage of glass in the trash, percentage of plastic in the trash, percentage of compostable items in the trash, etc.) as our estimated projection for Duke's overall to-landfill composition

4. Data Analysis of Transferring to Single-Stream and Post-Consumer Compost Collection

Inspired by the waste audit results, we built models assessing the worth of transferring to single-stream recycling, from both environmental and economic perspective, through interviews with Duke staff and analysis of data they provided,.

Working with Arwen Buchholz (Duke's Recycling & Waste Reduction Coordinator) and Tavey Capps (Director, Sustainable Duke), we obtained data regarding how much 'trash' Duke sent to the landfill in fiscal year 2012, and landfill tipping fees associated with that. Capps gave us Duke's version of Clean Air Cool Planet's CO_2e calculator to determine the CO_2e that Duke might be able to save by switching to single-stream recycling. We also obtained detailed information of Duke's recycling crew's recycling collection and routine. Because Duke's recycling crew is only 5 people, they are limited in how frequently they can collect recycling. Lastly, Buchholz provided data regarding Duke's current recycling commodity revenue and current commodity pricing, as well as the pricing Duke would receive if it transitioned to a single-stream recycling collection system.

Taking all of the above data, we constructed 2 different models. The first model uses the aggregated percentage of recyclable and compostable materials found in our waste audits. We apply those percentages to Duke's annual tonnage to landfill to discover,

roughly, the total tons of potentially recyclable and compostable materials that could be recovered from Duke's 'to landfill' waste stream. Then, based on our research from how much universities have increased their recycling rates by transitioning to single-stream, we forecast a low, medium, and high potential increase in recycling rate Duke could potentially realize if it transitioned to single-stream. Each variation (low, medium, and high) analyzes Duke's potential: landfill CO_2e savings; the resulting tipping fee savings; as well as comparing the decline in recyclable commodity pricing because of switching to single-stream versus the (projected) increase in recycling rate, and therefore change in recycling commodity revenue.

Our second model is based on the findings by SERA Inc. (Skumatz 2012) and Jamelske and Kipperberg (2006) (described in the next section), which state that transitioning to single-stream recycling can create efficiencies in collection of recycling. This model analyzes the potential efficiency increase Duke's recycling crew could experience if Duke transitioned to a single-stream system; and therefore it projects a low, conservative, and high estimate about how increased efficiency could lead to servicing more buildings.

(Further details of the models and parameters we used for the analysis are included in the results section below.)

Procurement

1. **Review Environmental Preferable Purchasing policies**

In order to understand policies and practices, we examined EPP policies or guidelines of other universities. Researched universities are listed in Table 6 below:

Yale University	Johns Hopkins	University of California, Los Angeles
Harvard University	Emory University	University of California, Berkeley
Stanford University	Dartmouth University	Michigan State University
Purdue University	Berea College	University of Notre Dame
Brown University	Arizona State University	University of South Carolina
Cornell University	Macalester College	University of Pennsylvania
Clemson University	University of Michigan	Western Washington University
Princeton University	Northwestern University	University of Washington, Seattle
American University	George Mason University	State University of New York at Cortland
Georgetown University	Western Kentucky University	State University of New York at Brockport

Table 6: IHE's from which we researched and analyzed EPPs.

Analyzing the EPPs of the aforementioned universities, and also Duke's 2004 EPP, gave us insight into management practices that we hope to make recommendations to Duke's existing purchasing policies.

We selected listed universities above based on two criteria: 1) being comparable to Duke in size 2) substantial sustainable purchasing polices or guidelines on sustainability/purchasing websites as determined by a Google search of green purchasing and green supply chain management. 3) We selected the 10 schools that have the highest score for purchasing policies in the STARS program.

We analyzed and summarized the most commonly used sustainable purchasing policies and practices in these universities. By doing so, we gained knowledge of what practices are mostly valued by higher educations. We examined specific examples of how these practices are adopted in each school. Secondly, we searched for novel and constructive green purchasing approaches to reference Duke.

2. Interviews

We conducted three interviews of experts in the area of procurement within and without Duke. First, we interviewed Mary Crawford, Director of Duke's Procurement Programs. Because of Duke's aforementioned decentralized purchasing, Crawford suggested that we interview Joseph Honeycutt, Manager of Duke's Fleet Maintenance, to

find out his department's current guidelines. We interviewed Joseph on what Duke's transportation department had already done on sustainable supply choices and what they seek opportunities to do in the future. During the interview, he also guided us through Transportation Department repair facility. We also interviewed Tammy Hope, Quality Assurance Manager of Duke's Dining Services, to obtain information of Duke's dining services and compost programs.

Outside of Duke, John Shepherd conducted a phone interview with Joseph Mastracchio, co-author of Yale's University Buying Guide, on June 15, 2012. Shepherd interviewed Mastracchio because Mastracchio coauthored Yale's Buying Guide, but more importantly, because Mastracchio was the lead researcher in a Yale report examining the impact of the University's environmentally driven purchasing practices.

Results

WR&R

1. Multiple-Stream Universities

Our findings indicate that universities that have not transitioned and are not researching transitioning to single-stream recycling, keep multiple-stream recycling to maintain the revenues created by their recycling commodities. Multiple-stream recycling allows IHE's to maintain the revenue streams created by recycling commodities. Brown initiated a single-stream pilot program on campus, and found that recyclable items in trashcans decreased from 3.26% to 1.61% after single-stream implementation. They estimated that single stream recycling could increase their campus-wide recycling rate by 20% to 40% and could decrease their collection cost (Brown Single Stream Report 2012). However, Brown determined that the cost and effort of educational outreach needed for creating an effective single-stream system, wasn't worth abandoning their $50,000 (annual gross average) generated by their recycling commodity revenue (Baum et al. 2012)

In 2009, the University of Colorado, Boulder, (CU) initiated a single-stream pilot program because Boulder County invested $6 million in upgrading their MRF to be a single-stream MRF. While the transition was successful for Boulder in general, transitioning cost CU over $10,000 in lost revenue because transitioning meant abandoning their recycling

commodity revenues, especially paper-fiber (DeBell 2012). Beyond lost revenue, the University's recycling witnessed extreme contamination, as Jack DeBell (Director of CU Recycling) stated, "People think that EVERYTHING can go in [the single-stream] bins" (DeBell 2012). DeBell's experience with the pilot program was that the University didn't save any money in collection costs, and for the most part, any increase in recycling volume was created simply by the increase of trash in the bins (DeBell 2012). The University abandoned their single-stream pilot program, and is again a multiple-stream campus.

Clemson University and Stanford University are unique examples of multiple stream universities capitalizing on the value in their waste streams because each university has a MRF on campus. Because they don't sell their recyclables to a third party vendor, they're able to create middle-man-free revenue. In 2011, Clemson made $80,000 (gross) from their recyclables, enough to pay for the salaries of their recycling crew, recycling fleet maintenance and fuel, with some leftover (Interview with Thomas Jones, Clemson Recycling, June 12, 2102). Clemson does collect single-stream recycling at athletic events because it is easier for the event participants. In 2011Stanford grossed $671,000 (Baum et al. 2012). These two universities are unique in having their own MRF, but are good examples of the financial benefits of robust recycling programs.

Julie Muir from Stanford suggested that these financial implications make transitioning to single-stream recycling an unattractive proposition (Interview with Julie Muir, July 2, 2012). By sorting their own materials, Stanford gains control over to whom they sell their commodities. At this point, transitioning to single-stream recycling means forgoing the $671,000 (FY 2011) revenue their MRF generates. Stanford has a robust recycling program in place and isn't considering abandoning its current system.

2. Single-Stream Universities

Rob Gogan, Harvard's Supervisor of Recycling stated that a "strong demand for composting was a compelling reason to switch to a single-stream system. It enabled us to remove some of the recycling barrels to make space for compost receptacles without overcrowding the loading docks and recycling rooms" (Phone interview with Robert Gogan, June 28, 2012). Further, Cambridge, MA, was transitioning to single-stream recycling and Gogan asserts that the University and its community should share recycling

habits so as not to force citizens to learn two different recycling habits; one for on campus and one for life off campus (Phone interview with Robert Gogan, June 28, 2012). Harvard began single-stream recycling at its Law School in 2008 (Harvard University Office For Sustainability 2013). Single-stream recycling has raised Harvard's recycling rate from 42% to 55% in two years. Their recovery rate increased by 10% at the same time because of composting (Phone interview with Robert Gogan, June 28, 2012). Transitioning to single-stream meant forgoing Harvard's historical recycling commodity revenue. However, the loss was offset by Harvard's drastically reduced tipping fees through single-stream and post-consumer compost driven landfill diversion (Baum et al. 2012).

Single-stream recycling isn't a silver bullet. Harvard conducted a post-transition waste audit in 2012, that revealed that 41% of the trash that have been recycled, 38% of materials were compostable, and 4% could have been reused. Only 18% of the trash should have gone to the landfill (A. Powell 2012a).

Harvard has created an educational component for their transition. They have hired undergraduate students to hunt for obsolete recycling signs on campus. These undergraduates also "spread word about" single-stream recycling to their peers. The fact that Harvard's post-transition waste audits still show significant recyclable and compostable items in campus trashcans suggests that a more robust education program is needed (Phone interview with Robert Gogan, June 28, 2012).

Harvard, Yale, Cornell, and Ithaca College all transitioned to single-stream recycling because the community in which the institution is located was transitioning to a single-stream MRF (Chapman 2011; Baum et al. 2012). Yale, Cornell, and Ithaca transitioned in 2011, and Cornell is the only institution that has been able to quantify the impacts of transitioning: Spring Buck, (Communications and Outreach Coordinator, Cornell) sent John Shepherd an email on March 20, 2013 stating that they just quantified the results, and single-stream recycling increased their diversion rate from 62%-66% (a 6% increase in diversion rate). As Buck mentions, single-stream recycling was the only change to their program that year, so it stands to reason that single-stream recycling is responsible for the diversion rate increase.

3. Survey of Peer Institutions

The complete results to this survey can be found in Appendix 1. Below are the most salient findings from the survey.

Of the 46 schools that responded, the lowest recycling rate was 10%, the average recycling rate was 39%, and the highest recycling rate was 71%. Duke's FY 2011 recycling rate was 39%, which puts Duke on par with the surveyed schools.

In regards to multiple-stream recycling versus single-stream recycling, below are excerpts from our survey findings document:

Is your institution's primary recycling collection single-stream, multiple-stream, or a combination of the two?

	Out of 46	Percentage
Single	13	28%
Multiple	18	39%
Combination	15	32%

The 18 schools that answered "Multiple" were asked, **Is your institution considering transitioning to single-stream?**

	Out of 18	Percentage
Yes, we're seriously considering transitioning.	4	22%
We're researching it, but not committed to transitioning	7	38%
No, we're happy with our current system.	7	38%

Comment from one university: *"We're actually somewhere between "no, happy with current" and "researching but not switching yet." Happy & confident in dual-stream recycling collection. Keeping an eye on developments, pros and cons of the single-stream method more on an assessment basis."*

The 15 schools that answered "Combination" were asked, **Is your institution considering transitioning to a single-stream only system?**

	Out of 15	Percentage
Yes, we're considering transitioning to single-stream only	2	13%
We're researching it, but not committed to transitioning entirely to single-stream	3	20%
No, we're happy using both systems	10	66%

In the second question, please note that Stanford and Clemson represent 2 of 7 schools content with multiple-stream recycling. As mentioned earlier, they're unique in

that they have on campus MRFs generating significant revenue for the schools (Clemson = $80,000 in FY2011, and Stanford = $671,000 in FY2011), which means that 5 of the 18 multiple-stream collection schools are content with multiple-stream recycling despite not having an on campus MRF.

With regards to benefits and challenges of transitioning to single-stream recycling, increased recycling rate was the most common benefit, and educating the consumers that all recycling can now be placed in one bin was the most common challenge. Please refer to Appendix 1 to see the comments from our participants.

4. Our Findings of Duke's Current/Baseline Recycling Operations

Arwen Buchholz is the Director of Duke's Recycling & Waste Reduction Department. She oversees Duke's 5-person recycling crew that services 255 buildings (8,588,378 gross square feet (GSF)), collecting 1,350 recycling bins a week. The waste management and recycling at the Fuqua School of Business is serviced by an outside contractor, as is recycling at the Duke Hospital and Medical Center. Some recycling bins on campus need more than weekly collection, but because the recycling crew has only 5 employees, they are unable to service overflowing bins as needed.

Duke's campus needs uniform recycling bin signage. Buchholz believes that Duke as at least 10 different types of recycling bin signage describing what can be recycled and what cannot. A troubling example of this can be found at the 3rd floor recycling bins at Bostock Library. If one were to, for example, want to recycle a recyclable plastic clamshell, the signage at said location indicates that this recyclable plastic clamshell cannot be recycled in these bins – the bin for plastics, aluminum, and glass bin says for beverage containers only, yet no bin for other plastic exists despite Sonoco's ability to recycle these clamshells. Each building is responsible for paying for the labels on their built-in recycling collection bins. Updating the bins to accurately reflect the recycling that Duke can collect is costly to the building, thus, leaving outdated recycling labels on recycling bins as a prevalent cost savings initiative (Phone conversation with Buchholz, March 19, 2013). Inconsistent signage (instructions) creates confusion in recycling participation, and demands that recyclers read each bin's sign rather than understand a campus-wide protocol for recycling. Duke's multiple-stream recycling bin signage does not accurately

capture the entirety of items that Sonoco can recycle. Further, it deters participants from recycling items that can be recycled.

The University continues multiple-stream collection, because Duke receives a higher commodity price from Sonoco for office paper and cardboard, which are more valuable when not co-mingled (Conversation with Arwen Buchholz, March 20, 2013).

Duke's WR&R program is not responsible for the University's compost collection nor disposal. Duke Dining Services has contracted Brooks Contractor (Brooks) to facilitate the compost program of the entire University, including setting up bins, collecting compost, and compost fee for all of the 31 on-campus eateries (Interview with Tammy Hope, 3/27/2013) Hope further explained that some of the eateries collect both pre-consumer and post-consumer compost, while others collect only pre-consumer compost. Brooks can compost everything from meat, coffee grounds to napkins, except for glass, aluminum and plastic (Interview with Tammy Hope, 3/27/2013). Hope indicated that Brooks possess the capability to compost a large range of waste, compared to other compost contractors, and because of this, Brooks does not experience problems from compost contamination that other composting contractors struggle with. The University offers post-consumer compost collection at The Loop, The Marketplace, The Great Hall, The Refectory at the Divinity School, Pitchfork Provisions, and at the Faculty Commons (Interview with Tammy Hope, 3/27/2013)

5. Waste Audits

We audited 4 buildings, 3 special events, a football game, and a basketball game.

Currently, data reflecting the tons of trash each building produces annually are not being tracked individually. We only have the tonnage that the entire University, including Duke Hospital and SOM, sends to the landfill annually. Because of this, we cannot say, for example, because the French Science Building sends X tons to landfill annually, the waste audit results should count for X% of Duke's waste stream. We therefore assumed that the average waste streams of these buildings accurately represents Duke's waste stream. Buchholz agreed that she was comfortable in assuming the aggregate averages for our audits as reflective of the makeup of Duke's entire waste stream. Therefore, we averaged

the percentages of recyclables and compostable from our 7 audits to produce an estimated breakdown of Duke's entire waste stream, and our analysis below reflects that assumption.

Applying the aggregate averages from our trash audit, and applying them to Duke's FY12 landfill tonnage, Table 7 shows that, on the most macro scale, 70.21% of the items thrown in trashcans could have been recycled or composted, meaning that only 27.79% of the items were really trash.

	Percentage	Weight (Tons)
Recyclables	47%	4,383
Compost	23%	2,195
COMBINED NON-TRASH (Recyclables + Compostable Items)	**70%**	**6,578**
Real Trash	30%	2,791
Total	100%	9,369

Table 7: Macro level breakdown of Duke's landfill stream using aggregate average percentages from 7 waste audits, applied to Duke's FY12 landfill data.

As mentioned in our Methods section, we have 3 different categories of waste audits. Our first includes a routine day at Duke. For this first category, routine day at Duke, we audited the French Family Science Center (FFSC), The Fuqua School of Business, and Duke's School of Nursing (SON). Figure 4 shows a detailed breakdown of the different streams sent to landfill for a routine day at Duke for these three buildings. Figure 5 shows the routine day waste audit data combined with audit data from 3 special events; Sanford's Election Night Party, Fuqua's social event night, and the SON's Holiday party. Figure 6 shows the waste audit data from two athletic events: UNC at Duke football game, October 20, 2012; Ohio State at Duke men's basketball game, November 28, 2012. Figure 7 shows the overall waste audit data, including typical days, special events, and athletic events.

