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TRASH MATTERS: AN INVESTIGATION INTO THE CURRENT WASTE MANAGEMENT
AND RECYCLING STRATEGIES IN RURAL NORTH DAKOTA
AND FORESEEABLE SOLUTIONS

by

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Bachelor of Science, Purdue University, 2008

A Thesis

Submitted to the Graduate Faculty

of the

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This thesis, submitted by Amy J. Densborn in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.



Rebecca Romsdahl Ph.D., Chairperson

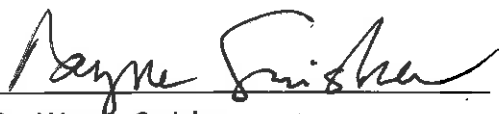


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This thesis meets the standards for appearance, conforms to the style and format requirements of the Graduate School of the University of North Dakota, and is hereby approved.



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MANAGEMENT AND RECYCLING STRATEGIES IN RURAL NORTH DAKOTA
AND FORESEEABLE SOLUTIONS

Department Earth System Science and Policy

Degree Master of Science

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ABSTRACT

Rural North Dakota is behind the times for establishing an economically and socially beneficial method for collecting recyclables from residents, and in some areas providing sustainable trash removal. As the waste stream continues to grow, so will the burdens on our landfills, our resources and our environment for generations to come. An even worse alternative to landfilling garbage is the use of burn barrels, which release dioxins into the local environment, settling on vegetation and waterways and further bio-accumulate in the food chain. Rural residents currently do not have conveniently located or affordable disposal options for household generated waste and forced to burn the garbage in a burn barrel.

The purpose of this study was to gain insights into the current perceptions and level of satisfaction regarding the current waste and recycling options that are available in rural communities. Identification of residents' attitudes and behaviors were examined through a statewide survey and from the responses, recommendations for policy are provided to make waste disposal more sustainable and recycling more readily available. To gain insights on the current infrastructure options, interviews among transfer station operators were conducted to assess the disconnect between residents' knowledge of a station existence. Waste generation rates from each landfill from the years 2006-2014 were used in a comparative analysis with

gross domestic product to assess how efficiently waste is being handled relative to economic growth with the recent oil boom.

Based on the results of the survey, 60% of residents are participating in some form of recycling and would like to see more convenient and affordable options provided. The majority of respondents expressed willingness to pay for those additional services as well. About a quarter of the respondents admitted to burning their garbage because they do not currently have an affordable disposal option and 41% are not concerned with the health effects of burning trash. This indicates a need for improved educational campaigns that deter backyard burning, in addition to providing more drop-off locations for recycling.

These findings provide an interesting insight into the motivations and perceptions regarding waste and recycling strategies within rural North Dakota. The results should be utilized when developing future waste management policies and expanding the network of recycling drop-off stations to more communities.

CHAPTER I INTRODUCTION

For centuries humans have grappled with the problem of what to do with solid waste. It has been in the last half of the 20th century that waste management has shifted gears from placing emphasis how to dispose of waste to what is the best way to manage the waste. Every single person on this planet contributes to waste generation throughout our everyday life. There is no end to the amount of waste that a society can produce; although, there has to be a safe place to store it when there is no other resolution. Waste generation is directly linked to trends in consumption and output such as population growth, level of manufacturing, agricultural productivity, and overall economic performance (United Nations Environmental Programme, 2011). Residential waste is not the only concern in North Dakota at the moment, but also the proper disposal of oil field waste. With the influx of people immigrating into the state to work in the oil fields, there have been several issues with illegal dumping of municipal and hazardous waste. The landfills in western North Dakota were not designed to withstand the volume that is incoming today because of the oil boom prosperity. As economies grow, so do their energy needs-translating to higher rates of waste generation (Brisson, 1997; United Nations Environmental Programme, 2011).

Landfilling is still the common method of solid waste management throughout the state of North Dakota because it is relatively inexpensive. Landfilling is far cheaper than recycling and usually proves more convenient because of the sparsely distributed population

across a large geographic area; making transportation costly and little economic incentive for recycling. It is typical for Municipal Solid Waste (MSW) to be transported 125 miles or more for disposal (Tillotson, 2009). Another significant barrier that North Dakota faces is the distance to end markets (or lack thereof) for the recycled materials. There is no Materials Recovery Facility (MRF) located in North Dakota, which means all recycled materials are shipped to Minneapolis, Minnesota to be processed then sold to the final markets for reuse. Without the presence of an economic incentive to make a profit from recycled materials, the items are ending up in the landfill (ND State Dept. of Health and Consolidated Laboratories, 1993).

Unlike citizens who live in urban populated areas, rural residents are held responsible for properly disposing of their own trash; the economic burden falls on the resident. The state assumes that the rural landowner has the tools (pickup truck) and the money (fuel and expendable income to pay the landfill) to transport the garbage to a nearby facility (if one is available). However, no one is required to participate and there is no enforcement within the rural areas. The spread out geographical distribution of North Dakota has made it difficult to make sustainable waste disposal and recycling economically feasible, yet there are other nearby states with significant rural populations that have implemented policies and developed partnerships among nearby communities to make it more convenient and affordable for the rural communities. Such states as Minnesota and Montana were assessed to provide a comparative analysis of how other nearby regions are coping with the challenges within the rural areas.

Importance of Study

Since North Dakota is one of the fastest growing states in the nation according to population growth, it is critical that as a state we are increasing the longevity of our landfills by adhering to the concept of reduce, reuse, and recycle. Fargo and Bismarck are ranked as the fourth and fifth fastest growing metropolitan areas in the nation while three out of the top five micro areas (<10,000 people) have ranked as the fastest growing. The city of Williston took the lead with the fastest growth in the nation, Dickinson second and Minot fifth (North Dakota Department of Commerce, 2014). North Dakota is expanding and will continue to grow in population for the foreseeable future. The history of waste management in N.D. has significant relevance to the current issues and challenges that the state is facing today.

Currently, rural residents face many barriers to properly disposing of their trash and recyclable materials. The permitted facilities are not conveniently located, hours are random, the items they can dispose of are not clearly defined, and most residents are not even aware if they have a facility nearby. A clean environment is a public good and to attain this, the community has to collectively take the initiative to manage waste safely. If the community is not made aware of a safe place to dispose of their waste, then a clean environment can never be obtained.

It is also important to ensure intergenerational equity by safeguarding common resources such as land, air and water for future generations. Equity is maintaining fairness within the social justice system. Within any community, everyone has equal access to the same basic resources and opportunities that promote an acceptable standard of living. Future

generations do not have a say in the decisions that are made today, therefore it is our society's obligation to maintain the integrity of our resources (Beder, 2000).

This study provides a statewide snapshot of waste management sector over the past 10 years in North Dakota, in addition to evaluating current rural waste management strategies and proposing viable solutions to disposal options that can be implemented on a state level to help maintain environmental quality. To do this, a statewide survey was implemented among residents and interviews were conducted among transfer station operators because these are the individuals that have direct influence on the waste management sector in North Dakota. The residential survey helped determine the current waste management issues rural residents are faced with, their willingness to pay and overall interest in a more convenient disposal option, and determine the perceived detriment to the environment with their current disposal alternative. To help provide further insights to the issues rural landowners are faced with, interviews among transfer stations operators helped determine what materials are actually accepted, what counties the facility serves, if recycling is accepted and how much contamination occurs on site from illegal disposal.

Research Objectives

The objectives for this study include: (1) examine the current state of waste management and recycling within North Dakota, (2) pinpoint the failures or barriers to households' perceptions about recycling and devise solutions to overcome these barriers, (3) evaluate the demographic and socio-economic factors that influence the demand for infrastructure with the rural community, (4) identify which counties within North Dakota are suffering the most because of lack of access to adequate disposal options, (5) propose

recommendations for how to implement recycling programs within the rural communities, in addition to looking into potential partnerships.

Assessing the environmental attitudes of residents regarding their current waste management system is necessary to support implementation of future policy options that will both benefit the household as well as the environment. Understanding the perceived barriers that rural households are faced will help create practical educational awareness tools to focus on the communities that are interested in participating in recycling program.

Implications of Research

The research will help evaluate the current state of rural waste management and the level of satisfaction, perceptions and behaviors among residents. The survey results will help determine the areas of the state that are in the greatest need for additional options, education/outreach efforts and their willingness to pay for establishing the infrastructure to make disposal more convenient and environmentally sustainable. There are numerous opportunities available through the USDA and the Rural Assistance Center that provide grant money for rural communities to help with offsetting the cost of new infrastructure, as well as providing training and educational tools to inform residents about the importance of sustainable waste disposal and recycling. There are sections of this study that will serve as a valuable resource guide for local governments throughout North Dakota to address some of the current issues with facilitating collection and disposal services, in addition to developing strategies to implement programs and encourage partnerships.

Much emphasis has been placed on establishing cost-effective and sustainable options for urban areas, while rural communities are left to fend for themselves. Many of the rural

recycling programs are operated by individual interests who display strong leadership qualities; whereas urban areas are usually run by an institution (Haque and Hamberg, 1996). Prime examples of states that are comprised of a large rural population and economically rely heavily on the agricultural industry are the states bordering North Dakota. Both Minnesota and Montana have implemented partnerships between counties to help make recycling successful and cost-effective for all parties involved and decrease the use of burn barrels. Examples of successful campaigns are provided below as a possible solution to the current state of waste and recycling in rural North Dakota. There are obviously major differences in the environmental policy regulations between North Dakota and Minnesota. Minnesota in general is much more progressive in their recycling initiatives compared to North Dakota because of mandated legislation to promote sustainable waste management practices. A committee called the Select Committee on Recycling and the Environment (SCORE) was developed after the consolidation of landfills at the end of the 1980s. This committee has implemented legislation that requires all counties have to “convenient” opportunities for recycling and any city above 5,000 in population within the Twin Cities metro area to have curbside recycling (Minnesota Pollution Control Agency, 2014).

For example, Lincoln County, which is located in the southwest corner of Minnesota bordering South Dakota, recently adopted drop off sites throughout the county because of the environmental concerns with burning garbage. The population within the county is about 5,830 according to the 2013 United States Census Bureau. There are containers for both trash and recycling. Initially the participation was only about 25% when the program started in 2008, but today it has reached nearly 60% participation rate. This has helped cut back on the

backyard burning and has decreased costs to the landowner significantly. Initially landowners were paying \$115 per month for a rural collection serviced twice a month, while today they pay \$30 for a community drop-off site. The community drop-off site is not locked or fenced, but has not experienced many occurrences of illegal dumping thus far (Minnesota Pollution Control Agency, 2014).

Another excellent example of a county taking initiative to put a stop to backyard burning is in Redwood County also located in Minnesota in the southwest corner close to Lincoln County. There were 15,744 residents according to the 2013 U.S. Census Bureau. By using GIS technology, they identified which townships within the county were lacking sufficient waste collection and recycling services and then arranged meetings with county officials and residents to evaluate the interests in developing more convenient disposal options. The county received grant money to help develop these sites and purchased all the bins necessary for disposal. The four established sites were left unstaffed and open 24 hours a day, 365 days a year and have yet to experience substantial contamination issues. Yet again, this method of waste disposal proved to be an economically and environmentally viable solution for the rural landowners. Their costs went from approximately \$41.00 to \$1.50-\$3.00 per month and all the sites were within a 3 miles radius from each household making it extremely convenient (Minnesota Pollution Control Agency, 2014).

Montana also represents a state that relies on agricultural products as the main revenue for the state and has 64% of the population residing in rural areas (Rural Assistance Center, 2014). Even though a large proportion of the residents live in rural Montana, there has

still been great success of diversion based on the recycling and composting goals that the Legislature proposed in 2005 because of the regionalization approach throughout the communities. The Montana Integrated Waste Management Act approaches waste management from a hierarchy perspective, instead of focusing on just a few methods. These approaches, in order of priority are source reduction, reuse, recycling, and composting. This method aims to minimize the amount of waste going to the landfill and instead focus energy into developing programs and building infrastructure to reach the diversion goals set forth by the state legislatures. One of the most successful outcomes from proposal was the implementation of the “Hub and Spoke” concept, which helped make rural recycling possible by developing a cooperation between nearby local communities. Several communities aggregate their recyclables, and then ship them to one central location, thereby creating the volume that is needed to make it a profitable scenario. This was all accomplished through workshops among the local representatives; without their support and help, this strategy would not have been successful. A regional recycling approach has many benefits such as increasing the potential for cooperative marketing, which in turn increases revenues; conserves valuable landfill space and avoids tipping fees; provides new opportunities for jobs; shared operating costs helps make it more affordable (Montana Dept. of Environmental Quality, 2013). For example, the goal for waste diversion for 2012 was 19% and the state surpassed the goal reaching 21.9% recycling/diversion rate (State of Montana, 2012).

Even more recently, there has been a campaign called “Don’t Waste Montana,” which provides information to rural communities about how to reduce consumption, reuse materials, and recycle the remaining materials. Currently, the campaign only encompasses Broadwater,

Jefferson, and Lewis & Clark counties, but eventually the entire state will be included. The overall goal is to provide the tools needed to conserve Montana's natural resources and keep it beautiful for generations to come. This project is managed by a non-profit organization called Recycle Montana (Recycle Montana, 2015).

It is obvious that there is a big difference in management styles between these two states. Montana and Minnesota are both actively seeking to increase recycling and diversion rates by implementing goals through the legislature and providing the tools at a local level to make it feasible. Yet, North Dakota is ages behind in term of promoting and monitoring recycling rates and updating the waste management plan developed in 1993. As proven in other states, developing partnerships between communities can provide efficient and cost-effective means of adequately disposing of waste in more rural localities. By identifying the factors and behaviors that are influencing the decision making process for rural landowners, recommendations can be proposed to the state representatives to help improve the flow of waste throughout the state and provide an environmentally safe means of disposal. Progress within the waste management hierarchy takes time and requires attitude and behavior changes among individuals first through educational awareness followed by modifications in legislation.

CHAPTER II

OVERVIEW OF WASTE REGULATIONS, LAWS, AND EXISTING CONDITIONS

The state of North Dakota developed a Solid Waste Management Plan in July of 1993 which evaluated the current status of waste and recycling efforts across the state and proposed goals for the next 20 years. These goals were as follows: (1) by 1995 at least 10% reduction in volume of municipal waste deposited in landfills, (2) by 1997 at least a 25% reduction in volume of municipal waste deposited in landfills, (3) by 2000 at least a 40% reduction in volume of municipal waste deposited in landfills.

The 1993 Waste Management Plan emphasized the importance of implementing more educational programs across the state to inform people of the importance of reduce, reuse, recycle. While the goals were not met by 2000, there was great success in implementation of recycling and yard waste composting programs across the state. These sorts of programs were not near as prevalent prior to the creation of the Waste Management Plan (Tilloston, 2009).

Consolidation of Landfills

Prior to the 1990's, households in North Dakota dealt with solid waste management as individual communities using local landfills. However, the Environmental Protection Agency (EPA) devised stricter regulations under "Subtitle D" of the Resource Conservation Recovery Act (RCRA) which forced all landfills to abide by more stringent criteria, in turn forcing about 106 landfills to shut down across the state because meeting the requirements would have

been too costly. This law was developed to help reduce the negative externalities to society that accompanied general disposal of garbage. The most expensive requirements were mandating synthetic liners and leachate collection systems for all landfills. This resulted in the regionalization of waste management across the state with residents relying on a system of 13 municipal solid waste landfills that meet the requirements of the RCRA (ND State Dept. of Health and Consolidated Laboratories, 1993 and Dooley et al., 1993).

Transfer Stations

A transfer station is defined as a temporary holding station for municipal solid waste until it can be reloaded onto a larger truck to travel the long distance to a final disposal facility. Currently there are 31 permitted transfer stations across the state, although only 26 accept municipal solid waste from households (North Dakota Dept. of Health-Waste Division, 2014). Utilizing transfer stations cuts down on costs in labor and operation because several loads are combined into a larger truck. By combining loads of waste material in this manner, local communities and waste management companies can reduce transportation cost, which often hinders the rural communities from adequate disposal (EPA, 2001).

Pay As You Throw

Pay as you throw (PAYT) is a volume based waste collection service that creates an economic incentive to recycle more and create less waste because they are charged per unit of waste discarded (EPA, 2012). This waste collection strategy has become increasingly popular within the U.S. over recent years. According to a 2006 survey conducted by the EPA, 26.3% of communities throughout the nation have in place a PAYT system. Currently seven towns implement this type of service across the state: Devils Lake, Drayton, Fargo, Hamilton, Oakes,

St. Thomas, and Wahpeton. Valley City Landfill, which is located in Pembina County, is completely enforced by PAYT system and has proved highly effective since establishment in 2000. There are city ordinances established that make it illegal to throw garbage away in another person's trash bin and those enforcement are highly regarded. This landfill is owned and operated by the city and is a perfect example of a facility running based on utility and not for profit. The entire community works in cooperation with each other by monitoring the trash output within the neighborhoods and watching guard in the city dumpsters. Every person is held financially liable for the amount of trash they produce (Olson, 2014).

Curbside and Drop-Off Recycling Programs

In general, recycling data is hard to obtain because North Dakota does not have strict enforcement policies for maintaining records of the recycling stream. Currently there are 17 curbside pick-up programs which include the following towns: Bismarck, Bowman, Devils Lake, Fargo, Fordville, Forest River, Gilby, Grafton, Grand Forks, Gwinner, Harvey, Mayville, Minto, Park River, Pembina, St. Thomas, and Wahpeton. There are significantly more drop-off sites throughout the state because of the reduction in the overhead charges associated with recycling. Essentially, it is 'free labor' when people sort and drop off their own materials. Currently there are 37 towns/cities who offer drop off sites (ND Department of Health-Division of Waste Management, 2010).

Yard Waste Composting Programs

According to the North Dakota Administrative Code in Section 33-20-01.1-03 composting is defined as "the controlled biological decomposition of organic solid waste under aerobic conditions." Burying yard waste allows a resource to go to waste, as well as taking up

precious landfill space that could be used for other products that are not as easily recycled. The benefits of composting are as follows: reduces disposal costs at landfill, saves valuable space at the landfill, final product of the compost can be used as a low cost landscaping material or as an alternate daily cover at the landfill, and incorporating compost into soil provides additional nutrients and organic matter, which helps improve soil water retention (South Dakota Dept. of Environment & Natural Resources, 2014). As of March 2013, there are 46 towns/cities that provide a composting program within the state. Unfortunately, yard trimmings and food waste still accounts for 28% of the total U.S. municipal solid waste stream according to a 2012 waste generation study conducted by the EPA (EPA, 2014).

Important Laws Regarding Waste Disposal

All municipal solid waste laws are regulated by the EPA under Volume 40 of Federal Regulations as Subtitle D. These regulations specify minimum criteria pertaining to garbage which includes just about every type of trash imaginable, from tires to construction materials to waste from water treatment plants. The North Dakota Department of Health regulates all solid waste storage, transportation and disposal through the North Dakota Solid Waste Management Rules. All private and public entities must apply and be approved for site location before trash can start legally being buried. However, there is one exemption to this law which is inert waste facilities. Inert waste includes waste from the production of agricultural products, oil field exploration and production waste. The location of these facilities must be in areas which do not pose harm to human health or negatively impact environmental resources; generally located in areas that contain clay-rich soils, away from steep terrain, wetlands, and floodplains (Dept of Health, 1996; Dept of Health, 2009).

