Extended Producer Responsibility Cost-Benefit Study

Working Paper 2: Recycling Analysis

Current Recycling Programs, Outcomes, and Costs in Minnesota compared to a Modeled Statewide EPR System for Packaging and Printed Paper

FINAL DRAFT

Executive Summary

Working Paper 2 is the second of three working papers that comprise a cost-benefit study on extended producer responsibility (EPR) for consumer packaging and printed paper (PPP) in Minnesota. This study models one possible design of an EPR system for PPP (as envisioned by Recycling Reinvented) in a single state (Minnesota) using state-specific data to model the potential impacts of a state-based EPR system.

The first working paper outlined the assumptions for the scope of an EPR system in the state.

This second working paper examines the costs and outcomes of the current recycling system; models a system that expands access to recycling and implements collection best practices for residential recycling; institutes a coordinated statewide program for away-from-home recycling; improves the efficiency of processing; and estimates the costs of the modeled EPR system.

The third working paper will estimate how the costs of a future system could be allocated to producers under a hypothetical EPR financing system. It will also examine existing and future markets for consumer PPP collected in Minnesota.

The key findings and projections of Working Paper 2 are summarized below. The methodology and data sources used for this study are described in detail in the appendices.

Key Conclusions for **Residential Recycling**

Access: The modeled EPR system would provide the following residential recycling services:

- Expand direct collection service (curbside and multifamily) from 70 percent of Minnesota households to 87 percent under the modeled system.
- Expand single-stream recycling from approximately 60 percent of households (as of 2011) to 100 percent under the modeled system.
- Standardize and expand the materials collected and collection method for recycling to reduce confusion among Minnesotans about how and what to recycle.

Education: Many communities in the state spend less than the recommended level of $1 per household per year on recycling education. This working paper suggests a cost structure that includes $1 per household in spending on basic education plus an additional $1 per household on a statewide campaign to promote increased recycling, including promotion of away-from-home recycling opportunities and return of plastic bags and film to retail collection points.

Recycling results: After examining current recycling data, reviewing data from pilot projects and leading programs in Minnesota that have delivered measurable results, and extrapolating these possible impacts to a statewide level, the working paper estimates that the current level of residential recycling collection of 407,000 tons of consumer PPP could increase to 544,000 tons, an increase of 34 percent. Factoring in material losses, the modeled system is estimated to increase net residential tons recycled from 375,000 tons to 495,000 tons, resulting in a 66 percent residential recycling rate for consumer PPP.

Key Conclusions for **Away-from-Home Recycling**

This study models a producer-financed away-from-home recycling program that supports recycling collection in public spaces and retail-based collection of plastic bags and film.

The public space recycling program will provide one recycling bin for every:

- 300 people in urban areas;
- 350 people in suburban areas; and
- 400 people in rural areas.

These recycling bins will be paired with and installed next to existing public trash bins. Examples of where these bins will be located include parks, pedestrian areas, public transit, libraries, schools, and government buildings. The bins will collect the same list of recyclables accepted in residential recycling programs.

The retail-based collection of plastic bags and film will be available for household film drop-off at least 70 percent of grocery stores in the state and numerous additional retail locations, ensuring that 95 percent of Minnesota households have access to at least one collection location within 10 miles of their home.

Recycling results: The public space recycling program modeled is projected to result in 19,000 additional tons of consumer PPP recycled. In addition, expansion of retail collection infrastructure combined with the investment in statewide promotion and education is projected to result in a four-fold increase in retail-based plastic bag and film collection, increasing the tons of designated material collected from the approximately 500 tons estimated under the current system to 2,000 tons under the modeled EPR system.

Key Conclusions for **Recycling Processing Infrastructure**

Minnesota's recycling processing infrastructure includes many small processing facilities that are out-of-date and not capable of processing the expanding quantity and variety of materials being collected by residential recycling programs. At the same time, the large MRFs that provide the majority of processing capacity in the state are capable of sorting materials collected using single-stream methods and have surplus capacity to process additional materials. This working paper estimates that adjustments to the state's arrangement of processing infrastructure could reduce processing costs for consumer PPP materials by between $16 and $20 per ton.

Key Conclusions for **Consumer PPP Supply and Recycling Rate**

This working paper estimates that 977,000 tons of consumer PPP were supplied and discarded (disposed or recycled) in 2011 and that 452,000 tons were recycled and delivered to end markets (net of material losses throughout the system), achieving the equivalent of a 46 percent consumer PPP recycling rate. Under the modeled EPR system, the total tons of consumer PPP recycled would increase by nearly one-third, to 592,000 tons, resulting in a consumer PPP recycling rate of 61 percent of estimated total supply.

Key Conclusions for **PPP Recycling Program Costs**

This working paper estimates that the annual ongoing program operation costs of the modeled system—including service costs for statewide residential and away-from-home programs, accounting for cost savings achieved through processing infrastructure adjustments, and net of material revenue—would be approximately $64 million, or an average of $122 per ton of PPP recycled. Total costs and spending levels under the current system are unknown but estimates of system costs for residential recycling in 2011 are estimated to range between $61 million and $74 million, or $149 to $182 per ton collected. These estimates suggest that the modeled EPR system could result in a substantial increase in projected tons of consumer PPP collected within approximately the same spending range as under the current system.

Notes on Assumptions and Limitations

This working paper does not estimate several costs and benefits:

- It is assumed that an EPR system such as the one modeled here would be rolled out over several years. However, to simplify the analysis, the modeled system represents a fully implemented EPR system. Some, but not all, capital costs are factored into the cost estimate. In general, costs of ongoing capital requirements, such as the annualized costs of processing infrastructure adjustments, and annualized maintenance and replacement costs of collection infrastructure (e.g., trucks, carts, public space bins) are included, but some start-up costs, such as the purchase of new collection infrastructure, such as rolling carts and single-stream collection trucks, needed for initial rollout of the modeled system, are not. The third working paper of this study will provide some general discussion of the likely premiums required in the first years of the program to cover one-time start-up costs, based on what has been observed in Canadian EPR programs.
- Costs incurred by producers under an EPR system not directly related to recycling program operations (such as for producer responsibility organization (PRO) administration, enforcement, and market development) are not included in this paper. These costs will be estimated and described in the third working paper of this study.
- Potential savings to households have not been estimated because the fees currently paid by households for curbside recycling in Minnesota vary tremendously in amount and financing method and cannot be reasonably generalized. Furthermore, methods of current financing for waste management, recycling, and waste prevention programs often combine costs into a single price so that the portions used specifically for PPP recycling cannot be isolated. How these fees would change, if at all, under EPR for PPP is unknown. However, households that pay directly for unsubsidized residential recycling collection, either through private subscription or a utility bill, would likely see direct cost savings as these charges would be eliminated. Working Paper 3 will more fully discuss the potential cost impacts of an EPR system on households in Minnesota.
- There is no assumption of increasing or decreasing current SCORE grants to county governments in Minnesota, or of any other changes to the State's Solid Waste Management Tax (SWMT).

Section 1. Introduction and Overview

1.1 Study Goals and Scope

The purpose of the study is to help better understand and evaluate the possible impacts, including costs and benefits, of implementing a state-level extended producer responsibility (EPR) system for consumer packaging and printed paper (PPP) in the U.S.

This study models one possible design of an EPR system for PPP (as envisioned by Recycling Reinvented) in a single state (Minnesota) using state-specific data to model the potential impacts of a state-based EPR system. The methodology and modeling tools are designed, with limitations, to be transferable to other states interested in assessing the potential impacts of EPR on their own recycling system outcomes.

1.2 Working Paper Overview

This working paper, which is the second of three to be developed as part of this study, presents: 1) an overview of consumer PPP recycling in Minnesota, and 2) projected effects of the modeled EPR system on the outcomes and costs of consumer PPP recycling in Minnesota, compared to current conditions. The working paper focuses primarily on PPP recycling in the residential sector, but also discusses potential outcomes and costs of providing additional support for away-from-home recycling under EPR.

The overarching definitions, principles, and assumptions that form the basis of the study design are described in detail in Working Paper 1, which can be found online at www.marketbasedrecycling.com.

Working Paper 3 will address approaches to producer financing for the modeled EPR system as well as an assessment of recycling markets and market development needs to support the modeled material collection outcomes described in this working paper.

Working Paper 2 is organized as follows:

1.3 Methodology Overview

This study is based primarily on reported data from current recycling programs in Minnesota, and from statewide waste composition study data released in October 2013.

Most of the data used in this analysis come from information reported by Minnesota's 87 county governments (and one solid waste district) as part of the 2011 SCORE Survey.[1] The SCORE Survey, conducted annually by the Minnesota Pollution Control Agency (MPCA), provides an extensive county-level dataset related to recycling across the state.

In addition, the Study Team compiled data from residential recycling programs across the state using four primary sources:

- Reporting by 117 municipalities in the Twin Cities metro area using the Re-TRAC database established by the Solid Waste Management Coordinating Board (SWMCB), a joint powers board comprised of commissioners from six of the seven counties in the Twin Cities metro area.
- The MPCA's 2012 Curbside Recycling Survey of municipal and county recycling coordinators covering 340 municipalities in the state.
- A Foth survey of 59 municipal programs undertaken on behalf of the MPCA as part of its study of waste collection service arrangements, completed in June 2009.
- Specific information collected about individual municipal and county residential recycling programs gathered directly through interviews and email exchanges with recycling coordinators.

To maximize consistency in the analysis, 2011 was used as the base year, the most recent year for which comprehensive data were available. All quantity data are presented in 2011 tons, and cost data are presented in 2011 dollars.

This study projects the performance and costs for residential recycling under a modeled EPR program using data from existing programs in Minnesota. This approach ensures that projections are feasible and based on realistic achievements of residential recycling programs in the state.

In a few areas of the study, necessary data were not available from Minnesota and data from outside the state were used. Examples include:

- **Residential waste composition**. The recent Minnesota Waste Composition Study does not present the tons or composition of disposed waste by generating sector (e.g., residential, commercial, etc.). To estimate the supply of consumer PPP generated by different sectors, composition estimates from neighboring Wisconsin, which shares similar resident demographics and waste generation patterns with Minnesota, were used.

- **Processing infrastructure optimization**. The Study Team utilized extensive analyses of processing infrastructure optimization conducted in the Canadian province of Ontario to inform its projections for potential efficiencies achieved through infrastructure optimization under the modeled EPR system.
- **Away-from-home programs**. The Study Team drew on information from the Canadian Beverage Container Recycling Association's away-from-home recycling programs in the Canadian province of Manitoba. This is the most comprehensive large-scale program of its type in North America. This data set informs the paper's projections of potential additional collection gains, and associated costs, achievable through support for away-from-home recycling programs under the modeled EPR system.

Additional detail on the data and analytical methodology used in this study—and a discussion of the strengths, limitations, and areas of uncertainty in the analysis—is provided in **Appendix A**.

1.4 Definition and Estimation of Consumer Packaging and Printed Paper Supply

In Working Paper 1 the Study Team laid out a general definition of consumer packaging and printed paper (PPP) and a methodology for estimating consumer PPP supply to be used in the study. Under a legislated EPR system, the actual supply of consumer PPP would be determined in part by the definitions of designated materials included in the legislation and by data reported by producers of designated materials as required under the legislation as well.

Because this study models a hypothetical EPR system, the definitions, assumptions, and data used to define and estimate consumer PPP supply in Minnesota should be understood as hypothetical as well, and treated as general estimates only, for the purposes of modeling.

As defined in Working Paper 1, consumer packaging includes all materials used to protect or contain a commodity or product intended for consumption or use by an individual consumer. Printed paper includes all paper printed with text or graphics as a medium for communicating information to an individual consumer, such as newspapers, magazines, catalogs, and phone books (but not including bound reference or literary books, or text books). Designated materials are those materials covered by an EPR system, and thus materials whose producers incur fees to finance the recycling system. All designated materials are typically included in the calculation of total supply of PPP, but not all designated materials are necessarily included in a producer-funded recycling collection system.

To estimate the supply of consumer PPP, the Study Team analyzed existing data on recycling and disposal of municipal solid waste (MSW) in Minnesota in 2011 and developed assumptions about the quantity and distribution of designated materials in the MSW stream. Details about the assumptions and calculations used are provided in **Appendix A**.

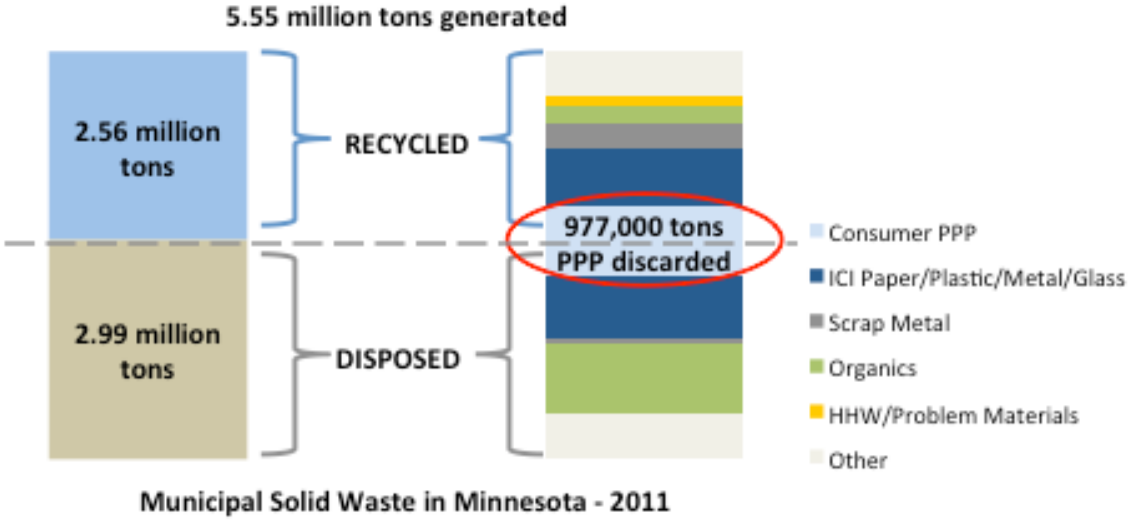
Quantities and Composition of Consumer PPP

In 2011, 5.55 million tons of MSW were generated statewide in Minnesota (including waste that was landfilled, combusted for energy recovery, disposed on-site, recycled, or composted).[2] Of this, 46 percent is recycled or composted.

Across both disposed and recycled waste, 2.59 million tons comprise the four major material categories within which consumer PPP is found: Paper, Plastic, Metal (not including scrap metal), and Glass. The MPCA Report on 2011 SCORE Programs notes that 2.56 million tons of MSW was recycled in 2011, of which 1.24 million tons is in these four categories.[3] Of all material in these four categories disposed and recycled in 2011, approximately 977,000 tons are estimated to be material that would be designated as consumer PPP under the modeled EPR program.[4]

Figure 1 illustrates how designated PPP fits within the larger MSW stream.

Figure 1. Consumer PPP as a Portion of Total Municipal Solid Waste Generated in Minnesota, 2011



This study focuses primarily on consumer PPP discarded at home and the portion of that material captured through the residential recycling system in the four major material categories comprising consumer PPP: Paper, Plastic, Metal, and Glass. However, not all consumer PPP is discarded at home. ("Discarded" means to be collected for recycling or for garbage.)

The majority of consumer PPP does end up in the residential waste stream, either disposed or recycled, but the exact proportion differs for different types of PPP. For some material types, the percent of material designated as consumer PPP is discarded entirely at home. For example, corrugated cardboard boxes are generally designated as consumer PPP if they are intended to reach the individual consumer but not if they are used as intermediary transport packaging intended to be discarded by the retailer prior to final sale to the consumer. The vast majority of corrugated cardboard boxes intended to reach the individual consumer make it into the consumer's home and so, by default, virtually all corrugated cardboard designated as consumer PPP is found in the residential waste stream.

For other designated PPP materials, the location of material discard extends beyond the home because consumer use or consumption (and subsequent discard of the empty beverage container) happens across a range of locations, including the home but also at the office, a restaurant or bar, event venue, even while walking down the street. Still, even for highly portable consumer PPP such as beverage containers, the majority of material is found in the residential waste stream.[5]

Table 1 presents the estimated total supply of consumer PPP in Minnesota, including estimates of the proportion of material discarded (either disposed or recycled) at home and away from home. Overall, approximately **76 percent** of all designated PPP is estimated to be discarded at home.[6]

Table 1. Estimated Supply of Consumer PPP in Minnesota, 2011

	Designated Consumer PPP (all sources)	Designated PPP discarded at home	Designated PPP discarded away from home*	
	Tons	*Tons*	*Tons*	*% discarded at home*
Paper	**563,000**	**454,000**	**109,000**	**81%**
Plastic	**194,000**	**140,000**	**54,000**	**72%**
Metal	**63,000**	**45,000**	**18,000**	**71%**
Glass	**158,000**	**107,000**	**51,000**	**68%**
Total	**977,000**	**746,000**	**231,000**	**76%**

Note: Figures may not sum to totals due to rounding.

**Discarded away-from-home tons include designated materials discarded at institutional, commercial, and industrial (ICI) locations, as well as public spaces and venues.*

The estimated supply of consumer PPP serves as the denominator for both the estimated recycling rate of consumer PPP under current conditions, presented in **Section 2.7**, and the projected recycling rate under the modeled EPR system, presented in **Section 3.6**.

Section 2. Current Conditions under Existing Recycling Programs in Minnesota

Recycling in Minnesota is a combination of public and private sector activities, with involvement from all levels of government, private recycling collection and processing firms, and individuals as consumers, taxpayers, and waste generators. The current status of consumer PPP recycling in Minnesota is influenced by numerous factors:

- government policies and regulations related to recycling;
- the total supply of PPP generated (driven by the consumption patterns of Minnesota residents);
- the recycling collection services provided by both public sector and private sector entities;
- methods of financing these activities; and,
- the behavior of Minnesota residents at the point of discard.

This section describes the current conditions in Minnesota related to each of these elements and summarizes the associated status of consumer PPP recycling in the state, based on best available data.

2.1 Current Policy Context of Consumer PPP Recycling

The State of Minnesota already has a number of significant policies and regulations in place related to recycling, including several that are considered "best practices" for encouraging the collection and recycling of consumer PPP. In addition, many local governments within the state have their own policies and ordinances related to recycling. The following is a brief summary of the key policies related to PPP recycling currently in place in the state.