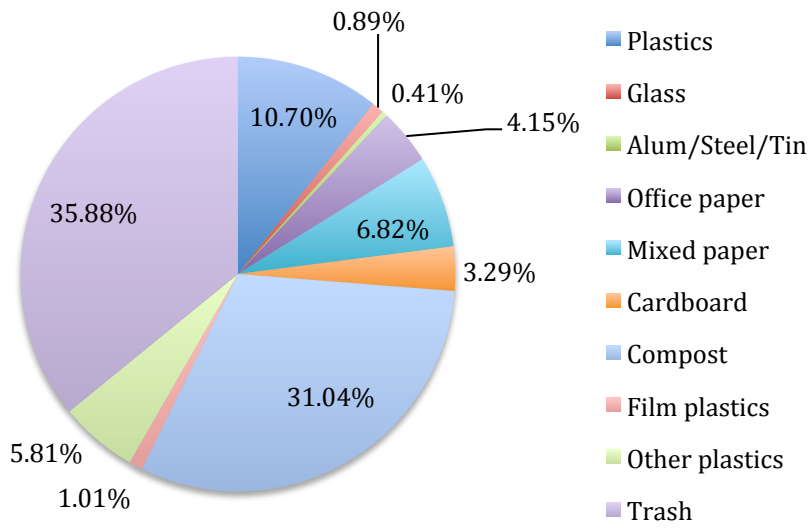

Figure 4: Percentages of different waste streams of a routine day from FFSC, Fuqua, and SON,

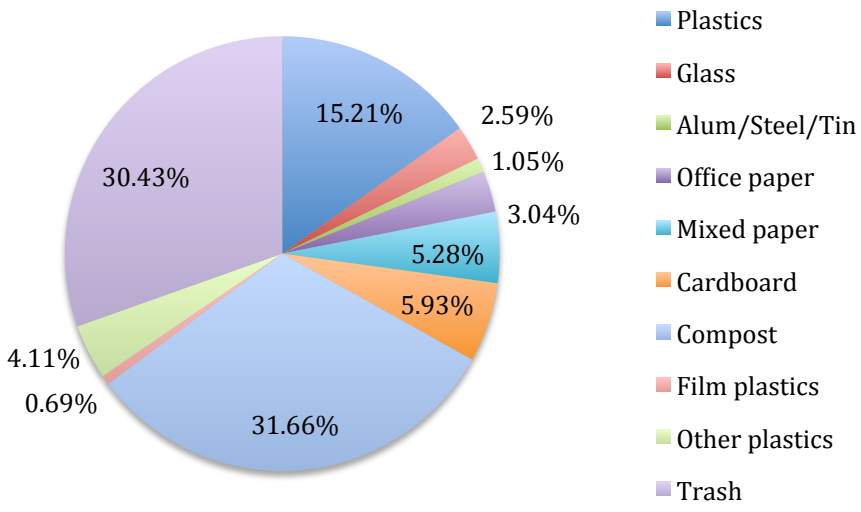

Figure 5: Percentages of different waste streams of routine day audit combined with special events audits from Sanford Election Night, a networking event at Fuqua, and SON Christmas Party

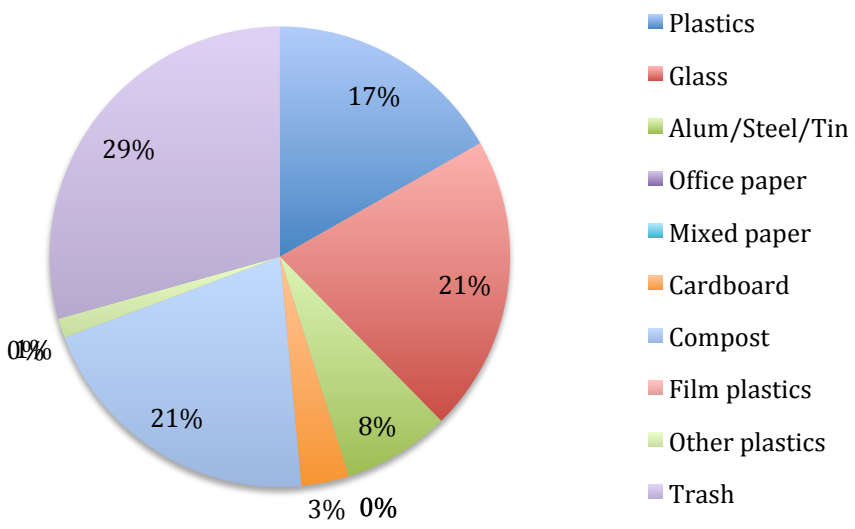

Figure 6: Combined waste audits from 2 athletic events: UNC at Duke Football game, October 28, 2012; and Ohio State at Duke Men's Basketball Game, November 28, 2012.

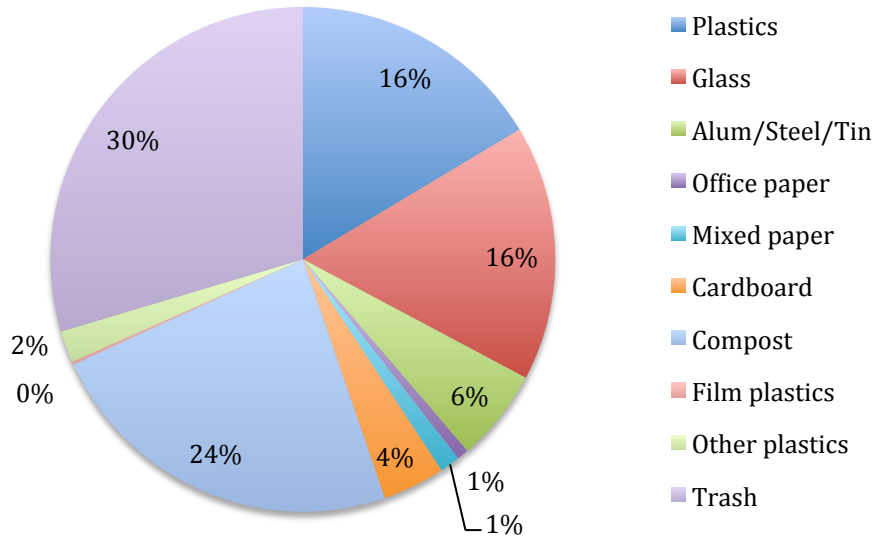

Figure 7: Combination of ALL 7 waste audits.

Figure 4, Figure 5, Figure 6 and Figure 7 illustrate the percentage breakdown of real trash and the categories of waste that could have been diverted from the landfill (plastics; glass; aluminum, steel, & tin; office paper; mixed paper; cardboard; compost; film plastics; other plastics; and trash). Comparing the data between typical days and special events, we

found that special events raised the percentage of plastics in the waste stream, therefore, lowering the overall percentage of trash. No significant changes in percentage were found in other streams.

From the Figure 4 and Figure 5 above, we see that the top three components in the streams in the trash are compost (31.66%), office paper (30.43%), and plastics (15.21%). All three of these streams have more suitable disposal options than landfills. As mentioned earlier, landfills emit 10 million metric tons of methane annually (P. 2004), which translates into roughly 132 million tons CO_2e (US Composting Council 2008). Because composting can remove 55% of this methane emission (P. 2004), this data suggests a need to create a public post-consumer composting program at Duke. Paper is a valuable commodity stream for Duke, office paper in the waste stream means forgoing the higher recycling revenue from non-contaminated white-office paper.

Comparing Figure 5 and Figure 6, we see that recyclables composition from athletic events is very different from the waste stream from academic buildings. It has a higher recyclable percentage among the trash can waste stream resulting from more plastics, glass and metals. On the other hand, athletic events waste stream contains less paper and compost. This content composition should accord with reality intuitively, because waste from athletic events is mostly beverage and food containers that audiences consume during games. Overall, athletic events waste stream has a lower percentage of trash.

As mentioned earlier, the intent of our waste audits were to understand Duke's waste stream as created by the entire Duke community, not just the students, which is compelling given that there are 14,591 students and 34,863 employees (Duke University Office of News & Communications 2013). Because the employee to student ratio is more than 2:1, it is important to understand the trash generated by these employees. Not every employee has an office nor a desk, but office trash can illustrate trash primarily generated by non-students. Table 8 shows that only 29% of office trash was actually trash, 40% of the office trash could have been recycled, and 32% could have been composted.

Offices Only		
	Pounds	**Percent**
Recycling	37	39%
Compost	29	31%
Trash	27	28%
Total	93	100%

Table 8: Waste audit data from offices only.

Figure 7 details the aggregate breakdown of all 7 audits. We found that the athletic event audits changed the percentage of recyclables dramatically from the result of four buildings. This can be explained by the fact that the total weight of audits of two sport events (1152.55 lbs.) is about three times of the total weight of trash from four teaching buildings (374.65 lbs.). Duke frequently hosts home games for varsity athletics (men's and women's soccer, men's and women's tennis, men's and women's basketball, men's and women's lacrosse, football, field hockey, etc.), these events contribute significantly to Duke's waste stream, and Buchholz considers our athletic data as acceptable and accurately representative of the athletic contribution to Duke's waste stream. Moreover, with regard to the three special events in the audit of four buildings (except for the Fuqua event that we intended to include in our audit), the other two special events happened coincidently on the date we decided to take our sample of waste audit. For this reason, we think these three special events can represent the natural chance that a special event would happen in a building. In conclusion, taking the average of all waste audit numbers may provide a rough estimate of the trash constitution at Duke.

Our waste audits revealed that 16.41% of trash to landfill was recyclable plastic, but consider how light plastic is, and that our percentage is by mass, we decided to create a visual proxy to better illustrate how to visualize the plastic landfilled at Duke. We realize that the plastics stream was more than just plastic water bottles, but to understand what 16% of 1,527 pounds of trash looks like in terms of plastics, we created the Plastic Water Bottle Equivalent (PWBE). The International Bottled Water Association claims that the average plastic water bottle weighs 12.7 grams (Lauria 2010a). 16% of 1,527 pounds of trash is the equivalent of 8,948.6 plastic water bottles. Applying PWBE to Duke's annual trash to landfill (9,369 tons), the plastic component (assumed by our waste audits) can be represented by 113 million plastic water bottles (to the landfill annually). Again, using the

PWBE does not state that Duke sent 113 million plastic water bottles to the landfill, it merely gives a visual representation of how much plastic was sent to the landfill in a unit with which most people are familiar.

Again, this is not to say that all of Duke's plastic landfill stream is plastic water bottles. Our waste audit team did not record the number of plastic water bottles in trashcans, but we should have. Anecdotally, plastic water bottles were the most prevalent plastic item in the audits from athletic events. Given that only 31% of plastic water bottles are recycled annually (Lauria 2010b), the following finding is applicable to WR&R as it is to Procurement, but will be discussed in WR&R. Universities such as The University of Vermont, Bishop University, University of Winnipeg, Brandon University, Queen's University, University of Ottawa, Memorial University of Newfoundland, Trent University, Fleming College, Washington University (Missouri), University of Portland, Gonzaga University, Belmont University, Brandeis University, Seattle University, and DePauw University have enacted plastic water bottle bans on campus, and Northwestern is pushing for the same bottled water ban (Mullikin 2009; Carapezza 2013; AASHE 2012).

Overall, our audits discovered that only 30% of what Duke sends to the landfill is actually trash, and a shortcoming of our audits was failing to record the items we defined as real trash. Though we didn't catalogue trash-items, some examples include (but not limited to): candy wrappers; a yarn hat from the football game, wax paper, single-serve coffee creamer packaging, single-serve Flavia™ brand coffee pouches, single serve Swiss Miss™ hot chocolate powder metallic-paper envelopes, and beer bottle-tops.

We will use these waste audit data, and a projected breakdown of Duke's trash constitution as the foundation for our model in order to predict how transitioning to single-stream recycling might alter the amount of recyclable and compostable items in Duke's current (projected) landfill stream. Additionally, we will also predict the potential financial and environmental benefits associated with the transition.

6. Data Analysis of Transitioning to Single-Stream and Composting

We built a model based on our waste audits and Duke's FY12 landfill tonnage to reflect the range of recycling rate increases that Duke could potentially experience by transitioning to a single-stream recycling system. This model projected that if, through

transitioning to single-stream recycling, Duke captured the recyclables currently in the waste stream, Duke could realize changes in: tons sent to landfill, landfill tipping fee reduction, and CO_2e saved by recycling rather than landfilling these recyclables. Table 9 shows the projected results at various capture rates of recyclables currently estimated to be landfilled annually. For the column "Tons CO_2e Saved," we multiplied the projected avoided tons recyclables by 0.2567, Clean Air Cool Planet's CO_2e waste coefficient – the same coefficient Sustainable Duke uses in calculating carbon reduction. The rows highlighted in grey illustrate the potential effect single-stream recycling could have on Duke based on SERA Inc.'s findings that single-stream recycling can increase recycling rates by 20%-45% (Skumatz 2012). This means that if by transitioning to single-stream recycling, Duke experienced a 20%-45% increase in recycling rate, Duke could: capture between 10% and 30% of the recyclables currently sent to landfill; save between $18,627 and $55,882 in annual tipping fees; and divert between 112 and 337 tons CO_2e annually.

Projected Benefits from Transitioning to Single-Stream Collection: Impacts from Recyclable Items

	Potential Captured Tons Recyclables	New Total Tonnage Recyclable	New Recycling rate	Recycling rate increased by	New Tons To landfill	New Tipping Fee	Tipping Fee Saved	Tons CO_2e Saved
0%	0	2,805	39%	0%	9,369	$398,191	$0	0
5%	219	3,024	42%	8%	6,359	$388,877	$9,314	56
10%	438	3,243	45%	16%	6,140	$379,564	$18,627	113
15%	657	3,462	48%	23%	5,921	$370,250	$27,941	169
20%	877	3,681	51%	31%	5,702	$360,936	$37,255	225
25%	1,096	3,900	54%	39%	5,482	$351,623	$46,568	281
30%	1,315	4,119	57%	47%	5,263	$342,309	$55,882	338
35%	1,534	4,339	60%	55%	5,044	$332,995	$65,196	394
40%	1,753	4,558	63%	63%	4,825	$323,682	$74,509	450

Projected Benefits from Transitioning to Single-Stream Collection: Impacts from Recyclable Items								
	Potential Captured Tons Recyclables	**New Total Tonnage Recyclable**	**New Recycling rate**	**Recycling rate increased by**	**New Tons To landfill**	**New Tipping Fee**	**Tipping Fee Saved**	**Tons CO_2e Saved**
45%	1,972	4,777	66%	70%	4,606	$314,368	$83,823	506
50%	2,191	4,996	70%	78%	4,387	$305,054	$93,137	563
55%	2,411	5,215	73%	86%	4,168	$295,740	$102,451	619
60%	2,630	5,434	76%	94%	3,948	$286,427	$111,764	675
65%	2,849	5,653	79%	102%	3,729	$277,113	$121,078	731
70%	3,068	5,873	82%	109%	3,510	$267,799	$130,392	788
75%	3,287	6,092	85%	117%	3,291	$258,486	$139,705	844
80%	3,506	6,311	88%	125%	3,072	$249,172	$149,019	900
85%	3,725	6,530	91%	133%	2,853	$239,858	$158,333	956
90%	3,945	6,749	94%	141%	2,633	$230,545	$167,646	1,013
95%	4,164	6,968	97%	148%	2,414	$221,231	$176,960	1,069
100%	4,383	7,187	100%	156%	2,195	$211,917	$186,274	1,125

Table 9: Range of projected changes to Duke's landfill stream if Duke transitioned to single-stream recycling (based off of FY12 landfill data and estimated composition of waste stream). The grey area represents the 20%-45% average recycling rate increase as discovered by SERA Inc. (2012).

If transitioning to single-stream recycling only rerouted a meager 5% of recyclables from trashcans to recycling bins, Duke could save up to $9,313 in annual tipping fees. As described below, saving $9,313 would more than cover the annual cost of fuel for Duke's current recycling fleet.

Duke's 2012 survey, and Baum et al.'s (2012) findings, indicate that universities transitioning to single-stream collection free up collection bins by the fact that single-stream recycling requires only 1 bin rather than 3 or more (Baum et al. 2012; Buchholz, Capps, and Shepherd 2012). By reducing bins, universities also free up real estate allowing

for the addition of compost bins. Capps and Buchholz both agreed that if the University were to transition to single-stream recycling, Duke would be better poised to simultaneously implement a post-consumer compost collection system as well. Because of this, we created a model based on Duke's FY12 combined with our waste audits as an assumed composition of the University's total trash waste stream to project potential results if Duke were to implement a post-consumer composting program. For compost CO_2e Savings, we again used Clean Air Cool Planet's compost CO_2e coefficient of 0.18. Table 10 shows our projected results. Again, please note that if Duke were able to capture only 5% of the compostable items being landfilled, the University could lower its annually tipping fee by roughly $4,600.

