Waste Audit and Waste Management Education at College of the Rockies Cranbrook

MGMT 490, Capstone Final Report

Jennifer M Jenks

Natalie Panattoni

College of the Rockies

Greg McCallum

Table of Contents

Table of Figures

Introduction

Waste sent to landfill is often comprised of many materials that could have been re-used, re-purposed or recycled. There is also far too much waste being produced globally. According to Duke University, “the average person [residing in the United States] generates 4.3 pounds of waste per day” which equates to over 1,500 pounds per year (Duke University, 2016). Once the waste reaches landfill, it releases methane gas as well as soil and water contaminants (Environment Victoria, 2013). Given the environmental impacts of landfill waste, an increasing number of educational institutions, municipal governments and businesses are adopting waste-reduction strategies (Musulin, 2015). The current research project provides the College of the Rockies with a baseline measurement of current waste production. Stated alternatively, this research informs the College of the Rockies on how much waste is being generated at the Cranbrook campus. A general understanding of the types of objects being thrown away is also gained by this study. Such information may be used in the future to measure waste reduction progress and may also be used as a benchmark against waste production at similar educational facilities. Overall, it is the goal of the researchers to provoke positive change that ultimately reduces waste output.

Research Question and Objectives

Central to the development of this research, as determined by the researchers and the Sustainability Committee of the College of the Rockies, is the following research question:

What is the quantity, and nature, of waste destined for landfill currently produced at the College of the Rockies Cranbrook Campus during normal operational hours?

The overarching goal of this research is to reduce waste at the Cranbrook College of the Rockies campus. The present study has three objectives designed to make waste reduction possible. Establishing a methodology for measurement is the first objective. Conducting the waste audit to create an initial baseline measurement of waste is the second objective. The third objective is to identify appropriate waste management strategies for the college as well as forecast waste reduction goals and expectations. Support from the college community is needed to ensure that best waste disposal practices are understood and adopted.

The Project Collaborator

Organizations who worked in collaboration with this study include College of the Rockies Cranbrook and SouthEast Disposal. The Sustainability Committee at College of the Rockies undertook the tasks of providing personal protective equipment, assisting with the measurement of waste, and maintaining communications with SouthEast Disposal. Participation of the project collaborators is given further description below in the methods sections.

The Issue Identification Process

The Sustainability Committee at the College of the Rockies was the first to express interest in knowing how much waste is being generated at the Cranbrook campus. As such, the issue under research has been identified through a client-driven process. A needs assessment component also exists for this project. Assessment of waste audit methods and determining what is appropriate given the available resources at the College is the responsibility of the researchers. The literature review and development of project methodology therefore represents the needs assessment component.

Sustainable Business Issue: Waste Management

The core industry under study is the industry of waste management and recycling. The current project addresses waste management as a sustainable business issue. Waste Management may be analyzed in terms of how waste output at the college is related to the economic, environmental and social health of the college community. The following sections interpret the relationships between waste management and the concepts of economic feasibility, environmental health and social health:

Economic

A waste audit is defined as the processes of studying, measuring and analysing the waste produced in a given area, or facility, within a given time frame. For most organizations, a waste audit is economically feasible. The total cost of the current waste audit was approximately $450 before taxes. For a summary description of the costs incurred, please refer to appendix G on page 41. At the conclusion of a waste audit, there is potential for financial benefits to exist. Over the long-term, reductions in waste may result in fewer waste hauls being necessary, and thus a reduction in waste hauler expenses.

Environmental

Reducing waste has a positive impact on the overall health of the planet. Sending out less waste means less fossil fuels burned in the process of transporting waste. Although recycling requires transportation as well, there are significant benefits to avoiding the landfill. According to the Provincial Government of Saskatchewan, “the more waste we put in the ground, the more our landfills release methane gas, a contributor to climate change” (Government of Saskatchewan, 2013). Another contaminant produced in landfills is known as leachate; “a toxic sludge that can kill plants and animals” (Government of Saskatchewan,

2013). Most concerning, leachate can “contaminate our water supplies” and is therefore capable of polluting a large geographic area not confined to the landfill it was produced in (Government of Saskatchewan, 2013). The Saskatchewan Government urges that the sustainability issue of waste is not receiving the concentration that it is merited; “Waste causes pollution, contributes to climate change and squanders more money, energy and natural resources than most of us realize” (Government of Saskatchewan, 2013). Considering the impacts of waste, the overarching objective of the current research study is indeed waste reduction. For waste to be successfully reduced, however, it must be measurable. Understanding what types of waste are being produced and in what quantities will help to direct waste reduction efforts in an effective manner. Further, measurement allows for clear goals to be set and for celebration as progress is achieved. The present study, therefore, establishes a baseline of waste output. The baseline may be used to set specific and clear waste reduction objectives. Future audits can then be compared to the baseline for the purpose of tracking waste reduction and waste diversion progress.

Social

Socially, this project aims to inspire positive behavioural change among college community members to reduce waste. It is the expectation of the researchers that by conducting the present study, individuals within the college community will become more aware of their own contributions to landfill waste. The results of the waste audit may be used to direct future efforts in educating the college community on how to effectively sort waste. For example, as discussed in the Waste Reduction Potential section on page 22, it is crucial that objects sent for recycling be clean. Rinsing objects such as food containers in order to recycle them is one way many individuals could reduce their contributions to landfill waste. Waste reduction

strategies initiated by the college or the Sustainability Committee may be refined and improved based upon audit results. There is hope that students and faculty will reduce waste not only on campus, but will also use their knowledge outside of the college.

Anticipated Research Benefits and Outcomes

The anticipated benefits from this project to the Sustainability Committee, the College of the Rockies, and the researchers are:

- Quantitative data regarding waste production which will prove useful to the College of the Rockies,
- Academic materials which can be referenced for the benefit of future waste audits or other applied research,
- Potential financial benefit to the college or Sustainability Committee from waste reduction,
- Improved brand strengths for the College of the Rockies, South East Disposal, and the RDEK as a result of supporting environmental initiatives,
- Societal benefit of a reduction in waste being sent to the RDEK landfill,
- Personal benefits to the researchers of applied research experience and the exceptional credibility to which it is related on a resume.

Waste audits give stakeholders a clear idea of how much waste is being produced. The relative amount of waste that can be deferred from landfill by improving sorting practices is also made apparent. By bringing specific and relevant waste issues into attention, a reduction in waste sent to landfill is encouraged. The baseline measurement of waste obtained in the audit can be used to track progress of waste reduction in proceeding years.

The researchers expect to benefit from applied research experience and earn a credible addition to their professional resumes.

Research Deliverables

- Documentation of waste audit procedures,
- Baseline measurement of waste production at the College of the Rockies Cranbrook Campus which may also be used as a benchmark measurement for comparison to other educational institutions,
- Analysis of waste content in terms of identifying recyclable and compostable components,
- Recommendations for the improvement of current waste management practices

Literature Review

The purpose of the literature review was to determine the optimal methodology for conducting a waste audit at the College of the Rockies Cranbrook campus. Completed prior to project implementation, the literature review explores how successful waste audits have been conducted at other institutions/facilities. From this review, the researchers identify possible benefits and challenges faced in other waste audits. Conclusions involving other educational institutions are of particular relevance, since they allow predictions into how a waste audit may be conducted at the College of the Rockies. Applying the knowledge they acquired from the literature review, the researchers proposed a waste audit method tailored to the needs and limitations of the College of the Rockies.

Determining Waste Quantity

Two basic methods have been identified for determining waste quantity. CleanRiver, a recycling products company, suggests weighing the waste by bagful and recording the results (Midpoint International, 2016). Another method identified is to measure waste by volume, such as the volume of the dumpsters used multiplied by the number of dumpsters filled (PLAN, 2015). In order to gain further understanding of these methods, three waste audits at Canadian educational institutions were reviewed including mini waste audits at the University of Alberta, an audit at Humber College in Toronto Ontario, and an audit at St. Thomas Aquinas Secondary, also in Ontario. None of these waste audits reviewed used a volume-based method. There was variance however, in how much of the waste was weighed and the sorting methods used.

