28 April 2006

Eric Josephson
City of Cambridge Public Works Department
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Re: Cambridge Rubbish Re-routing Proposal

Dear Mr. Josephson,

Enclosed is a summary of our project, entitled "Municipal Rubbish Removal: A Model for Improving Efficiency. " It was written during our time working at the Cambridge Department of Public Works, from March 13, 2006 until April 27, 2006. Preliminary research and work was done at Worcester Polytechnic Institute, Worcester, Massachusetts prior to arriving in Cambridge. We are simultaneously submitting a copy of this report to Professors Gerstenfeld and Vernon-Gerstenfeld for evaluation. After careful revision from the faculty, the original copy of this report will be filed and accessible through the Gordon Library at Worcester Polytechnic Institute. We thank you for the time and dedication that you and others at the Cambridge Department of Public Works have given us.

Sincerely,

Kerri Edlund

Meghan Horsley

John Ramsden

Report Submitted to:

Professor Vernon-Gerstenfeld

Professor Gerstenfeld

By:

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In Cooperation With

Mr. Eric Josephson, MIS

Cambridge Department of Public Works

MUNICIPAL RUBBISH REMOVAL: A MODEL FOR IMPROVING EFFICIENCY

April 28, 2006

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Cambridge Department of Public Works or Worcester Polytechnic Institute.

This report is the product of an education program, and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

ABSTRACT

The goal of this project, conducted for the Cambridge DPW, was to create a model to be used by other Cambridge and other cities and towns to increase efficiency of their current rubbish management system while also increasing awareness of the social implications involved. We created a twelve step methodology that can be adapted to fit any city or town by taking into consideration the unique attributes. In creating this method, we prepared recommendations for new routes for some zones in Cambridge.

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Our group would also like to thank Sanitation Supervisors John McGrath, Lenny Silva, and Bill Frazier. Their expertise of the routes proved most helpful while we were designing our proposed routes for the City of Cambridge. The time they took to describe the routes, drivers, and the streets of Cambridge, was very much appreciated and instrumental in our providing efficient routes.

We would like to also thank George Styrianopolous whose extensive knowledge of GIS helped us greatly in completing this project. The DPW as a whole has been accommodating and respectful of our requests.

Our team would like to extend sincerest gratitude to Professor Arthur Gerstenfeld and Professor Vernon-Gerstenfeld for their constant support and direction during this project. We are truly grateful for their advice and suggestions over the course of the pre-project and project work.

EXECUTIVE SUMMARY

City living has its advantages and disadvantages. Some advantages include proximity to schools and highways, public transportation and various forms of entertainment. The disadvantages consist of environmental concerns, traffic congestion, and global issues that affect every city, town and person in the world. These issues include health, ecology, safety, traffic and occupation unions. In cities, the heightened population can magnify these into serious issues that need to be addressed.

Cities develop departments to deal with these issues; some of these departments are the Department of Public Works (DPW) and the Department of Transportation. These departments need to work together and grow in conjunction with the changing demographics of the city so that the issues are well managed.

The current rubbish management system in Cambridge, MA is outdated and inefficient. The current collection routes were established thirty years ago with twenty-eight trucks collecting rubbish. Over the years an increase in resident recycling has allowed the City to reduce its fleet to its current eight trucks. This is because the City outsources its recycling collection to a private company. As the DPW decreased the fleet, they divided the streets the old trucks collected among the remaining trucks. As an effect of this, the current rubbish removal routes are very scattered. Routes that are consolidated are more efficient, save on gas and make it easier to test new rubbish removal technologies.

There were three main goals of this project. The first was to improve the efficiency of the current rubbish management system in Cambridge by creating new routes. This would make is easier for the sanitation department to determine the area

each truck is collecting garbage in. Also, it would aid the department in testing new rubbish management technologies. The second goal was to investigate the issues involved with rubbish collection. These issues include health and safety, traffic and accidents, environment and contractual obligations with the Union. The final goal was to create a model that can be used by other cities and towns. We created a twelve step methodology that can be easily adapted to any city or town wishing to improve their rubbish removal system.

We found that the best way to consolidate routes was to rearrange them based on tonnage per street segment and street characteristics. Street characteristics include whether or not the street is a one-way, if it is divided, how congested it is, if the homes are one family or multi-family and if it needs to be collected in one or two trips. We discovered these findings through analyzing maps, completing calculations, viewing routes and interviewing sanitation supervisors.

While completing our project, we acquired much useful information. We discovered many of the difficulties that the workers face on a daily basis. We noticed, for instance, the intricacies of the current routes and the streets of Cambridge. Many of the streets are difficult to maneuver the truck through and there are others that are one-way streets but they require two passes to collect all the rubbish.

Over the course of this project, we have established a methodology that can be applied to any city or town wishing to improve their rubbish management system. This twelve step process has been applied to the City of Cambridge and used to create new routes for the Thursday and Friday zones. We have recommended that the City use these steps to create new routes for the other zones. The steps are as follows:

1. Pick an original day of focus. This day should be a representation of the most problematic day in the town or city. The reason for this is so that all factors will be present from the very beginning.
2. Use GIS to overlay maps. Overlay the city street centerlines along with the map which contains the number of bedrooms per household and the rubbish routes. The routes should then be split into segments so that each segment is between two intersecting roads. Calculate the number of bedrooms per street segment.
3. Use these numbers to calculate the number of bedrooms each truck driver has on the chosen day.
4. Calculate the average number of tons (or pounds) per truck for that day, using a full years worth of data. Disregard any data that is appears illogical.
5. Use these two data sets to calculate the number of tons per bedroom for each truck.
6. One can then find the number of tons per street segment by multiplying the number of tons per bedroom by the number of bedrooms on a given street segment.
7. To verify that this calculation is accurate use GIS to calculate the mean number of people per bedroom within one census block for each census block throughout the whole city.
8. Then choose a number below the mean and a number above the mean that will portray flawed data. We decided that areas with less than 0.5 people per

bedroom (half our mean) or with more than 2.2 people per bedroom (twice our mean) was unrealistic and labeled these neighborhoods as problem areas.

9. Review problem areas using GIS and prior calculations to see if there are any factors that are yielding this result.
10. Physically go view the routes. This should be done along with a Sanitation Supervisor so that he/she can share information about the city and current problems the workers face.
    a. Review problem areas that could not be explained by reviewing data. For example maybe there is a housing project on that street and number of bedroom data was unavailable, causing there to be a large number of people per bedroom.
    b. Look at each individual street and label it based on the follow attributes:
        i. Type of road (one-way, main, divided, narrow)
        ii. If the road can be collected in one trip down or if two trips are necessary
        iii. Congestion factor
11. Use the notes you took, along with the number of tons per street segment, to move the routes around, switching one street segment with a similar one. Note: we found it convenient to use a base route for each truck depending on the current collection system.
12. Repeat previous steps for all other zones.

We used this model to create new routes for Cambridge. This enables the City to determine where the rubbish is coming from that a particular truck is collecting. This will make it easier to find the people who are disregarding the rules and mixing items such as recyclable items in with their rubbish. Therefore, the City can then take the necessary action against the offending area. The new routes are also consolidated, resulting in less time driving from one area to another for pick up and making it easier to test new equipment and technologies.

Our twelve step methodology will also prove to be helpful in updating Cambridge's routes whenever needed. If there is an instance where the fleet is reduced to seven trucks the DPW now has the method needed for re-designing their routes. Continuously updating the rubbish collection routes will enable the City's municipal rubbish service to remain as efficient as possible.

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CHAPTER ONE: INTRODUCTION

Over the years, the population of cities has outgrown the population of suburban areas in many different countries. In Latin America and the Caribbean, seventy-four percent of the total population lives in cities. Seventy-three percent of the people in Europe and more than seventy-five percent of the people in Canada, Australia, New Zealand and the United States all live in urban areas. These numbers are not necessarily true for all other countries in the world; some have less, but still a significant amount of, residents living in the city. For example, in Africa and Asia approximately one third of the total population lives in urban areas. There is a noteworthy variation of population within the specific countries. The countries of Algeria, South Africa and Tunisia in Africa all have more than fifty percent of their population living in cities (Migration and Urbanization: Internal Migration and Urbanization, 2006).

Living in the city has many advantages such as proximity to schools, highways, and jobs, public transportation and various types of recreation. However, with the increasing population, the issues associated with daily living may magnify into serious concerns that need to be addressed. These include health, environmental problems, safety, and traffic, which, unaddressed, can be detrimental to the city and the well-being of its inhabitants. Rubbish, air and water pollution and other environmentally related concerns are negative impacts on both the city and its inhabitants (Ensuring Environmental Health, 2003).

Within cities there are many committees and departments that are established specifically to deal with the issues that plague the city. These committees and departments may include, but are not limited to, the Department of Public Works, and the

Department of Transportation. On the one hand, when these departments work together and are in good working order, the problems in the cities are well managed. On the other hand, if the departments do not grow in conjunction with the changing demographics of the city as well as with the expectations of the taxpayers, then the department cannot function efficiently.

In Cambridge, Massachusetts, the current rubbish management system is inefficient because it is outdated. The current collection technique was established thirty years ago. Since then, there has been the addition of new neighborhoods, streets, and intersections which disrupt the collection routine, but the routes were never reevaluated. There has also been an influx in recycling that has led to a decrease in the number of rubbish trucks. The combination of all these factors has lead to poor routing.

The current routine's disorganization is contributing to the many problems associated with the city such as health, environment, safety, and traffic flow. There are health problems associated with rubbish collection because of the rodent infestation as well as unsanitary conditions. The extra time that the trucks spend on the road due to the inefficient routes adds to exhaust pollution. The safety of the workers is put at risk every day due to the materials that people may throw away, such as needles and glass that can jut through rubbish bags. With the trucks on the road during business hours, traffic flow is disrupted due to trucks making frequent stops and adding to the traffic congestion in the City. With these issues in mind, it is clear that the City is in need of an improved rubbish collection plan.

We worked in association with The Cambridge Department of Public Works with the specific goal of redesigning and consolidating the rubbish routes. In order to help diminish these problems, our objective was to evaluate the current rubbish collection routes and propose a more efficient solution. We analyzed the current census and other pertinent data, completed extensive interviews with experts in the field, shadowed sanitation workers to view their work habits and used GIS to help us visualize the data we collected during the project, so we could provide the best possible solution.

To assist the City of Cambridge with their rubbish collection dilemma, we provided consolidated routes for Thursday and Friday. Along with this, we also supplied a method to be used for altering and consolidating routes for the other days of the week. This method is based on the research conducted and can be applied to any city or town provided that all differing characteristics are considered.

CHAPTER TWO: BACKGROUND

This chapter is intended to give a background on rubbish management, the city of Cambridge, and our project. We explain how rubbish management came to be and also why an effective system was, and still is, necessary in the United States. The history of Cambridge and its current management is of importance to this project since we will need to be aware of the current regulations of the city and also the current demographics. It is helpful to know some of the history of Cambridge in order to evaluate how the routes were established. The history of Cambridge is given as background information to better understand the development of the City. Some important information in this chapter includes the departments in the City, the current rubbish collecting routes and methods and a discussion of rubbish removal technologies.

BRIEF HISTORY OF RUBBISH MANAGEMENT IN THE US

Pitchel (2005) gives a brief history of early U.S. rubbish management. Rubbish management in the U.S. developed slowly over the years, progressing from an almost nonexistent rubbish management plan to what we see today.

The first law for rubbish management was in 1657 when the City of New Amsterdam, now New York City, prohibited its citizens from throwing rubbish into the streets. This may seem like a minute step towards a good rubbish management plan, but at the time it was ground breaking. However, an organized rubbish management plan did not emerge until over one hundred years later.

In 1792, Benjamin Franklin hired slaves to clean up the streets in the vicinity of his house and neighborhood. The rubbish was disposed of in a nearby river. Clearly, this system was still individually based and there was no type of municipality involvement at the time.

In 1795, The Corporation of Georgetown, now a part of the District of Columbia, was the first city to create an ordinance for rubbish management. The ordinance forbade long-term storage on private property and dumping on city streets. However, it did not prevent rubbish that would inevitably be thrown into the streets by citizens. To remedy this, Georgetown hired private carriers to clear their streets. They would then cart the rubbish away from the city to a dump.

It was not until the late 1800's that there was a new way of disposing of municipal rubbish. Until that point there was an "out of sight out of mind" mentality that cities used when dealing with rubbish (Melosi, 2005). The idea was to move all rubbish to the open lands surrounding cities, away from people; however, coastal cities dumped their rubbish into the ocean.

Figure 1: Coney Island beach pollution from disposal off the New York City coast. Rubbish Management Practices, Boca Raton 2005.

Dumping in the ocean is a good example of a poor rubbish disposal method. Figure 1 depicts pollution caused by dumping rubbish off the New York City coast. The refuse that the city had dumped into the ocean washed back on to the beach due to the currents. This created health and safety issues on public beaches. For the most part, beaches were deserted until the city could clean them. This type of environmental catastrophe forced the local administrators to address the problem of rubbish management; thus beginning the new movement of rubbish disposal, incineration. Incineration decreased the total volume of rubbish to be disposed of by reducing it to ash.

Rubbish collection in the United States progressed far better than rubbish disposal. In 1880, a study showed how slowly the United States progressed in developing a comprehensive rubbish management system in all the major cities. Only 43 percent of all U.S. cities provided some municipal rubbish management. However this figure slowly improved; an independent survey conducted by MIT in 1902 of 161 US cities showed that 79 percent had developed some means of rubbish collection. However, it was not until 1930 that almost all major cities in the United States provided a rubbish management system for their citizens.

RECENT MUNICIPAL RUBBISH MANAGEMENT

Rubbish management is a crucial problem within any city. Melosi (2005), states that the U.S. has been in and out of a "Rubbish Crisis" since the 1960's. This crisis is due to an increasing amount of rubbish being produced, lack of federal funding for rubbish management, and not continuously evaluating the city's system.

Figure 2 indicates the rate that per capita generation of rubbish (in pounds per person per day) and total rubbish generation (in million tons) has increased nationally from 1960 to 2003. The graph clearly shows that municipal solid rubbish is increasing in an almost linear fashion. This is because the population is always growing and, therefore, more rubbish is produced.

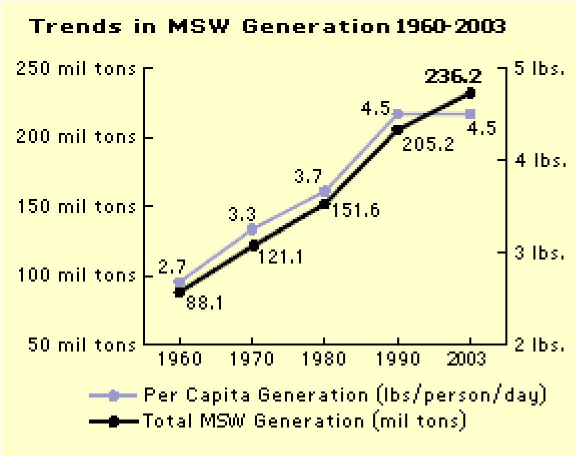


Figure 2: Trends in Municipal Solid Rubbish Generation: 1960-2003. **http://www.epa.gov/epaoswer/non-hw/muncpl/facts.htm**

Not only has the amount of rubbish increased, but the types of materials that are being produced as rubbish have drastically changed. For example, in 1944, styrofoam was invented by the Dow Chemical Company and began to be used as a packaging material. In 1960, plastic also gained popularity as a packaging material. Beginning in 1963, the use of aluminum and other alloys also increased. The introduction of personal computers in 1981 brought another form of rubbish to households. Since these materials are not biodegradable, nor are they safe to burn in incinerators, new issues developed that were not present in the early 1900's (Melosi, 2005). In order to deal with an increasing amount of non-biodegradable materials, such as styrofoam, action needed to be taken.

Recycling has become the "new" way of disposal. The ability to reuse materials to make other products reduces the amount of material that is dumped in land fills. Pitchel (2005) remarks on ways to manage these non-biodegradable materials. In 1898, the first material recovery facility was built in New York City. It was able recover 37 percent of the rubbish that was created. Other laws were introduced to encourage recycling in order to conserve resources. In 1972, Oregon became the first of many states to pass a law allowing consumers to return bottles for a refund (Recycling, 2006).

Table 1 shows how rubbish was disposed of between 1960 and 2003. The amounts are shown in thousands of tons. The labels on the left are the means by which the rubbish was disposed of. Some notable aspects of the table are that rubbish generation is increasing as the years go by and the apparent increase in recycling efforts over the years.

Table 1: Trends in Rubbish Management Disposal in the U.S.

	Thousands of Tons								
	1960	1970	1980	1990	1995	2000	2001	2002	2003
Generation	88,120	121,060	151,640	205,210	213,700	234,020	231,230	235,520	236,170
Recovery for recycling	5,610	8,020	14,520	29,040	46,150	52,430	52,760	53,760	55,420
Recovery for composting*	–	–	–	4,200	9,600	16,450	16,550	16,740	16,850
Total Materials Recovery	5,610	8,020	14,520	33,240	55,750	68,880	69,310	70,500	72,270
Discards after recovery	82,510	113,040	137,120	171,970	157,950	165,140	161,920	165,020	163,900
Combustion**	27,000	25,100	13,700	31,900	35,540	33,730	33,600	33,350	33,100
Discards to landfill, other disposal†	55,510	87,940	123,420	140,070	122,410	131,410	128,320	131,670	130,800

* Composting of yard trimmings, food scraps and other MSW organic material. Does not include backyard composting.
** Includes combustion of MSW in mass burn or refuse-derived fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets and tire-derived fuel).
† Discards after recovery minus combustion.
-- The amount disposed using the given method is negligible.