Chapter 23-29 in the North Dakota Century Code titled “Solid Waste Management and Land Protection,” also provides an overall depiction of the critical statewide laws that residents are obligated to abide by. This section again emphasizes the requirement of any solid waste management facility or solid waste transporters to have a valid permit issued by the state department (23-29-07). Regarding the issues of littering and opening burning (23-29-05.1), it clearly states that a person is not allowed to abandon litter, furniture, or major appliances on public property or on another’s private property. Burning of solid waste is more of a grey area as it states that burning is not allowed unless the burning is aligned with the rules adopted by the department. Chapter 33-15-04, “Opening Burning Restrictions,” explains in more depth exactly what is allowed to be burned and who is permitted to open burn across the state. The state does permit burning of refuse produced by the domestic household if these three conditions are met: (1) There is no collection or disposal service available within the municipality. (2) The material being burnt is from a building/household accommodating no more than one family. (3) The burning takes place on the same property that the waste was produced. It also states that all burning will not cause air pollution, which is further clarified in Chapter 33-15-01 as defining air pollution as the air contamination in such quantities and duration that make it injurious to human health, welfare, or property or animal plant life or if the burning interferes with enjoyment of life or property.

Environmental Impacts of Backyard Burning

The trash stream today has changed compared to that of a few decades ago. Today’s garbage is full of plastics and treated paper that release a mixture of carcinogens when burned. Backyard burn barrels generally produce low-temperature fires because of the low

availability of oxygen, which in turn produces large quantities of smoke. This smoke produces toxic air pollutants that are released directly into the air, in addition to the being inhaled at ground level. The major concern from burning trash is the impact on regional air quality because of the release of dioxins. Other harmful, but less prevalent pollutants are particle pollution, polycyclic aromatic hydrocarbons, carbon dioxide, hexachlorobenzene, ash, and volatile organic compounds. All of these impacts present short and long-term environmental impacts (EPA, 2013).

One of the most threatening toxins from burning is dioxins. These are highly toxic chemicals that form during the combustion process of certain chlorinated chemical such as plastics, wood treated with pentachlorophenol (PCP), and pesticide-treated waste (Minnesota Dept. of Health, 2006). The plastics that contain pesticide residues are the most concerning because that is some of the most harmful pollutants to the environment and rural landowners often rely on pesticide use to maintain profitable levels of agricultural productivity. Dioxins also accumulate in the food chain, mostly within the fatty tissues of animals; the higher up in the food-web-the more concentrated the levels become. The half-life of dioxins within the body is projected to be 7 to 11 years (World Health Organization, 2014). According to the EPA, “one burn barrel can produce as much or more than a full-scale municipal waste combustor burning 200 tons a day and are the #1 source of dioxin in the U.S.” (EPA, 2013; Minnesota Pollution Control Agency, 2014). They also remain in the environment for lengthy time periods by settling out of the air into water and vegetation. Since most rural families rely on agricultural and cattle production as their means of livelihood, they often are not aware that they are ingesting these harmful pollutants (World Health Organization, 2014). The ultimate

side effects from ingestion are damage to the immune system, disruption of the hormonal system and cancer (EPA, 2013).

CHAPTER III

LITERATURE REVIEW

Living in the rural community brings challenges to finding affordable and convenient trash/recycling collection. In most areas the costs for rural trash collection can be two-three times more expensive compared to urban centers (Minnesota Pollution Control Agency, 2014). Developing the necessary infrastructure for disposal can be daunting because the cost of shipping the waste can be more expensive than the value of the good itself. However, there are strategies to overcome these issues creating a more environmentally friendly and economical waste management approach. To develop a successful waste management system in North Dakota, it is essential to consider the value of recycling, the barriers and incentives to the households to recycle, the economic importance of sustainable waste management, and evaluate how other states with similar rural population abundances have coped with the challenges.

Importance of Recycling

Recycling has proven environmentally efficient from a resource conservation standpoint, as well as making logical financial sense. According to the EPA, in 2010, the U.S. diverted 85 million tons of materials from the landfills because of recycling efforts, which is roughly five times more than the recycling rate in 1980. Clearly, Americans have gathered the importance of recycling and many cities across the nation have adopted policies and regulations that mandate recycling as a part of the waste management system while other

regions have yet to jump on the 'bandwagon' because the U.S. government leaves it up to the local communities to enforce individualized regulations. The feasibility of a program depends on the community's resources and structure since not all are created equal. In many areas across the nation, there simply are not enough resources to make recycling an economically viable option, which is part of the problem North Dakota is faced with. However, that does not mean there is not a cost-effective solution to the lack of recycling opportunities within the rural areas (EPA (a), 2014).

There are several key benefits to recycling that create environmental, financial, and societal returns such as: reducing the need to landfill and incinerate; save energy and reduce additional pollution caused by extraction and production of virgin materials; plentiful manufacturing jobs for citizens and maintains a competitive nature in the global market; decreases emissions of GHGs that contribute to climate change; conserves natural resources for future generations (EPA (a), 2014). With the impact of global climate change, waste reduction behaviors are essential in mitigating these issues. Simply disposing of solid waste produces significantly more greenhouse gases compared to the process of recycling. Firstly, anaerobic decomposition is the process that breakdowns the trash that is sent to the landfill and this process create methane, which is a greenhouse gas 21 times more potent than carbon dioxide. Secondly, if a facility utilizes incineration, the byproduct of that process is carbon dioxide, which is also a prevailing greenhouse gas. Thirdly, transportation of waste consumes fossil fuels, which emits greenhouse gases via the combustion process and finally, the extraction of raw materials to replace those materials that were discarded requires the use of additional fossil fuels. Typically, the demands energy are lower when producing a

manufactured good from recycled materials compared to that of making a product from virgin materials. Additionally, since paper is one of the biggest components of the waste stream, humans are under-utilizing an optimal carbon storage resource that trees provide. Trees have the ability to absorb carbon dioxide from the atmosphere and store it in wood through a process called carbon sequestration. Therefore, the more recycling of paper products, the more trees can remain unharvested and continue to sequester carbon from the atmosphere (EPA, 2007).

Attitudes, Behaviors, and Barriers in Recycling

Understanding what motivates and demotivates people is the first step to understanding what encourages people to participate in recycling of solid waste. The Waste & Resources Action Programme (WRAP) developed a report in 2008 that explored peoples' barriers to recycling at home in the United Kingdom. Despite this report not originating from the United States, its outcomes are still implicit. The study found these four factors as the main barriers to recycling in a local community: 1.) Physical: containers are not available or they are placed inconveniently; a lack of space for storage at the home; unreliable collection pick-up times, or inability to transport materials to the drop-off site. 2.) Behavioral: people are too busy; forget to put it out on the curb on specific collection day; think the drop-off locations are unsafe and dirty. 3.) Lack of knowledge: unaware of which materials go in which containers; not understanding how the local community handles materials as in if drop-off sites are located or if curbside recycling is offered. 4.) Attitudes and perceptions: people do not see the environmental benefits of recycling; do not want to take the time to sort the waste; do not feel personally rewarded from recycling (Pocock et al., 2008).

According to Nigbur et al., 2004, the supposed effectiveness of recycling is one of the biggest motivations for households to recycle. The more that people view recycling as effective, the more likely they are to participate. In terms of perceived knowledge and benefits of recycling, several studies have emphasized the importance of this, such as Oskamp et al., 1998 and Harland et al., 2007 who both found that residents who believed more strongly in the environmental benefits of recycling were more likely to participate in recycling programs. To corroborate these findings, Simmons and Widmar, 1990 developed a study in Somerset County, New Jersey which helped determine what motivates people to recycle through a voluntary survey. They found that those who were confident in their knowledge of what and how to recycle were more likely to recycle than those with less confidence in recycling, even among those who had strong conservation ethics. Additionally, social pressure is another motivational factor that influences recycling rates. People can be motivated by actual pressure they receive from family and friends simply by watching them participate in the activity. Just knowing that your neighbors, friends and family are recycling, can inspire or motivate people to jump on the bandwagon. Also, people are motivated by economic incentives, such as lotteries that reward random recyclers for his or her efforts; however these incentives do not provide long-term behavior change. Once the incentive is no longer an option, the recycling rates will destabilize again (Gamba and Oskamp 1994; Wener and Makela 1998). Conversely, there is extensive literature (McKenzie-Mohr and Smith, 1999; Morris, 2000; Huang et al., 2011) who has studied the effectiveness of ongoing pay-as-you-throw (PAYT) programs and their ability to help increase rates of recycling. For example, the city of Plymouth, Massachusetts imposed a mandatory PAYT program for all residents in 2013 and

the results after just one year was a 44% reduction in solid waste, as well as almost doubling their recycling rates (16% before PAYT to 31% with PAYT). The amount of waste that was diverted from the landfill is equal to the amount of greenhouse gases that 1,700 cars would produce. Furthermore, the recycling collected in one year span of time is equal to same amount of energy that would have been used to power 660 houses (Waste Zero, 2014). When people are penalized financially for not participating, the rates of waste inevitability will decrease.

In terms of barriers to recycling, lack of knowledge is a significant barrier keeping people from participating in recycling programs across the nation according to Schultz, 2002 who determined that “increasing knowledge will translate into change in behavior.” However, that change in behavior was minimal and short-lived, so why do recycling campaigns continue to promote educational literature? It is a cheap and effective means of providing the information to the person who simply needs the details of recycling. Simmons and Widmar, 1990 also concluded that if recycling is considered to be too inconvenient or too time-consuming, individuals will be less likely to recycle because it is not worth the input of time. The individuals that possess a stronger idea that recycling is inconvenient tend to recycle less or not at all. This includes inconveniences such as lack of time, lack of storage space, messiness, too much effort to move the recycling bin to the curb, and too few drop-off sites or inconvenient locations (Pocock et al., 2008).

Economic Evaluation of Solid Waste Management

There are several different policies that help encourage or provide incentives for efficient waste management and recycling programs. It is imperative to analyze the various policies that incorporate valuation of environmental externalities to effectively determine adequate policymaking processes that are sustainable economically, socially and ecologically. Landfilling is expected to remain a significant method for dealing with waste management for the foreseeable future, therefore it is critical to effectively and sustainably manage these landfills (Zacharof and Butler, 2004).

Without economic incentives, households do not accept the costs associated with waste reduction or disposing of waste in a more environmentally sustainable manner. In fact, instilling charges on households might encourage illegal disposal because the other options are not economically viable. Sigman, 1998 conducted an analysis of illegal oil dumping and found that, "policies that elevate the cost of legal disposal encourage illegal dumping." This follows on par with the recent illegal dumping occurrences that have taken place in North Dakota. Since there are not any permitted hazardous facilities within the state boundaries to legally dispose of the waste, the economic burden is placed on the individual to transport it to a facility out of state. Relating to household waste, Fullerton and Kinnaman, 1995 determined the legal collection and disposal of waste typically results in less environmental damage than illegal burning or dumping of waste. However, if taxes are too high on trash disposal then illicit dumping is more likely to occur because the individual does not want to incur the cost associated with proper disposal. Burning or dumping is not a market activity that can be taxed directly, however it can be discouraged indirectly by imposing a tax on all output, in addition

to developing a rebate on proper disposal either through recycling or garbage collection. This results in a deposit-refund system for all consumption goods, not just on recycled materials.

Fullerton and Kinnaman, 1995 also found that there are challenges among different levels of government since states usually establish tax rates, but the municipal governments are the one who subsidize garbage collection. If the municipality does not have the funds to subsidize garbage collection, then the burden is placed on the residents within the community. Historically, most households have paid for garbage removal either with a flat monthly fee or through local or income taxes. This form of policy is classified as a tax to the user. One of the most direct approaches to internalizing the social marginal collection and disposal costs associated with trash disposal is to tax each bag that a household produces or otherwise known as a PAYT system. In many areas of the U.S., including North Dakota, households that produce larger quantities of trash pay the same amount as households who produce smaller quantities, therefore the social marginal costs of that extra bag are not accounted for by the user, but are displaced to the rest of society. Many studies have substantiated the concept of PAYT or pricing trash disposal fees according to the social marginal costs such as Jenkins, 1993; Fullerton and Kinnaman 1996; Podolsky and Spiegel, 1998. These studies determined that the economic benefit of charging per unit of garbage, instead of a flat fee could be anywhere from \$3- \$13 per person, per year. As long as households are faced with the full societal costs of their disposal choices, they are more likely to engage in source reduction behavior (Kinnaman and Fullerton, 1999). According to the latest EPA data, which is from 2006, there are more than 7,000 communities that participate in a PAYT program, which on average reduces the

residential trash output by 20% and has saved millions of dollars in tipping fees to the landfills (EPA, 2012).

Understanding the market incentives and the barriers associated with each type of material, that is included in the waste stream is a necessary step to efficiently develop a waste management system. Every state has to propose and implement the effective policies that determine the societal balance between the costs of recycling each material. Huhtala, 1997 and Brisson, 1997 developed the private and external costs associated with recycling each type of material. Huhtala, 1997 developed a model that evaluated the economic and environmental benefits and costs between landfill capacity and recycling. The results determined that social benefits of recycling paper, cardboard, and metal surpass the social costs, while glass and plastics do not quite withstand the cost benefit ratio. Additionally, the study added contingent valuation to estimate the non-market benefits of recycling, such as the value of cleaner local air and recycling as 'an environmentally friendly disposal method relative to landfilling. Approximately 70% of the survey sample, which took place in the Helsinki region in Finland supported recycling as an alternative as long as it did not involve an additional cost to the household. Brisson, 1997 found similar results in terms of the social benefits of recycling aluminum out weight the associated costs to society, with glass, ferrous metals, paperboard and plastic following in decreasing order of societal benefits.

When materials are disposed of that result in the net loss of natural resources the consequence is a depletion of natural capital. This does not just result in the loss of raw materials, but also results are losses associated with other resources such as water and fossil

fuels, depending on the processing requirements. The United Nations Environmental Programme developed a report in 2011, which provided evidence to support the transition to a “green economy” and the importance of resource efficiency. For example they determined the energy savings from recycling different materials such as: aluminum (95%), copper (85%), plastics (90%), steel (74%), lead (65%) and paper (40%). Producing paper from recycled stock instead of virgin pulp reduces water pollution by 35% and air pollution by 74% and producing steel from recycled scrap reduces air pollution by 86%.

Ley et al., 2002 determined that accounting for site-level external costs at the landfill is inefficient and in actuality, if the externalities were accurately accounted for it would raise the social surplus in the US market for municipal solid waste disposal by \$.23 billion dollars yearly. Ultimately, if the waste sector viewed waste as a resource and circumvented the final disposal of many materials, resource efficiency would be maximized, which would benefit the economy tremendously. For example, McKinsey and Company, 2011 found that 30% of the worldwide demand for resources in 2030 could be met by developing resource improvements and the global economic benefits of resource efficiency improvements could eventually be as great as \$3.7 trillion a year. This validates the importance of safeguarding the resources that we have today by minimizing consumption and investing more time, money and energy into waste reduction activities.

Market forces alone will not drive sustainable waste management because often they encourage the cheapest option, which in rural North Dakota is no management at all. A poorly managed waste system imposes social and environmental costs to society, which often are not

recognized with a dollar amount because they are considered an externality of the product. Often many of the strategies for waste reduction such as recycling and composting produce numerous benefits-they create more jobs, protect public health, require less capital investment, minimize CO₂ emissions, and provide secondary material to the production processes (United Nations Environmental Programme, 2011).

To help overcome the lack of an effective waste management system in a particular area, methods such as contingent valuation (CVM) can be useful to measure the environmental benefits of proposed improvements for individuals through directly asking peoples' Willingness to Pay (WTP). CVM has become one of the most popular methods to assign a monetary price to a non-market good and works by asking individual's willingness to pay to conserve or improve the current state of the surrounding environment. This monetary rate will depend on personal assessment of the value of the product or service as everyone has their individualistic ideas about environmental goods. WTP also is a factor of the demand side of the market because it only considers the benefits associated with the investment in the environmental improvement or service, not the costs that will be incurred by the service providers (Fujita, et al., 2005).

CHAPTER IV METHODOLOGY

The study area is the state of North Dakota, which covers approximately 68,976 square miles with roughly 51% of the state's population residing in rural communities (RAC, 2014). The residents that will be a part of the survey are located in towns of less than 10,000 since the focus is on improving rural waste management strategies. To achieve an impression of population impacts on waste management, looking at population distribution is essential. According to the Center for Rural Health, only 4 out of the 53 counties are considered urban or having more than 2,500 people within the county limits. Currently there are 723,393 people which is an increase of 7.6% in population size since 2010. After years of out of state migration and declining population, North Dakota is now experiencing growth. In fact, many of the counties and communities are ranked as some of the fastest growing in the nation. Since the Bakken is expected to continue productivity over the next 25-50 years, there is the possibility that many of the landfills will reach capacity before originally anticipated with the previous rates of growth. When the Waste Management Plan was developed in 1993, the population was projected to decline over the years because during that time the state was experiencing net emigration. In fact, between 1950 and 2010, N.D. had the 2nd slowest population growth rate in the nation. It was projected that by 2010, the population would be 591,896; however North Dakota has been experiencing immigration and will likely continue to grow. Therefore, it is imperative to increase the rates of reduction through composting and

recycling throughout the state to preserve the longevity of the landfills (ND DoH and Consolidated Laboratories, 1993; Mather and Jarosz, 2014)

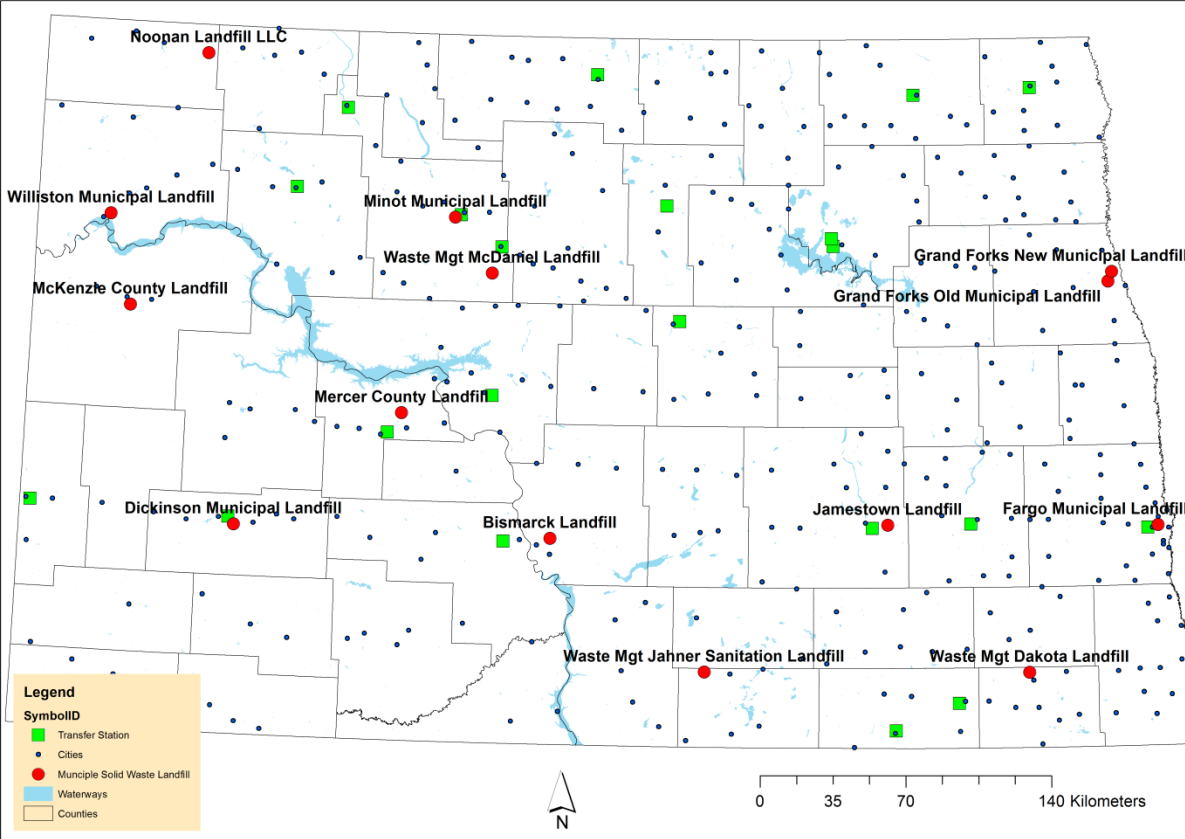


Figure 1. The distribution of landfills and transfer stations across the state (North Dakota Hub Explorer, 2014 and the DoH, 2014).