At the University of Alberta, mini waste audits are conducted every quarter year to measure contaminants in recycle streams (Leblanc, Kwasny, Yan, & McCartney, 2016). A recent publication in Bio Cycle describes the mini-audit process; “Sustainable operations and building maintenance staff worked together to conduct mini waste audits. They selected a sample of Zero Waste stations, set aside the material generated from about half of a day, then sorted and weighed it” (Leblanc, et al, 2016). To allow for a necessary amount of efficiency, “these audits used simplified categories of ‘correct’ or ‘impurity’” (Leblanc, et al, 2016). By regularly conducting mini-audits, the University receives timely feedback on contamination levels and the effectiveness of current waste management. In addition, the University receives information from their waste hauler indicating the weight of total waste hauled (Leblanc, et al, 2016). Given that total waste is already being weighed, waste audits are used exclusively to measure contaminants and are thus quite simple to execute.

When waste hauler weights are not available, a more comprehensive waste audit is needed. The Humber College in Toronto Ontario conducted their own audit by collecting waste and recycling bags from one day and loading them into a temporary dumpster for the day. The dumpster was hauled offsite for sorting and weighing. Of all the waste collected, only a relative 50% sample was sorted and weighed. The resultant amount was then extrapolated to reflect a full day's waste production (Urban Resource Group Inc., 2015). Although a one-day audit would not be as accurate as having waste hauler weights, it does serve to indicate the waste production on at least a notional level.

St. Thomas Aquinas, a secondary school in Ontario, also completed a one-day waste audit. As was the case with Humber College, St. Thomas Aquinas Secondary did not sort and weigh all of the waste. The institution weighed a minimum of one quarter of the total number of bags. Bags were chosen to be weighed at random with no discrimination to defining characteristics such as size, weight or smell (St. Thomas Aquinas Secondary, 2012). Compared to the method used by Humber College, the method at St. Thomas Secondary is likely to have the higher risk of error due to the small sample size. However, this method would require less labour to measure a lower number of bags.

Determining the Nature of Waste

There are many different ways that the nature of waste can be determined. The elected method depends on the goals and limitations of the institution. As described above, the University of Alberta only uses two categories: "Correct or Impurity" (Leblanc, et al, 2016). An audit at Appalachian State University was similarly focused, as it was mostly concerned with the amount of waste being sent to landfill that could have been recycled in their existing recycling program (Maxwell, 2014). Appalachian state also included other

categories that could potentially be added to their program. Their categories for sorting waste are: “program recyclables, other recyclables, compostable materials, and all other materials. Program recyclables are recyclables accepted in Appalachian’s existing single stream recycling program” (Maxwell, 2014). Both universities hand sorted the materials into their categories.

In contrast, St. Thomas Aquinas took a comprehensive approach to their waste sort by using the following categories:

- Recyclable plastic (#1, 2, 5)
- Non-recyclable plastic
- Recyclable paper (including cardboard and newsprint)
- Organic paper
- Recyclable Metal
- Glass
- Food and yard waste
- Multi-composite/other waste

(St. Thomas Aquinas Secondary, 2012). The extensive sorting system at St. Thomas is most relevant as a diagnostics procedure to determine which materials could be most easily diverted from landfill if a recycling system were to be established. This contrasts with the more simplified university audits, which were concerned with the effectiveness of current recycling programs.

The audit at Humber College had an additional objective regarding the nature of waste. When collecting waste, the auditors labeled the bags by colour according to which campus it

was from, and where on campus the waste was disposed of. The table below represents the colour coding system Humber College used to determine the nature of its waste. (Urban Resource Group Inc., 2015)

Humber College Waste Identification

Note: Common areas include hallways, classrooms and washrooms

	Residences	Food Areas	Common Areas
Lakeshore Campus	Yellow	Red	Black
North Campus	Green	Blue	Clear

Figure 1: Humber College Waste Identification

The method used by Humber to classify waste streams pinpoints the areas that are producing the most waste. The institution can then effectively choose where to focus its waste reduction efforts. (Urban Resource Group Inc., 2015)

In all of the above examples, the goals of the institution dictated the categories used for sorting waste. Categories may be derived from observations made when sorting, location of waste production, or if it is divertible from the landfill or not. Another observation is that the waste was sorted by hand which is a labour-intensive process. If the labour requirement is prohibitive, an alternative to hand sorting is a visual estimate method (PLAN, 2015). To conduct an audit with the visual estimation method, the weight of one dumpster worth of waste must be known. Relative proportions of different types of materials within the dumpster are then visually estimated with the total weight allocated to the different materials as a result of that estimation (PLAN, 2015). Given the high risk for error, this method is not recommended unless it is the only method available.

Reflecting Normal Operations

A challenge faced when conducting waste audits is extrapolating data to represent more than one day's worth of waste. The amount of waste produced day to day varies for reasons due to seasonality, attendance and other unusual things. As described by the Post Landfill Action Network, "Examples of unusual things that can affect waste generation during the school year include:

- Weather: snow and rainwater add weight to dumpsters
- Winter sand tracked indoors and swept up by housekeeping
- Renovation Projects
- Campus-wide events" (PLAN, 2015).

It is necessary therefore, to consider how the waste audit results or methodology may need to be adjusted to reflect normal operations. For example, the University of Alberta can adjust for seasonality by taking measurements every quarter year for several consecutive years and comparing results from the same quarter when measuring progress. Another option is to extend the waste audit period to encapsulate waste produced over several days. The University of Northern British Columbia conducted a waste audit in 2008 that used a five day waste collection period (Smyth, 2008). The data was used to estimate average waste production over the months of September to April (Smyth, 2008). When determining how to extrapolate data, institutions should also consider the average number of occupants on a given day, and which days are busiest or slowest for attendance (Midpoint International, 2016).

Benefits of Conducting a Waste Audit

Many benefits of conducting a waste audit have been identified through the literature review. One benefit that is of interest to the College of the Rockies is establishing a baseline of waste production. This waste output can be used to map progress of an institution's efforts to reduce waste (Ontario Ministry of Environment, 2008). Additionally, waste audits can determine the nature of generated waste, allowing waste sorting habit changes to be targeted at the source of the problem (Urban Resource Group Inc., 2015). A financial benefit may also exist if it is found that the current waste hauler frequency is higher than necessary, and the expense of waste hauling can be reduced (Midpoint International, 2016). Finally, conducting a waste audit is symbolic of an institutions commitment to sustainability. Demonstrating such a commitment enhances the public image of an organization, namely the College of the Rockies, and helps to communicate the importance of waste reduction initiatives.

Research Model

Proposed Model

The original research model proposed for the waste audit by the researchers was offered in consolidation with the literature review as well as with specific needs and limitations of the College of the Rockies. Resource limitations, such as limits on available time and storage space, required that waste involved in the study be collected over the course of one day.

The initial plan was to have the waste collected by SouthEast Disposal and transported to the Henderson Pavilion located on the Wycliffe Exhibition grounds for sorting in early January. Due to schedule restrictions, the audit was rescheduled for February 1st and 2nd. The additional time allowed for a change in location as well as a thorough review of logistics

to ensure the success of the audit. SouthEast Disposal allowed the sorting team to sort the collected waste in their industrial yard, reducing costs significantly. The sorting team separated waste into key categories, weighing sorted divertible waste by the bagful, comparable to the total weight of all waste provided by SouthEast Disposal. Raw data was recorded to determine key ratios of waste destined for landfill and divertible waste. For an example of the data collection sheet, see Appendix B.