Note. This table is adapted from information found at the EPA "Municipal Solid Rubbish in the United States: 2003 Data Tables." Retrieved February 15, 2006 from **http://www.epa.gov/epaoswer/non-hw/muncpl/pubs/03data.pdf**

Solid Rubbish Disposal Act

The Solid Rubbish Disposal Act was added as Title II of the Clean Air Act in 1965. The Clean Air Act, established in 1963, was an important milestone in environmental awareness; it was the first time the Federal Government set rules for air pollution. The Clean Air Act has become an umbrella for many environmental mandates, including the Solid Rubbish Disposal Act. The establishment of the Solid Rubbish Disposal Act is important because it promotes programs that have led to national research and the development of rubbish management techniques. The Act pushes for more efficient organizational arrangements, new methods of collection, separation, recovery, and recycling of solid rubbishs, and the environmentally sound disposal of hazardous rubbishs. It also lists guidelines for solid rubbish collection, transport, separation, recovery, and disposal methods. The Act is essential because it provides federal funding to cities that wish to improve their rubbish management systems (Pitchel, 2005).

HISTORY OF CAMBRIDGE

Cambridge, Massachusetts was established in 1846 when three rival villages: Old Cambridge, Cambridge Port and East Cambridge united. Before that, between 1830 and 1846, the area now bounded by Eliot Square, Linden Street, Massachusetts Avenue and the River, was known as Newtowne. Each family that inhabited Newtowne owned a house in the village, planting fields outside the village and a share in the common lands. The majority of the residents, of both Newtowne and Cambridge were farmers, artisans and tradesmen.

The Potato blight that struck Ireland in 1845 brought thousands of immigrants to Cambridge in hopes of a better life. At the start of the twentieth century, immigrants from other countries such as Poland, Portugal, and Italy fled to the city as well as Russian Jews and French Canadians. The city grew and changed both demographically and physically with the coming of new inhabitants. In 2000, Cambridge's population was 101,355. There are over fifty languages spoken and eighty-two countries represented in public schools. There are also a number of college students from around the world that attend the City's Universities such as Harvard, MIT, Radcliffe and Lesley that make up part of the City's demographics (A Brief History of Cambridge, 2004).

CITY DEPARTMENTS

Cambridge has a number of public departments that serve the City such as the Fire Department, Police Department, School Department, Department of Public Works, Sanitation Department, and Traffic, Parking and Transportation Department. Public Departments are an important part of any city, especially one of such varied demographics. These units are designed to enhance the quality of lives for the general public and serve the needs of every citizen (Public Works Department, 2003). For more information regarding the Sanitation Department and the Traffic, Parking and Transportation Department please refer to Appendices B and C respectively.

DPW Regulations

Within cities, there are regulations which are established so that the city can better provide for the public. There are certain regulations that the Cambridge DPW sets and enforces; some differ from those set forth by the DPW's of other cities. Every city is comprised of different layouts, demographics, and politics. These differences make each city unique and, therefore, their public departments have unique methods of serving the public. This accounts for the need of different regulations within each city.

In Cambridge, even large apartment buildings are allowed to use municipal rubbish services, as long as they can meet the City regulations. Also, in Cambridge, certain items are not collected by the Sanitation Department. These items include those collected for recycling such as glass, metal and plastic containers, cardboard, paper, and yard rubbish; and household hazardous rubbishs such as paints, chemicals, fluorescent bulbs, tires and car batteries. Cambridge residents who wish to have their rubbish collected are not to place their bags or barrels on the curb prior to 3 p.m. the day before it is to be picked up and must remove their empty barrels by 6 p.m. the day the rubbish is collected. On Wednesdays, an additional truck is sent out to collect large appliances that citizens have requested to be picked up. The City charges $20 for the removal of these appliances (Public Works Department, 2003). Cambridge's rubbish management practices are fairly common when compared to the methods used by other cities in the region; however, there are subtle variations within each system.

In Worcester, Massachusetts, residents who wish to have their rubbish collected by the city rubbish removal service must place their rubbish in yellow rubbish bags that can be bought from the city for one dollar. The city will collect household rubbish such as paper products, small pieces of metal and wood, Pyrex, empty paint and aerosol cans, and pizza boxes. Broken glass will also be collected but the Worcester DPW mandates that it be wrapped in newspaper to avoid ripping through the bags. They also ask residents to place the rubbish on the side of the street between 6:30 and 7:30 a.m. the day of pickup, not the night prior. Residents are also requested to place the bags four feet from any recycling bins and place pizza under the yellow rubbish bags. Like the Cambridge DPW, the Worcester DPW requires that appointments be made to remove bulk items, such as furniture. There is also a residential drop off center that allows citizens to drop off an unlimited amount of bulk items for a small fee. Worcester residents may also make an appointment to drop off hazardous rubbish at this site (City of Worcester, Massachusetts, 2006).

Brookline, Massachusetts also provides a municipal rubbish removal service for their residents. They remove all typical household rubbish although they do not have a specific list of items available. They have no particular problems with rodents associated with their rubbish collection. That may be because the City Health Department has two health inspectors who are required to look into this issue. The Brookline Sanitation Department does not require that residents place rubbish in barrels, but they do ask that if barrels containing rubbish are stored outside that they be sealed. Residents are also asked to not put out more than three bags of rubbish to be collected by the City, but this rule is not strongly enforced. Apartments with under twenty units are allowed to use municipal rubbish removal service; those with over twenty units are encouraged to have a dumpster. The City does not provide dumpsters to any school, business or apartment buildings and therefore does not have the equipment necessary to collect from dumpsters. The worker routes and drivers are situated similarly to Cambridge's system; drivers and laborers are each assigned to a certain truck that has certain routes on certain days. All the routes are situated in zones, one for each work day of the week. Along with the truck driver and laborers the City employs two inspectors and a supervisor. The inspectors and the supervisor are out on the routes daily to be sure that the rubbish is being removed from the streets properly. Although the Department has limited manpower they found their system to be so efficient they were able to cut one truck out of their collection system (Department of Public Works Highway & Sanitation, n.d).

Although all three systems have similar regulations each has some unique to their city. Worcester requires residents to buy City rubbish bags, Brookline has a three bag limit, which they do not enforce, and as of April 3rd, 2006 Cambridge has required all rubbish being placed on the street the night prior to collection be placed in a lidded barrel. Rubbish set out the morning of collection can still be in a bag. Every city is different and some rules or regulations that work in one city may not work in another. To make a system more efficient, a city may need to consider rules and regulations that they currently do not have in place. For example, Cambridge may want to try an implement rules and regulations currently enforced by cities with highly efficient systems.

Private Collection

Many commercial and industrial businesses also use private agencies. The DPW is aware of the apartment buildings and businesses that are required to use private collection. The DPW has no way of determining which residents use the private service; this is an issue because each truck is supposed to collect about the same amount of rubbish tonnage. When a resident uses a private service and the city is unaware some trucks may have higher load sizes than others making the routes uneven.

Some smaller cities and towns decide to rid themselves of municipal rubbish removal services altogether. There are seventeen communities in Massachusetts that have made this change; some use single carriers for the entire city and others require citizens to hire their own private haulers. Easton decided to do away with municipal service in the 1980's to cut town taxes. At the time there was a landfill nearby and citizens would drop off their rubbish and recycling at their leisure. When the landfill closed due to environmental purposes residents were forced to fend for themselves. Of 6,000 households 3,200 use BFI as their rubbish collection agency, four other large agencies are used by 1,200 households and the remaining homes use smaller collections agencies, dump their rubbish in school or grocery store dumpsters or bring it to neighboring towns.

The average cost for citizens to remove their rubbish in Easton is $360 per year. However this cost is high compared to towns in Massachusetts that use a single private rubbish hauler agency. Randolph, a town slightly larger than Easton charges residents $200 per year for their city organized private rubbish collection, while smaller towns such as Pembroke and Whitman charge $240 and $225 a year respectively. Most residents of Easton would like to switch to a single private collector. The private collection agencies agree that it would make sense environmentally and economically (Schworm, 2005).

Although a single private collection agency might be the right system for Easton, Randolph, Whitman and other Massachusetts towns, some communities have found that a system with several different agencies can also be highly efficient. Jackson, Michigan no longer provides municipal rubbish removal for its citizens and there are very few complaints. Town residents have found that private agency can be very convenient. For example, if a resident is going on vacation for a few days, they can arrange for their rubbish to be collected a few days earlier. Other benefits include special pick-up dates, the return of the barrel to the house, sharing barrels with neighbors to save money and the company collecting rubbish from the backyard of the home instead of the street corner. Although it is not required, some neighborhood work together and opt to have only one or two agencies collect on their streets to increase efficiency, help the environment and reduce traffic flow (Solomon, 1999).

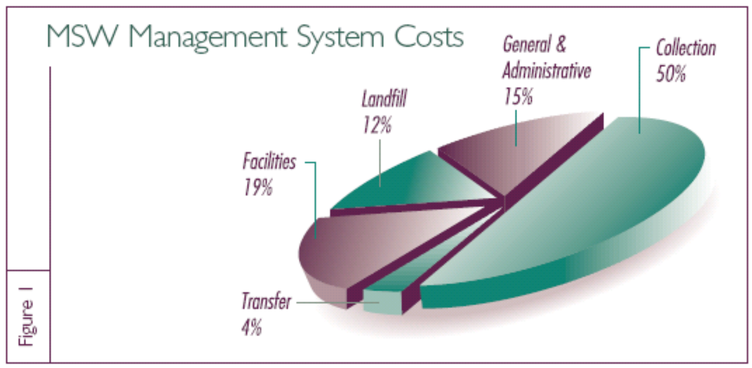
Some communities have found municipal rubbish removal systems provided by the city or town to be expensive and inefficient. As a result they have cancelled their programs and either contracted out to single agencies or required citizens to fend for themselves. Although this method of rubbish collection is useful to smaller communities, larger ones, such as Cambridge may have trouble do to high numbers of apartment housing, projects, schools, and crowding of streets.

ESTABLISHING THE CURRENT ROUTES

The current routes were established approximately thirty years ago. At that time, the fleet was made up of twenty-eight trucks, along with the man power to run the fleet. Once recycling was established and mandated within the City, it was feasible to decrease the fleet from twenty-eight trucks down to fourteen. With the new mandate in effect, recyclable items, such as paper and glass, were no longer collected as rubbish, reducing the overall tonnage. Over the years, recycling became more popular and the rubbish fleet was reduced further. In effect, the Cambridge Department of Public Works required the use of ten trucks as opposed to the original twenty-eight. Today Cambridge only requires the use of eight trucks. Although the number of trucks decreased, the routes were never reevaluated. The streets that the removed trucks had collected were added to the remaining ones. This caused the routes to be scattered and inefficient; these are the issues we addressed in this project.

RUBBISH REMOVAL TECHNOLOGIES

The main drive for the improvement of rubbish management technology is increased efficiency. The collection of municipal solid rubbish, MSW, results in fifty percent of the total cost of a rubbish management system, as shown in Figure 3. Therefore the more efficient the collection of MSW is, the better it will be for the city. Many cities use a rear loading style truck to collect rubbish. The EPA identifies two different technologies that a municipality can implement in order to greatly improve there MSW collection. These are the use of semi-automated and fully automated collection trucks. (Collection Efficiency, 1999)



Source: *Integrated Municipal Solid Waste Management: Six Case Studies of System, Cost and Energy Use: Summary Report.* 1995, SWANA, 50 pp, GR-G 2700.

Figure 3: MSW Management Systems Costs

The most common technology for the collection of MSW is done by using a rear loader style collection truck. These are the same type of trucks that Cambridge currently uses. A rear loader style truck has an opening

Figure 4: Rear Loading Truck. Retrieved from http://www.rdk.com/inventory_details.php?unit_id=0G0388#go

in the back of the rubbish container, or hopper, with a compacting blade inside. This allows for the crew of the rubbish truck to throw rubbish into the back of the truck. The rubbish is then compacted using the blade so that more rubbish is ultimately collected. The first truck of this design was made by the Garwood Company in 1938 and was known as the Garwood Packer. A rear loader is ideal for residential areas of any population density. It also requires less operation space than more modern vehicles. This enables the rear loader to operate in narrow alleys and streets with overhanging telephone wires or trees. Unfortunately this style of truck requires more manual labor than automated and semi-automated side loader trucks. This is because the rubbish crews, usually two laborers, have to physically get the rubbish from a collection point on the street and carry it to the opening on the back of the truck. (Rubbish Trucks, 2006)

Automated and semi-automated side loading rubbish trucks differ from a standard rear loader truck because they have a hydraulic arm that lifts the rubbish from the street and dumps it into the trucks hopper. In a semi-automated rubbish truck, there is a crew of one driver and one laborer. A worker is still needed to transport the specially designed container from the curb to be placed into the truck's lifting arm. Once the container is in the arm it is lifted and dumped into the truck, it is then returned to the street where the worker will carry it back to the curb. A fully automated truck only requires a driver. The lifting arm can be controlled by the driver to grab rubbish from the curb and then dump it into the truck.

Figure 5: Side Loading Truck. Retrieved from http://www.rollinsmachinery.ca/

The side loaders are compatible with residential areas of any density. They can service more houses than a rear loading truck, providing that all rubbish is placed in the specially designed containers. However, a drawback with having a lifting arm is that they require more space above and around the truck. This is because the arm can get caught in telephone wires or break tree limbs (Rubbish Truck, 2006).

We found that the purchase price of a Volvo rear loading style rubbish truck is $64,900 (Trucks, 2004a) and the price of a Volvo side loading style rubbish truck is $94,000 (Trucks, 2004b). RDK Truck Sales confirmed that on average, side loading style rubbish trucks are more expensive than rear loading rubbish truck. They explained that the side loading trucks are more expensive because of the hydraulic arm that is used to lift the rubbish. The running cost for a rear and a side loading style truck differs greatly; the rear loading trucks cost more overall because they require more personnel to operate. Also, there is always the risk of workers compensation due to injury from lifting rubbish into the truck. The side loading style trucks require fewer workers to operate and there is a decreased chance of worker injury. The hydraulic arm that does all of the lifting may cause extra costs it self. The arm is a very complicated assembly of joints and hydraulic cables, if it breaks down its needs to be repaired by a specially trained technician. Overall the benefit of one truck over the other is dependant on the attributes and needs of a city (Collection Efficiency, 1999).

CHAPTER THREE: METHODOLOGY

PURPOSE AND GOALS

There were three main goals of this project. The first was to improve the efficiency of the current rubbish management system in Cambridge by creating new routes. This would make is easier for the sanitation department to determine the area each truck is collecting garbage in. Also, it would aid the department in testing new rubbish management technologies. The second goal was to investigate the issues involved with rubbish collection. These issues include health and safety, traffic and accidents, environment and contractual obligations with the Union. The final goal was to create a model that can be used by other cities and towns. We created a twelve step methodology that can be easily adapted to any city or town wishing to improve their rubbish removal system.

OBJECTIVES

Our main objectives of this project were to create a methodology that can be easily adapted to other cities and towns, to analyze the current routes in Cambridge and make recommendations on how to improve their current system. We analyzed the current routes by observing the daily routine as well as reviewed maps of the trucks and routes. We used this analysis to develop the aforementioned methodology. While at the DPW, we interviewed some of the rubbish truck drivers. We drove the routes, in conjunction with conducting interviews, allowing us to review how drivers perform their daily duties and how their performance may contribute to the system's inefficiency. We also reviewed data to scrutinize other inefficiencies of the rubbish removal system.

ASSUMPTIONS

In order to develop our methodology completely, we needed to make various assumptions. These involve both the data we were given by the DPW and that we collected ourselves. When calculating the number of bedrooms per route, we had problems with corner houses. We had to decide on which street segment corner homes' rubbish was collected. It was unreasonable to try and view every corner house in the city of Cambridge to determine this. As a result of this problem, we decided that we would assign one half of the home's total bedrooms to each street segment adjacent to the house.

When we were determining the average tonnage per truck per day we overlooked any data that appeared illogical. For example if a truck was picking up 3.6 tons and normally collected about ten tons on that day, we decided not to use that data in our calculations. There are various reasons that the truck may have had such low tonnage for that day, one being that it broke down. We did not ignore low or high tonnage on days that all trucks had low or high tonnage. For example, if a truck normally collected ten tons, but collected fifteen on a day after Christmas and all other trucks had similar tonnage changes on that day, we decided not to ignore the data.

We wanted to provide the DPW with our calculations in both tons and pounds. This is because most people are more familiar and can understand pounds better. When converting our data we assumed that the tonnage collected was in 'short tons,' 2000 pounds per each ton, as opposed to 'long tons,' 2240 pounds for every ton. We also used three significant figures in our calculations.

There are some streets that have high tonnages or unique layouts that require the truck to make two passes in order to collect all the rubbish. This means that the rubbish truck must travel down each side of the street. If the street is a one-way, the truck travels down it twice in the same direction, concentrating on one side at a time. While explaining what direction the drivers should take when completing their routes, we made some assumptions regarding the tonnage. If the street needed two passes but the driver was only collecting one side at a given time, we divided the total tons for that segment in half when calculating the tonnage collected for that part of the day.

The average number of people per bedroom for Cambridge was 1.1 people. Our liaison suggested that anything less than 0.5 people per bedroom and anything more than 2.2 people per bedroom would be unreasonable and therefore labeled a problem area. This was an assumption since there was no numerical method in determining what our cutoffs would be.

DATA COLLECTION

Preliminary Research

We used tools, such as Google Maps, to hand-draw all of the one-way streets onto a map of the City of Cambridge that showed the current routes. Google Maps is a software tool that allows users to view streets of a city or town. The direction of the street is represented with an arrow when that street is a one-way street. Once completed, we needed to get a better feel for the routes themselves. We went out on Tuesday's routes to observe the challenges the workers faced. This enabled us to better understand the task since we then knew some of the difficulties that we needed to take into consideration. We noted all the one-way streets, divided roads, and problem areas. We used a hard copy of a map of Tuesday's routes to label street difficulty and neighborhood and street type. Neighborhood type ranged from suburban wealthy areas, to thickly settled areas. The suburban wealthy areas are those with large, single family homes, situated further apart. Street types included narrow, divided, main, and one-way or a combination. Narrow streets are those in streets that the rubbish truck may have difficulty navigating. This information aided us in redesigning the routes.

