

Genesee County: Material Recovery Facility Feasibility Study



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I. Introduction

1.1 Acknowledgments

We would like to thank the Genesee County Metropolitan Planning Commission and Michigan State University (MSU) for their collaboration to give our team the opportunity to not only be a part of, but also lead this preliminary investigation that was a direct priority of the 2012 Genesee County Solid Waste Management Plan. This practicum team wants to commend the entire Urban & Regional Planning program's faculty for securing this opportunity. This report would not be possible without the mentoring, dedication, and direction from our outstanding professors. Additional contributions have been made by additional professional sources from ReCommunity, the MSU Surplus Store and Recycling Center, and the Resource Recovery and Recycling Authority of Southwest Oakland County. Having assistance and guidance has made our research and work more successful and ultimately has given every team member a sense of reality in the professional field of planning.

1.2 Executive Summary

Our team, senior undergraduates of the Urban and Regional Planning program at MSU have composed a feasibility study of implementing a material recovery facility (MRF) in Genesee County, Michigan. A MRF is a recycling plant utilized to separate and prepare recyclable materials for end use distribution. This

project was created by the establishment of a client partnership between the GCMPC and the School of Planning, Design & Construction at MSU. This team has elaborated the current social and economic conditions within Genesee County and laid out several recommendations that we believe are obtainable by the county. The client has required that the materials involved in this study will be common household recyclables diverted from residential waste only. This is a direct priority by the current Michigan Governor, Rick Snyder's, 2014 statewide recycling goal. An investigation was conducted to determine what parameters could be required to implement and successfully operate a MRF under current conditions within the county.

Our methodology has revolved around compiling data that includes general recycling knowledge and statistics, literature reviews, socioeconomic data, facility site criteria, and case studies. The group made two site visits to operational MRF's in Michigan. Our field experiences have allowed us to observe the day to day operations of a functioning MRF while interviewing their personnel to acquire the facilities independent data. This data then allows the team to compare and contrast the MRF's which then segue to create transferable data.

The report concludes with several recommendations made by our team that explain what will be the best option for Genesee County regarding a MRF implementation. The recommendations are broken down into, site location characteristics, facility criteria and costs, education strategy, and cost recovery. and education strategies that have been proven to heighten recycling rates. With the close of the 2016 spring semester, this team will have made a recommendation for

the Genesee County Metropolitan Planning Commission. Based on our findings and recommendations, we believe establishing a MRF is in fact, a feasible opportunity for Genesee County.

1.3 General Recycling Information

Recycling is a resource recovery method involving the collection and treatment of a waste product for use as a raw material in the manufacture of the same or another product (ReCommunity, 2015). The methodology has existed since the industrial revolution, publicized during both world wars, and was prioritized in the later half of the twentieth century. Today, recycling represents a progressive and environmentally friendly way to manage the waste that communities produce and offer alternatives to material use. According to the Environmental Protection Agency (EPA), approximately 34.3% or 87 million tons of all solid waste in the United States (U.S.) was recycled in 2013 (EPA, 2016). Although there is an array of materials that can be recovered or disposed of and eventually processed for recycling, the most common household recycled materials are papers (mixed papers, cardboard, newspapers), plastics, metal cans (aluminum, steel) and glass. Table 1.A shows national recovery rates of recyclable materials from municipal solid waste (MSW).

2012 U.S. Generation, Recovery, and Discards of Products in MSW

(millions of tons and percent of generation of each product)

Table 1-A

Product*	Weight Generated	Weight Recovered	Recovery as Percent of Generation	Weight Discarded
Durable Goods				
Steel	14.57	3.94	27.0%	10.63
Aluminum	1.52	Not Available	Not Available	1.52
Other Non-Ferrous Metals	2.00	1.36	68.0%	0.64
Glass	2.19	Negligible	Negligible	2.19
Plastics	11.46	0.77	6.7%	10.69
Rubber and Leather	6.52	1.35	20.7%	5.17
Wood	6.16	Negligible	Negligible	6.16
Textiles	3.88	0.55	14.2%	3.33
Other Materials	1.73	1.30	75.6%	0.42
Total Durable Goods	50.03	9.27	18.5%	40.76
Nondurable Goods				
Paper and Paperboard	30.60	15.44	50.5%	15.16
Plastics	6.51	0.13	2.0%	6.38
Rubber and Leather	1.01	Negligible	Negligible	1.01
Textiles	10.15	1.70	16.7%	8.45
Other Materials	3.07	Negligible	Negligible	3.07
Total Nondurable Goods	51.34	17.27	33.6%	34.07
Containers and Packaging				
Steel	2.23	1.61	72.2%	0.62
Aluminum	1.87	0.71	38.0%	1.16

Glass	9.38	3.20	34.1%	6.18
Paper and Paperboard	38.01	28.92	76.1%	9.09
Plastics	13.78	1.90	13.8%	11.88
Wood	9.66	2.41	24.9%	7.25
Other Materials	0.30	Negligible	Negligible	0.30
Total Containers and Packaging	75.23	38.75	51.5%	36.48
Other Wastes				
Food, Other	36.43	1.74	4.8%	34.69
Yard Trimmings	33.96	19.59	57.7%	14.37
Miscellaneous Inorganic Wastes	3.90	Negligible	Negligible	3.90
Total Other Wastes	74.29	21.33	28.7%	52.96
Total Municipal Solid Waste	250.89	86.62	34.8%	164.27

Source: EPA Generation, Recovery, and Discards of Materials in MSW, 2012

* Includes waste from residential, commercial, and institutional sources.

† Includes lead from lead-acid batteries.

‡ Details might not add to totals due to rounding. Negligible = less than 5,000 tons or 0.05 percent.
Includes recovery of other MSW organics for composting.

1.4 Statistical Analysis of Recycling in the United States

Given the amounts of waste produced in the United States, of which a majority is discarded in more than 1,900 landfills, state recycling rates have substantially increased since 1960. As of 2010, an estimated one-third of the approximate 243.5 million tons of municipal solid waste that was generated was eventually recovered for the sole purpose of recycling. Progress has been achieved, in terms of general materials that were recovered from overall U.S. For example, in

2000, there was an estimated 69.5 million tons of waste materials that was recovered from existing municipal solid waste streams (Recovery of U.S., 2016).

In 2012, significant volumes of materials from the various categories of recyclables were either recycled and/or composted. Accounting for the highest levels of material recovery were paperboard and paper, yard trimmings, and metals. During 2012, the U.S. was able to recycle over 64% of the paperboard and paper waste material generated. In addition, more than 19 million tons of assorted yard trimmings were subsequently composted, presenting a five-fold increment in overall recycling initiatives (Recovery of U.S., 2016).

Table 1-A provides further data concerning recovered material. From this data, the highest of the product categories is the recovery of Containers and Packaging, with a rate of 51%. Of these materials, steel, aluminum, and paper products present the most recycled municipal solid waste, with more than 76% of total waste paperboard containers, paper, and packaging recycled. 72% of steel packaging, majorly in the form of cans, had been recycled; with aluminum packaging recycled at an approximate 38% of the total. (MSW Generation, 2012).

Aluminum beverage cans were recycled at a rate of approximately 55%, showcasing a major step forward in recycling. The total percentage of recycled glass was an estimated 34%. Plastic containers and other associated packaging were recycled at a rate of 14%. This low rate is of notable concern; given that most of these plastic-based materials were from milk, water, and soft drink bottles. Nevertheless, plastic bottles still remained the most recycled products in the year 2012 (Statistics and Facts, 2016).

Recovery rates for PET (Polyethylene terephthalate) jars and bottles was at 31%, with recovery of HDPE (High Density Polyethylene) and natural bottles (white translucent products) approximated at over 28% of the total municipal solid waste product category generated. Accordingly, in 2012, the general recovery of various non-durable municipal solid waste was at an approximated 34%. Notably, non-durable products are types of goods that generally last for maximum of three years, i.e. mechanical/ newspaper paper (MSW Generation, 2012).

The total percentage of other paper recovered, such as magazines and office paper, was at 43%. Footwear, assorted textile products, and clothing were also included in this non-durable product category, with specific products recycled at an approximate rate of 16%. The data portrays an average rate of over 18% of all durable municipal solid waste products recovered in the year. On a special note, there are extremely high rates of the recovery of lead from various lead-acid batteries disposed, with an estimated 96% recovery rate, hence, falling amongst the most recycled of all national waste products (MSW Generation, 2012).

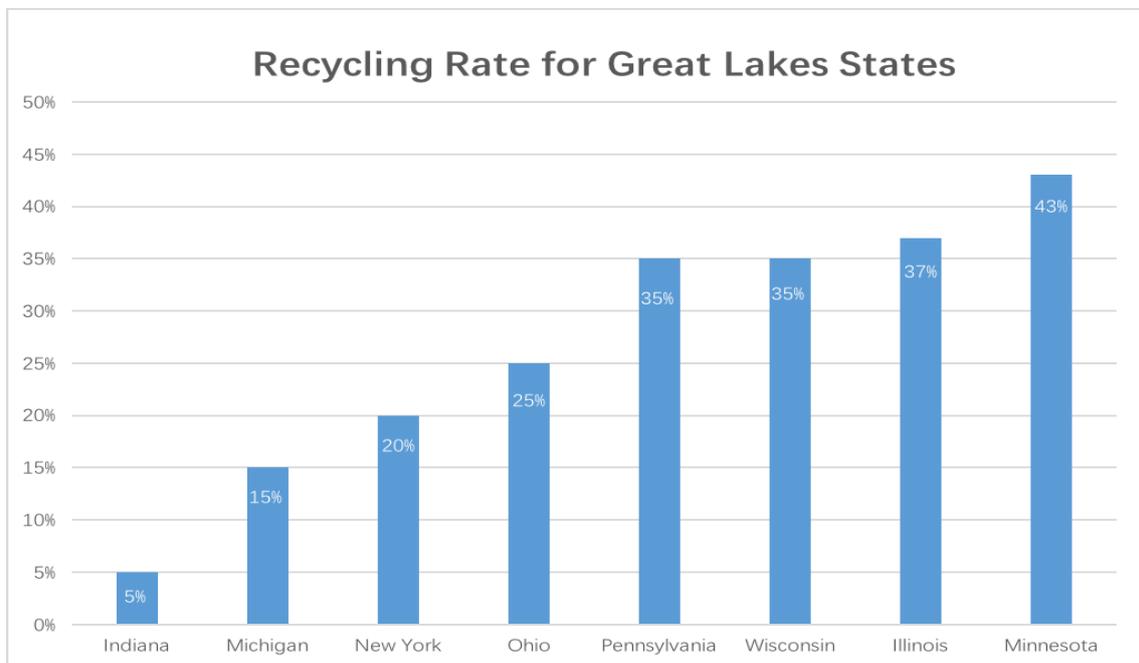
Durable goods produced an estimated 27% of recovered steel, with significant gains derived from appliances and other miscellaneous products. Consequently, when measured at the national level in terms of percentage generated, the MSW products having the highest levels of recovery rates in the year 2012 were: lead-acid batteries at 96%, corrugated boxes at 91%, and steel cans at 71%; followed by mechanical papers/ newspapers at 70%. Major appliances produced 64% of recycled products and yard trimmings at 58%. 55% of Aluminum cans were

recovered, with tires at 45%, and then mixed paper at 43%, as shown in Table 1.1. (MSW Generation, 2012).

1.5 Recycling Averages

Figure 1-A, shows approximated 2013 recycling rates of the all the Great Lakes States by material volume. Michigan is second to last and 10% below the Great Lakes States' average of 26% as well as 20% behind the national average. Genesee County is far below any of the averages at only 6.2% (GCMPC, 2012) .

Figure 1-A



Source: Public Source Consultants, 2013.

A 35% national recycling rate indicates more than just adequate participation. People have been delivered the message of recycling benefits and adhering to separating their waste at the curb. Although different places around the country may

have certain advantages to secure a high recycling rate, Genesee County lags in achieving a recycling rate comparable to other counties state and nationwide. In addition to supporting a recycling coalition among individual communities, Genesee County must adopt a proactive attitude and take the initiative to lead by example. Keeping records would also enhance their ability to track progress.

1.6 Recycling Terminology

When discussing recycling, it is important to define waste the terminology, services, and types of material. The average person's municipal policy makers may not have a good understanding of not only how and what to recycle, but also what services may increase recycling participation. The following terms are provided to assist us in completing this feasibility study.

Solid Waste - Solid wastes are any discarded or abandoned materials. Solid wastes can be solid, liquid, semi-solid or containerized gaseous material (NYSDEC Division of Materials Management, n.d.).

Solid Waste Management Plan (SWMP) - In Michigan, this is a state mandated document that dictates how a county or municipality will reduce, manage, and dispose of its solid waste. It will guide the development and implementation of a solid waste management program by setting the criteria for appropriate decision-making.

Municipal Solid Waste (MSW) – Common household garbage. Recyclable materials that are thrown away then become categorized as MSW.

Recyclable Materials – Reusable waste from a waste stream including but not limited to sorted or unsorted newsprint, glass, aluminum, ferrous and nonferrous cans, plastic materials, mixed paper, and cardboard accumulated and intended for

recycling or reuse and collection by a collection company or authorized contractor (Code Publishing Company, 2016).

Participation Rate - The percentage of the residential population that participates in recycling.

Recycling Rate - Percentage of the volume of waste that is recycled.

Curbside Pickup – A service that picks up gathered residential recyclables, similar to trash haulers.

Drop Off – Fixed locations within a community that leave the individual responsible for bringing in recyclables to sorting containers that will await transportation to be processed.

Pay as You Throw (PAYT) - Residents are billed by the amount of trash they produce. The aim of PAYT is to create the incentive to recycle more and create less waste, therefore reducing the resident's billing fee (EPA, 2016).

Bottle Deposit - A type of container deposit legislation that requires a refundable deposit to the redeemer on beverage containers in order to promote a high rate of recycling or reuse (Containing Recycling Institute, 2016). *e.g. \$0.10, Michigan. \$0.05, New York.*

Subscription Service - A resident may request waste handling services from a private hauler.

Dual Stream– Recyclables are segregated by material category by the household and collected by separate trucks.

Single Stream – Recyclables are mixed and discarded into only one receptacle and collected by one truck.

Material Recovery Facility (MRF) - A recycling plant utilized to separate and prepare recyclable materials for end use distribution.

1.7 Common Recyclables

Figure 1-B depicts graphics of acceptable recyclable materials found in the typical residential household. It is necessary for communities to differentiate between trash and recyclable materials so that more recyclables are not being combined with MSW.

Figure 1-B



Source: *Recycle Right*, 2016

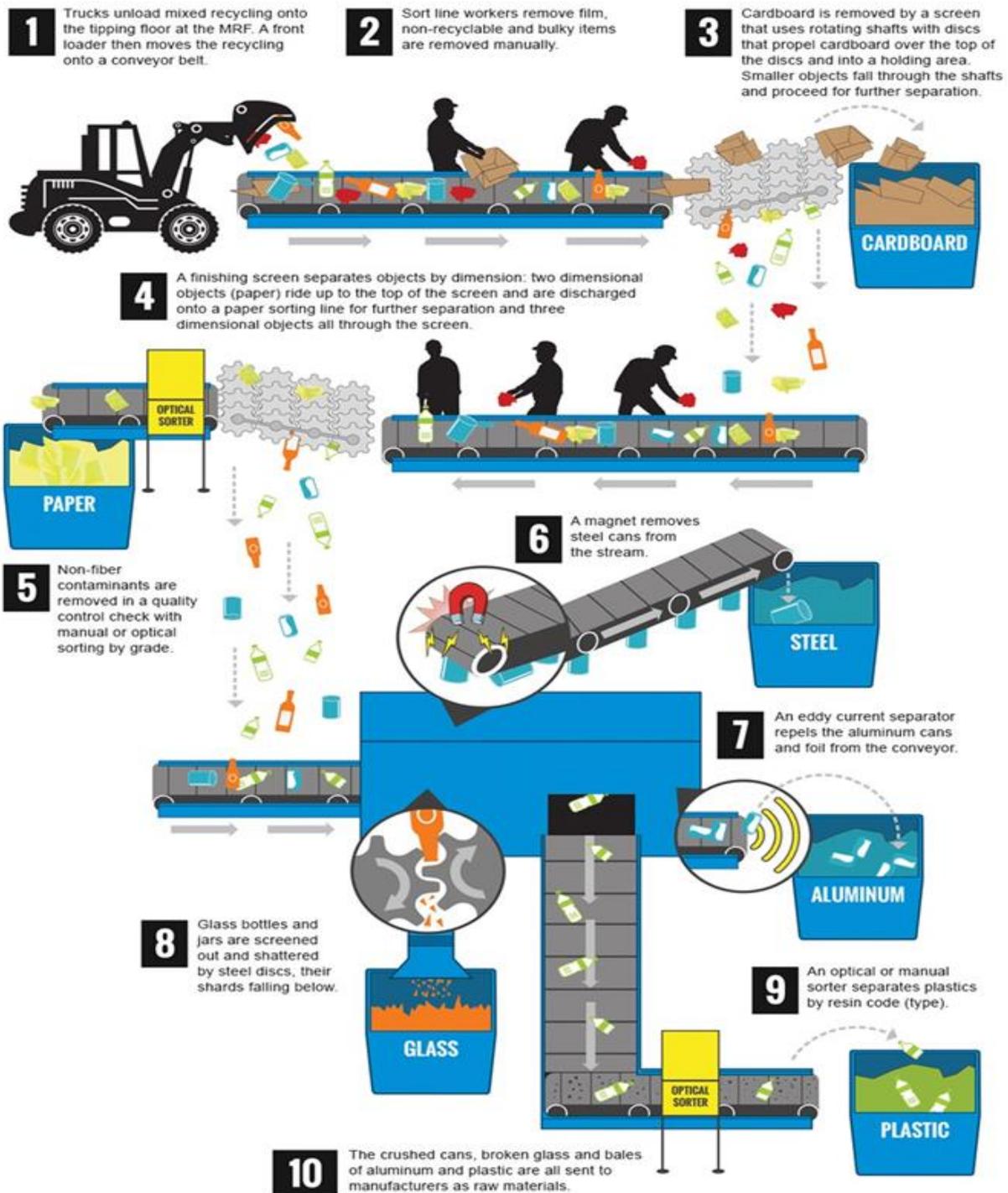
Individual municipalities may have their own specifications and regulations as to how and what materials are eligible for recycling. In addition, it is not recommended to bag recyclable materials because a hauler or recycling plant may consider it refuse or hazardous materials and discard it. Additionally, a MRF may not house the ability to sort bagged materials.