Extrapolating Data

In order to accurately extrapolate the waste audit data, and therefore estimate the amount of waste produced throughout an operational year, an estimate of the college population is required. Unfortunately, the researchers were unable to obtain a population estimate from the Internal Research department due to exceptional time constraints on the department. Future researchers may obtain population information with more ease by requesting the number of full-time equivalent students per semester from internal research at least three months before the summary of their project. The number of full-time equivalent students in each semester would then serve as the populations in the calculation (in appendix H) to arrive at a more accurate estimation of annual waste.

Literature Review and Research Model Summary

Determining the amount, and nature, of waste produced at the Cranbrook College of the Rockies has been accomplished through a one-day waste audit. Audit examples reviewed in this study determined waste quantity by weighing their waste. If researchers did not have access to a scale, they planned to use a volume based measurement. The nature of waste produced could have been determined in many ways. After reviewing the methods of several educational institutions, the researchers feel that sorting by a few key categories such as

paper recyclables, refundables, and plastics, is most appropriate for the College of the Rockies. Careful consideration has been given to events that may alter audit results, such as attendance fluctuations. The researchers hope to provide a reliable baseline measurement of waste which can be used in the future to measure waste reduction progress.

Research Methods

Determining Waste Quantity

The waste audit began by collecting waste from the College of the Rockies Cranbrook campus over a one day period on Wednesday, February 1, 2017. For purposes of the audit, SouthEast Disposal supplied a rollaway bin and placed it at the kitchen delivery entrance, moving the permanent bin elsewhere on campus where it would not be used. Waste from all departments in Kootenay Centre, Summit Hall, Pinnacle Hall, and the Aboriginal Gathering Place was collected in the rollaway bin for the audit. On the morning of February 2, 2017 SouthEast Disposal picked up the rollaway bin (and replaced the regular bin) hauling it offsite to the SouthEast Disposal yard for sorting. The waste was weighed and sorted by a delegated crew including the researchers and other volunteers. A total weight of all waste was provided by SouthEast Disposal.

Determining the Nature of the Waste

Nature of waste, for the purposes of this project, is defined by the types of substances found in the waste as well as to what extent the total amount of waste is comprised by each material. For example, if a proportionately large amount of paper is found, it could be said that the nature of the waste is largely paper. To determine the nature of waste produced at the college, the waste collected has been physically sorted in categories. Certain categories of material that comprise the nature of waste are of particular interest to the College

because they represent waste or recycle streams that could be diverted from landfill in the future. The Sustainability Committee at the College has already committed to purchasing fifteen new waste sorting bins that encourage proper waste sorting and recycling practices. The new bins are to be strategically placed around the college to encourage their use. Categories of waste that the bins allow users to sort include paper recycling, refundables, and other waste. In addition, the Sustainability Committee has expressed interest in including a fourth sorting pod for organic waste and compostable materials. Given the potential capacity of the new waste sorting bins, the categories of waste that are of value in the audit are;

- Paper recycling,
- Other “yellow bin” recyclables such as numbered plastics and tin cans,
- Refundables, including pop bottles, beverage cans and water bottles,
- Compostable materials,
- Clear, food grade glass, and
- Other waste.

Once sorted, each individual category was weighed to determine its proportion of the overall quantity of waste. Taken together, the different proportions of the six waste categories will define the nature of the waste.

Reflecting Normal Operations

The researchers will face several challenges in attempting to reflect the normal operations of the college with their research results. Things such as weather (precipitation adding weight to dumpsters), sand tracked indoors and swept up, renovation projects and special on-campus events affect waste generation during the school year (PLAN, 2015). Researches

will also consider the average amount of faculty and students on campus on a given day as these numbers fluctuate throughout the week and in different seasons. Choosing an appropriate week day to conduct the audit, such as one with relatively high attendance on campus that does not coincide with renovation projects or special events, will help to minimize distortion in the amount of waste generated that day. At the College of the Rockies, Tuesdays and Thursdays have the highest student attendance. Monday is a routine garbage pick-up date, which would leave Tuesday as an ideal weekday to begin the audit because the day is begun with no waste currently on campus. Even with these considerations, due to scheduling conflicts, the waste was collected on a Wednesday. Garbage collection by SouthEast Disposal is Monday, Wednesday and Friday; therefore the rollaway bin was empty on Wednesday morning, ready for waste collection. On the following day, the waste was sorted and weighed. To ensure that the college community does not distort audit results by altering their behaviour, the waste audit was not public knowledge to all of the college community. Only the sorting crew, the Sustainability Committee of the college, and members of the janitorial staff were aware of the date and duration of the waste audit prior to its conduction. During the waste audit, care had to be taken that data was recorded promptly and in a manner that is easy to understand. Recorded weights were always accompanied by the category of waste to ensure that valuable data was not lost and all of the waste was included in the data analysis. To this end, every weight will be linked with one of the following descriptions: paper, recyclable plastics, clear glass, tin cans, refundable beverage containers, paper towel, and non-divertible waste. The researchers took the raw data for use in data analysis and extrapolation. Extrapolation is the process of converting the amount of waste generated in one day into an estimation of the amount of waste produced over a longer period of time such as a year. A simple example of data

extrapolation is how St. Thomas Aquinas Secondary conducted their waste audit. Weighing only 25% of their waste, the school multiplied their total weighed waste by four to estimate one day's operations, then by five to represent one week, and then by 40 to represent a whole year's worth of waste (St Thomas Aquinas Secondary, 2012). This method serves only as a simple example because as a secondary school it has relatively the same attendance each day all year round. As a post-secondary institution, the College of the Rockies' attendance rate varies per day and per semester. Appropriate adjustments for seasonality include consideration of the average attendance rates per season, the operational days in those seasons, and the total operational days in a year.

Equipment and Safety

The procedures described above are incomplete without more consideration given to crew safety and the equipment which is required for the audit. Sorting crew members were briefed on the procedures of the audit and were aware of all potential safety risks such as contact with allergens or sharp material. For example, the scent of peanuts may be present in discarded food which would be a risk to someone with a severe allergy. Volunteer crew members were also advised that they may leave the waste audit at any time, and were under no commitment to perform labour that they do not wish to perform. The crew was supplied with personal protective equipment comprised of coveralls and gloves. Closed toed footwear, preferably waterproof, was required for participation in the audit. As suggested in the waste audit report of Humber College, taking pictures of the audit process will help to illustrate certain situations (Urban Resource Group Inc., 2015). Crew members brought cameras to contribute photographs for the enhancement of the audit report. Crew members were required to sign a field trip consent form along with a photo consent form (see

Appendices C and D) for liability purposes, protecting the college. Other equipment required included a scale for weighing waste, a clipboard with paper and writing utensils, a large tarp, shovels, extra garbage bags, and sanitation equipment. The tarp was laid out on the ground of the SouthEast Disposal yard to collect any waste that may not be picked up.

Rationale

The methods outlined in the above sections have been chosen as a result of the literature review, as well as the consideration of the needs and limitations of the College of the Rockies. The literature review includes waste audit reports from various organizations which led to some general conclusions as to how a waste audit is best conducted. Considering the size and limitations of the College of the Rockies, the chosen methodology is an attempt to adopt and modify previous procedures in an appropriate manner. For example, Humber College conducted a waste audit consisting of two campuses and the student residences. Due to the large quantity of waste, the audit report claimed that the researchers weighed only half of the collected waste and extrapolated data to reflect a whole days' waste (Urban Resource Group Inc., 2015). The waste audit at the College of the Rockies involved only one campus with fewer students. The researchers correctly predicted that the sorting of one day's waste was to be a manageable task. Choosing weight as the quantity unit is a direct result of the literature review, since it was generally found that measurements based on volume tend to be less accurate (PLAN, 2015). The SouthEast Disposal industrial yard was chosen as the sorting location due to budget and transportation constraints. Although it was cold due to being exposed to the winter weather conditions, the location was spacious to facilitate sorting. The sorting categories had been chosen as a means to align audit results with the future plans of the Sustainability Committee.