Mandatory Residential Recycling
Under Minnesota law, residents must have access to residential recycling. By statute (§115A.552), county governments are assigned primary responsibility for this, and must "ensure that residents have the opportunity to recycle," defined as:

- At least one recycling center in each county, and sites for collecting recyclable materials that are convenient for persons to use.
- Curbside pickup, centralized drop-off, or a local recycling center for at least four broad types of recyclable materials (paper, plastic, metal, and glass) in each city with a population of 5,000 or more.
- Monthly pickup of at least four broad types of recyclable materials in cities with 5,000 residents or more in the Twin Cities metro area, and with 20,000 residents or more in other parts of the state.

Some county and municipal governments also independently mandate that residents recycle. Others, especially where curbside service is largely subscription based, do not mandate that residents recycle, but do require haulers to make recycling collection services available to all residents.

According to the 2011 SCORE Survey, 31 county governments require haulers to provide recycling collection services and 19 (and the Western Lake Superior Sanitation District, which has jurisdiction over the Duluth metro area) have enacted ordinances explicitly requiring residents to recycle.

Disposal Bans
By state statute (§115A.95), once recyclable materials are separated from other solid waste, they may not be disposed as waste; this disposal ban, however, does not apply to recyclable materials not separated from mixed municipal solid waste. In addition, 20 counties also report having banned recyclable materials such as paper, plastic, metal, and glass from disposal.

"Pay As You Throw" (PAYT) Unit-Based Garbage Pricing
Variable rate (either by volume or weight) pricing for garbage collection, also described as "Pay As You Throw" (PAYT), is already required by state statute (§115A.93) in Minnesota as a condition of licensing for hauling companies and for local governments that provide residential garbage collection directly or through contracts with private haulers. These requirements only mandate that prices increase in some way above a base unit price but not that prices increase proportionately as the volume or weight of garbage disposed increases.

In practice, according to the Minnesota Pollution Control Agency (MPCA), most residential garbage pricing structures utilize volume-based pricing structures that increase only a small amount above the base unit price as container sizes increase. Few residents are offered garbage service with pricing that increases proportionally with container volume or with the actual amount of garbage disposed.

Although the application of PAYT policies could be strengthened, Minnesota is one of only a handful of states in the country with mandatory statewide PAYT regulation of any kind, placing it at the forefront of PAYT implementation best practices in the United States. As mentioned in Working Paper 1, this study does not assume any changes to the state's current PAYT policies.

Solid Waste Management Tax (SWMT)
The State also levies a tax on solid waste generators, which is collected by garbage haulers (or remitted directly by self-haulers). The tax is 9.75% of the total cost of garbage collection service for residential generators and 17% for commercial generators. In addition to generating revenue for the State, the tax creates an incentive for waste generators to recycle because recycling is exempt from the tax, if separately itemized.

This study does not assume any changes to the SWMT or to the "SCORE" grants to county governments, only a small portion of which is spent on consumer PPP recycling.

2.2 Demographic Summary of Minnesota

The state of Minnesota has 87 counties, 854 cities, and 1,785 unincorporated townships, as well as wholly unorganized areas in 16 counties. In 2011, the state population was 5.33 million.

For this study, the state's counties have been classified into three categories—Urban, Suburban, and Rural—based on the Rural-Urban Continuum (RUC) codes developed by the U.S. Department of Agriculture (USDA). (See **Appendix B** for a complete list of counties using this classification.)

- **Urban**. There are 27 counties classified as urban (RUC codes 1-3) in Minnesota. These counties are home to 76 percent of the state's population. All of the state's 17 cities with more than 50,000 residents lie within these counties. Within this grouping of Urban counties, there are four major urban centers:

  - The Twin Cities Metro Area (TCMA) spans seven counties and is home to 54 percent of the state population (2.87 million), including 14 of the 17 cities with more than 50,000 residents. The TCMA is responsible for 56 percent of all municipal solid waste (MSW) generated statewide.
  - Rochester, located in Olmsted County in the Southeast of the state, is the third largest city in the state with a metro area that covers two additional counties.
  - Duluth, in St. Louis County, has a metro population of nearly 280,000 that spans much of adjacent Carlton County as well.
  - St. Cloud, located primarily in Stearns County, though extending into Benton and Sherburne Counties, has a metro area of approximately 180,000 residents.
- **Suburban**. There are 27 counties classified as Suburban, which is defined as counties with an urban population of at least 20,000 or that are located next to populations centers. Suburban counties encompass 16 percent of the state's population.
- **Rural**. The remaining 33 counties have urban populations of less than 20,000 residents or are not adjacent to the state's metro areas. These counties account for 8 percent of the state's population.

Subdivisions of Minnesota's counties including cities, townships, and unorganized areas have also been classified into three categories,[7] based on population:

- **Large** – cities with more than 50,000 residents. There are 17 cities in this category, all within Urban counties. These 17 large cities are home to 32 percent of the total state population.
- **Medium** – cities and townships with 5,000 to 50,000 residents. There are 130 such cities and townships, encompassing 38 percent of the total state population.
- **Small** – cities, townships, and unorganized areas with fewer than 5,000 residents. There are 2,492 cities and townships and 16 unorganized areas in this category, covering the remaining 30 percent of the state population.

Table 2 presents a detailed breakdown of Minnesota's population and the number of single-family and multifamily households by the county and municipal classifications described above. Although the classifications are established based on total resident population, the primary unit used for analysis in this study is the household.

Table 2. Minnesota Population and Household Counts, 2011

	# of Counties *# of Municipalities**	Population (2011) #	 %	Households (2011)** #	 % Single-Family	 % Multi-family
Urban	**27**	**4,090,086**	**77%**	**1,596,439**	**80%**	**20%**
Large	*17*	1,703,458	32%	679,896	73%	27%
Medium	*101*	1,642,268	31%	632,126	81%	19%
Small	*724*	744,360	14%	284,417	87%	13%
Suburban	**27**	**812,254**	**15%**	**326,497**	**91%**	**9%**
Medium	*21*	296,948	6%	119,844	81%	19%
Small	*804*	515,306	10%	206,653	90%	10%
Rural	**33**	**429,906**	**8%**	**178,359**	**91%**	**9%**
Medium	*8*	84,700	2%	34,465	79%	21%
Small	*964*	345,206	6%	143,894	90%	10%
Statewide	**87**	**5,332,246**		**2,101,295**	**82%**	**18%**

Note: Figures may not sum to totals due to rounding.

**27 cities and townships span county boundaries. For this analysis, they have been classified at the municipal level by total municipal population, but population has been allocated to each county based on geographic distribution as reported by the Minnesota State Demographer's office.*

*** For this study, single-family households are defined as all detached units, including mobile homes, and attached units with up to 4 units per property.*

2.3 Attributes of Existing Residential Recycling Programs

As noted above, the majority of consumer PPP is discarded at home, so the primary driver of PPP recycling is the performance of residential recycling collection programs. The following section describes the current conditions for residential recycling collection in Minnesota, including current roles and responsibilities, service access and participation, collection infrastructure and types of services provided, materials currently collected, promotion and education activities and investments, and estimated costs of service on a per-household and per-ton basis.

Roles and Responsibilities for Residential Recycling Collection Service

The vast majority of residential recycling collection services in Minnesota is provided by the private sector, either under contracts with local governments to provide recycling collection to their residents or through direct subscription arrangements by residential customers with the private sector.

Only a small number of Minnesota municipalities act as direct service providers to their residents. The largest municipal service providers are Minneapolis (where half of the city's households are served by the municipality, while the other half are served by contracted private haulers), St. Cloud, and Red Wing.

There is no statewide accounting of the total number of households served through subscription arrangement but according to a survey of curbside recycling programs conducted by the MPCA in 2012, which included responses from 332 municipalities across the state, approximately 62 percent of households represented by the survey with access to direct collection service were in areas with contracted service and

38 percent were in areas with subscription-based service.[8] The percent of households with contracted service was slightly higher (70%) in Suburban counties and slightly lower (59%) in Rural counties.[9,10]

Most contracted service arrangements are between individual municipalities and private haulers, but there are also 26 county governments that contract with private haulers to provide curbside recycling service to households, including 21 county governments that are the exclusive providers of residential recycling collection in their jurisdictions.

Many county governments also provide drop-off recycling services for residents at recycling centers and other drop-off points that are either directly operated by the county government or by private haulers or non-profit entities under contract with the county government.

Residential Service Access and Participation

As noted above, under state law, Minnesota residents are entitled to access to at least some form of recycling for the four major recyclable material categories. In general, Minnesota residents are primarily served through one of the following two service options.

- **Direct collection**, divided into two types of collection service:
  - Curbside recycling collection, where recycling is picked up directly from individual households. This service is provided primarily to single-family homes and some small multi-unit dwellings.
  - Building-level recycling collection, where recycling from a group of households is picked up via a consolidated location on the premises of a multi-unit dwelling.
- **Drop-off recycling**, meaning designated locations where residents may bring materials for recycling. Many drop-off recycling sites are designed specifically to serve residents who do not have curbside or building-level recycling collection, although some sites are also intended to supplement service in areas served primarily through direct collection.

According to the 2011 SCORE Survey, 77 percent of all Minnesota households had access to direct collection (curbside or building based), while the remaining 23 percent had access to drop-off recycling only. However, some portion of households with access to subscription-based service chooses not to subscribe. (This information is not reported by private haulers and is not tracked by most local or state governments.) These households do not receive a recycling container and are not included on recycling routes, and thus cannot be accurately described as "served" for the purposes of estimating service costs. For this study, it is assumed that 75 percent of households with access to subscription-based recycling service actually subscribe while 25 percent decline service, leading to an assumed direct collection service level of 70 percent of households in the state.[11]

Table 3 presents estimated levels of residential recycling service as of 2011. The majority of direct collection service occurs in Urban areas, where 76 percent of households are estimated to have direct collection service. As shown in **Table 3**, the proportion of residents in Suburban and Rural counties with direct collection service is estimated to be much lower (50% and 38%, respectively).

Table 3. Estimated Residential Recycling Service, 2011

	Total HHs	Direct Collection Service				No Direct Collection			
		Contracted (% of HHs)		Subscription-Based (% of HHs)		Non-Subscribers (% of HHs)		Drop-Off Only (% of HHs)	
Urban	1,596,439	820,200	(51%)	393,300	(25%)	131,100	(8%)	251,800	(16%)
Suburban	326,497	123,700	(38%)	39,800	(12%)	13,300	(4%)	149,700	(46%)
Rural	178,359	45,100	(25%)	23,500	(13%)	7,800	(4%)	101,900	(57%)
Statewide	**2,101,295**	**989,000**	*(48%)*	**456,600**	*(22%)*	**152,200**	*(7%)*	**503,400**	*(23%)*

Note: Figures may not sum to totals due to rounding.

Residential Collection Infrastructure and Services Provided

Direct collection services for Minnesota residents vary widely from place to place, with each program offering a seemingly unique set of materials accepted, collection instructions for residents, container type and configuration, and collection schedule. Generally, however, services can be grouped into two primary categories:

- **Single-stream, cart-based collection** – these programs typically provide residents with 64-gallon or 96-gallon rolling, lidded carts and collect commingled recyclable materials on a weekly or (more commonly) biweekly basis.
- **Dual or multi-stream, bin-based collection** – these programs typically provide residents with one or more 18-gallon bins. Residents are asked to separate materials by type, either grouping all acceptable containers in one bag or container and all paper materials in another bag or container (for dual-stream collection), or separating specific material types (e.g., glass, metal, plastic, paper) into their own bags and placing them into open-top 18-gallon bins. Collection may be weekly, bi-weekly, or monthly.

Under contracted service, decisions about the infrastructure and services provided to households for direct recycling collection are typically made by the local government contracting for services. Under subscription-based service, decisions about service offerings are typically made by private haulers, although local governments may require haulers to collect a standard set of materials as a condition of licensing.

As with information about contracted and subscription-based service, there is no statewide accounting of the total number of households served under each of the service types, but an analysis conducted by the Study Team of data collected by the MPCA through the 2012 Curbside Recycling Survey conducted by the MPCA in 2012 indicates that approximately 43 percent of households in areas with contracted service had single-stream collection in 2011.[12] The 2012 Curbside Recycling Survey report also states that although no formal reporting tracks the types of service available in communities with subscription-based recycling service, data suggest that the vast majority of residents living in these areas have access to single-stream recycling.

Table 4 presents estimates of the percentage of households served with each collection method as of 2011, assuming that all households with subscription-based service are served via single stream and that households with contracted service are served proportionately according to the methods reported in the MPCA 2012 Curbside Recycling Survey, adjusted for 2011.[13]

Table 4. Estimated Residential Recycling Collection Methods, 2011

	# of HHs with Direct Collection Service	Single-Stream Collection	Dual/Multi-Stream Collection
Urban	1,213,500	62%	38%
Suburban	163,500	53%	47%
Rural	68,600	53%	47%
Statewide	**1,445,600**	**61%**	**39%**

Drop-off recycling sites for household use are primarily provided by county governments, with some private sites accepting household recyclables as well. The number of drop-off sites accepting PPP materials from households is unknown but there is at least one site per county.[14]

Most municipalities do not run drop-off sites themselves. Only 15 of 126 municipalities included in the survey of municipal programs conducted by the Study Team reported tons collected via drop-off, and drop-off tons accounted for only 6.4 percent of tons collected through those programs.

Materials Collected in Residential Recycling Programs

The materials that make up the majority of tons collected across the four major categories are generally consistent across programs but there is variation within each category, especially plastics.

- **Metal** – The majority of programs accept largely the same types of materials (food and beverage containers only). Some programs also accept aluminum foil, trays, and other aluminum containers, including empty aerosol and paint cans, and a few also accept small scrap metal items.
- **Glass** – Virtually all programs accept all glass food and beverage containers only; most programs instruct residents to discard lids in the garbage but some allow them to be left on the containers.
- **Paper** – Virtually all programs accept all printed paper, office paper, and paper products like newspaper, magazines/catalogues, and mixed mail, as well as kraft paper, boxboard containers, and corrugated cardboard; some programs accept all polycoated cartons and packaging, others accept only limited types of cartons, and others accept no polycoated paper; some programs accept pizza boxes while others prohibit them.
- **Plastic** – Variation is the widest in this category, with some programs accepting only PET and HDPE bottles and ranging across a large number of variations in acceptance to programs accepting all plastic containers, including all #1-#7 resin identification code numbers, shapes, injection mold and thermoform variations; some programs explicitly prohibit caps and lids while others allow them; most programs do not accept plastic bags and film but some do.[15]

Variation in materials accepted does not necessarily align with the type of collection infrastructure used. For example, some single-stream programs do not accept polycoated paper cartons, pizza boxes, aluminum foil, or aerosol containers, while a number of dual and multi-stream programs do accept these materials.

Residential Recycling Promotion and Education

Evaluations of best practices in residential recycling have repeatedly identified sufficient, sustained investment in recycling promotion and education (P&E) as a major determinant of program performance, and have suggested that a sustained investment of at least $1 per household per year is needed.[16]

In Minnesota, promotion and education to support residential recycling are spread across multiple entities and, as with most elements of the state's residential recycling system, varies widely from place to place.

In jurisdictions with contracted service, local governments either incorporate P&E requirements into contracts with private haulers or provide P&E directly to residents in their area. In subscription-based areas, private haulers may conduct their own P&E activities. In addition, municipal or county governments may conduct some level of P&E as well, often using funds provided through the state's SCORE grant program.

The analysis conducted by the Study Team of municipalities in Minnesota with available data about program expenditures, services provided, and tons collected revealed that municipal programs spent $0.47 per household, on average, on P&E activities in 2011.[17] Large municipalities tended to spend less per household ($0.32, on average), while medium and small municipalities spent more ($0.62 and $1.74 per household, on average, respectively). **Section 2.4** provides more detail on the sources of these spending estimates.

Minnesota county governments also invest in varying degrees of P&E, either as the sole providers of recycling P&E in the county, or to supplement activities conducted by municipal governments and private haulers. These activities, however, tend to be integrated into P&E efforts across a broader spectrum of messages about recycling and waste reduction and promotion of various programs provided by the county government, so it is difficult to assess how much is dedicated specifically to promotion of residential recycling of the four major material categories.

In counties where the county government is the sole provider of residential recycling collection, either through direct collection or drop-off recycling, spending on P&E in 2011 ranged between $0.02 and $2.28 per household, with an average of $0.99 per household in counties with direct collection and $0.12 per household in counties with drop-off recycling only.[18]

In addition to local government P&E investments, there has been some investment in statewide P&E through a campaign called "Recycle More Minnesota," financed by the MPCA using grant funds. The MPCA spent approximately $250,000 in 2007-2009 to develop and implement the campaign, which included development of branded messaging, rollout of an interactive website, and a series of movie theater and radio advertisements. The campaign was designed to promote recycling for a broader category of materials beyond consumer PPP, so it is difficult to say how much of this spending was targeted at delivering messages specifically related to increasing recycling of these materials.

2.4 Estimated Performance and Costs of Existing Residential Recycling Programs

Estimated Residential Recycling Program Performance and Residential Recycling Rates for Consumer PPP

An analysis of the tons of residential recycling reported shows that, in 2011, approximately 407,000 tons of the four major categories of recyclables (Paper, Plastic, Metal, and Glass) were recycled statewide, equivalent to 0.194 tons per household. Analysis of the tons collected by county suggests that residential recycling program performance varies across county classes, with the higher per-household recycling achieved in Urban areas, as shown in **Table 5**.[19]

Table 5. Estimated Residential Recycling Program Performance, 2011

	# of HHs	Tons	Tons/HH Collected
Urban	1,596,439	321,000	0.201
Suburban	326,497	56,000	0.171
Rural	178,359	30,000	0.170
Statewide	**2,101,295**	**407,000**	**0.194**

For this study, all materials collected for recycling from the residential sector in the four major material categories (Paper, Plastic, Metal—excluding scrap metal—and Glass) are assumed to be designated PPP.[20]

Table 6 presents the estimated tons of designated PPP collected through the current residential recycling system in Minnesota in 2011 by material category, and the corresponding estimated collection rate as a percentage of the total residential supply estimate from **Table 1**.[21]

The recycling process results in material losses in the form of contamination (material collected that is not recyclable, such as food scraps) and outthrows (recyclable material that is discarded because it is not properly sorted at the MRF or cannot be effectively utilized in the remanufacturing process). Accounting for these material losses is important for understanding the actual recycling rates and tons of consumer PPP materials available for remanufacturing under current conditions and modeled system. **Table 6** also presents estimated residue rates of materials collected developed by the Study Team—broken out by estimated processing losses at the MRF and end user losses for each material category—and the resulting estimated recycling rates of consumer PPP in the residential stream.