Interviewing

We found that it was much more helpful to talk with the supervisors, rather than the drivers, about our project. We have been in close contact with three of the Sanitation Department Supervisors throughout this project. All of the supervisors are supportive of our project and provide very helpful advice about how to change the routes because they were once were truck drivers themselves. They were able to explain some of the intricacies of rubbish removal in Cambridge that we could not see by simply looking at data. The supervisors informed us of which drivers typically emptied the dumpsters that needed to be picked up every day. With this information we knew we had to make that particular driver's route a little smaller and lighter than the other drivers' routes to account for the extra tonnage from the dumpster.

As a result of the interviews with the supervisors, we decided to concentrate on one day's routes to begin our project. The supervisors agreed with our suggestion and asked that we use Tuesday as an example, since it is the biggest zone.

While re-working Tuesday's routes and conferring with the supervisors, it became apparent that Tuesday was no longer a good day of focus. It contains many housing projects that the City collects rubbish from, but there is no bedroom data available for these dwellings. Therefore, we switched our focus to Thursday. It encompassed all the difficulties associated with Cambridge's rubbish removal and had more accurate and complete data. Also, Thursday's routes are closer than Tuesday's routes to the Cambridge DPW, where we are working. This made Thursday's routes more accessible and, therefore, easier to observe.

Archival Research

Current traffic and driving regulations that exist within the City have a large effect on the Sanitation Department's performance. We need to take these regulations into consideration while designing the new routes because the workers are required to abide by them. For example, we cannot have a rubbish truck going the wrong way down a one-way street.

We obtained records of accident reports. This gave us an idea of the types of incidents that occur while on the job. We were able to use this information for a basis of the health and safety issues associated with our project.

For Thursday's routes, we calculated the tonnage per street segment, the area of a street between two intersecting streets. We used an Excel spreadsheet containing the tonnage per truck, per day for the fiscal year 2004-2005 to create a formula to complete these calculations. Since this was an approximate calculation, we devised a way to check our work and determine problem areas. We used the number of people per block along with the number of bedrooms per street segment to determine the number of people per bedroom. We then found the mean and used it to determined outliers. The outliers were areas that required further investigation as to why the calculations were not working out as expected. GIS has proved to be helpful in these calculations and visualizing our data. It allowed us to join different tables on similar attributes so that we were able to view tables containing bedrooms for each building. We used census data to view the population per block. We combined this data to calculate the number of people per bedroom. This calculation entailed dividing the number of bedrooms per census block by the number of people on that block.

When designing our proposed routes, we based our recommendations on the tonnage per street segment; location of one-way streets, dumpsters, schools, commercial accounts, apartment buildings and housing projects; and city regulations. Maps showing the locations of the dumpsters, schools and commercial accounts can be found in Appendix D.

GIS Maps

We had various maps of the current route system available to us through the DPW. We had a large map of the entire city that showed the collection zones of the five days. The map also showed each of the eight trucks routes for that day shown in different colors and labeled by truck number and driver. We also had a smaller map showing only Thursday's routes, again with each route labeled by truck number and driver and shown in a distinct color.

Using the data of number of people per bedroom, we were able to flag problem areas; areas where our calculations may be off and we needed to investigate further. GIS attribute tables allowed for easy calculation of the mean for this data. While discussing the data with our liaison, he suggested that anything less than half and more than two times the mean would be an area marked for further investigation. We used these numbers because they yield a reasonable amount of problem areas while maintaining a reasonable number of people per bedroom.

CHAPTER FOUR: DATA & ANALYSIS

There is much data that must be collected in order to propose a design for new rubbish removal routes for the City of Cambridge. We combined and analyzed GIS maps and other data that was available from the DPW with data that we collected and calculated. We used our analysis to propose a method which can be easily adapted for cities and towns throughout the world for designing new routes.

DATA

Shadowing the truck routes gave us a better sense of the neighborhoods and how drivers approach the current routes. For example, we noticed that although Inman Street is a one-way street, the rubbish truck must go down it twice, concentrating on one side of the street at a time to collect all the rubbish. This is a result of multifamily houses and therefore a larger tonnage of rubbish than if the houses were single family homes. We also observed that Mullins Court, shown as a street on the map, is not a street but a walkway. We also discussed the speed of the drivers with their supervisors; it is typical that a faster driver, such as Driver G, will finish his route approximately one hour prior to a slower driver such as Driver F. In cases like this Driver G would be required to help Driver F until his route is completed. In order to avoid these instances we designed our routes with the intention that each driver will finish his route at approximately the same time.

While at the DPW, we were given the opportunity to speak with four of the drivers who drive the routes on a daily basis. We found one of the drivers we interviewed to be skeptical of our project and we are concerned that all drivers carry a similar attitude. However, he did bring up some important issues regarding our changing the routes. Some feel that more experienced drivers will revert back to the old routes that they are more comfortable. We addressed this issue with the Sanitation Department Supervisors who assured us that if the routes we propose are more efficient than the current routes, they will be sure that the drivers follow the new routes.

The DPW provided us with excel spreadsheets that showed us the tonnage collected per truck, per day for every work day in the 2004-2005 fiscal year. Using the GIS network within the DPW, we obtained the number of bedrooms per household in Cambridge. This layer was already established within the DPW database from information obtained by the Assessor's office. Another GIS layer used for calculations was the population per census block. Attribute tables in GIS were applied to a formula to find the number of people per bedroom. Using the number of people per block and the number of bedrooms within that block, we divided one by the other to obtain the number of people per bedroom and then found a mean. For Cambridge, the mean number of people per bedroom is 1.186. While investigating Thursday, we marked the problem areas, any blocks with less than 0.5 or more than 2.2 people per bedroom. Within Thursday, there were fifteen blocks that needed further investigation as to why the numbers were not corresponding correctly.

Interviewing our liaison and the three supervisors of the Sanitation Department proved to be very helpful. They relayed to us some issues they are concerned about including health and safety of the workers and residents, traffic and accidents, environmental issues, fines from the transfer station, and staying in compliance with the Teamsters Local 25 Union contract.

Health and Safety

Cambridge has developed a rodent problem due to uncovered rubbish being left on the streets overnight. We have found that it is the area around Massachusetts Avenue in Thursday's collection zone that is the most afflicted by the rat infestation. The map in Appendix E shows areas where there have been complaints regarding rats. The major area of complaints is central to Massachusetts Avenue and circled in black for easy spotting.

To prevent this rodent problem, the City must concentrate on sanitation. The main reason rats will move into an area is food. Rats are scavengers and will seek out any open source of food, mainly rubbish. Many people will throw out their leftovers or spoiled food along with their rubbish. If the rubbish is not properly sealed, it will become a feasting ground for rats which chew through the plastic rubbish bag to get to whatever food may be inside. This is amplified if a city employs a curbside pick up because when the rubbish is outside, it is even easier for rats to get to. In order to prevent this from happening, the city must mandate that all rubbish be in hard bodied receptacles, such as metal or plastic containers. These containers make it more difficult for rats to get to the rubbish. The City of Cambridge is implementing a closed lid container policy for all of its citizens. This policy went into affect April 3, 2006. This mandate requires anyone who wishes to place their rubbish out the night before their collection day to place all plastic rubbish bags in lidded cans. Residents who place their rubbish out the morning of their collection day may still use plastic rubbish bags. In effect, no plastic bags will be left on the sidewalks overnight which will hopefully aid in rodent control.

The health and safety of rubbish management employees is frequently put to risk. If the laborers are only traveling a small distance between houses they ride on the back of the truck instead of climbing back into the cabin. This can be very dangerous because a laborer could be killed if they were to fall of the truck. For example, a worker in Virginia was killed when he lost his balance on the back of a rubbish truck. His death was caused by extensive damage to his skull and brain. Due to this accident, some departments in Virginia are requesting that employees wear helmets while riding on the back of the vehicles (County Rubbish Collector, n.d.). No incidents like this have been reported in Cambridge, but this type of accident could happen if workers are careless.

The Cambridge Department of Public Works requires all rubbish men to wear gloves and long pants while working. This dress code is enforced to protect the workers from sharp needles or glass that may be in rubbish bags. The Sanitation Department is yet to have an accident report that describes an injury related to glass or needles. They also ask all workers to wear bright yellow vests so they are easily seen by the truck driver and other drivers on the roads. While shadowing a truck with the Department Head, Mr. Bill Frazier, on Tuesday, March 21, 2006, we noticed a laborer not wearing a yellow vest. Mr. Frazier immediately radioed the truck driver and insisted he inform the laborer that he must wear the vest to be in compliance with DPW regulations. Although laborers are not always watched by supervisors during their routes, they are reprimanded when seen not following rules. Specific incidents are discussed further in the Traffic and Accidents section.

Traffic and Accidents

Based on the information we collected when viewing the collection routes we determined that approximately half of the rubbish on Cambridge's streets can be collected in one pass. This means that the rubbish truck drives down the middle of the road and each laborer collects the rubbish on separate sides of the street. Appendix F lists all streets contained in the Thursday zone and states whether or not the rubbish on the street can be collected in one pass. This is a good method for smaller, less busy streets because it reduces the amount of time the truck is on that particular street as well as the amount of time that it is on the road for that day. It can be somewhat frustrating and time consuming, however, to be stuck driving behind a truck that is collecting both sides of the street when there is no way to pass. Although the trucks are slow and a nuisance on residential streets, sometimes their lack of speed can be beneficial to a neighborhood. The slow speed of the rubbish trucks cause drivers in that neighborhood to slow down during the time it is collecting in that area. This may help reduce the number of accidents in a residential area since drivers frequently drive too fast through residential areas (Reagin, 2002).

There are many accidents in Cambridge involving rubbish trucks. The accident reports we obtained from the DPW describe ten accidents in the last twelve years of various natures, involving low telephone wires, other rubbish trucks, and parked and moving passenger vehicles. Workers are required to report all accidents to their supervisors. There are a variety of forms that need to be filled out and a review committee evaluates the accident and provides suggestions regarding the driver's actions and any consequences that are to follow. Blank accident report forms are included in

Appendix G as well as some examples of accidents in Appendix H; all names have been removed from the document to protect the driver. We observed that one driver in particular was involved with seven of the ten accidents. The review committee established that this particular driver should undergo additional training in order to improve his truck driving.

The trucks often cause congestion, particularly on main roads, but sometimes they drive too fast through dangerous intersections causing other problems. For example, on March 6, 2003 a rubbish truck driver rear-ended a passenger car because the truck skidded when trying to break in snowy conditions. After review of the accidents, a review committee made several suggestions to the driver. They included suggestions that the driver slow down when driving in compromising weather and that he be more aware of his surroundings. A full report of this incident is contained in Appendix H. There are nine other accident reports, from the last twelve years, involving moving vehicles; six involving other moving vehicles, one involving a parked car, one involving another rubbish truck and one involving power lines.

Environment and Transfer Station

The Cambridge DPW switched from diesel fuel to bio-diesel in 2004. The City no longer uses bio-diesel fuel due to a high increase in cost. The United States Environmental Protection Agency, EPA, and the United States Department of Energy have both confirmed that bio-diesel fuel qualifies as a clean-burning fuel. In the U.S. it is made primarily made from soy beans and its pure form is known as bio-diesel B100. It can be used in any vehicle or machinery that diesel is used in and can be mixed with diesel in any ratio. The most common form is B20, which is comprised of a 20/80 bio-diesel/diesel mixture. This form costs approximately fifteen to thirty cents more per gallon than normal diesel (Edwards, 2003).

Based on information provided by the DPW each rubbish truck fills their 35 gallon tanks approximately once a week. In 2005, the department paid approximately $1.99 a gallon for diesel fuel, which resulted in a total cost of $557.20 a week for the fleet. If B20 was used instead of diesel it would cost roughly $641.20 a week. For a full year, at this price, bio-diesel would cost $4,368 more than diesel. The cost versus the benefit will differ depending on the company using the fuel. B20 causes twenty percent less pollution than pure diesel, but it comes at a high cost to the Department (Economics of Bio-diesel Versus Petroleum, 2006).

The City hires a private company to take care of the recycling and yard rubbish services. At the beginning of 2006 the Somerville transfer station, where Cambridge dumps its rubbish began to fine cities for dumping recyclable materials. Since this is a relatively new regulation Cambridge does not have any reports regarding these fines. Mr. Josephson explained to us that the transfer station video monitors each dump. This enables them to see which trucks are discarding recyclable material and charge the appropriate city. Dumping of this material can be inevitable at times. For example, if a tire or microwave is thrown into a dumpster, a worker may not notice and it will be discarded with the rest of the material in the dumpster.

Unions

The City of Cambridge has a collective bargaining agreement with the Teamsters Local 25. City workers belong to this union. All stipulations in the contract must be followed by the City of Cambridge. The contract is negotiated every three years and is either renewed or changed. Larry Silva, a Supervisor for the Department of Sanitation, is also the Department's Union representative. He is the person who negotiates the contract and also makes sure that the contractual obligations are being met by the Department.

There are many conditions in the contract that must be met. Some of these include that "The City shall not use less than eight (8) packers, unless sufficient personnel are not available as a result of illness, injury or vacation" (Collective Bargaining Agreement, 2005). This is important because there are many days when there are fewer than eight packers, rubbish trucks, on the road. On these days, it is generally one truck that cannot be sent out for reasons such as lack of personnel or truck maintenance. This causes a problem for the other seven trucks that go out on the routes that day. The truck that finishes first is sent back out to pick up the rubbish that was supposed to be picked up by the absent truck. These extra streets result in more tonnage being picked up by the other trucks. This may result in extra time spent at the transfer station.

Another contractual obligation is that "No permanent civil service employees of the Department of Public Works shall be laid off as a result of reducing the minimum number of packers to be used" (Collective Bargaining Agreement, 2005). This clause of the contract is very important because it ensures that the workers will still be employed even if the number of trucks in the fleet is reduced.

Both of these points are very important issues that are faced by the Department of Public Works. Often it is very difficult to ensure that all eight trucks are out on the routes. If the fleet size was ever decreased and the workers were permanent employees, the Department of Public Works is obligated to find those workers jobs within the

Department. It is evident that contractual obligations can be very difficult to meet, but they must be followed.

DATA ANALYSIS

We combined all this data in GIS to propose new routes for Thursday's zone. We averaged the tonnage collected by every truck on every Thursday for the fiscal year 2004-2005. Using GIS we were able to add layers to the rubbish route map provided by the DPW. We created a map that showed the number of rooms per household layered on top of the rubbish routes. We then determined the number of bedrooms rubbish is collected from on each truck's route and the number of bedrooms collected for each street segment. We divided the average tonnage by number of total bedrooms on a route to get the average tonnage per bedroom. We then multiplied this number by the number of bedrooms on a street segment to get an average amount of tonnage collected on each street segment. Below is a sample of a Thursday zone calculation. The data we used for our calculations, the total number of bedrooms and tonnage, can be found in Appendix I.

Truck 24:

Thursday average (FY2004-2005) = 10.68 tons

Number of bedrooms per route = 1467

Average tons per bedroom = 10.68/1467 = 0.007280164 tons

Bedrooms on one street segment = 79

Tons per segment = 79 * 0.007280164 = 0.049 tons

After determining the amount of rubbish collected, on average, for every street segment in the Thursday zone, we began to analyze our data. While rearranging street segments we strived to keep a base route, containing familiar streets, for each driver. We chose to keep base routes so the drivers were still working in areas that they are comfortable with. We then added and removed street segments not contained in the base route with other street segments holding similar characteristics. We used one-way streets as a reference when designing the routes because in areas with a lot of one-ways, a truck may have to loop around four or five times in order to cover the entire area. Also, we considered major roads with center dividers as borders of routes and even designed the routes so that one truck would be collecting one side while another truck collected the other.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

Our conclusions and recommendations are based on the data we collected and our observations during the span of our project. They include recommendations on how to change the current rubbish removal routes for Thursday's zone and how they will affect the City of Cambridge. The route consolidations will enable Cambridge to have a better idea of the area each truck is collecting from. This will aid the Sanitation Department in testing new equipment and improving the total efficiency of the system. We will then discuss the model that we created to change the rubbish routes, which can be applied to any city's rubbish collection program with some minor changes.

We analyzed and redesigned the routes for Thursday. We then used street characteristics and tonnage to determine the exact direction in which the routes are to be completed. We provided maps with arrows showing which streets to take as well as written providing starting and ending points. We determined the starting and ending positions for each unique route based on the location of the DPW and the transfer station. The directions were written based on the location of one-way streets, how many passes each street needed, and the tonnage per street segment. This documentation also provides the approximate tonnage that would be collected in both the morning and afternoon portions if followed. The instructions for each truck can be found in Appendix K.

By evaluating and changing the routes, we were able to consolidate them so that each truck has a particular section. If our proposed routes are adopted, the supervisors will be able to know where rubbish came from by which truck picked it up. This is important because the transfer station monitors the rubbish being dumped and fines the

City for dumping recyclable materials. The route consolidation enables Cambridge to pinpoint the area from which the material was collected; therefore, Cambridge can take proper action to reduce the collection of these materials.

The consolidated routes also allow Cambridge to test new equipment and practices. This is because the routes we created have been given specific directions in which they are to be completed. Using the consolidated routes for testing, the City has firm ground for their conclusions and for comparisons. This is true for any new equipment or techniques which the City wishes to test.

The overall efficiency of the rubbish removal system is greatly improved since the routes are consolidated. This is primarily because trucks are no longer traveling long distances between their routes without picking up rubbish. This also ensures that there are no streets left unassigned. This is important because with the old routes, unassigned streets were picked up by the truck that finished first. The current method resulted in the routes being scattered and inefficient.