Summary of Data Collection and Analysis

The research method chosen to best address the research question is a waste audit. The waste audit involves gathering data on the weight of waste produced over a day at the College of the Rockies Cranbrook campus. Further, sorting the waste into valuable categories and weighing each category allows for a determination of the nature of the waste. Through various precautions, such as avoiding special event dates, the researchers have minimized the possibility for distortion in the amount of waste collected. In analyzing the data, the researchers will determine how much waste the college can divert from landfill by implementing the new waste sorting bins. In addition, the analysis will reveal the proportion of waste currently destined for landfill that is compostable. This proportion will assist the Sustainability Committee in deciding whether or not to invest in adding a compost option to the new bins.

Sample Parameters

The waste collected for the study is essentially one large sample of the waste generated at the College of the Rockies. In order to ensure the reliability of the data, the sample is not random. Sample parameters were chosen carefully to reflect normal operations as closely as possible. College areas involved in the study include Kootenay Centre (main campus building), Summit Hall, Pinnacle Hall and the Aboriginal Gathering Place. Trades such as carpentry, welding and automotive mechanics are included. The Children's Centre and student housing areas are omitted from the study. Abnormal waste, such as construction waste or waste generated by special on-campus events, are also excluded from the study. The waste sample collected is all of the waste generated over a single weekday at the college.

Findings

Quantity of Waste

SouthEast disposal weighed all of the waste collected for the audit. The weight of waste collected totalled 297 pounds prior to sorting. If the same amount of waste was produced on every operational day at the college, then 22,275 pounds would be produced in the winter semester. Over one year, 66,825 pounds would be produced (See Appendix H). As discussed on page 13, a more accurate analysis requires an estimate of the college population throughout the year.

Nature of Waste

During the audit, the following categories of waste were sorted and weighed: numbered plastics, paper, paper towel and organic (compostable) materials. Although tin cans, food grade glass and electronics were identified in our methodology as being categories of interest, none of such materials were found in the waste sample. A count of 22 refundable beverage containers were found. The refundable beverage containers were not weighed due to the assumption that their weight would be negligible. The chart below (figure 3) lists the categories of waste which were weighed, alongside each result in pounds.

Figure 2: Refundable Beverage Containers

Category	*Weight (lbs)*
Numbered Plastics	10
Paper (not including paper towel)	20.4
Paper Towel	36.8
Organics	59.4

Figure 3: Waste Category Weights

An effective means of translating the weight of each category into an understanding of the nature of the waste, is to determine each categories percentage of the total weight (as stated above, 297 lbs). As shown in the chart below, most of the waste is "other" or landfill waste while the next most prominent category is organic material.

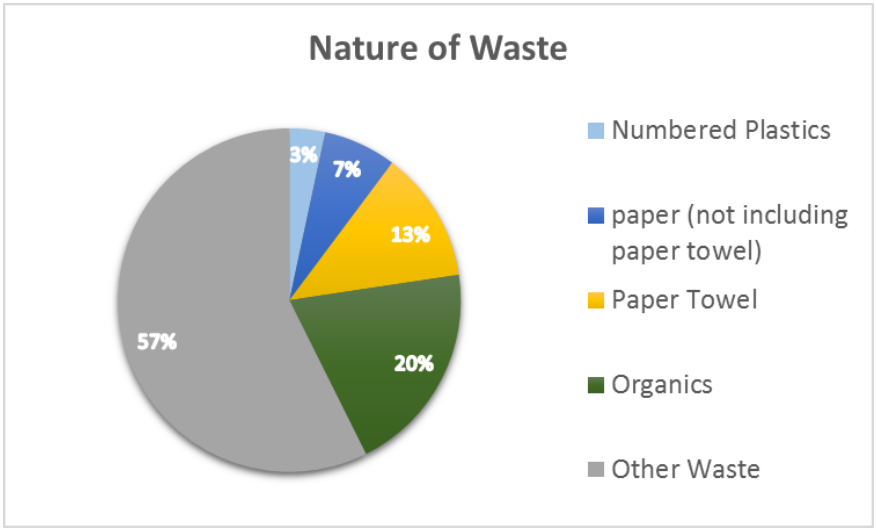


Figure 4: Nature of Waste

Ten percent of the waste sent to landfill was recyclable while 33% was compostable. As stated in the guest College of the Rockies blog entry, titled Rinse and Recycle, "126.6 pounds (42.6%) of waste sent to landfill was composed of recyclable or compostable materials" (Jenks & Panattoni, 2017). One of the observations our team made was that there seemed to be a large amount of single use disposable gloves, bibs and facial masks. We assumed these objects were from the nursing and dental departments. Through email correspondence with the coordinator of the dental program and the lab assistant for the nursing program, it was determined that the amount

of waste from those departments was normal for the current (winter) semester. Furthermore, there is little fluctuation throughout the week in lab frequencies during the winter semester. In the fall, the dental program has fewer labs resulting in less gloves and bibs being used during that time. In spring, glove and bib use is highest for the program. It is the prediction of the researchers that the amount of gloves, bibs and masks found in our winter audit would represent an average from the year although further study is required for an accurate assessment of glove, bib and mask use.

Waste Reduction Potential

Another important observation made in the blog entry is that, “most recyclable paper destined for landfill was coffee cups” (Jenks & Panattoni, 2017). The inherent challenge involved with recycling coffee cups is that they must be rinsed in order to be recyclable to not contaminate paper products. Similarly, “numbered plastics were generally from food containers (coffee lids, yogurt cups, sandwich containers) that needed to be rinsed in order to be recycled” (Jenks & Panattoni, 2017). In the event that paper cups and food containers were to be rinsed out regularly before recycling, then 10% of the waste by weight from the Cranbrook College of the Rockies could be diverted from landfill. As previously noted, there were no tin cans or clear glass found in the waste sample. As a result, it is reasonable to assume that the kitchen staff at the College of the Rockies is actively sorting out tin cans and food grade glass for recycling. If composting is adopted by the college, it is the belief of the researchers that the kitchen staff would embrace the practice. Therefore, if organics composting was adopted by the college in addition to rinsing and recycling food containers 30% of the waste by weight would be diverted. By composting the paper towel as well as the

organics, while also rinsing and recycling food containers, then a 43% reduction in waste by weight could be achieved.

Key Findings

As reported in the blog entry, the researchers agreed on the following key findings from the waste audit:

- Rinse and Recycle. “Reduce, reuse, and recycle” is not enough. Critical to making recycling successful is to rinse out coffee cups and plastic containers so they don’t have to be thrown away and they don’t contaminate a recycle stream. Think Reduce, Reuse, Rinse and Recycle.
- A significant reduction in landfill waste would result from composting as well as rinsing and recycling. Organics accounted for 59.4 pounds (20%) of waste from a single day at the college (Jenks & Panattoni, 2017). In addition, 13% of the waste is compostable paper towel. Thus, composting could result in a 33% reduction in landfill waste.
- The lack of food grade glass and tin cans is impressive as well as encouraging (Jenks & Panattoni, 2017).
- Further study regarding glove, bib and mask use may reveal significant seasonal differences in waste composition.

Discussion

In relation to the literature review, some of the audit findings were unexpected. Coffee cups were not a focal point of discussion in any of the audits reviewed. The audit at Humber College identified 7% of their landfill waste as “hot and cold beverage cups,” while mixed

paper and cardboard represented 13.45% of their waste (Urban Resource Group, Inc., 2015, p. IV). As such, the researchers did not predict that they would observe coffee cups as being the dominant source of paper waste. Similarly, the prominence of disposable gloves in the waste was also unanticipated. In terms of quantity of waste, the research team had little in the way of a hypothesis. Perhaps due to vague impressions gleaned from the waste audits reviewed, all members of the team were surprised with how little waste was present for sorting.