Projected Benefits from Transitioning to Single-Stream Collection: Impacts from Compostable Items					
	Potential Captured Tons Compostable Items	**New Tons To landfill**	**New Tipping Fee**	**Tipping Fee Saved**	**Tons CO_2e Saved**
0%	0	9,369	$398,191	$0	0
5%	110	6,468	$393,526	$4,665	20
10%	220	6,359	$388,861	$9,330	40
15%	329	6,249	$384,197	$13,994	59
20%	439	6,139	$379,532	$18,659	79
25%	549	6,029	$374,867	$23,324	99
30%	659	5,920	$370,202	$27,989	119
35%	768	5,810	$365,537	$32,654	138
40%	878	5,700	$360,873	$37,318	158
45%	988	5,590	$356,208	$41,983	178
50%	1,098	5,481	$351,543	$46,648	198
55%	1,207	5,371	$346,878	$51,313	217
60%	1,317	5,261	$342,213	$55,978	237
65%	1,427	5,151	$337,549	$60,642	257
70%	1,537	5,041	$332,884	$65,307	277
75%	1,646	4,932	$328,219	$69,972	296
80%	1,756	4,822	$323,554	$74,637	316
85%	1,866	4,712	$318,889	$79,302	336
90%	1,976	4,602	$314,224	$83,967	356
95%	2,085	4,493	$309,560	$88,631	375
100%	2,195	4,383	$304,895	$93,296	395

Table 10: Project results of transitioning to a post-consumer compost collection system (based on FY12 landfill data and waste audit stream analysis).

Using the same assumptions as above, we then modeled the potential results if Duke were to transition to both single-stream and composting, Table 11 shows the potential results of single-stream plus composting, assuming a commensurate percentage capture of each recyclables and compostable items.

Projected Benefits from Transitioning to Single-Stream Collection: Impacts from Recyclable + Compostable Items					
	Tons Diverted From Landfill	**New Tons To landfill**	**New Tipping Fee**	**Tipping Fee Saved**	**Tons CO2e Saved**
0%	0	9,369	$398,191	$0	0
5%	329	9,040	$384,213	$13,978	76
10%	658	8,711	$370,234	$27,957	152
15%	987	8,382	$356,256	$41,935	228
20%	1,316	8,054	$342,277	$55,914	304
25%	1,645	7,725	$328,299	$69,892	380
30%	1,973	7,396	$314,320	$83,871	456
35%	2,302	7,067	$300,342	$97,849	532
40%	2,631	6,738	$286,363	$111,828	608
45%	2,960	6,409	$272,385	$125,806	684
50%	3,289	6,080	$258,406	$139,785	760
55%	3,618	5,751	$244,428	$153,763	836
60%	3,947	5,422	$230,449	$167,742	912
65%	4,276	5,093	$216,471	$181,720	988
70%	4,605	4,765	$202,492	$195,699	1,064
75%	4,934	4,436	$188,514	$209,677	1,140
80%	5,262	4,107	$174,535	$223,656	1,216
85%	5,591	3,778	$160,557	$237,634	1,292
90%	5,920	3,449	$146,578	$251,613	1,368
95%	6,249	3,120	$132,600	$265,591	1,444
100%	6,578	2,791	$118,621	$279,570	1,520

Table 11: Potential impact of transitioning to single-stream recycling and post-consumer compost collection (based on FY12 landfill data and waste audit findings).

As well as examining the reduction in tons to landfill, landfill tipping fee, and CO2e driven by transitioning to single-stream recycling (and post-consumer composting), we also analyzed the potential increase in laborer efficiency if Duke were to transition to single-stream. As mentioned earlier, Duke's 5 person recycling crew spends 2 hours a day,

each, separating office paper and cardboard from the collected recycling because of the high commodity value of office paper and cardboard. Table 12 illustrates how much this 5-person crew collects weekly. For the purpose of our models, we inflated total bins a week to 1,450 to capture special events such as athletic events, parties, and beyond.

Baseline Collection

	GSF	Bins/Week	Buildings	Average Bins/Building
BLDG	3,709,089	682	63	11
BLDG/DO	1,945,633	266	19	14
DO	2,933,655	350	173	2
Total	**8,588,378.55**	**1,450**[2]	**255**	**6**

Table 12: Weekly Recycling Collection by Duke's 5 person recycling team. GSF = Gross Square Feet. BLDG indicates that the recycling crew enters the building; BLDG/DO indicates that the recycling crew collects from an outside location at that building, and also enters the building to collect recyclable items. DO indicates that the recycling crew does not enter the building, but only collects recyclables placed outside the building.

To understand the efficiency of the laborers, we analyzed how they spend their 8 hours a day. As well as spending 2 hours of every day sorting through recycled materials at the warehouse, these laborers are also given 1.5 hours of breaks daily. Table 13 shows the baseline efficiency of these laborers in one week, based on the baseline collection numbers from our findings presented in Table 12.

All 5 Laborers 1 Week

Hours a week	Weekly Sorting Hours
200	50

Scheduled Break Hours	Scheduled Labor Hours	Bins per Hour	GSF per Hour	Buildings per Hour	**Minutes Between Bins**
37.5	112.5	12	76,341	2.27	**4.66**

Table 13: Baseline efficiency of recycling crew. The first component of this model takes the recycling crew's 200 work hours a week and subtracts from it lunch breaks, break hours, and hours spent sorting white office paper from Duke's recycling, which results in a total of 112.5 work hours a week (all 5 employees). Bins per Hour, GSF per Hour, Buildings per Hour, Minutes Between Bins were calculated by applying the 112.5 weekly work hours to the findings from Table 12.

[2] They actually collect a documented 1,310 bins a week; 1,450 is the estimated number of bins when accounting for athletic events and special events in their weekly collection.

Were Duke to transition to a single-stream recycling collection, the Duke recycling crew would no longer have to spend 2 hours, each, a day sorting through recycling. For this model we estimated the range of collection increase single-stream could create: our values range from single-stream saving each worker 30 minutes a day, to the full 2 hours a day. Table 14 shows our predicted incremental increase in weekly collection capabilities based on scheduled break hours applied to our weekly labor efficiency as described in Table 13.

With Single-Stream Implementation

Extra 0.5 Hours Each a Day			**Weekly Hours Freed Because of Single-Stream**			**12.5**
Scheduled Break Hours	Scheduled Labor Hours	**Extra Bins Collected**	Total Bins a Week	**Extra GSF Collected**	Total GSF a Week	**Percentage Increase**
37.5	125	**161**	1,611	**954,264**	9,542,642	**11%**

Extra 1 Hour Each a Day			**Weekly Hours Freed Because of Single-Stream**			**25**
Scheduled Break Hours	Scheduled Labor Hours	**Extra Bins Collected**	Total Bins a Week	**Extra GSF Collected**	Total GSF a Week	**Percentage Increase**
37.5	137.5	**322**	1,772	**1,908,528**	10,496,907	**22%**

Extra 1.5 Hours Each a Day			**Weekly Hours Freed Because of Single-Stream**			**37.5**
Scheduled Break Hours	Scheduled Labor Hours	**Extra Bins Collected**	Total Bins a Week	**Extra GSF Collected**	Total GSF a Week	**Percentage Increase**
37.5	150	**483**	1,933	**2,862,792**	11,451,171	**33%**

Extra 2 Hours Each a Day			**Weekly Hours Freed Because of Single-Stream**			**50**
Scheduled Break Hours	Scheduled Labor Hours	**Extra Bins Collected**	Total Bins a Week	**Extra GSF Collected**	Total GSF a Week	**Percentage Increase**
37.5	162.5	**644**	2,094	**3,817,057**	12,405,435	**44%**

Table 14: Estimated increase single-stream recycling could create in Duke's recycling crew's weekly collection ability, based on baseline collection data.

Table 14 is important because, as mentioned earlier, Duke's recycling crew does not have the ability to collect from the Hospital or SOM, nor to collect from the majority of the campus recycling bins more than once weekly. Buchholz receives complaints from various buildings stating that by mid-week the recycling bins are full. As estimated by our model, if single-stream recycling freed only 1 hour from sorting, the recycling crew could become 22% more efficient. These numbers suggest that the crew could collect from buildings more than once a week. The ability to collect more than weekly suggests a reduction of recyclables in trashcans. If single-stream recycling liberates a realized 2 hours from each laborer's work-day, the crew could collect the majority of bins on campus twice a week. Or, this increase in efficiency could give the recycling crew the ability to start collecting from the Hospital or SOM. At the time of this report, the recycling crew did not collect from 337 buildings and locations (Hospital, SOM, Fuqua, and others). Creating 10 additional work hours a week would not allow the recycling crew to add all of these buildings to their location, but it does provide an opportunity for them to increase the number of buildings and GSF from which they collect. Further, this projected efficiency could allow the recycling crew to improve their existing collection from DO (collecting from an outside drop off location) to going into buildings (BLDG) as described in Table 12.

The last component of recycling crew efficiency that we analyzed was the efficiency of the recycling fleet. Currently, Duke's recycling crew operates 4 trucks to collect the recycling from campus buildings. As mentioned earlier, a significant benefit to single-stream recycling is vehicle efficiency. Multiple-stream recycling vehicles are compartmentalized to carry, and separate, the multiple streams being recycled; so one compartment for glass, one for aluminum, and so on. The inefficiency is that if one of the compartments fills to the top, the truck has to return to the warehouse to drop off the

recyclables, regardless of how full or empty the other compartments are. In single-stream recycling, the vehicle only returns to the warehouse when it is completely full – therefore eliminating the need to abort collection routes before the truck is optimally loaded.

Duke Waste Reduction & Recycling is uncertain exactly how Duke's recycling fleet will look if the University transitions to single-stream recycling. One possibility is that of the 4 operating trucks, Buchholz would be able to abandon 3 of them, transferring all of the responsibilities to truck 730. The second possibility is that Buchholz replaces all 4 vehicles with a rear-loading trash (recycling) truck. Because we don't know the future of the fleet, assuming Duke transitions to single-stream, we generated a model the savings in both money spent on fuel, and the commensurate CO_2e emissions reduction. As with our waste audit CO_2e emissions coefficient, we used Clean Air Cool Planet's emissions calculator's (the same calculator that Sustainable Duke uses) regular fuel coefficient of 0.009 to estimate CO_2e emissions from these vehicles. Table 15 shows our findings. Note that vehicles 799, 654, and 776 are highlighted in grey, and 730 is not. This is because 799, 654, and 776 are older vehicles, and 730 is the newer recycling truck. Under the scenario where Duke Waste Reduction & Recycling does not purchase a new rear-loading trash (recycling) truck to collect single-stream recycling, vehicle 730 would be the only vehicle the fleet would use to collect the recycling. Therefore, the below data suggests that if Duke transitions to single-stream recycling, it would save $5,874.40 in gas money, and reduce 13.8 tons CO_2e simply by taking these three vehicles out of service. That said, our model still lacks the increased mileage that vehicle 730 would absorb by operating as the only recycling collection vehicle.

Vehicle	Gallons	Times Fueled	Mileage	Gas Money ($3.82 a gallon)	Annual Tons $C0_2e$
799	690.6	26	3,264	$2,638.09	6.2
654	464.4	16	2,046	$1,774.01	4.2
776	382.8	12	2,539	$1,462.30	3.4
730	353.6	12	2,357	$1,350.75	3.2
Total	**1,891.4**	**66**	**10,206**	**$7,225.15**	**17.0**

654, 776, 799	1,537.8	54	7,849	$5,874.40	13.8
730 Estimate	353.6	12.0	2,356.6	1,350.8	3.2

Table 15: Duke's FY11 recycling fleet fuel data.

If Duke does purchase a rear-loading diesel truck, the truck will cost the University approximately $141,000. In FY2011 Duke's recycling fleet used $7,225.15 in fuel, emitting 17.0 tons CO_2e. Based on trash collecting trucks at Duke, the diesel rear-loading recycling truck is projected consume $9,886.62 in fuel, and emit 25.25 tons CO_2e. Table 16 does not incorporate the $141,000 cost of the new diesel loader, but it does incorporate the projected fuel cost and CO_2e emissions of the rear-loading collection vehicle with the financial and CO_2e savings from Table 9. Though perhaps not realistic, it is worth noting that if single-stream recycling and post-consumer compost collection can capture 55% of the recyclable and compostable items sent to the landfill, the cost of the rear-loader would be covered in the first year.

With Rear-Loader Fuel Cost and CO_2e Emissions					
Recyclables Only			**Recyclables + Compostable Items**		
% Of Items Diverted from Landfill	Tipping Fee Saved	Tons CO2e Saved	% Of Items Diverted from Landfill	Tipping Fee Saved	Tons CO2e Saved
5%	-$572.93	31.00	5%	$4,091.88	50.76
10%	$8,740.75	87.26	10%	$18,070.37	126.77
15%	$18,054.44	143.51	15%	$32,048.87	202.78
20%	$27,368.13	199.77	20%	$46,027.36	278.80
25%	$36,681.82	256.02	25%	$60,005.86	354.81
30%	$45,995.50	312.28	30%	$73,984.35	430.82
35%	$55,309.19	368.53	35%	$87,962.85	506.83
40%	$64,622.88	424.79	40%	$101,941.34	582.84
45%	$73,936.57	481.04	45%	$115,919.84	658.85
50%	$83,250.25	537.30	50%	$129,898.33	734.87
55%	$92,563.94	593.55	55%	$143,876.83	810.88
60%	$101,877.63	649.81	60%	$157,855.32	886.89
65%	$111,191.32	706.06	65%	$171,833.82	962.90
70%	$120,505.00	762.32	70%	$185,812.31	1,038.91
75%	$129,818.69	818.57	75%	$199,790.81	1,114.92
80%	$139,132.38	874.82	80%	$213,769.30	1,190.93
85%	$148,446.07	931.08	85%	$227,747.80	1,266.95
90%	$157,759.75	987.33	90%	$241,726.29	1,342.96
95%	$167,073.44	1,043.59	95%	$255,704.79	1,418.97
100%	$176,387.13	1,099.84	100%	$269,683.28	1,494.98

Table 16: Landfill tipping fees and CO2e emissions offset by fuel cost and CO2e emissions generated by using a diesel rear-loading truck to collect single-stream recycling. Please note that these numbers do not include the $141,000 price of the new rear-loader.

7. Salient WR&R findings from other IHE's

This section will not detail every WR&R program researched in other IHE's SSPs, CAPs, Progress Reports, or RECYC-L and/or Green School List emails, but it will showcase programs and initiatives that the authors of this paper find compelling.

Purdue is a single-stream collection campus. As a landfill diversion initiative, faculty and staff do not have trashcans in their offices nor cubicles, only a recycling bin. Each floor has a centralized 96-gallon trashcan, which makes recycling easier, and throwing something away more difficult – if faculty and staff want to throw something away, they have to get up and walk down the hall to do so, but they can recycle at their cubicle (Purdue University 2010).

American University performed a 2010 waste audit that revealed that 13% of their residence hall trash was bathroom generated paper towels. In 2012 American University implemented their campus wide composting program, not just because of bathroom generated paper towel collection, and American's initial but limited analysis indicates that the compost collection has helped create an 84% landfill diversion rate (email from Helen Lee, Zero Waste Coordinator, American University, February 26, 2012). Anecdotally, though we didn't record the mass of paper towels and toilet paper in our waste audits, all members of the waste audit team were shocked by the ubiquity of paper towels and toilet paper in our audits.

Procurement Policies

1. Procurement policies at other IHEs

This section will summarize the EPP policies and practices we found in other Institutions of higher education. They are presented in two parts. The first part summarizes the practices that are commonly adopted among universities. Some unique and constructive policies and practices are presented in the second part to reference Duke for further improvements.

Common practices

a. Promoting green vendors/products

The most prevailing policy adopted by researched universities is promoting green vendors among their vendor list or green products that are available at University stores or nearby stores. Twelve out of thirty (40%) researched universities implemented this kind of practice by using various approaches to realize this goal. Some of them give a special list of all green vendors that have partnerships with the university or a list of sustainable products available in university stores, such as Purdue, UCLA and University of Washington. Others give credits to sustainability performances when they evaluate and choose their preferred vendors. The rest publish information about sustainability factors in the list of their preferred vendors. The information could include the programs that certify their products as sustainable product or energy efficiency products or the sustainable practice they adopt along their supply chain. For example, Berea College will ask vendors their green initiatives and EPP practices information and incorporate that information into contracts (https://www.berea.edu/sustainability/operations/).