Maps of the current and proposed routes for Thursday can be found in Appendix J. These maps depict the consolidation of each truck's route while maintaining a base route so the drivers are working in a familiar area. We designed the routes using an twelve step process that may be applied to any city with minor changes made to fit the city's unique characteristics. These steps represent the basic procedure for consolidating routes in order to increase efficiency within a rubbish removal system. The steps are as follows:

1. Pick an original day of focus. This day should be a representation of the most problematic day in the town or city. The reason for this is so that all factors will be present from the very beginning.
2. Use GIS to overlay maps. Overlay the city street centerlines along with the map which contains the number of bedrooms per household and the rubbish routes. The routes should then be split into segments so that each segment is between two intersecting roads. Calculate the number of bedrooms per street segment.
3. Use these numbers to calculate the number of bedrooms each truck driver has on the chosen day.
4. Calculate the average number of tons (or pounds) per truck for that day, using a full years worth of data. Disregard any data that is appears illogical.
5. Use these two data sets to calculate the number of tons per bedroom for each truck.
6. One can then find the number of tons per street segment by multiplying the number of tons per bedroom by the number of bedrooms on a given street segment.
7. To verify that this calculation is accurate use GIS to calculate the mean number of people per bedroom within one census block for each census block throughout the whole city.
8. Then choose a number below the mean and a number above the mean that will portray flawed data. We decided that areas with less than 0.5 people per

bedroom (half our mean) or with more than 2.2 people per bedroom (twice our mean) was unrealistic and labeled these neighborhoods as problem areas.

9. Use GIS and previous calculations to determine factors that may be yielding this result. These could be miscalculations, misconstrued data, or anything else of that nature. However, these factors may not be able to explain the problem areas. In this case, further investigation is necessary.
10. Physically go view the routes. This should be done along with a Sanitation Supervisor so that they can share information about the city and current problems the workers face.
    a. Review problem areas that could not be explained by reviewing data. For example maybe there is a housing project on that street and number of bedroom data was unavailable, causing there to be a large number of people per bedroom.
    b. Physically inspect each individual street and label it based on the following attributes:
        i. Type of road (one-way, main, divided, narrow)
        ii. If the road can be collected in one trip down or if two trips are necessary
        iii. Congestion factor
11. Use the notes you took, along with the number of tons per street segment, to move the routes around, switching one street segment with a similar one. Note: we found it convenient to use a base route for each truck depending on the current collection system.

12. Repeat previous steps for all other zones.

This model methodology is based on data obtained by viewing and completing calculations of Cambridge's Thursday routes. We verified that this model methodology is effective and complete by applying the same system to Cambridge's Friday routes. We were not able to apply all steps to Friday due to time constraints and the project coming to an end. Therefore, the routes we have proposed for Friday were based solely on tonnage and one-way streets. Because of this, these proposed routes will need a closer look and the attributes of the area will need to be taken into consideration by making any necessary adjustments to the routes. We then supplied the DPW with quantitative data for Monday, Tuesday and Wednesday so that, with further qualitative research, they may continue to consolidate the routes. For this project, because we are unfamiliar with Cambridge, we had our routes reviewed by a Sanitation Department supervisor, who will bring them to the commissioner to be approved.

In summary, we are recommending to the DPW new routes for Thursday and Friday's rubbish collection. In addition, we have provided a methodology for them to keep updating their route system. Finally, we have developed a model that we believe other cities will find helpful for improving the efficiency of their rubbish collection routes.

APPENDICES

APPENDIX A: CAMBRIDGE DEPARTMENTS

Cambridge Department of Public Works

The Department of Public Works was established in 1946. Before the establishment of the Department, other departments existed including the Parks Department, Streets Department, and Building Department. All of these and more are now subdivisions of the Department of Public Works.

Currently, the Department is located at 147 Hampshire Street in Cambridge. There are many subdivisions including the Sanitation Department, which we will be working closely with. Other subdivisions include the Administrative Division, Buildings, Parks & Urban Forestry, Engineering, Recycling and more. Their mission statement is as follows:

The mission statement of the Cambridge Department of Public Works (DPW) states:

> The Cambridge Department of Public Works (DPW), operating within the framework of the City's goals, provides dependable, high quality and accessible service - maintaining, improving and expanding a safe, healthy, attractive and inviting physical environment. The Department supports the infrastructure of a vibrant community through comprehensive planning, scheduled maintenance, collaborative efforts, the provision of information, and emergency preparedness and response.

Since we will be working closely with the Sanitation Department and our liaison Eric Josephson, it is necessary to explain the duties of this division in further detail. The solid rubbish disposal program provides weekly pickup. The map below shows these zones and their pickup days.

Figure 6: Map of the city of Cambridge and the current pickup zones.
http://www.cambridgema.gov/TheWorks/schedules/rubbish.html

Currently, pickups include residents, schools, commercial accounts and public housing. The City's litter ordinance is strictly enforced. Rules such as placing rubbish on the curb no earlier than 3:00 p.m. on the day before pickup and removing it no later than 6pm the day of pickup are put into effect to help keep the streets clean. Every resident is responsible for keeping his/her walkway and sidewalk in front of the home clean of any rubbish.

As of April, 2006, the sanitation Department no longer allows plastic rubbish bags outside of a rubbish container to be placed on the curb the night before collection. This is because of a rising rodent problem in the city. The department hopes to reduce the problem on a short term basis with this regulation and is looking into long term solutions as well. A possible long term fix would be switching all trucks to side-loaders which require a special bin which is rodent proof.

The workers' day is done once all rubbish for their route has been collected and brought to the dump site. The workday begins at approximately 7am and ends around 2pm. There are eight trucks and three workers on each truck: one driver and two laborers.

Figure 7: Example of a bin used with side loading trucks. http://www.ci.fremont.ca.us/Environment/Rubbish/ResidentalRubbish.htm

Sanitation Department

The Sanitation Department, headed by William Frazier, is a division of the DPW that is responsible for the collection of rubbish in the city. Eight trucks, each manned with a driver and two laborers collect rubbish for all residential areas, public buildings, schools and some commercial accounts on a daily basis. The city is broken into five zones and each zone has a different collection day, Monday through Friday. All eight trucks work in collaboration to collect all the rubbish from each zone during a work week (Public Works Department, 2003). The figure below shows the current collection zones: Monday is shown in light green, Tuesday in turquoise, Wednesday in grey, Thursday in beige and Friday in light pink. The figure also shows each of the eight trucks route for that particular day. The key of this map depicts the different trucks which are shown as a numbered, colored circle. The colors coincide with the truck routes on the map.

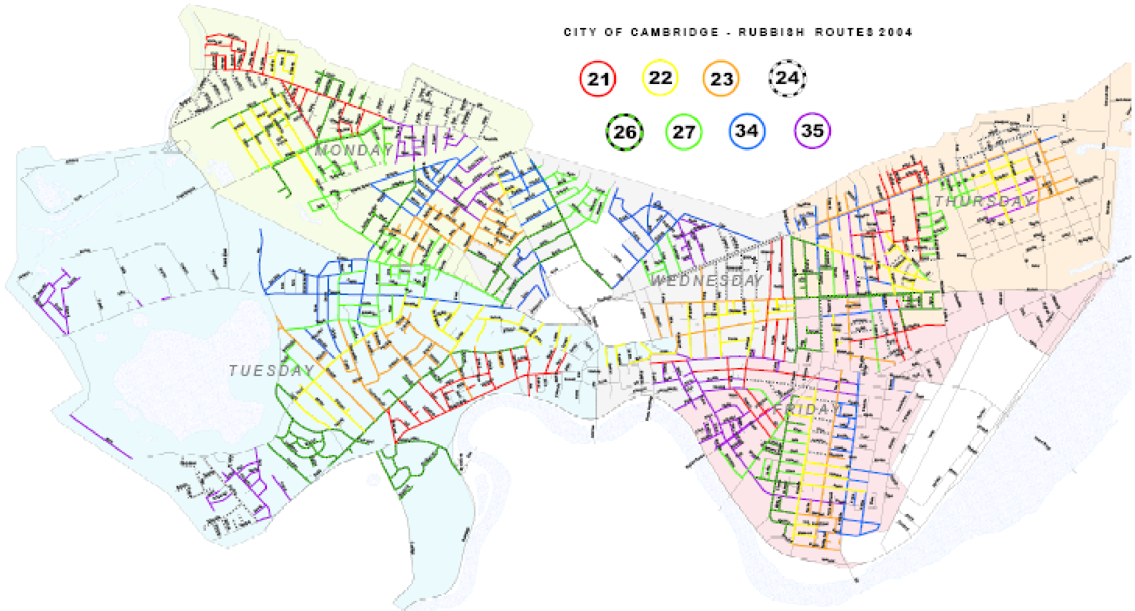


Figure 8: Rubbish Zones and Truck Routes. Personal Communication, Eric Josephson, 01/23/06

Traffic, Parking and Transportation Department

This department is organized to meet the needs of all Cambridge's residents, businesses and visitors. It promotes transportation safety and the reduction of the harmful aspects of transportation such as air pollution, noise and congestion. The Traffic, Parking and Transportation Department sets rules and regulations in order to ensure that the Department as a whole can serve the city as it was created to do so. The rules set forth by this department must be followed by the DPW. That means that rubbish trucks cannot go the wrong way down one-way streets, must stop at all stop lights and stop signs, and must not block traffic just like every other vehicle on the road (Traffic, Parking & Transportation, n.d.).

APPENDIX B: ABOUT GEOGRAPHIC INFORMATION SYSTEMS

Geographic Information Systems

Geographic Information Systems (GIS) is a computer technology used for mapping, managing databases, and integrating data which in turn helps solve problems. GIS is used for a number of applications. It can be used to map present or future locations of objects, predict patterns, and even create models of data.

GIS has three main views to help organize and portray the data. These views are the Database View, the Map View, and the Model View. In the Database View, GIS is used to connect a visual to the database. This is known as a "Geodatabase." A database is inputted into the system which can then be visualized by being translated into vectors, or lines, and rasters, or pixels. This view is often used to map things such as addresses, terrains and networks. Although this view is helpful in that a database can be visualized, it does not have to be used this way. The database can be viewed and manipulated just like any other database.

The Map View is the main use of GIS and is also know as "Geovisualization." In this view, features and relationships are easily pinpointed on the Earth's surface. This is useful because the map is interactive. The user can pan and zoom around the map focusing on certain aspects. Much like Google Maps or Yahoo Maps, you can click and zoom on a certain location to view pertinent information. This view also allows the user to edit the map and add or delete specific attributes.

The Model View, also known as "Geoprocessing" is used so the user can enter their data and use tools to apply to that data. The user will then see the results of using that tool. These operations are then strung together and the user can see the progress, basically a sequence diagram (or process tree). Modeling is crucial in validity of data, the ability to see the flow of data through a system is crucial in identifying errors.

Often, visualizing data allows the user to see the big picture. Patterns and relationships are easily identified, much more so than if the user was looking at straight text. Large databases often become overwhelming and hard to understand, and sometimes too hard to explain. By using GIS, one is able to model and test the efficiency of scenarios before they are put into practice. This is helpful in that high priced trial runs can sometimes be skipped over and the plan put directly into effect after testing it using GIS. GIS also allows the user to see the impacts his/her changes will have on the future. With the ability to look at multiple scenarios comes the power to decide which one is ultimately the best fit for the project. Various criteria can be observed and compared at once rather than separately which may make the situation harder to understand (What is GIS, 2006).

APPENDIX C: INTERVIEWS

Phone Interview with Mr. Eric Josephson

City of Cambridge Public Works Department

147 Hampshire Road

Cambridge, MA 02139

Phone: 617 349-4808

ejosephson@CambridgeMA.GOV

Conducted on: 1/23/06

In talking with Mr. Josephson, we asked the following questions, with a summary of his responses below:

1. Has there been any work done on this project in the last 5-10 years and if so will we have access to it?
    a. There has been discussion about what to do and how to fix the problem, but no one has moved forward and there is nothing documented.
2. So basically, what we got is that you want a better system of routes for these trucks, is that correct?
    a. Yes, we would like a system that will be more efficient than the current, we would like to post the routes so that they are accessible, and basically consolidation is our goal.

3. Are there any limitations that we should know about before we go ahead with our proposal?
    a. We would like to keep the current zones (days on which certain areas are collected) only because it would be difficult to change those days due to the residents. We would be willing to look at it, if it was in the best interest and you gave a compelling case.-
4. Does your department keep records of yearly budgets and expenditures and if not where can we find this information?
    a. We do keep all of that. I can show it to you when you come in on February 1st

Some additional information that we got from him while conversing is highlighted below:

Buildings with 8+ apartments have to have private pick-up. The city does pick up from some public housing and businesses. Never pick up from places such as Harvard and MIT. Things that they know are how many bedrooms in each parcel, also units, and how much rubbish (tons) is collected each day. The city pays per ton at the transfer station. For the city, there is no limit on the number of barrels that a person can put out on the sidewalk. Mr. Josephson informed us that they want to reconsolidate the routes so that they are not as scattered. As of now, there are trucks that start at one end of the route and then all of a sudden jump to the other end with nothing in between. They would like to not keep the trucks on busy roads for a long amount of time; they do have to turn off as much as possible to let traffic by.

We confirmed that it would be possible for us to, at some point, shadow a truck along its route.

Interview with Mr. Eric Josephson, Mr. John McGrath and Mr. Larry Silva

City of Cambridge Public Works Department

147 Hampshire Road

Cambridge, MA 02139

Interview with Mr. Eric Josephson, Mr. John McGrath and Mr. Larry Silva

Conducted on: 2/1/06

1. Can you think of any social implications that are associated with rubbish collection?
   a. We have a big problem with rats in the city. This is one of the main reasons that we are looking to make the routes more efficient and pick up the rubbish sooner rather than later.
2. What are some of the rules and regulations that the sanitation department has put into effect? Are these strictly enforced?
   a. There is a compliance officer who will actually give out a ticket if he finds someone who has not been picking up the rubbish from the sidewalks and walkways in front of their house. Effective April 2006, there will be no plastic bags accepted. All rubbish must be placed in a barrel due to sanitation and safety reasons. The state has mandated the size of barrels allowed. The city of Cambridge will begin to enforce this rule.

3. How many dumps per day does each truck make?
    a. Each truck makes 2 dumps per day regardless of whether they have a full load or not; one at 10am and another at the end of their route.
4. How many tons can each truck hold?
    a. Each truck can hold 9-10 tons when relatively new, but that is pushing it.
5. What types of accounts do you have? Roughly how many of each?
    a. We have approx. 150 commercial accounts grandfathered from past years. We are not accepting anymore and once they don't renew, that's it. We have somewhere in the range of 800-900 apartment buildings, 8 school dumpsters, all public housing in Cambridge, 10 firehouses, all police stations, golf course, and various departments around the city. We are also doing a trial run in the projects. The schools require a second pick-up, once in the morning and again after lunch time (around 1pm). These are of course in addition to our residents.
6. What is the daily work schedule like?
    a. The guys come in around 7am and leave in the trucks between 7:20 and 7:30. Their day typically ends around 1pm-2pm. This of course depends on how long the last trip to the dump site takes. Mondays and Tuesdays are their longest days where Wednesdays are the shortest. They take their breaks after their first dump at 10am.
7. What are some of the safety precautions, such as uniforms, that the workers take?
    a. There are no set uniforms, but the guys must wear gloves. During the winter they tend to wear the jumpsuits, but during the summer the major rule we have is that the guys all have to wear long pants. Not sure who supplies the gloves.

8. What kind of fuel do the trucks use?
    a. They use diesel fuel. We were using bio-diesel for a while, but that became too expensive and so we went back to just straight diesel. We are hoping to switch back to bio-diesel.
9. Are there any limits on the number of barrels per house?
    a. There is no limit on the number of barrels per household, as long as they follow the rules.
10. Is the recycling policy strictly enforced?
    a. The policy is not strictly enforced. It is outsourced to a privatized company.
11. Are you, or would you consider, looking into buying new equipment?
    a. We have been looking into hybrid trucks and side loaders which would help take care of the rodent problem. Side loaders require plastic bins which are rodent proof. Equipment is tested on a consolidated route.
12. Where is the dumping site?
    a. The dumping site is located in Somerville.
13. Is the type of rubbish accepted strictly enforced? (No hazardous rubbish, etc.)
    a. If blatantly obvious, then tires, paints, car batteries, etc., will not be accepted. But if they are concealed, we really have no way of knowing.
14. How do you work around holidays?
    a. When a holiday is during the work week, rubbish pick-up is put off by a day. So if there is a Monday holiday, pick-up would be Tuesday-Saturday.

15. If it is more efficient to change the zones, days of pick-up, would you be willing to consider it?
    a. We would rather not change the zones due to that if we did we would be changing the pick-up days for people. With a compelling argument we would be willing to consider it, it has been done before.

In general, this interview went really well. We were able to talk with four people. The interview was pretty casual, more of a conversation than an interview. We confirmed with them that we could ride around in the trucks to get a better idea of what the guys go through on a daily basis. We talked about some of the concerns that the supervisors and the drivers have with this project. We were given many different maps of the current routes. These maps showed us just how disjoint the routes really are. Even though we can make the routes more efficient, we cannot make the drivers more efficient. They still may take the "scenic route" or the long way around just because they like it better. In order to limit this problem, we plan on giving the routes with starting and stopping points and also hints along the way.