The Study Team used different processing loss estimates for single-stream collection and dual/multi-stream collection, applied to the estimated tons collected based on the portion of households served by each collection method (data on the tons collected using each collection method were not available). The methodology used to develop the estimated residue rates are described in detail in **Appendix A**.

Table 6. Current Residential PPP Recycling Tons Collected and Recycling Rate, 2011

Designated PPP Discarded at Home		PPP Collected for Recycling			Residue Rate		PPP Recycling	
	Tons	*Tons Collected*	*Tons/HH*	*% collected*	*% processing loss**	*% end user loss***	*Tons Recycled (minus losses)*	*% recycled*
Paper	454,000	267,000	0.127	59%	1.8%	2.0%	256,000	56%
Plastic	140,000	26,000	0.012	19%	3.4%	7.0%	24,000	17%
Metal	45,000	29,000	0.014	64%	3.4%	4.0%	27,000	60%
Glass	106,000	86,000	0.041	81%	10.1%	11.0%	68,000	64%
Total	**746,000**	**407,000**	**0.194**	**55%**	**3.8%**	**4.4%**	**375,000**	**50%**

Note: Figures may not sum to totals due to rounding.

**Based on MRF residue estimates from WM Twin Cities single stream MRF of 1.73% for paper, 4.22% for plastic and metal, and 15.22% for glass (applied to 61% of material), and assumed 2% MRF residue for dual stream (applied to 39% of material).*

***Based on base case end user loss rates estimated by DSM in Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont, October 2013, Table 40.*

Estimated Residential Recycling Program Costs

To estimate the current costs of residential recycling collection programs, the Study Team calculated weighted average costs per household from a sample of 78 municipally contracted direct collection programs and 18 county-provided direct collection programs with reported collection costs and P&E spending, as well as 7 county-provided drop-off recycling programs with cost and spending data.[22] Data for direct collection programs in Urban areas come from 2011 reports to Re-TRAC by municipalities with contracted collection in the Twin Cities metro area. Data for Suburban and Rural direct collection programs, as well as drop-off recycling programs, come from the 2011 SCORE survey completed by county governments that act as the sole providers of residential recycling collection services in their jurisdiction.[23]

Table 7 presents the estimated weighted average costs for sample residential recycling programs in Minnesota based on the Study Team's analysis. To enable comparison of current program outcomes to projected program outcomes under the modeled system (discussed in **Section 3.3**), weighted average tons collected per household for these programs were also calculated.[24]

Table 7. Cost Ranges and Estimated Average Costs for Residential Recycling Programs, 2011

	Programs in Sample	Annual Per HH Collection Costs			Annual Per HH P&E Spending			Tons Per HH Collected
		Weighted Average	*Low*	*High*	Weighted Average	*Low*	*High*	Weighted Average
Direct Collection – Urban	78	$36.15	*$15.12*	*$75.36*	$0.47	*$0.03*	*$4.87*	0.188
Direct Collection – Suburban/Rural	18	$33.26	*$7.51*	*$75.91*	$0.99	*$0.23*	*$2.28*	0.164
Drop-off Recycling	7	$29.89	*$8.57*	*$50.00*	$0.12	*$0.02*	*$0.63*	0.089

Costs reported by these programs are generally gross contract costs, and do not reflect revenue received for the sale of recyclable materials remitted back to the municipal or county government. However, according to the MPCA's 2012 Curbside Recycling Survey, the majority (70 percent of those surveyed) of municipal and county governments that contract for residential recycling service do not receive a revenue share. Private haulers, though, do factor revenue from the sale of recyclable materials into their contract pricing bids, thus suggesting that contract costs do account for the value of recyclable materials collected, and are thus assumed to be net of material revenue.

The prevalence of subscription-based residential recycling service in Minnesota makes it difficult to estimate total residential PPP recycling program costs under the current system, both because very little is known about subscription service costs and because of the uncertainty about the portion of households in these areas that actually subscribe for service.

In addition, the wide range of reported service costs and P&E spending among sample programs analyzed demonstrates the magnitude of variation in service costs and spending under the current system. The small sample size of drop-off recycling programs with available data on costs also weakens the reliability of these data as a source for generalized cost estimates at the state level.

To develop an estimate of residential PPP recycling program costs statewide under the current system, the Study Team assumed that per household costs and P&E spending under subscription service were similar to contract service costs, and that these costs were only applicable to subscriber households (as estimated in **Table 3**).

To account for the uncertainty in costs, **Table 8** presents an estimated cost range rather than a single cost estimate. The range was derived by applying the weighted average per household service costs and P&E spending presented in **Table 7** to the estimated number of households served (under contract and subscription-based direct collection and via drop-off only) in each area (Urban/Suburban/Rural), plus or minus ten percent.

Table 8. Estimated Statewide Residential PPP Recycling Program Costs, 2011

	Estimated Annual Residential Recycling Costs (Collection + P&E)			Residential Recycling Tons Collected	Estimated Average Cost/Ton		
	Low		High		Low		High
Urban	$46,803,000	-	$57,204,000	321,000	$145.80	-	$178.21
Suburban	$9,083,000	-	$11,102,000	56,000	$162.20	-	$198.25
Rural	$4,867,000	-	$5,948,000	30,000	$162.23	-	$198.27
Statewide	**$60,753,000**	**-**	**$74,254,000**	**407,000**	**$149.27**	**-**	**$182.44**

Separately, in 2009 the MPCA estimated that net residential recycling costs for direct collection programs in the Twin Cities metro area were between $110 and $143 per ton, including facility tip fees; collection and transport; and other costs, including the cost of bins and program administration, accounting for commodity revenues and profits.[25] This estimate suggests a somewhat lower cost than estimated here for tons collected in the Twin Cities metro area. However, tons collected outside of the metro area are believed to incur higher costs due to the longer distances required for transport to processing facilities.

Current Methods of Program Financing and Charges to Residents

Just as the types of collection infrastructure and services provided vary widely under current recycling programs in the state, so do methods of financing residential recycling collection programs.

In areas with subscription-based recycling service, private haulers charge residents directly for recycling collection service, although in some counties they receive funds from county governments through the state SCORE program to subsidize the costs of service for residents.

In jurisdictions with contracted collection service, local governments collect funds from residents to cover the contract costs as well as other government costs associated with provision of recycling service. County governments also receive SCORE program funds from the State to support a wide range of recycling and waste reduction-related activities, a portion of which may be used to finance residential recycling collection or P&E activities. Some county governments pass funds through to municipal governments to subsidize the costs of recycling service for residents (or use funds directly, if service is contracted at the county level), but others do not.

The ways in which Minnesota residents currently pay for recycling collection service include:

- Fees for recycling on utility bills, either with specific line items for recycling service or embedded into the prices charged for garbage service.
- Indirect financing through property taxes, either with a specific assessment for recycling on the tax bill of residential property owners, an assessment for general solid waste on the tax bill, or (less common) through the use of general funds raised from property taxes.
- Indirect financing through taxes or fees on garbage collection services, usually collected by garbage haulers and remitted to the county government, which uses the funds collected to support a wide range of solid waste management and planning activities, with recycling collection being just one element.

In cases where recycling collection service is contracted by the municipality, funds are sometimes raised directly by the municipal government (or their contracted hauler) and are sometimes raised by the county government (especially when financed through property taxes or solid waste charges), which then remits a portion of funds to the municipality.

Some local governments use a combination of direct utility bill fees and property tax assessments or solid waste fees to finance their recycling programs.

Amounts paid by residents for direct collection service range dramatically, even within geographically similar areas.

Amounts paid by residents for direct collection service range dramatically, even within geographically and demographically similar areas. For example, residents in the City of Bayport, a small municipality on the shores of the St. Croix River in Washington County, pay $7.50 per month via a charge on their garbage bill for curbside recycling collection. In Lake St. Croix Beach, just 7 miles downriver, property-owning residents pay the equivalent of $2.65 per month via property taxes for recycling. The services provided and materials covered through curbside programs in the two cities are very similar.[26]

Of the 61 municipalities with reported per-household charges in the analysis of municipal programs performed by the Study Team, total annual charges ranged from $15 to $90 per household, with an average annual charge of $48.24 per household.[27]

It is important to note that charges to residents, especially those levied via property taxes or solid waste fees, are often used to cover a range of programs and activities beyond recycling collection services for the four major material categories, such as collection and recycling of hazardous or problem materials and, in some cases, operation of solid waste and recycling facilities in the county. However, the fees charged to residents are distinct and to some extent disconnected from the costs of providing residential recycling collection of the four major material categories paid by the local governments that provide these services. The service costs used in this study are based on contract costs (which are linked to the direct costs of providing residential recycling collection services) and not fees charged to residents.

As noted in **Section 2.1**, residents also pay a state tax on garbage collection services. Most of the revenue raised from this tax goes to the State's general fund and the MPCA, but a portion—$14.5 million in 2011, approximately 22 percent of funds raised—is used to finance the SCORE program, which supports recycling programs, including curbside recycling programs but also recycling for problem materials, HHW, yard debris, and other waste reduction programs.[28] The MPCA does not track the portion of this $14.5 million that is used to support residential recycling but anecdotal information provided by county and municipal recycling coordinators suggest that it is relatively small.

2.5 Existing Away-from-Home Recycling Programs

Opportunities for away-from-home recycling of consumer PPP cover a diverse array of public spaces, from streetscapes, parks, and other public outdoor venues, to sports arenas and event centers, and even airports and bus/rail stations.

Away-from-home recycling programs at public spaces are generally operated by the municipal, county, or state agencies responsible for them, or by private firms contracted to operate the venues on behalf of their public entity owners. Information about existing away-from-home recycling programs in public spaces in Minnesota is not formally tracked or reported, and because of the diversity of venue types, generalizations about the extent, performance, or costs of these programs are very difficult to make, and compilation of data on these programs is beyond the scope of this study. Where recycling opportunities in public spaces do currently exist, the tons of consumer PPP collected for recycling are assumed to be currently reported as part of the ICI stream.

Two notable away-from-home recycling programs in Minnesota that do track and publicly report some data are operated by the Recycling Association of Minnesota (RAM). One program, called "Message in a Bottle," provides away-from-home recycling collection containers for bottles and cans at gas stations, car wash facilities, and convenience stores. Collection containers are provided free of charge to the host locations, and materials are collected and sorted for sale to end users through partnerships with two nonprofit organizations providing employment opportunities for individuals with disabilities. Funding for these programs comes largely from corporate contributions.

RAM estimates that each host location collects an average of one ton (2,000 lbs.) of beverage containers (primarily PET bottles and aluminum cans) per year. The Message in a Bottle program has expanded substantially in recent years, and now has more than 500 collection containers in 15 communities statewide, with annual collection totally approximately 500 tons.[29]

RAM also operates "It's In The Bag," a plastic bag and film recycling program that provides consumers the opportunity to deposit unwanted plastic bags at participating retail locations. The program also provides employment for adults with disabilities, who collect and sort the plastic material from participating stores. The material is then shipped to Trex Company, Inc., where it is recycled into composite lumber. Retail stores are provided with free custom collection bins, but are charged $4.00 per pick-up for collection. RAM estimates that the program collects more than 500 tons (1 million lbs.) of plastic bags and film annually.[30]

2.6 Existing Recycling Processing Infrastructure and Material Flow

Approximately 85 percent of the consumer PPP collected in Minnesota is processed by nine privately owned and operated materials recovery facilities (MRFs) located in the state. Several of the largest and most efficient of these MRFs are located in the Twin Cities metro area and these large MRFs sort and process recyclables that are collected both locally around the MRFs, as well as from other parts of the state that are trucked in, often over considerable distances.

In addition to the large MRFs, there are approximately 70 additional MRFs that process the remaining 15 percent of consumer recyclables collected in the state. These facilities include publicly owned and operated recycling centers, small private MRFs located in Minnesota, and four private MRFs that are located in adjoining states.[31]

Table 9 lists the nine primary MRFs that process the vast majority of the state's consumer PPP collected for recycling. The MRFs listed have a combined annual processing capacity of approximately 200 tons per hour, over 700,000 tons per year.[32] Furthermore, these MRFs, which make up the vast majority of processing capacity in the state, are capable of sorting materials collected using single-stream methods. Many of the small processing facilities, however, are out-of-date and not capable of processing the expanding quantity and variety of materials being collected by residential recycling programs.[33]

Table 9. Principal Minnesota MRFs

MRF	Type
Republic Services – (Inver Grove Heights) Republic Services (Minneapolis) Dem-Con MRF (Shakopee) LJP Enterprises (North Mankato) Randy's Sanitation (Delano) Tennis Sanitation (Saint Paul Park) Waste Management - Recycle America (Minneapolis)	Single Stream
Eureka Recycling* (Minneapolis) Advanced Disposal – (Rochester)	Dual Stream

* *Eureka Recycling will begin receiving single-stream recyclables in 2014.*

2.7 Estimated Recycling Rate of Consumer PPP under Current Conditions

To estimate the overall recycling rate of consumer PPP under current conditions, the Study Team combined estimated tons recycled through residential recycling collection, estimated tons recycled through the Recycling Association of Minnesota's dedicated away-from-home recycling programs, and estimated tons of designated consumer PPP recycled through other ICI recycling programs. (Note that this estimate does not include all tons recycled by ICI generators, only tons thought to be designated consumer PPP within the larger ICI recycling stream.)

Table 10 presents the estimated recycling rate of consumer PPP under current conditions, calculated as the portion of total designated consumer PPP supply from **Table 1** estimated to be recycled through the combination of recycling systems in place in Minnesota, as of 2011.

Table 10. Estimated Consumer PPP Collection Rate, 2011

Designated Consumer PPP Supply		Tons Recycled (minus losses)					Recycling Rate
	Tons	*Residential*	*Public Space Recycling**	*Retail Bag and Film Recycling***	*ICI (Other)****	*Total*	
Paper	**563,000**	**256,000**			**38,000**	**294,000**	**52%**
Plastic	**194,000**	**24,000**	**300**	**500**	**15,000**	**40,000**	**21%**
Metal	**63,000**	**27,000**	**100**		**10,000**	**37,000**	**59%**
Glass	**158,000**	**68,000**	**200**		**13,000**	**81,000**	**51%**
Total	**977,000**	**375,000**	**500**	**500**	**76,000**	**452,000**	**46%**

Note: Figures may not sum to totals due to rounding.

**Public space recycling estimates are only for the Message in a Bottle program, based on information provided by the Recycling Association of Minnesota.*

***Retail bag and film recycling estimates are only for the It's In The Bag program, based on information provided by the Recycling Association of Minnesota.*

****Estimated tons of ICI recycled are based on the designation percentages developed by the Study Team applied to 2011 SCORE Survey ICI recycling data. Tons collected were adjusted to account for residue, assuming all ICI materials were collected and processed using single-stream methods.*

Section 3. Projected Conditions under Modeled EPR System in Minnesota

The conditions for the EPR system modeled for this study are based on definitions and assumptions established by the Study Team and Recycling Reinvented, laid out in Working Paper 1. The elements included in the modeled EPR system are designed to achieve Recycling Reinvented's three primary goals for an EPR system:

1. Increase the tons of PPP collected and recycled and available for use in domestic manufacturing.
2. Minimize the costs incurred for increasing collection and recycling and processing of PPP.
3. Maximize the environmental benefits from recycling PPP compared to disposal, through increased collection of PPP for recycling, improving material quality, and through improvements to the recycling system and end market opportunities for PPP.

The modeled EPR system is designed to achieve these goals through:

- Universal residential recycling service for all state residents based on best practices for increasing residential recycling participation;
- Increased opportunity for away-from-home recycling;
- Standardized and coordinated recycling promotion and education messages and campaigns;
- Optimization of collection and processing infrastructure and operations to streamline material flow, minimize system costs, and improve material quality.

This section describes the conditions in Minnesota related to each of these elements under the modeled EPR system and the projected effects of the modeled system on consumer PPP recycling in the state.

3.1 Assumed Policy Context of Modeled EPR System

Roles and Responsibilities of Producers

For this study, it is assumed that the EPR system would be the result of state legislation obligating producers of designated consumer PPP to take responsibility for the end-of-life management of those materials, either individually or through a producer responsibility organization (PRO). It is assumed that the legislation would establish a target recycling rate for designated materials to be achieved by producers within a given timeframe. There are many specific details of an EPR system that would be established through legislation that are not defined for the purposes of this study, such as whether producer obligation and the target recycling rate would be set for all consumer PPP or for only PPP in the residential stream.

Under the modeled EPR system, obligated producers would assume responsibility for providing residential recycling service for PPP materials for all Minnesota residents. In addition, producers would provide for opportunities to collect clean plastic bags and film, as well as opportunities to recycle at select "away-from-home" venues such as public spaces.

It is assumed that this obligation would be met by contracting with private haulers or local governments to provide recycling collection and transfer service, with private or public entity processors to provide recycling processing and delivery to end markets, and with private or public entities to design and carry out promotion and education (P&E) activities.

3.2 Attributes of Residential Recycling Programs under Modeled EPR System

As noted in **Section 2.3**, Minnesota residents already have a high level of access to recycling services at home, but the nature, convenience, and effectiveness of these services varies widely. This section describes how residential recycling service would change under the modeled EPR system.

The modeled system results in a projected increase in Minnesota households with direct collection service, from 70% to 87% of households statewide.

Residential Service Access and Participation

Under the modeled EPR system, residential recycling service would be expanded, standardized, and provided free of charge automatically to all residents in the state. **Table 11** presents the criteria used for determining the types and extent of residential recycling service under the modeled system.

Table 11. Residential Recycling Service Provided under Modeled EPR System

County Class	Direct Recycling Collection		Drop-Off Recycling
	Curbside Collection For Single-Family Households*	Building-Level Collection For Multifamily Households	
Urban	• **ALL** cities • Townships with 1,000+ residents	• **ALL** cities • Townships with 1,000+ residents	• Townships with fewer than 1,000 residents • Unorganized areas
Suburban and Rural	• Cities and townships with 1,000+ residents	• Cities and townships with 1,000+ residents	• **Cities** and townships with fewer than 1,000 residents • Unorganized areas

**For this analysis, single-family households are defined as all detached units, including mobile homes, and attached units with up to 4 units per property.*

Providing residential recycling service according to these criteria achieves the following:

- Maintains the level of curbside and building-level collection service currently available;
- Expands and increases curbside and building-level collection in similar communities that do not currently have this level of service;
- Ensures that multifamily households receive universal and consistent service;
- Eliminates incentives for households in subscription areas to "opt out" of recycling to avoid subscription costs.[34]

The result is a projected increase in the percent of Minnesota households with direct collection service, from **70 percent** of all households to **87 percent** of households statewide, as shown in **Table 12**.