Purdue has two separate lists for individual and department purchasers. One is a list of green products available at university stores that can be purchased by students daily. Another list contains university suppliers that provide green products or support related green purchasing programs (Purdue 2011). Purdue will continue to improve sustainable purchasing in their e-procurement system through following two methods: 1) listing sustainable products at the top of web-based-search results to encourage sustainable product purchasing; 2) emphasizing green products through sustainable branding and/or logos. The University of Michigan also has two green catalogs listed by suppliers and products separately to guide university purchasers (University of Michigan 2011).

Cornell has five lists of preferred suppliers, three of which have sustainability requirements for suppliers to be considered as a preferred supplier, including office supplies, carpeting, and office furniture. All of their suppliers of office products joined recycled toner cartridge programs and provide environmentally friendly products and paper with post consumer recyclables. Their supplier of carpets is a leader to use recycled materials in manufacturing, distribution and installation processes. Their supplier of office furniture has been awarded several times for their sustainable practices in purchasing, manufacturing and distribution (Cornell 2010).

UCLA established a list of "Strategic Sourcing Alliance Suppliers", which contains UCLA's preferred vendors. A supplier's commitment to sustainability in manufacturing, product offering, transportation and end of life treatment is crucial to be considered as preferred vendor. UCLA scores each vendor based on their energy consumption in manufacture process, transportation distance, packaging strategy and disposal method and then decide if one can is eligible to become a preferred supplier (UCLA 2011). Those suppliers contain many purchasing aspects. What's worth noticing is that they included not only regular categories such as office supplies, furniture products, lab and sciences products, IT products and IT services, they also included suppliers of bottled drinking water and alcohol services. University of Washington also used "strategic sourcing" in order to develop best-value contracts, which will not only benefit customers in terms of price and quality, but also meet environmental and other social responsibility goals ("Strategic Sourcing | Procurement Services" 2013). Berea College considers recycled content, energy efficient, waste minimization, durability, solid waste and total life cycle impact when they choose their suppliers and contracts (Berea College 2013)

UC Berkeley and University of Washington both have built online purchasing websites, on which a catalog of suppliers who provide sustainable products is available. The products include janitorial supplies, lab supplies, office supplies and so on("Supplier Portfolios | Procurement Services" 2013).

On the contrary to other universities who list vendors for various items and categories, Brown had developed a list of sustainable products that one can purchase for dorm rooms. They also listed the suppliers who provide those products. The list has 28 categories that covers organic bedding, CFL or LED lighting, smart power strips energy efficient appliances water filtration units and so on. For those items that are available at Brown Bookstore, they are marked with "Green Room Choice" labels.

Instead of building a separate list of sustainable vendors, one can also emphasize sustainability by publishing sustainable information of their existing vendor list. For example, Northwestern University has a column of Sustainability Info on their preferred vendor matrix.

One other thing to be noticed, most of the green suppliers/vendors/products lists are developed for department buyers within the university. Only three schools had lists for

students. They are green product list at University stores by Purdue and green product list for dorm by Brown.

b. Paper Consumption

Every university with green purchasing policies that we researched schools have either policies related to paper consumption or policies specifically stressed its importance. This is especially compelling when understanding that, ton for ton (40 cases), recycled versus virgin paper:

30% Postconsumer Copy Paper Saves:

- The equivalent of 7.2 trees (forty feet in height and 6-8 inches in diameter)
- 2,100 gallons of water
- 1,230 kw hours of electricity
- 18 pounds of air pollution

100% Postconsumer Copy Paper Saves:

- The equivalent of 24 trees (forty feet in height and 6-8 inches in diameter)
- 7,000 gallons of water
- 4,100 kw hours of electricity
- 60 pounds of air pollution (74% less than virgin)
- 35% less water pollution than virgin paper (Prema 2005; NYU Office of Sustainability 2013).

Joseph Mastracchio is part of Yale's Purchasing Standards team working to improve Yale's purchasing footprint. He indicated that Yale was working on exactly how to track paper, which is trickier than it might first appear, at the time of interview (2012). Paper is purchased in reams, but recycled in pounds. Further, paper isn't just white office paper, but its sticky notes, drafting paper, notebooks, note pads, day-by-day desk calendar's etc. – paper purchased not described by reams. Because of this Yale is working to use pounds as it's common denominator for tracking paper in and paper out. Yale does purchase all of its printer paper through Office Max, which makes tracking printer paper easy. In analyzing this tracked printer paper he noticed that the School of Nursing was going through "massive amounts of paper," far more than any other department or school (Mastracchio

2012). To curb their rampant paper usage, Yale bought all nursing students iPads, which cost the University much less than the amount of paper they were going through annually. We questioned this decision, wondering if he had completed a full Life Cycle Analysis of the footprint of iPads versus the School of Nursing's annual paper consumption. He admitted that he hadn't but said that responsible purchasing isn't an exact science; its not about doing everything absolutely right, but doing what you believe to be the best thing at that moment. Further, ego's need to be removed from purchasing guidelines and sustainability strategic planning, "At Yale and other academic institutions, there's a clear reluctance to let go of an idea. In the spirit of progress, we all need to be able to admit where we were wrong so that we can move forward productively" (Mastracchio 2012). At that moment, iPads were the more environmentally friendly option.

Another of his printer paper initiatives relates more to how the University utilizes their purchases as opposed to how they purchase them. He discovered that the majority of what The School of Drama was printed was single-sided; and with the hundreds of double to triple spaced scripts the students printed, he saw an opportunity for improvement. He hired software developers to add an "*aggressive*" pop-up component to the University's printing software: "This document is scheduled to be printed single-sided, is it possible to print it double sided?" If the user answered "no" the same question would pop-up multiple times. This initiative saved 17,000 sheets of paper in its first year, 2011 (Mastracchio 2012).

Yale's last paper initiative is that with the exception of diplomas and other "important" documents, using Office Max's purchasing portal, Yale purchasers cannot purchase non-recycled paper; all paper must be 30% recycled or higher (Yale University 2011). Before Yale's deal with Corporate Express, virgin paper was cheaper than recycled paper, but because of Yale's bulk buying power, Yale was able to leverage a deal making recycled paper $0.30 less a case than its virgin equivalent; saving both trees and money (Yale University Procurement Department 2010). However, we have no information of how their recycled price is currently, since there has been dramatic price change happened since 2010.

Berea College adopts the most progressive policy of printing services. They use 100% recycled paper for all printers and copiers(Berea College 2013). Green Camps

Representatives at Johns Hopkins (which will be explained later in this section) have fully switched to purchasing only 30% recycled content paper and set double-sided printing to default. Others recommend students and staff to do so in there green procurement guideline or listed as one criterion to become certified of Green Office, such as Harvard, UCLA, UC Berkeley, and University of Notre Dame. Purdue made default double-sided printing as one of its 2025 long-term goal for purchasing aspect of sustainability.

Harvard, UCLA, made recycled content requirement (30% or higher) one of the criteria to become certified green office.

UCLA negotiated with supplier of paper to get recycled paper at a discounted price, making it at the same price as its supplier's virgin stock. Since then, recycled paper consumption has increased about 15%. Western Washington University also negotiated with Office depot to encourage the use of recycled paper by providing them at a discounted and competitive price ("Purchasing - WWU OS" 2013).

UC Berkeley bookstore has switched to 100% green books made with recycled paper. Moreover, it gradually reduce the use of virgin paper and transfer to recycled paper with at least 30% postconsumer waste recycled content.

University of South Carolina encourage their students and staff to reuse paper that has been used only one sided. To do so, they keep a pile of scrap paper beside printers or copiers.

Harvard extended use of recycled paper to cover envelops and letter paper. Notre Dame, on the other hand, extended use of recycled paper to bathroom tissue and paper towels. According to their calculations, they have saved 543 million BTU of energy and 513,000 gallons of water annually since adoption of this strategy

c. Life cycle consideration

Four universities emphasized the importance of life cycle thinking strategy, including Yale, UC schools, Berea College and Stanford (UCOP 2011). Because they adopted cradle-to-grave evaluation methodology, they look beyond just raw material sourcing and manufacturing phase of the product. Delivery and overall usage was all taken into account when developing green purchasing strategies.

Because of the life cycle thinking strategy, Yale assessed the commodity impacts not only of their production phase, but also of their delivery phase (SSP Yale 2010). Assessing

the impacts of external deliveries is one of their goals set in 2010-2013 sustainability strategic plan (2010). After the assessment, they designed a strategy that implemented the policy of no delivery of office supplies on Mondays to reduce external delivery impact (SSP Yale 2010). They also realized the internal and close relationship of reducing consumption and improving disposal, both of which are important practices to reduce overall environmental impact. Georgetown University and Western Washington University as well listed reducing truck deliveries and order only what is needed as one of their criteria to get Green Office Certificate (SSP Georgetown University 2010, ("Purchasing - WWU OS" 2013). Western Washington University Central Stores is also working to consolidate delivery of both deliveries to university end-users and vendor deliveries to campus ("Purchasing - WWU OS" 2013).

Purdue has also worked with its vendors on improving their delivery schedules. One component of this includes consolidating deliveries; where its feasible, Purdue asks vendors to reduce deliveries from daily to every other day or more, reducing the associated GHG with a vehicle delivering goods daily. Further, vendors now deliver their goods to Purdue at roughly 6am so that their delivery vehicles avoid morning traffic; saving time, GHG emissions from a vehicle idling in traffic, and in the case of one Purdue food vendor, this created a 30% savings on fuel expenses in just one year (Purdue University 2010)..

Both Michigan and University of Notre Dame encourage purchasers to maintain minimum dollar amount each time to reduce overall packaging expenses and reduce delivery trips to save energy.

d. Green office

Although not every researched university has Environmentally Purchasing Policy available, 13 of 30 universities established Green Office Certification programs, which include purchasing segment.

Some of the items on the checklists stand out that are not regular among other schools. Harvard require purchaser to go to Harvard Reuse List first before they purchase furniture, books and office supplies. University of Notre Dame encourage purchaser to buy rechargeable batteries. University of South Carolina give points to offices with reusable bags and reusable mugs, dishware, and silverware for use in rooms and kitchens.

e. Cleaning product policies

Brown University has reduced their cleaning supplies from 164 to 50, which has created "greater inventory control, and a streamlined delivery system developed to lower our carbon footprint. Finally, when compared to traditional cleaning products, green cleaning products are formulated to reduce risk to human health. With the exception of the use of bleach, specifically to address the cleaning needs of bodily fluids (at a 10:1 ratio), none of the cleaning products used at Brown contain harmful chemicals" (C. Powell 2012).

Western Washington University and Macalester College have the most aggressive policy regarding cleaning products: all their cleaning products are Green-Seal approved ("Sustainability - Campus Projects" 2013).

Individual practices

a. Sustainable Purchasing Manual

Currently, only Yale, Arizona State University, George Mason University among all our researched schools have implemented comprehensive purchasing guide that include standards of variety of products that will be possibly bought by university buyers. As we can see from the former part of the result, most universities only implement several green purchasing policies or initiatives that will constraint purchasing of certain category of merchandize, such as paper, electronic appliances or cleaning products. Although these programs contribute to the environment to some extent, universities have opportunity to contribute much more to the environment by implementing a comprehensive sustainable purchasing policy.

In their manuals/guidelines, they provided criteria or certification programs to help university buyers identify sustainable products in each category. For example, the guideline will recommend buyer to by paper products that have recycled content or to buy Energy Star certified appliances. All of the three sustainable purchasing manuals/guidelines have covered following areas: office supplies, electronics, cleaning supplies, furniture, paint, vehicle, appliances and water services. Arizona State University and George Mason University have extended that list to include pest control products, plastic products, wood products, and packaging and construction materials.

Both Purdue and UC Berkeley have listed developing a comprehensive sustainable purchasing policy as their long-term goal to improve procurement.

b. Online systems

Purdue University has created a centralized, online purchasing portal (Purdue University 2010). The advantages to this portal are twofold. 1) It allows the University to track the entirety of goods purchased with University money. This allows for easier analysis of how and where Purdue spends money; enabling opportunities for sustainable improvement such as merging orders from different departments from the same vendor to decrease packaging and transport related CO_2 emissions. The ability to consolidate orders and shipments creates both financial and environmental savings. 2) It allows Purdue to dictate what purchasers can and cannot buy. This is crucial because Purdue can therefore force purchasers to buy, for example, green cleaning products and/or recycled paper. University of Washington at Seattle also use e-procurement tool for same reasons.

Notre Dame installed a new program called TravelND, which is an online business travel and expense reporting system. Currently, all their flight booking and travel expense submitting procedure can be streamlined into an electronic system. This new system can save 400,000 sheets of paper per year, which represents 5tons of wood or 10,000 pounds of greenhouse gas emission.

UCSB has eliminated paper catalogues (such as Office Max or Staples) and has transitioned to a "100% electronic and paperless system for all procurement and accounting operations" (University of California, Santa Barbara 2008); Penn is currently working on implementing the same policy (University of Pennsylvania 2013).

c. Purchasing Coordinator

Further, Purdue is currently working on hiring a full time Purchasing Coordinator to monitor Purdue's purchasing as a full time job (Purdue University 2010). It might seem like an unimportant position, but the sustainability teams and/or purchasing teams at many universities have more work than they can currently handle – and continually tracking items such as ball-point pen purchases would rank low on their triage-style to-do lists. Having a full time Purchasing Coordinator will give the Purdue 40 hours of weekly labor dedicated solely to looking for sustainability and financial opportunities for improvement.

d. Green campus representatives

This sustainability initiative actually relates more than just sustainable purchasing, which can be extended to cover various areas of sustainability education and promotion. As

we discussed in the survey section before, education component is crucial to transition to single-stream recycling. Similarly, some universities stress the importance of sustainability education on campus through hiring representative staff or students.

Johns Hopkins sustainability office established the Green Campus Reps program for the representative staff to evaluate sustainability practice of their office and provide regular feedback regarding environmental and cost savings. Green Campus Reps have made several noticeable accomplishments in their offices, such as eliminating usage of disposable cups and utensils in break rooms and purchasing of bottled waters. Moreover, they recycle batteries and toner cartridge. We will discuss other accomplishments separately in other sections.

State University of New York at Cortland has established a similar program that hires students to promote environmental education and sustainability consciousness in resident halls on campus.

2. Procurement policies at Duke University

Mary Crawford is the Director of Duke's Procurement Department and our main contact when we are working with the Procurement Department to research current Duke procurement practices and thus make recommendations to Duke's procurement policies. She provided all the following information regarding Duke's current procurement system. Duke's 2004 EPP (Appendix 2) was one of the first university published EPPs which has helped other universities wishing to create their own EPPS, and while laudable, Duke's EPP cannot enforce that purchasers *must* purchase one item instead of another. Essentially, the document has spectacular intention without compulsory restrictions (Interview with Mary Crawford, May 30, 2012).

Currently, Duke's purchasing program is not centralized. Those granted the right to purchase with university funds are required to attend a 15 minute information session describing what they can and cannot buy (personal items and guns to name a few), and are then given a P-Card and allowed to make purchases with Duke's money. P-card owners have a large scope of purchasing authority since they only need Procurement staff's permission to purchase items in excess of $20,000. At the time of this report, there are

roughly 6,000 P-Card holders at Duke, which means roughly 6,000 purchasers buying items based on individual decisions. Moreover, only financial information about purchasing activities is tracked. Currently, there is no system installed to track sustainability information of their merchandise, leaving us limited information to analyze how Duke's purchasers are performing, from an environmental perspective.

Non-centralized purchasing also means that each department at Duke has their own vendor relationships as well as purchasing guidelines. For example, at the time of this report, Duke had roughly 750 vehicles. However, Joseph Honeycutt, Director of Duke's Fleet, only directly manages 100 of these vehicles. Duke's police department manages their fleet, Duke's Facilities Management Department (FMD) manages roughly 175 vehicles. For the case of this study, managing a fleet entails everything from purchasing vehicles to maintaining them, to disposing of them when the department no longer needs them. Because each department manages their own fleet, it presents challenges for Procurement in terms of negotiating bulk contracts, consolidating motor oil and antifreeze for recycling, as well as creating environmental purchasing policies by which all departments with a vehicle could abide (Interview with Joseph Honeycutt, January 22, 2013).