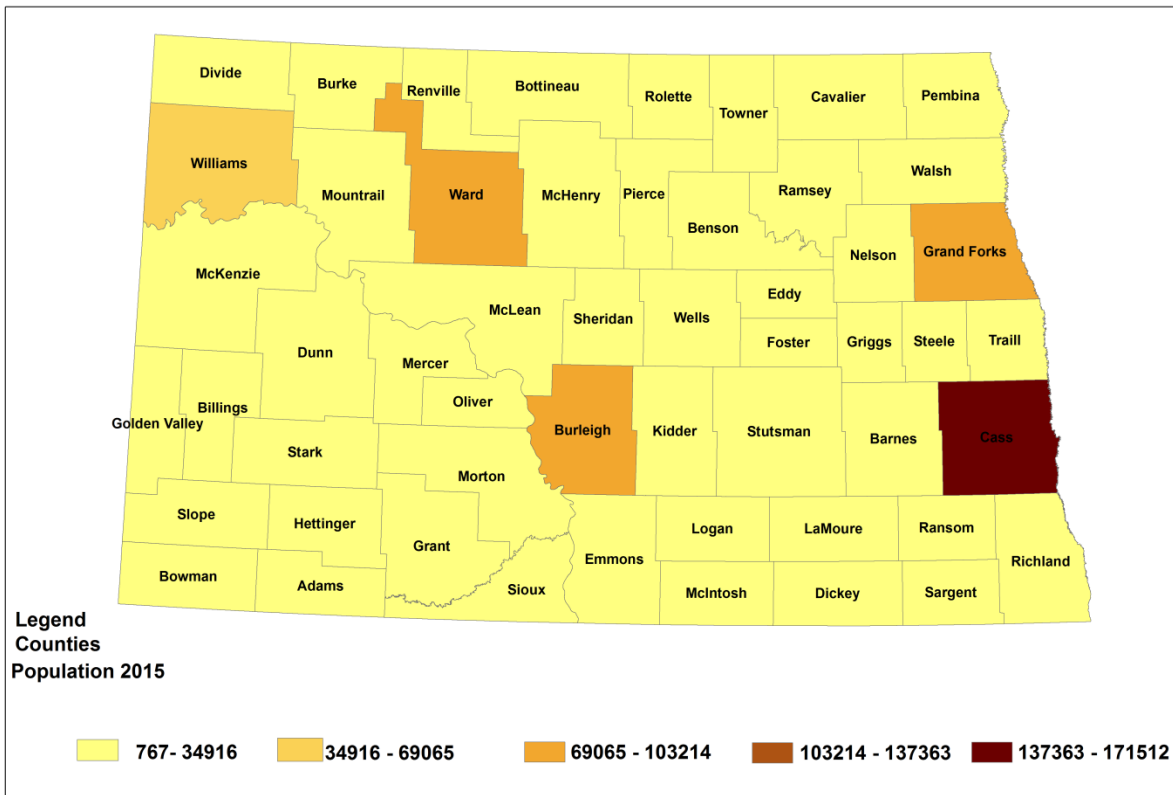


Figure 2. Population density within each county in 2015. This illustrates that most of North Dakota is classified as having a low population (United States Census Bureau, 2015).

Periodically it is important to determine the perceptions of households regarding the level of satisfaction with current waste management and recycling opportunities, especially when the burden of properly disposing of trash is placed on the household in the rural populations because of the distance to end facilities. Because participation in recycling and proper trash disposal is a determinant of individuals' motivations in the rural communities, it is of the essence to understand the actions and behaviors of households before proposing changes in policy.

Data was obtained through the ND Department of Health-Waste Division and through a mixed mode approach of a questionnaire mailed to rural households in towns of less than 10,000 people, as well as interviews with transfer station operators. The quantitative data includes yearly waste generation rates for municipal waste from each permitted facility within North Dakota.

The survey data was collected through a mailed questionnaire, in addition to giving the option for participants to complete the survey on-line through Qualtrics. Unfortunately, no one participated in the on-line survey. The survey was created (Appendix) to identify householders' opinions of a variety of topics such as: (1) level of satisfaction with current trash disposal and recycling options; (2) environmental concerns related to burning trash and illegal dumping; (3) willingness-to-pay for a more convenient and sustainable option for trash disposal; (4) participation in recycling programs and the current barriers that households face.

Identification of Survey Area

The total rural population was 367,634 according to 2013 Rural Assistance Center (Rural Assistance Center, 2014). The survey population is a randomly selected sample of 600 rural residents across the state, based on a standard confidence interval of four and a 95% confidence level. The confidence interval can also be referred to as the margin of error or plus-or-minus the reported value from respondents and the confidence level is how sure the The household names were obtained from Central Address System Inc (CAS) through a random sampling of residences that lived in cities with less than 10,000 people. CAS has been ranked as one of the Direct Marketing's most advanced companies providing mailing and telephone lists (CAS, 2014). The interviews with the transfer station coordinators were conducted over

the phone and basic questions were asked about hours, materials accepted, the various counties the facility services, and issues with on-site contamination.

Survey Design and Implementation

On a daily basis, people are besieged via several media sources making it exceedingly difficult to break through the barrier of initial contact to the participant, however, employing a combination of different modes of surveying methods increases the likelihood that someone will be reached. Dillman et al. 2009 utilized several different combinations of response methods and in general, switching to a different mode was an effective means of improving response rates. Utilizing mixed mode approach can also counteract a particular weakness that one individual mode might have by providing a cost-effective means of another alternative. Increasing the response rate has two main benefits: reduces the prospect of nonresponse bias and decreases the standard errors. Also, by using different modes of new technology, respondents may view the approach as cutting edge or sophisticated (Baum et al., 2012). It has the advantages of improving timeliness of the survey by allowing respondents to participate in the mode that they find the most convenient, in addition to reducing coverage error. In an instance when a particular mode cannot cover the entire target population of interest, there is an alternative method that can be used for participants (Dillman et al., 2009).

According to the Pew's Research Center's Internet and American Life Project Spring Tracking Survey conducted in 2013, 62% of rural populations have a connection to high speed broadband internet (Zickuhr and Smith, 2013). There are also legal and cultural barriers to contacting people by e-mail since Internet service providers are private rather than public providers. People see this as an invasion of privacy since there is no prior existing relationship

formed. Professional survey associations also do not support distributing surveys through e-mail. Establishing a preexisting relationship is necessary for participants to form trust and the willingness to participate. Another barrier with distributing surveys through e-mail is the potential for it to go to the spam folder and never reach the participant (Dillmen et al, 2009).

Many surveyors tend to shy away from distributing surveys through the mail because of the fear of inadequate response rates; however it is essential to consider the type of participant with each survey. Using multiple contacts with different appealing features will grab the attention of more respondents in comparison to simply mailing out the same survey over and over (Dillman et al, 2009). The mail is still a widely used source of communication throughout the rural communities, which is why it was valued as a reasonable mode of surveying (Whitacre et al., 2014). There are however some disadvantages with paper-based survey research such as the increased probability of human error in data processing. To help mitigate this, the data was double-checked after each response was entered.

The questionnaire was reviewed by University of North Dakota faculty and graduate students within the department. The University of North Dakota Institutional Review Board reviewed and approved the questionnaire, follow-up letter, Qualtrics survey, and research protocol.

The first initial survey went out February 10, 2015 and the reminder letter was mailed on February 25, 2015. Surveys were returned until the end of April. Additional follow-up surveys and reminders would have likely resulted in a higher percentage of respondents; however financial limitations constrained the survey to a pre-notice letter, single mailing of the

survey with a cover letter and postage paid returned envelope, followed by a reminder letter. Of the 600 mailed questionnaires, 166 (28%) households responded to the survey. There were roughly about 40 return-to-senders from either outdated addresses or inability for the post-office to access the mail-box. All survey responses were routed through campus mail to the author for data collection and analysis.

Data Analyses

Once the survey results were collected, all responses were entered into IBM SPSS Statistics V23. Frequency distribution graphs and cross tabulations were developed to summarize the frequency of responses. This analysis helps show how two different variables are correlated with one another. For example, households' interest in participating in recycling based on which county they reside in is a useful way to make recommendations for proposed drop-off sites within the counties that express the most interest. A Likert scale is an ordered scale from which respondents choose the option that best aligns with their view or opinion. There were five options given with each Likert scale question. Qualitative content analysis was used to make inferences about the open-ended questions, including suggestions about how to improve the current waste management system within each county.

In statistical terms, correlation is a method to determine if there is a linear association between two continuous or ranked variables. The output of a correlation test is the correlation coefficient, which denotes the strength of the linear relationship. A correlation coefficient of zero indicates no linear relationship exists between the two variables, and a -1 or +1 coefficient indicates a perfect linear relationship. The closer the correlation coefficient is to +1 or -1, the stronger association between two variables. All three correlation coefficients

were tested: Pearson’s, Spearman’s Rank, and Kendall’s Tau were used to test the robustness of each method since each have different criteria for testing. Pearson’s correlation requires the data to be parametric or normally distributed, however the results were non-parametric or distribution-free. This test is also highly influenced by extreme values, which may affect the strength of the relationship. Both Spearman’s Rank and Kendall’s Tau assume the data is non-parametric and an independent random-sample, which was more characteristic of the survey results (Hauke and Kossowski, 2011). The correlation coefficients of all three tests were very similar, within .05 of each other and significance levels or p-values were consistent between the different tests. The analysis proved that all three tests outputted reliable results verifying that all three statistical procedures could be used. For simplicity sake, only Kendall’s Tau correlation coefficient was reported since p values are more accurate with smaller sample sizes (Hoskin, 2015). The equation for Kendall’s Tau correlation coefficient was calculated as follows in SPSS:

$$\tau = \frac{(\textit{number of concordant pairs}) - (\textit{number of discordant pairs})}{n(n - 1)/2}$$

Where τ is the correlation coefficient, n is the number of observations, a concordant pair is when the rank of the second variable is greater than the rank of the former variable and a discordant pair is when the rank is equal to or less than the rank of the first variable. A positive linear relationship occurs when there is a much larger number of concordant pairs than discordant pairs. If the number of discordant pairs is much greater than concordant pairs then that results in a negative relationship and if the number of concordant pairs is about equal to discordant pairs then the variables are weakly correlated (Statistical Research, 2012).

Current Functionality Issues

As of right now, properly disposing of waste is not convenient or affordable for most residents in the rural communities. The goal is to stop the burning and burying of solid waste and promote more recycling. A critical component to ensuring success of the proposed new transfer facilities or drop off sites is developing an educational approach that encourages the community that participating in the new program will be of value to the environment, as well as to themselves. It is important to keep in mind these three aspects when selecting ideal site locations:

1. Place the site adjacent to a road that is well trafficked by residents to allow them to conveniently dispose of their trash as they travel.
2. Attempt to place the site in a more densely populated area.
3. Determine the distance citizens will be required to drive to properly dispose of their waste.

CHAPTER V RESULTS

The study received 166 completed surveys out of 600 mailed questionnaires; a 28% response rate. This response rate is considered satisfactory considering the challenges associated with mailed questionnaires and the subject matter. Due to financial and time limitations, monetary incentives were not provided to solicit a higher response rate and therefore the survey strictly relied on voluntary participation. It should be noted that no attempt was made to contact the non-respondents, so the generalizability of the study results are limited. However, two factors do help to moderate this limitation. First, in terms of respondents background (i.e. gender, age, income, education), those completed surveys were representative of the community as a whole. Secondly, the respondents included people who recycle and non-recyclers indicating that people participated in the survey even though they do not currently have a stake in the topic matter. In this section, respondent demographic characteristics are examined, as well as the waste generation rates within North Dakota and the foreseeable implications that may have on the state's GDP.

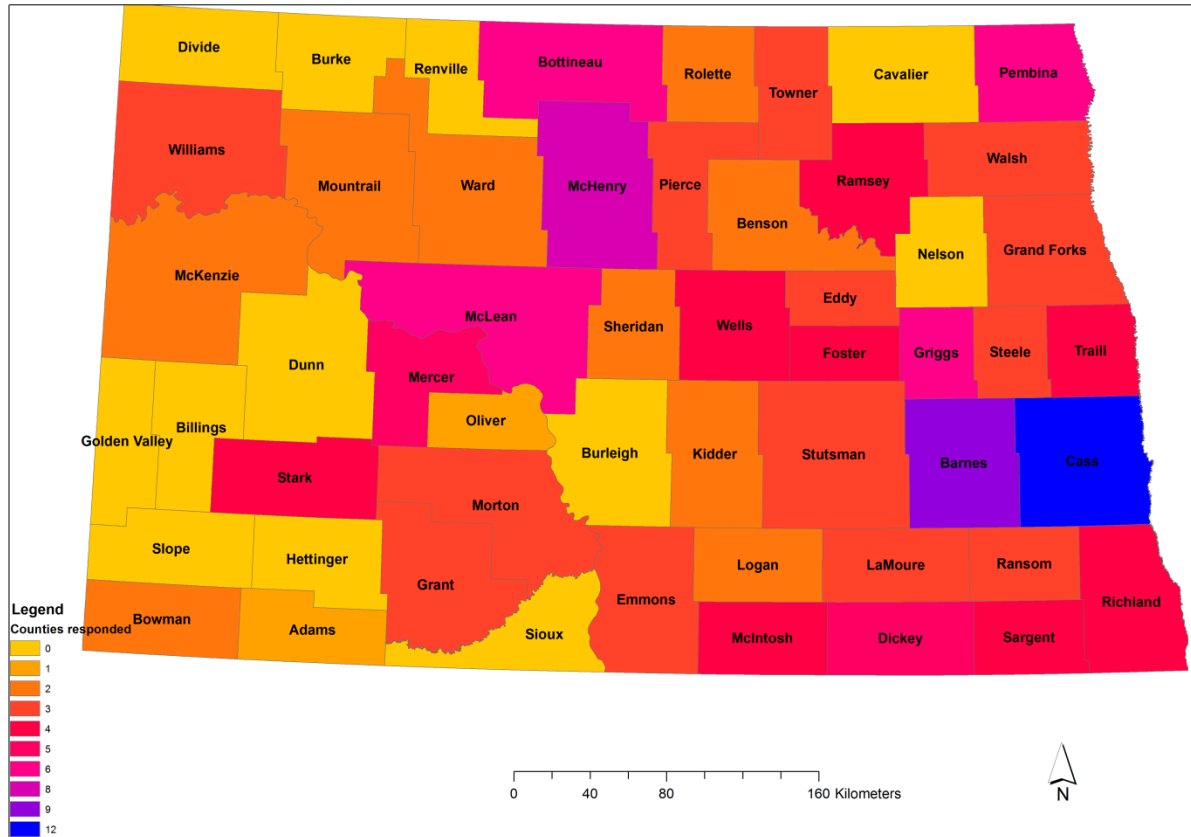


Figure 3. Spatial distribution of households that responded to the survey. Out of the 53 counties that were surveyed, 12 counties did not respond to the questionnaire.

Respondent Characteristics

General demographic characteristics of the survey respondents are reported in Table 2-6. The majority of the respondents fell into the category of 50 years and older (76%), which was to be expected since older people tend to be retired and have more free time to participate in recreational activities such as participating in a questionnaire. Additionally, older people are more likely to participate in mailed questionnaire if they are in the confines of their own home compared to participating in a survey out in the public (Weisburg, 1992). Within the rural area, both genders (43.1%) were responsible for taking care of the garbage and 33.5% said that the males were responsible while 21% said the females were responsible.

The majority of residences were a 2 person household (55%), 19.8% had 1 person and 16.8% had 4 people or more within the household.

Table 1. Descriptive statistics for sociodemographic variables in survey.

Variable	Mean	Std dev	Min	Max	N
Age (60-69 years)	4.45	1.35	1	6	164
Education (some college)	3.26	1.03	1	5	164
Number in household	2.2	0.95	1	4	164
Combined yearly income (\$50,000-\$75,000)	4.55	1.56	1	6	146
Occupation (employed)	2.78	1.33	1	5	162
Person responsible for trash (Both genders)	2.1	0.88	1	3	143

Table 2. Percentage of age distribution of waste and recycling survey.

Age	18-29 years	30-39 years	40-49 years	50-59 years	60-69 years	70+ years
(n=164)	3	18	16	38	43	46
Percent	1.8%	10.8%	9.6%	22.8%	25.7%	27.5%

Survey respondents overall have a relatively high level of education. About 41% of respondents are college graduate or post graduates, with 31% of other attending some college (Table 3). Only about 2% of respondents had less than a high school diploma.

Table 3. Distribution of Survey Respondents' Education

Education	Percent	(n=164)
Some High school or less	2.4%	4
High school graduate	23.4%	39
Some college	31.1%	52
College graduate	29.3%	49
Post graduate	12.0%	20

The majority of residences were a 2 person household (55%), 19.8% had 1 person and 16.8% had 4 people or more within the household (Table 4). Thirty-six percent of respondents had combined household yearly income of \$75,000 or more, which is an indication that they can afford waste management services (Table 5).

Table 4. Survey respondents number of people within household

Number of people in household	Percent	(n=164)
1 person	19.8%	33
2 people	55.1%	92
3 people	6.6%	11
4+ people	16.8%	28

Table 5. Distribution of survey respondents yearly income.

	Under \$15,000	\$15,000-\$25,000	\$25,000-\$35,000	\$35,000-\$50,000	\$50,000-\$75,000	\$75,000 or more
n=146	8	12	15	27	24	60
Percent	4.80%	7.20%	9.00%	16.20%	14.40%	35.90%

Since the majority of respondents fell into the category of 50+ with two people in the household, it was expected that the occupation of the main income earner of the household would be retired. According to Table 6., 36.5% of respondents were classified as being retired

and the rest of the respondents were either self-employed as a laborer or an employee of a private company.

Table 6. The occupation and age of the main income earner within the household.

		Occupation of the main income earner in the household					Total
		Self-employed as a laborer	Employee of a private company	Employee of government	Retired	Other	
AGE	18-29	3	0	0	0	0	3
	30-39	6	8	3	1	0	18
	40-49	7	5	3	0	1	16
	50-59	6	18	4	3	5	36
	60-69	14	9	2	14	3	42
	70+	2	0	1	42	1	46
Total		38	40	13	60	10	161

Perceptions and Behavior Regarding Trash Disposal

To gain an understanding of the recycling rates within the rural community, it is imperative to assess the current perceptions and attitudes regarding their local trash disposal options. Sixty-four percent of respondents said they were serviced by a state, county or city trash collection service and 35% said they were not. This number was higher than anticipated from initial research; however, after further analysis into waste flow in the rural communities, there are several private trash collection businesses that service households. Eleven out of the 34 respondents, who listed where they drop off their trash, listed a private hauling company. When questioned about how much their trash collection cost the price went from \$14-\$120 monthly with the average cost of \$16.50 monthly.