Table 12. Residential Recycling Service, Current and Projected

	# of HHs	CURRENT SYSTEM (2011)				PROJECTED UNDER MODELED SYSTEM	
		Direct Collection		No Direct Collection		Direct Collection	No Direct Collection
		Contracted	*Subscription-Based*	*Non-Subscribers*	*Drop-Off Only*	*Contracted*	*Drop-Off Only*
Urban	1,596,439	820,200 *(51%)*	393,300 *(25%)*	131,100 *(8%)*	251,800 *(16%)*	1,540,700 *(96%)*	55,700 *(4%)*
Suburban	326,497	123,700 *(38%)*	39,800 *(12%)*	13,300 *(4%)*	149,700 *(46%)*	209,100 *(64%)*	117,400 *(36%)*
Rural	178,359	45,100 *(25%)*	23,500 *(13%)*	7,800 *(4%)*	101,900 *(57%)*	83,300 *(46%)*	95,100 *(54%)*
Statewide	**2,101,295**	**989,000** *(48%)*	**456,600** *(22%)*	**152,200** *(7%)*	**503,400** *(23%)*	**1,833,100** *(87%)*	**268,100** *(13%)*

Note: Figures may not sum to totals due to rounding.

Residential Collection Infrastructure and Services Provided

Under the modeled EPR system, all curbside collection would be provided using cart-based, biweekly single-stream collection of a standardized list of materials. For multifamily households, single-stream collection of a standardized list of materials would also be provided, using recycling containers and service levels that provide sufficient capacity for recycling by residents.

Residents not served by direct collection would have access to convenient drop-off recycling locations accepting the same set of materials. Under the modeled system, it is assumed that drop-off recycling locations in areas without direct collection service would be strategically placed to maximize convenience and usage, and would serve an average of 1,000 households per location.

The universal use of cart-based single-stream collection methods for curbside collection under the modeled EPR system provides significant benefits, with some associated trade-offs. The following section describes why this method of collection is projected to increase the quantity and types of material collected through the residential recycling system and reduce collection costs. In addition, the effects of this method of collection on material quality are discussed.

Increasing the quantity and types of material collected

Utilizing cart-based single-stream collection for residential curbside recycling programs has been shown to increase the quantity and types of material collected for two reasons:

- **Increased capacity**. The introduction of carts, which are usually 64 gallon or 96 gallon containers, provide households with greater capacity for storing and diverting recyclable materials, compared to the smaller (usually 18 gallon) bins traditionally used in dual or multi-stream programs, and in some single-stream programs as well.
- **Broader material acceptance**. Single-stream collection enables the inclusion of a wider range of materials accepted in the program, allowing households to divert new materials not previously accepted for recycling collection.

Because implementation of single-stream collection has often been coupled with an increase in the container size and the addition of new material types accepted, it is difficult to determine the relative impact of each of these variables. However, multiple studies have shown that these two variables combined do correlate with an increase in residential recycling collection.[35,36]

On its own, the use of the single-stream collection method (without increased capacity and addition of acceptable materials) has not been shown to independently increase household participation or material diversion.[37] Still, recent surveys suggest that residents in Minnesota do want the convenience of single-stream recycling, and there has been a rapid increase in the adoption of this collection method in the state in recent years.[38]

Reducing collection costs

The benefits of single-stream collection largely come from efficiencies in the collection process, resulting from automation of collection (made possible by the use of carts) and maximization of truck capacity. Automated collection has also been shown to decrease worker injuries.[39]

The efficiency gains of single-stream collection are especially pronounced in less densely populated areas. An evaluation of the comparative efficiency of automated cart-based single stream collection and manual collection of bin-based dual-stream collection in rural areas in Ontario showed that automated collection reduced collection times by an average of 44 percent.[40] Although single-stream programs typically have lower collection costs than comparable dual or multi-stream systems, some of the savings are absorbed by higher processing costs.[41]

Effects of Single-Stream Collection on Contamination and Material Quality

It is widely acknowledged that single-stream collection involves trade-offs, including an increase in the residue rate and potential effects on material quality.[42] However, the negative effects of single stream have been shrinking in recent years as prevalence of this collection method has spread and matured, collection practices have been adapted to address contamination, and market and technology conditions have continued to evolve.[43,44]

One example of the market transformations that have occurred as a result of the growth of single-stream collection is in the recycled glass industry. Glass, once considered to be made virtually worthless when collected in single-stream systems, has become much less problematic with the advent of optical sorting that allows for color separation of mixed cullet, enabling glass from commingled stream to be used for manufacturing of new glass bottles. Since the opening of optical sorting facilities by eCullet and Strategic Materials in the Twin Cities metro area, glass cullet from single-stream programs throughout Minnesota is now primarily reprocessed back into glass bottles manufactured in the state. The development of reliable end markets for mixed glass cullet has been one of the primary drivers of the transition to single-stream collection by municipal programs in Minnesota.[45]

Furthermore, cart-based collection offers benefits of drier materials and potential for increased fiber capture, especially corrugated cardboard, as larger boxes can be placed in carts rather than being tied together and placed alongside bins, where it is susceptible to rain and snow.[46]

Still, residue rates of single-stream programs are higher than dual or multi-stream programs, even when using best practices in single-stream collection.[47] On balance, however, the increased quantity of materials collected through cart-based single-stream programs is expected to result in an increase in recovery of marketable materials overall.

Materials Collected in Residential Recycling Programs

Under the modeled EPR system, all residential recycling programs would collect a standardized and expanded set of materials covering nearly all packaging and printed paper in the residential stream.[48] (See **Table A-2** in **Appendix A** for a list of materials assumed to be targeted for collection under the modeled system.)

- **Metal** – all metal containers and packaging, unless food soiled or containing hazardous or dangerous substances.
- **Glass** – all glass containers would be accepted.
- **Paper** – all printed paper and paper packaging, including polycoated cartons and packaging, unless food soiled or damaged by moisture.
- **Plastic** – all plastic containers, including both injection mold and thermoform containers. Plastic bags and film packaging would not be allowed, but would be collected separately through a commercial take-back program. (*See Section 3.4 for details*).

In line with the standardization of collection methods, the standardization of materials accepted would allow for more streamlined and consistent recycling messaging, and would help to bolster collection of PPP materials not universally collected under current programs.

Residential Recycling Promotion and Education

Under the modeled EPR system, promotion and education (P&E) related to recycling would be streamlined and synchronized across the state, creating efficiencies in development and deployment, and enabling investments in more, and more effective, P&E activities.

As noted in **Section 2.3**, sufficient, sustained investment in recycling P&E is a major determinant of program performance. A recent survey of recycling practices among Saint Paul residents found that while "current recycling education materials are informative, clear, and translated into many languages…many residents never see them." The survey report goes on to note, "knowledge and information about recycling presents a significant and frequently cited barrier to recycling for Saint Paul residents, especially residents in multifamily housing."[49]

Under the modeled EPR system, basic recycling guidelines and other educational tools that provide residents with instructions about what and how to recycle would be made consistent across all communities with direct recycling collection service.

By standardizing the collection method and list of materials accepted, P&E activities across the state could be streamlined.

By standardizing the collection method and list of materials accepted for recycling in residential collection programs, P&E activities across the state could be streamlined, eliminating the need for each program to invest in developing recycling guidelines and other collateral specific to a unique list of materials and recycling preparation instructions.

Resident education would be deployed using best practices for clearly communicating recycling instructions, and with sufficient funding to ensure all residents (including households in multifamily buildings) receive them through multiple channels on a regular basis. In addition, under the modeled EPR system, funding would also be devoted to broader, more visible campaigns promoting recycling and reaching residents throughout the state.

The effects of this type of P&E campaign investment were evaluated through a pilot campaign implemented in three jurisdictions in Minnesota—St. Louis County, McLeod County and the Western Lake Superior Sanitary District, which represents Duluth— in 2008-09. These jurisdictions partnered with the Curbside Value Partnership (CVP) to implement a grassroots and social marketing campaign designed to increase participation in existing residential recycling programs. The campaign was designed around existing creative material developed by the state's Recycle MORE program (itself a partnership of the MPCA and the RAM) and supplemented with support from the CVP. Campaign elements included billboards, in-store promotional displays at area retailers, movie theater ads, and local public access channel ads.

The campaign, which was implemented in an area covering 107,500 households, cost approximately $85,000, or around $0.80/household. The participating jurisdictions reported an average increase of 13 percent in residential recycling tonnage collected in the three months following the campaign launch, compared to the same period in prior years.[50] However, subsequent evaluation showed that recycling tonnage dropped back to pre-campaign levels the following year, suggesting that sustained investment would be required to maintain recycling participation among households.[51]

3.3 Projected Performance and Costs of Residential Recycling Programs

To project the estimated performance and costs of residential recycling programs under the modeled EPR system, the Study Team analyzed the performance and costs of existing residential recycling programs in 26 municipalities with contracted service and one countywide program serving 31 municipalities.

All programs included in the analysis provide direct recycling collection using the set of best practices identified for inclusion under the modeled EPR system.

All of the existing programs included in the analysis utilize the following practices:

- Contracted recycling service provided to all residents in the jurisdiction (including all multifamily households).
- Cart-based single-stream collection for single-family households and in-building single-stream collection for multifamily households.
- Acceptance of a wide range of PPP materials, including most plastic containers and packaging.[52]

See the sidebar for a list of municipalities included in the best practices analysis.

The programs analyzed span both Urban and Suburban counties (23 of the 57 municipalities in the sample are in the Twin Cities metro area), with populations ranging from 289 residents to more than 76,000 residents.

Municipalities in Best Practices Analysis	
Anoka	Centerville
	Spring Lake Park
Crow Wing	Baxter (direct collection)
	Brainerd (direct collection)
	Breezy Point (direct collection)
	All 42 other cities and townships used as basis for best practice drop-off analysis
Dakota	Farmington
Hennepin	Brooklyn Park
	Deephaven
	Greenfield
	Greenwood
	Maple Grove
	Medicine Lake
	Minnetonka Beach
	Minnetrista
	Shorewood
	Tonka Bay
	Woodland
Ramsey	Falcon Heights
	Vadnais Heights
Washington	Afton
	Birchwood
	Dellwood
	Grant
	Grey Cloud Island Township
	Lake St. Croix Beach
	West Lakeland Township
Winona	All 31 cities and townships

Sample programs also cover a range of population densities, including municipalities with exclusively single-family households to municipalities where multifamily households comprise more than 40 percent of the population. The average multifamily population in the sample was 15 percent of all households.

In addition, the Study Team analyzed the performance and costs of drop-off recycling service in Crow Wing County, covering 42 small suburban municipalities where no direct recycling collection is available, and where drop-off locations are conveniently located, serving an average of 1,000 households per location. **Table 13** summarizes the attributes of the municipalities included in the best practices analysis.

Table 13. Attributes of Programs Included in Best Practices Analysis Sample

	# of Programs	# of HHs Represented	County Classification (by % of HHs Represented)	% SF HHs	% MF HHs
Direct Collection Best Practices	**27** 26 municipal programs, 1 countywide program covering 31 municipalities	**106,764**	**72% Urban 28% Suburban**	**85%**	**15%**
Drop-Off Recycling Best Practices	**1** countywide program covering 42 municipalities	**16,430**	**100% Suburban**	**99%**	**1%**

On average, programs in the best practices analysis achieved significantly higher performance—increasing average tons collected per household by 32 to 54 percent—compared to the full set of programs analyzed for this study. Among best practices programs that reported service costs, these higher performance outcomes were achieved at lower average costs relative to comparable programs in the average program sample. **Table 14** compares average outcomes from the best practices programs sample with average outcomes from the full set of programs analyzed as part of this study. (For more detail on the full set of programs analyzed, see **Section 2.4**.)

Table 14. Best Practices Program Outcomes Compared to Average Program Outcomes

	# of Programs in Sample		Annual Tons/HH Collected		Annual $/HH Service Costs		Annual $/HH P&E Spending	
	Average Programs*	Best Practices	Average Programs	Best Practices	Average Programs	Best Practices	Average Programs	Best Practices***
Direct Collection – Urban	**78**	**23**	**0.188**	**0.249**	**$36.15**	**$35.17**	**$0.47**	**$0.75**
Direct Collection – Suburban/Rural**	**18** counties	**4** 3 municipalities, 1 county serving 31 municipalities	**0.164**	**0.252**	**$33.26**	*unknown*	**$0.99**	*unknown*
Drop-Off Recycling**	**7** counties	**1 county** covering 42 municipalities	**0.089**	**0.133**	**$29.89**	**$15.66**	**$0.12**	*unknown*

Average programs data come from **Table 7 in **Section 2.4**.*

***Suburban and Rural programs in both program samples are primarily countywide programs; no Rural counties were included in the Best Practices sample.*

****Only 15 of the 27 programs in the direct collection best practices analysis sample reported P&E spending.*

Projected Average Residential Program Performance and Costs

The assumed baseline performance and costs of the modeled EPR system are based on the average performance and costs of the best practices sample programs described above. Because the sample programs analyzed provide service to all residents in their jurisdictions, including all multifamily households, it is assumed that the program performance achieved by these programs is representative of the overall performance of providing service to all households, and that the average service costs are representative of the costs of providing service to all households as well.

This study assumes the modeled EPR system will spend the recommended level of $1 per household per year for standard promotion and education (P&E) activities, such as regular mailings to residents about the recycling program. In addition, the modeled EPR system includes an additional $1 per household in annual spending to support a statewide multimedia communications and outreach campaign promoting recycling, using social marketing best practices shown to be effective in increasing participation). The analysis assumes that the investment in P&E will result in in an additional 10 percent increase in tons per household collected over the baseline projected per household under the modeled EPR system.[53]

Table 15 presents the per-household performance and costs used as the basis for projected outcomes of the modeled EPR system. These values were selected by the Study Team based on the weighted average performance of the best practices sample programs analyzed, adjusted upward to account for the assumed effects of additional P&E spending under the modeled EPR system.

Table 15. Assumed Average Program Performance and Costs under Modeled EPR System

	Annual Tons/HH Collected for Recycling		Annual $/HH Collection Costs	Annual $/HH P&E Spending
	Baseline	With P&E Multiplier of 10%		
Direct Collection	**0.250**	**0.275**	**$35.17**	**$2.00**
Drop-off Recycling	**0.135**	**0.149**	**$15.66**	**$2.00**

Under the modeled EPR system, annual service costs reflect fully loaded contract costs, including the net costs of collection and processing and revenue from the sale of recyclable material. It is assumed that annual service costs include the annualized capital costs of ongoing collection service, such as standard replacement of carts and trucks, but not the initial capital costs of establishing best practices programs, such as the purchase of carts for initial distribution to households not currently served by cart-based single stream collection.

The assumed per household performance and service costs used for the modeled EPR system do not vary by county class or municipality size. The best practices program analysis conducted by the Study Team suggested that, although performance and costs do vary across best practices programs, the variations do not follow consistent patterns based on municipality size. Furthermore, similar outcomes were achieved by direct collection programs in both Urban and Suburban counties.

Far less data on drop-off recycling programs are available, and the Study Team was limited to use of available data on best practices drop-off programs in a single Suburban county as the basis for projected outcomes in areas served by drop-off recycling only under the modeled system. For the purposes of modeling, it is assumed that all areas served by drop-off achieve similar performance at similar costs.

Projected Total Statewide Residential Program Performance

The projected collection outcomes of providing residential recycling service statewide under the modeled EPR system were calculated by applying the assumed average per household tons collected (shown in **Table 15**) to the total number of Minnesota households based on the criteria for service established as part of this analysis (described in **Table 11**). Practically, this means that all households assumed to receive direct collection under the modeled system were projected to recycle 0.275 tons annually and all households assumed to have access to drop-off recycling only under the modeled system were projected to recycle 0.149 tons annually. The resulting collection outcomes projected under the modeled system are distributed across Urban, Suburban, and Rural areas based on the distribution of households in Minnesota.

> The modeled EPR system results in a projected 34 percent increase in residential recycling tons collected.

Under the modeled EPR system, total residential recycling tons collected are projected to increase as a result of widespread implementation of best practices for residential recycling, including expanded access to direct collection service, increased capacity for residents through the use of cart-based single-stream collection, a larger and standardized set of materials collected statewide, and increased investments in consistent and large-scale education.

Combining all of these factors, the residential collection outcomes are estimated to result in a projected **34 percent increase in residential collection** of recyclables, compared to the current system.

Table 16 shows the projected tons collected under the modeled EPR system compared to the estimated tons collected under the current system (initially presented in **Table 5**).

Table 16. Residential PPP Recycling Collection, Current and Projected

	# of HHs	CURRENT SYSTEM (2011)		PROJECTED UNDER MODELED SYSTEM	
		Residential Tons Collected for Recycling	Average Tons/HH	Residential Tons Collected for Recycling	Average Tons/HH
Urban	1,596,439	321,000	0.201	432,000	0.271
Suburban	326,497	56,000	0.171	75,000	0.230
Rural	178,359	30,000	0.170	37,000	0.208
Statewide	**2,101,295**	**407,000**	**0.194**	**544,000**	**0.259**

Table 17 presents the projected residential PPP recycling rate achieved under the modeled EPR system as a result of the projected increase in residential recycling collection compared to the current system, after accounting for material losses.[54]

Under the modeled EPR system, the residential PPP collection rate is projected to be 73 percent of all designated consumer PPP discarded at home, compared to 55 percent under the current system. Accounting for processing and end user losses, the residential recycling rate is projected to be 66 percent of all designated consumer PPP discarded at home, compared to 50 percent under the current system. For more detail about the estimated supply of PPP discarded at home, see **Table 1** in **Section 1.4**. For more detail about the current system estimates, see **Table 6**.