One example for non-centralized purchasing is the purchasing of cleaning products. Two departments, University Housekeeping and Residence Life Housekeeping, are in charge of purchasing cleaning products for Duke University campus except for Health system. Duke's health system has a separate cleaning product outside contractor Crothall. Additionally, School of Nursing has their own contractor for cleaning products as well. Moreover, each individual building and department has the right to decide which cleaning products to purchase, and can purchase them through Duke or independently. In conclusion, the Duke community has the ability to purchase, and make purchasing decisions, centrally or individually.

As stated above, responsible purchasing should also include the end-of-life for purchased items. Duke's Procurement Department operates the Duke Surplus Program, a warehouse for working equipment no longer in use, such as computers, furniture, and lab equipment. Departments no longer in need of these items contact the Procurement Department, which arranges for the transports of these items to the Reuse warehouse. Mary Crawford started the Reuse Warehouse because she saw repurposing unused

working items as the greenest thing that she could do. “I think we (Duke) buy way too much. Its just who we’ve become” (Crawford 2012). While the warehouse diverts items from Duke’s waste stream by repurposing unwanted working items, the warehouse has its downside. Items in the warehouse are crudely cataloged, meaning that Duke employees looking to adopt these surplus items must travel to the warehouse to see if the warehouse has what they’re looking for. Further, goods put back into Duke’s system are not tracked unless their value exceeds $5,000, making it difficult to quantify the warehouse’s impact on reducing Duke’s purchases.

The creation of Duke’s Reuse Warehouse fully embraces a complete life cycle approach to responsible procurement. This needed intra-university reuse program compliments obtaining with disposing of responsibly, retarding the need for unneeded purchases. However, Duke’s Procurement department still has room for growth in terms of sustainability. The decentralized purchasing program hinders the efficacy of even the most robust EPP simply because Procurement doesn’t have the ability to consolidate purchases, and therefore misses opportunities of creating savings in bulk buying, packaging, shipping fees, and CO_2 emissions.

Discussion and Recommendations

Below is a list of specific recommendations for both components of this project (WR&R and Procurement) that will be discussed in further detail.

<u>Overall Recommendation</u>

1) Improve the connection between procurement and waste management

<u>WR&R</u>

1) Transition into a single-stream collection University.
2) Borrow from Purdue’s centralized office trashcan model
3) When implementing single-stream recycling, simultaneously implement a campus-wide post-consumer compost collection program.
4) Adopt American University’s bathroom paper-towel compost collection program.

Procurement

1) Move to more centralized purchasing system.

2) Establish a comprehensive procurement tool, borrowing from Yale, Arizona State University, George Mason University.

3) Add a filter for green products on Buy @ Duke or publish sustainable information about vendors.

4) Set double side printing as default

Close connection between procurement and WR&R

The Procurement Department and Waste Reduction and Recycling are undeniably connected – what goes in must come out. We think that Yale University embraces this macro level understanding, and takes it a step further; "success in reducing waste and increasing recycling requires the Facilities Department to improve how our waste is collected, but it also entails all of us to rethink what we need to purchase, how much we need, and how we chose to dispose of a product or packaging" (Yale University 2011). Responsible purchasing and disposal is the job of these departments, but it also requires that the faculty, staff, employees, and students realize their ability to impact what comes in and how it goes out. Environmentally responsible strategies, initiatives and programs can only do so much, but to truly reduce incoming resource and outflowing waste demands conscious participation from the Duke community.

Meaningful waste reduction programs must be thoughtfully produced by Duke's departments such as Procurement and WR&R, but initiatives cannot be fully effective without being embraced and practiced by the Duke community. Behavior change is a crucial component of responsible purchasing and disposal. Changing bins from multiple-stream collection to single-stream collection doesn't mean anything unless the consumers take the time to separate trash from recycling, and potentially compost.

One of the charges of the Materials Management Subcommittee, part of the Campus Sustainability Committee, is to review and recommend strategies for reducing the life-cycle impacts of materials used at Duke, and to educate the campus community regarding source reduction, sustainable product alternatives, waste diversion through recycling, composting & reuse programs, and responsible end-of-life disposal. Diving deeper into the plastics

component of our waste audits suggests an opportunity for the Materials Management Subcommittee to analyze the University's plastic consumption, specifically, an opportunity to explore single-serving items (forks, clamshell containers, plastic beverage bottles). Remembering that our waste audits revealed that 16% of trash to landfill was recyclable plastic. The real issue is changing the way the University consumes. This can be both from Procurement as well as from behavior change by students.

Our research revealed that at least 16 universities have already created a plastic water bottle ban (Mullikin 2009; Carapezza 2013; AASHE 2012). Again, this does not state that plastic water bottles are the only offenders in Duke's waste stream; it just highlights a top down approach to reduce waste. Further, banning plastic water bottles at Duke cannot solely revolutionize Duke's seemingly disposable-single-serving-culture problem. Duke isn't a home where employees, staff, faculty, and students have the luxury of making all of their own meals in their own kitchens, and therefore eliminating single-serving waste of their meals. There are dining options (Great Hall, East Campus Marketplace) where people can sit down for a container-less meal, but the reality is, the habits of Duke's residents require single-serving options. Removing plastic water bottles from campus simply suggests a way to create behavior change by eliminating a purchasing option.

WR&R

The authors of this paper recommend that Duke University transition to single-stream collection on campus. This presents an opportunity to capture, some, if not a significant portion of the estimated 6,500 tons of recyclable and compostable items annually landfilled by Duke, and the commensurate 1,500 tons CO_2e. Below is a discussion summarizing the benefits and the problems with single-stream recycling, as well as our reasoning why Duke should make this transition.

Julie Muir of Stanford Recycling stated that she believes that single-stream recycling "dumbs down" a process that demands elevated thinking. The results from The University of Colorado's initial transition to single-stream were disastrous and proved this "dumbing down" effect; essentially CU's community treated the single-stream bins as just another trash can – over $10,000 of revenues were lost because of the significant commodity contamination (DeBell 2012). In a source separated situation, participants are offered a

moment to think about how they dispose of their waste – this is my one use paper plate, my one use pop can, my one use plastic water bottle – where as a single-stream system, to an extent, offers a "dump and run" situation without a moment to reflect upon the waste one created and abandoned; the opportunity to recognize one's personal impact is lost. This does not, however, guarantee that participants always consider their waste in a multiple-stream system.

Contamination from single-stream recycling can turn potentially recyclable items into down-cycled products, or even worse, landfilled items. An inability to reuse existing materials can lead to the harvesting virgin materials, and therefore the environmental degradation included in creating and manufacturing these products. Single-stream recycling forces paper recyclers to use more bleach and other chemicals than they would in using pulp from a multiple-stream system.

Single-stream recycling has inarguable drawbacks. These drawbacks don't make it bad nor environmentally unfriendly. However, despite single-stream's shortcomings, the number of single-stream MRFs doubled between 2006-2011 (Morawski 2010). Duke's *University Recycling Benchmarking Survey* revealed that 61% of the universities surveyed use single-stream recycling, or at least a combination of single and multiple stream recycling; and out of the 18 schools that use multiple-stream recycling, 61% are considering transferring to single-stream recycling. Universities such as Harvard, Yale, and Cornell have transitioned to single-stream recycling because their communities have. As Gogan stated in an interview, a university wants to have the same recycling habits as the community because forcing students, employees, and staff to learn two different recycling habits (on campus and off campus) will make recycling more confusing and less attractive (phone interview with Rob Gogan, June 28, 2012). Further, Buchholz agrees that she wants Blue Devils to have one universal habit of recycling in Durham, both on and off campus (interview with Buchhoz, March 19, 2013).

Further, even though Duke's office paper and cardboard is transported to Raleigh (Sonoco MRF) protected from single-stream contamination, the glass collected from Duke is not. With the exception of white office paper and cardboard, Duke's recycling is deposited to Sonoco's Durham transfer station where it is comingled with the City of Durham's single-stream recycling, and when it reaches Raleigh, it is further commingled

with the City of Raleigh's recycling to be processed in a single-stream MRF. Duke is in a single-stream community, and maintaining multiple-stream recycling will continue to protect white office paper and cardboard, however, Sonoco also processes the City of Durham and the City of Raleigh's recycling (a combined population of 640,720 people), making Duke's recycling roughly 10% (based on population) of these combined cities. Regardless of multiple-stream collection at Duke, its recycling is ultimately processed at a single-stream MRF.

Harvard, Yale, and Cornell transitioned to single-stream recycling to create one community recycling habit, and because Duke's recycling is ultimately processed as single-stream recycling, the authors of this paper believe that Duke should transition to single-stream recycling with the intention of realizing the benefits described below. As stated by Skumatz, "all actors indicated that single-stream was the direction of the future – and the future is already here. The horse is out of the barn, with mostly benefits, but with important, but manageable, disadvantages affecting certain sectors along the chain" (Skumatz 2012). Durham and the Triangle have transitioned, and unless Duke builds their own MRF, maintaining multiple-stream recycling ignores the world beyond the University's campus. Transitioning to single-stream recycling can be beneficial, and the below details embracing single-stream recycling could allow Duke to capitalize on its advantages.

Based on the findings from Duke's 2012 survey, and the 2012 paper by Baum et al., IHEs that transitioned from a multiple-stream collection system to single-stream realized increased recycling rates. SERA Inc. determined that municipalities and institutions transitioning to single-stream recycling generally experience between 20%-45% (Skumatz 2012). Harvard University's recycling rate jumped from 42% to 55% (31% increase) by transitioning to single-stream recycling (Baum et al. 2012). Duke's FY12 recycling rate was 39% which is similar to Harvard's 42%. Yale transitioned to single-stream recycling with the goal of increasing their recycling rate by 25% (Varman 2011).

Sustainable Duke and WR&R are currently conducting a single-stream pilot program at the Sanford School of Public Policy. If the pilot program is successful, the authors of this paper recommend that Duke should transition to a single-stream system, because our objective was looking for an opportunity to increase Duke's recycling rate and landfill diversion. Empirically, our data suggests that transitioning to single-stream recycling could

have a significant impact on recycling rate, CO_2e diversion, landfill mass and tipping fee reductions, and potentially creating a tremendous efficiency increase for Duke's recycling crew. Further, the bins no longer used to collect the multiple streams could be converted into campus-wide post-consumer composting containers that Duke would not have to spend money to purchase.

Transitioning to single-stream recycling would create a simple mechanism to borrow from Purdue's centralized trashcan initiative. Remembering that only 30% of office trash was actually trash, Purdue's program offers a compelling program that could potentially capture the near 40% of recyclables sent to landfill in Duke's offices. Transitioning to single-stream recycling would make implementing this practice easier because it would allow Duke to have one recycling bin at every cubicle rather than a bin for every stream. A separate compost bin could help divert another 32% of what Duke offices send to landfill. It appears that single-stream recycling plus removal of office trashcans could create a significant increase in exclusively office generated recyclables and compostable items.

Because our data suggests that nearly a quarter (23%, 2,195 tons, 395 tons CO_2e) of what Duke landfills could be composted, the post-consumer compost collection ability of converting to single-stream alone makes transitioning compelling. Moreover, because transitioning to single-stream recycling will require a robust educational initiative and potentially challenging paradigm shift in habits, implementing single-stream recycling and campus-wide-post-consumer-compost-collection simultaneously will eliminate the burden of having to create two different educational campaigns and habit change regimens; one big change, one big habit shift. Even if Duke decides not to switch to single-stream recycling after research, we suggest to set up additional post-consumer compost collection to current system, considering compostable constitutes 23% of Duke's current waste stream.

Lastly, creating a more prevalent post-consumer-compost-collection system on campus will enable Duke to borrow from American University's program of composting restroom generated paper towel waste.

Procurement

Moving to more centralized purchasing system

The challenge with implementing an effective EPP at Duke is due to the decentralized purchasing process teamed with an inability to create purchasing requirements (Interview with Crawford, June 24, 2012). Constrained by the decentralized purchasing process at Duke, the Procurement department is unable to create rigid purchasing standards, such as a requirement for a particular percentage of post-consumer recycled printer paper, thus making implementing an effective EPP challenging.

Three common procurement practices that IHEs implement to improve their sustainability are providing green products lists, green/preferred vendors lists and web-based e-procurement. All of these practices allow universities to operate a more centralized procurement system. These practices integrate purchasing activities across the campus and guide them toward selected greener vendors. Integration has three benefits: 1) the university will be able to obtain a better price with increased ordering volume; 2) the vendor lists include at least some sustainability consideration, such as sustainability related programs, overall sustainability performance or life cycle assessment results; and 3) bulk buying provides the opportunity to reduce transportation frequency, which will further decrease impact of purchasing activities by consuming less transportation energy.

Therefore, we suggest that Duke procures more products University-wide to develop a more centralized procurement system. Examples could include cleaning supplies that are not purchased through one centralized department, and vehicle maintenance services such as an oil recycling or a tire disposal service. Having a more centralized procurement system could allow Duke to get better prices through higher volume purchasing. Further, it could allow the Procurement department an ability to control and require the purchasing of sustainable products. Lastly, consolidated purchasing will make tracking purchases easier, and therefore it will improve the ability to analyze the University's purchasing, and hopefully reveal opportunities for further efficiency tweaks.

Purchasing tool

Among all the universities that we researched, only Yale, Arizona State University, and George Mason University have a comprehensive purchasing guide that includes

standards of a variety of product. Most universities only implement procurement programs or initiatives for certain categories of merchandizes, such as paper, electronic appliances or cleaning products. Although these programs contribute to the environment to some extent, universities have opportunities to contribute much more to the environment by implementing a comprehensive sustainable purchasing policy for many categories. Both Purdue and UC Berkeley have stated that developing a comprehensive sustainable purchasing policy is a long-term goal to improve procurement.

To make sustainable procurement at Duke more comprehensive, we suggest that Duke creates a purchasing tool with advisory or mandatory standards that cover the following areas: office supplies, electronics, cleaning supplies, furniture, paint, vehicles maintenance, appliances, laboratory supplies. Possible sustainable suggestions for each category could be:

- Office supplies: post-consumer recycled content
- Office paper: 30% or greater post-consumer recycled content
- Electronics: EPEAT certified (verification level "Silver" or "Gold"), Energy Star certified
- Cleaning products: Green Seal certified, EPA DfE Approved
- Toilet paper, paper towels: EcoLogo certified, Green Seal certified
- Furniture: BIFMA (Business and Institutional Furniture Manufacturer's Association) Level certification, Cradle to Cradle Gold and Silver certification, Indoor Advantage certification, Polyvinyl Chloride (PVC) Free, Volatile Organic Compound (VOC) Free
- Paint: Low or no volatile organic compounds (VOCs), Green Seal certified (GS-11)
- Vehicle oils: 25% or higher re-refined oils
- Vehicle parts: Rebuilt vehicular parts
- Vehicle engine coolants: recycled content
- Appliances: Energy star certified where available

Our proposal is that this tool informs the user about sustainable products making sustainable purchasing as convenient as possible. An associated educational tool (video or

presentation) provided at the required at P-Card training would help educate purchasers about why sustainable purchasing is important.

Providing a filter for green products on Buy @ Duke or sustainable information about the vendor

As a long-term goal to facilitate purchasing of green products, we recommend that Buy@ Duke constructs a similar function to the Staples Advantage website, which is a function or button that filters available products and showcases green products. That way, users can find sustainable products and/or vendors without much effort. A substitute solution would be creating a sheet that lists both sustainable products and sustainable vendors. Both methods would give purchasers convenient access to sustainable information before they purchase.

We suggest this as a long-term goal, because the process requires a considerable amount of negotiation and collaboration work with numerous current vendors. However, we believe this could contribute significantly to Duke's sustainable procurement if accomplished.

Setting double side printing as default

Our study indicated that paper consumption is an important area for universities deciding about which sustainable purchasing area they should focus on. Because Duke's decentralized purchasing creates challenges in forcing the purchase of recycled paper, Duke can reduce printing and conserve paper through two initiatives. First, Duke could create a double-sided printing default on University computers. Secondly, Duke could borrow from Yale in implementing a pop-up system that alerts the user to choose double-sided rather than single-sided printing.

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Appendix

Appendix 1: Sustainable Duke's 2012 Recycling Benchmarking Survey.