As stated above, 43% of the waste sent to landfill from the College of the Rockies is divertible as recycling or composting. Compared to the educational institutions reviewed prior to the waste audit, such results are favourable. To illustrate, the table below compares the percentages of divertible waste in landfill streams at College of the Rockies, University of Alberta, Appalachian State University, Humber College and St. Thomas Aquinas Secondary.

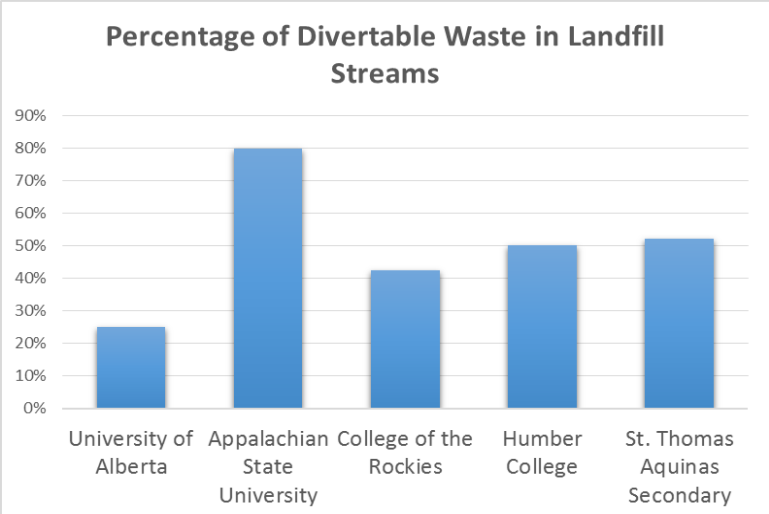


Figure 5: Percentage of Divertible Waste in Landfill Streams

At the University of Alberta, which has the highest purity of waste, "the landfill stream still consists of 20 to 30 percent recyclable or organic material" (Leblanc et al., 2016, p 25). Appalachian State University had the least favourable results with 79.7% of their landfill waste stream being recyclable or compostable (Maxwell, 2014). Humber College and St. Thomas Aquinas Secondary reported that 50.08% and 52.08% of their respective waste streams were divertible (Urban Resource Group Inc., 2015, p. IV.

St.Thomas Aquinas Secondary, 2012, p. 8). It is encouraging to note that the College of the Rockies is currently performing well compared to three of the four institutions. Going forward, the University of Alberta may become a source of valuable information regarding waste reduction and composting.

Recommendations

Following the analysis of waste audit results the researchers developed recommendations for the College of the Rockies to reduce waste destined for landfill. Prior to conducting the audit the researchers developed the following questions to answer post audit:

- Are there any suggestions that can be made regarding waste management education in light of the results?
- Is the proportion of divertible waste satisfactory to implement the new bins, or should more action be taken?
- Do the new bins adequately reflect the waste reduction needs?

In terms of waste management education, recommendations are limited. It was found that, for the most part, students and faculty at the college are sorting waste to the best of their abilities. Paper, clear glass, tin cans and refundable beverage containers were mostly diverted from landfill due to proper sorting practices. Where the researchers expect the small bits of paper and few beverage containers are coming from is small waste bins in hallways or classrooms that aren't accompanied by another option for waste sorting. With no convenient option, individuals will often toss their divertible waste in the nearest bin without taking time to find somewhere else to put it. For this reason, the researchers recommend eliminating all single stream waste bins. That is to say, that no waste bins will only have the

option of collecting waste strictly destined for landfill – especially in high-traffic areas such as the cafeteria, the lobby, high-traffic hallways, and study areas.

The new waste sorting bins, or "collection pods," will be implemented by the Sustainability Committee and the facilities team at the college. The researchers were curious if the audit results would justify the purchase of the new pods. Currently there are stations throughout the college where students can choose to sort waste into either landfill destined waste or refundable beverage containers. There are also locations that offer paper recycling bins. The new collection pods will allow for the sorting of three waste streams, reducing the potential acts of thrashing divertible waste if the stream in question is not present at that waste location. Given the levels of divertible waste the researchers would recommend implementing an additional stream: organic. A significant portion of the divertible waste destined for landfill was of organic nature. Implementing an organic waste stream to the current waste collection program is more complex than just adding another bin. To include composting, the college will have to take measures to properly manage the composting materials in a way that it will break down and not attract wildlife. Following the breakdown of the organic waste, the resulting compost will have to be managed. The nutrient rich compost could serve a number of purposes including landscaping projects at the college. The resulting compost could also be donated to a community garden, or be useful to the college should they choose to establish their own garden. The bulk of compostable materials are derived from the kitchen and cafeteria, as well as washrooms (paper towel). Should the college choose to adopt composting practices, the researchers recommend placing bins in the kitchen, cafeteria, and washrooms.

The new bins do not adequately reflect the current waste reduction needs of the college. The divertible paper and plastic waste that was discovered during was deemed destined for landfill by the disposing individual because it was unfit to be recycled (needed rinsing). Most of the divertible paper and plastic waste was derived from disposable coffee cups (and lids) as well as plastic food containers, both of which needed to be rinsed before recycling. Two recommendations are stemmed from this finding. Firstly, in terms of education, students and faculty should be reminded that paper coffee cups as well as any plastics numbered 1-6 are recyclable if they are clean. Currently, however, there are signs at water fountains and washroom sinks asking individuals to refrain from rinsing any food or beverage container to avoid plugging drains. Thus, these signs discourage anyone from rinsing their otherwise recyclable item. This brings the researchers to their other recommendation: implementing a rinse and recycle station. The college needs an area specifically intended for rinsing recyclables, preferably near a collection pod. This will drastically reduce the amount of paper and plastic recycling that is currently being directed to the landfill. Another point to note about disposable coffee cups is that the cafeteria can help reduce generation of these cups. They may do so by advertising the discounted price for hot beverages if someone brings their own reusable mug.

Lastly, the small quantity of waste surprised the researchers. Their final recommendation is to review the current garbage collection schedule. It is recommended that the garbage collection by SouthEast Disposal be reduced to no more than twice a week, hopefully reducing associated costs. Based on the quantity of waste collected in a one day period, the researchers believe that garbage collection once per week would suffice. It has been brought to the attention of the researchers, however, that the attendance on the day of waste collection for the audit was low. Therefore, to account for higher traffic days, along

with campus wide events and the desire to not attract wildlife, the researchers feel that collection twice per week would be adequate.

To recap, based on the waste audit results, the researchers recommend the following:

- The elimination of all single stream waste bins, especially in high-traffic areas
- The implementation of an additional waste stream: organic waste
- When implementing an organic waste collection program, begin by locating bins in the kitchen, cafeteria and washrooms
- Waste reduction education should remind students and faculty that paper coffee cups as well as any plastics numbered 1-6 are recyclable if they are clean
- The implementation of a rinse and recycle station
- Ensure the consistent use of a monetary incentive to bring reusable cups for cafeteria use
- The reduction of garbage collection by SouthEast Disposal to no more than twice a week, potentially reducing associated costs.

Conclusions

Waste sent to landfill is often comprised of many materials that could have been re-used, re-purposed or recycled. At the College of the Rockies Cranbrook campus, the divertible waste destined for landfill consisted mostly of organic waste as well as paper and plastic recycling. Concluding the study, the researchers would like to revisit the research question:

What is the quantity, and nature, of waste destined for landfill currently produced at the College of the Rockies Cranbrook Campus during normal operational hours?