1.8 Material Recovery Facility

This study will focus on what may be required to implement and sustain a MRF in Genesee County. These facilities house large scale and highly technical machines to separate and sort the materials they receive and process them in a variety of ways to be shipped offsite to their end user customers. There are two types of MRF's, clean and dirty. A clean operated MRF separates recyclables only, while a dirty one separates materials mixed with waste. Generally, a clean MRF is far simpler to manage due to the absence of mixed waste materials and can be ran with less than a dozen line personnel in two shifts. Figure 1-C, shows a detailed diagram of the typical start to finish process of a clean MRF. It describes what happens once a truck carrying recyclables arrives at the facility and shows the individual steps taken to sort and process the materials. The layout of equipment used varies, yet the process is universally the same. We will discuss in greater detail the types of equipment generally found in a MRF in, *1.9 E*).

Standard Clean MRF Operation

Figure 1-C



Source: Advanced Disposal, 2016

1.9 Literature Review

The literature review discusses several attributes that detail the factors influencing residential recycling rates and participation. These topics include demographics, market profits, waste management, policy, and education.

1.9 A) Recycling and Demographics

Residential recycling programs have existed for decades, and have also been one of the categories that contributes a significant gain to increased participation and recycling rates. Even though there are many factors that could influence the household recycling rate, many studies have found that demographic characteristics have great impacts on the subject.

The most common demographic categories that have been discussed are age, income, and education. Our team examined that age has a positive influence on recycling rate. According to *Factors Influencing the Rate of Recycling: An Analysis of Minnesota Counties (2009)*, the middle aged population and elderly are more likely to recycle. Similarly, we found that higher education attainment has been a positive association with higher recycling rates.

In addition, our team expected that higher income demographics would lead to a higher recycling rate. However, the *Factors Influencing the Rate of Recycling* has indicated the opposite. Higher income people tend to consume more products which would generate more solid waste, yielding a lower recycling rate (Sidique, 2009). The findings in the demographic data for the municipalities found within

Genesee County matches the author's. Generally, elderly and higher educated people have a positive impact on the recycling rate. In contrast, higher incomes influence recycling rates negatively. *The Factors Influencing the Rate of Recycling (2009)*, also illustrated that for every \$1,000 increase in annual income per capita, the rate of recycling will drop by a 0.2 percentage point.

Implementing community education programs to the population would increase recycling rates by a considerable amount. The data shows for a recycling education sector, "spending one dollar per person per year will increase the rate of recycling by approximately 2%" (Sidique, 4). The report also indicated that when curbside pickup and drop-off services are implemented together, the recycling rate tends to increase. The team notes that several communities in the county currently provide curbside pickup.

1.9 B) The State of Michigan

Influenced by the huge volumes of MSW produced every year, the Michigan Department of Environmental Quality (MDEQ) utilizes data – EPA per capita estimates – towards estimating the overall amounts of MSW generated in Michigan. The estimate is at 46 million tons produced annually, a figure that would be much greater if it were not for existing practices on waste prevention. Based on the Public Act 359 (1996), which amended the state Solid Waste Management Act, landfills are required to continuously report on the total amount of MSW received from various geographical locations and sources (Solid and Waste Recycling, 2002).

Through various state laws passed during the previous decade, the state of Michigan has been able to subsequently reduce the overall amounts of MSW deposited in its landfills. In addition, such waste is often utilized in various ways such as: the barring of the deposit of yard waste from the state's landfills through establishment of composting sites; barring the discarding of tires and instead redirecting such waste to proper locations for their recycling; and the barring of all waste products having hazardous materials and/ or toxins instead requiring their depositing in specialized locations suitable for such waste management practices (Solid and Waste Recycling, 2002).

In general, Michigan's Waste Management Division (WMD) ensures the reviewing of both operating licenses and construction permits for industrial and municipal disposal facilities for non-hazardous solid-waste. In addition, it is responsible for the inspection of these sites with the aim of ensuring compliance with the set minimum operating requirements. The WMD manages the existing Disposal-Area Financial-Assurance Program that oversees facility operators as well as makes sure owners possess the necessary funds towards meeting operating costs, applying corrective action, and handling site post-closure monitoring and maintenance. Lastly, it administers both loans and grants which are related to solid waste management planning (Solid and Waste Recycling, 2002).

1.9 C) Profits and Enterprise Viability

A core issue of concern across the recycling industry is the low consumer demand, which is crucial toward ensuring overall business sustainability. To create a strong demand for recycled products; the products must be both high quality and competitively priced (Porter, 2002). This requirement is evident from the federal government's continued approach towards mandating various recycling processes, as well as setting very high recovery goals for both plastics and paper products. The aim is to avail an effective, workable approach that is unified and competently coordinated (Porter, 2002). The result is a direct challenge from the government to industry players to enhance the development of pertinent infrastructure, subsequently ensuring the incorporation of the products into existing manufacturing processes.

Demand for recyclables is also enhanced through government interventions in the form of a government-mandated demand. Dewar points to the presence of four core avenues of ensuring this sustainability: pertinent procurement policies, the 'green' labelling of recycled products, the presence of effective utilization rates, and further enhancing mandates concerned with minimum recycled content volumes. In reference to both utilization rates and mandates concerning minimum recycled content, they are important in increasing overall demand through directly engaging manufacturers to additionally include recycling processes within their various operations (Dewar, 2001).

Governments are able to further increase prevailing recycling demands by enacted procurement policies, as either price preference or set-aside programs. Set-aside programs ensure that a specific amount of company spending is solely reserved towards the recycling of materials (Pittel, 2002). On the other hand, price preference programs account for provision of adequately larger budgets in relation to the purchase of recycled items. Ultimately, it is the recycled product labeling which provides the best possible government regulatory measures, aimed at increasing demand for recyclables.

1.9 D) Recycling Policies

There are several federal and state policies and programs that strive to promote recycling in Michigan. According to Governor Snyder (2014), the MDEQ presented a plan of action whose goals are to rise the state's recycling rates to 30%. By 2015, the number of counties that can access residential recycling should increase to 29. This number should increase to 45 counties by 2016 and to 83 counties by 2017 (Snyder, 2014). This course of action strives to achieve these goals through tracking, measurement and reporting systems, increasing access to recycling opportunities, education and technical assistance programs, active innovation support and market development, continuous state-level leadership, and timely solid waste planning processes. In addition, over \$1 million was allocated to the budget proposal for boosting recycling program in Michigan.

Genesee County has advocated a new recycling process among its residents. The Keep Genesee County Beautiful is a program that offers valuable information on recycling needs and strategies for the county. According to *Keep Genesee County Beautiful (2016)*, some of the information given to community members on recycling includes acquiring blue recycling bins, water and filter collection and distribution sites, yard waste and residential garbage collection guidelines, recycling guidelines, collection maps, and recycling facilities within Genesee County that strive to promote a culture of recycling within the Genesee community.

Michiganders recycle bottle deposit returnables at a high level and more than 90% of cans and bottles are returned for the purposes of recycling (Flechter, 2016). Returnables account for only 2% of all waste products (Flechter, 2016). The rate of recycling in Michigan is estimated at approximately 15% which is lower than the majority of Great Lakes States, as well as other U.S. states. It is estimated that there are recyclable materials worth over \$435 million that could be diverted from landfills. In addition, only 23 of the total 83 counties in Michigan have convenient recycling centers for residents in terms of accessibility. According to the Department of Environmental Quality (DEQ) (2015), the primary reason for low recycling rates in Michigan are the lack of convenient access to recycling centers, lack of public awareness, and weak leadership in addressing the recycling challenge.

1.9 E) MRF Equipment

In order to maintain successful business models, it is important to understand how these facilities work. A MRF must target the recyclable materials it will be processing and distributing. Therefore, this makes it important to consider what equipment will be necessary to carry out the specific mechanical separation and sorting of the materials. (Elgar, 2014). Genesee County will primarily focus on the collection of residential recyclables.

Based on our research and site visits, the purchase of such equipment needs to be based upon their life-cycle cost/ expenditure estimates and not just the initial purchase value. Some of the equipment used in MRF's are scales (weighing); loaders (in-house movement of material); conveyors; trommels (carefully utilized for maximum material separation); vibrating screens (separating larger/ lighter waste from smaller, heavier material); magnetic separators (separation of metals); air classifiers and knives (separation of lighter containers such as plastics from heavier ones like glass), optical sorters, and balers vital in 'densifying' various materials in order to ease and enhance transportation efficiency (Beck and Associates II-8, 1991). In addition, granulators (for chopping plastics to smaller pieces); flatteners, blowers and densifiers (compressing aluminum can loads into easily transportable loads); crushers (for densifying glass) if used, and receptacles that enable efficient and effective storage of processed recyclables.

The higher the level of mechanization, the greater the frequency of mechanical breakdowns, and associated risks. Avoiding such problems related to

facility shutdowns means ensuring that internal storage and equipment redundancy of both unprocessed and processed waste materials needs to be in-built. This means that the equipment should be of quality construction, heavy duty, and designed for maximum output/ performance. Contracted mechanics and technicians should require minimum maintenance and servicing, unless a mandatory input is required. (Beck and Associates II-7, 1991). Furthermore, Material quality assurance is also an important cost risk. For example, contamination from one stream's collecting point/ jurisdiction may inherently containment other waste streams collected, and thus, causing a rejection that would be at a great cost to the municipalities, recycling facilities, stakeholders, and the MRF as a whole (Beck and Associates II-9, 1991).

1.9 F) Material Market

Recycling is a promising endeavor that not only ensures some level of environmental protection and sustainability is achieved but also can be an economically viable initiative by itself. These benefits inform the reasons why governments are continuously enhancing the recycling sector with the aim of creating economic opportunities for various sector players. Indeed, the sector is projected to be a very big and lucrative industry in the future. Sustainable development by way of recycling still remains the strategically projected avenue through which enterprise economic progression can be effectively achieved.

Before starting a MRF, it is recommended to research the field to better understand the business dynamics. Based on the findings of this research, the vast

market for the industry of recycled products generally tends to fluctuate.

Nonetheless, recycling of aluminum cans seems to hold the greatest potential due to the wide availability of the products and the good prices. This field is also critical toward supporting the environment since aluminum production often has a heavy toll on ecosystems.

It becomes apparent that recycling and subsequent composting of waste material is beneficial in a variety of ways. Not only is the environment better preserved, but also business enterprises can enhance their sustainability and corporate responsibility. Materials obtained from recycling activities notably fetch a strong price, making the activity lucrative for entrepreneurs. Striving towards sustainable development continues to yield positive results, especially when related to recycling as a business 'for profit' venture. Overall, the successes of recycling as an endeavor are founded on whether or not recycling is economically viable as an enterprise (Miller et al., 2007).

Existing marketing also issues have to be taken into account; such as competition, capacity for quality product production and assurance, waste recovery procedures, active stakeholder participation and market dynamics. This means ensuring the best possible location for the MRF; identification of key markets; enhancement of private-public partnerships and participation; determining of best possible market opportunities, and marketing capacity through cooperative marketing. Cooperative marketing aids in the provision of 'desired' economies of scale in terms of increased competitiveness (for small facilities and/ or jurisdictions) and transportation to existing markets.

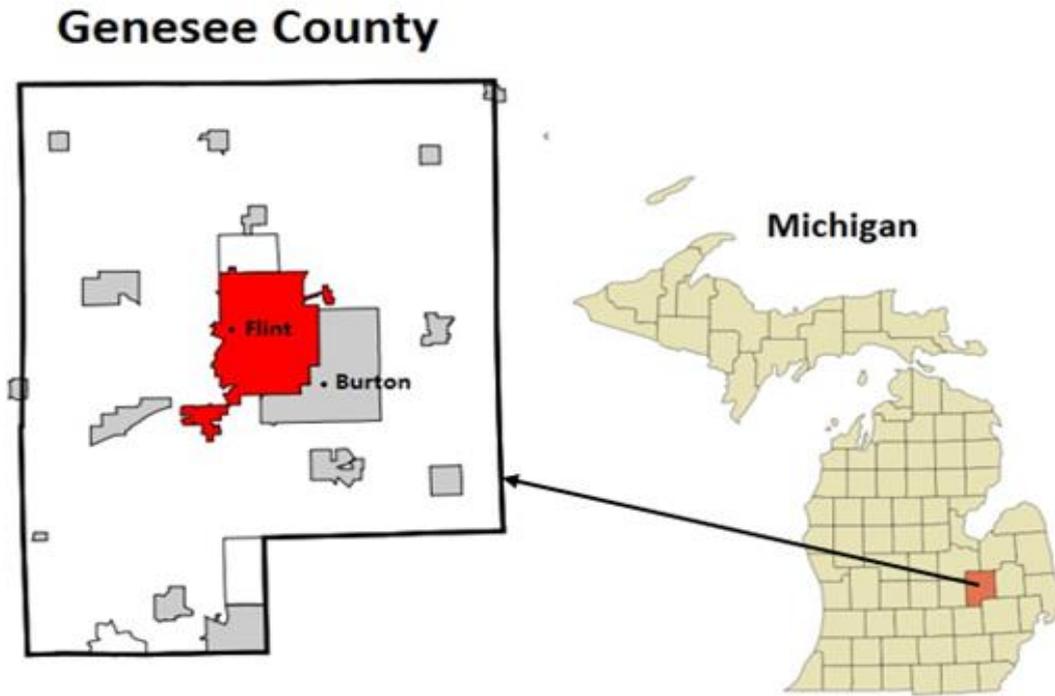
II. Genesee County Background:

This section focuses on the general land, social, and economic characteristics of Genesee County. Founded in 1837, the county land area is approximately 648 square miles and is located in the southeastern portion of the state's Lower Peninsula. The surrounding counties are Lapeer County (east), Shiawassee County (west), Oakland County (southeast), Livingston County (southwest), Tuscola County (northeast), Saginaw County (northwest). In terms of municipalities, the county is composed of 5 villages, 17 townships, and 11 cities (Genesee County, 2014).

Figure 2-A identifies the spatial location of the county within Michigan, while Figure 2-B gives a detailed satellite representation of the county with quadrant markings indicating the individual villages, townships, and cities. In Figure 2-A, we can visualize the location of Genesee County within the state and then view the county perimeter that encompasses the City of Flint in red and the remaining cities in gray.