Phone Interview with Mr. Bob Fiore

Worcester Department of Public Works

Worcester, MA

Phone: 508-929-1300

Phone interview with Mr. Bob Fiore of the Worcester Department of Public Works

Conducted on: 2/17/06

1. What are the City's major issues with rubbish management?
   a. Right now, we do not have any major issues. However, when we initially started collecting recycling, we had some problems with people putting syringes in there to be picked up. These were people with diabetes, so it wasn't drug issues, but it was still an issue as we do not want out workers getting stabbed by the needles.
2. Do you have standardized methods?
   a. The only really standardized method that we have is that residents must place their rubbish in certain bags. These bags can be purchased at a number of places in the city, but we will only pick up rubbish in the acceptable bags. We do not require these bags to be placed in barrels, residents can place the bags on the curb and we will pick them up.
3. Do people use private collection?
   a. We only pick up from buildings with six units or less, anything more than that, the tenant or owner must arrange for collection through a private company. We

currently pick up approximately 52,000 households and there are 67,000 in the City, just to give you an idea.

4. Rules that you have regarding collection
    a. One major rule that we have is that residents must place their bags on the curb between 6:30 and 7:30 a.m. on the day of pick up. The major issue that we face with this is that people place their bags out the night before, which can cause a problem. There are other rules, but these are all printed on the bag.
5. Do you think that your system is efficient or is there room for improvement?
    a. I feel that our system is efficient as it can be. Every year a survey is sent out to the residents so that they may rate the different departments in the City, such as the Sanitation Department, Police and Fire Departments, and others. Each year, when we get the survey back, the Sanitation Department has very high marks. People are pleased with the job that we are doing.

Phone Interview with Mr. Ed Gilbert

Brookline Department of Public Works

Brookline, MA

Phone: 617-730-2156

Phone interview with Mr. Ed Gilbert of the Brookline Department of Public Works:

Sanitation Department

Conducted on: 2/17/06

1. What are the City's major issues with rubbish management?
    a. We really don't have any major issues. Rats and other rodents are kept to a minimum thanks to our outstanding Health Department. We also have two inspectors on duty on a daily basis, so they make sure that our workers are doing their job and rubbish is not left out on the streets. This helps keep the rodent problem under control as well.
2. Do you have standardized methods?
    a. We don't have special bags that residents must use; we are more concerned with the size of the bags than the strength. Residents are not required to put their bags into barrels; they can simply place the bags on the curb for pick up. However, if the residents wish to store their bags outdoors prior to pick up, on their property, we do require that those bags be placed in a barrel and that the barrel be sealed with a lid.

       We do have a limit of three bags per household for pick up. This is not strictly enforced. The residents are supposed to pay if they go over, or we are not supposed to pick up more than the allowed three bags, but we do. We will pick up extra rubbish because we do not want it sitting out on the streets causing more of a problem. However, we will only pick up the extra if it is not demolition.
3. Do people use private collection?
    a. We pick up from buildings with up to twenty units. We used to pick up pretty much everywhere, but over the years we have backed away from picking up from the larger units. It is my belief that any place with over fifteen units should have dumpsters, roll-aways, or two pick ups a day. We do not supply those materials,

nor do we make multiple pick ups, so this is somewhat of a problem for us. Those units who wish either for those supplies or multiple quick ups a day hire their own private collection.

4. Do you think that your system is efficient or is there room for improvement?
    a. I feel that our system is very efficient. The town is cordoned off into different zones, which are the pick up days. Each truck has its own routes. The guys do their routes and we also have the two inspectors and a supervisor out there every day making sure that the job is getting done. With this much coverage, it is rare to find anything on the road, so yes, I believe that we have a great set up and are efficient even though we are limited on man power and trucks. A couple of years ago, we actually found our system to be so efficient that we were able to cut down our force by a truck, which also saved us some money.

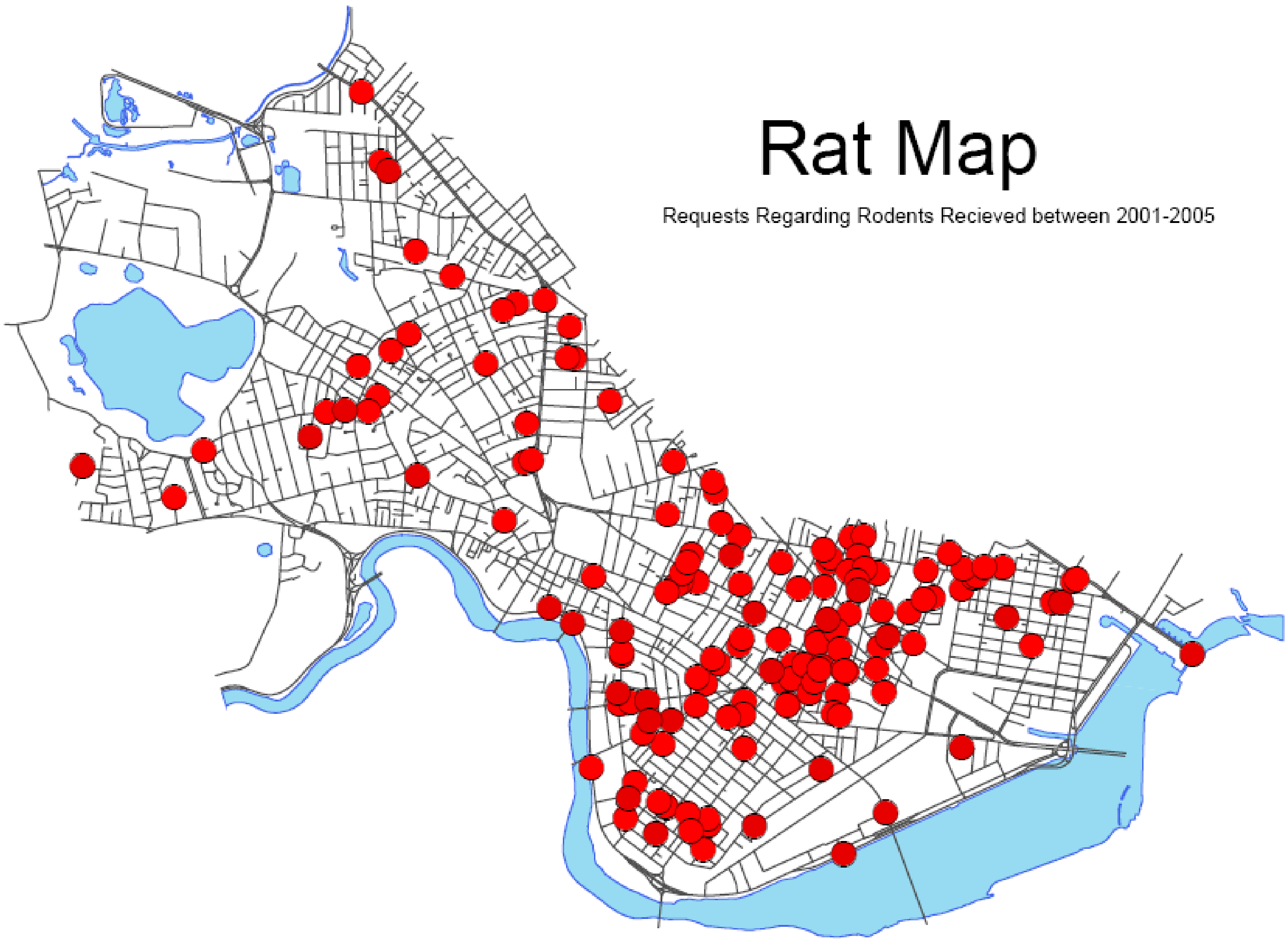
APPENDIX D: LOCATION MAPS

School Locations

Dumpster Locations

Commercial Account Locations

APPENDIX E: RAT COMPLAINT MAP



APPENDIX F: THURSDAY STREET INDEX

This list contains all the streets associated with Thursday's routes and whether or not they may be collected in 1 pass or if 2 passes are necessary.

Street Name	*Passes*	*One-Way*
2^{nd}	2	Parts
3^{rd}	2	No
5^{th}	2	No
6^{th}	2	No
7^{th}	2	Parts
8^{th}	1	Yes
Amory Pl.	1	No
Amory St.	2	Yes
Bent St	2	Yes
Berkshire Pl	1	No
Berkshire St	2	Parts
Bristol St	1	Yes
Broadway St	2	No
Cambridge St	2	No
Cardinal Mederios Ave	2	No
Carlisle St	1	No
Charles St	2	Parts
Clark St	1	Parts
Clary St.	1	No
Columbia St	2	No
Cornelius Way	1	No
Crossland St.	1	No
Davis St	1	No
Elm St	1	Yes
Fulkerson St	2	Yes
Gardner Rd	1	No
Gore St	2	No
Harding St.	2	Yes
Harvard	1	No
Hamlin St.	1	No
Hampshire	2	No
Hardwick St	1	Yes
Hunting St.	1	No
Inman St	2	Yes
James Way	1	No
Jefferson St	1	Yes
King Pl	1	No
Lambert St	1	Yes
Lincoln St.	2	Yes

Livermore St.	1	No
Lope Ave	2	No
Marcella	1	No
Marion St.	1	No
Market St	1	Parts
Marney	1	No
Max Ave	1	No
Memorial Way	1	No
Michael	1	No
Murdock St	1	No
Norfolk St	1	Yes
Oak St.	1	Yes
Oakland St.	1	No
Otis St.	2	No
Palmello	1	No
Plymouth St	1	Yes
Porter	1	No
Portsmouth St	1	Yes
Portland	2	No
Prospect St	2	No
Sciarappo St	2	Parts
Seckel	1	No
Spring	2	No
St. Mary Rd	1	Yes
Thorndike St	1	Parts
Tremont St.	2	Yes
Union St.	1	Yes
Union Ter.	1	No
Vandine St	1	Yes
Warren St	1	Yes
Webster St	2	No
Willow St	1	Yes
Windsor St	2	Parts
Winter St.	2	Parts
York St	1	Yes

APPENDIX G: BLANK ACCIDENT REPORT FORMS

Commonwealth of Massachusetts
Motor Vehicle Crash Operator Report

When Should You File a Report
- You should file a report if you're the operator of a vehicle involved in a crash where the damage to any one vehicle or property is over $1000, or if there is an injury to any person, even if a police officer was on the scene. You should file the report within 5 days of the date of the crash.

When Should You NOT File a Report
- You should not file a report if the crash occurred on a private road, driveway, private parking lot or other private way.

Why this Report is Important
Data from this report is used for many purposes including:
- Identifying locations with a large number of crashes.
- Improving dangerous highways and intersections.
- Developing highway safety public information programs.
- Developing programs to save lives and reduce highway injuries.

How To Complete This Form

Please carefully complete all sections of this form that apply to your crash, **circling the answer** where appropriate. Illegible reports will be returned to you.

Section A: Crash Location
- Complete section A1 or A2.
- Use official names of all locations, streets and landmarks.
- Use street name and route #, if applicable
- Be as precise as possible when describing the location.
- Provide enough information to locate the crash to a specific point, not just a street or roadway.

Section B: Vehicle You Were Driving
- Provide information on your license and the vehicle you were driving.
- Use the codes provided to indicate the cause of the crash.

Section C: You and Your Passengers
- Provide information on you and your passengers at the time of the crash.
- Use the codes provided to indicate occupant information.

Section D: Other Vehicles Involved in the Crash
- Provide information on the other vehicle(s) and operator(s) involved in the crash.
- If more than one vehicle involved, please use additional form completing Section D only.

Section E: Non-Motorist(s) Involved
- Provide information on the non-motorist(s) involved in the crash.
- If more than one non-motorist involved, please use additional form completing Section E only.

Section F: Crash Conditions
- Use the codes provided to indicate the conditions at the time of the crash.

Section G: Crash Diagram
- Draw a diagram of how the crash occurred.
- On the diagram, Vehicle 1 represents your vehicle.

Section H: Witness Information
- List all the people who saw the accident but were not involved.

Section I: Property Damage Information
- Indicate all non-vehicular property that was damaged in the crash.

Section J: Crash Narrative
- Describe the crash including events prior to the crash for your vehicles and all other vehicles.

Section K: Signature
- Please sign and print your name and indicate the date you completed the form.

Where to send completed reports:

- ❑ Mail or deliver one copy to your local police department in the city or town where the crash occurred.
- ❑ Mail one copy to your Insurance Company
- ❑ Mail one copy to the RMV at the following address:
  Crash Records
  Registry of Motor Vehicles
  P.O. Box 199100
  Boston, MA 02119-9100

City/Town Where Crash Occurred	Date of Crash	Time of Crash ____:____ _AM _PM	# Vehicles Involved:

Section A: Crash Location

Please complete Section A1 or A2 below to indicate the location of the crash.
If you need additional space to describe the crash location, please use the Crash Narrative Section on the last page of this form.

SECTION A1: Complete this Section if the crash occurred at an intersection of two or more streets:

Step 1: **Please indicate the route or roadway where you were traveling when the crash occurred:**

Route # ____ Name of Roadway/Street ____

Step 2: **What was the name (or names) of the intersecting streets?**

Route # ____ Name of Roadway/Street ____

Route # ____ Name of Roadway/Street ____

OR

SECTION A2: Complete this Section if the crash did NOT occur at an intersection:

Step 1: **Please indicate the route, roadway and address where the crash occurred:**

The crash occurred on Route #: ________ at Street or Address Number: ________

on the Street/Roadway known as: ________

Step 2: **Please provide as much of the following specific location information as possible:**

The crash occurred (estimate the number of feet) ________ feet

(indicate direction as N/S/E/W) ________ of

a) Mile Marker number __ __ __ . __

OR: b) Exit Number ________

OR: c) Intersecting Street/Roadway ________ Route # ________ Street/Roadway Name

OR: d) Landmark ________

Section B: Vehicle You Were Driving

Number of occupants in vehicle (including yourself): ____

Was vehicle damage above $1000? _ Yes _ No

Driver's License Number	License State	Date of Birth	Age	Sex _ M _ F	License Class _ D _ A _ B _ C _ M _ Unknown	Commercial Driver's License Endorsements H _ Hazardous N _ Tank vehicles P _ Passenger transport T _ Doubles/triples X _ Tank and Hazardous

Your Full Name (Last, First, Middle)	Street Address	City/Town	State	Zip

Insurance Company	Vehicle Registration #	Reg. Type	Reg. State	Vehicle Year	Vehicle Make

Indicate your type of vehicle

1 Passenger car
2 Light truck (van, mini-van, pick-up, sport utility)
3 Motorcycle
4 Bus (15 or more passengers)
5 Bus (7-15 passengers)
6 Single-unit truck (2 axles)
7 Single-unit truck (3 or more axles)
8 Truck/trailer
9 Truck tractor (bobtail)
10 Tractor/semi-trailer
11 Tractor/doubles
12 Tractor/triples
13 Unknown heavy truck
14 Motor home/recreational vehicle
97 Other
99 Unknown

Full Name of Vehicle Owner (Last, First, Middle)	Street Address	City/Town	State	Zip

Vehicle Travel Direction

_ N _ S _ E _ W

What Was Your Vehicle Doing Prior to Crash?

1 Travelling straight ahead
2 Slowing or stopped
3 Turning right
4 Turning left
5 Changing lanes
6 Entering traffic lane
7 Leaving traffic lane
8 Making U-turn
9 Overtaking/passing
10 Backing
11 Parked
97 Other
99 Unknown

Please Indicate the Sequence of Events as they occurred to YOUR Vehicle by writing the corresponding number (1-52, or 97, 99) in up to 4 boxes below.

What happened first?	What happened 2nd (if applicable)?	What happened 3rd (if applicable)?	What happened 4th (if applicable)?
☐	☐	☐	☐

Collision with

1 Motor vehicle in traffic
2 Parked motor vehicle
3 Pedestrian
4 Cyclist
5 Animal-deer
6 Animal-other
7 Moped
8 Work zone maintenance equipment
9 Railway vehicle (train, engine)
10 Other movable object
11 Unknown movable object
20 Curb
21 Tree
22 Utility pole
23 Light pole or other post/support
24 Guardrail
25 Median barrier
26 Ditch
27 Embankment/Sloping shoulder
28 Highway traffic signpost
29 Overhead sign support
30 Fence
31 Mailbox
32 Crash cushion/Impact attenuator
33 Bridge
34 Bridge overhead structure
35 Other fixed object (wall, building, tunnel)
36 Unknown fixed object

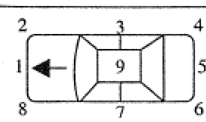
Non-Collision

40 Ran off road right
41 Ran off road left
42 Cross median/centerline
43 Overturn/rollover
44 Equipment failure (blown tire, brakes, etc)
45 Fire/explosion
46 Immersion
47 Jackknife
48 Cargo/equipment loss or shift
49 Separation of units
50 Downhill runaway
51 Other non-collision
52 Unknown non-collision
97 Other
99 Unknown

Was your **Vehicle Towed From the Scene Due to Damage?** _Yes _No

Vehicle Damaged Area

(circle up to three)



10 Undercarriage

11 Totaled

Section C: You and Your Passengers

Please provide the full name, address, and DOB or Age for all passengers in your vehicle. Then write the corresponding code in each of the boxes for each occupant of the vehicle (yourself and all passengers). A list of the possible codes is provided at the bottom of this section.