The researchers feel that their study has adequately addressed all elements of their research question. The current research project provided the College of the Rockies with a baseline measurement of current waste production, informing the institution of the quantity of waste that is being generated at its Cranbrook campus. By conducting a waste audit the researchers have determined that 43% of the waste generated on audit day was divertible from the landfill if proper measures were taken. The nature of divertible waste mostly comprised organic/ compostable materials. The implementation of the new waste collection pods is believed to be beneficial to the college, however to capitalize on waste reduction the researchers recommend the implementation of organic waste collection and composting program, as well as a solution to rinse food-soiled recyclable containers. By reducing the overall waste destined for landfill it is believed that waste hauler services may also be reduced to save funds at the college. Overall, it is the goal of the researchers to provoke positive change that ultimately reduces waste output.

Thank You Notes

The researchers would like to thank the following persons/organizations for their valued input, time and support throughout this research project:

- Greg McCallum for providing significant guidance and input for the study,
- COTR Sustainability Committee for sponsoring the waste audit,
- Carmen Vadillo for participation in sorting through the waste on audit day, as well as providing photo and video content,
- Allan Knibbs and COTR Facilities Department for their assistance in the organization and project implementation as well as providing protective gear and tools for waste sorting,

- Program Coordinators Barb Fenwick, Sandi Hill, Marla Jones and Nursing program lab assistant Jenny Damstrom for program information and support,
- Brian Millis and the student life department for suggestions and support,
- South East Disposal for transporting the waste as per the required project schedule and providing a location for conducting the waste audit,
- And lastly the RDEK for their willingness to provide a location for conducting the audit

References

Duke University. (2016). *How much do we waste daily?* Retrieved from Duke University Centre for Sustainability & Commerce: https://center.sustainability.duke.edu/resources/green-facts-consumers/how-much-do-we-waste-daily

Environment Victoria. (2013, June 16). *The Problem with Landfill.* Retrieved from:

http://environmentvictoria.org.au/resource/problem-landfill/

Government of Saskatchewan. Ministry of Environment. (2013). *Green Living: Reducing Waste.* Retrieved, Oct. 10, 2016, from:

http://www.environment.gov.sk.ca/ReducingWaste

Hoods, I. (2013). *Zero waste budget: draft for expert review.* Retrieved from:

http://www2.gov.bc.ca/gov/content/environment/waste-management/zero-waste

Jenks, J. M., & Panattoni, N. M. (2017, March 8). GUEST BLOG: Rinse and Recycle - What a small team of researchers learned by sorting through the garbage. [Web log post]. Retrieved from: http://www.cotr.bc.ca/blog/story.asp?ID=90

Leblanc, S., Kwasny, J., Yan, K., & McCartney, D. (2016). Organics Recovery on Rise at University of Alberta. *BioCycle, Vol 57* (Issue 7), p24-26.

Maxwell, Jennifer. (2014). *Waste Audit: Executive Summary.* Retrieved from: http://sustain.appstate.edu/sites/sustain.appstate.edu/files/FINAL%20exec%20summary%20feb%202014_1.pdf

Midpoint International Inc. (2016). *How to Complete a Waste Audit in 5 Easy Steps.* Retrieved from: https://cleanriver.com/waste-audit-in-5-easy-steps/

Midpoint International Inc. (2016). *8 Recycling Tips for Facility Managers.* Retrieved from: https://cleanriver.com/8-recycling-tips-for-facilitymanagers/?utm_source=Beyond+the+Bin+September+2016&utm_campaign=Beyond+the+Bin+September+2016&utm_medium=email

Musulin, K. (2015, Aug 31). 10 trends defining the industry – and why they matter. *Waste Dive.* Retrieved from: http://www.wastedive.com/news/10-trends-defining-the-waste-industry-and-why-they-matter/404810/

n.a. (2016). I. Retrieved from: http://urbanimpact.com/waste-audits/

Ontario Ministry of Environment. (2008). *A Guide to Waste Audits and Waste Reduction Work Plans for Industrial, Commercial and Institutional Sectors*. Retrieved from: https://dr6j45jk9xcmk.cloudfront.net/documents/1355/227-guide-to-waste-audits-en.pdf

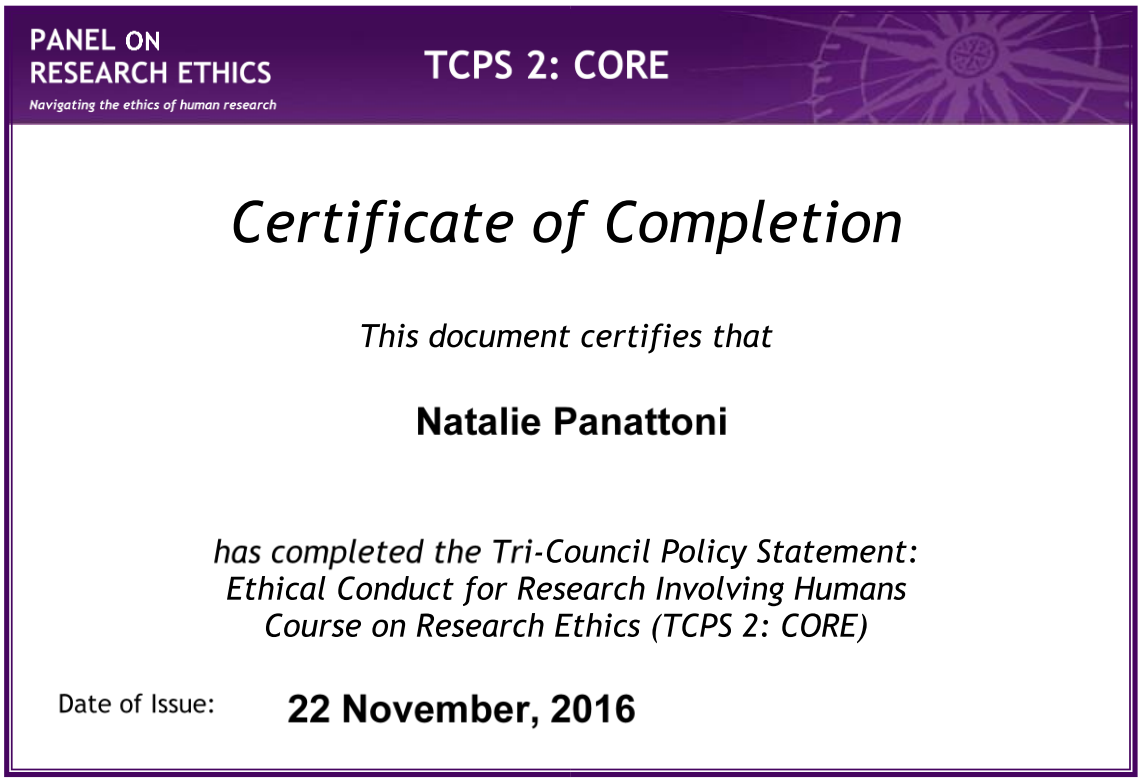
PLAN. (2015). *Waste Audit Manual.* Retrieved from: http://www.postlandfill.org/wp-content/uploads/2016/02/PLAN-Waste-Audit-Manual-preview.pdf

St. Thomas Aquinas Secondary. (2012). *Waste audit report results and waste reduction workplan*. Retrieved from: http://www.hcdsb.org/Schools/Environment/Waste/Analysis%20Results/2012_AQUI.pdf

Smyth, D. (2008). 2008 *University of Norther British Columbia waste audit report*. Retrieved from: http://www.unbc.ca/assets/green/wasteauditreport.pdf

Urban Resource Group Inc. (2015) *Waste audit & reduction work plan: Humber institute of technology & advanced learning North and Lakeshore campuses*. Retrieved from: http://www.humber.ca/sustainability/sites/default/files/uploads/documents/2015%20-%20Humber%20Institute%20of%20Technology%20%20Advanced%20Learning%20Waste%20Audit%20Report_%2528March%203%20revised%2529.pdf