According to Figure 4., the majority of respondents (59%) expressed satisfaction with their current trash disposal option and 29% fell into the non-applicable category because they either burn their garbage or use another form of disposal.

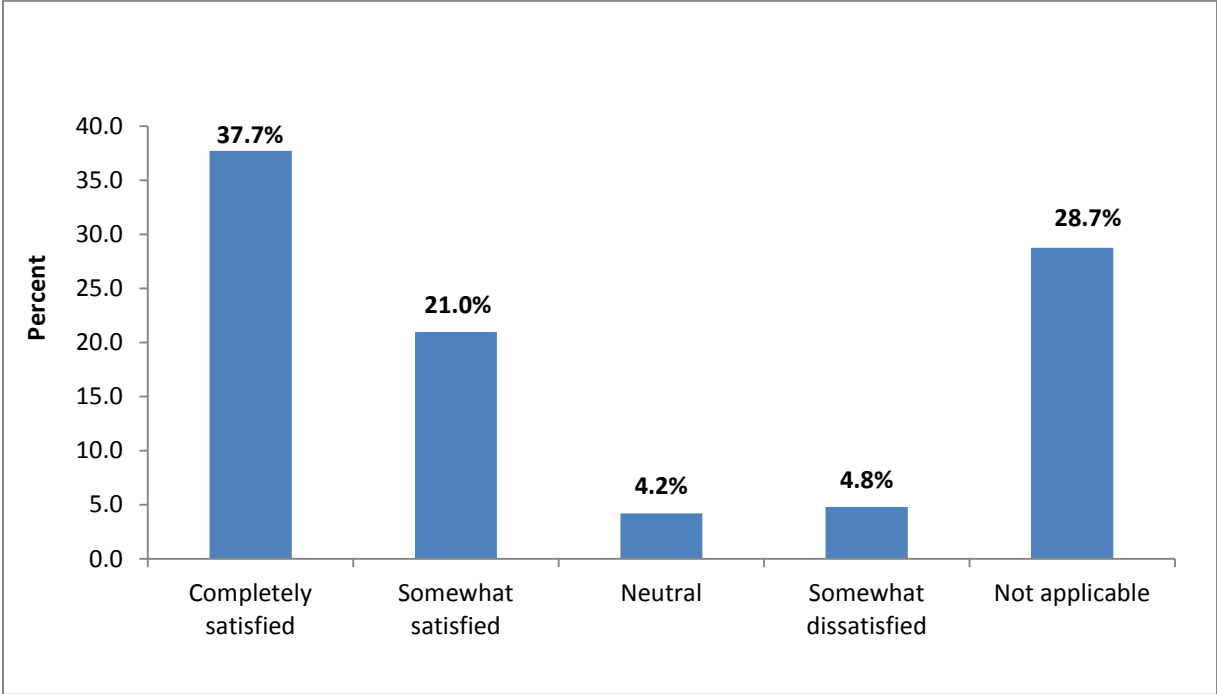


Figure 4. Survey respondent level of satisfaction with current trash collection service.

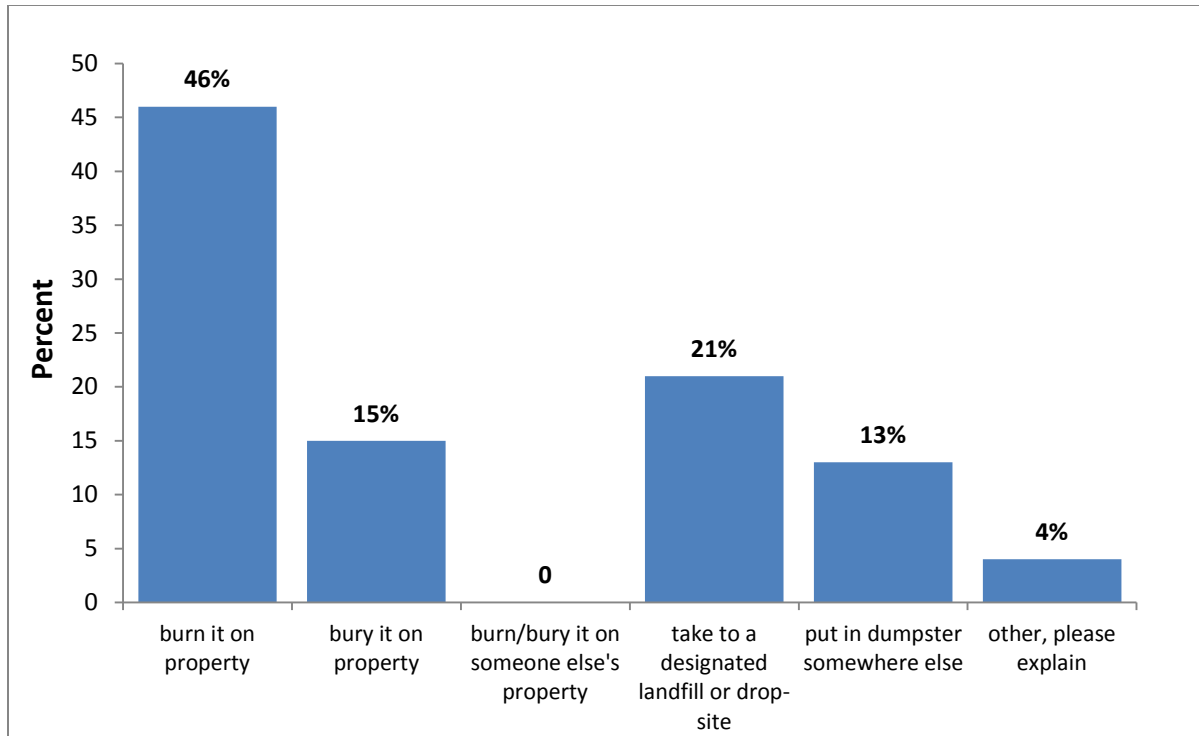


Figure 5. Respondents' method of trash removal if do not currently have a trash collection service.

The vast majority of respondents (46%) when asked how they dispose of their trash if they do not have a trash removal service responded with burn it on property (Figure 5).

Twenty-one percent stated that they take their trash to a landfill or drop-off site and 15% admitted to burying their trash on their property.

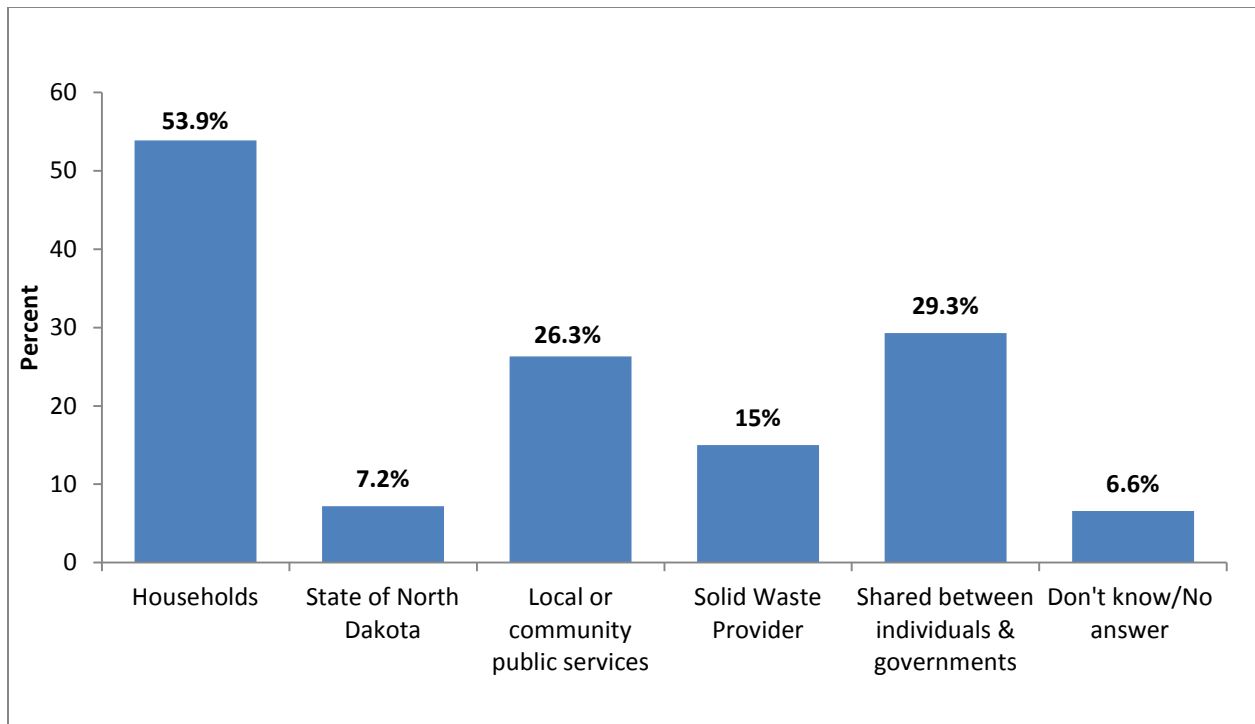


Figure 6. Respondents' belief of who should hold the greatest responsibility for disposing of trash.

More than 50% of respondents believe it is the responsibility of the household or individual to properly dispose of trash. Twenty-nine percent believe the responsibility should be shared between individuals and governments and 26% think it is the responsibility of the local or community public services (Figure 6).

Health and environmental concerns associated with inadequate trash disposal were also addressed. When questioned about the level of concern related to backyard burning, 41% of respondents said they were not concerned, 30% moderately concerned, 20% no opinion and only 7% said they were concerned (Figure 7). These results are as expected since most of the rural population is comprised of older residents who are accustomed to burning their trash without experiencing any adverse health effects.

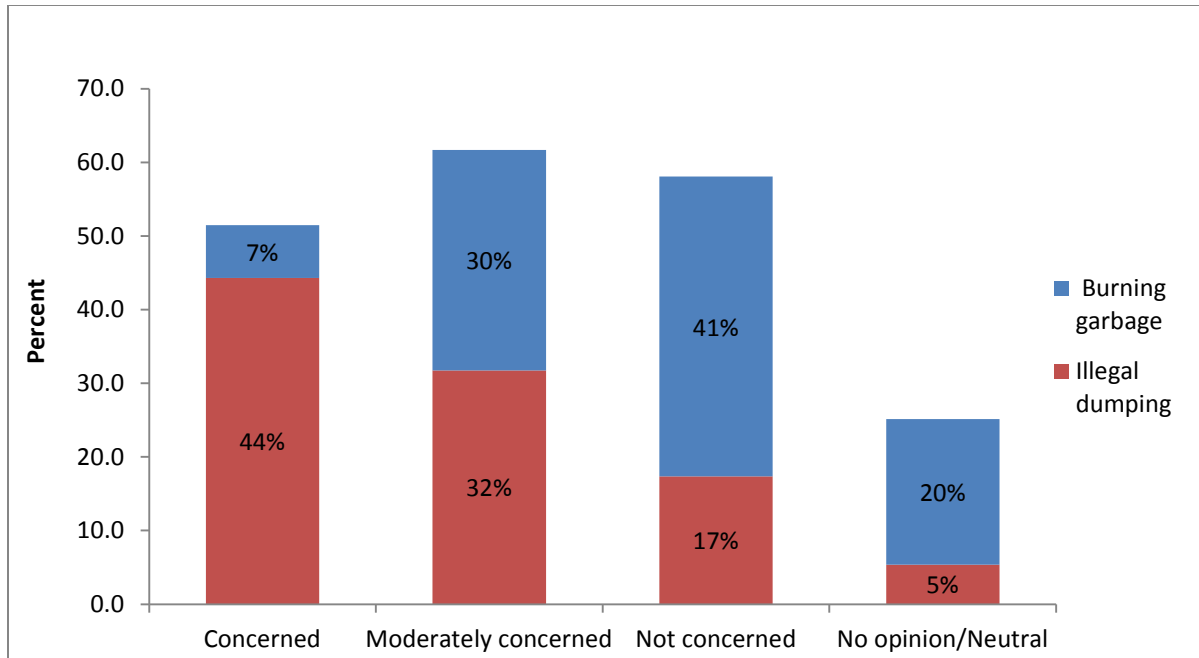


Figure 7. Respondents' level of concern about the health risks associated to burning trash and illegal dumping occurrences.

In terms of significant correlations between socio-economic variables and burning trash-age, the number of people within the household and occupation, all had statistical significance at the .05 level (2-tailed).

Table 7. Relationship between backyard burning concerns and socio-demographic variables.

Independent Variable	level of significance (p)	correlation coefficient
Income	0.611	0.036
Education	0.133	0.101
Age	0.011*	-0.168
Number in household	.00*	0.263

The significance level for *age of respondent* was $p = .011$, which is moderately significant and the correlation coefficient was $r = -.168$ indicating that as the respondent gets older; they are less concerned with the health risks related to burning of garbage. The significance level for *number of people in the household* was $p = .000$ and the $r = .263$, demonstrating that the greater number of people within the household, the greater the concern for health risks associated to burning trash. Both *education and income* were not significant.

With the recent incidents of illegal dumping taking place out west, 76% of respondents expressed concern for illegal dumping within their county according to Figure 8. Enforcing a mandatory collection service would likely cut down on the illegal dumping occurrences, therefore resulting in less environmental degradation (Fullerton and Kinnaman, 1995). Two of the five socio-demographic variables showed a significant relationship: *age and number in household* (Table 8). However, the strength of those relationships was very weak since they were close to zero (Hoskin, 2015).

Table 8. Association of socio-demographic characteristics and level of concern regarding illegal dumping.

Independent Variable	level of significance (p)	correlation coefficient
Income	0.431	0.055
Education	0.133	0.101
Age	.00*	-0.254
Number in household	.00*	0.296

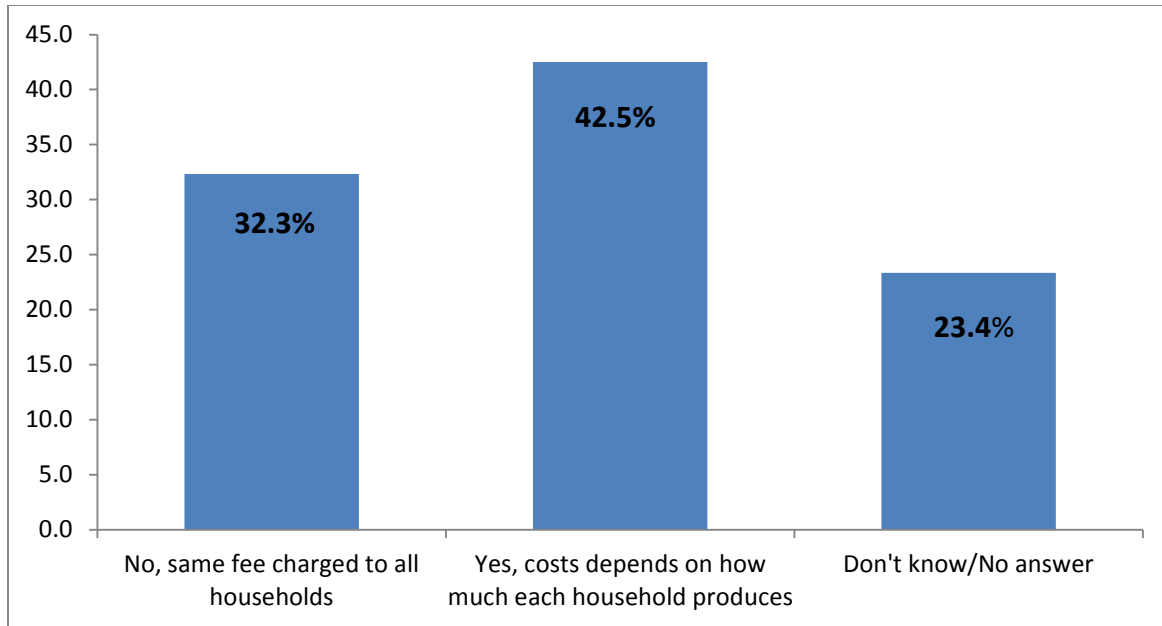


Figure 8. Respondents' agreement that trash disposal fees should be dependent on how much each household produces.

When asked whether or not households should be charged according to how much waste they produce, 43% of respondents agreed that the more waste a household produces, the more expensive the disposal fee should be; while 32% said that the same fees should be charged to all households and 23% selected don't know or no answer (Figure 8). There was no significant relationship between any of the five demographic variables and whether the respondent felt a PAYT program would be effective means of reduction within their community.

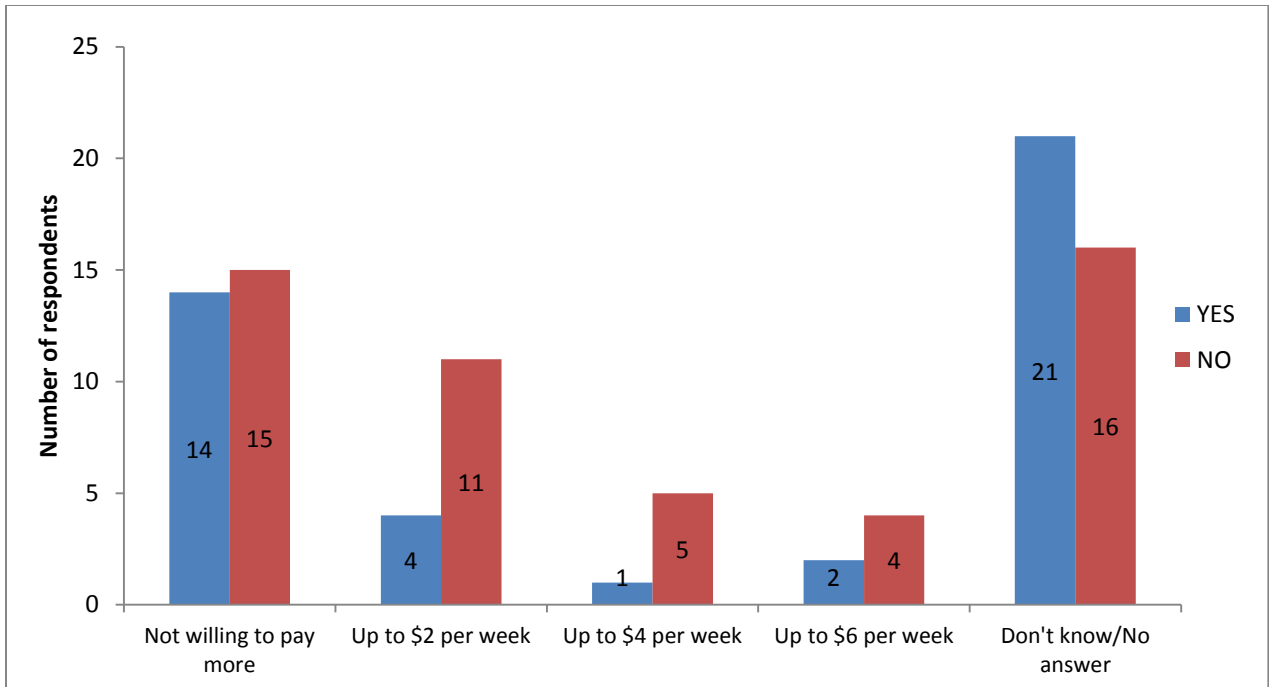


Figure 9. Relationship between respondents currently having a waste collection provider and how much they are willing to pay to have a more conveniently located drop-off site.