University Recycling Benchmarking Survey

Summer 2012

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In July 2012, Sustainable Duke (Office of the Executive Vice President) and Duke Sanitation and Recycling Services (Facilities Management) created and distributed a survey to investigate the recycling collection and reporting of other universities. The survey was sent to 49 schools, 46 responded. The data in this report is courtesy of the following institutions:

Appalachian State University
Arizona State University
Auburn
Baylor
Boston College
Brown
Bucknell
Clemson
Colorado State University
Columbia
Cornell
Dartmouth
East Carolina University
Elon
Emory
Florida State University
George Mason
Georgetown
Georgia Tech
Harvard
Ithaca College
Johns Hopkins
Michigan State University
North Carolina State University
Northwestern
Notre Dame
Princeton
Purdue
Stanford
The Ohio State University
University of California Santa Barbara
University of Chicago
University of Colorado
University of Florida
University of Maryland, College Park
University of Massachusetts, Amherst
University of Miami
University of Michigan
University of North Carolina, Chapel Hill
University of North Carolina, Asheville
University of Oregon
University of Pennsylvania
University of South Carolina
University of Virginia
Wake Forest University
Yale

This survey was created to help Duke evaluate and improve upon our existing recycling and waste reduction program, and therefore Duke's data is **not** incorporated into this analysis. The percentages below represent a quick glimpse of the reported data.

Lowest Recycling Rate, 10%
Average Recycling Rate, 39.71%
Highest Recycling Rate, 71%

Lowest Diversion Rate, 20%
Average Diversion Rate, 52.44%
Highest Diversion Rate, 92%

Recycling and Diversion Rates

The table below is a sorted list describing percentages of schools that include the following items in their recycling rate and diversion rate. Of the 46 schools surveyed, 45 have recycling rates, 15 have separate/additional diversion rates, and one university calculates only a diversion rate.

Recycling Rate Items

Item	Out of 45
Office Paper	100.00%
Newspaper	100.00%
Cardboard	100.00%
Magazine	97.78%
Aluminum	97.78%
Shredded Paper	95.56%
Plastics (any)	97.78%
Steel/Tin Cans	95.56%
Glass	88.89%
Scrap Metal	82.22%
Electronics	80.00%
Hard Cover Books	80.00%
Pallets	68.89%
Student Move-Out	66.67%
Other Batteries	64.44%
Light bulbs	62.22%
Compost - Food	60.00%
Toner/Ink-Jet Cartridges	57.78%
Household Batteries	53.33%
Compost - Yard Waste	51.11%
C&D (Institution Managed)	46.67%
White Goods	45.65%
Tires	46.67%
Motor Oil	37.78%
Cooking Oil	37.78%
Anti-Freeze	33.33%
Compost - Greenhouse	31.11%
C&D (Construction Contractors)	31.11%
Compost - Animal Bedding	28.89%
Other	22.22%

Diversion Rate Items

Item	Out of 16
Other	50.00%
Compost - Food	43.75%
Compost - Yard Waste	31.25%
Student Move-Out	31.25%
C&D (Construction Contractors)	25.00%
Electronics	25.00%
Scrap Metal	25.00%
Other Batteries	25.00%
Light bulbs	25.00%
C&D (Institution Managed)	25.00%
Compost - Greenhouse	18.75%
Compost - Animal Bedding	18.75%
Pallets	18.75%
Cooking Oil	18.75%
White Goods	18.75%
Household Batteries	18.75%
Toner/Ink-Jet Cartridges	12.50%
Motor Oil	12.50%
Glass	12.50%
Aluminum	12.50%
Hard Cover Books	12.50%
Tires	6.25%
Office Paper	6.25%
Shredded Paper	6.25%
Newspaper	6.25%
Magazine	6.25%
Cardboard	6.25%
Plastics (any)	6.25%
Steel/Tin Cans	6.25%
Anti-Freeze	0.00%

The Survey Details

What items do you include in your recycling rate?

Office Paper	
out of 45	45
percentage	100.00%
Shredded Paper	
out of 45	43
percentage	95.56%
Newspaper	
out of 45	45
percentage	100.00%
Magazine	
out of 45	44
percentage	97.78%
Cardboard	
out of 45	45
percentage	100.00%
Glass	
out of 45	40
percentage	88.89%
Plastics (any)	
out of 45	44
percentage	97.78%
Steel/Tin Cans	
out of 45	43
percentage	95.56%
Aluminum	
out of 45	44
percentage	97.78%
Electronics	
out of 45	36
percentage	80.00%
Household Batteries	
out of 45	24
percentage	53.33%
Other Batteries	
out of 45	29
percentage	64.44%

Compost - Food	
out of 45	27
percentage	60.00%
Compost - Greenhouse	
out of 45	14
percentage	31.11%
Compost - Animal Bedding	
out of 45	13
percentage	28.89%
Compost - Yard Waste	
out of 45	23
percentage	51.11%
Scrap Metal	
out of 45	37
percentage	82.22%
Toner/Ink-Jet Cartridges	
out of 45	26
percentage	57.78%
Pallets	
out of 45	31
percentage	68.89%
Light bulbs	
out of 45	28
percentage	62.22%
Motor Oil	
out of 45	17
percentage	37.78%
Anti-Freeze	
out of 45	15
percentage	33.33%
Cooking Oil	
out of 45	17
percentage	37.78%

White Goods	
out of 45	21
percentage	45.65%
C&D (Institution Managed)	
out of 45	21
percentage	46.67%
C&D (Construction Contractors)	
out of 45	14
percentage	31.11%
Tires	
out of 45	21
percentage	46.67%
Hard Cover Books	
out of 45	36
percentage	80.00%
Student Move-Out Material	
out of 45	30
percentage	66.67%
Other*	
out of 45	10
percentage	22.22%

***Other Items Included in Recycling Rate:**

furniture
surplus
bedding
wood
grass-cycling
mulch
move-in materials
carpet
ceiling tiles
ballasts
animal carcasses

Of the 46 schools, 15 (33.33%) calculate a separate diversion rate. The following diversion rate data includes these 15 schools as well as diversion data from the university that calculates *only* a diversion rate. (Please note: It is because of this university that there are so many "1s" next to items considered *traditional* recyclables).

What items do you include in your diversion rate?
Reporting

Office Paper	
out of 16	1
percentage	6.25%
Shredded Paper	
out of 16	1
percentage	6.25%
Newspaper	
out of 16	1
percentage	6.25%
Magazine	
out of 16	1
percentage	6.25%
Cardboard	
out of 16	1
percentage	6.25%
Glass	
out of 16	2
percentage	12.50%
Plastics (any)	
out of 16	1
percentage	6.25%
Steel/Tin Cans	
out of 16	1
percentage	6.25%
Aluminum	
out of 16	2
percentage	12.50%
Electronics	
out of 16	4
percentage	25.00%
Household Batteries	
out of 16	3
percentage	18.75%
Other Batteries	
out of 16	4
percentage	25.00%

Compost - Food	
out of 16	7
percentage	43.75%
Compost - Greenhouse	
out of 16	3
percentage	18.75%
Compost - Animal Bedding	
out of 16	3
percentage	18.75%
Compost - Yard Waste	
out of 16	5
percentage	31.25%
Scrap Metal	
out of 16	4
percentage	25.00%
Toner/Ink-Jet Cartridges	
out of 16	2
percentage	12.50%
Pallets	
out of 16	3
percentage	18.75%
Light bulbs	
out of 16	4
percentage	25.00%
Motor Oil	
out of 16	2
percentage	12.50%
Anti-Freeze	
out of 16	0
percentage	0.00%
Cooking Oil	
out of 16	3
percentage	18.75%

White Goods	
out of 16	3
percentage	18.75%
C&D (Institution Managed)	
out of 16	4
percentage	25.00%
C&D (Construction Contractors)	
out of 16	4
percentage	25.00%
Tires	
out of 16	1
percentage	6.25%
Hard Cover Books	
out of 16	2
percentage	12.50%
Student Move-Out Material	
out of 16	5
percentage	31.25%
Other*	
out of 16	8
percentage	50.00%

***Other Items Included in Diversion Rate:**
surplus/reuse
donations/reuse
textiles
appliances
student move-out items
plastic necks smaller than body

The 16 schools that have diversion rates, were asked, **Which rate do you report publically?**

Both Recycling and Diversion	
Out of 16	10
Percentage	62.50%

Recycling Only	
Out of 16	1
Percentage	6.25%

Neither	
Out of 16	1
Percentage	6.25%

Diversion Only	
Out of 16	4
Percentage	25.00%

All 46 participating schools were asked, **In addition to reporting tons of recycling, what additional metrics does your institution use in reporting recycling? (Pick all that apply)**

None	
Out of 46	28
Percentage	60.87%

Per GSF	
Out of 46	1
Percentage	2.17%

Other*	
Out of 46	13
Percentage	28.26%

Per Capita	
Out of 46	10
Percentage	21.74%

*Other reporting metrics:
net cost per ton; revenue per ton; tons per recycling staff; vs. pounds of trash per capita; WARM; for surplus program we track number of items like desks, chairs, etc.; AASHE STARS; per capita at football games due to fluctuations in attendance

All 46 participating schools were asked, **Does your institution have any other ways of reporting recycling? (Pick all that apply)**

No	
Out of 46	17
Percentage	36.96%

Water Conserved	
Out of 46	7
Percentage	15.22%

Trees Saved	
Out of 46	9
Percentage	19.57%

GHG Emissions Avoided	
Out of 46	11
Percentage	23.91%

Recycling Revenue	
Out of 46	19
Percentage	41.30%

Recycling Revenue versus Landfill Fees	
Out of 46	16
Percentage	34.78%

Other*	
Out of 46	9
Percentage	19.57%

*Other ways to report recycling:
energy saved; landfill reduction; jobs, benefit to state; items donated

Solid Waste and Recycling Collection

Is your office's primary <u>solid waste</u> collection in-house or outsourced?

	Out of 46	Percentage
In-House	18	39.13%
Outsourced	9	19.57%
Combination	19	41.30%

The schools that answered "Combination" were asked, **Please describe how you use a combination of Outsourced and In-House collection**. Please note, all responses are anonymous, so any mention of the university have been redacted or changed to *University X* and any mention of contractors or haulers has been changed to *Company* X to preserve anonymity; spelling was corrected. Below are the responses:

- The emptying of dumpsters is outsourced. In-house staff collects metals, tires, wood, electronics, oil, batteries, light bulbs, and more from throughout campus. The compost collection is done in house through an academic unit.
- Some areas do not have compactors and these areas are serviced in-house by small dump trucks. Trucks are dumped in campus compactor for landfill waste. Areas with compactors and open tops are serviced by outside contractor. Either put on a scheduled or called in as needed.
- On-site collection – moving waste from interior bins to outside dumpsters (of both recycling and compost) is collected by both INTERNAL and OUTSOURCED custodial + dining staff. External collection of recycling (from building exteriors/dumpsters to central recycling plant) is done by INTERNAL staff. External collection of compost is done by OUTSOURCED company using their trucks. Shipping recycling to buyers and off-site collection facilities is done by both INTERNALLY OWNED and OUTSOURCED companies/trucks, depending on material. I believe we use our own trucks to ship the solid waste to a waste-for-energy facility
- Our compactor truck drivers get smaller stops from tight quads and alleyways with mini-packer trucks. Then they dump recycling or trash into contractors' large trucks. The contractors then pick up larger stops and take our school's refuse (and only our school's refuse) to the transfer station where they weigh in and get a tare sheet for each load. Our box truck drivers also get all bulk recyclables (reusables, computers, clothing, books, furniture, scrap metal, scrap wood etc.), universal waste, and do barrel/hamper swaps. These goods are staged and sorted, processed and shipped by a combination of volunteer group labor and our own drivers.
- The campus recycling office will collect the materials throughout campus and bring them to a few central locations. The contractor will then come and haul the materials from those sites.

- We have a recycling department that picks up recycling from a few buildings on campus that do not have recycling dumpsters. This office also plays a role in contracts for general recycling on campus as well as Game-day Recycling. This office also houses the majority of the budget for recycling on campus.
- *Company X* is the contractor. All custodial staff are University employees.
- MSW is collected by outsourced vendor while bulky waste and animal bedding is collected by University staff (unionized).
- In-house collection to large, outdoor centralized compactors and bins which are hauled by an outside vendor
- In house and contracted custodial staff remove trash from inside buildings. Solid waste contractor services all outdoor dumpsters, compactors, roll-offs, and sidewalk bins. In house staff service towable trash carts in one housing area.
- We collect everything but the City picks it up and takes it to the landfill.
- Custodial staff and grounds staff pick up trash from barrels and empty into dumpsters. Solid Waste company is contracted to provide and empty dumpsters.
- The vast majority of our Solid Waste is handled in-house. 3 large compactor sites (2 dining halls and 1 at the *University X* of Medicine) are outsourced.
- Solid waste is basically collect by university staff or disposed of by students by having materials brought to collection dumpsters, which are then hauled away by a contractor.
- Much is done in house, but we have contracted vendors for compactors, roll-offs, some bottle & can collection, some paper collection, carpet, woody waste, and scrap metal.
- Our housekeeping staff collects the building waste and either takes it to a near by 8yd dumpster or leaves out side for the grounds crew to transport to a dumpster. The dumpsters are emptied by *Company X*.
- Our in-house housekeeping staff empties desk-side and in-building trash-cans and brings them out to the dumpsters. Housekeeping also brings corrugated cardboard out to dumpsters. Students in residence halls are responsible for bringing their own trash and recycling outside to dumpsters and recycling carts. Our contracts are separated into front-load (trash and cardboard) and roll-off (trash and cardboard) services, and are contracted to *Company X*. We own our own dumpsters and compactors, and our in-house staff performs maintenance on the compactors, and minor painting on the dumpsters, but *Company X* does major repairs on the dumpsters, such as welding and bottom replacements, etc. We also have our own mini-roll-off truck and provide roll-off service ourselves for certain events like move-in, move-out, athletic events, etc., but that is also supplemented by roll-offs that are provided and hauled by *Company X*. We also have walkway sites on campus, the trash portion of which are serviced by Grounds.

- We collect most buildings in house. Facilities that need roll offs or compactors typically outsource. Organics collection is outsourced.
- Recycling staff collect, process and arrange transport of recyclables to contracted broker. Solid Waste is collected by building services and project management staff and placed in own & leased contain

Are there instances where your office does not directly collect and/or manage contracts for your institution's solid waste?

	Out of 46	Percentage
Yes	26	56.52%

The 26 schools that responded "yes" to the above question were asked, **Does your office receive this solid waste data?**

	Out of 26	Percentage
Consistently	12	46.15%
Inconsistently	9	34.62%
Never	5	19.23%

The schools that answered either "Consistently" or "Inconsistently" were asked, **Please describe the protocol for reporting this data to your office.** Again, all responses are anonymous, so any mention of the university have been redacted or changed to *University X* and any mention of contractors or haulers has been changed to *Company* X to preserve anonymity; spelling was corrected. Below are the responses:

- The custodial department emails the invoice to the E&E Office; Project Managers are supposed to do the same with C&D reporting but are inconsistent about doing so. Generally the Programs Coordinator must track down the solid waste data from separate individuals for C&D, batteries, bulbs, surplus, food, and yard and leaf waste.
- As of this past year, the Office of Sustainability requests data on an annual basis as a part of our Sustainability Strategic Plan data reporting. Waste data comes from the following groups: Facilities Services (which our office is a part of, this includes the regular waste and recycling streams [what we count as our recycling rate], motor oil recycling, scrap metal recycling, battery and light bulb recycling), dining services (for compost data), procurement (for paper shredding data and some data on ink/toner recycling), IT Services (for some e-waste data), and from our office (for e-waste data from our collection events). Please note that the diversion rate reported on the previous page is an estimate based on our fiscal year 2011 recycling rate and fiscal year 2010 diversion rate data. We are currently finalizing our fiscal year 2011 data for a number of areas, including diversion rate. We would like to collect C&D data but so far there has not been a system in place for contractors to report it to the

University, other than that they are complying with the City's C&D recycling requirements and those for LEED, if applicable.