Appendix A: TCPS 2: Core Certificates



PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

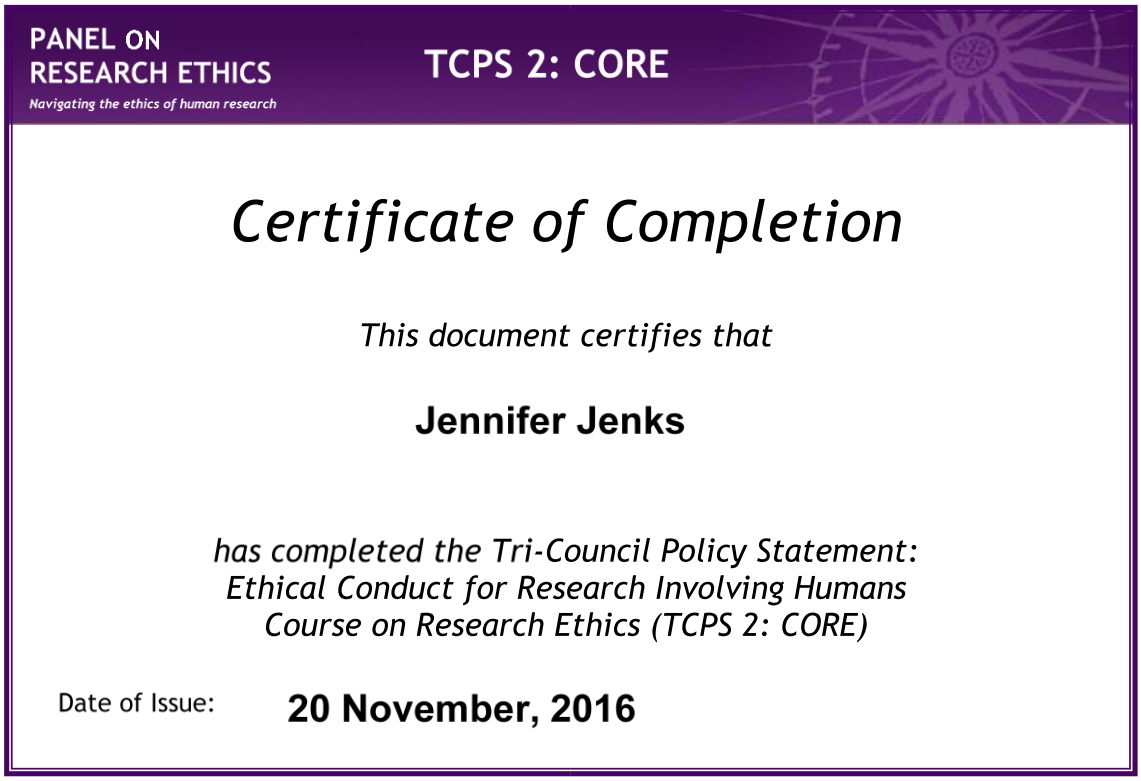
Certificate of Completion

This document certifies that

Natalie Panattoni

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **22 November, 2016**



PANEL ON RESEARCH ETHICS
Navigating the ethics of human research

TCPS 2: CORE

Certificate of Completion

This document certifies that

Jennifer Jenks

has completed the Tri-Council Policy Statement:
Ethical Conduct for Research Involving Humans
Course on Research Ethics (TCPS 2: CORE)

Date of Issue: **20 November, 2016**

Appendix B: Raw Data Collection Sheet

Data Collection Template

Instructions: Please record your name and weight of yourself wearing your protective gear without holding any waste. After sorting waste into categories please weigh yourself holding a bag of a selected category and record the weight. Do not subtract your initial weight, that will be done by the researchers. Please weigh twice before recording on the data sheet to ensure accuracy.

Name _____

Weight _____

Category	Weights of Sorted Waste				
	1	2	3	4	5
Paper (not including paper towel)					
Numbered Plastics					
Tin Cans					
Refundable Beverage Containers					
Paper Towel					
Clear Glass					

Comments/Observations:

Appendix C: Letter of Consent

College of the Rockies Field Activity Consent Form- Medium to High Risk

Medium to High Risk activity (waiver form, Policy 3.3.3): these are activities which have an inherent risk of injury by virtue of the activity itself, risks that the student or guardian must accept and from which the student or guardian releases the college from all responsibility. These activities may require specialized clothing or equipment or training and they carry the risk of serious injury or death even for experienced practitioners.

Activity Name: COTR Waste Audit

Activity Date: Thursday, February 2-Friday, February 3rd 2017

Activity Location: South East Disposal Yard (see map attached)

Activity Transportation: Students look after their own transportation.

Activity Description (describe the activity and potential risks along with the supervision and oversight that will be provided):

The waste audit was initiated by the COTR Sustainability Committee. Two student researchers have offered to conduct the waste audit to fulfil the capstone research requirement for their BBA in Sustainable Business Practices Degree. The Sustainability Committee Assistant has also offered to assist.

Their research question and objectives are as follows:

"What is the quantity, and nature, of waste destined for landfill currently produced at the College of the Rockies Cranbrook Campus during normal operational hours?

The overarching goal of this research is to reduce waste at the Cranbrook College of the Rockies. The present study has three objectives designed to make waste reduction possible.

1) *Establishing a methodology for measurement*
2) *Conducting the waste audit to create an initial baseline measurement of waste.*
3) *To identify appropriate waste management strategies for the College as well as forecast waste reduction goals and expectations."*

To mitigate the risks the following will be provided:

-Coveralls

-Gloves

-Face masks

-Students will provide sturdy foot wear and work clothes

-racks, garbage tongs, garbage cans

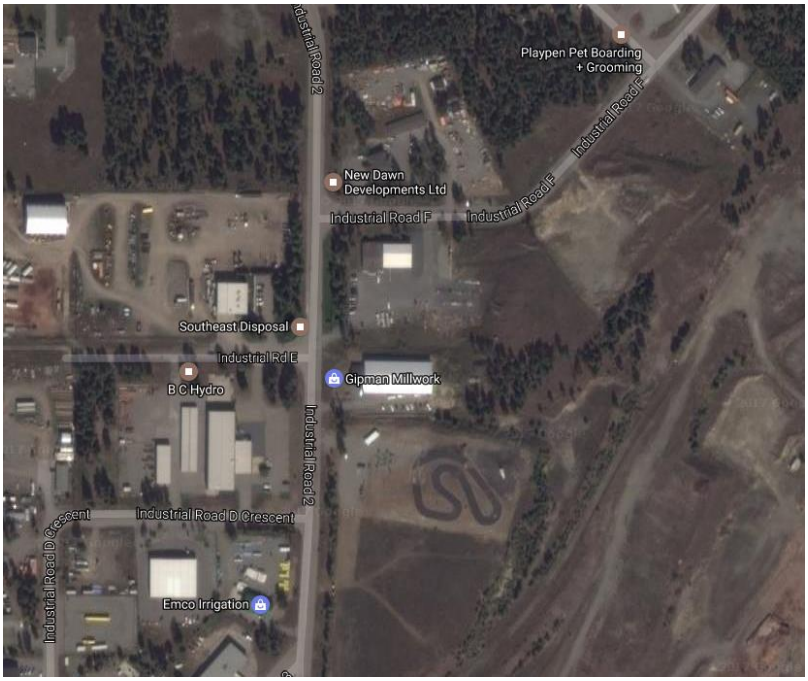
Students under the age of 19 years old require parental consent.

Accidents can be the result of the nature of the activity and can occur with or without any fault on either the part of the student, or the college or its employees or agents/partners, or the facility where the activity is taking place. By participating in this activity, you are accepting the risk of an accident occurring, and agree that this activity, as described above, is suitable for you. Risks include being cut by sharp objects, being exposed to toxic substances, injuries from heavy lifting.