Figure 9 displays the relationship between how much each person is willing to pay per week for a drop-off location and whether or not they are currently being serviced by a state, county or city trash pick-up provider. Fifteen people were willing to pay \$2 more a week, 6 people were willing to pay \$4 and \$6 more per week, 29 not willing to pay more and 37 selected don't know/no answer. Unfortunately, this question was left blank by 44% of respondents making it the most omitted question on the survey. Looking back on the design of the survey, there should have been a non-applicable option for the people who already have a collection service. Additionally, the relationship between WTP and household yearly income was examined to determine if the level of income affected how much a person was willing to pay for a convenient service. In all the salary ranges except households that made

less than \$15,000 a year, respondents were willing to pay an additional \$2, otherwise, the more money a household makes, the more they are willing to pay for a service.

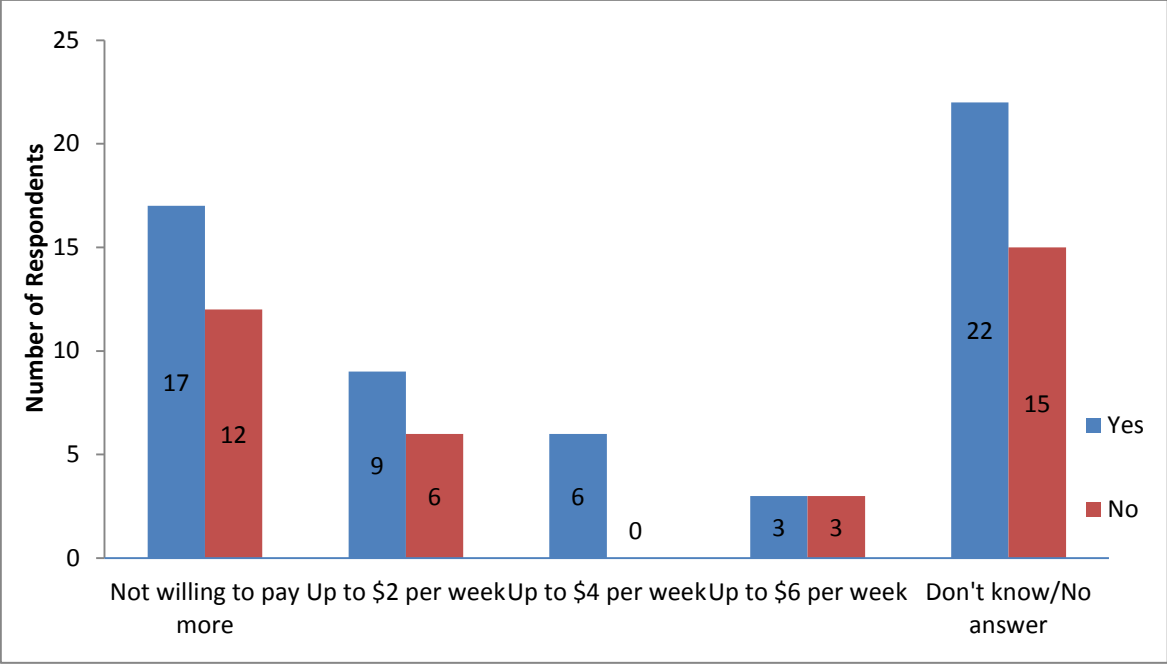


Figure 10. Relationship between participation in recycling and WTP for a drop-off site.

Figure 10. displays the relationship between respondents participating in some form of recycling and their willingness to pay for a more convenient drop-off location. In general, the respondents who are already recycling are willing to pay something additional to have a closer recycling facility; whereas the non-recyclers are more reluctant to pay.

Perceptions and Behaviors Regarding Recycling

The second part of the survey focused on the attitudes and behaviors of residents regarding recycling within the local area. The section was designed to determine the current barriers that residents are faced with within the rural communities and devise solutions to the issues through suggestions provided by the respondents.

When asked whether or not they recycle, 62% of respondents said they do recycle and 38% said they do not recycle (Figure 11). Eighty-one individuals who are 50 years and older said that they do recycle, which is roughly 50% of the sample size (N=164). According to a survey conducted by the Institute of Scrap Recycling Industries, Inc., younger generations are less likely to recycle than older generations. For example, 61% adults ages 65+ hold the belief that it is socially responsible to recycle compared to 53% of adults ages 18-34 (Carpenter, 2014). In general, age is positively correlated to recycling, especially retirees since they have more time to spend on activities such as recycling (Meneses and Palacio, 2005). The question explicitly stated household materials such as paper, glass, aluminum and cardboard as items that could be recycled and about 30% of people who said they recycle only recycle aluminum because they can get cash back. There is an economic incentive motivating the resident to recycle aluminum instead of allowing it to end up in the landfill. When the Kendall's Tau correlation coefficient was tested, none of the independent variables were significant or showed a strong linear relationship.

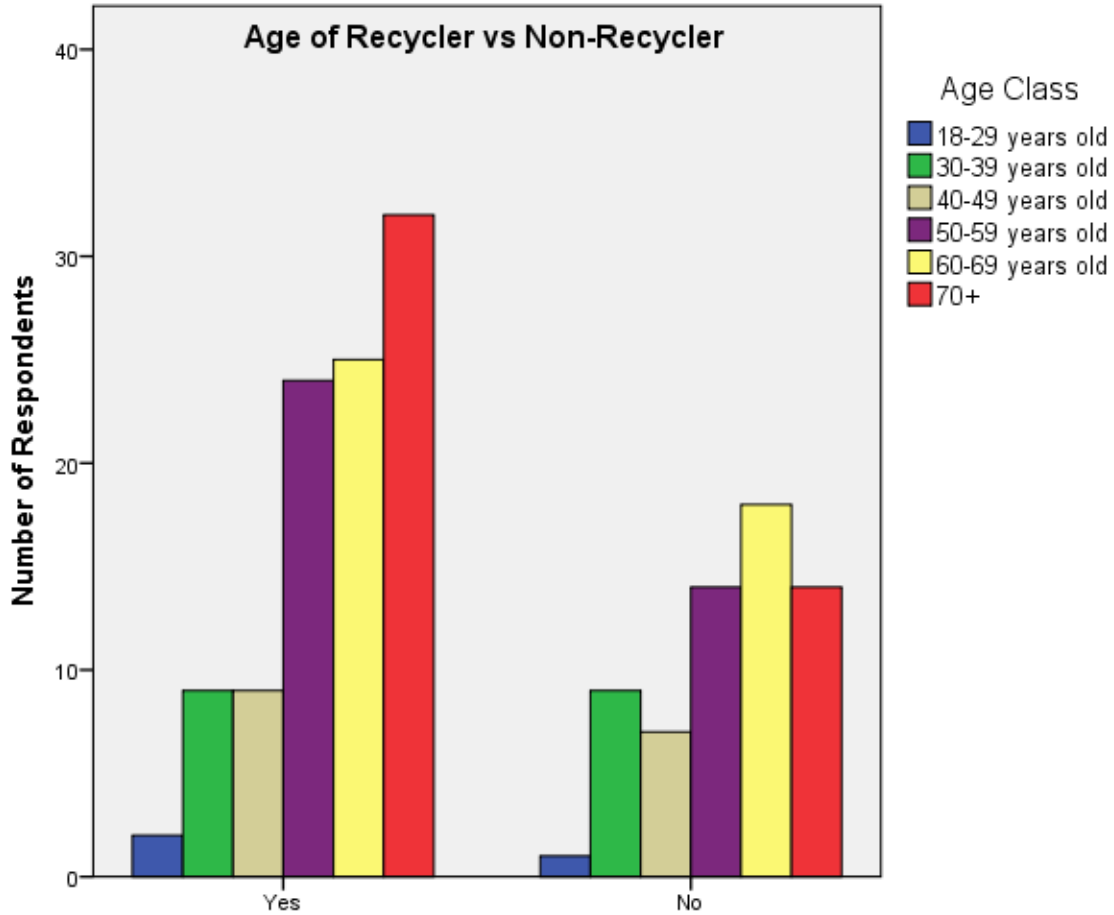


Figure 11. Respondents’ age distribution in correspondence to whether or not they recycle.

When questioned about where the household drops off their recycled materials, 46% of respondents said at a drop-off site, 9.6% said other, 4.2% take to a friend or family’s house, and 1.2% said landfill. Thirty-eight percent of respondents choose non-applicable, which indicates that they do not participate in any recycling program according to Figure 12.

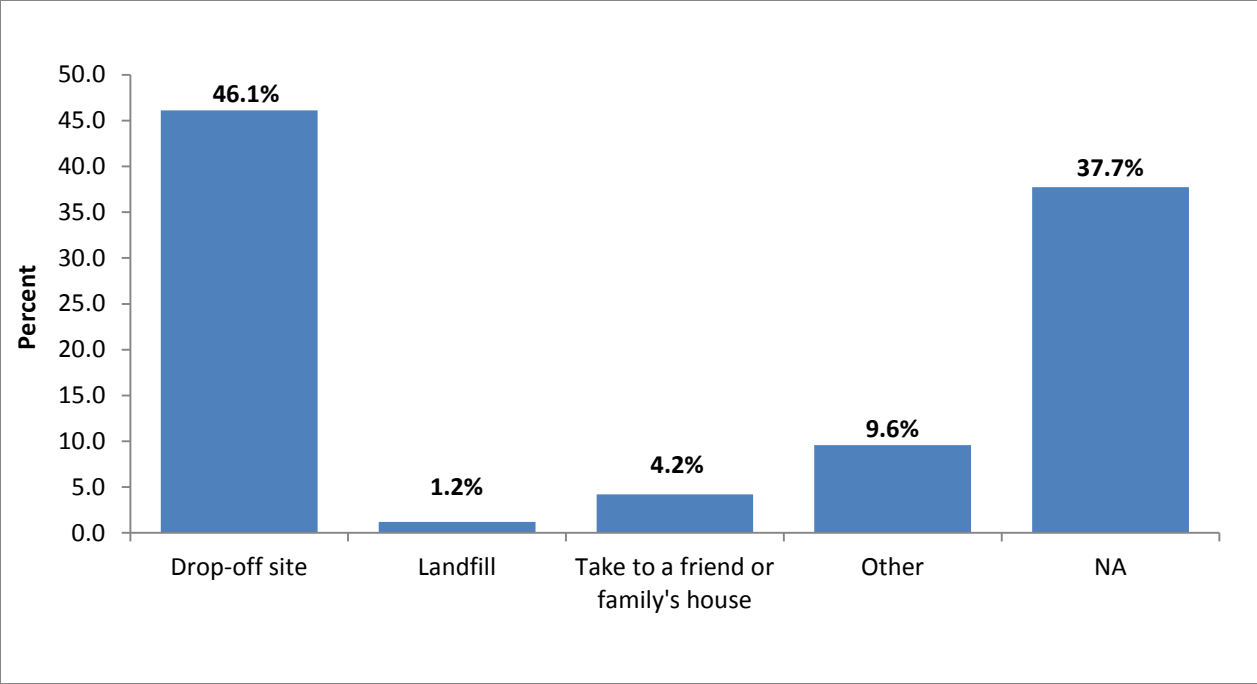


Figure 12. The location of where recycled materials are taken according to respondents.

If the respondent recycled, the question was then asked what was the main reason the household participates in recycling and according to Figure 13, 39% selected that it teaches good values, 21% said conserves resources and 20% said have less trash to throw away. The option “other” was selected by one person who said they only recycle glass and cans because they do not burn, but if they did burn they would not recycle those items.

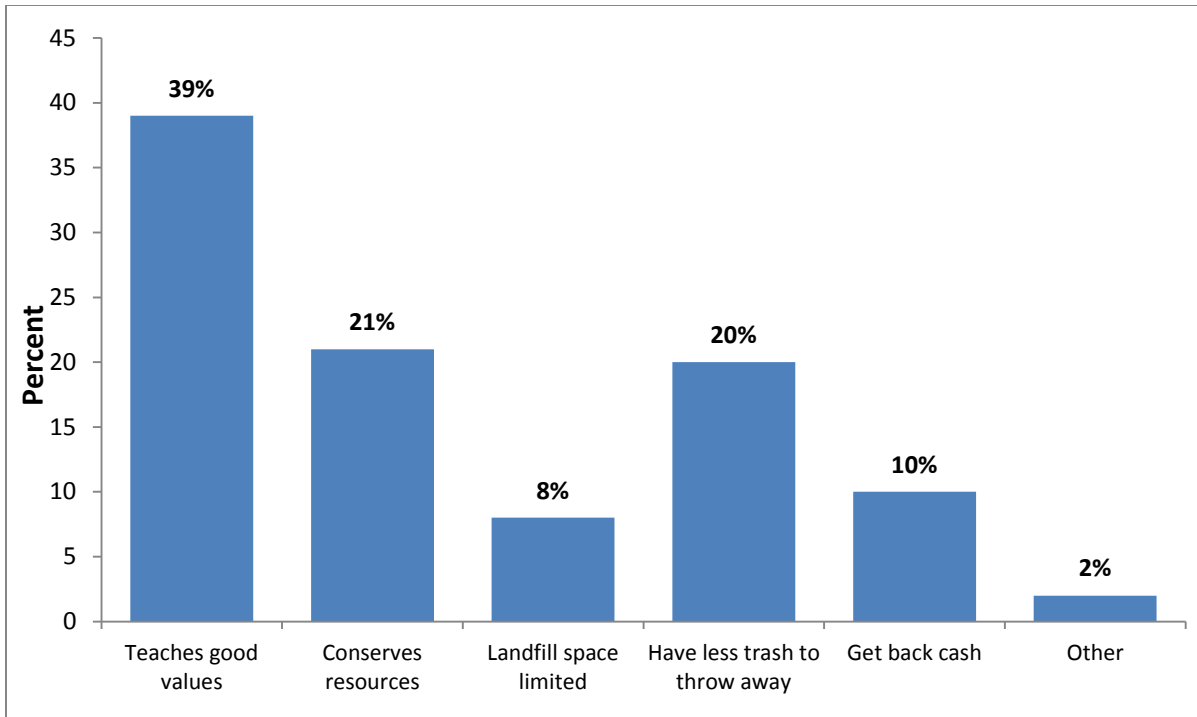


Figure 13. Respondents' motivations to recycle.

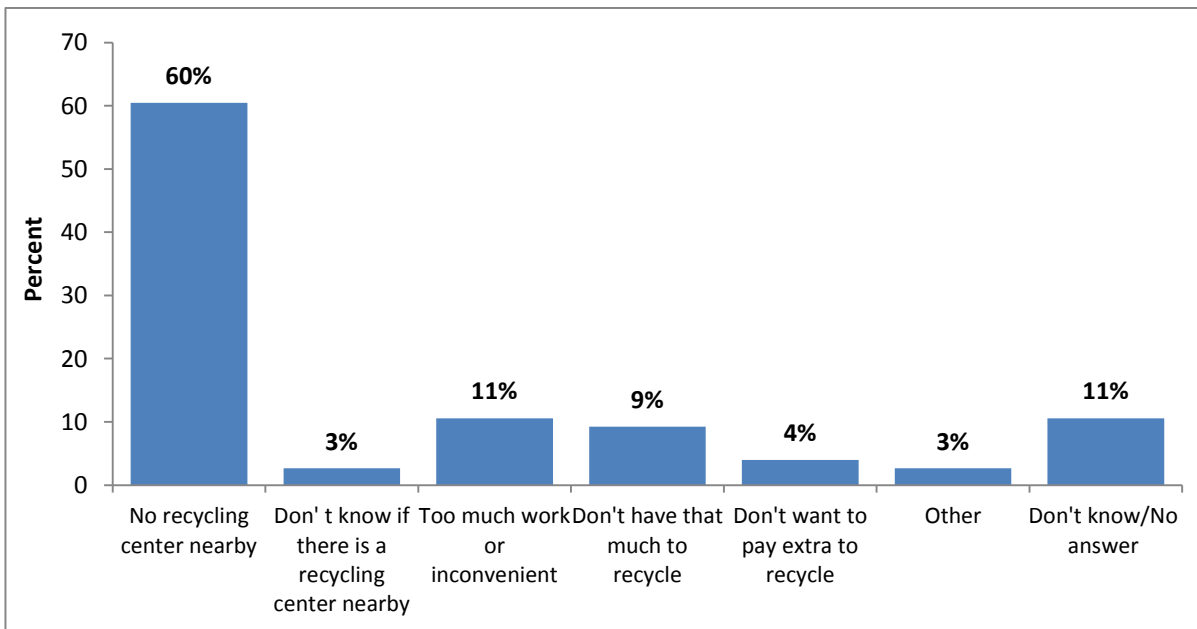


Figure 14. Respondents' reasoning for not participating in recycling.

Respondents were asked what the biggest deterrent was for not recycling within their household and the majority of participants, 60% choose No recycling center nearby. Eleven percent of participants selected too much work or inconvenient as well as Don't know/no answer. The other options were selected at such small quantities that they are not worth consideration (Figure 14).

To help gain insights into how far residents are traveling to drop-off their recyclables a question was asked about how far they have to drive to recycle their items and the average distance was 28 miles. The most common distance was 0-10 miles with 27% of the respondents and second most selected was 50+ miles with 11% of respondent selection. This indicates that some respondents have more readily available recycling centers than others across the state.

When respondents were asked what would motivate them to recycle if they do not currently, an overwhelming percentage (43%) said sites closer to home (Figure 15). Twenty-seven percent of respondents said they would recycle if curbside pick-up was available and 13% selected being paid for recycling. These results are similar to previous research that indicates that people are more inclined to recycle if it is convenient to participate in the activity (Simmons and Widmar, 1990). Both sites closer to home and curbside pick-up are direct factors of convenience for the household. Eight percent said law requiring recycling, 7% choose Don't Know and 2% nothing can be done.

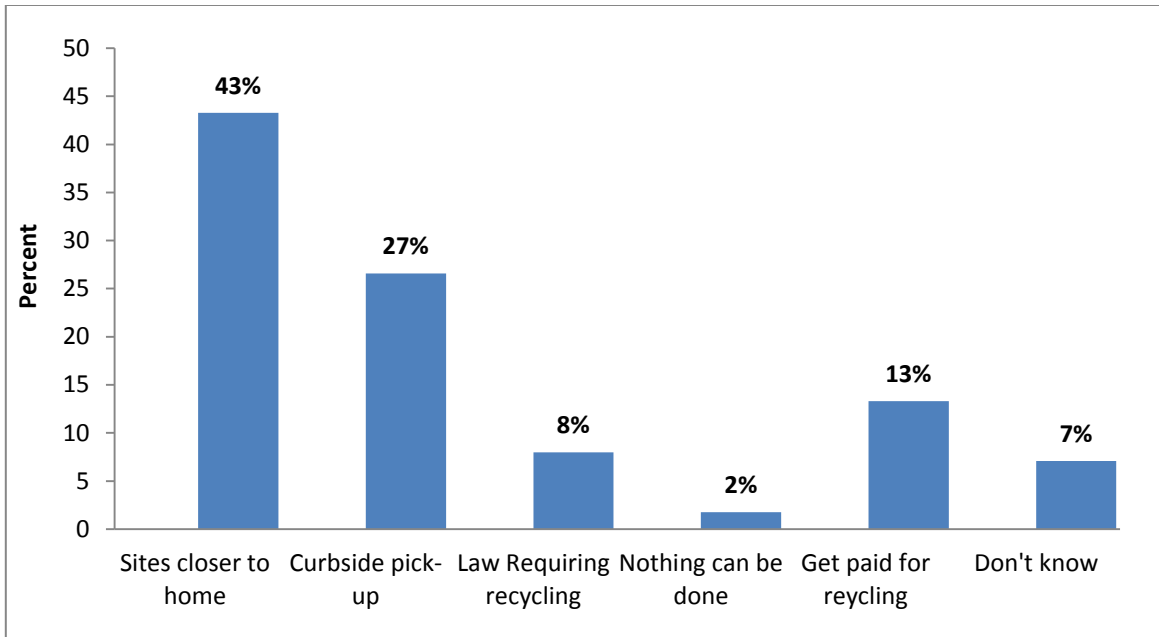


Figure 15. Respondents' motivations to recycle if they do not currently.