Genesee County Location Map

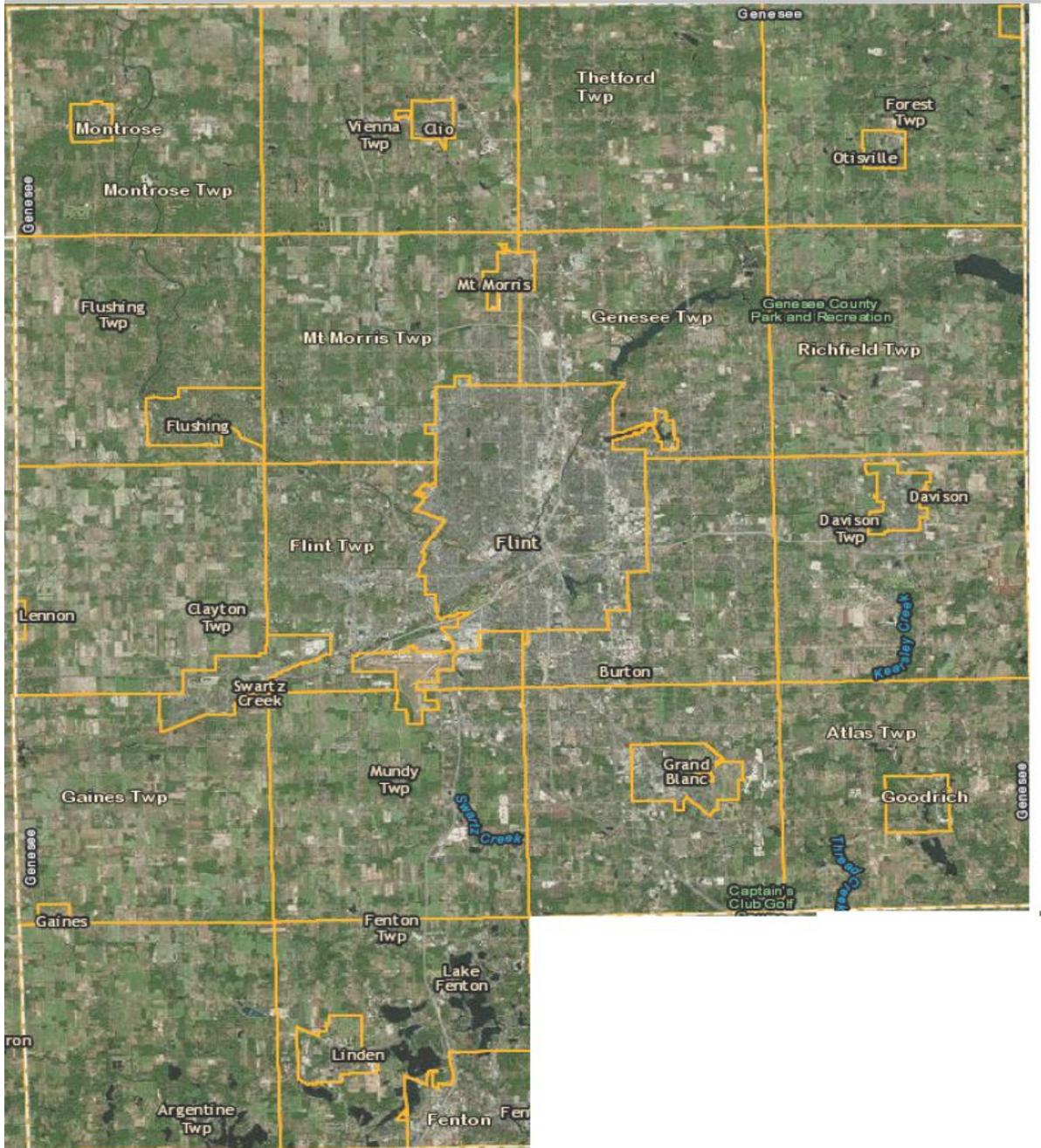
Figure 2-A



Source: Arkvan, 2007; USDA. 2007.

Satellite Imagery of Genesee County

Figure 2-B



Source: Genesee County GIS Department, 2014.

2.1 Socio-Economic Profile

This profile will cover both the State of Michigan and Genesee County. The six demographic categories that will be discussed are population, age distribution, housing occupancy, employment status, household income, and education attainment. From analyzing the collected data, the practicum team can achieve a better understanding of the targeted area.

Population

Table 2-A shows the total population for the State of Michigan and Genesee County. Between the year of 2000 and 2014, both Michigan and Genesee County were experiencing a decline in their total population. The State of Michigan had a minor rebound in 2010 comparing to 2000, whereas Genesee County has been encountering a continuous decline of population. As for Genesee County in 2014, there was a total loss of 17,487 residents within its jurisdiction which is a 4.01% decrease of the total population in 2000. Michigan's is not as significant with a loss of 49,420 residents, which is only 0.50% of the total population in 2000. However the population loss in Genesee County accounts for 35.38% of the total loss in Michigan, considering when Genesee County's land area is only 0.67% of the State of Michigan.

Table 2-A Michigan and Genesee County Populations

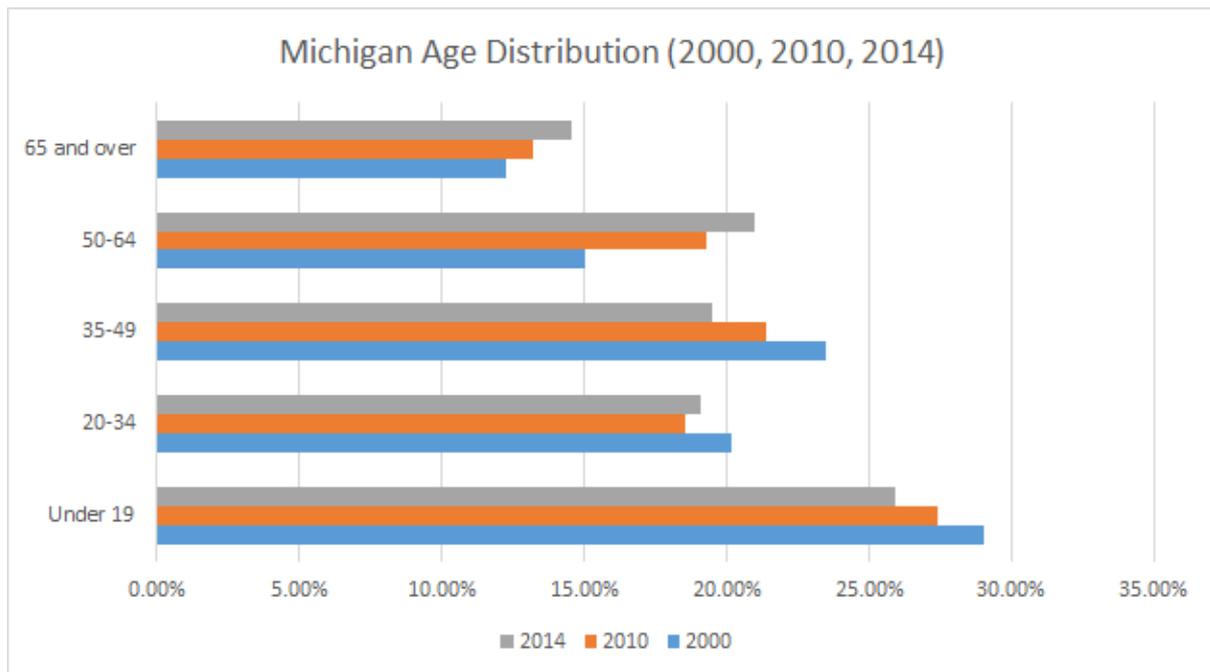
	2000	2010	2014
Michigan	9,938,444	9,952,687	9,889,024
Genesee County	436,141	433,054	418,654

Source: U.S. Census Bureau Data 2000 and 2010. ALS American Factfinder Data 2014.

Age Distribution

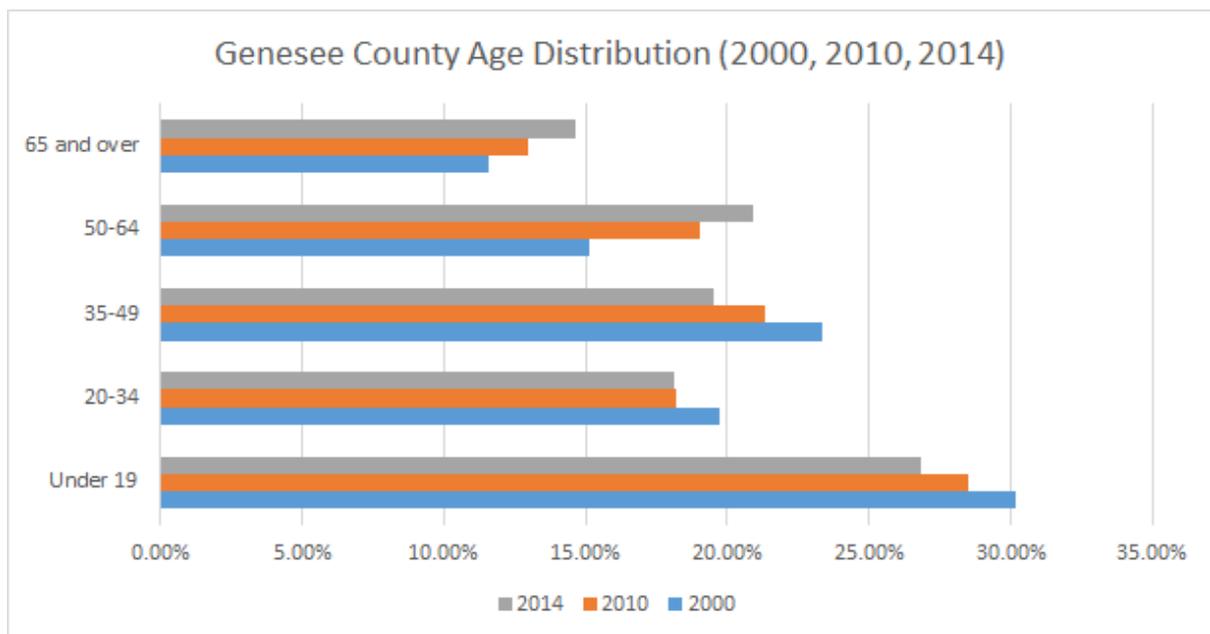
In Figures 2-C.1 and 2-C.2, both of the population distributions in the state and county have shifted towards the older age group. The populations under 49 years old has decreased over the 14 year period for both the state and the county, while the age group that is 49 years and older has increased. It shows that the younger population and workforce has moved outside both Genesee County and the State of Michigan to seek employment opportunities elsewhere. In contrast with population loss there is an increase in the retired population. Even with the population loss and the aging of population, the age group under 19 still remains the largest single category.

Figure 2-C.1



Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Figure 2-C.2



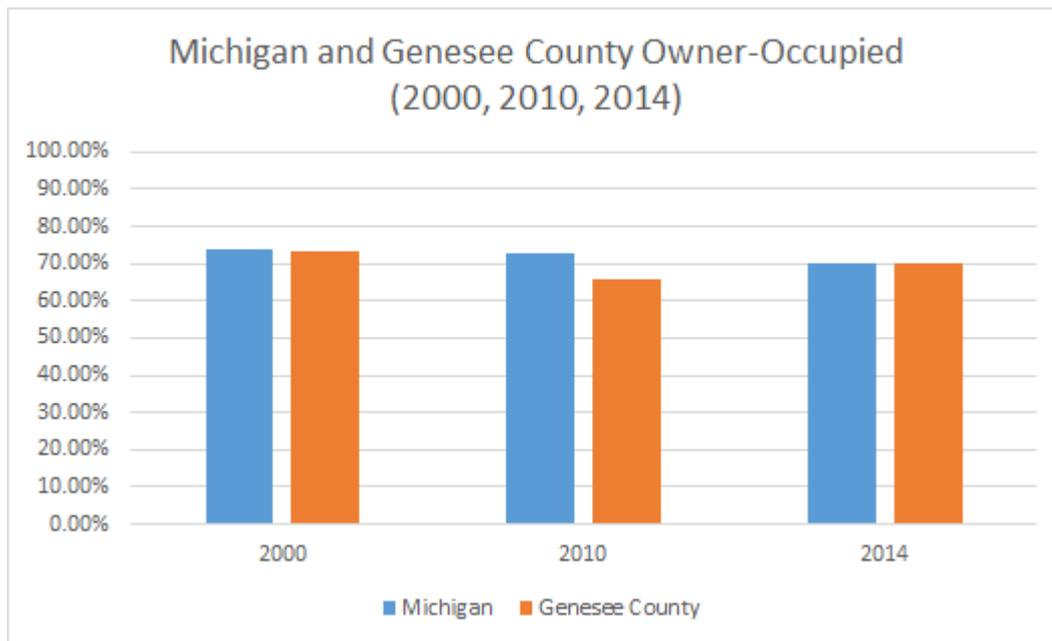
Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Housing Occupancy

The Figures 2-D.1 and 2-D.2 show that in Michigan, there were a total of 4,234,279 housing units in 2000, and as for 2014, there was an increase of more than 300,000 housing units (7.22%). However, in comparison there was a loss of housing units in Genesee County of 1192 units (-.26%) between 2010 and 2014, but an overall increase of 7,275 housing unit (3.96%). This is only half of the state percentage. At the same time, both the categories of owner and renter occupied rate had an opposite trend between Michigan and Genesee County.

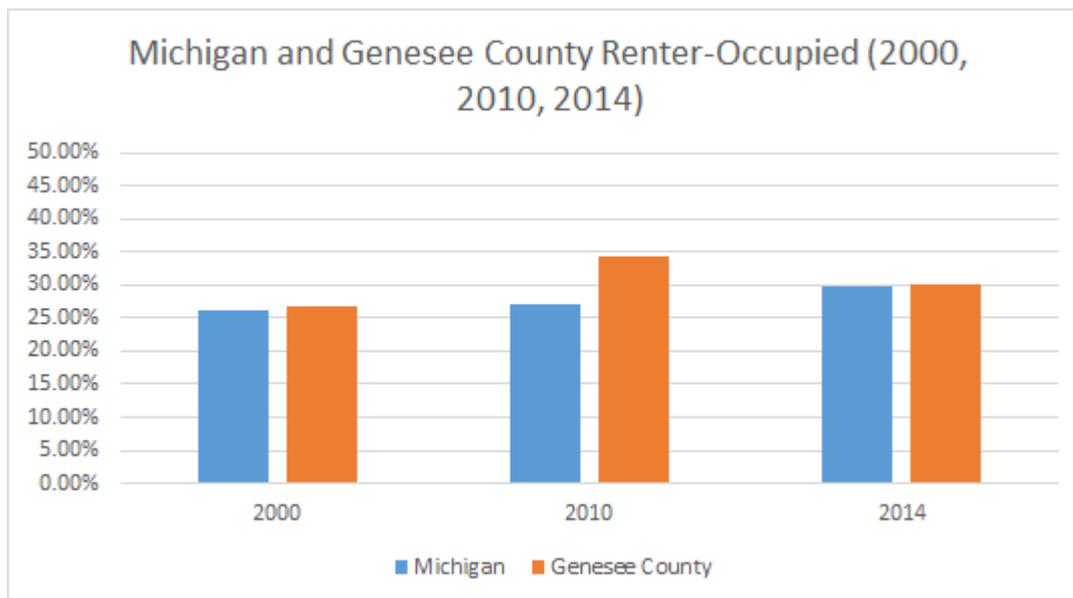
Specifically, the State of Michigan had a continuous decreasing shift, whereas Genesee County had a rise between 2000 and 2010, but then a drop in the next four years. In 2000, the Michigan owner-occupied rate is 73.80% and the renter-occupied rate is 26.20%. In 2014, it has dropped to 70.20% in the owner-occupied rate while the renter-occupied rate increased to 29.80%. In a fourteen-year period, a total of 3% shifted from the owner-occupied housing to renter-occupied housing. However, unlike the state, Genesee County actually had an opposite shift in the same time period. The total shift occurred to be 3.30%, moving from more renter-occupied to more owner-occupied housing.

Figure 2-D.1



Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Figure 2-D.2

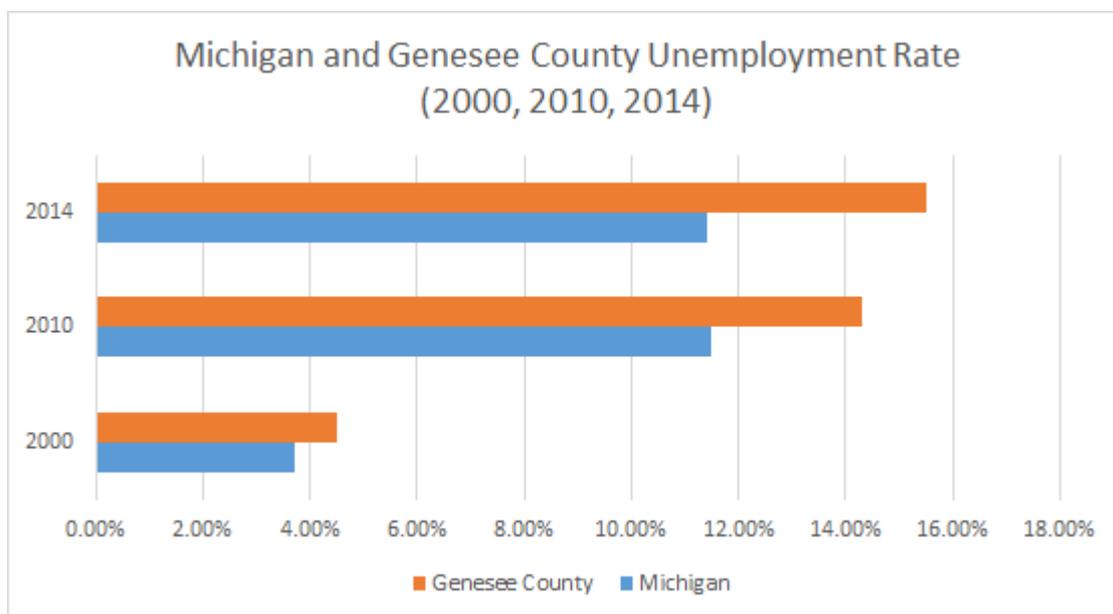


Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Employment Status

The unemployment rate in the state of Michigan and Genesee County had both increased between 2000 and 2014. According to Figure 2-E, during that time, the unemployment rate in Michigan has grown to 7.7%. Genesee County's has increased from 4.5% to 15.50%, indicating a total shift of 11.00%. The unemployment rate in Genesee County has always been higher than the state average. By 2014, the unemployment rate difference between the County and the State has reached 4.1%. With a high unemployed population, Genesee County is currently facing a low economic status.