		Date of Birth/Age	Sex (M/F)	A	B	C	D	E	F	G	H	Name of Medical Facili
Driver (See previous page)												
Name of Passenger 1 (Last, First, Middle)	Address City/Town State Zip											
Name of Passenger 2 (Last, First, Middle)	Address City/Town State Zip											
Name of Passenger 3 (Last, First, Middle)	Address City/Town State Zip											

A. Seating Position
1 Front seat - left side (or motorcycle driver)
2 Front seat - middle
3 Front seat - right side
4 Second seat - left side (or motorcycle passenger)
5 Second seat - middle
6 Second seat - right side
7 Third row - left side (or motorcycle passenger)
8 Third row - middle
9 Third row - right side
10 Sleeper section of cab
11 Enclosed passenger area
12 Unenclosed passenger area
13 Trailing unit
14 Riding on vehicle exterior
97 Other
99 Unknown

B. Safety System Used
0 None used
1 Shoulder and lap belt
2 Lap belt only
3 Shoulder belt only
4 Child safety seat
5 Helmet
99 Unknown

C. Air Bag Status
1 Deployed-front
2 Deployed-side
3 Deployed both front and side
4 Not deployed
5 Not applicable
99 Unknown

D. Air Bag Switch
1 Switch in ON position
2 Switch in OFF position
3 ON-OFF switch not present
4 Unknown if switch is present
99 Unknown

E. Ejected From Vehicle?
0 Not ejected
1 Totally ejected
2 Partially ejected
3 Not applicable
99 Unknown

F. Trapped?
0 Not trapped
1 Freed by mechanical means
2 Freed by non-mechanical means
99 Unknown

G. Injured?
1 Fatal injury
Non-fatal injury:
2 Incapacitating
3 Non-incapacitating
4 Possible
5 No injury
99 Unknown

H. Transported for Medical Care?
1 Not transported
2 EMS (emergency service)
3 Police
97 Other
99 Unknown

Section D: Other Vehicle(s) Involved in the Crash

Number of occupants in the Vehicle: ___ **Was vehicle Damage above $1000?** _ Yes _ No **Moped?** _ Yes _ No **Hit and Run?** _ Yes _ No

Driver's License Number	License State	Date of Birth	Age	Sex _ M _ F	License Class _ D _ A _ B _ C _ M _ Unknown	Commercial Driver's License Endorsements H _ Hazardous N _ Tank vehicles P _ Passenger transport T _ Doubles/triples X _ Tank and Hazardous

Full Name of Vehicle Driver (Last, First, Middle) | Street Address | City/Town | State | Zip

Insurance Company | Vehicle Registration # | Reg. Type | Reg. State | Vehicle Year | Vehicle Make

Indicate type of vehicle
1 Passenger car
2 Light truck (van, mini-van, pick-up, sport utility)
3 Motorcycle
4 Bus (15 or more passengers)
5 Bus (7-15 passengers)
6 Single-unit truck (2 axles)
7 Single-unit truck (3 or more axles)
8 Truck/trailer
9 Truck tractor (bobtail)
10 Tractor/semi-trailer
11 Tractor/doubles
12 Tractor/triples
13 Unknown heavy truck
14 Motor home/recreational vehicle
97 Other
99 Unknown

Full Name of Vehicle Owner (Last, First, Middle) | Street Address | City/Town | State | Zip

Vehicle Travel Direction
_ N _ S _ E _ W

What Was The Vehicle Doing Prior to Crash?
1 Travelling straight ahead
2 Slowing or stopped
3 Turning right
4 Turning left
5 Changing lanes
6 Entering traffic lane
7 Leaving traffic lane
8 Making U-turn
9 Overtaking/passing
10 Backing
11 Parked
97 Other
99 Unknown

Section E: Non-Motorist(s) Involved in the Crash

Indicate the type of non-motorist involved 1 Pedestrian 2 Cyclist 3 Skater 97 Other 99 Unknown

What was the non-motorist doing prior to the crash?
1 Entering or crossing location
2 Walking, running or cycling
3 Working
4 Pushing vehicle
5 Approaching or leaving vehicle
6 Working on vehicle
7 Standing
97 Other
99 Unknown

Where was the non-motorist prior to the crash?
1 Marked crosswalk at intersection
2 At intersection but no crosswalk
3 Non-intersection crosswalk
4 In roadway
5 Not in roadway
6 Median (but not on shoulder)
7 Island
8 Shoulder
9 Sidewalk
10 Shared-use path or trails
99 Unknown

Date of Birth/Age | Sex _ M _ F | Full Name of Non-Motorist (Last, First, Middle) | Street Address | City/Town | State | Zip

Safety Equipment?
0 None used
6 Helmet
7 Protective pads (elbows, knees, etc.)
8 Reflective clothing
9 Lighting
10 Other
99 Unknown

Injured?
1 Fatal injury
Non-fatal injury:
2 Incapacitating
3 Non-incapacitating
4 Possible
5 No injury
99 Unknown

Transported for Medical Care?
1 Not transported
2 EMS (emergency service)
3 Police
97 Other
99 Unknown

If transported, please indicate Hospital/Medical Facility:

Section F: Crash Conditions

Light Conditions
1 Daylight
2 Dawn
3 Dusk
4 Dark - lighted roadway
5 Dark - roadway not lighted
6 Dark - unknown roadway lighting
97 Other
99 Unknown

Weather Conditions (up to two)
1 Clear
2 Cloudy
3 Rain
4 Snow
5 Sleet, hail, freezing rain
6 Fog, smog, smoke
7 Severe crosswinds
8 Blowing sand, snow
97 Other
99 Unknown

Traffic Control Device
1 No controls
2 Stop signs
3 Traffic control signal
4 Flashing traffic control signal
5 Yield signs
6 School zone signs
7 Warning signs
8 Railroad crossing device
99 Unknown

Was the traffic control device functioning at the time of the crash?
1 __ Yes
2 __ No

Road Surface
1 Dry
2 Wet
3 Snow
4 Ice
5 Sand, mud, dirt, oil, gravel
6 Water (standing, moving)
7 Slush
8 Other
99 Unknown

Roadway Intersection Type
1 Not at intersection
2 Four-way intersection
3 T-intersection
4 Y-intersection
5 On ramp
6 Off ramp
7 Traffic circle
8 Five-point or more
9 Driveway
10 Railway grade crossing
99 Unknown

Trafficway Description
1 Two-way, not divided
2 Two-way, divided, unprotected median
3 Two-way divided, protected median
4 One-way, not divided
99 Unknown

School Bus Related?
1 __ Yes
2 __ No

Work Zone Related?
1 __ Yes
2 __ No

Manner of Collision
1 Single vehicle crash
2 Rear-end
3 Angle
4 Sideswipe, same direction
5 Sideswipe, opposite direction
6 Head on
7 Rear to rear
99 Unknown

Section G: Crash Diagram

Please draw a diagram of the roadway or streets where the crash occurred, indicating the vehicles involved and direction of travel using the following symbols:
→ = Direction
[1] = Vehicle 1 (Your Vehicle)
[2] = Vehicle 2
O = Pedestrian/Non-Motorist

Select one of the following if the crash did not occur on a public way:
__ Off-street parking lot
__ Garage
__ Mall/shopping center
__ Other private way

Section H: Witness Information

Witness Name (Last, First, Middle)	Address	Phone

Section I: Property Damage Information (Other than Vehicles)

Owner Name (Last, First, Middle)	Address	Phone	Property and Damage Description

Section J: Crash Narrative

Section K: Signature

________________________ Print ________________________ Date __________
"Signed under Pains and Penalties of Perjury"

APPENDIX H: MARCH 6, 2003 INCIDENT FORMS

Section A: Crash Location

City/Town Where Crash Occurred: Somerville
Date of Crash: 3-6-2003
Time of Crash: 1:20 __AM ✓PM
Vehicles Involved: 2

Please complete Section A1 or A2 below to indicate the location of the crash.
If you need additional space to describe the crash location, please use Section J on the last page of this form.

SECTION A1: Complete this Section if the crash occurred at an intersection of two or more streets — **OR** — **SECTION A2: Complete this Section if the crash did not occur at an intersection**

Section A1

Step 1: Please indicate the route or roadway where you were travelling when the crash occurred:

Route# ______ Name of Roadway/Street ______

Step 2: What was the name (or names) of the intersecting streets?

Route# ______ Name of Roadway/Street ______

Route# ______ Name of Roadway/Street ______

Section A2

Step 1: Please indicate the route, roadway and address where the crash occurred:

The crash occurred on Route #: ______ at Street or Address Number: ______

on the Street/Roadway known as: 160 McGrath Hwy

Step 2: Please provide as much of the following specific location information as possible:

The crash occurred (estimate number of feet) ______ feet

(indicate direction as N/S/E/W) ______ of

a) Mile Marker number ______

OR: b) Exit Number ______

OR: c) Intersecting Street/Roadway ______ Route# ______ Name of Roadway/Street

OR: d) Landmark Pats Tow impound yard

Section B: Vehicle You Were Driving

Number of occupants in vehicle (including yourself): 1
Was vehicle damage above $1000? __Yes __No

Driver's License Number	License State	Date of Birth	Age	Sex	License Class	Commercial Driver's License Endorsements
[redacted]	MA	7/14/51	51	✓M __F	__D __A ✓B __C __M __Unknown	H __ Hazardous; T __ Doubles/Triples; N __ Tank vehicles; X __ Tank and Hazardous; P ✓ Passenger transport

Your Full Name (Last, First, Middle)	Street Address	City/Town	State	Zip

Insurance Company	Vehicle Registration	Reg. Type	Reg. State	Vehicle Year	Vehicle Make
City of Cambridge	[redacted]		MA		International

Indicate your type of vehicle

1 Passenger car
2 Light truck (van, mini-van, pick-up, sport utility)
3 Motorcycle
4 Bus (15 or more passengers)
5 Bus (7-15 passengers)
(6) Single-unit truck (2 axles)
7 Single-unit truck (3 or more axles)
8 Truck/trailer
9 Truck tractor (bobtail)
10 Tractor/semi-trailer
11 Tractor/doubles
12 Tractor/triples
13 Unknown heavy truck
14 Motor home/recreational vehicle
97 Other
99 Unknown

Full Name of Vehicle Owner (Last, First, Middle)	Street Address	City/Town	State	Zip
City of Cambridge	147 Hampshire St	Cambridge	MA	02139

Vehicle Travel Direction: __N ✓S __E __W

What Was Your Vehicle Doing Prior to the Crash?

1 Travelling straight ahead
(2) Slowing or stopped
3 Turning right
4 Turning left
5 Changing lanes
6 Entering traffic lane
7 Leaving traffic lane
8 Making U-turn
9 Overtaking/passing
10 Backing
11 Parked
97 Other
99 Unknown

Please Indicate the Sequence of Events as they occurred to YOUR Vehicle by writing the corresponding number (1-52, or 97, 99) in up to 4 boxes below.

What happened first?	What happened 2nd (if applicable)?	What happened 3rd (if applicable)?	What happened 4th (if applicable)?
1			

Collision with

1 Motor vehicle in traffic
2 Parked motor vehicle
3 Pedestrian
4 Cyclist
5 Animal- deer
6 Animal- other
7 Moped
8 Work zone maintenance equipment
9 Railway vehicle (train, engine)
10 Other movable object
11 Unknown movable object
20 Curb
21 Tree
22 Utility pole
23 Light pole or other post/support
24 Guardrail
25 Median barrier
26 Ditch
27 Embankment/Sloping shoulder
28 Highway traffic signpost
29 Overhead sign support
30 Fence
31 Mailbox
32 Crash cushion/Impact attenuator
33 Bridge
34 Bridge overhead structure
35 Other fixed object (wall, building, tunnel)
36 Unknown fixed object

Non-Collision

40 Ran off road right
41 Ran off road left
42 Cross median/centerline
43 Overturn/rollover
44 Equipment failure (blown tire, brakes, etc)
45 Fire/explosion
46 Immersion
47 Jackknife
48 Cargo/equipment loss or shift
49 Separation of units
50 Downhill runaway
51 Other non-collision
52 Unknown non-collision
97 Other
99 Unknown

Was your Vehicle Towed From the Scene Due to Damage? __Yes ✓No

Vehicle Damaged Area (circle up to three): (1) (2) 3 4 5 6 7 (8) 9

0 None
10 Undercarriage
11 Totaled
97 Other
99 Unknown

Section F: Crash Conditions

…ons
…
…ark - lighted roadway
…ark - roadway not lighted
…ark - unknown roadway lighting
…ther
…nknown

Weather Conditions (up to two)
1 Clear
2 Cloudy
3 Rain
(4) Snow
5 Sleet, hail, freezing rain
6 Fog, smog, smoke
7 Severe crosswinds
8 Blowing sand, snow
97 Other
99 Unknown

Traffic Control Device
(1) No controls
2 Stop signs
3 Traffic control signal
4 Flashing traffic control signal
5 Yield signs
6 School zone signs
7 Warning signs
8 Railroad crossing device
99 Unknown

Was the traffic control device functioning at the time of the crash?
1 ___ Yes
2 ___ No

Road Surface
1 Dry
2 Wet
(3) Snow
4 Ice
5 Sand, mud, dirt, oil, gravel
6 Water (standing, moving)
7 Slush
8 Other
99 Unknown

Roadway Intersection Type
(1) Not at intersection
2 Four-way intersection
3 T-intersection
4 Y-intersection
5 On ramp
6 Off ramp
7 Traffic circle
8 Five-point or more
9 Driveway
10 Railway grade crossing
99 Unknown

…dway Description
…wo-way, not divided
…wo-way, divided, unprotected median
…wo-way, divided, protected median
…ne-way, not divided
…nknown

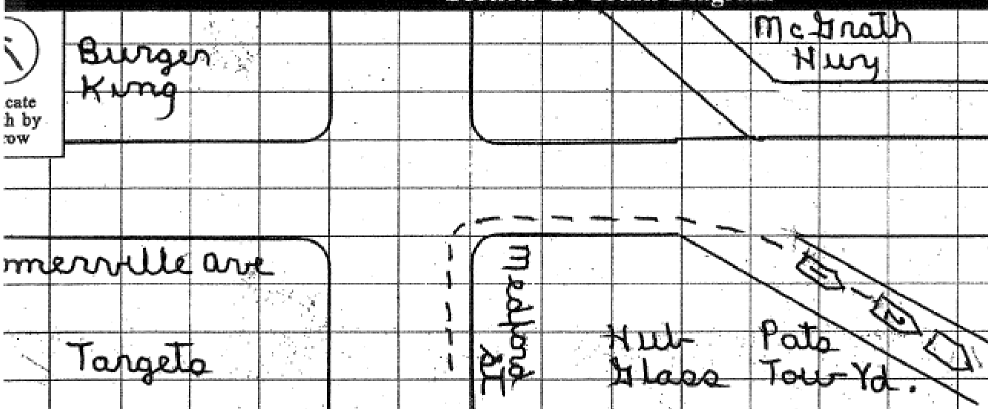
School Bus Related?
1 ___ Yes
2 ✓ No

Work Zone Related?
1 ___ Yes
2 ✓ No

Manner of Collision
1 Single vehicle crash
(2) Rear-end
3 Angle
4 Sideswipe, same direction
5 Sideswipe, opposite direction
6 Head on
7 Rear to rear
99 Unknown

Section G: Crash Diagram

…cate …h by …ow



Please draw a diagram of the roadway or streets where the crash occurred, indicating the vehicles involved and direction of travel using the following symbols:
→ = Direction
[1] = Vehicle 1 (Your Vehicle)
[2] = Vehicle 2
O = Pedestrian/Non-motorist
(↗) = North

Select one of the following if the crash did not occur on a public way:
___ Off-street parking lot
___ Garage
___ Mall/shopping center
___ Other private way

Section H: Witness Information

…s Name (Last, First, Middle)	Address	Phone

Section I: Property Damage Information (Other than Vehicles)

Name (Last, First, Middle)	Address	Phone	Property and Damage Description

Section J: Description of What Happened

…hicle 1 was at 160 McGrath Hwy. Vehicle 2 was at a full …top. Because There was a vehicle at a stop in front of …hicle 2. I Tryed To stop and I went into a skid and hit …ehicle 2 in the rear end. Vehicle 1 was moving at 10 to 15 …PH prior to impact. at the Time of the accident I was …riving rubbish Truck # 22.

Section K: Signature

…ed under Pains and Penalties of Perjury" Prin… Date 3-8-2003

Section C: You and Your Passengers

Provide the full name, address, and DOB or Age for all passengers in your vehicle. Then write the corresponding code in each of the boxes for each occupant of the vehicle (self and all passengers). A list of the possible codes is provided at the bottom of this section.