Respondents in each county expressed different motivating factors for recycling. Some respondents expressed that if there were a more conveniently located site for recycling, they would participate while others said they were WTP to have a drop-off site. According to Figure 16, only two counties selected only WTP in comparison to the nine counties that said they were WTP and wished they had a site closer to home for recycling. Those respondents who selected that WTP are already utilizing a drop-off station, but would be WTP to have a more conveniently located site. Although, most counties were only motivated to recycle if the site was closer to home.

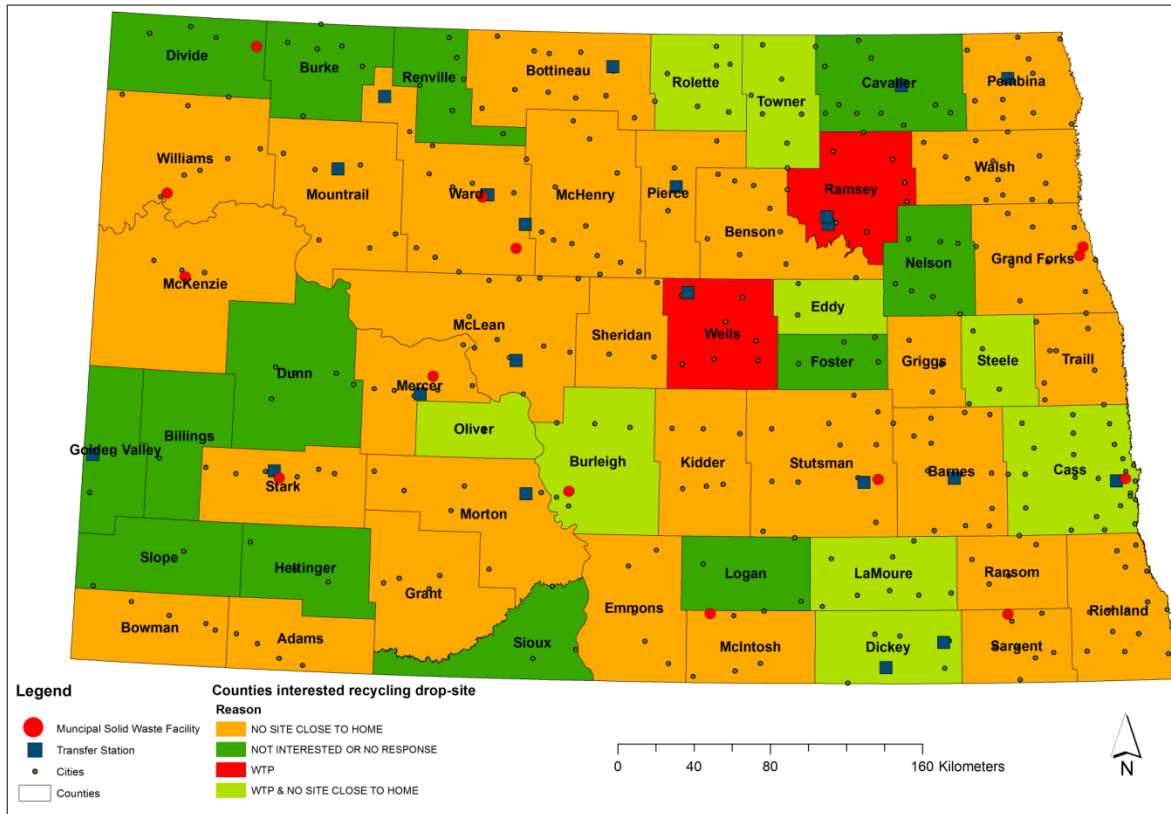


Figure 16. The distribution of respondents who expressed an interest in having a more conveniently located drop-off site for recycled materials. Most respondents expressed that they would participate in recycling if there was a nearby site and/or they were willing to pay to have a closer location.

To effectively communicate with rural households, it is imperative that we take advantage of the preferred method of communication when promoting educational tools and awareness regarding sustainable waste management practices. Participants were asked what the best method of communication would be to inform residents about waste reduction and recycling programs and according to Figure 17., 55% of respondents said direct postal mail, 43% newspaper and 34% utility bill. Radio announcements and county websites were both ranked at about 9% and Other was selected by 6% of respondents. Participants were allowed to select more than one answer, which is why the total sum of the percentages adds up to be more than 100%.

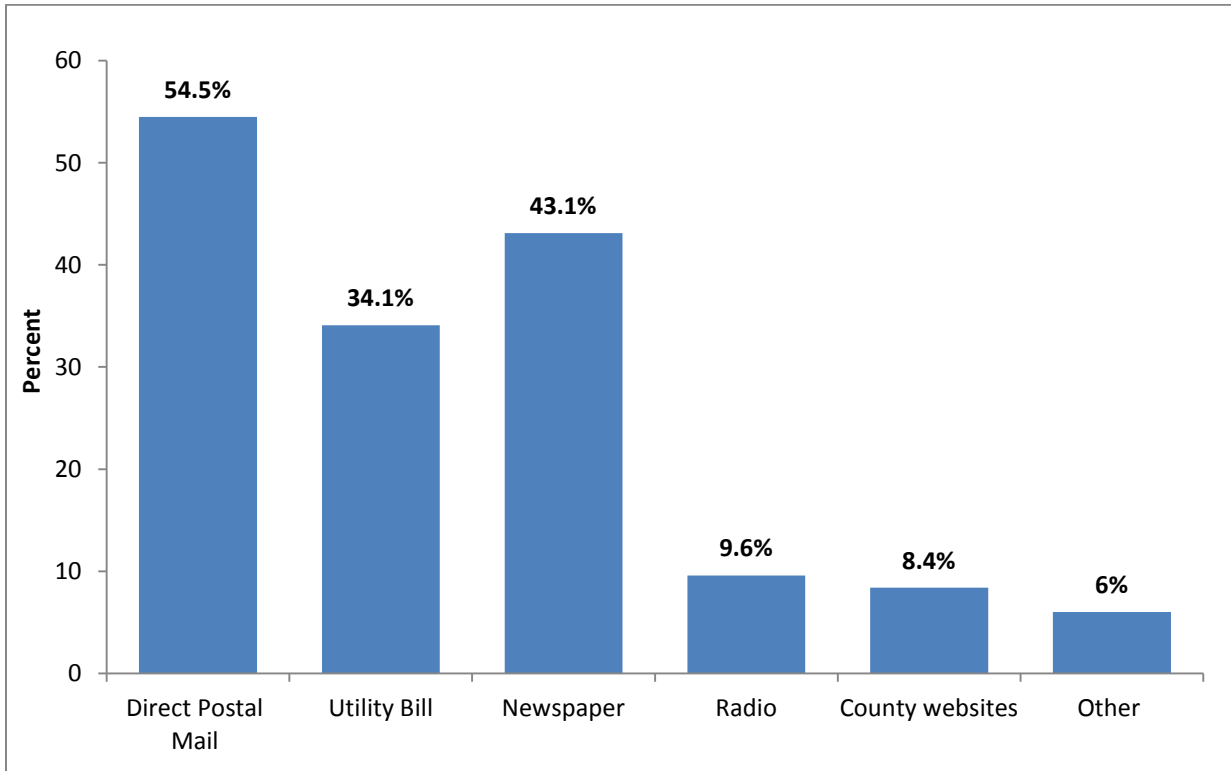


Figure 17. Respondents' preferred method of communication regarding waste management information.

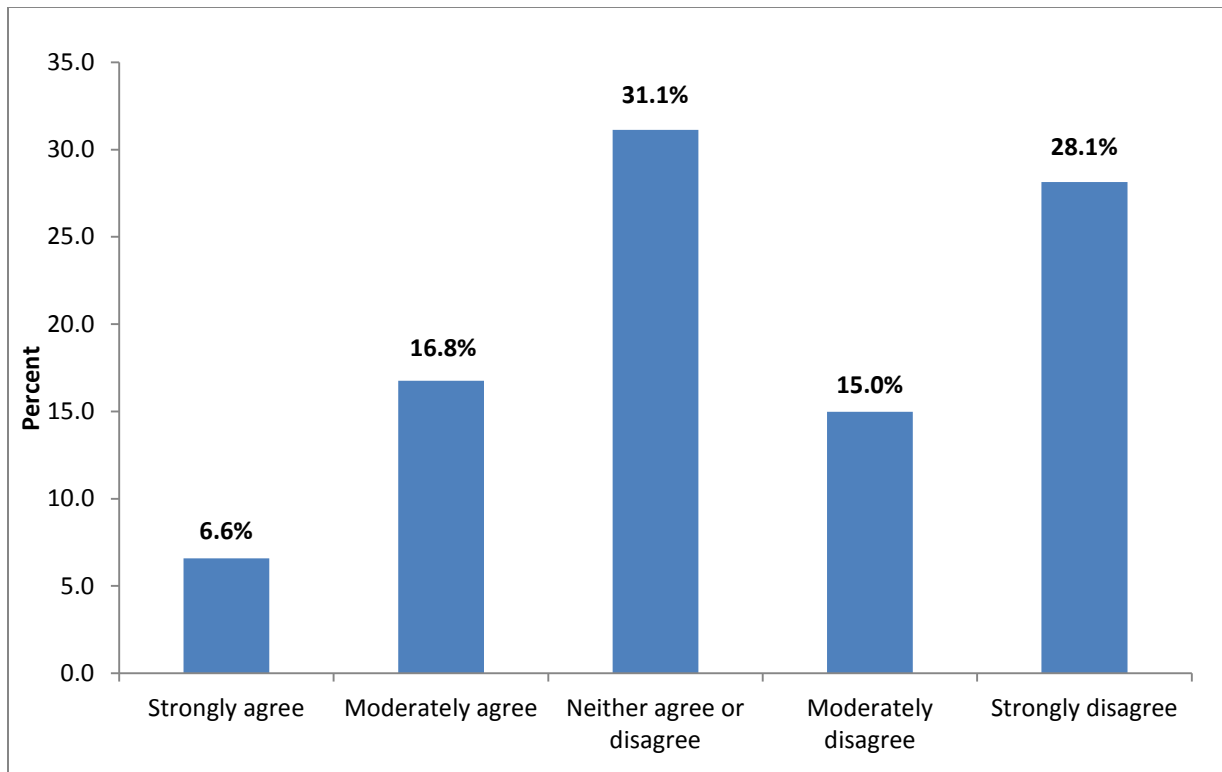


Figure 18. Respondent agreement that trash disposal fees should be increased to encourage more recycling.

When respondents were asked whether trash disposal fees should be increased to encourage more recycling, 31% of respondents neither agreed nor disagreed and 28% strongly disagree (Figure 18.). It is possible that respondents selected the midpoint on the Likert scale because they were indifferent or felt they did not have enough information to formulate an opinion (Lam et al., 2010; Krosnick, 1991). Seventeen percent of respondents said they moderately agree, 15% said they moderately disagree and 7% said they strongly agree.

Transfer Station Operations

Out of the 26 transfer stations listed on the Department of Health website, 13 interviews were conducted. The other 13 either had disconnected numbers or never returned the messages left. Currently there is a disconnection between the transfer stations and households in terms of hours of operation and materials that are accepted at each station. Many facilities are only open for a couple hours, a few days a week, making it challenging for anyone with a full time job the opportunity to utilize the service of the station. Also, not many of the facilities, only three accept recyclable materials. If they do, they only take cardboard and paper because of the lack of market and cost of shipment.

North Dakota Waste Generation Rates

Rates of solid-waste generation vary widely within the United States depending on the states' regulations and policies regarding waste management. For example, in 2013 the average municipal refuse that was generated per person, per day was 4.40 pounds and in North Dakota, the average person generated 6.0 pounds per day (Department of Health Data, 2015 and EPA (b), 2014). This is a prime illustration of the lack of recovery and source reduction within our state. The oil boom has brought economic growth, in addition to waste expansion from the arrival of people to the western portion of the state. In Figure 19., McKenzie County landfill has experienced a 978% increase in municipal trash influx from 2006 to 2014 and the other three landfills have doubled or more compared to the 2006 flow of trash. These four Bakken landfills accounted for more than 247,500 tons of municipal garbage in 2014, which was approximately a third of the total waste generated within all of North Dakota (Department of Health Data, 2015).

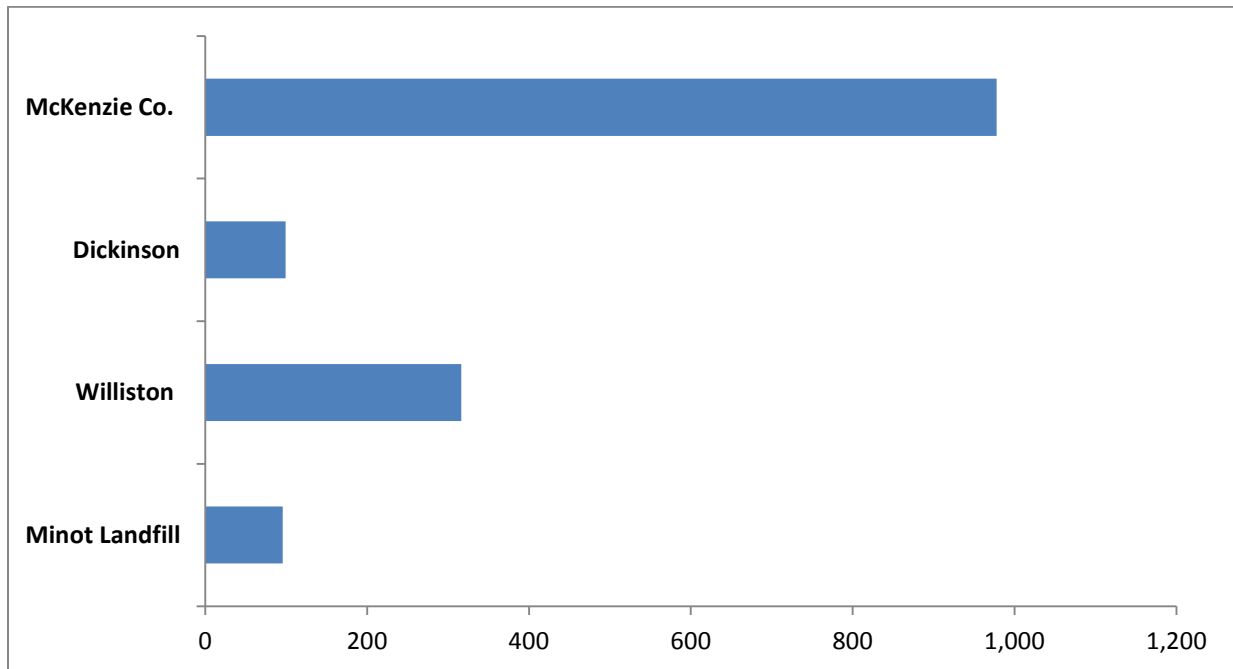


Figure 19. The percent change in the waste stream in Western North Dakota landfills from 2006 to 2014.

Waste generation rates disclose the consumption levels within a particular society, which is a critical aspect of developing sustainable policies (EPA (d), 2014). Within the past few years, waste generated in North Dakota has surpassed the Gross Domestic Product according to Figure 20, which is an indication of wasted resources. The waste generation rates were missing for years 2009 and 2011, so the forecast function was used to interpolate between years. The equation used to calculate the unknown years is as follows:

$$\text{FORECAST} = (x, \text{known } y\text{'s}; \text{known } x\text{'s})$$

where x is the year corresponding with the unknown waste value, *known y 's* is the first known waste value and last known waste value, and *known x 's* is the first known year and last known year.

The connection between GDP and solid waste is that it displays the link between economic vitality and waste prevention and reduction activities. When waste generated exceeds per dollar GDP there is a loss of energy and resources implying that the society is not using materials efficiently and negatively impacting the environment. Typically, increased economic growth correlates with increased material consumption, which is accurate depiction of the current waste generation rates within North Dakota; however the trend in GDP should stay above MSW generated in an economically sound and waste efficient society (United National Environmental Programme, 2011). Patters in MSW generation must be addressed to progress towards a more sustainable living.

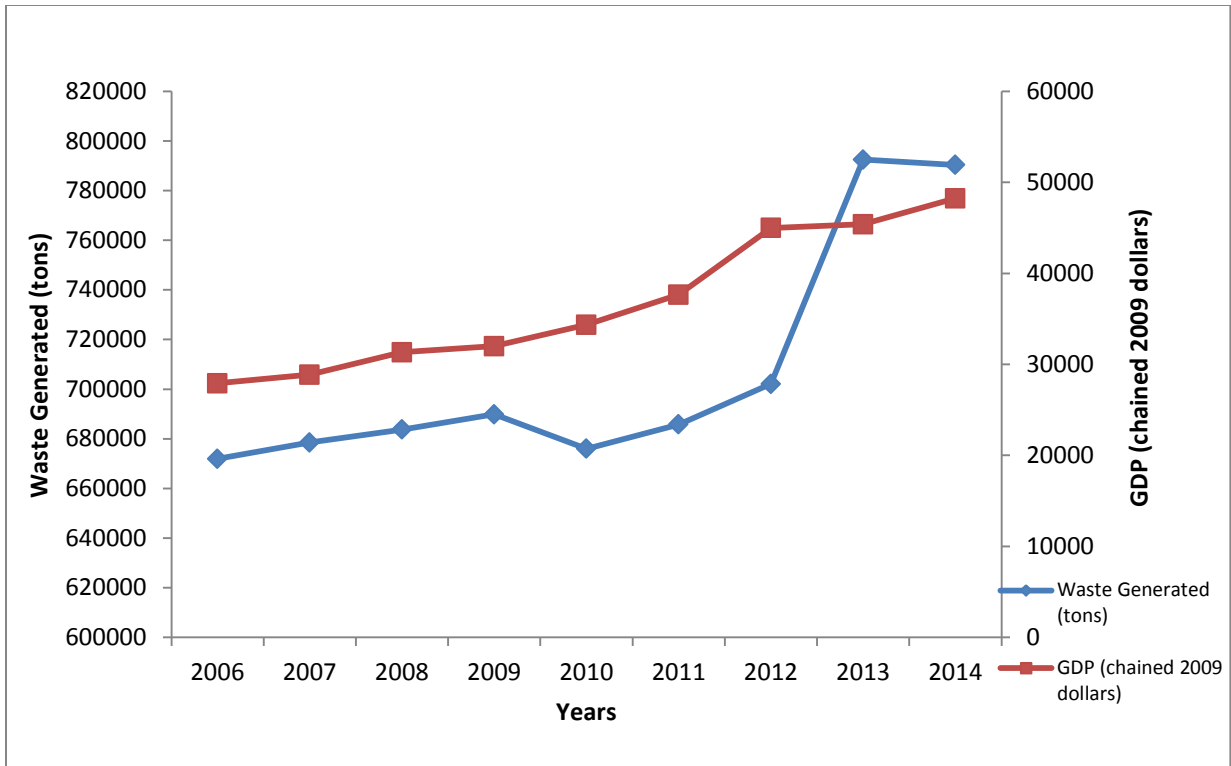


Figure 20. Municipal Solid Waste Generated per dollar of GDP in North Dakota from 2006-2014 (Department of Health Data, 2015).