Table 17. Residential PPP Recycling Rate, Current and Projected

Res. PPP Supply (Discarded at Home)		CURRENT SYSTEM (2011)			PROJECTED UNDER MODELED SYSTEM		
	Tons	*Collected* (%)	*Residue Rate* (MRF + end user)	*Recycled* (%)	*Collected* (%)	*Residue Rate* (MRF + end user)	*Recycled* (%)
Paper	**454,000**	**267,000** *(59%)*	**3.8%**	**256,000** *(56%)*	**363,000** *(80%)*	**3.8%**	**349,000** *(77%)*
Plastic	**140,000**	**26,000** *(19%)*	**10.4%**	**24,000** *(17%)*	**40,000** *(29%)*	**11.2%**	**35,000** *(25%)*
Metal	**45,000**	**29,000** *(64%)*	**7.4%**	**27,000** *(60%)*	**36,000** *(80%)*	**8.2%**	**33,000** *(73%)*
Glass	**106,000**	**86,000** *(81%)*	**21.1%**	**68,000** *(64%)*	**106,000** *(100%)*	**26.2%**	**78,000** *(74%)*
Total	**746,000**	**407,000** ***(55%)***	**8.2%**	**375,000** ***(50%)***	**544,000** ***(73%)***	**9.0%**	**495,000** ***(66%)***

Note: Figures may not sum to totals due to rounding.

Projected Total Statewide Residential Program Costs

Projected total statewide residential program costs were estimated following the same methodology as the performance projections presented in **Table 16** above. Under the modeled EPR system, total costs have three primary drivers: average per household costs for direct collection, average per household costs for drop-off recycling, and average per household spending on P&E. Under the modeled system, total costs were assumed to be $35.17 per household receiving direct collection, $15.66 per household receiving drop-off only service, and $2.00 per household for all households for P&E (as shown in **Table 15**).

Table 18 shows the projected costs of providing residential recycling service statewide under the modeled EPR system, compared to the current system costs estimated range from **Table 8**. These projected costs are assumed to reflect residential recycling service costs, net of material revenue, utilizing the state's existing processing infrastructure. They do not include costs for away-from-home programs or potential savings due to processing infrastructure adjustments. These additional costs and saving are addressed in **Table 22**.

Because there is a great deal of uncertainty around current total system costs and spending under the current system, it is not possible to state with confidence whether total costs under the modeled EPR system would increase or decrease overall. However, the modeled EPR program is projected to reap significant increases in tons of recycling collected, resulting in a substantial increase in projected tons of consumer PPP collected within approximately the same spending range as under the current system.

Table 18. Residential PPP Recycling Program Costs, Current and Projected

	CURRENT SYSTEM (2011)		PROJECTED UNDER MODELED SYSTEM	
	Estimated Annual Residential Service Cost *(Collection + P&E)*	Estimated Total Cost/Ton	Projected Annual Residential Service Cost* *(Collection + P&E)*	Projected Total Cost/Ton
	Low - High	Low - High		
Urban	$46,803,000 - $57,204,000	$145.80 - $178.21	$58,253,000	$134.85
Suburban	$9,083,000 - $11,102,000	$162.20 - $198.25	$9,846,000	$131.39
Rural	$4,867,000 - $5,948,000	$162.23 - $198.27	$4,775,000	$128.97
Statewide	**$60,753,000 - $74,254,000**	**$149.27 - $182.44**	**$72,874,000**	**$133.97**

Note: Figures may not sum to totals due to rounding.

** Projected cost estimates are based on assumed average costs per household presented in* **Table 15**.

In addition, the modeled EPR system is anticipated to achieve efficiencies and economies of scale in collection activities, as well as in streamlined and coordinated promotion and education that are likely to result in cost savings over time. However, because the analysis is based on the performance and costs of existing best practice programs in Minnesota that do not currently benefit from the economies of scale of a coordinated statewide program, these potential cost savings are not factored into the estimates presented in this study.

3.4 Away-from-Home Recycling Programs under Modeled EPR System

The producer-financed away-from-home recycling system modeled for this study is assumed to be limited to public spaces that are maintained by local authorities at any level of government, and to retail-based collection of plastic bags and film. The following section describes the attributes and estimated performance and costs of each of these two modeled elements.

Attributes of the Modeled Public Space Recycling Program

The public space recycling program will provide one recycling bin for every:

- 300 people in urban areas;
- 350 people in suburban areas; and
- 400 people in rural areas.

These recycling bins will be paired with and installed next to existing public trash bins. Examples of where these bins will be located include parks, pedestrian areas, public transit, libraries, schools, and government buildings. The bins will collect the same list of recyclable materials accepted in residential recycling programs.

This study assumes that local authorities will empty paired trash and recycling bins at their own cost, and that there will be little or no additional cost to collect from recycling bins as long as they are paired with an existing trash bin. The quantity of discards generated at each existing waste bin location will remain the same as before the introduction of a paired recycling bin – the only difference is that the public will now separate the same quantity of discards into the appropriate collection container, either trash or recycling.

Avoided disposal costs are assumed to more than compensate for any minor incremental time or expense associated with emptying paired trash and recycling bins, compared to only emptying trash bins (which would need to be emptied on a more frequent basis in the absence of a paired recycling bin).

Projected Performance and Costs of the Modeled Public Space Recycling Program

The public space recycling program modeled is projected to collect approximately 19,000 tons of marketable consumer PPP, net of material losses,[55] with further breakdown of materials as follows (note, figures do not sum due to rounding):

- Approximately 12,000 tons of paper marketed to paper mills each year, including newspapers, magazines, single-serve milk and juice cartons, and consumer packaging from quick service restaurants (including hot and cold drink cups, bags, and other coated paper-based food packaging materials).
- Approximately 3,000 tons of plastic PPP consisting primarily of beverage containers and drink cups.
- Approximately 2,000 tons of aluminum cans.
- Approximately 1,000 tons of glass bottles.

This study assumes that recycling programs for consumer PPP generated on private industrial, commercial, and institutional (ICI) property will not be funded under the modeled EPR system. For comparison purposes, existing quantities of consumer PPP collected and recycled from private buildings such as hotels, malls, restaurants, and office buildings are estimated at approximately 76,000 tons per year (net of material losses) in Minnesota.

Under the modeled system, it is assumed that producers incur all collection and processing costs after recyclables from public bins have been consolidated at a central point. The same collection trucks and routes that service multifamily recycling collection containers can service these public space recycling consolidation points as well. Because the accepted material stream of the public space recycling program covers the same materials collected in residential recycling systems, the same transfer and processing infrastructure used for residential recyclables can also process materials collected through the public space recycling program.

The Study Team projects the net cost of such as statewide public space recycling program to be approximately $1.7 million per year, including the following annualized capital and operating cost elements:

- Initial purchase and ongoing maintenance/replacement cost of recycling bins;
- Cost of collecting recyclables from consolidation points (assuming one consolidation point for every twelve bins, on average);
- Cost of transfer and processing by regional single-stream MRFs that process residential recyclables (adjusted to account for higher levels of contamination); and
- Offsetting material revenues, which reduce the net cost of the program.

Attributes of the Modeled Retail-Based Collection Program for Plastic Bags and Film

The modeled EPR system also assumes that clean recyclable plastic bags and film would be accepted for recycling from Minnesota households at a majority of grocery stores and other select retail locations in the state.

Under the modeled system, participating retail locations would host plastic bag and film collection kiosks and bale and/or store collected bags and film from kiosks (along with pallet wrap and other film generated on site) for pick-up provided on an as-needed basis. Collected materials would be direct hauled to film recyclers.

The modeled system assumes that at least 70 percent of the state's 933 grocery stores and a number of other retail locations serve as collection sites, ensuring that 95 percent of Minnesota households have access to at least one collection location within 10 miles of their home.

Projected Performance and Costs of the Modeled Plastic Bag and Film Collection Program
This expanded collection infrastructure combined with the investment in dedicated statewide P&E is projected to result in a four-fold increase in retail-based plastic bag and film collection, increasing the tons of designated material collected from the approximately 500 tons estimated under the current system to 2,000 tons under the modeled EPR system.

The retail-based approach to plastic bag and film collection is already utilized by many retail locations (including through the existing *It's In The Bag* program operated by the Recycling Association of Minnesota) and is generally cost neutral from an operational standpoint, generating sufficient revenue to offset the labor costs and dedication of floor space associated with collection.[56]

Under the modeled system, it is assumed that the PRO would build on this approach, resulting in a collection program with negligible operational costs.[57] The more significant cost associated with this approach is for promotion and education of the program, which, under the modeled system, is included in the statewide recycling campaign discussed in **Section 3.3**.

3.5 Recycling Processing Infrastructure and Material Flow under Modeled EPR System

As noted in **Section 2.6**, Minnesota's recycling processing infrastructure includes many small processing facilities that are out-of-date and not capable of processing the expanding quantity and variety of materials being collected by residential recycling programs. At the same time, the large MRFs that provide the majority of processing capacity in the state are capable of sorting materials collected using single-stream methods and have surplus capacity to process additional materials.

The state's current arrangement of processing infrastructure results in inefficiency and higher costs compared to hub-and-spoke arrangements identified by numerous studies as optimal for maximizing system efficiencies and improving overall performance.[58]

This study assumes that the modeled EPR system would include adjustments to the state's processing infrastructure arrangement to achieve improved efficiency and reduce system costs. As part of this study, the Study Team created a transfer and processing system model for Minnesota to analyze potential cost reductions that could be realized under a producer-financed processing system.

The potential processing infrastructure adjustments described in this section are presented for modeling purposes only, and do not include considerations of asset ownership or financial obligations of existing processing facilities.

The Study Team used the transfer and processing model to evaluate post-collection costs under three scenarios:

1. ***Baseline*.** The first scenario models estimated transfer and processing costs under the existing system set of business relationship, which is a non-centrally managed system of processing, where approximately one-third of the tonnage of PPP collected statewide is processed at existing small local MRFs and recycling centers, and the remainder is processed by large regional MRFs.
2. ***Optimized transfer and processing at existing regional MRFs*.** The second scenario models a system in which PPP flows are centrally managed by the producer responsibility organization (PRO) and directed to the state's existing single-stream MRFs to optimize and reduce total system cost. Under this scenario, small local MRFs are replaced with a network of transfer stations, with one transfer station in each county, except in counties with existing regional MRFs to which materials from the host county are direct hauled.
3. ***Optimized transfer and processing at optimally located regional MRFs*.** The third scenario models a system in which PPP flows are centrally managed by the producer responsibility organization (PRO) and directed to optimally located single-stream MRFs. As with the second scenario, small local MRFs are replaced with a network of transfer stations. In addition, two new regional MRFs are opened in parts of the state currently lacking such facilities, and excess capacity in the Twin Cities metro area is repurposed to recycling non-residential streams or closed.

Processing costs under the baseline scenario are assumed to be incorporated within the total projected annual costs of the modeled EPR system presented in **Table 18**. The possible cost savings of the alternative scenarios described in this section would reduce the total projected annual costs of the modeled EPR system.

Processing Costs and Possible Cost Savings under Modeled EPR System

To project possible cost savings under the modeled EPR system, the Study Team relied on a MRF model of single-stream processing costs at different design capacities and utilization under single shift and two-shift per day scenarios. This model was developed for a study with similarities to this one in that it evaluated cost savings that Ontario's PPP EPR system could achieve if the PPP being collected there were processed in an optimized transfer and processing system. That study was performed for Waste Diversion Ontario's Continuous Improvement Fund Office, and included an external technical advisory review of the model and its inputs and assumptions in consideration of potential disruptions to existing processing businesses that could result if the findings of the report were implemented there.[59] Processing cost estimates at different design levels of throughput and utilization (in terms of shifts per day) are presented in **Table 19**.

Table 19. Single-stream MRF Processing Costs Based on Economies of Scale

Annual Quantity (tons)	**24,601**	**36,081**	**49,202**	**57,401**	**72,161**		**114,803**		**144,322**	**229,606**
Design, Operation (tons/hr, shifts)	14 tph, 1 shift	20 tph, 1 shift	14 tph, 2 shifts	32 tph, 1 shift	40 tph, 1 shift	20 tph, 2 shifts	63 tph, 1 shift	32 tph, 2 shifts	40 tph, 2 shifts	63 tph, 2 shifts
Processing Cost ($USD/ton)	$126	$114	$97	$93	$91	$86	$85	$71	$69	$64

Table 19 shows that considerable cost savings are achievable by:

- Large MRFs compared to small MRFs; and
- Two shift per day operations compared to one shift per day operations.

It should be noted that the processing cost rates shown above are gross costs and do not include revenues, which would result in lower net processing costs per ton than shown in the table. Processing costs for small dual stream MRFs were based on the same reference study and modeled as a flat $163 per ton based on the cost profile of an 11,600 ton per year single-stream processing facility.[60] This estimate for small MRFs can be compared to an assessment conducted approximately ten years ago of five Minnesota publicly-owned facilities ranging in annual processing from 2,000 to 6,300 tons per year of dual-stream or multi-stream recyclables. That study found gross processing costs for those small-scale facilities in Minnesota ranged from $89 to $314 per ton, and depended on a number of factors including extent to which material had been pre-sorted.[61] The effect of inflation and single-stream collection would be expected to result in higher processing costs on average than was reported in that study.

The Study Team applied these costs, along with transfer costs estimates developed for the study, to each of the three processing infrastructure scenarios evaluated to project processing costs and possible cost savings under the modeled EPR system.[62] The results of each scenario are described below.

Baseline Processing Costs

The baseline scenario was modeled by applying the processing and transfer cost estimates to existing material flow arrangements, but with the higher consumer PPP recovery quantities projected to be collected under the modeled EPR system. This model assumes that a significant quantity of collected PPP is still processed at small local MRFs where collection would be single stream but sorting would be primarily manual with a cost of $163 per ton. The fully amortized cost of reconfiguring these small MRFs to handle single-stream recyclables is included in the $163 per ton cost rate. Under this scenario, the modeled gross annual post-collection costs (direct delivery, transfer, and processing) are projected to be **$68 million**. As noted above, these transfer and processing costs are gross costs and do not account for revenue from the sale of recyclable materials, which are assumed to be incorporated within the total projected annual net costs of the modeled EPR system presented in **Table 18**. If the market basket of residential PPP commodities averages $105 per ton, there would be a total of $57 million in commodity revenues, the gross cost of the EPR system, including collection and processing, would be $130 million, with processing composing slightly more than half of gross system costs.

Optimized transfer and processing at existing regional MRFs

The second scenario was modeled so that all collected tons would either be direct delivered or transferred to one of eight existing larger regional single stream MRFs so that the system cost was minimized. **Table 9** listed eight MRFs that either currently are or soon will be processing single-stream recyclables in the state. The combined annual processing capacity of these eight MRFs is approximately 700,000 tons per year, and the Study Team estimates they are currently approximately 50 percent utilized on average with residential recyclables (not including non-residential recyclables they may process). Under this approach, the utilization of these existing regional MRFs would increase to 87 percent of target processing rates (based on full two shifts per day, five days per week), and resulting in processing cost savings through economies of scale, even though transportation costs increase over the baseline scenario. Under this scenario, the modeled gross annual post-collection costs (direct delivery, transfer, and processing) are projected to be **$60 million**. This would result in a **net savings of $8.4 million** below the total projected annual costs of the modeled baseline EPR system.

Optimized transfer and processing at optimally located regional MRFs

The third scenario modeled included the construction of new single-stream MRFs in regions of the state where sufficient population and tonnage of PPP collected exist to support cost-effective MRF operations, with savings on transfer cost to existing MRFs (currently clustered around the Twin Cities metro area) offset the costs of new MRF construction and operation. The modeled scenario recommended the construction of two new 20 ton per hour single-stream MRFs, one in Crow Wing County to serve as a processing location for northern counties, and a second MRF in Rochester. These two facilities would replace MRF capacity in the Twin Cities metro area, maintaining a processing system with the same capacity utilization as modeled under the second scenario (87 percent of target processing rates based on full two shifts per day, five days per week).[63]

Under this scenario, the modeled gross annual post-collection costs (direct delivery, transfer, and processing) are projected to be approximately **$58 million**. This would result in a **net savings of $10.5 million** below the total projected annual costs of the modeled EPR system.

Table 20 shows the side-by-side results of the three modeled scenarios.

Table 20. Projected Processing Costs and Cost Savings Scenarios under Modeled EPR System

	Baseline Scenario		Optimized Transfer to Existing MRFs		Optimized Transfer and MRF Locations	
	$ millions	$/ton	$ millions	$/ton	$ millions	$/ton
Delivery/Transfer Cost	$9.7	$18	$15.4	$28	$13.7	$25
Processing Cost	$58.6	$108	$44.5	$82	$44.1	$81
Total Post-Collection Cost	$68.3	$126	$59.9	$110	$57.8	$106
Savings Compared to Baseline Scenario	**n/a**	**n/a**	**$8.4**	**$16**	**$10.5**	**$20**

For the purposes of this study, the modeled EPR system is assumed to utilize the third scenario, in which cost reductions are achieved through optimized transfer and processing at optimally located regional MRFs. It should be noted that both optimized system scenarios include repurposing or closing existing processing capacity. The cost of retiring outstanding debt associated with existing facilities has not been calculated because it would require a survey of all facilities, which was beyond the resources of this study.

Significant additional cost savings beyond that considered in the two optimization options discussed above could also be achieved by expanding selected existing single stream MRFs to higher hourly processing capacities, and closing other smaller facilities – this analysis too was beyond the scope of this study. If EPR were to be implemented in Minnesota, a systems optimization study to assess facility-by-facility the cost of stranded assets and potential for additional optimization savings over those identified in this analysis.

The processing cost analysis of this section focused on cost savings that could be achieved under EPR by a producer responsibility organization-managed system of processing that could lower costs through economies of scale, compared to the existing unmanaged system. No assumption over ownership of capital was necessary for this analysis. Recycling Reinvented in its EPR White Paper envisions that the producer responsibility organization (PRO) will have long-term contracts with waste haulers, MRFs, and municipalities who in turn will be responsible for owning and managing their capital, investing in efficiency improvements, and managing their own daily operations.

3.6 Projected Recycling Rate of Consumer PPP under Modeled EPR System

Under both the current system and the modeled EPR system, collection of consumer PPP occurs through multiple channels, including:

- Residential recycling collection;
- Dedicated away-from-home recycling programs;
- Commercial (ICI) recycling collection from commercial establishments where consumer PPP is generated, such as bars and restaurants, schools, and in general commercial recycling streams when individual consumers discard consumer PPP items at various locations outside of the home.