		Date of Birth/Age	Sex M/F	A	B	C	D	E	F	G	H	Name of Medical Facility
Driver (See previous page)		7/14/51 51	M	1	0	5		0	0	5	1	
Name of Passenger 1 (Last, First, Middle)	Address / City/Town / State / Zip											
Name of Passenger 2 (Last, First, Middle)	Address / City/Town / State / Zip											
Name of Passenger 3 (Last, First, Middle)	Address / City/Town / State / Zip											

A. Seating Position
1 Front seat - left side (or motorcycle driver)
2 Front seat - middle
3 Front seat - right side
4 Second seat - left side (or motorcycle passenger)
5 Second seat - middle
6 Second seat - right side
7 Third row - left side (or motorcycle passenger)
8 Third row - middle
9 Third row - right side
10 Sleeper section of cab
11 Enclosed passenger area
12 Unenclosed passenger area
13 Trailing unit
14 Riding on vehicle exterior
97 Other
99 Unknown

B. Safety System Used
0 None used
1 Shoulder and lap belt
2 Lap belt only
3 Shoulder belt only
4 Child safety seat
5 Helmet
99 Unknown

C. Air Bag Status
1 Deployed-front
2 Deployed-side
3 Deployed both front and side
4 Not deployed
5 Not applicable
99 Unknown

D. Air Bag Switch
1 Switch in ON position
2 Switch in OFF position
3 ON-OFF switch not present
4 Unknown if switch is present
99 Unknown

E. Ejected From Vehicle?
0 Not ejected
1 Totally ejected
2 Partially ejected
3 Not applicable
99 Unknown

F. Trapped?
0 Not trapped
1 Freed by mechanical means
2 Freed by non-mechanical means
99 Unknown

G. Injured?
1 Fatal injury
Non-fatal injury:
2 Incapacitating
3 Non-incapacitating
4 Possible
5 No injury
99 Unknown

H. Transported for Medical Care?
1 Not transported
2 EMS (emergency service)
3 Police
97 Other
99 Unknown

Section D: Other Vehicle(s) Involved in the Crash

Number of occupants in the Vehicle: 2 **Number of injured occupants:** 0 **Was Vehicle Damage above $1000?** ✓ Yes __ No **Moped?** __ Yes ✓ No **Hit and Run?** __ Yes ✓ No

[redacted] | License State: MA | Date of Birth: 4/25/63 | Age: 39 | Sex: ✓ M __ F | License Class: ✓ D __ A __ B __ C __ M __ Unknown | Commercial Driver's License Endorsements: H __ Hazardous, T __ Doubles/Triples, N __ Tank vehicles, X __ Tank and Hazardous, P __ Passenger transport

Full Name of Vehicle Driver (Last, First, Middle) | Street Address | City/Town | State | Zip

Insurance Company | [redacted] | Reg. Type | Reg. State: MA | Vehicle Year: 1988 | Vehicle Make: Pontiac

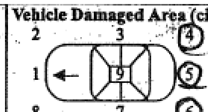
Indicate type of vehicle
(1) Passenger car (circled)
2 Light truck (van, mini-van, pick-up, sport utility)
3 Motorcycle
4 Bus (15 or more passengers)
5 Bus (7-15 passengers)
6 Single-unit truck (2 axles)
7 Single-unit truck (3 or more axles)
8 Truck/trailer
9 Truck tractor (bobtail)
10 Tractor/semi-trailer
11 Tractor/doubles
12 Tractor/triples
13 Unknown heavy truck
14 Motor home/recreational vehicle
97 Other
99 Unknown

Full Name of Vehicle Owner (Last, First, Middle) | Street Address | City/Town | State | Zip

Vehicle Travel Direction
__N __S __E __W

What was the vehicle doing prior to the crash?
1 Travelling straight ahead
(2) Slowing or stopped (circled)
3 Turning right
4 Turning left
5 Changing lanes
6 Entering traffic lane
7 Leaving traffic lane
8 Making U-turn
9 Overtaking/passing
10 Backing
11 Parked
97 Other
99 Unknown

Vehicle Damaged Area (circle up to three)



0 None
10 Undercarriage
11 Totaled
97 Other
99 Unknown

Section E: Non-Motorist(s) Involved in the Crash

Indicate the type of non-motorist involved 1 Pedestrian 2 Cyclist 3 Skater 97 Other 99 Unknown

What was the non-motorist doing prior to the crash?
1 Entering or crossing location
2 Walking, running, or cycling
3 Working
4 Pushing vehicle
5 Approaching or leaving vehicle
6 Working on vehicle
7 Standing
97 Other
99 Unknown

Where was the non-motorist prior to the crash?
1 Marked crosswalk at intersection
2 At intersection but no crosswalk
3 Non-intersection crosswalk
4 In roadway
5 Not in roadway
6 Median (but not on shoulder)
7 Island
8 Shoulder
9 Sidewalk
10 Shared-use path or trails
99 Unknown

Date of Birth/Age | Sex __M __F | Full Name of Non-Motorist (Last, First, Middle) | Street Address | City/Town | State | Zip

Safety Equipment?
0 None used
6 Helmet
7 Protective pads (elbows, knees, etc.)
8 Reflective clothing
9 Lighting
10 Other
99 Unknown

Injured?
1 Fatal injury
Non-fatal injury:
2 Incapacitating
3 Non-incapacitating
4 Possible
5 No injury
99 Unknown

Transported for Medical Care?
1 Not transported
2 EMS (emergency service)
3 Police
97 Other
99 Unknown

If transported, please indicate Hospital/Medical Facility:

PUBLIC WORKS ACCIDENT REVIEW LOG

EMPLOYEE NAME: **DATE: 4/29/03**

MEETING: **ACCIDENT REVIEW** **UNION: TEAMSTERS 25**

REVIEW COMMITTEE MEMBERS IN ATTENDANCE:

SUMMARY OF FACTS:

Based on information gathered at this review and: An Accident Report dated 3/8/03, Supplemental Reported dated 3/11/03; An Accident Report dated 9/12/02, and Supplemental Report dated 9/12/02 and Police Department Report dated 9/12/02, the following undisputed facts were realized.

3/6/03 – While driving Rubbish Packer #22 saw the 2 vehicles in front of him "hit the brakes". At the time, there was no obstruction in front of the lead vehicle. In order to stop he also hit brakes, but went into a skid and hit the vehicle in front of him.

9/12/02 – While driving a street cleaning announcement truck, stopped at the sign on Franklin St at the intersection of Western Ave. While making a right turn onto Western Avenue, a car passed him on the right causing the collision. Unfortunately, the car was driven by an off duty Cambridge Police Officer.

EMPLOYEE STATEMENTS:

3/6/03 - states he was carrying 5 tons of rubbish in the packer at the time of the accident. He further states that he allowed three car lengths between his truck and the vehicle in front of him. There was also snow on the ground.

both agreed that under the conditions at that time, should have been traveling at a slower speed. also agreed that needs to be more cautious during inclement weather conditions.

9/12/02 – Again, stated that the car passed him on his right on a one lane street. The off duty officer told that he blew his horn but that did not hear it because of the Street Cleaning Announcements coming from his truck.

suggested that he use more caution and be more aware of his surroundings while driving in these situations.

SUPPLEMENTAL ACCIDENT REPORT

(SUPERVISOR SHALL COMPLETE THE FOLLOWING IN DETAIL)

A. PERSONAL INJURY

1. What was the employee doing when injured?

2. From your investigation, how did the injury occur?

3. Describe in detail

4. Name of witnesses to the incident

B. EQUIPMENT DAMAGE

1. What was the employee's assignment when the equipment was damaged?
Drive #22 in Sanitation department

2. From your investigation, how did the equipment get damaged?
Slippery + icy conditions. Traveling to close to vehicle in front of him.

3. Describe in detail the damage to the equipment.
Car in front was heavily damaged on impact

4. Name of witnesses to the incident.

C. SUPERVISOR TO SCHEDULE MEETING TO REVIEW PROTOCOL

1. Meeting was held/will be held on 3-11-03 to discuss safety protocol.

2. Describe protocol discussed: Extra distance should be given especially during adverse weather conditions.

3-11-03
Date

Signature of Supervisor

RESPONSES TO **ACCIDENT OF 3/6/03**

1. Attached is Motor Vehicle Crash Report, Supplemental Report and DPW Accident Review Log.

4. Copies of photos are attached to Motor Vehicle Crash report. However, original photos were sent to City's Law Department with copy of the crash report at the time of the accident.

5. Statement made by can be found on the Accident Review Log.

6. See attachment for Number 1 above.

7. Attached is copy of the Motor Vehicle Registration at the time of the alleged accident.

8. Attached is copy of the Certificate of Title at the time of the alleged accident.

9. According to and had completed his rubbish route and was driving to Waste Management (the City's rubbish transfer station) to unload the contents of his truck.

12. N/A

13. Attached

15 Personnel File

APPENDIX I: TABLES USED FOR THURSDAY CALCULATIONS

Truck #	21/36	22/29	23	24
	10.81	12.14	11.27	11.14
	14.13	14.34	11.64	10.77
	13.08	12.51	10.77	13.00
	10.54	11.34	9.48	8.95
	12.98	12.97	12.18	11.44
	11.21	13.04	12.00	11.78
	12.31	14.35	12.95	12.88
	12.55	6.58	10.34	8.58
	10.18	13.06	11.46	6.53
	14.53	14.37	13.56	13.78
	12.52	11.09	9.22	8.31
	10.66	9.86	12.48	11.60
	13.87	14.45	12.84	13.21
	11.74	11.13	11.59	9.21
	12.30	8.73	12.85	7.25
	13.79	11.77	11.43	8.58
	9.31	11.85	6.41	10.74
	13.63	5.58	8.31	8.21
	16.78	8.31	12.85	5.86
	14.65	12.85	11.74	13.41
	11.21	6.08	11.09	7.94
	13.81	15.47	12.99	13.07
	17.08	14.33	12.63	10.48
	12.78	16.16	11.79	14.84
	15.87	14.10	11.23	14.91
	11.93	13.24	14.13	6.51
	14.24	14.99	9.86	11.67
	14.67	13.95	12.30	11.01
		14.09	10.17	7.63
		11.01	12.36	8.58
	13.18	14.16	15.45	12.33
	15.07	14.75	14.10	11.66
	16.19	14.17	11.97	10.43
	14.30	14.92		11.12
	15.79	16.92		12.04
		13.27		12.40
	15.77			13.62
	15.00			10.22
	15.12			
	13.93			
Yearly Average Tons	**13.45**	**12.55**	**11.68**	**10.68**
Yearly Average Pounds	26892.43243	25107.22222	23360	21352.10526

Truck #	26	27	34	35		Sum
	13.22	14.28	12.00	16.15		
	11.90	12.68	14.15	13.68		
	13.93	11.90	14.42	13.80		
	14.73	12.98	14.11	16.47		
	15.86	16.26	14.59	14.50		
	17.57	15.02	11.36	15.36		
	10.91	10.24	11.48	17.35		
	12.03	14.37	14.25	15.28		
	12.93	14.76	12.72	16.12		
	11.63	14.01	11.31	12.60		
	14.54	12.71	14.12	13.20		
	10.81	11.13	15.12	16.53		
	11.02	11.78	14.12	16.11		
	14.55	11.11	10.17	13.38		
	16.50	9.51	12.61	15.86		
	10.79	12.58	11.90	15.99		
	14.03	12.07	15.83	12.77		
	14.44	14.18	13.57	8.08		
	13.19	9.82	6.17	11.62		
	9.93	7.59	9.58	15.94		
	8.85	13.12	14.02	10.20		
	12.12	12.67	14.31	13.44		
	14.11	12.00	11.48	13.81		
	9.53	11.70	11.70	17.08		
	11.70	9.66	12.93	12.78		
	6.29	13.18	14.94			
	9.88	13.86	14.54	7.99		
	15.50	10.61	12.49	10.81		
	11.69	13.22	11.99	12.54		
	10.95	9.75	11.47	16.93		
	9.63	12.92	14.33	16.40		
	11.50	13.54	15.28	11.46		
	14.56	14.72	12.03	15.70		
	14.39	13.86	13.63	12.05		
	15.44	12.89	15.13	12.27		
	14.57	13.82	11.79	12.73		
	13.51	15.51	14.50	15.24		
	14.80	12.99	13.34	11.61		
	13.39	11.46	14.18	15.43		
	14.09	12.01	12.15	10.42		
	11.45	11.81	14.52	14.02		
	12.80	8.03	14.91			
	14.15		14.86	11.32		
			13.07			
Yearly Average Tons	**12.78**	**12.44**	**13.12**	**13.78**		**52.111**
Yearly Average Pounds	25553.95349	24871.90476	26235	27561.95122		104222.809

		Tons	Pounds
Daily Average:		**12.56**	25116.82117
Standard Deviation:		**0.998077573**	1996.155145

TRUCK	Bedrooms for Segment	Tons for Segment
23	9	0.100
23	0	0.000
23	109	1.209
23	118	1.309
23	73	0.810
23	22	0.244
23	9	0.100
23	0	0.000
23	48	0.532
23	31	0.344
23	25	0.277
23	11	0.122
23	18	0.200
23	15	0.166
23	28	0.311
23	0	0.000
23	2	0.022
23	0	0.000
23	12	0.133
23	2	0.022
23	33	0.366
23	50	0.555
23	2	0.022
23	18	0.200
23	0	0.000
23	30	0.333
23	18	0.200
23	5	0.055
23	25	0.277
23	59	0.654
23	45	0.499
23	7	0.078
23	96	1.065
23	3	0.033
23	8	0.089
23	53	0.588
23	7	0.078
23	26	0.288
23	0	0.000
23	16	0.177
23	15	0.166
23	5	0.055
Total Bedrooms	1053	
Tons Per Bedroom	0.011092118	

TRUCK	Bedrooms for Segment	Tons for Segement
35	62	0.613
35	37	0.366
35	100	0.989
35	68	0.672
35	14	0.138
35	66	0.652
35	48	0.475
35	18	0.178
35	41	0.405
35	47	0.465
35	0	0.000
35	26	0.257
35	3	0.030
35	114	1.127
35	46	0.455
35	61	0.603
35	34	0.336
35	39	0.386
35	35	0.346
35	34	0.336
35	24	0.237
35	7	0.069
35	31	0.306
35	13	0.129
35	8	0.079
35	6	0.059
35	14	0.138
35	41	0.405
35	3	0.030
35	58	0.573
35	29	0.287
35	35	0.346
35	132	1.305
35	23	0.227
35	89	0.880
Total Bedrooms	1406	
Tons Per Bedroom	0.009886202	

TRUCK	Bedrooms for Segment	Tons for Segment
27	45	0.324
27	38	0.274
27	36	0.259
27	81	0.583
27	110	0.792
27	118	0.850
27	52	0.375
27	42	0.303
27	43	0.310
27	17	0.122
27	99	0.713
27	15	0.108
27	14	0.101
27	41	0.295
27	3	0.022
27	3	0.022
27	18	0.130
27	87	0.627
27	65	0.468
27	52	0.375
27	136	0.980
27	23	0.166
27	20	0.144
27	64	0.461
27	17	0.122
27	41	0.295
27	27	0.194
27	47	0.339
27	49	0.353
27	19	0.137
27	23	0.166
27	33	0.238
27	21	0.151
27	11	0.079
27	9	0.065
27	6	0.043
27	10	0.072
27	115	0.828
27	77	0.555
Total Bedrooms	1727	
Tons Per Bedroom	0.007203243	

TRUCK	Bedrooms for Segment	Tons for Segment
22 / 29	44	0.333
22 / 29	95	0.719
22 / 29	96	0.726
22 / 29	13	0.098
22 / 29	4	0.030
22 / 29	14	0.106
22 / 29	19	0.144
22 / 29	29	0.219
22 / 29	24	0.182
22 / 29	7	0.053
22 / 29	13	0.098
22 / 29	111	0.840
22 / 29	79	0.598
22 / 29	37	0.280
22 / 29	41	0.310
22 / 29	48	0.363
22 / 29	19	0.144
22 / 29	19	0.144
22 / 29	4	0.030
22 / 29	6	0.045
22 / 29	17	0.129
22 / 29	14	0.106
22 / 29	29	0.219
22 / 29	23	0.174
22 / 29	67	0.507
22 / 29	21	0.159
22 / 29	61	0.461
22 / 29	100	0.756
22 / 29	34	0.257
22 / 29	72	0.545
22 / 29	6	0.045
22 / 29	104	0.787
22 / 29	13	0.098
22 / 29	45	0.340
22 / 29	41	0.310
22 / 29	42	0.318
22 / 29	35	0.265
22 / 29	25	0.189
22 / 29	48	0.363
22 / 29	40	0.303
22 / 29	42	0.318
22 / 29	9	0.068
22 / 29	49	0.371
Total Bedrooms	1659	
Tons Per Bedroom	0.007564798	

TRUCK	Bedrooms for Segment	Tons for Segment
26	14	0.161
26	48	0.553
26	5	0.058
26	107	1.232
26	28	0.322
26	24	0.276
26	22	0.253
26	215	2.475
26	104	1.197
26	7	0.081
26	81	0.933
26	162	1.865
26	0	0.000
26	17	0.196
26	26	0.299
26	43	0.495
26	2	0.023
26	5	0.058
26	19	0.219
26	7	0.081
26	9	0.104
26	31	0.357
26	0	0.000
26	33	0.380
26	0	0.000
26	10	0.115
26	0	0.000
26	0	0.000
26	0	0.000
26	9	0.104
26	0	0.000
26	5	0.058
26	3	0.035
26	6	0.069
26	6	0.069
26	0	0.000
26	13	0.150
26	12	0.138
26	12	0.138
26	23	0.265
26	0	0.000
26	2	0.023
Total Bedrooms	1110	
Tons Per Bedroom	0.011513514	