Figure 2-E

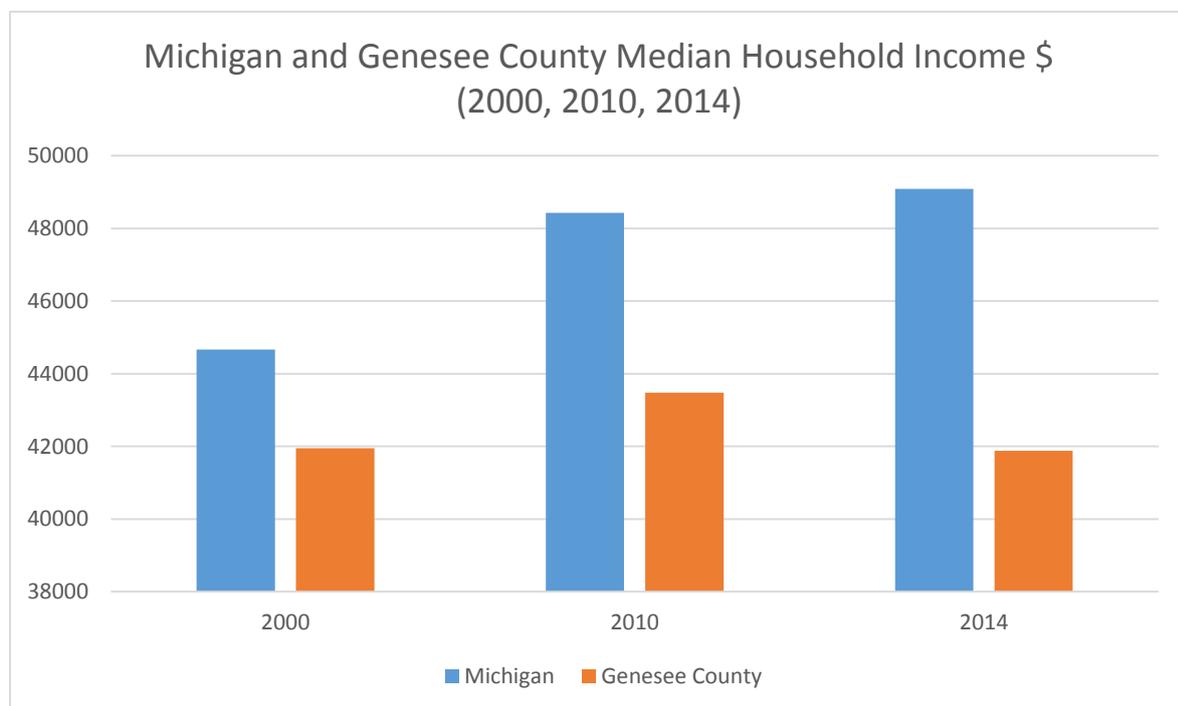


Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Household Income

Figure 2-F reflects the fact that Genesee County's median income has always been lower than the average of Michigan's. Especially in 2014, the difference has reached over \$7,000. Within Michigan, the median income increased 9.90% from \$44,667 to \$49,087 between 2000 and 2014. There was a minor median income increase of 3.65% from 2000 to 2010, but the fact that the median household income in 2014 is actually lower than fourteen years before should not be ignored. However, according to the literature review, lower median income means that Genesee County has a great potential to increase its recycling rate in the future.

Figure 2-F

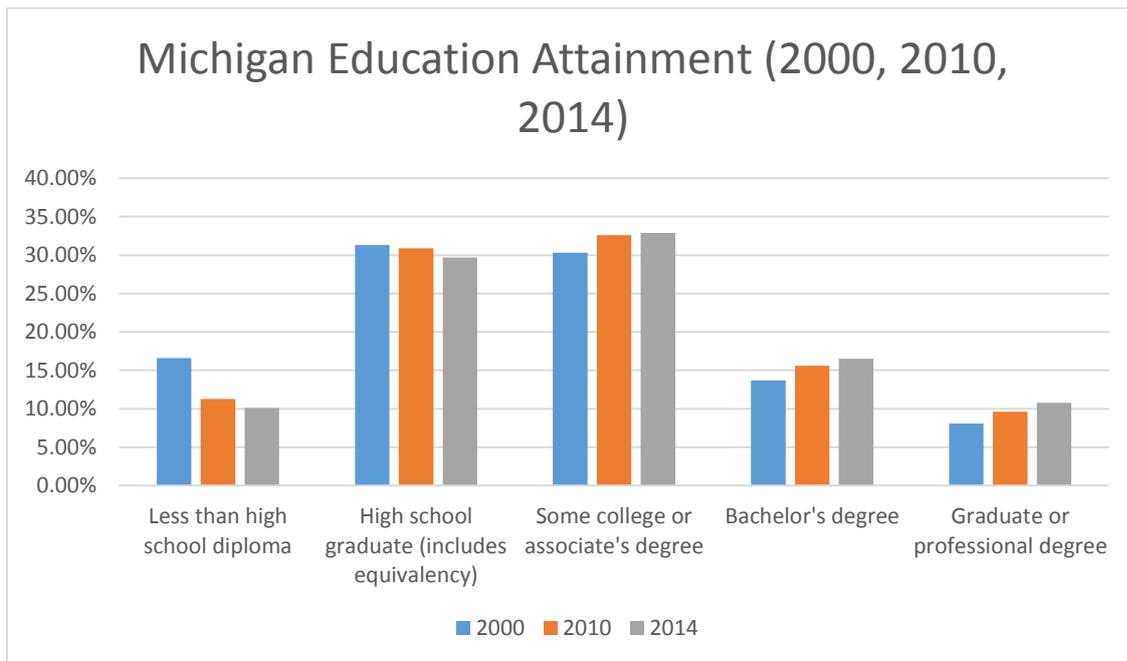


Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Education Attainment

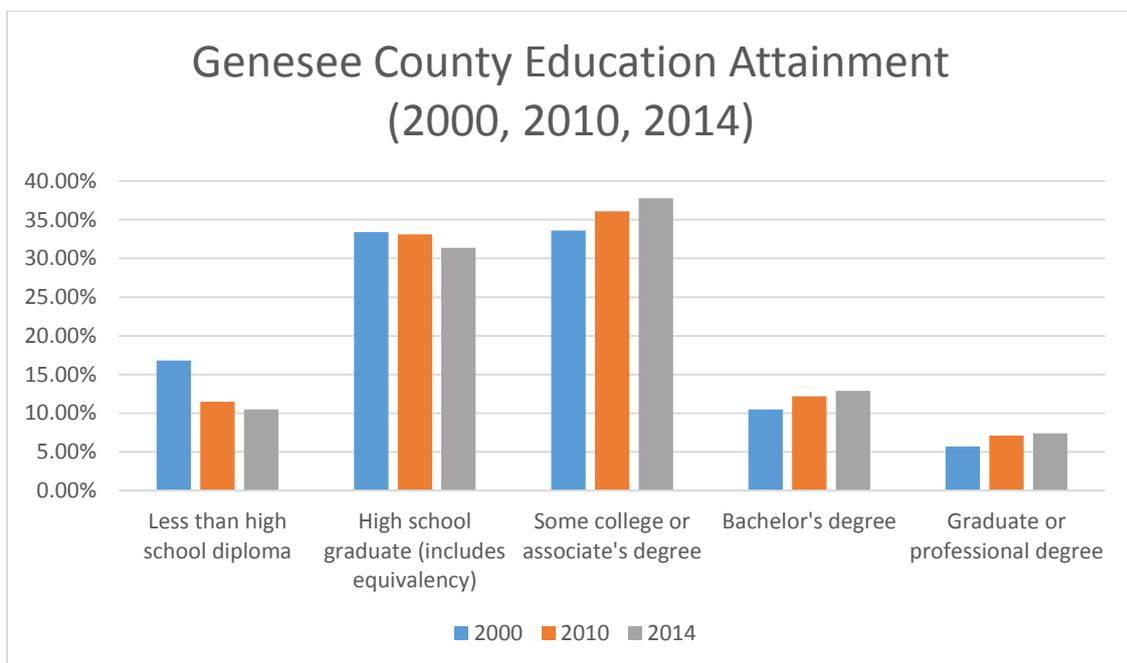
Figures 2-G.1 and 2-G.2 indicate a similar education trend in both Genesee County and Michigan. In the state of Michigan, between 2000 and 2014, there was a decrease in less than high school diploma or high school graduates. At the same time, there were more people that were attending post-secondary education in both 2000 and 2014. However, according to the data below, the largest positive change has occurred in the bachelor's degree, which is with a positive shift of 2.8%. The category for a graduate or professional degree also has a positive shift of 2.7%. Lastly, the population representing some college or associate's degree a lower positive shift of 2.6%. In comparison, Genesee County also had an increase in the same three categories. The largest change was 4.2% which was the some college or associate's degree group. And then it is bachelor degree group with a shift of 2.4%. The graduate or professional degree had a lower increase of 1.7%.

Figure 2-G.1



Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

Figure 2-G.2



Source: U.S. Census Data 2000 and 2010. ALS American Factfinder Data 2014.

SEP Summary

From the six demographic categories discussed in the previous of the section, the data shows that in addition to an aging population, Genesee County seems to be losing its residents. However, the largest age group within the county is the population under the age of nineteen. This age group may be advantageous to implementing educational recycling programs to children in primary and secondary schools, which may increase the recycling rate within the county. Similar to the state, Genesee County residents are also more likely to rent housing than in prior years. The continuous high unemployment rate could show that many residents are currently seeking employment opportunities. Median household income in Genesee County has been much lower than the state's overall rate, and in 2014, the difference between the state and the county has been the greatest. The population percentage in education attainment has been shifting towards the higher education level.

2.2 Current Recycling Rate

Representing the fifth largest county population in the state of Michigan, Genesee County has the potential to increase the state's recycling rate. Michigan currently has a recycling rate at about 15% and is one of lowest rates in the Midwest, while placing 10% behind the national average. As of 2012, Genesee had a countywide recycling rate of 6.2%. Reasons for this low rate might be the absence of curbside pickup in the City of Flint prior to 2013. Flint represents 20% of all MSW generated in the county. In 2013, Flint initiated curbside recycling which increased the city's participation rate from 5% to 16% (City of Flint, 2016). This gain is evidence of inducing a higher county recycling rate. In terms of tonnage in 2012, Genesee recycled 9,370 tons, while the state of Michigan recycled 232,623 tons of all residential recyclable materials (Annual Sustainability Report, 2013). According to this data, Genesee County is accountable for 4% of the state's recycled material, while representing just 4% of the state's total population.

The City of Flint's participation rate increased to 16% with the addition of a curbside pickup service. This indicates that providing recycling programs and collection services for larger cities would be most beneficial. Since the EPA believes 40% of MSW can be recycled and that 9,000 curbside services have already existed by 2000, Flint's implementation although late, is on track with many other nationwide municipalities that have established a 20-70% recycling goal. In order to facilitate participation in larger suburban and urban communities, curbside services should be easily accessible to a residence (Daniels and Daniels, 156,158,163).

In Table 2-B, there are listed local units of Genesee County who have already implemented curbside recycling pick-up, such as Argentine Township with a recycling rate of 1.6%, Richfield Township with rate of 1.2%, City of Mt. Morris with rate of 0.8%, and Village of Otisville with rate of 0.6%. Many of these municipalities lack public education programs on recycling and resource recovery (GCMPC, 2012). Educating the citizens in such areas would generally increase the recycling rate for those local units, which would also contribute to the augmentation of the average recycling rate for the county.

2.3 County Data Methodology

Table 2-B and 2-C include total residential materials recycled and landfilled as well as total amount of waste generated in pounds/week. Staff from the Genesee County Metropolitan Planning Commission were able to coordinate with local private waste haulers to calculate the figures for the random sampling of households regarding weight of material recycled versus the total amount of waste generated. Urban areas were defined as a minimum of 5,000 households while rural areas were classified of no more than 5,000 households. The Genesee County SWMP called for surveying at least 350 households per local unit of government in order to facilitate an accurate weight of material. For convenience, recyclable materials were not separated prior to being weighed. "Through the use of the U.S. Environmental Protection Agency's standardized method for calculating recycling rates, we were able to determine the rate for each jurisdiction sampled while using those figures to

calculate rates for jurisdictions with similar traits and number of households”

(GCMPC, 19). The calculations used were:

$$\textit{Total MSW Recycled} + \textit{Total Landfilled} = \textit{Total MSW Generated}$$

$$(\textit{Total MSW Recycled} / \textit{Total MSW Generated}) \times 100 = \textit{Recycling Rate}$$

Since the City of Flint implemented curbside recycling in 2013, the renewed data of the weight recycled materials and the recycling rate was unavailable to find. Our practicum team utilized two different calculation models to hypothesize the tonnage that Genesee County could collect after 2013 based on the new participation rate. The first set of calculations we used are the following:

$$\frac{\text{Total Material Collected in 2012}}{\text{Total \# of Participated Household in 2012}} \times \text{Total \# of Participated Household in 2013}$$

Genesee County Total Recycled Tons with City of Flint 16%

Participation Rate

9,658 tons/year

Genesee County Total Recycled Tons with City of Flint 30%

Participation Rate

10,239 tons/year

On average, in 2012, each household in the City of Flint would contribute 0.073 ton/year. However, after the City of Flint had implemented curbside pickup, the total number of participating housing unit increased from 2,024 to 5,970, and the participation rate went from 5% to 16%, which would contribute 425 tons/year recycled materials. In 2013, total tonnage for Genesee County increased from 9,233 to 9,658 tons/year. According to the Genesee County Solid Waste Management Plan and our research, it is achievable for all the municipalities to reach a participation rate of 30%. After using the same method of calculations, the total tonnage for Genesee County would be a total of 10,239 tons/year.

The second calculation method we used is from a study conducted in 2009 by Michigan State University. According to, *Factors Influencing the Rate of Recycling: An Analysis of Minnesota Counties*, the report's model showed that, "a 1 percentage point increase in access increases recycling rate by 0.04 percentage point" (Sidique, 4). With the second calculation method, the 2012 City of Flint recycling rate of 0.4% would now increase to a new recycling rate of 0.84%, based on the increase of the participation rate from 5% to 16%. Inputting the data into the previous calculation, we have found that Genesee County have recycled a total of 9,499 tons/year in 2013.

Comparing the output data from both models, we believe that Genesee County could roughly generate 9,500 tons of recycled material per year. However, with the proper educational programs and potential recycling ordinance implemented, we expect continuous growth in the weight of the volume of total recycled materials.

It is noted that due to the 2016 water crisis currently happening in Flint, there has been a massive use of plastic PET water bottles for public consumption. Millions

of water bottles have been donated and delivered to the lead contaminated communities of Flint. An estimated 176,000 cases of bottled water have been provided by the state since the declaration of the emergency (Karidis, 2016). This source alone would yield approximately, 50 tons of additional PET water bottles that would not only need to be recovered, but also contribute to the weighted volume of recycled materials in the county. Currently, this 50 tons of added material in the stream accounts for a half of one percent of all of the recyclables materials recovered by the county. That percentage will continue to grow as long as residents are reliant on bottled water and the water crisis is not treated.

2012 Genesee County Municipal Residential Recycling Rates

Table 2-B

Local Units of Government	Total Recycled (lbs/wk)	Total Landfilled (lbs/wk)	Total Waste Generated (lbs/wk)	Recycling Rate
Argentine Township	1,628	102,000	103,628	1.60%
Atlas Township	2,157	88,000	90,157	2.40%
Clayton Township	4,716	96,077	100,793	4.70%
Davison Township	19,503	209,885	229,388	8.50%
Fenton Township	14,695	257,692	272,387	5.40%
Flint Township	51,000	526,000	577,000	8.80%
Flushing Township	13,333	156,692	170,026	7.80%
Forest Township	2,197	53,769	55,966	3.90%

Gaines Township	3,602	90,308	93,909	3.80%
Genesee Township	25,297	345,577	370,874	6.80%
Grand Blanc Township	63,933	427,115	491,049	13.00%
Montrose Township	5,034	113,500	118,534	4.20%
Mt. Morris Township	11,547	316,308	327,854	3.50%
Mundy Township	17,859	214,000	231,859	7.70%
Richfield Township	1,437	119,192	120,629	1.20%
Thetford Township	2,863	98,692	101,555	2.80%
Vienna Township	6,619	102,000	108,619	6.10%
City of Burton	36,588	363,808	400,395	9.10%
City of Clio	7,251	98,692	105,944	6.80%
City of Davison	2,742	59,769	62,512	4.40%
City of Fenton	15,776	128,308	144,084	10.90%
*City of Flint	5,666	1,257,385	1,263,051	0.4%
City of Flushing	10,370	156,692	167,062	6.20%
City of Grand Blanc	10,704	63,615	74,319	14.40%
City of Linden	4,235	53,692	57,927	7.30%
City of Montrose	1,943	21,308	23,251	8.40%
City of Mt. Morris	403	51,692	52,095	0.80%
City of Swartz Creek	13,626	60,462	74,087	18.40%

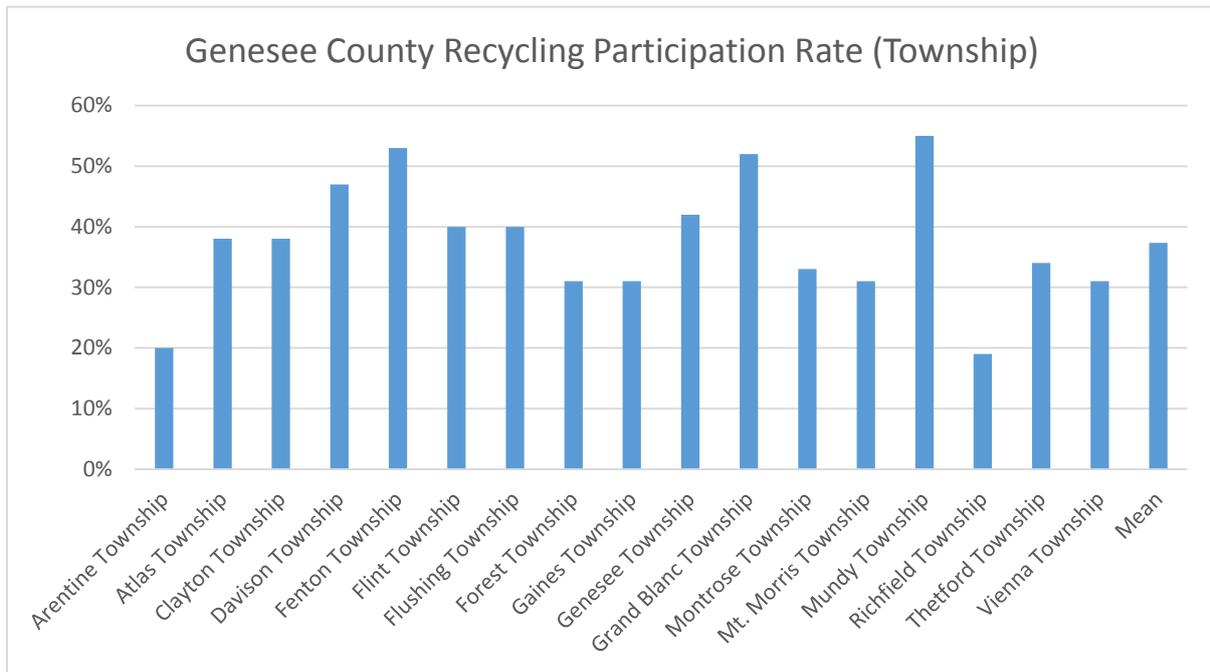
Village of Gaines	237	5,231	5,468	4.30%
Village of Goodrich	2,784	26,346	29,130	9.60%
Village of Lennon	278	6,577	6,855	4.00%
Village of Otisville	54	9,538	9,592	0.60%
Village of Otter Lake	322	5,692	6,014	5.40%
Total	360,398	5,685,615	6,046,013	6.20%

Source: GCMPC 2012.