- Managers/Project Leaders are required to provide monthly reports to my office as part of their approvals for payment. Accounting also forwards copies of any appropriate invoices.
- Data is reported directly by vendors. Compost weights are reported quarterly by the department collecting this material.
- From offices with which we enjoy good communications, we receive and tally the data monthly. From offices with which we do not have reliable communications, we get the annual data they report and use the previous year's data. From other offices, we do a volume to weight estimate based on reported refuse volumes.
- Our waste service provider, *Company X*, sends the monthly data several offices across campus including Recycling and Sustainability. We have one service provider, however, there are a couple of buildings that have their own contracts and pay for their own waste removal with this same provider.
- *Company X* project managers are supposed to report recycling data, but the reports are not always made.
- Through the Chair of our Waste Reduction working group, who is also the Director of our Building Services program.
- There are a few off campus areas that are on the city route for waste/recycling pick ups. We are constantly working to expand our campus boundaries for reporting and the challenges to this usually include finding ways to accurately track waste and recycling rates when they are collected as part of the city's normal route in those areas. I send out a reminder email once per month to various constituents all over campus and some of the vendors we work with that weigh our waste/recycling for us. They send me a monthly report on their various streams of recycling/waste. We have set up various tracking systems (including specialized spreadsheets, agreements with vendors to report weights, scales for university employees to weigh their recycled items, etc.) depending on what is being collected.
- End up having to track data down annually
- Our school works with their waste hauler, *Company X*, to collect waste data on a monthly basis. *Company X* updates the monthly data using a GoogleDoc that our school has access to.
- It's challenging. Most solid waste and recycling is collected by the city Department of Sanitation instead of a private hauler. Much of it is picked up curbside along with community residential waste so it's challenging for us to receive data as it's mixed with non-University recyclables during the collection process.
- Our e-waste recycling is controlled by our Asset Management department. They report to me their recycled weight on a monthly basis. / Also, our athletic

department outsources their waste. This vendor also reports to me the monthly weights.

- Driver turns in scale house receipts daily and the combined County operated MRF/Trash Transfer station provide a monthly invoice. This applies to the privately owned and operated compost facility to which we deliver single stream organic waste.
- Personal contact by this office
- We are currently improving the process to collect all data from all campus areas. Currently it is taken from bills.
- We receive monthly reports from the haulers with contracts on campus.
- Our Admin Assistant contacts departments requesting information. We have new protocol for C&D weights when building and renovation services are contracted out. Receiving information from paper shredding companies is difficult to obtain since individual departments obtain those services separately. University Athletics Stadium waste and recycling, C&D, some Farm waste are examples of contracted out waste and recycling collections.
- Materials Management numbers are reporting annually per calendar year. We request the information from various sources.
- In a big spreadsheet (we're primitive) that is our campus waste material tracking system.
- We are dependent on weights reported by contracted vendors or university departments that may have information presented to them.

Is your office's primary recycling collection in-house or outsourced?

	Out of 46	Percentage
In-House	25	54.35%
Outsourced	5	10.87%
Combination	16	34.78%

Are there instances where your office does not directly collect and/or manage contracts for your institution's recycling?

	Out of 46	Percentage
Yes	17	36.96%

The 17 schools that answered "yes" were asked, **Does your office receive this recycling data?**

	Out of 17	Percentage
Consistently	6	35.29%
Inconsistently	9	52.94%
Never	2	11.76%

The schools that answered either "Consistently" or "Inconsistently" were asked, **Please describe the protocol for reporting this data to your office.** Again, all responses are anonymous, so any mention of the university have been redacted or changed to *University X* and any mention of contractors or haulers has been changed to *Company* X to preserve anonymity; spelling was corrected. Below are the responses:

- End up having to track down data annually.
- Monthly email with tonnage data
- Monthly, quarterly and yearly reports from the solid waste contractor and reports from other recycling initiatives.
- Our office does not manage any solid waste contracts. We only report on the results and guide the effort.
- Most data is collected via a public database that the city reports for each community district.
- The only current instance where data is not consistently reported is for a number of buildings off the campus, which have a variety of uses, some for campus, some spaces leased to non-affiliated users. This waste generated due to University functions is currently difficult to weigh and report as it is not collected with the campus waste, but mixed.
- Recycling Coordinator solicits requests for data annually to individual departments, while compiling Annual Report.
- From offices with which we enjoy good communications, we receive and tally the data monthly. From offices with which we do not have reliable communications, we get the annual data they report and use the previous year's data. From other offices, we do a volume to weight estimate based on reported refuse volumes.
- We are currently improving this process. Facilities manages these accounts and we are working to set up a university wide reporting system.
- Departments on campus work with various confidential document shredding companies. We have to contact each of these companies at the end of every fiscal year and ask for the data.
- Some data is readily available, other information must be tracked down

- We are only able to report on what is provided us. With a decentralized system of procurement this is often difficult to determine where the recyclables may be collected/sent for processing. While there are still areas/departments that provide the numbers we can include them in the overall report.
- The monthly reports. I have a contact from these off campus facilities (such as our business offices, athletics, etc.). This person is in charge of tracking their data, notifying me of any changes/problems/questions, and reporting to me monthly.

Who removes <u>recyclables</u> from your buildings? (Pick all that apply)

	University-Employed Housekeepers	Contracted Housekeepers	University-Employed Recycling Crew	Private Recycling Contractors	Other*
Out of 46	35	17	19	7	7
Percentage	76.09%	36.96%	41.30%	15.22%	15.22%

*Others that remove recycling:

- Tenants of university-owned buildings
- Students in Dorms
- Associated Students Recycling
- Students
- Recycling crew only for cleanouts, loading docks and confidential paper. Rest is custodial
- Grounds Crew
- Student Recycling Crew

Who empties your institution's outdoor pedestrian trash and recycling bins? (Pick all that apply)

	Private Contractors		University Employed Recycling Crew		University Employed Solid Waste Crew	
	Trash	Recycling	Trash	Recycling	Trash	Recycling
Out of 46	2	2	10	19	13	14
Percentage	4.35%	4.35%	21.74%	41.30%	28.26%	30.43%

	Grounds		Other	
	Trash	Recycling	Trash	Recycling
Out of 46	33	22	1	3
Percentage	71.74%	47.83%	2.17%	6.52%

*Other:

- Recycling is currently housed within Grounds
- some student collection of outdoor recyclables
- the solid waste and recycling crew are one in the same (team of 3 full time employees who do all collections for pedestrian cans and building trash/recycling)
- Associated Students Recycling
- contracted house keepers/grounds

Hospital

Does your institution have a hospital?

	Yes	No
Out of 46	17	29
Percentage	36.96%	63.04%

The 17 schools that answered "yes" were asked, **Does your hospital have a recycling program?**

	Yes	No
Out of 17	16	1
Percentage	94.12%	5.88%

The 16 schools that answered "yes" were asked, **Is the hospital's recycling and/or diversion rate included in your institution's recycling and/or diversion rate?**

	Out of 16	Percentage
Yes, it is included in the institution's recycling and/or diversion rates	5	31.25%
No, it is reported separately	0	0.00%
No, its tracked but not publicly reported	2	12.50%
No, our hospital is a separate entity and we do not track this data	9	56.25%

Multiple-Stream Versus Single-Stream Recycling

Is your institution's primary recycling collection single-stream, multiple-stream, or a combination of the two?

	Out of 46	Percentage
Single	13	28.26%
Multiple	18	39.13%
Combination	15	32.61%

The 18 schools that answered "Multiple" were asked, **Is your institution considering transitioning to single-stream?**

	Out of 18	Percentage
Yes, we're seriously considering transitioning.	4	22.22%
We're researching it, but not committed to transitioning	7	38.89%
No, we're happy with our current system.	7	38.89%

Comment from one university: *"We're actually somewhere between "no, happy with current" and "researching but not switching yet." Happy & confident in dual-stream recycling collection. Keeping an eye on developments, pros and cons of the single-stream method more on an assessment basis."*

The 15 schools that answered "Combination" were asked, **Is your institution considering transitioning to a single-stream only system?**

	Out of 15	Percentage
Yes, we're considering transitioning to single-stream only	2	13.33%
We're researching it, but not committed to transitioning entirely to single-stream	3	20.00%
No, we're happy using both systems	10	66.67%

The 15 schools that answered "Combination" were also asked, **Please explain how you use a combination of both single-stream and multiple-stream recycling**. Spelling was corrected in the below answers.

- Single stream for primary collections, centralized collection of specialty recycling like soft plastics, batteries, bulbs, electronics, C&D, green waste, etc.
- Single stream in residence halls, to mimic the state recycling program. Separate fiber from bottles and cans office and academic spaces.

- The University has traditionally used multi-stream recycling bins in outdoor public locations but is starting to make the switch to single-stream/ commingled containers. *Company X* collects the outdoor public commingled receptacles and sorts them for CRV-value recyclables, then places the non-CRV items in *Company Z's* commingled dumpsters on-campus.
- We use source separation everywhere practical, but do allow for dual stream when volume is too low and use single stream for game recycling.
- Cardboard is collected separately from the single stream bottles, cans and paper.
- Commingled drink containers are single stream. Paper is multi-stream (White Paper, Mixed Paper, Newspaper).
- Multi-stream everywhere except for the University Hospital, Conference Center and exterior recycling pitch-ins
- Glass and plastic sometimes collected together; glass/plastic/cans sometimes collected together; mixed paper collected together.
- Single stream in the residence halls and for public areas, hallways and lobbies; desk side paper stream. Baled OCC from dining, book store and receiving warehouse is hauled to the MRF. The College is paid for recycling based on a rather complex but, very fair formula; based on the amount of fiber, paper and OCC. Single stream does not return much revenue.
- Each of our divisions uses a stream that works for them. For example, our undergraduate campus uses a dual stream recycling with bottles and cans in one and paper in the other. Some of our smaller divisions use a single stream.
- Single Stream: Cardboard, electronics, bulbs, mixed metals, organics, automotive waste. Multiple Stream: Glass, plastic, metal containers.
- Residential Halls are single stream - user takes materials to outdoor collection site. Academic Buildings are multi-stream.
- In public areas the categories are: white paper, non-white mixed paper, Glass/metal/plastic
- We advertise a dual-stream recycling program. We collect most items in one single stream (plastics, glass, colored papers, cardboard, metals), but collect white office paper and cardboard separately in high-volume areas because the office paper brings a premium price from our paper mill.
- We are in the middle of a transition from an old MRF that was separated to a new single stream facility. In fact the new single stream facility is coming on line this month (July 2012). We will continue to collect our streams separately on campus in order to educate our students and staff, as well as collect rebates on streams such as paper/cardboard.

The schools that used single-stream exclusively, as well as the schools that used both single-stream and multiple-stream recycling were asked the following questions, **Were there any hurdles transitioning to single-stream?** Spelling was corrected in the below answers.

- The cost of color-coordinating the barrels, setting up each solid waste room in a way we deemed ideal for the maximum capture of recyclables, signage, outreach, and training custodial staff to be consistent.
- Education is the biggest component. Making people aware of the switch and assuring them that all items can be placed in the same container and they will indeed be recycled. Along with it, signage and containers have been a big issue. Though we've had a single-stream system for over 4 years, many containers on campus are set up for multiple streams and/or have labels to that effect. This has been a major issue on campus.
- Contamination is higher, and once you start down that path, it is VERY hard to undo if markets change (again). Our collection process is efficient enough to continue what we are doing and offset our labor with revenue generated. Our only operation costs over the last couple years have been due to enlarging the program with bins and equipment.
- Hurdles in transitioning to single-stream were primarily related to education and outreach ranging from the training of custodial staff to staff, students, and faculty. Updating signage and messaging. There was a short period of time to communicate a large amount of information. Logistically, the transition of dual stream containers to single stream containers was fairly quick... with some areas needing a longer transition period due to a number of factors
- User education, hesitation about where products went, lack of confidence in the mechanized sorting process -- fear that one non-recyclable item in a batch of recycling would cause the entire batch to get sent to the landfill
- Responsibility to our vendors to provide clean recyclable material.
- We have staff do hand-sorting of the aluminum cans and other profitable items on site. I have not seen any cost-benefit analysis for this.
- Labeling on containers, signage and training.
- One hurdle with transitioning to single stream is eliminating the revenue stream from sorting out paper
- Communication to the campus community is key. There is still a lot of confusion around the differences in what can be recycled here on campus as opposed to the surrounding community and it has been 6 years since the transition.
- We still have an abundance of infrastructure (bins) designed around dual stream.
- Education and marketing around a complex "acceptables" list; funding capital equipment.

- Consistency of bins. Inconsistency of old bins and newer bins leads to confusion in the recycling message. Change of bins and providing consistency is dependent on purchasing new ones. Bins are expensive and we have an implementation plan to make the changes.
- The biggest hurdle is getting all of the recycling bin labels changed to single stream.
- The concern that there is enough fiber in the loads for the continued revenue generation. Re-educating the campus community.
- Changing the collection bins.
- Hurdles: on undergraduate/marine campus/etc. have been rather smooth diversion rate has gone up. Publicity ensuring continuity across all campus areas is difficult. People misunderstand the process. Problems with changing all bins.
- Lack of funding and staff made it difficult to educate all of campus about the transition. We also had to change the lids of every bin on campus, which took a long time and was confusing to people since some buildings were changed and others were not.
- We transitioned to the single stream collection operationally first. A route was created for our specialized truck to only collect single stream locations on campus (Residential Halls and Dining Halls). This year we will now label the bins for the "single-stream" at campus resident halls and apartments. Since campus residents are 75% - 80% freshman, we don't expect much confusion.
- It becomes highly contaminated. It downgrades the materials, it's impossible to pull out contaminants-it's a mess to market. We will never go totally single stream, I think it's a bad idea.
- Re-educating the community, staff letting go of the old way of doing things.

What benefits do you see from the single-stream system? Spelling was corrected in the below answers.

- It's going into effect in dorms for the first time this fall. We have nothing yet to report.
- As long as folks know about it, it's a much simpler system and far easier for folks to navigate. It's also beneficial because more and more of the new staff and students arriving on campus will be familiar with a single-stream system. Recycling rates have improved, however we can't say by how much because our recycling data going back that far is not reliable (in part because waste and recycling were managed with 3 separate contracts [not including the hospital], with 2 of the contracts splitting pickups at the dorms [one vendor collected multiple-stream recycling through December 2010 while another vendor collected the dorms' trash along with trash and single-stream recycling from the rest of campus).
- Simple

- At the same time we transitioned to single stream recycling, a number of additional recycle streams also came online. As such we have experienced more positive feedback about recycling due to reduced complexity on the part of the individual making a choice which bin to discard an item into. There has been positive feedback about recycling, increased questions and interest about what can be recycled, and our diversion rate is climbing.
- Significantly increased recycling rate.
- Less containers needed indoor however the same amount needed outdoor.
- Unclear; we cannot separate those benefits from other benefits such as changes in bin placement, number of bins, and dedicated collection and sorting staff.
- Recycling rate rose by 13% and we had more room for compost and bulk recycling barrels once we consolidated all paper, cardboard and bottles and cans into one barrel.
- A benefit to a single-stream system is for a higher recycling rate. Another benefit is to have one recycling bin next to a trash bin rather than two.
- Our recycling rates jumped from 23% to 40% in the first year. The ease to the end user is the biggest benefit in our eyes.
- Higher participation rates.
- Personally, I don't think mixing paper in with glass and liquid contaminants is a benefit long term. This will greatly contaminate the paper stream, and we / Things may change/develop down the road, but as of now we don't plan to change our separating of recycling from a user (inside buildings) or collection standpoint; just because of the new single stream facility. We will continue to separate our paper and drink containers.
- Too early to tell. The University just completed the transition last month. We anticipate fewer plastic liners being used (cost savings). There is also the decreased footprint of needing only two receptacles instead of at least three.
- Decreased footprint of the program (i.e. - less bins in hallways, 1 compactor instead of several bins); decreased cost of hauling; still able to find value in scrap metal, white paper, etc. by maintaining some processes that naturally separate out recyclables so little impact on revenues; easier to train custodial and grounds staff; able to color code for recycling recognizability.
- It makes it easier on our staff, since we don't have to do any on site sorting. Single stream is also easier for our campus community to understand, making it easier (but not easy) to get them to recycle.
- Simplifies the effort to recycle and improved recycling rates.
- Lower margin of error with people attempting to recycle. They can just throw it in the single-stream recycling bin instead of trying to think how to source separate.

- Reduced collection time, fewer people needed to collect from outdoor collection sites.
- Requires less labor and containers for collection.
- Smaller foot-print for collection areas, increase in materials accepted at the MRF. Instituting a post-consumer organic waste collection route to campus academic buildings and student apartment buildings.
- Ease of use, increased participation.
- Easier collection of multiple materials. People are willing to recycle more. More positive press. Recycling rate has increased
- We have seen increased participation. People seem to really like the convenience of not having to sort into categories.
- Campus residents will not have to sort their residential waste, which is more in line with our municipality recycling system.
- Streamlined collections.
- Ease of collection, increased collection efficiency, less labor expense in processing materials, vastly improved recycling rate as a result of a simplified message for the users.

Please share any lessons learned and/or drawbacks to transitioning to single-stream. Spelling was corrected in the below answers.