The consumer PPP recycling collection rate is thus driven by collection across all of these streams. This study assumes that collection of designated consumer PPP in the ICI stream remains constant and that gains in the recycling collection rate of consumer PPP are driven by increasing residential recycling collection and away-from-home recycling programs as projected in the sections above.

The modeled system is projected to result in a more than 30 percent in tons of consumer PPP recycled—from 452,000 tons to 592,000 tons—increasing the consumer PPP recycling rate in Minnesota from 46% to 61% of total estimated supply.

Table 21 on the following page presents the estimated recycling rates for designated consumer PPP under current programs and projected under the modeled EPR system, after accounting for material losses throughout the system.

Under the modeled system, recycling of consumer PPP in Minnesota is projected to increase by nearly one-third, from 452,000 tons under the current system, an estimated 46 percent of total supply, to 592,000 tons or 61 percent of total supply.

Table 21. Estimated Consumer PPP Collection Rate, Current and Projected*

	Designated Consumer PPP (estimate)		
	Discarded at home	*Discarded away from home*	*Total Tons Supplied*
Paper	454,000	109,000	563,000
Plastic	140,000	54,000	194,000
Metal	45,000	18,000	63,000
Glass	107,000	51,000	158,000
Total	746,000	231,000	977,000

	CURRENT SYSTEM (2011) Tons Recycled					Recycling Rate	
	Residential	*Public Space Recycling*	*Retail Bag and Film Recycling*	*ICI (Other)*	*Total Tons Recycled (minus losses)*	*Residential PPP*	*Total Designated PPP*
Paper	256,000			38,000	294,000	56%	52%
Plastic	24,000	300	500	15,000	40,000	17%	21%
Metal	27,000	100		10,000	37,000	60%	59%
Glass	68,000	200		13,000	81,000	64%	51%
Total	375,000	500	500	76,000	452,000	50%	46%

	PROJECTED UNDER MODELED EPR SYSTEM Tons Recycled					Recycling Rate	
	Residential	*Public Space Recycling*	*Retail Bag and Film Recycling*	*ICI (Other)*	*Total Tons Recycled (minus losses)*	*Residential PPP*	*Total Designated PPP*
Paper	349,000	12,000		38,000	399,000	77%	71%
Plastic	35,000	3,000	2,000	15,000	56,000	25%	29%
Metal	33,000	2,000		10,000	45,000	73%	71%
Glass	78,000	1,000		13,000	92,000	73%	58%
Total	495,000	19,000	2,000	76,000	592,000	66%	61%

Note: Figures may not sum to totals due to rounding.

3.7 Projected Total Annual Costs to Producers under Modeled EPR System

Under the modeled EPR system, producers—through a producer responsibility organization (PRO)—would finance the costs of providing the residential and away-from-home PPP recycling programs in Minnesota described in the preceding sections. Based on the analyses presented in this working paper, the total annual costs to producers for recycling program operations are projected to be approximately $64 million. As shown in **Table 22**, these costs are equivalent to approximately $122 per ton of PPP recycled and delivered to end markets.[64]

Table 22. Projected Total Annual Costs to Producers under Modeled EPR System

	Projected Total Annual Cost
Residential PPP Recycling Program Costs	$72,874,000
Projected Service Costs	**$68,671,000**
Projected P&E Costs	**$4,203,000**
Away-from-Home PPP Recycling Program Costs	$1,700,000
Projected Savings from Processing Infrastructure Optimization	($10,500,000)
Total Annual Costs	**$64,074,000**
Total Net Cost/Ton *(tons collected minus losses)*	$122

The third working paper developed as part of this study will estimate some additional costs expected to be incurred by producers under EPR—such as for administration, enforcement, and market development for materials without existing markets—and will model how these costs, along with the recycling program operation costs estimated in this paper, could be allocated to producers under a hypothetical EPR financing system. The third working paper of this study will also provide some general discussion of the likely premiums required in the first years of the program to cover one-time start-up costs, based on what has been observed in Canadian EPR programs and will more fully discuss the possible cost impacts of an EPR system on households in Minnesota.

Endnotes

[1] SCORE stands for the 1989 Select Committee on Recycling and the Environment, created by Minnesota Governor Perpich to find solutions to solid waste challenges in the state. The acronym is still used to describe activities carried out by county governments using funding from the Solid Waste Management Tax that was initiated by the SCORE, sometimes called the SCORE tax.

[2] The category "Problem Materials Not Recovered," described by the MPCA as "a calculated number that recognizes the amount still placed in garages, basements, etc." is not included in this estimate.

[3] Minnesota Pollution Control Agency, *Report on 2011 SCORE Programs*, December 2012.

[4] This overall estimate of designated material, based on the definitions established in Working Paper 1, was derived from waste composition and recycling quantity data for each of the four major material categories and estimates made by the Study Team of the percentage of material within each category that would likely be consumer PPP. See the discussion of **Section 1.4** in **Appendix A** for detail on the methodology used.

[5] According to an analysis of beverage containers conducted by the Minnesota Pollution Control Agency in 2009, 67 percent of beverage containers generated in the state (including all sizes of metal, plastic, and glass beverage containers) are discarded at home. An additional 3 percent are discarded in "specialty" sectors (public spaces including schools, recreational sites, and events), and the remaining 30 percent are found in the commercial waste stream. See Minnesota Pollution Control Agency, *Beverage Containers: Summary of the Stewardship Initiative for Minnesota and Wisconsin*, July 2009, p.6.

[6] Limitations in the data reported about quantity and composition of residential waste in Minnesota make it difficult to determine the amount of consumer PPP in the residential stream since some material categories contain both designated and non-designated materials. This estimate is based on assumptions made by the Study Team of the percentage of material within each category that would likely be consumer PPP. See the discussion of Section 1.4 in Appendix A for detail on the methodology used.

[7] The classifications used in this study differ from the statutory classifications used in Minnesota for legislative purposes.

[8] Minnesota Pollution Control Agency, *Curbside Recycling: Plastics and Program Characteristics – Summary of a Statewide Survey*, September 2013.

[9] Analysis based on data from the 2012 Curbside Recycling survey, provided to the Study Team by the MPCA.

[10] The levels of participation and tons of recycling collected on average per household with waste collection service tend to be higher when contracted recycling is provided, even in places where recycling by residents is mandatory but direct collection is available as a subscription service. A 2009 study conducted by Foth on behalf of the MPCA found that the average amount of recyclables collected per household per year in municipalities with subscription-based curbside recycling was 12 percent lower than in municipalities with contracted curbside recycling service. See Minnesota Pollution Control Agency, *Analysis of Waste Collection Service Arrangements*, Prepared by Foth, June 2009, p.65.

[11] This assumption is based on an informal estimate of one of the largest private haulers in the state that the average recycling subscription rate among its residential garbage customers is approximately 75 percent.

[12] This percent jumped to 62 percent in 2012 as Minneapolis, the state's most populous city, began to roll out single-stream, cart-based collection for its residents. Since 2011, several counties with countywide contracts and numerous municipalities also made the transition and the MPCA now estimates that approximately 70 percent of the population is currently served by single-stream collection. Saint Paul, Minnesota's second most populous city, is also planning to transition to single-stream, cart-based collection by the end of 2014.

[13] Based on data provided to the Study Team from the Minnesota Pollution Control Agency, *Curbside Recycling: Plastics and Program Characteristics – Summary of a Statewide Survey*, September 2013. Survey responses were adjusted to reclassify Minneapolis and Winona County as multi-stream collection locations, as both switched to single-stream collection in 2012.

[14] In the 2011 SCORE Survey, Minnesota counties report 1,244 drop-off sites available to residents (501 "recycling centers" throughout the state and 743 "recycling stations"). However, these numbers do not distinguish between publicly operated drop-off sites and privately operated ones, and do not note which sites collect PPP materials vs. those that collect other materials, such as batteries, textiles, used motor oil, etc. The largest number of sites reported are in Ramsey County, with 266 sites reported. Only one of these sites is known to accept PPP materials from households.

[15] Appendix B of the MPCA 2012 Curbside Recycling Survey Report, which details plastic recycling guidelines for 88 of Minnesota's larger cities and regional hubs, demonstrates the complexity and variety of interpretations around what types of plastic materials are acceptable for recycling. For example, while the survey found that 78 percent of municipalities with contracted programs reported accepting some types of plastic "Cups, Containers, and Packaging," only 20 percent collected all plastic containers (#1-7). For more information, see Minnesota Pollution Control Agency, *Curbside Recycling: Plastics and Program Characteristics – Summary of a Statewide Survey*, September 2013, p.7.

[16] KPMG, Blue Box Program Enhancement and Best Practices Assessment Project, July 2007, p.58.

[17] Based on Study Team analysis of municipal program data compiled from 2011 reports from municipalities in the Twin Cities Metro Area that use Re-TRAC to submit program data. For more information about the analysis, see the discussion of **Section 2.4** in **Appendix A**. Note that spending on promotion and education by private haulers may not be captured in this estimate, unless it is reported to the municipal government as a separate line item (separate from collection costs).

[18] Based on Study Team analysis of 2011 SCORE Survey responses and information about county recycling programs compiled by the Study Team.

[19] Although the relative importance of each factor is undetermined, the higher per household recycling rates in Urban areas is likely the result of a combination of higher levels of direct recycling collection, higher levels of contracted recycling service, more widespread deployment of cart-based single-stream collection, and higher levels of total generation by Urban area households.

[20] An analysis conducted by the Study Team of the material composition of residential recycling in the City of Seattle, where the most extensive classification of recycling composition in terms of PPP in the United States has been conducted, suggests that 97 percent of materials in these four categories collected from residents for recycling would be considered designated consumer PPP materials under the definitions established for this analysis. Based on an analysis of data from Seattle Public Utilities, *2010 Residential Recycling Stream Composition Study Final Report*, Prepared by Cascadia Consulting Group, August 2011.

[21] The collection rate estimates are based on data reported by county governments in the 2011 SCORE Survey, which use a range of methods to estimate quantity and composition of residential recycling materials, leading to inconsistencies and likely errors in reporting. These inconsistencies are believed to result in an overestimation of residential recycling tons collected, especially for glass containers. The Minnesota Pollution Control Agency has identified the need to revise the SCORE reporting process and is proposing a new measurement system that will result in more consistency and accuracy in measurement and reporting of residential recycling over time.

[22] Weighted average costs were calculated by dividing total costs reported by municipalities included in each of the seven sample groups (Urban-Large, Urban-Medium, Urban-Small, Urban total, Suburban/Rural County-provided direct collection, Suburban/Rural County-provided drop-off, Suburban/Rural County-provided total) by the total number of households in each sample group.

[23] A full list of municipalities and counties included in the analysis is provided in **Appendix C**. For more information about how these cost estimates were derived, see the discussion of **Section 2.4** in **Appendix A**.

[24] The average tons per household collected presented in **Table 7** were calculated for programs included in the sample only. These averages differ from the statewide estimates presented **Table 6**, which were used as the basis for calculating outcomes of the current system.

[25] Minnesota Pollution Control Agency, *Metropolitan Solid Waste Policy Plan, 2010-2030*, p.23.

[26] Information on residential fees provided by Washington County Environmental Services; other data based on analysis of information reported by Bayport and Lake St. Croix Beach to Re-TRAC, 2011.

[27] Based on Study Team analysis of municipal program data compiled from 2011 reports from municipalities in the Twin Cities Metro Area that use Re-TRAC to submit program data. For more information about the analysis, see the discussion of **Section 2.4** in **Appendix A**.

[28] In FY2012, the Solid Waste Management Tax (SWMT) brought in $68,995,520 and $48,296,864 of it went to the MPCA's Environmental Fund with the remainder going to state's general fund according to statute. From the Environmental Fund, $14.25 million was distributed to counties as SCORE grants. The remainder was spent on other waste-related activities such as landfill clean-up, but not recycling.

[29] http://www.recycleminnesota.org/gnews/73-unique-convenience-store-recycling-program-message-in-a-bottle-to-further-expand-in-twin-cities-through-innovative-partnerships

[30] http://www.recycleminnesota.org/programs/it-s-in-the-bag

[31] In Minnesota, many county governments operate recycling centers that do some level of post-collection processing and deliver recyclable materials directly to end markets. For this study, these facilities are considered MRFs. Facilities that only collect and transfer materials to other facilities for processing and marketing are not considered MRFs.

[32] Based on their combined hourly processing design capacity multiplied by two processing shifts per day, 7 hours of sorting per shift, 5 operating days per week, and 52 operating weeks per year. Many MRFs in Minnesota accept recyclable material from outside the state, especially western Wisconsin. Several MRFs outside Minnesota (Fargo, Sioux Falls) accept material from within Minnesota.

[33] Linehan, Dan, "North Mankato Weighs Recycling Options." *Mankato Free Press*, October 8, 2013. http://mankatofreepress.com/local/x1612860180/North-Mankato-weighs-recycling-options

[34] The likely effects of "opt out" decisions by residents are not reflected in the estimate of current residential service access, which includes all residents in areas with access to subscription-based service – regardless of whether they are subscribed or not. As a result, the projected effects of shifting to universal contracted service statewide likely underestimate the increase in the percent of households with service.

[35] An assessment of best practices for optimized packaging material recovery conducted by AMERIPEN estimated that single-stream collection increases recycling diversion by approximately 7 percent over dual-stream programs, and that the use of rolling carts increases the amount of collected material by approximately 20 percent over traditional collection bins. For more information see https://sites.google.com/site/ameripenprkmwiki/team-2-collection-and-processing-infrastructure/team-2-public-summary-findings

[36] A study of single-stream collection in rural areas in Ontario found that 42 percent of residents surveyed from a program that switched from bin-based dual-stream collection to cart-based single stream collection reported an increase in their rate of recycling as a result. See Stantec, *Recycling Collection Operations Review*, Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, 2009, pp.6-18.

[37] A comparative evaluation of single-stream and dual-stream collection programs in Ontario found no evidence to support the claim that single-stream collection improves participation by making recycling easier. Rather, the study found that participation was driven by providing residents with sufficient curbside capacity and with effective promotion and education. See HDR, *An Assessment of Single and Dual Stream Recycling Including Current Program Performance in Large Ontario Municipalities,* Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, March 2013.

[38] A recent consumer survey and study of recycling practices in Saint Paul reported that 9 in 10 residents want to recycle more types of plastics and 3 in 4 residents want single-stream collection. See Wilder Research, City of Saint Paul *Recycle it Forward,* August 2013.

[39] HDR, *An Assessment of Single and Dual Stream Recycling Including Current Program Performance in Large Ontario Municipalities,* Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, March 2013.

[40] Stantec, *Recycling Collection Operations Review*, Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, 2009, p.6-13.

[41] HDR, *An Assessment of Single and Dual Stream Recycling Including Current Program Performance in Large Ontario Municipalities,* Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, March 2013.

[42] In its assessment of single-stream collection for Waste Diversion Ontario, HDR reports that bale contamination is up to 15 percent higher from single-stream MRFs. But the study notes that this is often the function of market-driven MRF operations decisions (e.g., line speed, equipment settings, bale grade decisions) and not the sole or inevitable result of processing commingled material loads. See HDR, *An Assessment of Single and Dual Stream Recycling*, Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, 2013, p.9.

[43] A 2006 comparative analysis of the impacts of commingled recyclables processing commissioned by the MPCA found that "[r]esiduals generation in single-stream facilities is likely to be a function of collection vehicles and the collection methods used as well as processing equipment" and that "contamination of materials…can be minimized if the proper steps are taken in the collection of materials." See Tim Goodman & Associates, *Single-Stream and Dual-Stream Recycling: Comparative Impacts of Commingled Recyclables Processing*, Prepared for the Minnesota Pollution Control Agency, 2006, p.47.

[44] Elizabeth Royte, "Can China Make Us Better Recyclers?" Salon.com, November 6, 2013. http://www.salon.com/2013/11/06/can_china_make_us_better_recyclers_partner/

[45] Dylan de Thomas, *Surveying Single-Stream*, 2013 Resource Recycling Conference Presentation, August 28, 2013.

[46] Green Solutions, *Clark County Recycling Feasibility Study,* Prepared for Clark County Public Works, April 2007.

[47] HDR 's Ontario study reports average residue rates of 7 percent for dual-stream programs and 14 percent for single-stream programs evaluated in Ontario. See HDR, *An Assessment of Single and Dual Stream Recycling*, Prepared for Waste Diversion Ontario Continuous Improvement Fund Office, 2013, p.9.

[48] An assessment of a similar list of materials to be accepted for residential collection under the forthcoming EPR program in British Columbia estimated that 97 percent (by weight) of PPP supplied to households would be targeted for collection. See Multi Material British Columbia, *Packaging and Printed Paper Stewardship Plan*, April 8 2013, p.18.

[49] Wilder Research, City of Saint Paul *Recycle it Forward,* August 2013.

[50] Curbside Value Partnership, *Increasing Recycling Through Enhanced Education and Measurement*, Green Prosperity Conference Presentation, November 4, 2009.

[51] Wayne Gjerde, Minnesota Pollution Control Agency. Personal communication, December 3, 2013.

[52] All but one of the programs analyzed reported accepting at least some cups, containers, and packaging beyond plastic PET and HDPE bottles; most also accept polycoated and aseptic cartons.

[53] This level of expenditure for a statewide campaign is based on the average per-household costs of $0.80, reported by the Curbside Value Partnership of the 2009 campaign to increase residential recycling in Minnesota, with a $0.20 premium added to provide additional support for the use of multimedia communications strategies. See Curbside Value Partnership, *Increasing Recycling Through Enhanced Education and Measurement*, Green Prosperity Conference Presentation, November 4, 2009.

[54] Under the modeled system, all residential recycling tons are assumed to be collected and processed using single-stream methods, and so the Study Team applied the estimated single-stream residue rate to all projected residential tons collected. See Table A-3 in Appendix A for detail about the residue rate factors used in the study.

[55] The Study Team assumed that contamination in the public space recycling program would result in high residue rates, assumed to be 27 percent of gross tons collected. For more details on the methodology used to project tons collected through the public space recycling program, see the discussion of **Section 3.4** in **Appendix A**.

[56] Foth Infrastructure & Environment LLC, *Wisconsin Plastics Recycling Study*, Prepared for Wisconsin Department of Natural Resources, October 2012, p.40.

[57] Some initial investment on the part of producers would likely be required to supply stores with collection kiosks and potentially to provide baling equipment to stores without baling capacity already in place, but these start-up costs are not included in estimated annual program costs under the modeled system.