* Indicates a 2012 calculated estimate rate that does not reflect the addition of curbside pickup in 2013. Figures unavailable.

2.4 Participation Rate

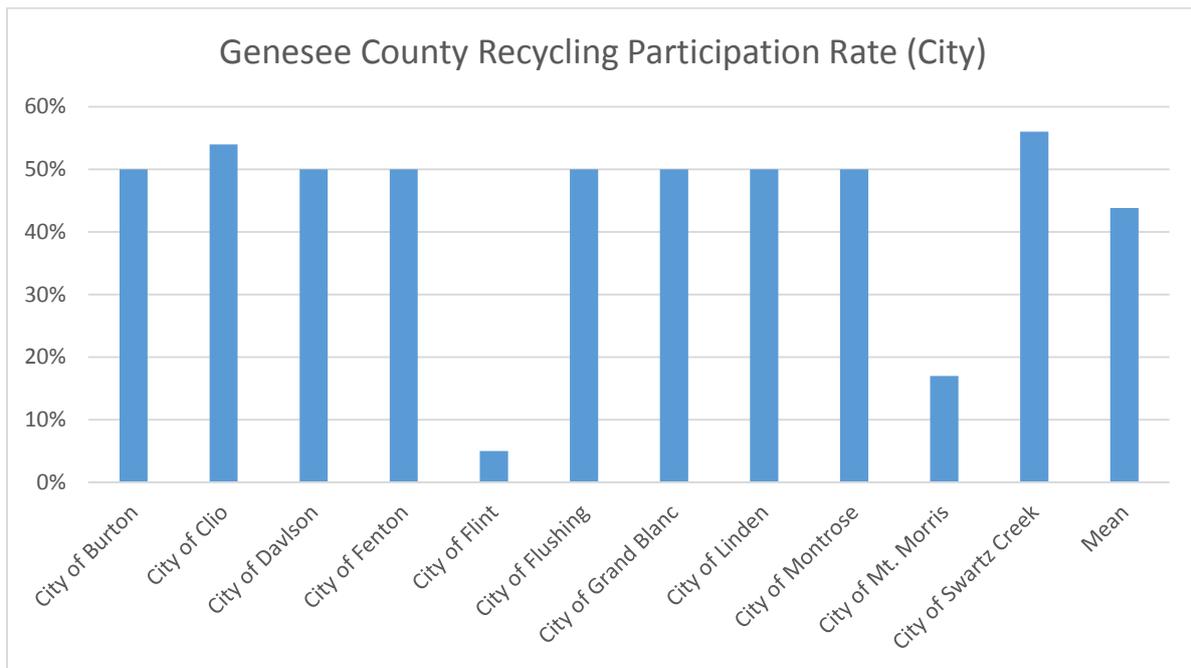
Figure 2-H.1



Source: GCMPC 2012.

Figure 2-H.1 shows the recycling participation rate in Genesee County for each township. The mean participation rate for those 17 townships is 37%. There are 8 townships with a participation rate lower than the average, which are Argentine Township (510 households), Forest Township (467 households), Gaines Township (766 households), Montrose Township (636 households), Mt. Morris Township (2457 households), Thetford Township (839 households), Vienna Township (1408 households), Richfield Township (568 households). Three townships have a participation rate of over 50%, which are Fenton Township (3094 households), Grand Blanc Township (5608 households), and Mundy Township (2952 households).

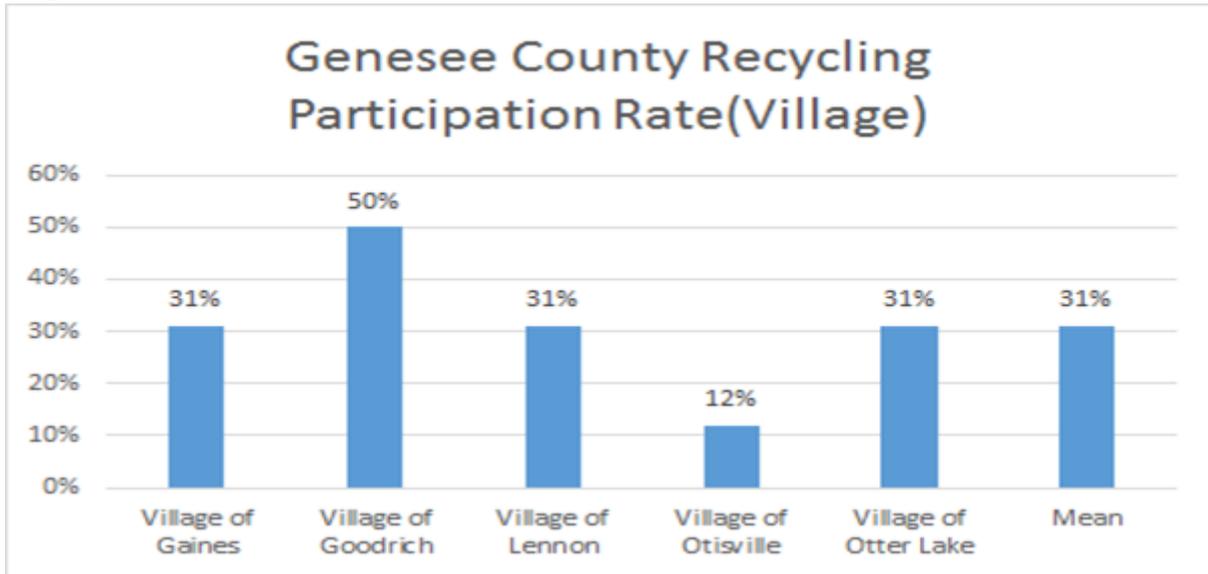
Figure 2-H.2



Source: GCMPC 2012.

Figure 2-H.2 shows the recycling participation rate in Genesee County for each city. Most cities' participation rate is equal to or above 50%, while the average rate is 44%. City of Clio (556 households) and City of Swartz Creek (1230 households) are greater than the 50% participation rate. Only two cities are under the average, which are the City of Flint (5,970 households) at 16% and the City of Mt. Morris (182 households) at 17%.

Figure 2-H.3



Source: GCMPC 2012.

Figure 2-H.3 shows the recycling participation rate for each village in Genesee County. The Village of Goodrich (269 households) has the highest rate, which is 50%, while the Village of Otisville (34 households) has the lowest rate of only 12%. The average is 31%, indicative that most villages have exceeded the average, with the exception of the Village of Otisville.

2.5 Existing Recycling Programs

The municipalities listed in Table 2.C all currently have private recycling curbside pickup services, except for the Villages of Lennon and Otter Lake. The City of Clio, City of Grand Blanc, Fenton Township, Flint Township, Flushing Township, Genesee Township, and Grand Blanc Township are collected weekly. The other Genesee County cities, townships, and villages are collected biweekly. Figure 2.14 shows not only collection point and frequency but also tells us that every municipality's curbside service is developed, operated, and evaluated entirely by private owners/operators. The City of Flint is the most recent municipality to initiate a curbside pickup service.

Existing Genesee County Recycling Collection Programs

Table 2-C

Program Name	Service Area 1	Public or Private	Collection Point 3	Collection Frequency 4	Program Development 2	Management Operation 2	Responsibilities Evaluation 2
Cities							
Recycling	Burton	Private	c	b	5	5	5
Recycling	Clio	Private	c	w	5	5	5
Recycling	Davison	Private	c	b	5	5	5
Recycling	Fenton	Private	c	b	5	5	5
Recycling	Flint	Private (2013)		b	5	5	5
Recycling	Flushing	Private	c	b	5	5	5

Recycling	Grand Blanc	Private	c	w	5	5	5
Recycling	Linden	Private	c	b	5	5	5
Recycling	Montrose	Private	c	b	5	5	5
Recycling	Mt. Morris	Private	c	b	5	5	5
Recycling	Swartz Creek	Private	c	b	5	5	5
Townships							
Recycling	Argentine	Private	c	b	5	5	5
Recycling	Atlas	Private	c	b	5	5	5
Recycling	Clayton	Private	c	b	5	5	5
Recycling	Davison	Private	c	b	5	5	5
Recycling	Fenton	Private	c	w	5	5	5
Recycling	Flint	Private	c	w	5	5	5
Recycling	Flushing	Private	c	w	5	5	5
Recycling	Forest	Private	c	b	5	5	5
Recycling	Gaines	Private	c	b	5	5	5
Recycling	Genesee	Private	c	w	5	5	5
Recycling	Grand Blanc	Private	c	w	5	5	5
Recycling	Montrose	Private	c	b	5	5	5
Recycling	Mt. Morris	Private	c	b	5	5	5
Recycling	Mundy	Private	c	b	5	5	5
Recycling	Richfield	Private	c	b	5	5	5
Recycling	Thetford	Private	c	b	5	5	5

Recycling	Vienna	Private	c	b	5	5	5
Villages							
Recycling	Gaines	Private	c	b	5	5	5
Recycling	Goodrich	Private	c	b	5	5	5
Recycling	Otisville	Private	c	b	5	5	5

Source: GCMPC 2012.

1 Identified by where the program will be offered. If throughout the planning area, then listed by planning area; only in specific counties, then listed by county; if only in specific municipalities, then listed by its name and respective county.

2 Identified by 1 = Designated Planning Agency; 2 = County Board of Commissioners; 3 = Department of Public Works; 4 = Environmental; 5 = Private Owner/Operator; 6 = Other 3

3 Identified by c = curbside; d = drop off; o = onsite; and if other explained

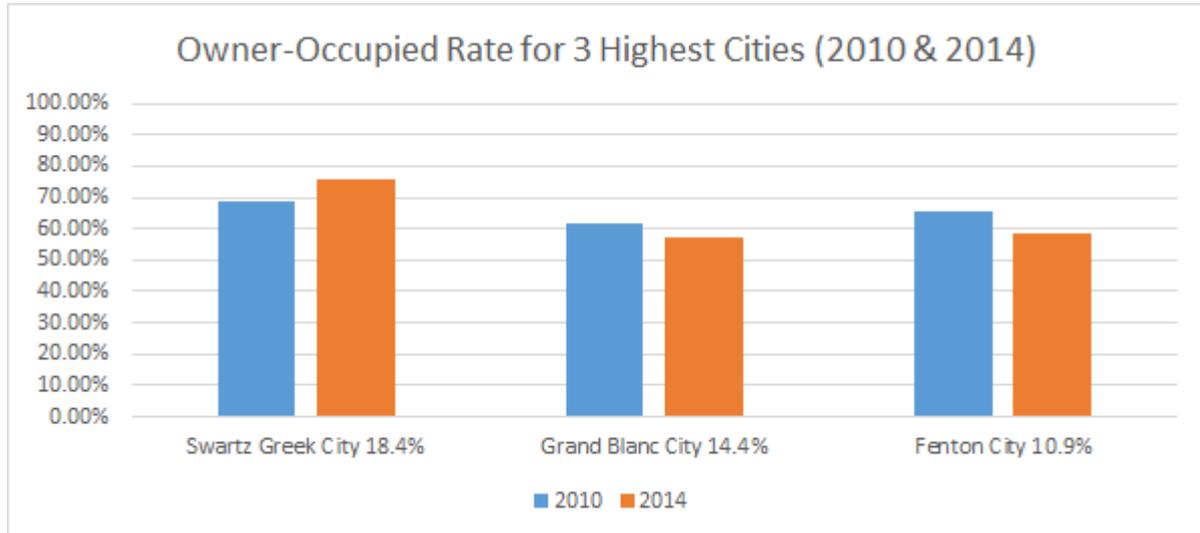
4 Identified by d = daily; w = weekly; b = biweekly; m = monthly; and if seasonal service also indicated by Sp = spring; Su = summer; Fa = fall; Wi = winter

2.6 Three Highest and Three Lowest Recycling Rate Municipalities in Genesee County

In this section of the feasibility study, the demographic characteristics of the top three and lowest three local units are ranked by recycling rate from the 2012 Genesee County SWMP. From analyzing this data, we can see the trend of which population group or groups are more or less likely to recycle in Genesee County, correlating with the literature review. We chose to examine the percentage of homeowners and renters, education attainment, median age, unemployment rate, and median income. We believe that these are the most pertinent characteristics in recognizing what socio economic trends affect recycling participation and recycling rate.

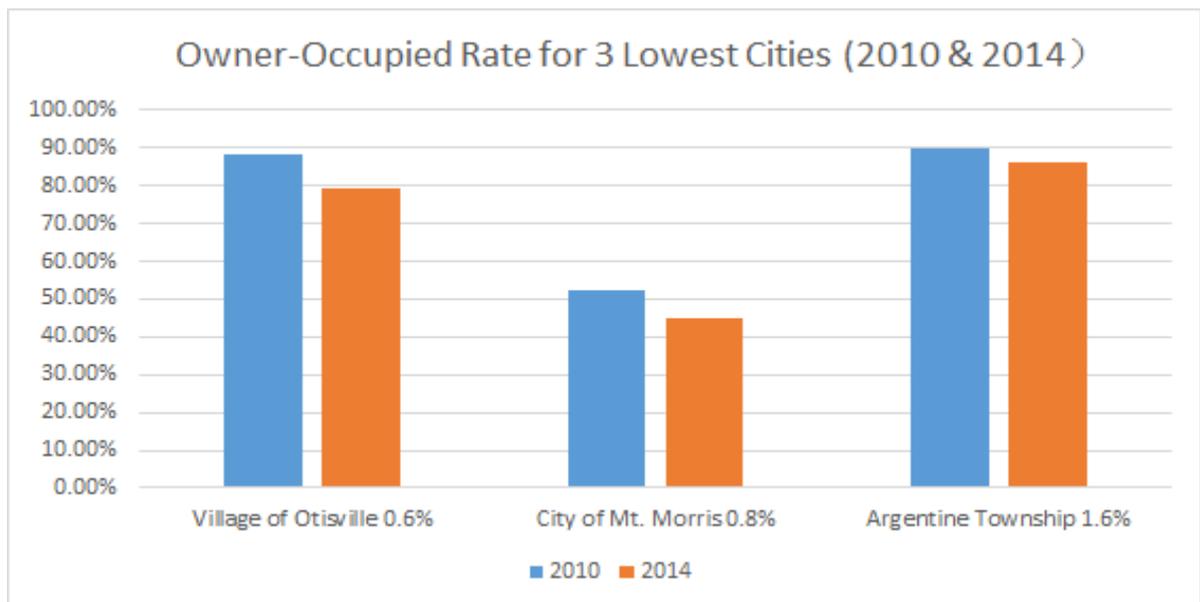
Owner vs. Renter Residential Housing

Figure 2-I.1



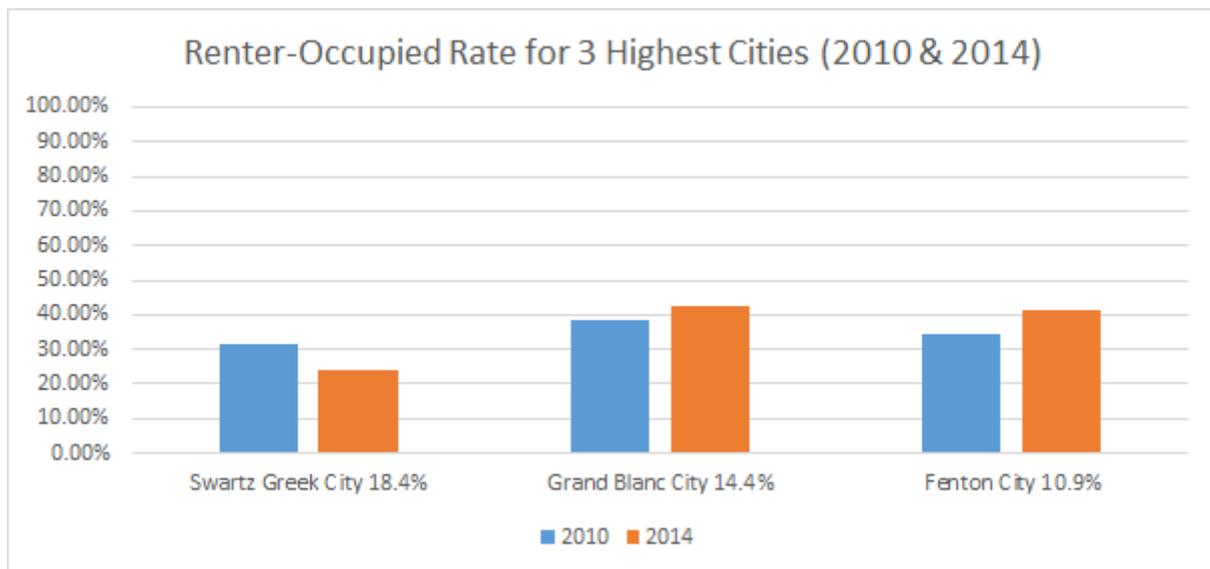
Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-I.2