CHAPTER VI DISCUSSION

Surveys are useful for providing insights into household behaviors and attitudes and allow the participant a chance to explain what motivates them by providing feedback. Survey respondent demographics provide an insight into rural life within North Dakota and may provide a role when developing new waste management policies in the future. In general, the majority of respondents (76%) were 50 years or older, which is as expected in mailed surveys since older people have the time to participate. The high education level is interesting since typically people who have a higher level of education also are more environmental cognizant (Mainieri et al., 1997 and Arslan et al., 2011). About 41% of respondents possess a college degree or some post-graduate work. The residents within the rural communities have educational tools to make an informed decision when it comes to properly disposing of their waste, but economically it does not make financial sense or it is too inconvenient. Also surprisingly when asked which gender was responsible for taking out the trash, 43% said both genders were in charge of that household duty. Stereotypically the male within the household is the one who takes responsibility, but this goes to prove that both the male and female are playing a role in how the trash is dealt with within the home. Regarding gender, several studies have indicated that women are more concerned about environmental factors such as participating in recycling activities and purchasing more green products compared to that of

men (Laroche et al., 2001 & Mainieri et al., 1997). Knowing that both genders hold responsibility for the disposal of the household waste will make developing future campaigns and advertisements easier because the target audience has been identified.

Since the median age of rural North Dakotans is older than median age of the entire state, (46 vs. 35.9 years old) it was expected that the majority of the households would contain two people (55%) since most of the respondents were likely retired (United States Census Bureau, 2014). These communities are comprised of retired couples (36.5%) mostly or single household families. Households with only one or two people may not feel that the amount of waste they produce is enough to make a difference in the grand scheme of things. The quantity of garbage produced does not warrant traveling to properly dispose of it. Also, because the majority of the respondents of the survey were 50 years and older and retired; they may not have as much mobility to carry their trash or recyclable materials to the car to transport to a facility, which is why they continue burning their trash.

Knowing the economic vitality of households can help determine the ability to participate in a future recycling program or proposed drop-off site. Financially, the majority of households are making more than \$75,000 a year indicating that they likely have the additional income to help subsidize paying for a collection service or taking the recyclables to a nearby drop station. Additionally, the majority of respondents were retirees, which also indicates that not participating in a recycling program is not because of lack of time, but more the inconvenience factor. Numerous respondents stated in the additional comments section that if recycling was made available that they would indeed participate.

Recycling Participation and Motivations

Since participation in recycling is not legislated, it is the responsibility of the individual to determine whether the activity is worthwhile based on their personal attitudes and incentives. Much greater emphasis has been placed on residential recycling than on reduction and reuse strategies since the former relies on very little government involvement, but instead commitment from the individual. The results of the survey suggest that much of the rural community, in particular the older generation is already participating in some form of recycling, whether it is just aluminum cans or other household materials. When asked whether the household participates in recycling, 62% of respondents said they did; however, half of those respondents admitted that they only recycle aluminum because they get money back since there is an established market for that recycled good. The Aluminum Association says the average recycling content for aluminum cans is 68 percent, which is the highest recycling rate of any recycled material (MacKerron, 2015). It is no coincidence that the highest material that is recycled also happens to be the only recycled good that offers an economic incentive in return. The market price for aluminum is consistent and static enough that consumers continually save their aluminum to return for profit. There are nearby facilities that accept aluminum cans, where as other types of recyclable materials lack sufficient recovery facilities resulting in rural household driving anywhere from 10-50+ miles to recycle.

Currently within the United States only 10 states have implemented such deposit-refund systems to help prevent recyclable materials from ending up in the waste stream, as well as discouraging illegal dumping/littering. Those 10 states have achieved recycling rates of 70-95% for beverage containers compared to the national average of non-deposit states of

22%. In addition to helping increase recycling rates, deposit-refund systems also significantly reduce beverage container litter; it is estimated that on average between those 10 states that have a deposit-refund system, the rates of litter have been reduced by 69-84%. Deposit-refund systems are the example of the most successful recycling programs in the country and are not incurred at the taxpayers' expense, but rather at the cost of the producer and consumer. When a retailer purchases beverages from a distributor, a deposit is paid to the distributor for each item purchased then the consumer pays the deposit to the retailer when the bottle is purchased. Once the consumer returns the empty beverage container to the redemption center, the deposit is refunded. The costs associated with managing the post-consumer beverage containers are the responsibility of the manufacture who sell and buy them (Bottle Bill Resource Guide, 2016). Roadside litter continues to be an issue in western North Dakota with the influx of people working in the oil industry. If there was a monetary incentive to keep people from throwing the used beverage container out the window, recovery rates would likely increase. Unfortunately, deposit systems often can be more expensive to implement compared to curbside recycling programs (Fullerton and Kinnaman, 1995); however deposit-refund systems might be more practical in North Dakota since much of the state is sparsely populated throughout a large geographical area and the deposit refund system relies on individual participation instead of governmental funding. Based on the survey results, half of the respondents who already recycle are willing to drive to recycle aluminum cans for a return, which means they likely would be willing to return their other beverage containers for a refund.

Also, surprisingly the greatest proportion of recyclers were 70 years and older, which might have to do with that particular demographic having the highest respondent rate, but recent research has proven that older generations are more likely to recycle compared to younger people. According to the Harris Poll on behalf of the Institute of Scrap Recycling Industries conducted in 2014, 62% of adults 18-34 believe recycling is the right thing to do compared to 78% of adults 65 and older (Carpenter, 2014). These results suggest that either current educational campaigns promoting recycling are ineffective or recycling has not been made convenient enough for younger generations to participate in it. Given that younger generations generally consume more and have a more active lifestyle than older people-it may be a factor of lack of convenience. The Harris Poll also proved that 62% of Americans agree that if a product is not convenient to recycle, they likely will not recycle it. This fact was corroborated when asked what the main reasons were for not recycling; Twenty-three percent of respondents selected "No recycling center nearby," further proving that if the option to recycle is not available near the household, the recycled good ends up in the waste stream. Only five percent of respondents selected "too much work or inconvenient," indicating that an overwhelming percentage of residents do not view recycling as a time consuming chore, but rather not an option at all since there are not any nearby facilities. Residents who are better informed about recycling and the locations have a great propensity to participate in the activity than those who are not as informed.

Very little research has been conducted in the rural communities within North Dakota about recycling and whether or not it is a program that should be expanded further. To successfully expand a program, it is necessary to understand how it is being used currently.

The majority of residents are utilizing a drop-off site for recycling, indicating that residents are aware of the location of the drop-off stations. If additional drop-off sites were made more readily available, then more people might be willing to participate in recycling. About 10% of respondents selected 'Other' and wrote in that they have curbside recycling as an option. The survey did not provide curbside recycling as a choice since only 17 communities are offered that service according to the Department of Health website; however some residents are paying to have a private hauler pick-up their recyclables. These residents are willing to pay extra to ensure that recyclable materials are not ending up in the waste stream.

Some of the most successful recycling campaigns have been designed based on the motivations and attitudes of the residents. There is no singular factor that is the determinant of recycling behavior; it usually is a variety of factors such as socio-demographics, attitudes, values, and level of convenience. The personal reasons why an individual participates in recycling can help develop future campaigns and communication strategies to enhance people's involvement in recycling programs. The majority of respondents (32%) selected 'teaches good values' as the main reason for why they recycle, which is to say that they are concerned about the welfare of the environment and understand the benefits of recycling. Moral and social norms do play a role in the psychology of why people participate in recycling. Moral obligation places the pressure on the individual to make the right choice whereas social norms are imposed from approval or disapproval from the outside (Sidique et al, 2010). Based on the results of the survey, the residents in the rural community believe it is the responsibility of the individual to properly dispose of trash reiterating that moral norms and values are playing a much bigger role than social norms. 'Conserves resources' was selected by 17% of

respondents indicating that people are concerned about the finite amount of resources that the earth is capable of producing and actively take steps to preserve the materials that have already been processed. People are knowledgeable about the loss of energy when materials end up in the waste stream compared to being reused or recycled into a new product. Following up right behind in third place was 'have less trash to throw away' with 16% of respondents selecting this option. Since most rural residents have to pay a private hauler or transport the trash themselves if they do not participate in backyard burning, some residents are motivated monetarily to save the extra money in tipping fees and instead recycle. Only 8% of respondents selected 'get cash back' as the main reason to recycle, which is not surprising since only aluminum cans provide a financial return in the state. This percentage would likely be higher if a deposit refund system was put into place for all beverage bottles. And finally, only 7% of people selected 'landfill space limited' as one of the main reasons to recycle. The residents of North Dakota are not afraid about scarcity of landfill space. The state has a vast amount of land that is unoccupied and could easily be converted over to landfill space if necessary. However, the residents of North Dakota are not taking into consideration the environmental externalities associated with landfilling waste such as the offensive smell associated with the decomposition of waste that nearby residents will be forced to smell and in turn, reduce the property value of the land (Kinnaman, 2006). Also the landfill gas, methane that is released during the decomposition process has a global warming potential 21 times greater than carbon dioxide and is contributing to the anthropogenic climate change.

Motivations associated with recycling rates can help determine the best approach to designing a future recycling program based on the current attitudes and behaviors of the

residents. The biggest motivation for residents to begin participating in recycling was to have drop-off sites closer to home. This again reiterates the need for recycling to be convenient for households for successful participation rates. Curbside pick-up was selected by 18% of respondents, which was surprising because curbside recycling would be even less effort on the part of the resident compared to a drop-off site. It is possible that a higher proportion of respondents selected drop-off site because of the concern that it would cost more money to initiate curbside recycling compared to a drop site. The major barrier respondents admitted to was the lack of convenience compared to the other options which focused more on laws and monetary incentives. Only one respondent selected 'nothing can be done' to motivate them to recycle, which is reassuring that the rural residents would indeed recycle if they were given a convenient option to do so.

Communicating with rural residents is not quite as easy as it is with urban communities since availability and need to have access to the internet is more infrequent because of the older demographics residing in the rural communities. How information is disseminated is crucial to gaining more participation in recycling. If residents do not have access to the information then it will be virtually impossible to implement an effective campaign. The respondents from the survey selected direct postal mail, newspaper and the utility bill as the preferred method of communication regarding waste management. More than 75% of respondents answered yes to wanting more information about waste and recycling options in their area, which proves that people are willing to change their behavior, but lack the resources to access the information. With the inconsistencies of the transfer

station hours and materials that they accept, residents are left to pay a private hauler or burn their garbage.

Physical barriers, such as no nearby drop site, and lack of knowledge seem to be the greatest barriers hindering residents from recycling compared to behavioral or attitudes and perceptions. The respondents are aware of the environmental benefits associated with recycling and feel a moral obligation and/or personal reward when participating in recycling. Since the majority of the respondents in this survey were 50 years or older, they have the time to dedicate to sorting recycled materials from the waste, therefore it is not surprise that behavior did not seem to be a barrier keeping people from recycling.

Perceptions and Behavior Regarding Trash Disposal

The majority of households, 38% within the rural communities are completely satisfied with their current trash disposal option; whether it is burning and burying it on their property or paying a private hauler to collect the garbage once a week. Very few people expressed dissatisfaction with how the system is devised today. Since the survey was comprised of mostly retired residents who were 50+ years old, those results are as projected because people are hesitant to change, especially if it is going to cost additional money. Implementing a mandatory pick-up service would not go over very smoothly with the residents.

The results from how trash is disposed of within the household were not as anticipated. Overwhelmingly, 65% of residents participate in some form of collection service and can pay anywhere from \$10-\$100 dollars monthly for this service. Some of the respondents stated that the city picks up the trash at the curbside, which means that they do

not reside on a remote farm, rather inside a small township of less than 10,000 people and are taxed to have the service. When asked if residents knew the name of the facility where they drop their trash off, 11 out of 34 respondents listed companies that were private haulers, which explains the more expensive monthly cost compared to a standard rate charged by the local town. Another 15 respondents listed official Department of Health transfer stations or landfills as the location that they take their trash to for disposal. The other eight respondents listed names of locations that were unidentifiable such as “parent’s house” or names of businesses’ dumpsters. This question did not prove as useful as hoped since only 34 people answered the question out of the 166 participants. However, it does show that rural residents are utilizing the transfer stations and landfills more than initially thought.

Twenty-five percent of residents admitted to burning on their property. These are likely the very rural areas that do not have city pick up and are unwilling to transport their garbage by truck to the nearest facility. These are also the people who have been burning their trash in their backyard for their entire lives, so they do not appear to seek another alternative. The relationship between residents age and level of concern related to backyard burning was negative and significant proving that as people grow older, they are in fact less concerned with health impacts of burning trash. Occupation also had a negative relationship, but significant indicating that people who are retired are not concerned compared to that of people who are employed with a private institution or self-employed. The number of people in the household also showed a significant relationship and a positive one, which indicates that as more people live in the household, the more concerned they are. The households with

more than two members in the family likely have children; therefore they are more concerned with the quality of the environment they are leaving for future generations.

Because the trash stream is comprised of very different materials than what it was a few decades ago, burning the garbage now is much more toxic to the environment than before. The synthetic materials such as plastics, treated paper, and packaging materials release hazardous mixture of carcinogens such as lead, mercury, and arsenic into the surrounding environment. About half of the respondents expressed concern for burning garbage while the other half of participants were not concerned. The residents who do participate in collection service were more concerned about the health risks associated with burning garbage, which might play a role in why they partake in a disposal service instead of burning their garbage. However, the respondents who do burn their garbage admitted to not being concerned about the health risks associated with it. A lack of information and education regarding the detrimental health effects might be the reasoning for the varying viewpoints in the survey. The educational brochure informing the public might only be made available on the internet at this point in time and not everyone in the rural area has access to internet or a desire to own a computer.

In terms of the level of concern regarding illegal dumping, respondents overwhelmingly, 76% expressed great concern. Numerous respondents stated concern for enforcing more stringent regulations regarding how trash is disposed of because residents do not want to see more trash in the ditch. There was greater survey response from the eastern portion of the state, indicating that even the residents who are removed from the Bakken oil

boom are concerned with the environmental impacts of dumping garbage. The respondents feel that households should be held accountable for properly disposing of trash, which is interesting because not everyone disposes of their trash in an environmentally sustainable manner. Respondents demonstrated willingness for individual citizens to take personal responsibility for reducing environmental damage caused by their waste. For most rural communities, the main issue with increasing waste management practices is who will pay for that additional cost associated with education, recycling, and recovering value from waste.

Throughout the United States, unit pricing schemes such as PAYT are employed as an incentive to encourage households to participate in waste reduction practices. PAYT methods help motivate households to reduce consumption of solid waste disposal services since they are charged according to the volume generated. It is a simple and fair way of charging the individual based on the amount produced. It is in contrary to the tradition of residents paying a fixed fee regardless of how little trash they generate, but instead fees are charged by the amount produced similar to how electricity and other utility services are priced. This type of policy is based on the polluter pays principle (PPP), which forces the polluters or consumers to bear the costs associated with the damage to the environment (Cordato, 2001). One of the biggest advantages to a variable-rate program is the inherent equity that is resulted in residents paying for only what they produce. The cost of managing of trash is no longer distributed evenly across a society through a flat tax, but the residents who recycle and produce less waste are allotted a smaller bill than their wasteful neighbor. The most effective way to enforce costs onto the polluter is through a tax, which is exactly what PAYT system aims to achieve. The majority of respondents, 43% of households agreed that

implementing a PAYT system within their community would be an effective means of reducing the waste generated. The residents who selected 'do not know' might be hesitant or reluctant to agree with the concept because of the uncertainty about the affordability of the service. Even though the survey results indicate that demographic variables are not related to PAYT, the results do imply that waste reduction and recycling campaigns will need to target all individuals, regardless of demographic profile. Although, when asked if "Trash disposal fees should be increased to encourage more recycling" the majority of respondents either said 'neither agree or disagree' and 'strongly disagree', which is contradictory to believing that a PAYT system would be beneficial for their community. The first question mentioned nothing about increasing fees, so respondents selected an option that led to less waste ending up in the landfill and more of it going to the recycling stream. Once the phrasing includes a monetary change, people are more hesitant to agree with the change in policy. Several people also wrote in the blank area that they would be worried that if trash fees did increase that more illegal dumping and littering would occur, which is a major concern for western North Dakota. Respondents who offered suggestions for improving the waste management strategies within their county were also the same people who were more apt to participate in recycling than those who provided no suggestions.

When questioned about WTP to have a more conveniently located drop-off site for waste and recycled materials only 55% of participants answered the question. The majority of respondents, 37 respondents selected "don't know/no answer". This might indicate that the individual did not understand what the question was asking or they might need additional information, such as a range of cost. Twenty-nine people said that they were not willing to pay

additional money for the service and 15 of those people do not currently have a trash provider, which means they are satisfied with their current waste management strategy of burning and burying or transporting their trash to a local facility. Since 59% of respondents' produce only 1-2 bags per household, per week, those respondents might not feel it is worth the extra cost to pay a hauler when the amount they produce is so little. Rural areas do tend rely more on locally sourced food and less on pre-packaged items; however there still is a concern that plastics are being burnt because of how prevalent plastics are in the manufacturing process today. Twenty-eight percent of the respondents are using 3-4 trash bags each week but the majority of those respondents have 3+ people living in the household, therefor more trash is produced per person. Although, the majority of respondents selected that they would be willing to pay \$2 additional dollars per week to have a drop-site. Eleven out of the 15 people who selected \$2 also do not have a provider--proving that some residents in the rural communities may be willing to pay additional money to have a convenient location for their trash and recyclables. Also, typically with WTP studies, respondents are more likely to select the lowest value because they do not want to pay more than is necessary-especially if they are not currently paying for the service (Blaine et al., 2005). Another interesting comparison was the relationship between the respondent already participating in some form of recycling and their WTP. In general, respondents who currently recycle are WTP more than those people who do not recycle, which is consistent with previous literature. This is as anticipated since the people participating in recycling have an incentive to recycle vs. burning or landfilling the materials; whether that incentive is to reduce the fees associated with trash disposal or they possess proenvironmental behaviors. Even though only 40% of respondents

are willing to pay additional money to have a drop-site, it can provide information to the state and local policy makers that some constituents are willing to expand the current waste disposal options and pay out of pocket for the service. Local politics play a critical role in the level of success that a new waste management strategy can have within a community.