[58] Waste Diversion Ontario Continuous Improvement Fund Office, *A Study of Optimization of the Blue Box Materials Processing System in Ontario*, Prepared by Resource Recycling Systems and StewardEdge, June 2012. Values from the original report have been adjusted from Canadian dollars and metric tons to U.S. dollars and short tons for this report. See also https://sites.google.com/site/ameripenprkmwiki/team-2-collection-and-processing-infrastructure/team-2-public-summary-findings

[59] Waste Diversion Ontario Continuous Improvement Fund Office, *A Study of Optimization of the Blue Box Materials Processing System in Ontario*, Prepared by StewardEdge with Resource Recycling Systems, June 2012.

[60] All of the small MRFs in Minnesota currently operate below this annual processing level; the use of a flat $163 per ton reference cost likely underestimates the average processing costs of these MRFs.

[61] Minnesota Office of Environmental Assistance, Materials Recovery Facilities Operational Assessment Final Report and Optimization Guide, Prepared by Tim Goodman & Associates, August 2003.

[62] See the discussion of **Section 3.5** in **Appendix A** for detail on the methodology used to estimate transfer costs.

[63] As indicated in the second scenario, there is already sufficient single-stream processing capacity for all additional materials to be collected under the modeled EPR system, so adding more capacity to the state would result in reduced utilization rates and higher processing costs, unless excess PPP processing capacity is repurposed to other uses such as ICI recycling processing. Note that this scenario was not conducted as a complete greenfield analysis where a general theoretical optimal number, size, and locations of MRFs would be calculated. Instead it was conducted as a more specific analysis of the invested capital in the existing system of MRFs, and where long-term savings could be realized by thoughtfully locating new facilities and repurposing existing consumer PPP capacity to other uses so that total system costs could be reduced.

[64] Net cost per ton is calculated based only on tons projected to be collected under the modeled EPR system, excluding tons collected from the ICI sector but not financed by producers.

Extended Producer Responsibility Cost-Benefit Study

Working Paper 2 Appendices

Appendix A. Methodology and Data Sources

Working Paper 2 of the Recycling Reinvented Extended Producer Responsibility Cost-Benefit Study models one possible design of an EPR system for PPP (as envisioned by Recycling Reinvented) in a single state (Minnesota), using state-specific data to project the potential impacts of a state-based EPR system.

To complete Working Paper 2, the Study Team collected and compiled available data and conducted a series of analyses designed to answer key questions about the current extent of consumer PPP recycling and develop projections about PPP recycling under a modeled EPR system.

The Study Team relied primarily on reported data from current recycling programs in Minnesota and the Statewide Waste Characterization Study completed in October 2013.[i] Projections about the potential performance and associated costs of residential recycling programs under a modeled EPR system in Minnesota are based on the actual performance and costs of programs already in place in the state, with adjustments and extrapolations for the changes that EPR could bring. In a few areas of the study, necessary data were not available from Minnesota and data from outside the state were used. To maximize consistency, 2011 was used as the base year for analysis, the most recent year for which comprehensive data were available. All quantity data are presented in 2011 tons, and cost data are presented in 2011 dollars.

The following sections describe the methodologies and data sources used in each of the key areas of the analysis. Sections are labeled to align with section numbering in Working Paper 2.

Section 1. Introduction and Overview

1.4 Definition and Estimation of Consumer Packaging and Printed Paper Supply

Available data on both recycling and disposed waste in Minnesota are categorized by material type but, as with most current methods of characterizing and quantifying solid waste in the U.S., they do not clearly distinguish between packaging/printed paper and materials of the same type that are not considered "consumer PPP" as defined in this study, such as plastic bags and film, some of which are packaging materials and some of which are trash bags, pallet wrap, agricultural film, and other non-packaging materials. Furthermore, some product or packaging types may either be considered consumer PPP or not depending on how and where they are generated – for example, a steel food can generated in the home is considered consumer packaging, but a steel food can generated in a restaurant kitchen is not.[ii]

[i] Burns & McDonnell, *2013 Statewide Waste Characterization Study – Final Report*, Prepared for the Minnesota Pollution Control Agency, October 2013.

[ii] Consumer PPP is considered to be any package or printed material that consumers take possession of, or is intended for an individual consumer's use, regardless of whether generated or discarded at home or away from home. In general, if an individual consumer does not touch it, it is not considered consumer PPP.

For this study, estimates have been prepared of the current supply of consumer PPP by sector, based on best available data. Because of the limitations associated with the data sources used, estimates have substantially higher degrees of uncertainty at the subcategory level than at the major material category levels of Paper, Plastic, Metal, and Glass. As a result, the estimated supply and recycling estimates presented in Working Paper 2 are reported more broadly by the major material categories for consumer PPP.

Total generation was determined for the four major material categories—Paper, Plastic, Metal, Glass—by summing data on disposed tons and recycled tons in each category. The 2011 SCORE Survey was the foundational resource used for these estimates. Recycled tons from this survey were reported by material type and by generating sector (i.e., Residential vs. Institutional/Commercial/Industrial, or "ICI") but disposed tons were reported without generating sector breakouts. To estimate disposed tons in each material type for the base year (2011), the Study Team applied the composition percentages from the 2013 Statewide Waste Characterization Study to the total disposed tons reported in 2011.

The methodologies for estimating recycled and disposed tons by generator and material type, and for estimating the portion of these tons assumed to be designated consumer PPP, are described below.

Recycled Tons

Recycling tons reported in the SCORE Survey are tracked and reported by county governments using a number of different methods, each with varying degrees of accuracy. The variation in measurement methods is acknowledged to lead to some errors and inconsistencies in reported data. However, to maintain the study goal of using state-specific data as the primary foundation for the analysis, the Study Team chose to rely on reported data as much as possible while correcting for abnormalities identified as having potentially significant impacts on model outcomes.

All tons reported in the SCORE Survey under the four relevant material categories (Paper, Plastic, Metal, Glass) were included in the generation estimates except for two scrap metal categories.[iii] In addition, the Study Team adjusted the reported tons in the "Aluminum" category, which were believed to include a significant amount of non-PPP material. The adjusted estimate was based on the difference between reported aluminum beverage container sales reported in the 2009 study of beverage container recycling in Minnesota, adjusted for the 2011 population, and estimated tons of aluminum beverage containers and foil disposed in the 2013 Statewide Waste Characterization Study.[iv]

Based on input from state officials and industry experts, the Study Team also recognized that reported tons in the "Container Glass" category likely included a substantial amount of non-container glass and non-glass contamination, resulting in an overestimation of the actual quantity of container glass collected and recycled. Because no reliable source data were available on the estimated total generation of container glass in Minnesota, the Study Team discounted the glass quantities marketed (shipped to beneficiaries for further sorting and cleaning) using elevated residue rate factors for this category to account for the assumed glass recycling overestimation due to non-glass materials included in the reported tons recycled from the SCORE Survey.

[iii] Tons reported in the SCORE Survey categories of "Commingled Aluminum/Tin/Steel" and "Other Metal Scrap" were not included in the recycling tons calculations.

[iv] Sales data from the MPCA, *Summary of the Beverage Container Stewardship Initiative for Minnesota and Wisconsin*, 2009, p.3.

While the overall tons reported in the SCORE Survey at the material category level were not changed for any categories except for Metal (due to the adjustment of the "Aluminum" category and the exclusion of scrap metal categories), adjustments were made to the distribution of reported tons in specific materials subcategories to reflect the average market basket of each of the four major material categories. This was done to more accurately account for the tons of materials reported in mixed material categories, such as "Mixed Paper" and "Mixed Plastic", reported in the 2011 SCORE Survey but not assigned to an appropriate subcategory.

Total estimated recycling tons were then attributed to Residential and ICI generating sector streams.

Residential recycling collection quantities were based on residential tons collected for recycling reported in the 2011 SCORE Survey, except for three counties that provided self-reported data and five counties where SCORE Survey data were identified as extremely abnormal compared to counties with similar geographic or demographic profiles. In the cases where abnormalities were identified, reported residential tons recycled were replaced with average tons per household from a group of comparable counties.[v] Within residential tons, all tons reported as recycled in the four major material categories—Paper, Plastic, Metal (excluding scrap metal categories) and Glass—were assumed to be designated PPP.[vi]

Estimated tons of ICI collected for recycling were assumed to equal to the difference between total tons reported in the SCORE Survey and residential and away-from-home tons estimated for each material category.

In addition, the Study Team collected estimated tons recycled through existing away-from-home programs operated by the Recycling Association of Minnesota. These tons were assumed to be included within the tons of recycling attributed to the ICI generating sector in the 2011 SCORE Survey.

Disposed Tons

To estimate disposed tons in each material type for the base year (2011), the Study Team applied the composition percentages from the 2013 Statewide Waste Characterization Study to the total disposed tons reported in the 2011 SCORE Survey (excluding tons in the category "Problem Materials Not Recycled").

Because the 2013 Statewide Waste Characterization Study did not break out composition or tonnage by generating sector, the Study Team also developed estimates for the portion and composition of disposed waste in the residential stream. To do this, the Study Team first developed an estimate of total tons of disposed waste in the residential stream using **49%** as the default percentage of total waste assumed to be residential. This assumption is based on Minnesota's 2000 Statewide Waste Characterization Study, the last time the state estimated the residential percent of disposed waste. This percentage was applied to the total disposed tons reported by each county in the 2011 SCORE Survey, with the exception of 12 counties, which had self-reported data on residential tons disposed or on the estimated residential portion of total tons.[vii]

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[v] Counties with self-reported residential tons recycled include McLeod, Mower, and Pine. Counties with reported residential tons recycled identified as abnormal and corrected include Cook, Dakota, Freeborn, Lac qui Parle, and Nobles.

[vi] An analysis conducted by the Study Team of the material composition of residential recycling in the City of Seattle, where the most extensive classification of recycling composition in terms of PPP in the United States has been conducted, suggests that 97 percent of materials in these four categories collected from residents for recycling would be considered designated consumer PPP materials under the definitions established for this analysis. Based on an analysis of data from Seattle Public Utilities, *2010 Residential Recycling Stream Composition Study Final Report*, Prepared by Cascadia Consulting Group, August 2011.

[vii] Counties with self-reported residential tons disposed include Chisago, Hubbard, Isanti, Kanabec, Le Sueur, Lincoln, Mille Lacs, Nicollett, Olmsted, Otter Tail, Pine, and Sibley.

In the absence of Minnesota-specific residential disposed waste composition data, the Study Team applied residential disposed waste composition percentages at the subcategory level within each major material category from the 2009 Wisconsin Statewide Waste Characterization Study to the estimated total residential tons disposed in Minnesota in 2011 to derive the estimated material composition and residential disposed tonnage of PPP categories of discards.[viii] Estimates of ICI tons disposed were assumed to equal the difference between total tons reported disposed and residential tons estimated for each material category.

Generated Tons

As noted above, total tons generated at the material category level were calculated by summing estimates of disposed tons and recycled tons in each category. Residential and ICI tons generated, and estimated tons at the material-specific level, were calculated by summing the recycled and disposed tons estimated using the methodologies described above.

Table A-1 presents estimated total generation of the four major material categories by material type and generating sector.

Table A-1. Estimated Total Generation of Paper/Plastic/Metal/Glass in Minnesota, 2011

Material	*Residential Tons* *(Disposed + Recycled)*	*ICI Tons* *(Disposed + Recycled)*	Total Tons (Disposed + Recycled)
Paper	*87,000*	*421,000*	**508,000**
Corrugated Cardboard and Kraft Bags	*176,000*	*39,000*	**215,000**
Newsprint (ONP)	*36,000*	*14,000*	**50,000**
Magazines/Catalogs	*148,000*	*406,000*	**554,000**
Mixed Recyclable Paper*	*109,000*	*184,000*	**293,000**
Compostable Paper	*33,000*	*37,000*	**70,000**
Other Paper**	*87,000*	*421,000*	**508,000**
Plastic	*226,000*	*382,000*	**608,000**
PET Packaging	*27,000*	*42,000*	**69,000**
HDPE Packaging	*18,000*	*35,000*	**53,000**
Mixed Plastic Packaging	*34,000*	*24,000*	**58,000**
Bags and Film Plastic	*72,000*	*137,000*	**209,000**
Other Plastic	*75,000*	*145,000*	**220,000**
Metal	*45,000*	*48,000*	**93,000**
Aluminum Beverage Containers	*12,000*	*18,000*	**30,000**
Steel/Tin Containers	*33,000*	*30,000*	**63,000**
Glass	*113,000*	*88,000*	**200,000**
Glass Containers	*106,000*	*51,000*	**158,000**
Other Glass	*6,000*	*36,000*	**43,000**
Total	*972,000*	*1,619,000*	**2,590,000**

Note: Figures may not sum to total due to rounding.

**Mixed Recyclable Paper includes office paper, boxboard, gable top and aseptic cartons, phone books, and low-grade paper.*
***Other Paper includes polycoated packaging, cups, and other food service packaging.*

[viii] Wisconsin was chosen because it shares similar demographics, population density and distribution, and economic conditions with Minnesota, and because its 2009 Waste Characterization Study provides detailed residential composition data according to material types that are similar to the material types used in the Minnesota 2013 Statewide Waste Characterization Study.

Designation of Consumer PPP

To project how much of the four major material categories would be designated as consumer PPP under the modeled EPR system, the Study Team developed designation percentages for each material type within the four major material categories, for both the residential waste stream and the ICI streams.

Table A-2 shows the designation percentages used. These assumed designation percentages were developed based on data from EPR programs in Canada and from recycling and waste composition studies in the United States with detailed information about material types within each stream.

Table A-2. Assumed Designation Percentages under Modeled EPR System

Material	Designated PPP in Residential Stream (Disposed + Recycled)	Designated PPP in ICI Stream (Disposed + Recycled)	Targeted for Collection under Modeled EPR System	
			At Home	Away-from-Home
Paper	**77%**	**10%**		
Corrugated Cardboard and Kraft Bags	**100%**	**0%**	**Y**	**Y** *(kraft bags only)*
Newsprint (ONP)	**100%**	**100%**	**Y**	**Y**
Magazines/Catalogs	**100%**	**100%**	**Y**	**Y**
Mixed Recyclable Paper	**92%**	**3%**	**Y**	**Y**
Compostable Paper	**13%**	**20%**	**N**	**N**
Other Paper	**13%**	**20%**	**Y** *(polycoated paper cups and packaging only)*	**Y**
Plastic	**62%**	**14%**		
PET Packaging	**100%**	**100%**	**Y**	**Y**
HDPE Packaging	**100%**	**15%**	**Y**	**Y**
Mixed Plastic Packaging	**100%**	**5%**	**Y**	**Y**
Bags and Film Plastic	**85%**	**4%**	**N**	**Y** *(clean recyclable bags and film only; collected only at designated collection kiosks)*
Other Plastic	**0%**	**0%**	**N**	**N**
Metal	**100%**	**37%**		
Aluminum Beverage Containers	**100%**	**100%**	**Y**	**Y**
Steel/Tin Containers	**100%**	**0%**	**Y**	**Y**
Glass	**94%**	**59%**		
Glass Containers	**100%**	**100%**	**Y**	**Y**
Other Glass	**0%**	**0%**	**N**	**N**

The total supply of designated consumer PPP estimated for this study was calculated by applying these percentages to the estimated tons presented in **Table A-1**.

Section 2. Current Conditions under Existing Recycling Programs in Minnesota

2.4 Estimated Performance and Costs of Existing Residential Recycling Programs

Estimated Residential Recycling Program Performance and Residential Recycling Rates for Consumer PPP
To estimate the overall performance of residential recycling collection in Minnesota, the Study Team divided the reported tons of consumer PPP collected from residents by county in the 2011 SCORE Survey (including all tons in the Paper, Plastic, Metal, and Glass categories except for scrap metal) by the number of households in each county.[ix,x]

Tons reported as collected from residents for recycling in the 2011 SCORE Survey were assumed to represent incoming gross tons to MRFs, meaning that they include materials ultimately discarded during processing, either as residue at the MRF or at the point of end use.

To account for the difference between tons collected for recycling and tons of consumer PPP actually used in the manufacturing of new products, the Study Team applied material-specific residue rate factors, including separate factors for processing losses at the MRF and end user losses. Different processing loss estimates were used for single-stream collection and dual/multi-stream collection, applied to the estimated tons collected based on the percentage of households served by each collection method (data on the tons collected using each collection method were not available).

Single-stream processing losses were based on residue rates reported by the Waste Management Recycle America Twin Cities single stream MRF in 2006.[xi] These factors were applied to 61 percent of all material collected in each of the four major material categories (the estimated percent of households served by single-stream collection).

Dual/multi-stream processing loss estimates were assumed to be 2 percent across all material categories, based on anecdotal reporting from dual-stream MRFs operating in Minnesota. This factor was applied to 39 percent of material collected in each of the four major material categories.

End user loss estimates were drawn from the recent study conducted by DSM Environmental Services Inc. for the Vermont Agency of Natural Resources.[xii]

Table A-3 shows the residue rate factors applied, by material category, in this study.

[ix] As noted above, the Study Team corrected 2011 SCORE Survey data for 8 counties, including 3 with self-reported data and 5 with data identified as extremely abnormal compared to counties with similar geographic or demographic profiles.

[x] Households in the portion of Carlton County served by the Western Lake Superior Sanitation District (WLSSD) were allocated to St. Louis County to enable alignment of household counts with tons reported by WLSSD, which were also allocated to St. Louis County. Combined tons reported by Pope/Douglas Counties were allocated to each county based on population.

[xi] Tim Goodman & Associates, *Single-Stream and Dual-Stream Recycling: Comparative Impacts of Commingled Recyclables Processing*, Prepared for the Minnesota Pollution Control Agency, 2006, p.12.

[xii] DSM Environmental, Systems Analysis of the Impact of Act 148 on Solid Waste Management in Vermont, October 2013, Table 40.

Table A-3. Residue Rate Factors Used

	Single Stream Processing Loss	Dual Stream Processing Loss	End User Loss
	%	%	%
Paper	1.7%	2.0%	2.0%
Plastic	4.2%	2.0%	7.0%
Metal	4.2%	2.0%	4.0%
Glass	15.2%	2.0%	11.0%

Estimated Residential Recycling Program Costs

There is no comprehensive statewide information about the specific costs of providing residential recycling service or the sources of financing for these services. The SCORE Survey collects information about expenditures and revenues of county governments across a range of recycling and waste reduction related activities including recycling of both non-PPP and PPP materials. The category used for reporting recycling expenditures is generally used to include only county government spending for recycling-related services across residential and ICI sectors. Although some county governments provide residential recycling service for or all of their residents, most residential recycling programs are provided by municipalities, and county governments only contribute a portion of funds used for these programs. Most counties do not collect information about total program costs or spending from municipalities in their jurisdiction.