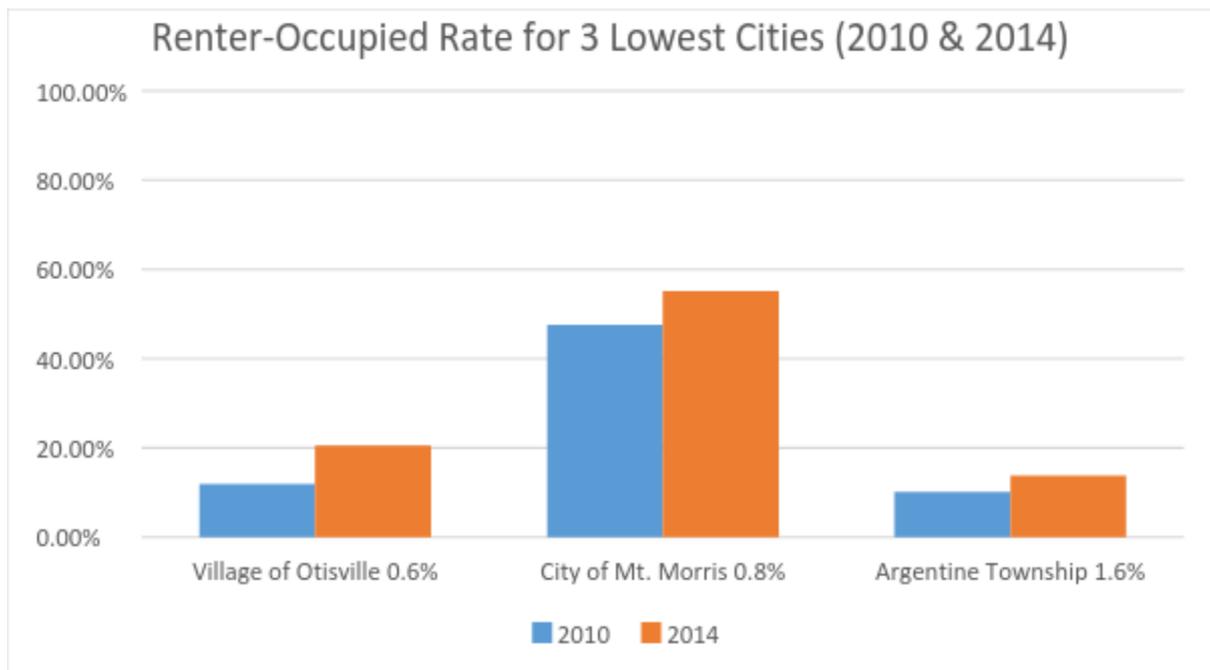
Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-I.3



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-I.4

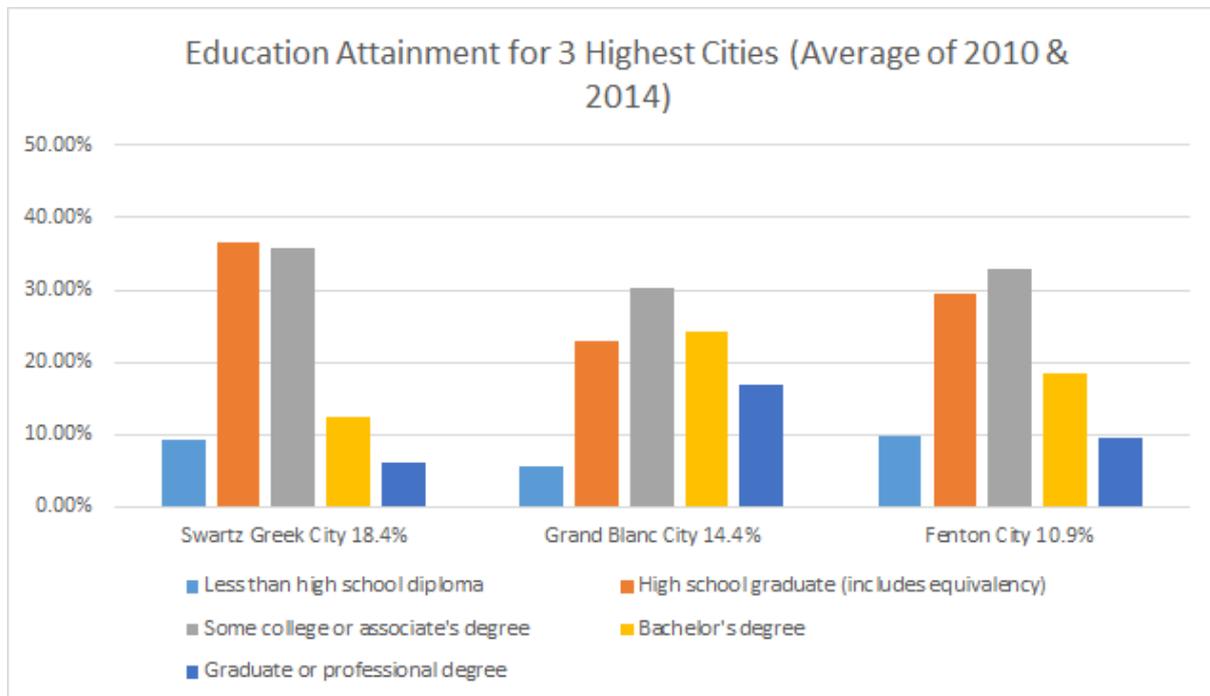


Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figures 2-I.1 – 2-I.4 show the percentage of occupancy between owners and renters. The percentage of owner occupied housing is greater than the renter occupied for all the six local units. Comparing Figures 2-I.1 – 2-I.4, the three communities with the lowest recycling rates are slightly more likely to own houses than the residents in the highest rate of recycling. From the data of the six municipalities, our team expects that renters recycle more than homeowners.

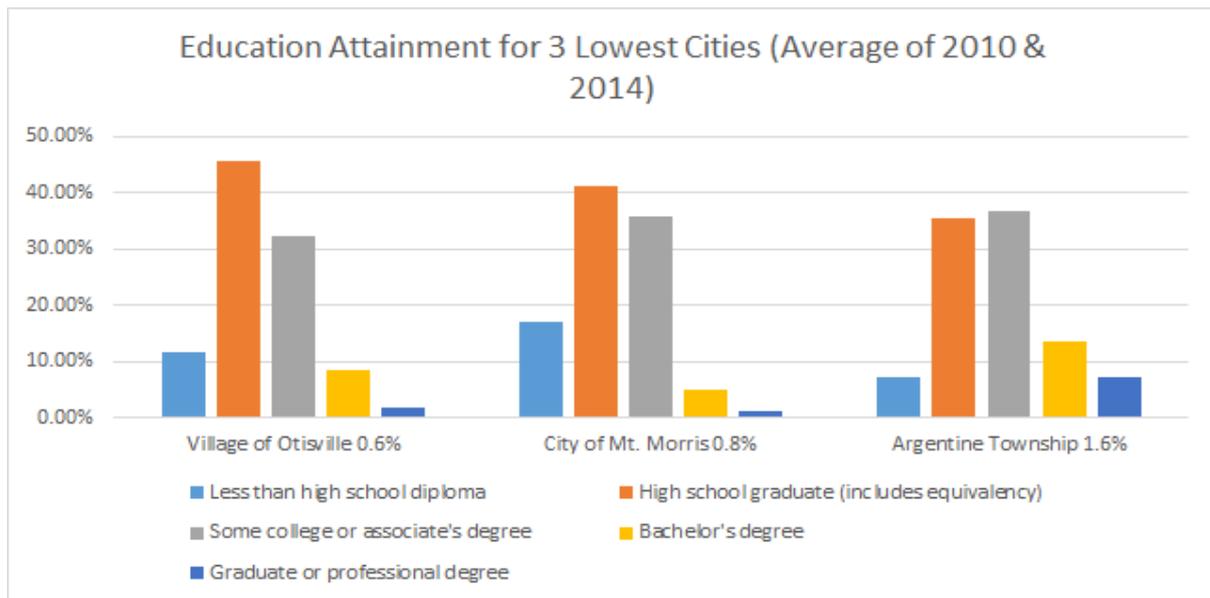
Education Attainment

Figure 2-J.1



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-J.2



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

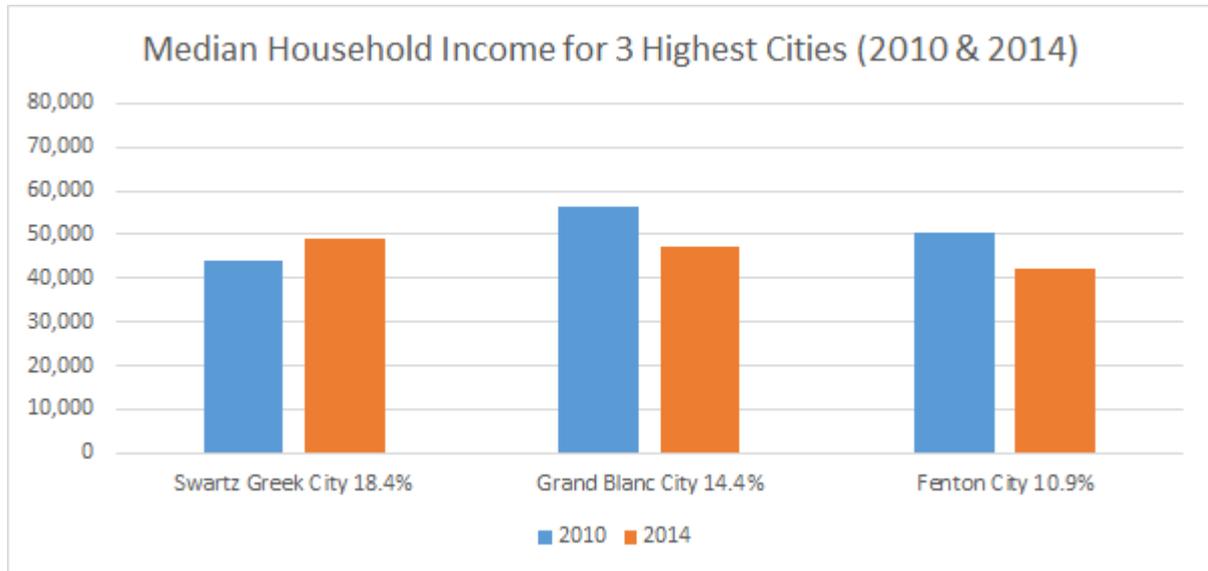
Figures 2-J.1 and 2-J.2 shows the education attainment for the targeted local units within Genesee County. Education is listed between less than high school through higher education. Our team has expectations that a person's education may impact their overall recycling participation.

In Figure 2-J.1, the group of people who attained some college or received an associate's degree has the highest population percentage. In comparison and on average, the top three units have higher percentages of population who have reached higher education level than the three lowest. In Figure 2-J.2, the highest percentage is the high school graduates population. The graduate or professional degree group has a relatively low percentage comparing to those three units with a higher recycling rate. This indicates that education attainment could be a factor that influences the recycling rate. The results show that higher education achievement

influences recycling rate positively, which matches the conclusion from the previous literature research.

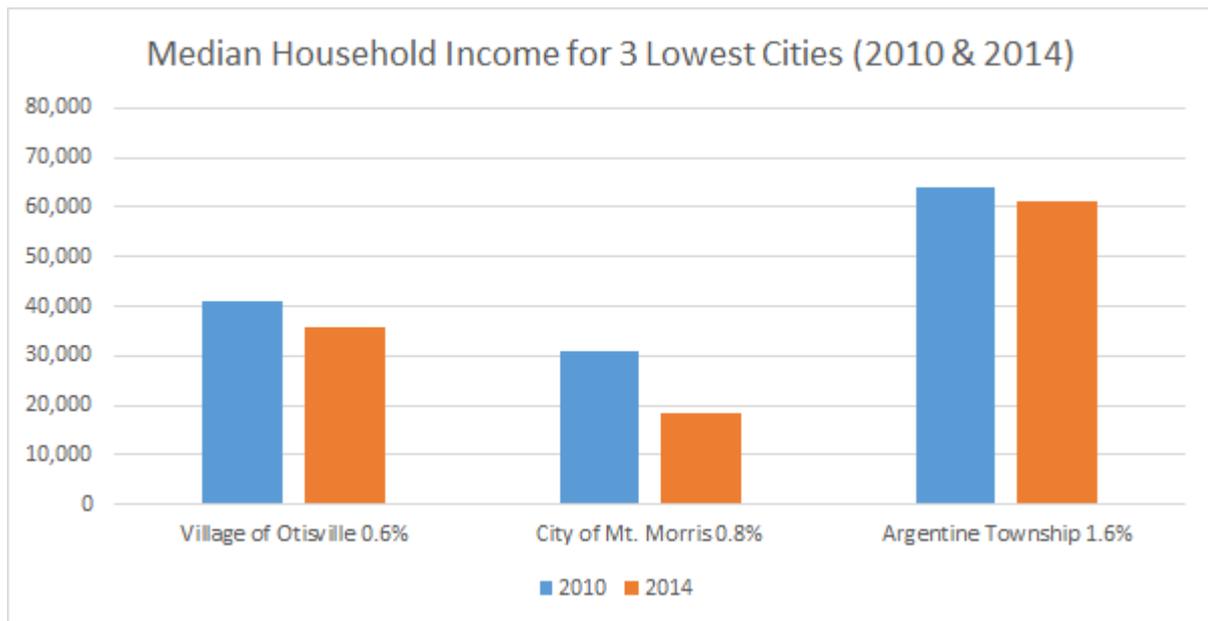
Median Household Incomes

Figure 2-K.1



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-K.2

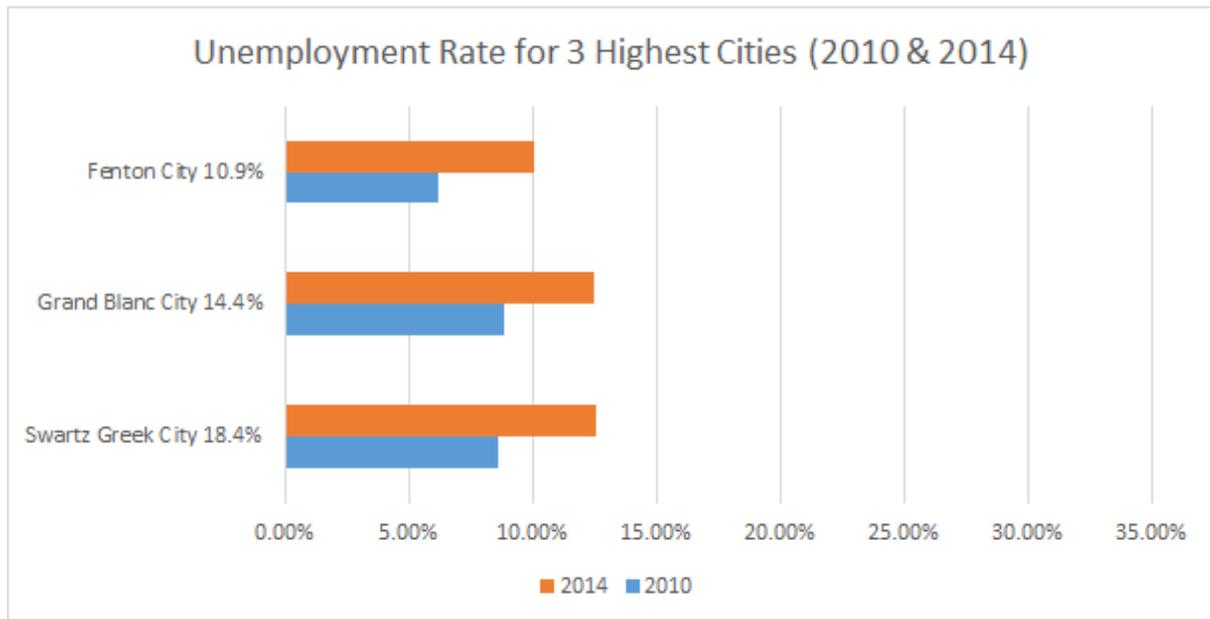


Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

From Figure 2-K.1 and Figure 2-K.2, the data shows that for most units with higher median household income tend to have higher recycling rate. This is the opposite than the results from the previous research. However, Argentine Township is an exception, where with the highest median household income between all six municipalities has a relatively low recycling rate of 1.6%.