Waste Generation Rates

Cheap landfill fees and fragmented waste management systems throughout the country have kept the recycling rates around 34% for the past two decades-far lower than other wealthy, developed nations (EPA c, 2014). Landfilling is still the cheapest option for disposing of waste within the state because of how unreliable the markets are for recycled materials, in conjunction with the distance to the markets and overall cheap landfilling prices. The average tipping fee in North Dakota 2014 was \$42.62 per ton of MSW compared to the national average of \$44 per ton (EPA (d) 2014 and North Dakota DoH Data, 2015). Since the waste disposal industry has organized its infrastructure around cheap landfilling-it makes logical sense that the most cost-effective solution to waste removal is to landfill, instead of recycle. When commodity prices are high, recycled material is in demand because it is cost-competitive with virgin materials; however once there is an imbalance, recycling is no longer cost-effective and those resources end up in the waste stream to decompose over the next several hundreds of years when otherwise that energy could have been recaptured. The waste management infrastructure of the United States is controlled by two main profitable enterprises, Waste Management Inc. and Republic Services Inc. who have designed their corporations as large centralized landfills to help keep down disposal costs for the consumer. The system was not designed to profit from recycling because then landfills would lose out of

profit margins. The cheaper the tipping fees, the less incentive there is to recycle. Taxing trash forces the consumer to either minimize the waste in the first place or recycle what waste remains to avoid the extra fee at the landfill. This concept is illustrated according to Figure 19., which displays the percent increase in trash in western North Dakota because of the oil boom and influx of residents. Because economic growth is correlated with increased material consumption, the rates of waste generated should follow the general trend of GDP, but in a resource efficient society, waste generated is always below GDP. The lower the rate usually implies that the society is more resourceful in material consumption and recovery of those materials (United National Environmental Programme, 2011; Fiksel, 2006). Because of the importance of agriculture within the state, the potential loss of prime farmland for additional landfill space should be a concern, as it will have widespread effects on the economy and the rural environment. The landfills are filling up far quicker than anticipated out west and eventually more land will have to be purchased to expand the landfill quantities. To help create a more sustainable society and reduce the negative effects on the environment, it is necessary for the state of North Dakota to consider an approach to waste management that integrates recycling more heavily.

Limitations in Survey Responses and Design

Gaining an inclusive perspective from survey research is virtually impossible because of the inability to capture 100 percent of the sample. Only using response rate as a measure of the representativeness of a surveys success is inaccurate because it is the nonresponse bias that is the issue; not the nonresponse itself. Response bias occurs when a percentage of the population that responded to the survey differs from the portion of the population that

failed to respond to the survey (Peytchev, 2013). To test for survey response bias, characteristics of respondents who returned the completed survey would be compared to those of respondents who failed to return the survey. Respondents of the survey did not include their names or addresses because of confidentiality agreements with the Institutional Review Board (IRB), and without this information, there was no way to know who responded and who declined to participate from the original list of 600 names. Additionally there was no auxiliary information about the households that refused to participate, so there was no way to compare the two groups (Whitehead et al., 1993; Peress, 2010). Some examples of nonresponse bias in this survey were that the majority of the sample, 76% of respondents fell into the category 50+ years old and 61% of those respondents were retired; which is a well-known fact that elderly people are more likely to participate in surveys (Brehm, 1993). Even though, the rural communities of North Dakota are comprised of older demographics relative to the rest of North Dakota, this survey did not capture the total population. When developing the survey, a mixed mode approach was implemented to help capture the younger respondents. Most likely the younger residents who live in the rural area would be more willing to take a survey on-line compared to a paper survey because they could have viewed the paper version as more time consuming or not as legitimate compared to participating on-line. However, no one participated in the on-line survey so the mixed mode method was not effective at reaching the younger population. When the younger demographics were assessed separately to determine if there were any major differences in their responses compared to the 50+ respondents, their responses aligned with the majority of the older population. For example, majority of 49 year old and younger are participating in

some form of recycling and the majority expressed concern with burning garbage and illegal dumping. Another possibility of non-response bias is that only respondents participated in the survey who was interested in the topic and the non-respondents did not have an interest either way about the subject matter, so they failed to participate (Groves, Presser, and Dipko, 2004). A way to help combat non-response bias would be to provide an incentive to those who may be less interested in the survey topic and it motivates them to participate. However, this was not an option with this survey because of limited funding and time constraints.

Another limitation to the design of the survey was the options provided for some of the questions. The reason “Don’t know/No answer” was provided as a choice to allow the respondent the option of selecting an answer that they felt comfortable picking, especially if they did not fully understand what the question was asking. However, after further research once the survey was returned, it was determined that the “don’t know” option promotes disengagement from the survey by providing an easy way out of answering the question. Providing “don’t know” for behavioral or attitudinal questions allows the respondent to avoid answering the question honestly and hurts the accuracies of the results (Mondak and Davis, 2001). Additionally, the layout of the survey could have been designed better to separate the questions that involved respondents who currently have a trash disposal provider and respondents who do or do not participate in recycling. For example, phrasing a question such as “If you do participate in recycling, please skip to question 2.5” instead of having the respondent select non-applicable to the questions that were not pertinent to their behavior.

CHAPTER VII CONCLUSIONS AND RECOMMENDATIONS

The purpose of this study was to: (1) examine the current state of waste management and recycling within North Dakota; (2) pinpoint the failures or barriers to households' perceptions about recycling and devise solutions to overcome these barriers; (3) evaluate the demographic and socio-economic factors that influence the demand for infrastructure with the rural community; (4) identify which counties within North Dakota are suffering the most because of lack of access to adequate disposal options; (5) propose recommendations for how to implement recycling programs within the rural communities, in addition to looking into potential partnerships.

One of the first steps towards improving the waste management scheme within North Dakota is to update the Waste Management Plan because this has not been done since 1993. Having an official "plan" helps guide the decision making process for state representatives, local governments, haulers, residents and businesses regarding waste management and recycling programs within the state. Designing a plan provides a common basis for all the stakeholders involved with decisions regarding waste and the resources needed to turn the plan into reality. Currently there is a lack of consistent reporting and documentation of trash and recycle flow within the state. To help combat that issue, the waste management plan should mandate that all facilities report waste and recycling materials

captured. Recording waste and recycled materials will keep track of the progress of each region and determine which areas are in need of additional recycling capacity because of lack of infrastructure. Top-down enforcement strategies may be necessary to promote the practice of recycling and disincentivize backyard burning. A better-developed structure and culture that supports recycling statewide will help increase the rates of participation.

It is imperative that residents of North Dakota adapt the idea that everyone is a waste producer and recycling generated household waste is the problem of the consumer. Based on the results of the survey, the propensity of rural residents to recycle is present, but greater rates of recycling could be obtained if it was made more convenient for households. A possible way to combat the indifference attitude towards recycling is to develop an information-driven communication campaign that focuses on presenting the statistics on recycling rates in the United States, specifically rural areas and the growing number of successful small towns who are aware of the benefits of recycling. This may help impact the perception that recycling is a worthless endeavor and instead promote more participation. As mentioned earlier in this report, there are examples of other rural communities who have been successful at encouraging residents to participate in recycling and developing partnership with nearby communities to keep transportation costs down and make it more of a profitable scenario.

Passing a no burn resolution in combination with education and incentive programs that deter rural households from backyard burning will also help promote higher rates of recycling. The implementation of no burn resolutions has been successful as shown by such

programs such as Burn Barrel Buy-Back Campaign developed in Chisago County in Minnesota-- for example. In a cooperative effort with local haulers, residents who ceded their burn barrels and signed up for the garbage service were offered the first six months at half price. Over a four year span of time there was a 40% reduction in the number of burn barrels within the county. Other local governments within Minnesota have adopted educational campaigns through advertisement such as Bernie the Burn Barrel TV ads and billboard displays to discourage backyard burning (Minnesota Pollution Control Agency, 2014). These sorts of initiatives or policies could be funded through rural grants and loans from the USDA to help offset initial costs of building the infrastructure, developing educational campaigns, and training staff.

Based on the interest expressed by the respondents in this study, and whether or not a transfer station was already available within that county; drop off sites are recommended for the counties without a current facility. Using GIS, drop sites were proposed using the central features tool and weighting the sites according to population density from 2010. In total, there are 21 drop off sites that are recommended based on the level of interest from the corresponding residents within that county and lack of current infrastructure. The Euclidean distance tool was used to calculate the distance from each transfer station to help determine where there was overlap in the proposed drop-off sites and the lack of an available station. The areas highlighted in pink and purple, in Figure 21, are the furthest away from the transfer station and the majority of the proposed drop sites fall within those outer limits. These proposed drop sites should be located in a central location within the town limits to make it convenient for the residents. Developing partnerships with neighboring counties to

make transportation costs more affordable would greatly enhance the rates of recycling within the rural community.

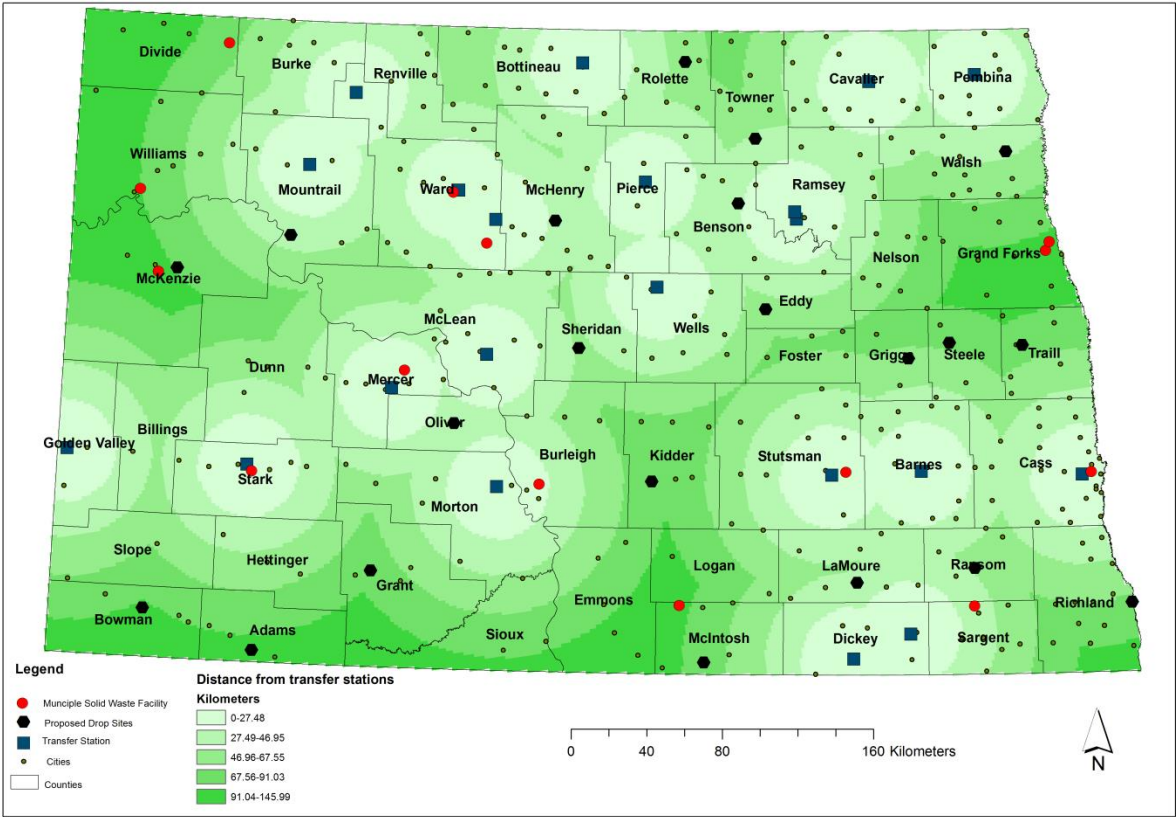


Figure 21. Proposed drop-off sites for counties that expressed interest in having a recycling station.

A very progressive policy shift would be to implement deposit-refund system for beverage containers statewide. Respondents in this study expressed their willingness to recycle aluminum cans because of the monetary return and indicated their willingness to participate in more recycling if it was readily available. Deposit refund systems not only help promote recycling, but they also decrease the incidences of illegal dumping along the roadside,

which was a concern of some rural residents in this study. Implementing such a market-based tool is an efficient and effective method to force the beverage industry to absorb the costs associated with litter and improper disposal of beverage containers when containers are not returned to the redemption facility. The redemption facilities should be located in a convenient location such as a grocery store to make returning the bottles as simple and hassle free as possible. The unclaimed deposit revenue should be used to support litter-reduction and recycling programs and/or container and handling costs. Allocation of the unclaimed funds in this way will ensure that the goals of the deposit-refund system are being met.

The combination of a weak recycling markets, as well as lack of strong recycling policy has led to the current situation within the state. Many stakeholders are involved within the solid waste management sector and include but are not limited to: North Dakota Department of Health, political officials at the regional levels, waste management service providers both state and private, and the residents of the state. All of these individuals play a crucial role in improving how waste and recycling is managed within the state. This study is a starting point for policy makers to examine the economic and environmental issues within the rural communities and provides ideas of how to promote future engagement in recycling. Further consultation within the rural communities is needed to develop an appropriate plan-as the success of a campaign will hinge of their participation. Distributing a more widespread survey across the rural households would be useful to help determine the current behaviors and motivations of those residents. Gaining a broader range of input would help in the developmental stages of building infrastructure and spreading the word about the additional disposal options. Furthermore, recycling rates should begin to be documented throughout the

state to help monitor the flow of recyclables and what areas of the state are still in need of more infrastructure or training. Changing the culture of waste management and recycling within North Dakota is much needed if progression towards a sustainable society is hopeful.

APPENDIX

To begin we would like to ask you questions about your perceptions and behaviors regarding trash and disposal in your household.

Directions: Please select the best answer for each question or fill in the blank where provided.

1.1 Is your household served by any form of state, county or city trash collection service?

- a. Yes
- b. No

1.2 If you do have a trash collection service, how satisfied are you with the service received from your trash collection provider?

- a. Completely satisfied
- b. Somewhat satisfied
- c. Neutral
- d. Somewhat dissatisfied
- e. Completely dissatisfied
- f. Not applicable

1.3 If you have a trash collection service, approximately how much do you pay for that service on a monthly basis?

1.4 If you do not have a trash collection service; how do you dispose of your trash?

- a. Burn it on your property
- b. Bury it on your property
- c. Bury/Burn it on someone else's property
- d. Take to a designated landfill or drop-off site
- e. Put in dumpster somewhere else
- f. Other, please explain-

- g. Not Applicable

1.5 How concerned are you about health risks related to burning garbage?

- a. Concerned
- b. Moderately concerned
- c. Not concerned
- d. No opinion/Neutral

1.6 How concerned are you about illegal dumping in your area (includes all household and oil field waste related)? *Definition of illegal dumping: discarding waste in an improper location where it does not belong or where environmental damage is created.*

- a. Concerned
- b. Moderately concerned
- c. Not concerned
- d. No opinion/Neutral

1.7 If you do not have a trash collection service; how far do you drive to dispose of your trash?

- a. 0 miles
- b. 1-10 miles
- c. 11-20 miles
- d. 21-30 miles
- e. 31-40 miles
- f. 41-50 miles
- g. 51+ miles

1.8 Do you know the name or location of the facility where you drop off your trash?

- a. No
- b. Yes, please list name or location _____

1.9 If you currently do not pay for a collection service, how much would you be willing to pay **per week** so you could have a conveniently (within your county limits) located drop-off site for waste and recyclable materials?

- a. Not willing to pay more
- b. Up to \$2 per week
- c. Up to \$4 per week
- d. Up to \$6 per week
- e. Don't know/No answer

1.10 On average, about how many 13 gallon (tall white) bags of trash does your household generate each week?

- a. 1-2 bags
- b. 3-4 bags
- c. 5-6 bags
- d. 7+ bags

1.11 There are several communities throughout North Dakota who enforce a pay as you throw system, which is a variable fee based on how much waste one household produces. Therefore, the more waste a household produces, the more expensive the disposal fee. Do you believe a pay as you throw system would be a beneficial method of waste reduction in your community?

- a. No, the same fee should be charged to all households regardless of how much they produce
- b. Yes, the cost should depend on how much each household produces
- a. Don't know /No answer

1.12 Who do you believe should hold the greatest responsibility for properly disposing of trash?
(Choose the best 2 answers).

- a. Individuals or households
- b. State of North Dakota
- c. Local or community public services
- d. Solid waste provider
- e. Share responsibility between individuals and governments
- f. Don't know/No answer

1.13 Do you have any suggestions for improving the waste management system in your county?

Next, we would like to ask you questions about your perceptions and behaviors regarding recycling.

Directions: Please select the best answer for each question or fill in the blank where provided.

2.1 Do you recycle household products (for example paper, glass, aluminum or steel cans, cardboard)?

- a. Yes
- b. No

2.2. If yes, what is the main reason your household recycles?

- a. Teaches good values, concern for environment, stewardship
- b. Conserve resources
- c. Landfill space is limited
- d. Have less trash to throw away
- e. Get back some cash
- f. Not applicable
- g. Other, please explain _____

2.3 Where do you recycle your items?

- a. Drop-off site
- b. Landfill
- c. Take to a friend or family's house to recycle
- d. Other
- e. Not applicable

2.4 If you recycle, about how far do you transport your recyclable materials?

- a. 0-10 miles
- b. 11-20 miles
- c. 21-30 miles
- d. 31-50 miles
- e. 51+ miles
- f. Not applicable

2.5 If your household does not recycle, can you describe the reason why?

- a. No recycling center nearby
- b. Don't know if there is a recycling center nearby
- c. Too much work or inconvenient
- d. Don't have that much to recycle
- e. Don't want to pay extra to recycle
- f. Other
- g. Don't Know/No Answer
- h. Not applicable

2.6 What would motivate you to recycle, if you don't currently?

- a. Recycling sites closer to home
- b. Curbside pick-up
- c. Law requiring recycling
- d. Get paid for recycling
- e. Nothing can be done
- f. Don't know/No Answer
- g. Not applicable

2.7 How strongly do you agree or disagree with the following statement: Trash disposal fees should be increased to encourage more recycling?

- a. Strongly Agree
- b. Moderately Agree
- c. Neither Agree or Disagree
- d. Moderately Disagree
- e. Strongly Disagree

2.8 What is the best method(s) to communicate with you about waste reduction programs or recycling? (**Choose the best 2 answers**).

- a. Direct postal mail
- b. Information sent with my utility bills
- c. Articles in the local newspaper
- d. Radio announcements
- e. Information on town/county websites
- f. Other

2.9 Would you like more information about how and what types of trash you can recycle, reuse, and compost in order to reduce the amount of trash you dispose of?

- a. Yes
- b. No
- c. Don't know/No answer

Finally, we would like to ask a few questions about you which will help us interpret the results.

Directions: Please select only ONE answer for each question.

3.1 How old are you?

- a. 18-29
- b. 30-39
- c. 40-49
- d. 50-59
- e. 60-69
- f. 70+

3.2 What is your highest education level?

- a. Some high school or less
- b. High school graduate
- c. Some college or trade school
- d. College graduate
- e. Post graduate

3.3 How many people live within your household?

- a. 1 person
- b. 2 people
- c. 3 people
- d. 4+ people

3.4 What is your combined households' yearly income?

- a. Under \$15,000
- b. Between \$15,000-\$25,000
- c. Between \$25,000-\$35,000
- d. Between \$35,000-\$50,000
- e. Between \$50,000-\$75,000
- f. \$75,000 or more

3.5 What is the occupation of the main income earner in the household?

- a. Self-employed as a laborer (ex: farmer, construction, machinist)
- b. Employee of a private company
- c. Employee of government (public sector)
- d. Retired
- e. Other

3.6 Which person is responsible for taking care of the garbage from your household?

- a. Male
- b. Female
- c. Both genders
- d. Unsure

3.7 What county do you reside in?

Additional Information

If interested in more information regarding open burning on your property, please go to the North Dakota Department of Health website. <https://www.ndhealth.gov/AQ/openBurning.htm>

If you are currently unaware of a nearby transfer station (drop-site for trash) location, please refer to this document for guidance. <http://www.ndhealth.gov/wm/Publications/TransferStations.pdf>

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