I understand that I may be exposed to medium risks while participating in this activity and that accidents and injuries may occur.

Name Student (print)	Signature of student	Name of Parent (print)	Signature of Parent	Date
Jennifer Jenks				Feb. 2, 2017
Natalie Panattoni				Feb. 2, 2017
Carmen Vadillo				Feb. 2, 2017

Figure 1: Map of approximate location of the study



Contacts:

SE Disposal

Kevin French - kevin@southeastdisposal.com

250-417-3607

COTR

Allan Knibbs –

knibbs@cotr.bc.ca

250- 489- 2751 ex 3227

Research Supervisor

Greg McCallum - gmccallum@cotr.bc.ca

250-427-6331 (cell)

Appendix D: Photo Consent Form

Photography / Video / Copyright
RELEASE FORM

I, _____ , do hereby give the

College of the Rockies permission to use, in any way they deem fit, the item/image/video/ logo described as

_____

I hereby release all rights and future claims to the aforementioned item. These images may appear in any of the wide variety of formats and media including, but not limited to, print, broadcast, videotape, CD-ROM, DVD, and electronic/online media.

[Parent/Guardian segment removed for purposes of this report, all participants of the waste audit were over the age of 19]

Name: (Please Print) _____
(I am 18 years of age or older.)

Signature: _____ Date: _____

FOR MORE INFORMATION:

Heather Jackson, Manager of Communications and Marketing
College of the Rockies • Box 8500, Cranbrook, BC V1C 5L7 Phone: 250-489-2751 ext. 3258
• Fax: 250-489-1790 email: jackson@cotr.bc.ca

COLLEGE OF
THE ROCKIES

Appendix E: Research Biases and Limitations

Several limitations exist for the current study which affect the project scope, methodology, implementation, and analysis.

- Conflicts of Interest: The supervisor for the current study is also a beneficiary of the study which may lead to biases in both project implementation as well as analysis of results.
- Research Biases: The research team is eager to make useful conclusions regarding the nature of waste. This may result in an unintentional over-or-under emphasis of observations made. Additionally, the sorting categories for the waste were determined based upon their relevance to the new collection pods and upon researcher expectations.
- Budget Constrictions: Renting an industrial scale was assumed to be an expense far beyond the Sustainability Committee's budget and thus was not an option pursued by the researchers. Weights were obtained through the use of an electronic bathroom scale. The accuracy level of the scale may have impacted results.
- Knowledge of Study: In order to avoid alteration of waste audit results, the college community could not know that a waste audit was going to take place. Certain members of the college community were instrumental to the study and were aware of the audit dates. Community members aware of the audit include the sustainability committee members, facilities staff, and the researchers.
- Research Timeline Constrictions: Capstone project course requirements dictate that the implementation of the applied research project is to be completed within 15 weeks during the winter semester at the college. Therefore the waste audit is held

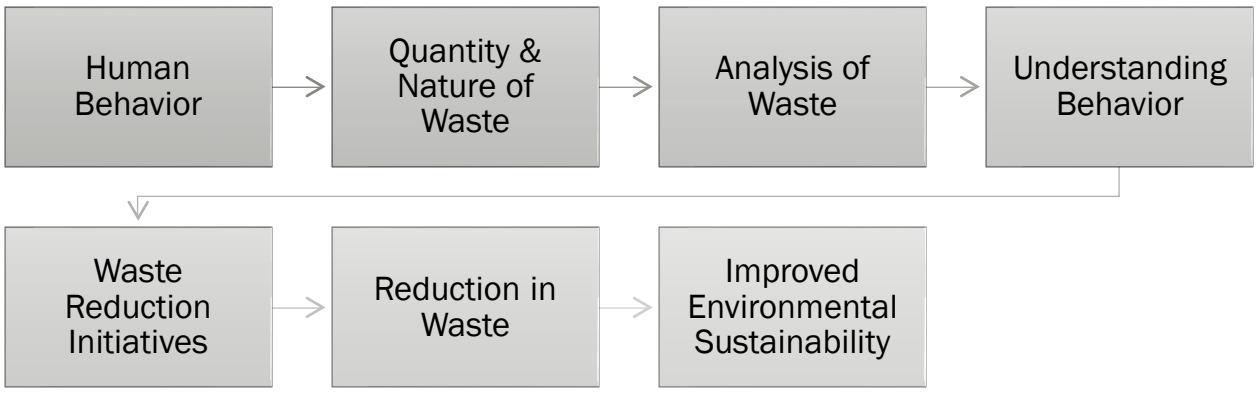
during winter. There are different courses offered in different seasons at the college. Thus, the nature of waste may vary from season to season. A more accurate assessment of the nature of the college's waste would involve three audits to reflect the three different mixes of courses.

- Schedule Discoordination: Due to the difficulty in aligning the schedules of the many individuals involved in enabling the current study, the audit was ultimately conducted on a Wednesday. The original intent of the researchers was to conduct the audit on a Tuesday as discussed in the Research Methods section above.
- Cold Weather: The cold weather resulting from having a winter waste audit also has impact upon audit results. Some of the waste collected in the audit had frozen into clumps that were not reasonably sortable. In addition, the distribution of weight in waste categories may have been altered since liquid may soak into materials such as paper towel and freeze.

Appendix F: Literature Review Conceptual Model

Waste audits are conducted in order to determine one or more characteristics of an organizations waste. The conclusions regarding a particular organizations waste are used to stimulate or inform waste reduction efforts. Existing literature on waste audit studies describe how various institutions have completed their audits as well as how those institutions may benefit from their efforts. The current study endeavors to both replicate, and expand upon, existing studies. Similar to previously conducted studies, this audit examines an organizations waste in order to conclude how it may be reduced. In expansion to previous studies, this audit demonstrates how a small team with modest resources can successfully complete a waste audit.

The conceptual model below illustrates the replicative intention of the current waste audit. Human behaviour is identified as the independent variable while waste quantity and nature are the dependant variables. By studying the nature and quantity of waste, conclusions regarding human behaviour may be drawn. Such conclusions may then be used to reduce waste.



Appendix G: Budget

The costs of the waste audit have been generously covered in full by the College of the Rockies. Not all costs were recorded, however, the following list summarizes identifiable costs associated with the waste audit:

- Moving the current waste bin away from the COTR Kitchen Dock area $50
- Drop off roll-off bin placement in place of the moved bin $90
- Rental of waste collection in roll-off bin ($6.50/day x 3 days) $19.50
- Pickup of roll-off bin and transport to SouthEast Disposal for weighing and audit $135
- Replacement of original waste bin back to the COTR dock area $50

Total recorded costs $344.50 plus applicable taxes.

In addition to the identifiable costs, other costs associated with the audit include:

- Disposable coveralls, approximately $40 ($10 x 4 pair)
- Work gloves, approximately $60 ($15 x 4 pair)

Total estimated costs to the College of the Rockies: $444.50 plus applicable tax

Appendix H: Extrapolation Calculations

In the findings section on page 20, it is estimated that; “If the same amount of waste was produced on every operational day at the college, then 22,275 pounds would be produced in the winter semester. Over one year, 66,825 pounds would be produced.” The following calculations provide these estimates:

- 297 pounds/day X 75 Operational days = 22,275 pounds in one semester.
- 297 pounds/day X 225 days = 66, 825 pounds per year.

If an estimate of population had been available, the calculation would have been:

75(Lbp X Sp) + 75(Lbp X Fp) + 75(297) = Estimated weight of waste produced in one year.

Where:

75 is the operational days per semester

297 is the weight of waste from an average day in winter

Sp is the Spring and Summer Population

Fp is the Fall Population

Lbp is the pounds of weight produced per person. (297 pounds divided by the winter population)