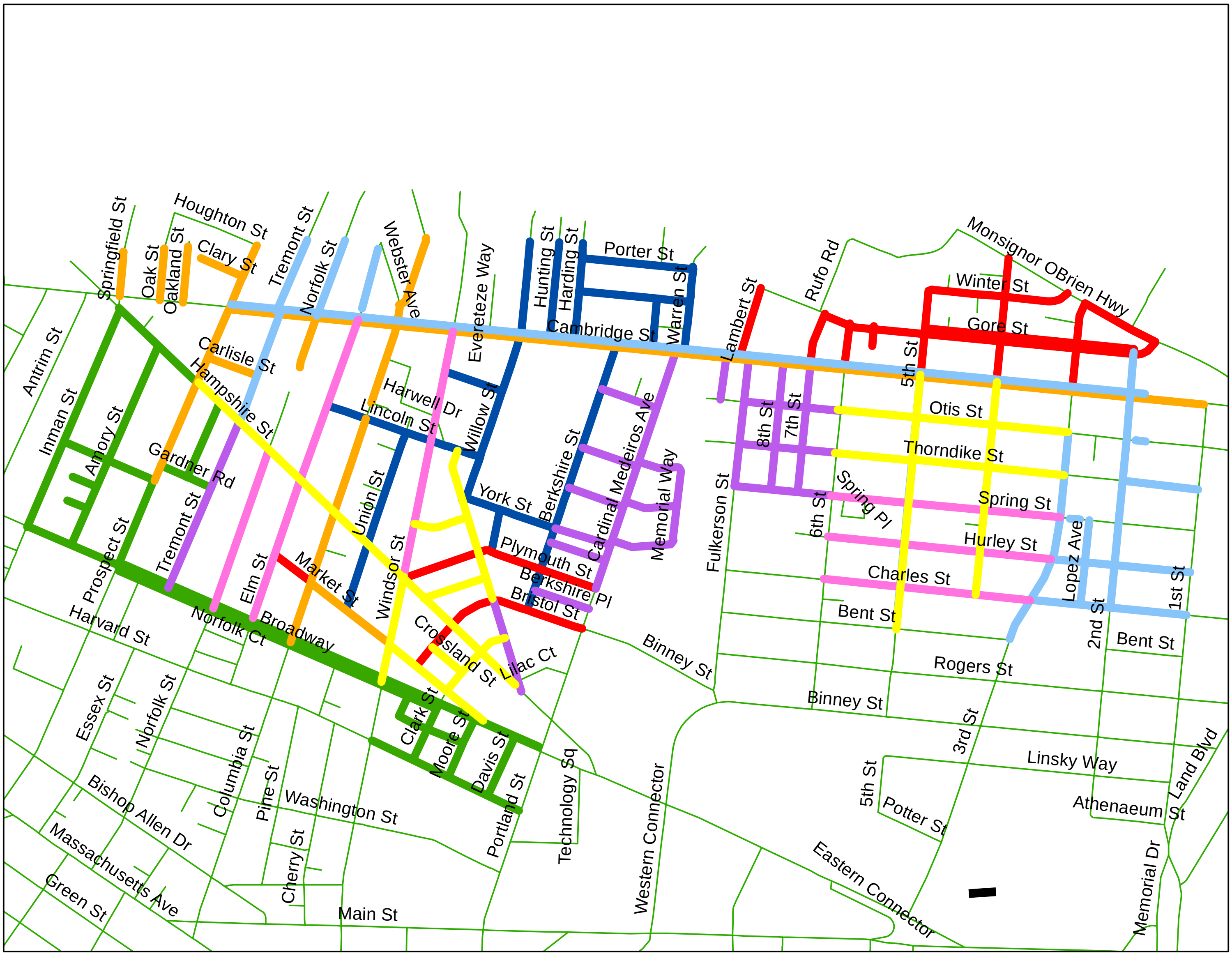
TRUCK	Bedrooms for Segment	Tons for Segment
21 / 36	203	1.47821778300
21 / 36	169	1.23063450900
21 / 36	79	0.57526701900
21 / 36	98	0.71362237800
21 / 36	104	0.75731354400
21 / 36	90	0.65536749000
21 / 36	126	0.91751448600
21 / 36	99	0.72090423900
21 / 36	75	0.54613957500
21 / 36	45	0.32768374500
21 / 36	82	0.59711260200
21 / 36	70	0.50973027000
21 / 36	117	0.85197773700
21 / 36	140	1.01946054000
21 / 36	140	1.01946054000
21 / 36	54	0.39322049400
21 / 36	46	0.33496560600
21 / 36	114	0.83013215400
21 / 36	40	0.29127444000
Total Bedrooms	1891	
Tons Per Segment	0.007281861	

TRUCK	Bedrooms for Segment	Tons for Segment
34	63	0.550
34	107	0.934
34	48	0.419
34	11	0.096
34	46	0.402
34	28	0.244
34	27	0.236
34	0	0.000
34	69	0.602
34	35	0.306
34	0	0.000
34	27	0.236
34	42	0.367
34	39	0.340
34	174	1.519
34	63	0.550
34	44	0.384
34	54	0.471
34	66	0.576
34	68	0.594
34	61	0.532
34	21	0.183
34	26	0.227
34	13	0.113
34	39	0.340
34	66	0.576
34	17	0.148
34	19	0.166
34	0	0.000
34	48	0.419
34	13	0.113
34	9	0.079
34	8	0.070
34	14	0.122
34	24	0.209
34	83	0.725
34	25	0.218
34	0	0.000
34	0	0.000
34	6	0.052
Total Bedrooms	1503	
Tons Per Bedroom	0.008729208	

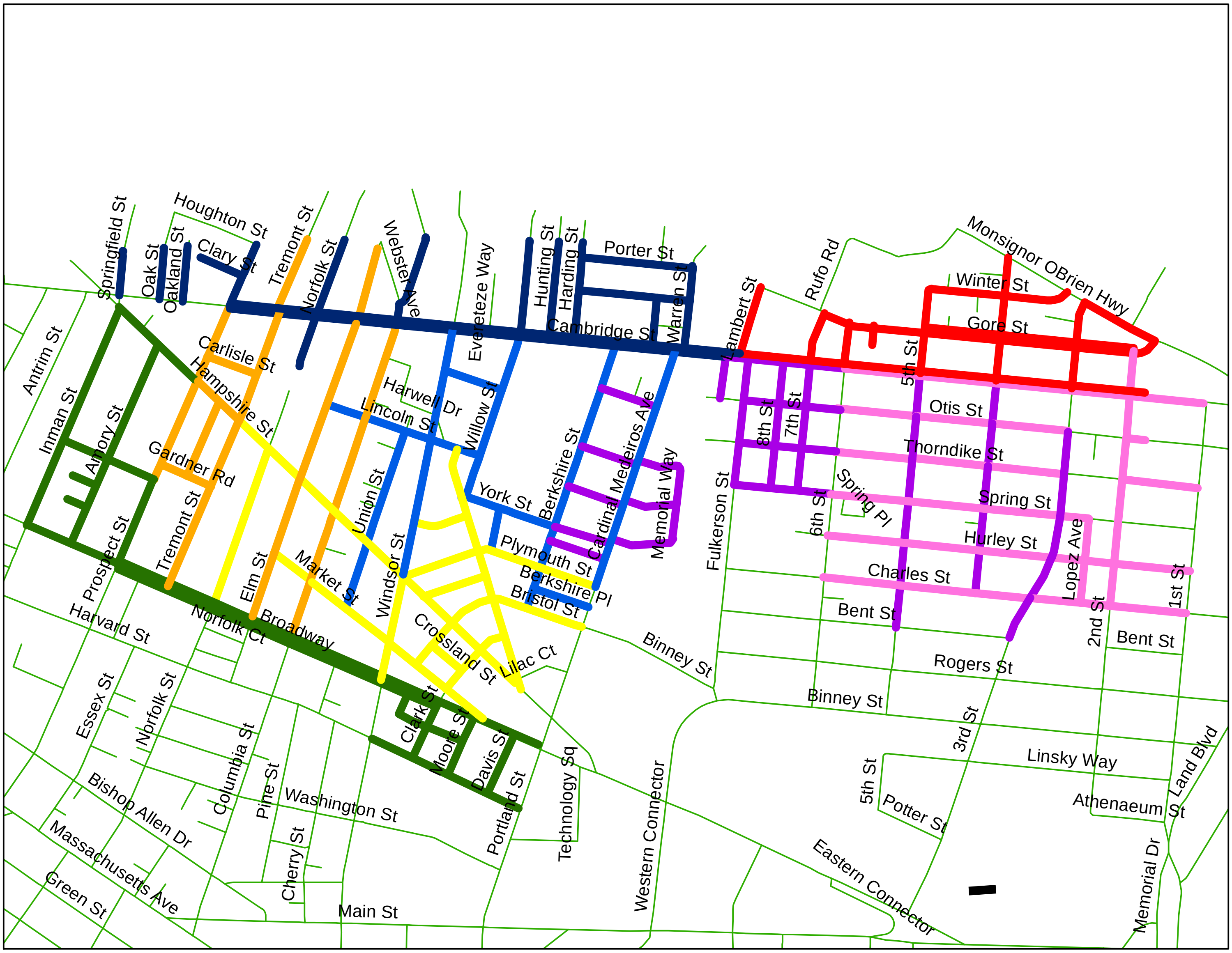
TRUCK	Bedrooms for Segment	Tons for Segment
24	79	0.575
24	100	0.728
24	37	0.269
24	113	0.823
24	12	0.087
24	85	0.619
24	38	0.277
24	114	0.830
24	16	0.116
24	105	0.764
24	36	0.262
24	14	0.102
24	68	0.495
24	37	0.269
24	3	0.022
24	46	0.335
24	8	0.058
24	8	0.058
24	42	0.306
24	50	0.364
24	42	0.306
24	33	0.240
24	24	0.175
24	2	0.015
24	3	0.022
24	15	0.109
24	51	0.371
24	78	0.568
24	89	0.648
24	40	0.291
24	31	0.226
24	27	0.197
24	21	0.153
Total Bedrooms	1467	
Tons Per Bedroom	0.007280164	

APPENDIX J: CURRENT AND PROPOSED ROUTES

Current Routes: Thursday



Proposed Routes: Thursday



Current Routes: Friday

Proposed Routes: Friday

APPENDIX K: DRIVER ROUTE DIRECTIONS

Driver: Carroll
Day: Thursday

Morning: *Approximately 5.9 tons + condos*

L onto Elm St
R onto Lincoln St
R onto Willow St
L onto York St
L onto Berkshire St
R onto Cambridge St
R onto Cardinal Medeiros Ave
R onto Berkshire Place
L onto Berkshire St
L onto Bristol St
L onto Cardinal Medeiros Ave
L onto Berkshire Pl
R onto Berkshire St

-Dump-

After Dump: *Approximately 6.3 tons*

Head West on Cambridge St
L onto Windsor St
L onto Hampshire St
L onto Bristol St
L onto Cardinal Medeiros Ave
L onto Cambridge St
L onto Willow St
L onto York St
R onto Hamlin St
R onto Plymouth St
R onto Hampshire St
R onto Columbia St
R onto Lincoln St
R onto Union St
L onto Market St
L onto Bristol St
L onto Hampshire St
R onto Columbia St
R onto Cambridge St
R onto Windsor St
R onto Hampshire St
R onto Columbia St
R onto Cambridge St
R onto Willow St
R onto Palermo St
L onto Windsor St
R onto Lincoln St.

-Dump-

Driver: Conole
Day: Thursday

Morning: *Approximate tonnage 6.89*

R out of DMV onto Hampshire St
R onto Inman St
R onto Cambridge St
L onto Oak St
R onto Houghton St
R onto Prospect St
R onto Cambridge St
R onto Oakland St, U-turn
R onto Cambridge St
R onto Springfield St
R onto Houghton St
R onto Prospect St
L onto Cambridge St
L onto Norfolk St
R onto Webster Ave
R onto Columbia St
R onto Cambridge St
L onto Norfolk St, U-turn
L onto Cambridge St
R onto Prospect St
L onto Clary St, U-turn
L onto Prospect St, turn around somehow
L onto Cambridge St

-Finish length of Cambridge St and dump-

After Dump: *Approximate tonnage 6.6*

Travel West down Cambridge St starting with first
R onto Columbia St**,** turn around some how
L onto Cambridge St
L onto Warren St
L onto Porter St
R onto Harding St
L onto South St
L onto Hunting St
R onto Cambridge St
R onto Willow St
L onto South St
L onto Windsor St
L onto Cambridge St
L onto Warren St
L onto Jefferson St
R onto Harding St
L onto South St
L onto Hunting St
L onto Cambridge St
L onto Warren St
L onto Jefferson St
L onto Marion St

-Dump-

Driver: Corey
Day: Thursday

Morning: *Approximate tonnage: 6.32*

Start on the corner of Cambridge St and Cardinal Medeiros Ave
Go Down Cardinal Medeiros Ave
L onto James Way
R onto Memorial Way
R onto Cornelius Way
R onto Cardinal Medeiros Ave
R onto Michael Way
R onto Memorial to Cardinal Medeiros Ave
L onto Cardinal M. Ave
R onto Plymouth St
R onto Berkshire St
R onto Vandine St
L onto Cardinal M. Ave
L onto York Pl
R onto Berkshire St
R onto Hardwick St
L onto Cardinal Medeiros Ave.
L onto Marney St.
R onto Berkshire St
R onto Marcella St
L onto Cardinal Medeiros Ave
R onto Cambridge St
R onto Max Ave
L onto Otis St
R onto 3rd St
R onto Bent St.
R onto 5th St
R onto Cambridge St
R onto Sciarappa St

-Dump-

After Dump: *Approximate Tonnage: 6.515*

Start corner of Max Ave and Cambridge
Go down Cambridge St to Fulkerson St
R on Fulkerson St, pick up right
L onto Spring St
L onto 6th St
L onto Cambridge St
L onto Fulkerson St
L onto Spring St
L onto 8th St
R onto Cambridge St
R on to 7th St
L onto Spring St
L onto 6th St
L onto Cambridge St
L onto Max Ave, U-turn on Max Ave
R onto Cambridge St
R onto 6th St
R onto Spring St.
R onto Fulkerson St.
R onto Thorndike St.
L onto 6th St.
L onto Otis St.
L onto Fulkerson St.
L onto Charles St
L onto Sciarappa St
L onto Cambridge St
L onto 5th St
L onto Bent St
L onto 3rd St

-Dump-

Driver: DiCecca
Day: Thursday

Morning: *Approximate Tonnage: 6.841*

Start where Market meets Broadway and head NW on Market St. (**L** from Broadway) – Collect both sides

R onto Bristol (Both sides)
L onto Cardinal Medeiros
L onto Plymouth (Both sides)
R onto Broadway
R onto Tremont St.
R onto Hampshire St. (This side)
L onto Webster (This side)

-Dump-

After Dump: *Approximate Tonnage: 6.398*

Do other side of Webster (heading toward Hampshire)
R onto Hampshire (This side)
L onto Tremont St.
L onto Broadway
L onto Norfolk St. (Both sides)
L onto Broadway
L onto Elm St.
R onto Market St. (Both sides)
L onto Clark
R onto Hampshire
L onto Webster
L onto Clark
R onto Crossland
R onto Bristol
L onto Webster
L onto Portsmouth
R onto Hampshire
R onto Windsor
R onto Seckel

-Dump-

Driver: Gianatasio
Day: Thursday

Morning: *Approximate Tonnage: 7.097*

R onto Hampshire St. Leaving the yard
L onto Inman St
L onto Broadway
L onto Amory St
L onto Amory Pl, turn back around
L onto King Pl, turn back around
L onto Amory St
L onto Hampshire St
L onto Inman St
L onto Broadway
L onto Amory St

-Dump-

After Dump: *Approximate Tonnage: 4.809*

Start Corner of Portland and Broadway
Go down Broadway
R onto Prospect St.
L onto Hampshire
L onto Inman St
L onto St Mary Rd
R onto Prospect St.
L onto Broadway
R onto Clark St
L onto Harvard St
L onto Portland St
L onto Broadway
L onto Windsor
L onto Harvard St
L onto Moore St
L onto Broadway
L onto Dickinson St
R onto Moore St
L onto Harvard St
L onto Davis St
L onto Broadway
R onto Antrim St.
R onto Hampshire St.

-Dump-

Driver: Marchetti
Day: Thursday

Morning: *Approximate Tonnage: 6.065*

Start where 6th St. meets Cambridge heading towards 2nd St.
Collect Cambridge St. (This side)
R onto 1st St.
R onto Otis St (This side)
L onto 6th St.
L onto Thorndike St. (Both sides)
R onto 1st St.
R onto Spring St. (This side)
L onto 6th St.
L onto Hurley St. (This side)
R onto 2nd St. (This side)
L onto Charles St. (This side)
L onto 1st St.
L onto Hurley St. (This side)
R onto 2nd St. (This side)

-Dump-

After Dump: *Approximate Tonnage: 6.244*

Begin on 2nd St. heading toward Charles St. (This side)
R onto Charles St. (This side)
R onto 6th St.
R onto Spring St. (This side)
R onto Lopez Ave. (This side)
L onto Charles St. (This side)
L onto 2nd St. (This side)
R onto Hurley St. (This side)
R onto 1st St.
R onto Bent St.
R onto 2nd St.
L onto Hurley St. (This side)
L onto 6th St.
L onto Charles St. (This side)
L onto Lopez Ave. (This side)
L onto Spring St.
R onto 6th St.
R onto Otis St. (This side)
L onto 2nd St.

-Dump-

Driver: Scalesse
Day: Thursday

<u>Morning:</u> *Approximately 7.79 tons*

L out of DPW onto Hampshire St
L onto <u>Columbia St,</u> turn around whenever possible where Columbia St meets Cambridge St
Travel Southwest down <u>Columbia St</u>, turn around wherever possible when Columbia St meets Broadway
Travel Northeast up <u>Columbia St</u>
L onto Hampshire St
L onto <u>Tremont St</u>
L onto Broadway
L onto <u>Elm St</u>

-End with last house on Elm St, dump-

<u>After Dump:</u> *Approximately 6 tons*

R onto Cambridge St
L <u>Prospect St</u>
L <u>Hampshire</u>
R <u>Tremont</u>
R Broadway
R <u>Prospect St</u>
R <u>Cambridge St</u>
R <u>Tremont St</u>
R <u>Hampshire St</u>
L <u>Prospect St</u>
L Gardner Rd
L <u>Murdock St</u>
L Hampshire St
R Prospect St
R <u>Carlisle St</u>
R <u>Tremont St</u>
R <u>Gardner Rd</u>
R Prospect St
R Cambridge St
L Norfolk St
L Webster St
L <u>Tremont St</u>

-Dump-

Driver: Silva
Day: Thursday

Morning: *Approximate Tonnage: 9.738*

Start on Lambert St. heading toward Cambridge St. – Collect both sides of Lambert St.
L onto Cambridge St.
L onto 3rd St.
R onto Monsignor O'Brien Hwy
R onto Gore St.
R onto 5th St.
R onto Winter St.
L onto Monsignor O'Brien Hwy
L onto Rufo Rd.
L onto Gore St.
R onto Gore Street Pl. (U-Turn)
R onto Gore St.
L onto Monsignor O'Brien Hwy
L onto 3rd St.
R onto Cambridge St.
R onto Sciarappa St.
L onto Winter St.
L onto 5th St.
R onto Cambridge St.
R onto 7th St.
R onto Gore St.
R onto 6th St.
L onto Cambridge St.
L onto 5th St.
R onto Winter St.
R onto Sciarappa St.
R onto Cambridge St.
R onto 7th St.
R onto Gore St.
R onto 5th St.
R onto Cambridge St.
Collect Cambridge St. from 7th to Lambert
R onto Lambert St.
R onto Gore St.
R onto 5th St.
R onto 6th St.
R onto Gore St.
L onto Sciarappa St.
R onto Monsignor O'Brien Hwy
R onto Cambridge St.
Collect Cambridge St. from 2nd St. to 3rd St.

-Dump-

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