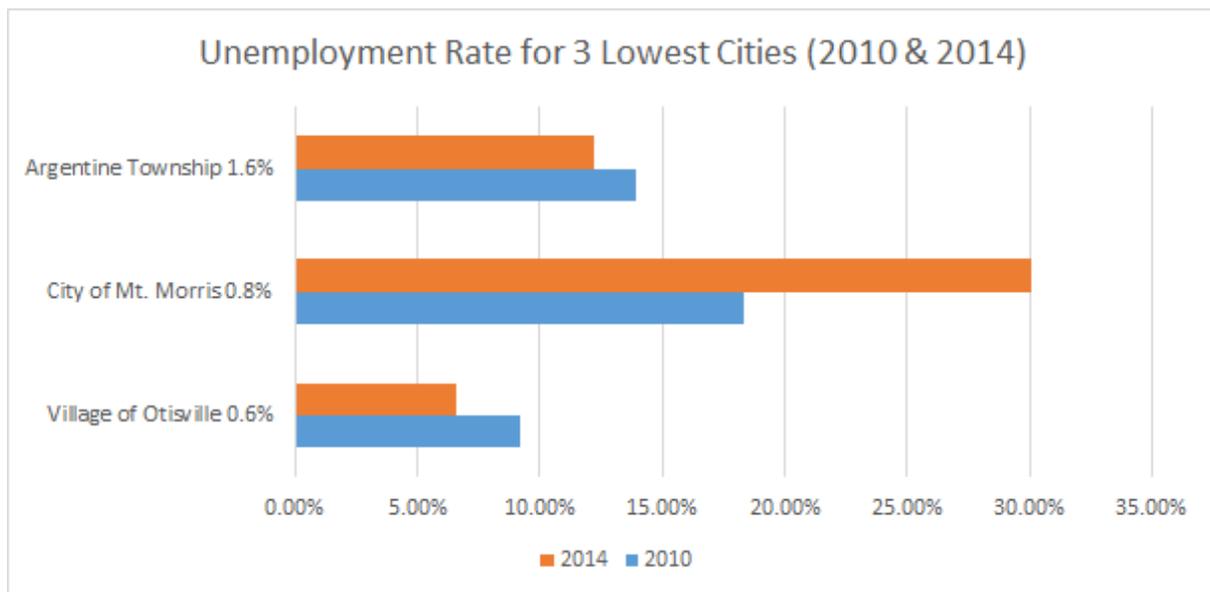
Unemployment Rate

Figure 2-L.1



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-L.2

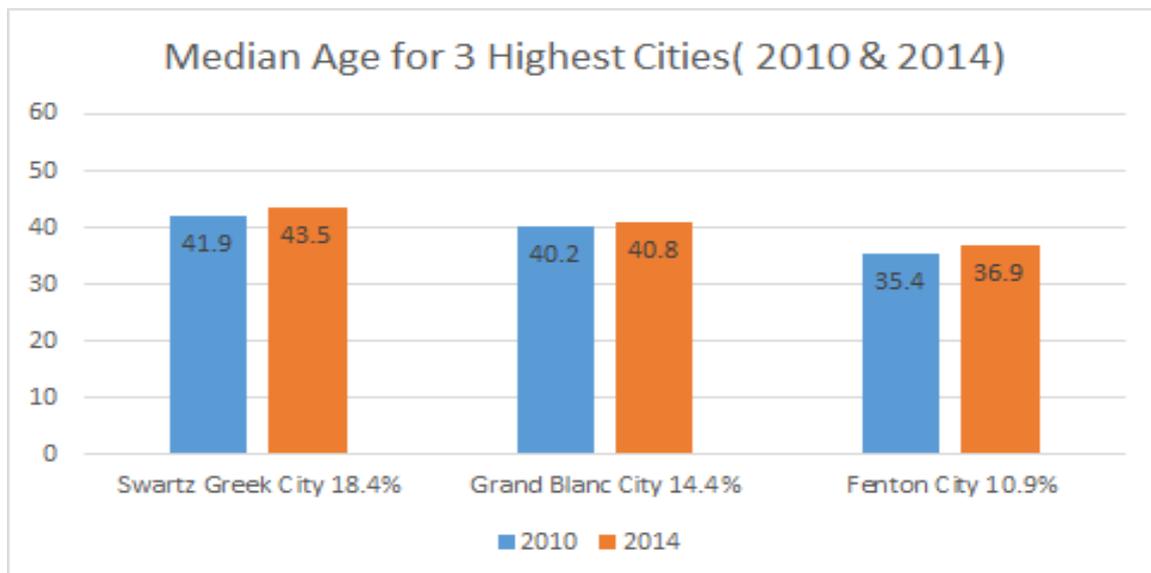


Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figures 2-L.1 and 2-L.2 reflect the unemployment rate for the top three and lowest units. Our team believes that unemployment rate has a negative correlation with the recycling rate. The collected data has shown that the cities who have higher recycling rates tend to have relatively lower unemployment rates, which in contrast, higher unemployment rates are associated with lower recycling rates.

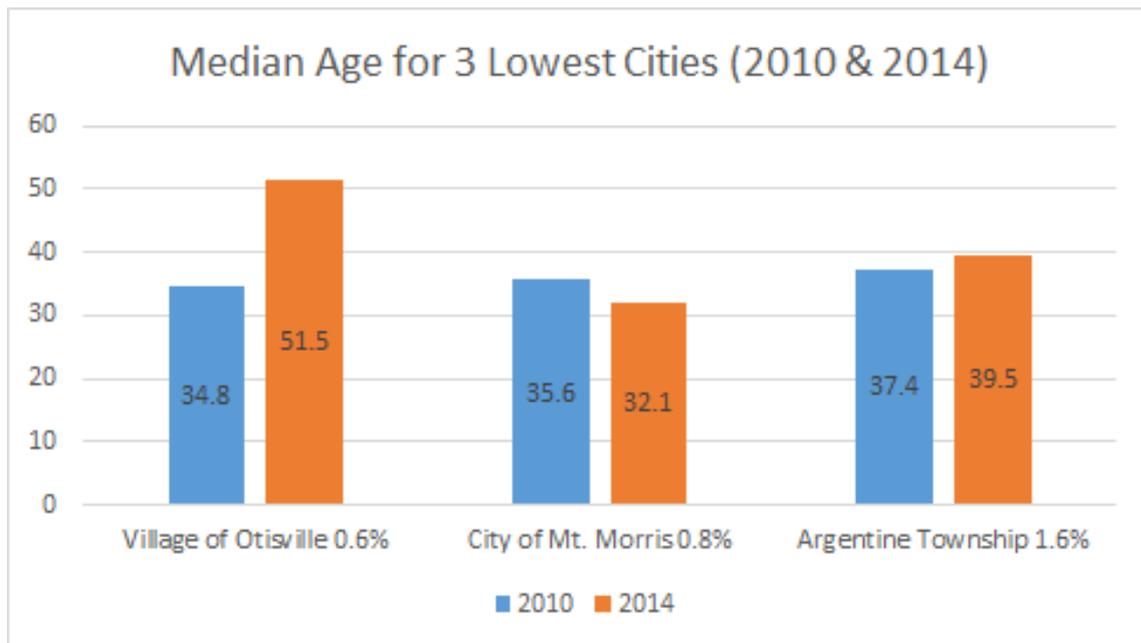
Median Age

Figure 2-M.1



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

Figure 2-M.2



Source: U.S. Census Data 2010. ALS American Factfinder Data 2014.

The range of the median age between the three units are 36.9 - 41.9 years old in 2010. In 2014, the range shifted to 35.4 - 41.9 years old, which indicates that the general population within these six cities has grown older than four years before. While the City of Flint has the relatively youngest population, the City of Swartz Creek has the relatively oldest population with the highest recycling rate of 18.4%.

The range of the median age between the three units is 34.8 - 37.4 years old in 2010. In 2014, the range shifted to 32.1 - 51.5 years old, which indicates that the general population within these three cities has grown older than four years before.

III. Site Criteria:

3.1 Transportation Infrastructure

It is expected that the Genesee MRF will provide recycling households that are underserved within the community. The MRF should be designed in such a way as to accommodate high volumes of vehicular traffic as anticipated, and this includes heavy equipment, public vehicles, and trucks that deliver material to the facility (Halfon, 1986).

The design and construction of the facility should contain details of points to receive and store the material. This infrastructure includes accessibility to roadways, weighing scales and parking areas (Stewart, 2008). A clear description of facilities for temporary on-site storage shall be given as well. A consideration should be given to designing a facility for which long wait times for trucks or trains delivering the material to the site are minimized (James, 1990).

At the facility, a screening of vehicles delivering material should be conducted to ensure that only the acceptable materials are being delivered. For accounting purposes, weighing of these materials may become necessary. A waste transport vehicle known to contain hazardous material or suspected hazardous material shall be denied access. A trained operator should be positioned during unloading in order to identify materials that are unacceptable. Such materials shall be segregated and be removed from the site. The procedure for receiving recyclable materials, documenting their sources, quantities and types and directing of vehicles to the

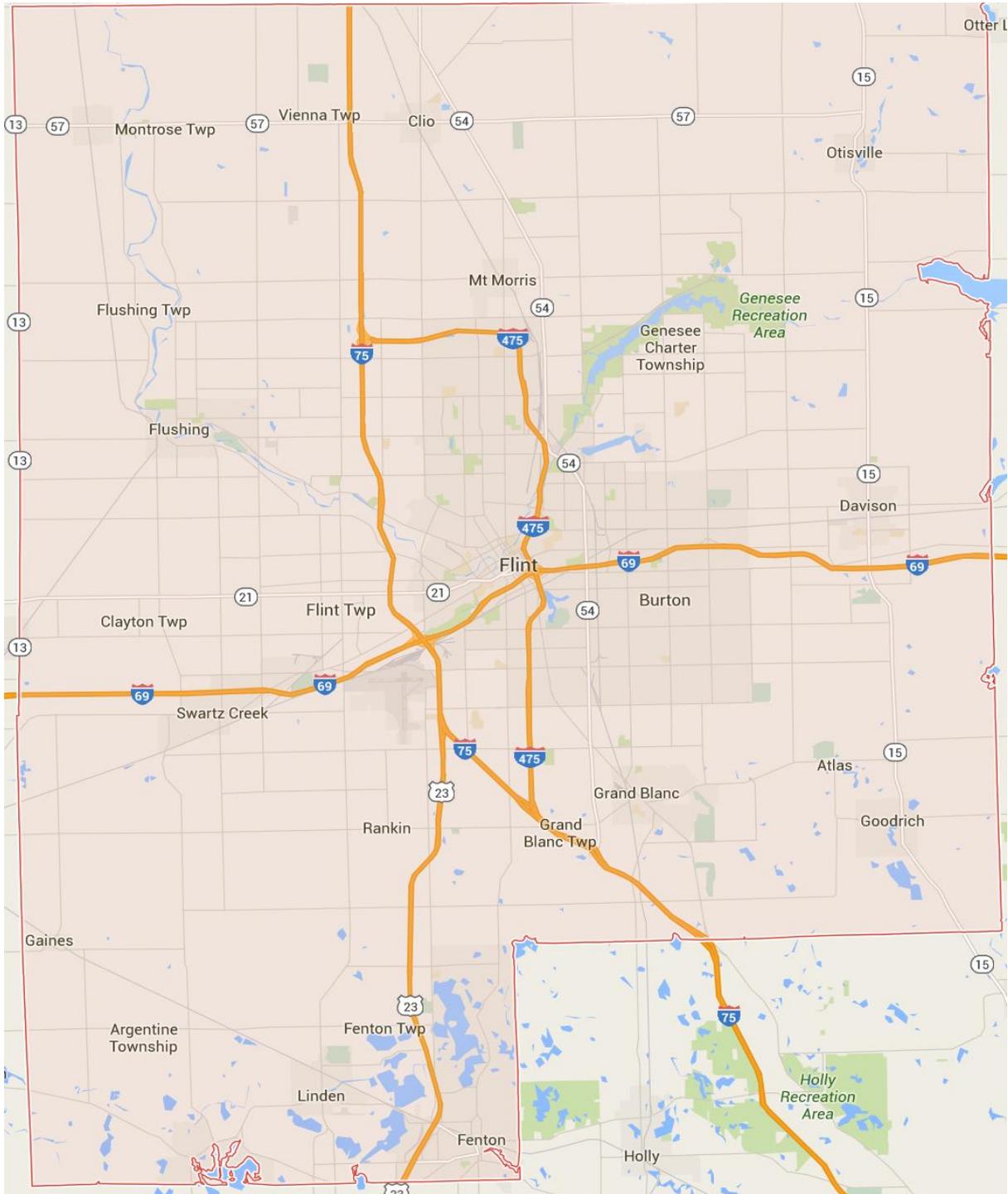
appropriate point at the site should be well outlined in an operational manual (Rodger, 2009).

The facility shall put measures and regulations to facilitate handling, storage, removal and disposal of any suspected or identified hazardous material. For such non-compliant material, details such as date of receiving, their type, source, owner, name and contact information of the transport company and transport vehicle identification shall be recorded.

An important consideration when choosing an appropriate site is transportation accessibility. The various industrial areas are the most ideal locations since these areas are well serviced with and provide different transportation modes. These include highways, road systems, or rail. Based on the need for transportation accessibility, a prime location would be near multiple highways to gain easy access for incoming truck traffic delivering the material. Figure 3-A shows the current interstates within Genesee County. Four different highways run through the county's boundary. One runs from west to east (I-69), and three run north to south, (I-75, I-495, and US-23). Our group predicted that the ideal location should be within a 10-mile radius to at least two of the routes displayed in this map. Accessibility to major road networks will also aid truck traffic and siting the location near the municipalities that generate the greatest volume of recyclable materials.

Genesee County Interstate Highway

Figure 3-A



Source: Google Maps, 2016

3.2 Zoning

Zoning refers to the government's control on physical land development and the uses of individual property. It also indicates whether structures may be erected in various districts in order to ensure safety, health and the general welfare of residents living and working in those districts (Cusack and Stockli, 2001). A MRF may be established in Genesee County in accordance with the municipal requirements. Through these requirements, environmental guidelines are provided for selection of a site, design, construction and operation of the facility to ensure a high environmental protection level.

A MRF should be zoned heavy industrial. They also have the potential to be built on brownfields. However, from our three case studies, we have found that only one was zoned as heavy industrial, the MSU MRF. The other two MRF's were zoned in a University District and on a Public Land District. *According to the Draft Zoning Code Section 50.9.27 Materials Receiving, Recycling, Wrecking and Salvage from Imagine Flint*, a MRF should be located in Production Center District. This is for the use of, "receiving and recycling of regular household byproducts ... and plastic or glass material already harvested from other products is permitted only in the PC District" (Draft Zoning Code, 2016). At the same time, implementing a MRF on a brownfield would minimize the risk of potentially contaminating a clean parcel of land, which would be optimistic for considering environmental factors, just like MSU has already done.

IV. Case Studies

4.1 MRF Comparison Study

Our field research included two MRF site visits. The first was to a MRF in New Boston, MI owned by ReCommunity, a private material recovery firm, and the second was the MSU MRF owned and operated by the university. The site visits allowed us to make observations about how different MRF's operate throughout Michigan. Table 4-A summarizes our findings of both the site visits as well as one additional example we have implemented into the report, the City of Ann Arbor MRF, also operated by ReCommunity.

The categories we feel would best help identifying the feasible knowledge to sustain MRF operations include, size, costs, owner/operator, operation type, volume intake, employment, and zoning. Knowing approximate square footage will determine what sized property parcel would be needed to build or renovate. Costs would indicate what the start up costs would be. Determining whether or not it would be publically or privately owned will need to be considered as well as possible partnerships. The type of MRF operation must be decided as well in terms of whether or not it will feed from a single stream system and operate clean or dirty. This will determine the specific equipment capital to procure. The intake volume of the material received is imperative. Employment is significant because it is a characteristic that would benefit the local economy. Generally, a MRF has two types of employees, staff and line personnel. Staff include managers, education officers, liaisons, and other administrative and sales employees. Line workers are the

employees who physically sort the materials, maintain the equipment, and supervise MRF activity. They can be temporary workers hired from staffing agencies and after a couple of months, may have the opportunity to become full time or part time line employees.