- We will be working with our waste hauler to gauge outcome.
- Make sure to have an outreach campaign in place at the time of launch, ideally combined with new/updated bins (if needed) or at least widespread signage. Our office was not around at the time of the switch, so we've only been able to tackle these projects more recently. Recycling is an issue of great confusion on campus; a campaign launched on day 1 of the switch would have been a huge help. / Because public perception is so important, make sure that janitorial staff collect waste and recycling using a double barrel collection cart. Until recently, ours used a single collection cart and a variety of practices to collect material in two streams (one inside the other, one hanging off the side, etc.). This caused a lot of confusion and distrust in the system, since staff and students would see janitorial staff placing recyclables in the trash collection container, when they were depositing it in a recycling bag inside this bin).
- Again, Simple.
- The biggest logistics impact we have seen to date are a few locations that required larger or additional recycle dumpsters. This is a challenge we welcome, and are working with our waste hauler to identify ways to increase recycle collection at some locations. Converting the campus to single-stream was done in partnership with the campus Building Care team. This partnership was crucial.

- Education on the user end is key -- In addition, we found it necessary to educate custodians and dining service workers not only on how the system works and where recyclables go but also on how to answer questions posed by student users on a daily basis.
- You need to comb through every floor of every building to update stickers, signs and labels. People have more faith in what it says on their local recycling barrel than in what their recycling crew tells them verbally.
- We use picture signs now to educate the campus community on recycling. We take photos that are specific to each location and print those on our signs to be posted in that facility. For example: Recycling signs for a food cafe on campus would have pictures of the cups, utensils, packaging, etc. that are specific to that facility on the sign so end users can take a quick look at the picture and know which container to place the item in.
- Signage is key.
- The issue with not using liners is our biggest challenge and we have yet to find a solution. Overall, this transition is a sustainable step because it will cut down greatly on our waste of plastic bags; however we have very limited staff, vehicles, etc. to do collections; so it will be a great challenge to overhaul our current collection system and revamp.
- We have been seeing a lot of contamination in the recycling, but I don't believe we can attribute that solely to being single stream.
- Retraining people and overcoming past no-no's (that are now acceptable) can be difficult. Also, surrounding municipalities may not be recycling single stream in their programs.
- Major drawback is people treat single stream receptacles like trash-cans.
- The consistency of the bins; staff training is important so they understand the changes.
- Using single-stream recycling you have the ability to lose the education component of source separating. You also have the ability to reduce the amount of items placed in the office pack bins, which is a high value commodity, because someone can now place paper a single-stream/commingled bin.
- You may receive less money from selling single stream vs. a separated stream but you save more money in labor costs. People recycle more if everything can go into one bin.
- Be very clear that it is single stream RECYCLING. Not all the solid waste in one bag/bin and some one will sort it out.
- Limited competition when shopping for disposal sites.
- Single Stream at residence halls has not posed any drawbacks.

- Single stream can be confusing for people if you do not use appropriate verbiage. Avoid saying things like "all in one". Make sure people know that "all recyclables are mixed".
- Be sure to calculate the labor savings from the reduction of collecting multiple streams inside the buildings. We found that the cost avoidance in labor on the interior of the buildings for our custodial staff more than offset the revenues generated from the separate streams.

All 46 participating schools were asked, **Any additional information we should know about your recycling program?** Any mention of the universities have been redacted or changed to *University X,* and any mention of contractors or haulers has been changed to *Company* X to preserve anonymity; spelling was corrected. Below are the responses:

- Allow plenty of time to coordinate the infrastructure and messaging.
- Not at this point. We are about to pilot some new bins in a few campus buildings (including side-saddle containers for offices) and we may have more to share at that point. We will also be conducting our first waste audit this fall, so hope to have much more information then to further develop our program.
- Our University's transition to single stream was done in parallel to our community's transition. As we are in a small city, staff, faculty, and off campus students were also hearing radio ads, receiving mailings, and reading press coverage about the community single stream transition that mirrored the marketing campaigns being done on the campus. The single stream recycling collected within our community is handled in two different ways. Residential recycling waste is sorted at a recycle center with highly technical machinery. The single stream recycling collected from businesses (and our campus) where contamination is low is sorted and marketed directly from our local county facility.
- Join RecycleMania to make reporting standards consistent across Ivy Plus group.
- *University X* is unique in that it has a partnership with its hauler, *Company X*, to operate its waste reduction, recycling and composting program. *Company X* is a family-owned, independent hauling company that provides recycling and garbage services, including collection, processing, and marketing of recyclables, operates a community drop off center, and provides recycling education and information for the *University X* community. Working with the Building, Grounds, and Maintenance Department, we continual plan and implement new programs to reach Zero Waste.
- We have a staff of 3 hard working employees that collect all outdoor pedestrian cans (recycling and trash), as well as all of the trash/recycling coming out of all buildings on campus and surrounding campus. They also haul off loads of cardboard bales, metal, etc. We have a new Surplus Property program started in 2011 that collects items from various departments on campus, and then allows other departments to come and re purpose these items. This is a small program (one surplus coordinator

with intermittent student help at the moment) but we are growing quickly in popularity and hope to expand soon (we are hiring a full time helper soon). We house these items in an offsite warehouse where university employees can come 'shop' for items (university use only: they can't take items for personal use). Surplus is a mostly free service for departments (free pickups of all items, and $30 flat fee for delivery of your items). Items are all given to departments free of charge.

- I think you should also be asking about education and outreach efforts i.e.. are there ongoing educational programs directed at recycling and if so, who runs them (which dept.). Also, would be good to know where in the university structure the waste and recycling program falls i.e.. Custodial, Grounds, dept. of its own?, within facilities or Office of Sustainability, etc. This program falls under the umbrella of Grounds Maintenance, but works closely with Custodial (both depts. fall within the University's Facilities Services branch). Are there University goals to increase recycling/diversion rates? At *University X*, the University has committed (as part of the University's Sustainability Strategic Plan) to increase recycling rate by 25%, above baseline 2009 levels, by June 2013. Another goal is to reduce MSW by 20% during the same timeframe. We are now being reconvened to develop more aggressive and longer-term Waste Reduction targets.
- Collaboration with key stakeholders. One person taking the lead, not the sustainability director, on recycling to help push through implementation and evaluation. With that person, a team of staff who help with implementation and a group of students to help promote the initiative.
- We are sticking with a multi stream program for the foreseeable future based on our waste and recycling being picked up by both the city and private haulers. That said, the more sorted the materials the more effective the recycling program especially for paper. We prefer to support as much local recycling as possible and if we went single stream more of our output would be sent oversees. Right now since all of our paper is not comingled it is being recycled at a plant in *Location X* that manufactures new pizza boxes that are then sold to local pizza shops. It's a good lifecycle we want to continue to support as well as a good incentive to members of the University who care about the local economy and are perhaps less interested in being green. If we switched to single stream, the plant would not be equipped to take our comingled paper.
- Due to budget constraints, we have an extremely low staffing level. Recycling Coordinator is responsible for Refuse, Recycling, and Moving Services departments. Current Recycling collections staff consists of four full time employees.
- We are committed to being a self-hauler to insure that bins and collection areas are always cleaned up and looking neat. We use small, non-CDL requiring trucks. The lighter weight trucks provide flexibility and better visibility, for the driver, on campus and cause less wear and tear on campus roads, fire lanes and sidewalks they need to travel to access buildings. Since no special license is required, nearly anyone can operate the trucks, including students over 21 years of age.

- *University X* is in transition to really improve our program over the next year. This will significantly change our recycling rate and the information we provided for this survey. Need to standardize across campus very important – lends to difficulty analyzing parts of waste stream to focus on – contamination can increase thus are future plan is to really focus on publicity and standardizing all bins across campus areas. I think overall it has been great but it is difficult for adaptation in some areas, specifically the hospital. This is why the next step is again incrementally implementing standards for each campus. Creating standards for reporting tracking bin collection, bin layout, bin look, and branding the recycling program will make it much stronger. Single stream allows us to do this very effectively as it reduces need for multiple bins etc.
- *University X's* current diversion rate goal is 65% by 2015.
- Our recycling program is strange because we don't handle solid waste and are student staffed. All of the "waste" management parts are all separate-this is stupid, it needs to be integrated. I hope this will happen but I proposed that the Recycling Program be re-branded as the Zero Waste Program as it's not really a recycling program as we handle multiple materials, do a lot of waste reduction, really want to reduce campus waste etc. It looks like this will be our new name. BUT ideally one group would handle the inside collections-trash, compost, recycling to centralize to loading dock areas. I also want the purchasing to become the Materials Management dept., take in the ZW Program (which would include all the recycling/composting and garbage) and re-vamp the entire way we do trash on campus. As far as tracking, we are using the stone and chisel method. But check with Re-Trac as their campus-tracking program is awesome.
- The sale of recyclables and its revenue is outlined by state statute. Revenues are to be used for program improvements/enhancements.

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Duke University would like to thank the schools that participated in this survey for your time and insightful feedback. We hope that the information will prove useful in your efforts to increase recycling and waste reduction at your institutions. Please feel free to contact Duke with questions or comments about the results.

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Appendix 2: Duke's 2004 EPP

Duke University

Environmentally Preferable Purchasing (EPP) Guidelines

A. Purpose

Recognizing our impact as a major purchaser of goods and services, Duke University gives preference to environmentally friendly products whose quality, function, and cost are equal or superior to more traditional products. This policy will

- conserve natural resources
- minimize pollution
- reduce the use of water and energy
- eliminate or reduce environmental health hazards to workers and our community
- support strong recycling markets
- reduce materials that are landfilled
- increase the use and availability of environmentally preferable products
- reward vendors who reduce environmental impacts in their production and distribution systems or services
- create a model for successfully purchasing environmentally preferable products that encourages other purchasers in our community to adopt similar goals
- support locally produced goods and services
- educate ourselves, our vendors, and our end users

B. Definitions

Environmentally Preferable Product: A product that has a lesser or reduced negative effect on human health and the environment when compared to competing products that serve the same purpose. This comparison may consider raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, and disposal of the product. This term includes recyclable products, recycled products, and reusable products.

Life Cycle Analysis: The comprehensive examination of a product's environmental and economic effects throughout its lifetime, including new material extraction, transportation, manufacturing, use, and disposal.

Practicable: Satisfactory in performance and available at a fair and reasonable price.

Post-consumer Content: The percentage of materials collected from end-users and recycled into the new product.

Recyclable Product: A product that, after its intended end use, can be demonstrably diverted from the University's solid waste stream for use as a raw material in the manufacture of another product, preferably higher value uses.

Reusable Product: A product, such as a washable food or beverage container or a refillable ballpoint pen, that can be used several times for an intended use before being discarded.

C. Data Collection and Performance Reporting

For purposes of setting goals and evaluating the performance of the University's green purchasing program, vendors may be requested to report the environmental attributes of their products.

Procurement and Supply Chain Management responsibilities:

- Collaborate with vendors to design and implement a data collection system for tracking the environmental attributes of products
- Compile records for the purpose of producing an annual summary of the University's environmentally responsible purchasing actions, and for evaluating the effectiveness of these actions in reducing the environmental impacts of University procurement
- Identify opportunities to educate end users about the impacts of their product choices

D. Priorities

- Ensure the health and safety of workers and citizens.
- Support the Durham economy by purchasing goods and services from local vendors
- Procure goods and services that are environmentally friendly without compromising cost or quality.
- Comply with all local, state, and federal laws that govern our procurement activity.

E. Areas of Focus

1. Source Reduction

Reducing unnecessary waste at the source allows the University to both mitigate the inefficient use of our natural resources and benefit economically from decreased handling and disposal costs.

Procurement activity may include:

- Institute practices that reduce waste, resulting in the purchase of fewer products whenever practicable and cost-effective, but without reducing safety or workplace quality.
- Purchase remanufactured products such as laser toner cartridges, tires, furniture, equipment and automotive parts whenever practicable, but without reducing safety, quality or effectiveness.
- Consider short-term and long-term costs in comparing product alternatives. Include evaluation of total costs expected during the time a product is owned, including, but not limited to, acquisition, extended warranties, operation, supplies, maintenance, disposal costs and expected lifetime compared to other alternatives.
- Purchase products that are durable, long lasting, reusable or refillable.

- Request that vendors eliminate packaging or use the minimum amount necessary for product protection to the greatest extent practicable.

- Request packaging that is reusable, recyclable or compostable when suitable uses and programs exist.

- Reuse pallets and packaging materials.

- Require that all equipment bought after the adoption of this Policy, when practicable, be compatible with products and services that provide source reduction benefits.

2. Recycled Content Products

The University has made significant investments in developing a successful recycling system and recognizes that recycled content products are essential to the continuing viability of that recycling system, and for the foundation of an environmentally sound production system.

Procurement activity may include:

- products for which the United States Environmental Protection Agency (U.S. EPA) has established minimum recycled content standard guidelines – such as printing paper, office paper, janitorial paper, construction, landscaping, transportation, vehicles, and non-paper office products – and which contain the highest post-consumer content practicable, but no less than the minimum recycled content standards established by the U.S. EPA Guidelines.

- Copiers and printers that can be used with recycled content products.

- Re-refined lubricating and industrial oil for use in vehicles and other equipment, as long as the product is certified by the American Petroleum Institute (API) as appropriate for use in such equipment.

- Asphalt concrete, aggregate base or portland cement concrete for road construction projects that contains recycled, reusable or reground materials.

- Recycled content transportation products including signs, cones, parking stops, delineators, and barricades.

3. Energy and Water Savings

Recognizing that the generation of electricity is a major contributor to air pollution and global warming issues, and that clean water is a finite resource, the University values products that minimize the use of these valuable resources.

Procurement activity may include:

- Energy-efficient equipment with the most up-to-date energy efficiency functions, including, but not limited to, high-efficiency heating and cooling systems.

- Efficient lighting with energy-efficient equipment.

- Products for which the U.S. EPA Energy Star certification is available and which meet Energy Star certification, when practicable. When Energy Star labels are not available, choose energy-efficient products that are in the upper 25% of energy efficiency as designated by the Federal Energy Management Program.

- Water-saving products.

4. Landscaping

Supporting low maintenance and environmentally sensitive landscapes minimizes the unnecessary use of fertilizers and water resources, therefore reducing the University's impact on the natural environment.

Procurement activity may include:

- Employ sustainable landscape management techniques for design, construction and maintenance. These techniques include, but are not limited to, integrated pest management, grasscycling, drip irrigation, composting, and procurement and use of mulch and compost that give preference to those produced from regionally generated plant debris and/or food waste programs.

- Minimize waste by selecting plants that are appropriate to the microclimate, species that can grow to their natural size in the space allotted them. Place preference on native and drought-tolerant plants that require no or minimal watering once established.

- Limit amount of impervious surfaces by procuring permeable substitutes such as permeable asphalt or pavers for walkways, patios and driveways.

5. Toxics and Pollution

The use of toxics and the generation of pollution should be minimized to reduce risks to health, safety, and the environment.

Procurement activity may include:

- Refrain from procuring cleaning or disinfecting products (i.e. for janitorial or automotive use) containing carcinogens, mutagens, or teratogens. Chemicals to be avoided are listed by the U.S. EPA or the National Institute for Occupational Safety and Health on the Toxics Release Inventory.

- Phase out chlorofluorocarbon-containing refrigerants, solvents and similar products.

- Procure readily biodegradable surfactants and detergents that do not contain phosphates.

- Maintain buildings and landscapes, manage pest problems through the application of prevention techniques and physical, mechanical and biological controls

- Procure products with the lowest amount of volatile organic compounds (VOCs), highest recycled content, and low or no formaldehyde in materials such as paint, carpeting, adhesives, furniture and casework.

- Reduce or eliminate the use of products that contribute to the formation of dioxins and furans, including, but not limited to:

    - Paper, paper products, and janitorial paper products that are bleached or processed with chlorine or chlorine derivatives

    - Products that use polyvinyl chloride (PVC), including, but not limited to, office binders, furniture, flooring, and medical supplies

- Procure products and equipment with no lead or mercury. For products containing lead or mercury, give preference to those with lower quantities of these metals and to vendors with established lead and mercury recovery programs.

- Consider vehicle procurement alternatives to diesel such as compressed natural gas, biobased fuels, hybrids, electric batteries, and fuel cells, as available.

6. Forest Conservation

The University has made significant investments in sustainable forestry, evident in the preservation of 7,000 acres of Duke Forest. That commitment extends to the purchase of wood products, in recognition of the valuable human and ecological health services provided by forests.

Procurement activity may include:

- Procure wood products such as lumber and paper that originate from forests harvested in an environmentally sustainable manner. Give preference to wood products that are certified to be sustainably harvested by a comprehensive, performance-based certification system. The certification system shall include independent third-party audits, with standards equivalent to, or stricter than, those of the Forest Stewardship Council certification.

- When practicable, procure locally, sustainably harvested wood.