MRF Comparison Chart

Table 4-A

MRF	Michigan State University	ReCommunity (Huron Charter Township)	ReCommunity (City of Ann Arbor)
Year Established	2009	2006	1995
Facility Size (square feet)	18,000	54,000	35,000
Building Cost	\$13.3 Million <small>(Includes Recycling Center & MSU Surplus Store)</small>	\$11 Million <small>(Includes Corporate Office)</small>	\$10 Million <small>(Adjusted for Inflation)</small>
Equipment Cost	N/A	\$9 Million	\$4 Million <small>(Adjusted for Inflation)</small>
Operation	Clean, Single Stream	Clean, Single Stream	Clean, Single Stream
Owner/Operator	Public	Private	Public/Private <small>(Ann Arbor owned/ReCommunity operated)</small>
Population Served (2014)	50,543	1,790,078	351,454
Households Served (2014)	15,176	817,106	148,106
Service Area Radius	5 Miles	10 Miles	>22 Miles

Volume Intake tons/per year (2013)	800	80,300	14,250
Employment	10 line/40 total	17 line/70 total	65 total
Zoning	University District (Built on Brownfield)	Heavy Industrial	Public Land District

Source: (Lindeberg, 1994), (City of Ann Arbor).

Case Study MRF Transferable Data

Table 4-B

MRF	Michigan State University	ReCommunity (Huron)	City of Ann Arbor/ReCommunity
Area/Volume	22.5 sq ft/ton	0.67 sq ft/ton	2.5 sq ft/ton
Volume/Household/Year	0.05 tons/hh/yr	0.10 tons/hh/yr	0.01 tons/hh/yr
Area/Employment	450 sq ft/person	771.40 sq ft/person	538.50 sq ft/person

Genesee County MRF Transferable Data

Table 4-C

MRF	Genesee County
Area/Volume	3.50 sq ft/ton
Volume/Household/Year	0.17 ton/hh/yr
Area/Employment	538.50 sq ft/person

With the information from Tables 4-A through 4-C, we may now estimate the potential requirements and parameters a MRF in Genesee County would need to be established and permanently sustained. The information obtained are approximate values. Among the MRF's researched, we see similar criteria in ReCommunity's Ann Arbor's data that could be comparable to Genesee County. Currently, Genesee recycles more than 9,370 tons of material annually. Now that the City of Flint's participation rate has tripled from 5% to 16%, there is greater opportunity to increase the participation rate closer to the county's goal and possibly yield a higher recycling rate. "With the implementation of a recycling program, backed by a resident education program, the county participation average of 29% could easily be attainable" (GCMPC, 12). Revitalizing the situation with strong recycling programs such as curbside pickup and progressive education coalitions, will substantially increase in the participation average (GCMPC, 2012).

4.2 Recycling Education in the U.S.

There are various educational programs that have been developed to motivate a culture of recycling in different communities within the U.S. One of the recycling programs that have played a role in facilitating education on recycling is the Florida Green School Awards (Florida Department of Environmental Protection, 2016). This program was started in 2009 after community stakeholders in Florida realized the importance of presenting awards to teachers, students, schools, education districts that had shown exemplary performance in recycling initiatives. There are five independent categories in which awards are given; they include students, teachers, classrooms, schools and school districts. There are also five green themes under which awards are given, which are green learning environments, service learning, exemplary programs in teaching and curriculums, recycling policy, and recycling partnerships.

The program aims at educating children from a young age on the benefits of recycling through rewarding educational curriculum such as teaching and learning programs that promote recycling. The program also promotes community partnerships in promotion of recycling by rewarding school districts which have policies that emphasize public-private participation in green school endeavors. The use of a rewards and recognition system is effective because it motivates different stakeholders within the Florida community to embrace recycling among other going-green initiatives.

Although the tangible benefits of this program cannot be quantified, it is prudent to assume that Florida's high recycling rate is linked to the creation of such programs. According to the Florida Department of Environmental Protection, (2016), Florida recycled 50% of its waste products in 2014, which met the legislation threshold set by state statutes. By 2020, it is expected that Florida will recycle 75% of its waste. Michigan recycles only 15% of its waste and programs such as the Florida Green School Awards may increase recycling rates in the state of Michigan.

Another program that has been involved in providing recycling education is the Boulder/Broomfield County School Recycling and Environmental Education Program (Eco Cycle Organization, 2016). This program facilitates collection of waste products for recycling from over 50,000 students in public schools within the St. Vrain Valley and Boulder Valley in Colorado. The program also provides timely feedback on the progress of the program to schools and it facilitates over 1,600 education presentations to students between pre-school and the twelfth grade (Eco Cycle Organization, 2016).

In addition, the Boulder/Broomfield County School Recycling and Environmental Education Program provides education to students on issues affecting the environment through group activities, discussions, crafts, games, slide shows and other interactive platforms. To keep teachers and students motivated, special projects such as the Rainforest and Recycling Fundraiser, "where 6,000 students in 12 schools learned about the benefits of recycling to the rainforest and saved aluminum cans to raise money to adopt acres of rainforest" (Eco Cycle Organization, 2016). The Kids Conference for Earth is "an all-day event that brought

170 children and parents together to participate in environmental workshops” (Eco Cycle Organization, 2016). These projects are organized on an annual basis to provide a platform where children can interact and share knowledge on environmental issues such as the benefits of recycling. The program has also reached beyond the community and has trained over 300 teachers outside the Boulder County to impart them with knowledge on school recycling, which they may then establish in their own communities (Eco Cycle Organization, 2016).

As a result of the effectiveness of the program, several awards have been given to the program founders and members. Some of these include the Colorado Alliance for Environmental Education, ‘2008 Best New Program Award’, the Colorado Association for Recycling, ‘2011 Outstanding Outreach Award’ and the EPA Region 8, ‘2007 Environmental Achievement Award’ (Eco Cycle Organization, 2016). A similar program may be adopted in Michigan to enhance educational awareness especially among students and teachers on the benefits of recycling.

An important recycling program that targets households is the Household Curbside Recycling Program in Knoxville, Tennessee (City of Knoxville, 2016). This is a program that targets the 22,500 city residents of Knoxville and it strives at motivating residents to participate in recycling efforts particularly for households. The program was launched in 2011 and the main goal was to involve over 20,000 households in recycling programs through providing carts where households can dispose of their waste (City of Knoxville, 2016). These carts are later retrieved, sorted and recycled into products for use by a variety of consumers.

The program initially involved placing 2,500 recycling receptacles for households on curbs. Residents who did not have access to these receptacles were placed on waiting lists to eventually receive them. Some of the features of the program include providing single stream type receptacles to households to dispose of their recyclables and weekly curbside collection at no additional cost. The most common materials that are recycled under this program include metals, plastics, paper, and glass. The benefit of the program was as the increase of materials recycled by the state of Tennessee while reducing volumes of materials dumped in landfills.

The Household Curbside Recycling Program has successfully achieved its goals. Initially, the program targeted 20,000 household resident participants, however, this figure has been surpassed and currently utilizes over 22,500 residents in Knoxville (City of Knoxville, 2016). Michigan may consider developing such a program to boost recycling within households, which will be in line with boosting recycling in the state.

A local example within Michigan would be the recent implementation of curbside pickup in East Lansing, Michigan. The City of East Lansing has a significant recycling program that targets households called, *New Curbside Recycling Cart Program*. This program implements single-stream curbside recycling to single-family households, duplexes, small unit, and multi-family households (City of East Lansing, 2016). Since the service is 100% free, it will attract more residents to participate in recycling. However, there is a requirement that claims that the recyclables must be allocated in a City of East Lansing recycling cart. In the Fall of 2015, more than

7,000 96-gallon carts were delivered to East Lansing residents. All of those carts were provided at no cost to the resident by The Recycling Partnership. In the first three months, there was a significant growth for recycling. The curbside recycling volume increased to 82% (City of East Lansing, 2016).

4.3 Business Models

Different MRFs have different models depending on their business models and management. Some of the companies use the merchant model. This means that instead of moving from one residential area to the next in search of the recyclable materials, they rely on getting these materials from companies that collect the residential trash. The waste is collected from different residential and business locations by other privately owned companies and brought to the recycling plant to be sorted out. This saves time and money and they may get only companies handling recyclable waste supplying to them hence minimal dirty MRF to sort. Genesee County with its different municipalities and townships can benefit from this model, as it will save time and cost of collecting recyclable materials (GCMPC, 2012).

In addition, there is also the cost model. This model handles all the financial costs that are incurred by the facility starting from capital of setting up the center, purchase of the tools and machineries among other operating costs. This model is suitable for private recycling plants and not those sponsored by local government. The cost model is important to establish whether is it making money or not or even

on whether to set up another facility. This cost model, however, largely depends on the location of the material recycling facility, the hours of operation, the recyclable products it is handling, where the material will be taken once it is collected and stored and the shipping costs.

The last model is the reprocessing model. Reprocessing involves the process of sorting out the materials until they reach the manufacturers. The sorting is already done by employees or machines. This model is divided into different processes depending on the materials being sorted out and processed. There is the single-stream process for glasses, metals and plastics and mixed waste process to eliminate all contaminants. This process is carried out until the last of the materials are sorted and placed in their different allocated spots ready to be shipped (Barlaz, Damgaard, DeCarolis, Levis, & Pressley, 2016). In order for these models to work as well as the recycling to be successful, it is important to understand how it works and issues that need to be considered. It is important for the MRF to identify which recyclable materials it will be dealing with, where the material will be sent to as well as what to do with the remnants that are also considered waste. In Genesee County, for example, a significant percentage of people work in the service sector, hence a lot of paper and plastic waste that can be recovered (GCMPC, 2012).

V. Recommendations

Introduction

Based on this feasibility study, we have ultimately determined a recommendation. We believe implementing a MRF is a feasible opportunity for Genesee County. Currently, we speculate the county has a potential to generate at least 9,861 tons/year and will continue to grow with the implementation of education and higher participation rates. According to the case study, the Ann Arbor ReCommunity MRF owned by the City of Ann Arbor, would provide a suitable comparison that would be most appropriate to the capabilities currently observed in Genesee County. The fact that the City of Flint now provides curbside recycling, will increase the county recycling rate because the City of Flint is the municipality that generates the most MSW in the county. Currently, waste haulers take the majority of recyclables collected to locations in southeast Michigan (GCMPC, 2012). To provide the Genesee County Metropolitan Planning Commission with an ideal implementation strategy, we have formulated the recommendation into what the MRF considerations should be, including site location characteristics, facility criteria innovative education policies, and cost recovery.

5.1 Site Location Characteristics

To choose an ideal site location for the MRF in Genesee County, we suggest the facility should be located in appropriate zones, such as heavy industrial, permitting production centers, and public use districts. The county residential units that are serviced by the MRF should be within a minimum 20-mile radius from the facility to reduce transportation costs, such as fuel. This will help in minimizing travel distances and will in turn translate to reduce operational costs.

The City of Flint, Flint Township, and Grand Blanc Township are the three municipalities generating the most recyclable materials by volume. Therefore, most of the recyclables would be arriving to the MRF from these areas and priority should be given in terms of siting a location closer to those municipalities. All three locations are near an intersection of three highways that either run directly through or by these municipalities in all four cardinal directions. Looking at the other three locations of MRF's from our case study, a MRF is generally located within a 1.5-mile radius from highways as well. Optimizing accessibility to major road networks will aid the flow of truck traffic.

5.2 Facility Criteria

The MRF in Ann Arbor has an approximate volume intake of 14, 250 (). Their material volume intake is only 4,000 more tons of material each year than what the Genesee County MRF could potentially intake. Modeling the MRF after Ann Arbor would be the better the choice among our case studies. The Genesee County MRF should be a clean, single stream operation. This will keep unwanted trash and other wastes out of the facility while creating an easier sorting process. Without the addition of wastes mixed in with the recyclable materials, there would also be less of a surface area required to handle the unwanted volume while reducing the workload. A public-private partnership could take the burden off the county and then rely on the private company to run the day to day operations. The facility size should be a minimum of 35,000 square feet in order to accommodate the different equipment, logistics operations, and administrative spaces. Funding options from the private sector, material revenue, or even allotments from transfer stations and landfills could contribute to funding operations (GCMPC, 2012).

Employment opportunities should be coordinated with staffing agencies or should use county or private employer leads to staff the MRF. The MRF should be prepared to accommodate approximately 40-70 employees, both line workers and other staff, and operate a minimum of two work shifts per business day. Additionally, the transferable data in Table 4-C is available to provide a foundation for determining customized data that would be more appropriate for Genesee County.

Genesee County could expect to purchase some or even all of the MRF equipment discussed. To procure the equipment, the county should be prepared to spend a minimum of \$4 million. Initial startup costs of the facility would be greater, requiring a minimum of \$10 Million and could even exceed as much as \$13 million. Depending on who sells the facility engineering and/or equipment, there could be negotiated pay back options for the buyer. For example, the MSU MRF received a ten year pay back option from a private firm to finance the \$13.3 million costs (RRS, 2016). It should be noted, the MSU MRF and the Huron MRF both include corporate office spaces and other facilities on property. An advantage, although costlier by having these types of spaces would ensure strong communication between the corporate and operational ends of the business.

In terms of a business model, a merchant model should suit Genesee County. It relies on getting materials from private waste haulers. The material collected from different the residential locations by privately owned companies can then be brought to the recycling plant to be sorted. This saves time and money, and has the benefit of contracting with companies that handle just recyclables, instead of receiving recyclables mixed with other unknown wastes. Since a cost model is more suitable for a private recycling plant, Genesee County, with its many municipalities, can benefit from a merchant model. This in turn will facilitate the recovery process (GCMPC, 2012).

5.3 Education Strategy

In order to increase the rate of recycling in Michigan and Genesee County, a program that combines education and promotional activities should be implemented. The program should appeal to different age groups and should utilize various media in education for community members on the importance of recycling in Genesee County. This will increase the number of the community members who are aware of the recycling initiatives and enable the county to achieve the goals of its recycling programs (Snyder, 2014).

The first category of stakeholders targeted are employees within Genesee County. Employers should be encouraged to instill an organizational culture that stresses the need of recycling, through enforcing recycling initiatives within business and other organization. Employees should be educated on the benefits and strategies for recycling during employee orientation programs. Environmentalists should also be invited to give lectures and presentations to employees on recycling initiatives. This trend would trickle down to the home life of their employees.

The second category targeted should be students. These types of programs should incorporate recycling knowledge into syllabi to empower students with information on recycling. Campus tours, student orientations, and advertisements in campus magazines are suitable platforms within which information on recycling can be disseminated to students within Genesee County. Coordinating site visits with recycling companies such as ReCommunity is also suggested because it actually

shows students where their recyclables go and will motivate their learning experiences.

The third category of stakeholders is households. Genesee County should provide knowledge on recycling to households through promotional methods that include a variety of media (Keep Genesee County Beautiful, 2016). Some mediums include advertisements in websites and social media, print sources, as well as use of promotional materials such as pamphlets which could be distributed to residents of the county. The use of these diverse promotional and educational forms of media will increase knowledge on benefits of recycling for Genesee County residents and increase participation and recycling innovation within the community.

Finally, the program should target government, for-profit, and nonprofit organizations. These important stakeholders in Genesee County should collaborate in providing solutions to the challenge of recycling within the county. They should mobilize their resources and provide funding that supports initiatives within Genesee County and the action plan developed by Governor Snyder. Partnership between government and other organizations will complement efforts made by Michigan in increasing the recycling rate (Snyder, 2014). Those stakeholders may also create grants and offer sponsorships or incentives for organizations and individuals who develop innovative and creative ways of increasing recycling. Under the program, the state government should reduce barriers to market entry for business that deal in recycled materials to enhance recycling rates within Michigan and Genesee County.

5.4 Cost Recovery

Table 5.1 displays three types of residential recycled materials and their annual recoverable tonnage in Genesee County predicted for 2017 (GCMPC, 2012). We researched the current Michigan market price of mixed plastic, mixed waste paper, and mixed clean glass. By calculating the annual tonnage with the current dollar per ton value, we were able to generate expected annual revenues for each type of material.

Expected 2017 Material Revenue

Table 5.1

Recycled Materials	Annual Tons	Current Market Price (\$/ton)	Annual Revenue
Plastic	2,200	65	\$143,000
Waste Paper	2,700	15	\$40,500
Glass	600	8	\$4,800

Source: GCMPC 2012, Friedland Industries Inc. 2016.

Estimated Revenue of Materials = \$188,300

5.5 Conclusion

In summation, recycling is a major challenge that faces Genesee County and Michigan at large. In spite of development of measures by the state government to increase recycling rates, Michigan still lags behind in recycling initiatives compared to other states within the U.S. Based on a survey from the 2012 Genesee County SWMP, 72% of respondents from Flint said that they were dissatisfied with the recycling services in their community. Only 64% of respondents from Flint are aware of recycling opportunities in their area (drop-off locations) as compared to 95% in the overall survey (GCMPC, 2012). It is important to develop an educational program that will sensitize and motivate residents on the importance of recycling in order to improve the rate of recycling within the county. This program should embrace educational and promotional strategies using a variety of media and platforms that residents have access to. It should also target diverse stakeholders and households as well as the government and for-profit and non-profits within Michigan. There are various programs that have worked effectively in other states in spreading education and knowledge on recycling and environmental conservation. Some of these include the Florida Green School Awards and the Boulder/Broomfield County School Recycling and the Environmental Education Program. In addition, the Household Curbside Recycling Program has successfully incorporated households in Knoxville, Tennessee with its recycling initiatives. These are the type of programs that should be replicated in Michigan to promote higher levels of recycling and facilitate the achievement of not only county but also state environmental conservation goals.

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