Furthermore, because many households in Minnesota receive service through private subscriptions, even municipal governments in many areas are uncertain about the costs, financing, and spending levels associated with residential recycling service.

To assess residential recycling program costs, then, the Study Team relied on data from a sample of municipal and county-contracted residential recycling programs that do collect and report on the costs and outcomes of their programs.

Estimated average residential recycling collection costs per household were calculated separately in this study for Urban areas, Suburban areas, and Rural areas (classified using USDA Rural-Urban Continuum codes - see **Appendix B** for a complete list of county classifications), using two separate data sources.

For **Urban** areas, estimated costs for this analysis are based on reported contract costs from a municipal dataset compiled for the six counties in the Twin Cities metro area that are members of the Solid Waste Management Coordinating Board (SWMCB). Exhaustive program data from municipalities in these counties are collected using a customized Re-TRAC database. The Study Team compiled 2011 data from 82 municipally contracted residential recycling collection programs in this database, including 78 programs with reported contract costs. See **Table C-1** in **Appendix C** for a list of all municipal programs included in this analysis.

Estimated collection costs reported in the study are weighted averages of reported contract costs divided across the number of households served under contract through these programs.

More limited data are available for residential recycling program costs in **Suburban** and **Rural** areas. To estimate average costs for programs in these areas, the Study Team used reported recycling expenditures and residential recycling tons collected in the 2011 SCORE Survey by county governments that act as the sole recycling service providers for residents in their jurisdiction, either with county-provided direct collection or drop-off recycling service. Of Minnesota's 87 counties, the Study Team identified 25 counties in this category, with 18 counties providing direct collection to some or all households and 7 counties providing drop-off recycling only.[xiii] **Table A-4** lists all counties included in this analysis.

Table A-4. Counties as Sole Providers of Residential Recycling

County Service Provided	Suburban		Rural	
Direct Collection	Brown Koochiching McLeod Mower Pipestone	Rice Steele Watonwan Winona	Big Stone Chippewa Cottonwood Jackson Lincoln	Lyon Renville Stevens Swift
Drop-Off Recycling	Pine		Cass Clearwater Grant	Norman Roseau Wadena

Estimated annual per household service costs presented in the study are weighted averages, the sum of total reported recycling expenditures by sample programs divided across the total number of households served through these programs. Averages for county-provided direct collection and drop-off recycling programs were calculated separately but due to the small sample size, data from Suburban and Rural counties were grouped together so the estimates do not account for differences between programs in these two areas.

It should be noted that all cost data represent government-contracted or directly provided services. As was mentioned previously, a substantial portion of Minnesota's households individually subscribe for waste and recycling collection service. Other studies have demonstrated that service costs are lower, on average, in communities with contracted service.[xiv] This study assumes that all PPP recycling services under the modeled EPR system would be contracted, since they would be paid by producers.

Estimated annual per household spending on P&E under existing programs was calculated using the same methodology and data sources as for estimated collection costs, described above, although with a smaller sample size for municipal programs in Urban areas: only 58 of the 82 programs in the sample reported P&E spending in 2011.

The Study Team used these weighted average per household cost estimates to develop an estimated range of residential PPP recycling program costs statewide under the current system, assuming that per household costs and P&E spending under subscription service were similar to contract service, and that these costs were only applicable to subscriber households. Because of the uncertainty associated with these cost estimates, the Study Team estimated a range of +/- 10% of the calculated total based on the weighted average per household costs.

[xiii] Four additional counties (Cook, Freeborn, Lac qui Parle, and Nobles) were identified as the sole providers of residential recycling services but did not have reliable residential recycling tons reported and were therefore not included in the analysis.

[xiv] Minnesota Pollution Control Agency, Analysis of Waste Collection Service Arrangements, Prepared by Foth, June 2009.

The range was derived by applying the weighted average per household service costs and P&E spending to the estimated number of households served (under contract and subscription-based direct collection and via drop-off only) in each area (Urban/Suburban/Rural), plus or minus ten percent.

Table A-5 shows how weighted average costs were applied to household counts to develop the estimated cost range of the current system.

Table A-5. Basis for Estimated Cost Range under Current System

	Direct Collection Service			No Direct Collection				
	HHs with Direct Collection	Annual Per HH Service Costs		Non-Subscriber HHs		HHs with Drop-Off Recycling	Annual Per HH Service Costs	
		Collection	*P&E*				*Collection*	*P&E*
Urban	**1,213,500**	**$36.15** *+/- 10%*	**$0.47** *+/- 10%*	**131,100**	*no service costs assumed*	**251,800**	**$29.89** *+/- 10%*	**$0.12** *+/- 10%*
Suburban	**163,500**	**$33.26** *+/- 10%*	**$0.99** *+/- 10%*	**13,300**		**149,700**	**$29.89** *+/- 10%*	**$0.12** *+/- 10%*
Rural	**68,600**	**$33.26** *+/- 10%*	**$0.99** *+/- 10%*	**7,800**		**101,900**	**$29.89** *+/- 10%*	**$0.12** *+/- 10%*
Statewide	**1,445,600**			**152,200**		**503,400**		

Current Methods of Program Financing and Charges to Residents
Estimated annual per household charges were calculated following the same methodology and data sources as for estimated collection costs for municipal programs for which data were available. Of the 82 municipal programs in the sample, 61 reported per household charges.

Section 3. Projected Conditions under Modeled EPR System in Minnesota

3.3 Projected Performance and Costs of Residential Recycling Programs

To project the estimated performance and costs of residential recycling programs under the modeled EPR system, the Study Team analyzed the performance and costs of a subset of the municipal and county program data compiled and analyzed as described under the discussion of Section 2.4, above. All programs included in the analysis provide residential recycling collection using the standardized set of collection practices identified for inclusion under the modeled EPR system, including:

- Cart-based single-stream collection for single-family households and on-site single-stream collection for multifamily households;
- Drop-off service for households without direct collection service, with drop-off sites conveniently located and serving an average of 1,000 households per location;
- Collection of a standardized set of materials covering the vast majority of packaging and printed paper generated in the residential stream.

Of the 82 municipalities from the SWMCB Re-TRAC database with contracted service and reported contract costs, 26 programs were included in the analysis. These programs provided contracted recycling service to all residents in their jurisdiction, including all multifamily households. See **Table C-1** in **Appendix C** for a list of all programs included in this analysis. In addition, one countywide program (in Winona County) serving 31 municipalities with universal direct collection service was included, and one countywide program (in Crow Wing County) providing drop-off recycling to residents were included.

Projected Average Residential Program Performance and Costs

As in the analysis of the current program performance and costs, weighted averages for these programs were calculated by dividing the total tons reported collected and total collections costs across the number of households served through these programs. Data from programs providing direct collection in both Urban and Suburban areas were analyzed together. Projections related to the performance and costs of providing drop-off recycling service are based solely on the data available from one Suburban county.

No programs in Rural areas were identified as having the attributes of programs to be provided under the modeled system, so no Rural area programs were included in the analysis. However, in the 2011 SCORE Survey, Rural counties reported collecting approximately the same average tons per household as Suburban counties, and the Study Team felt that it would be reasonable to assume that Suburban and Rural areas receiving the same services would likewise perform similarly under the modeled system. In addition, Rural households make up only 8 percent of the population in Minnesota and, under the modeled system, fewer than half of them would receive curbside collection, so the Study Team felt that potential differences in service costs between Suburban and Rural areas would not have a significant impact on the overall projected costs of the modeled system.

The weighted averages calculated for these programs are reported in **Table 14** in Working Paper 2, and were used as the basis for the baseline projections for residential recycling collection and for the projections of annual service costs on a per-household basis, shown in **Table A-6** below (corresponds to **Table 15** in Working Paper 2).

Table A-6. Assumed Average Program Performance and Costs under Modeled EPR System

	Annual Tons/HH Collected for Recycling		Annual $/HH Service Costs	Annual $/HH P&E Spending
	Baseline	+10% P&E Multiplier		
Direct Collection	**0.250**	**0.275**	**$35.17**	**$2.00**
Drop-off Recycling	**0.135**	**0.149**	**$15.66**	**$2.00**

The Study Team assumed that the modeled EPR system would spend $1 per household per year for standard promotion and education (P&E) activities, including information (which may be provided by local governments in coordinated communications) regarding collection day schedules and drop-off collection site locations and service hours. This base level of P&E spending is the minimum amount recommended by multiple studies as the minimum amount needed to leverage the full potential of residential recycling programs, and that this amount would support the baseline level of collection projected.[xv]

The Study Team assumed that the modeled EPR system would include an additional $1 per household in annual spending to support a statewide multimedia communications and outreach campaign promoting

[xv] KPMG, Blue Box Program Enhancement and Best Practices Assessment Project, July 2007, p.58.

recycling at home, away from home, and through return to retail plastic bag and film collection. The Study Team assumed that this campaign, using social marketing best practices shown to be effective in increasing recycling motivation and participation, would result in in an additional 10 percent increase in tons per household collected over the projected baseline.

The assumption of a 10 percent multiplier potential effect was developed based on outcomes reported by an evaluation of a pilot campaign implemented in three jurisdictions in Minnesota—St. Louis County, McLeod County and the Western Lake Superior Sanitary District, which represents Duluth— in 2008-09. The campaign, which was implemented in an area covering 107,500 households, cost approximately $85,000, or around $0.80/household. The participating jurisdictions reported an average increase of 13 percent in residential recycling tonnage collected in the three months following the campaign launch, compared to the same period in prior years.[xvi] However, subsequent evaluation showed that recycling tonnage dropped back to pre-campaign levels the following year, suggesting that sustained annual investments would be required to maintain recycling participation among households, which has been included as an annual cost in this study, and that long-term effects might be lower than projected based in this short-term campaign.[xvii]

Projected Total Statewide Residential Program Performance and Costs

To project the total number of tons would be collected through residential programs under the modeled system, the Study Team applied the average number of tons collected per household under the two service conditions to the total number of Minnesota households projected to receive each type of service under the modeled EPR system. Total program costs were projected in the same way, applying the average cost per household under the two service conditions to the number of Minnesota households receiving each type of service.

Table A-7 presents the figures used as the basis for projected residential tons collected and estimated system costs under the modeled EPR system.

Table A-7. Basis for Projected Residential Recycling Program Performance and Costs

	Direct Collection Service				No Direct Collection			
	HHs with Direct Collection	Average Tons/HH *Collected for Recycling*	Average $/HH *Collection*	Average $/HH *P&E*	HHs with Drop-Off Recycling	Average Tons/HH *Collected for Recycling*	Average $/HH *Collection*	Average $/HH *P&E*
Urban	1,540,700 *(96%)*	0.275	$35.17	$2.00	55,700 *(4%)*	0.149	$15.66	$2.00
Suburban	209,100 *(64%)*	0.275	$35.17	$2.00	117,400 *(36%)*	0.149	$15.66	$2.00
Rural	83,300 *(46%)*	0.275	$35.17	$2.00	95,100 *(54%)*	0.149	$15.66	$2.00
Statewide	**1,833,200** *(87%)*				**268,100** *(13%)*			

[xvi] Curbside Value Partnership, *Increasing Recycling Through Enhanced Education and Measurement*, Green Prosperity Conference Presentation, November 4, 2009.

[xvii] Wayne Gjerde, Minnesota Pollution Control Agency. Personal communication, December 3, 2013.

Additional residential tons projected to be collected under the modeled system were assumed to be distributed across material categories based on an average market basket of materials from a single-stream residential MRF,[xviii] assuming the following distribution of materials:

- Paper – 70.5%
- Plastic – 9.8%
- Metal – 5.0%
- Glass – 14.8%

To estimate the total tons of consumer PPP recycled, the Study Team adjusted down the estimated tons collected to account for material losses by applying the single-stream residue rate factors from **Table A-3** to all projected residential tons collected.

3.4 Away-from-Home Recycling Programs under Modeled EPR System

Projected Performance and Costs of the Modeled Public Space Recycling Program

Projected tons collected through public space recycling bins were based on tonnage factors from other public space recycling programs that the Study Team is familiar with. Based on these other study collection values, it was assumed that each bin would collect 1.5 tons per year of heavily contaminated recyclables, and that 0.4 tons (27%) of contamination would be removed, resulting in 1.1 tons per bin of recyclables that would be marketed. The program design modeled for these bins is that they would collect all materials accepted in the residential collection program; however, the composition collected in the bins would be vary based on the specific location in which they are situated. For example, bins in parks were assumed to collect primarily beverage containers; bins in schools were assumed to collect lunch milk containers, and bins at transit stops would have higher quantities of printed paper.

To project the corresponding costs to support this program, the Study Team assumed that only costs associated with the purchase and maintenance/replacement of recycling bins, the collection of recyclables from consolidation points (assuming one consolidation point for every twelve bins, on average), and the transfer and processing of collected materials were included. The Study Team assumed that there would be little or no additional cost to collect from recycling bins as long as they are paired with an existing trash bin, and that these costs would continue to be paid for by local authorities.

Collection of public spaces recyclables from consolidation points was modeled based on assuming a front-load truck would collect recyclables from front-load bulk containers on a dedicated public spaces route. Routing software and typical cost and productivity factors were used to calculate the time and cost that it would take for a route truck to service the front-load containers. Because the composition of materials in public space bins was modeled to accept mixed paper and containers, consolidated public space recyclables could be collected by the same route trucks used for multifamily recyclables at a lesser cost than modeled with the dedicated route methodology used for this study. Finally, because of the mixed nature of the collected public spaces recyclables, the Study Team assumed that they would be delivered to the same residential MRFs and transfer stations used for residential materials and transferred/processed for the same general cost. Due to the high contamination levels typically found in public spaces recycling programs, MRFs were assumed to charge a contamination surcharge for the material.

[xviii] The average market basket estimate used for this study is based on a proprietary residential recycling composition study performed by members of the Study Team for a single-stream MRF in Washington State in 2013.

Projected Performance and Costs of the Modeled Plastic Bag and Film Collection Program
To project the tons of consumer PPP that could be captured through the retail-based collection of plastic bags and film, the Study Team assumed that at least 70 percent of the state's 933 grocery stores and a number of other retail locations would serve as collection sites, ensuring that 95 percent of Minnesota households would have access to at least one collection location within 10 miles of their home - this collection access assumption is minimally higher than the current estimate of collection access (based on national statistics).[xix] Similarly, national statistics suggest that approximately 500 tons per year of residential film, primarily retail carry-out sacks, would be collected in a state with Minnesota's population. The Study Team projected that residential film returned to retail for collection would rise to approximately 2,000 tons of plastic bags and film, based on an aggressive promotion and education program, with an emphasis to collect other types of clean and dry residential polyethylene film such as cereal box liners and bread bags.

The primary costs of supporting retail-based collection of plastic bags and film is assumed to be promotion and education related to the program, and the cost of this for the modeled EPR system is assumed to be incorporated into the projected $1/household cost to support a statewide communications campaign. Retail film collection programs generally have a near zero net cost assuming that collection sites have free backhaul of collected film from retail stores to central warehouse and distribution centers, which is the case for most existing retail collection points.

3.5 Recycling Processing Infrastructure and Material Flow under Modeled EPR System

The Study Team created a transfer and processing system model for Minnesota for use in analyzing potential cost reductions that could be realized under a producer-financed processing system. The model was developed with two objectives in mind: (1) to provide planning-level cost estimates of suitable precision for evaluating whether alternative scenarios have significant differences in cost; (2) to use general calculated cost factors, rather than specific Minnesota MRF market price data, so that it can be used to model costs in states other than Minnesota as well.

The model accepts the following inputs:

- Tons of consumer PPP collected in each county (88 inputs for each of Minnesota's counties and the Western Lake Superior Sanitary District);
- Geographic coordinates for a prospective or existing recyclables transfer station in each county;
- Geographic coordinates for existing or prospective regional MRFs that recyclables could be direct-delivered or transferred to;
- Hourly processing capacities for existing single-stream MRFs, including and the ability to evaluate expansion scenarios for existing facilities;
- Ability to designate tonnage flows (including split flows) under a managed MRF processing system.

[xix] "Plastic Film and Bag Recycling Collection: National Reach Study," Moore Recycling Associates Inc., April 2012 reports that 91 percent to 93 percent of the U.S. population has access to plastic bag drop-off points within ten miles from their home and 72 percent to 74 percent also have access to film drop-offs for other types of clean and dry household polyethylene film.

Model outputs include:

- Whether it is less costly in each specific county for route trucks to direct-deliver their collected load of consumer PPP to the nearest large regional MRF or whether the system cost would be reduced by consolidating and shipping the recyclables by transfer trailer;
- Processing cost per ton at each existing or prospective MRF (modeled) based on tons per hour MRF capacity and extent to which that capacity is utilized for two shifts per day processing; and
- Total statewide post-collection delivery and processing cost.

Following is a list of cost and productivity assumptions embedded in the model, including a brief discussion of the source or basis of the assumption.

- As a baseline, the default location for route trucks to deliver collected tonnages in each county is assumed to be the center point of the four longitude and latitude lines that bound the limits of each county. The effect of this generalization is assumed to average out over Minnesota's 87 counties and is believed to be of suitable precision for this study. Options for more refined estimates would include substituting population centroids, geographic centroids, route truck travel time centroids, or specific locations of an existing waste transfer location or small recycling location in each county. For the purposes of the Minnesota analysis, the Study Team adjusted two of the modeled transfer site locations from default center points – moving the Beltrami County center point slightly south so that it would not be in the center of a lake, and moving the St. Louis County point from the center point to the coordinates for Duluth. St. Louis County is the largest county by total area in Minnesota; however, the vast majority of its population is in Duluth, which is in the extreme southeastern corner of the county.
- Distances between two map points were first calculated as the shortest directional distance between the two points, and then increased by 25 percent to provide an estimate of indirect road miles that would be traveled to drive between any two points. This 25 percent factor was developed by averaging the results of 18 different combinations of Minnesota counties and MRFs using internet-based driving directions software, with the goal of least travel time between locations. The average driving speed was set at 55 miles per hour.
- Collection route truck costs and transfer truck and trailer capital and operating costs (including capital financing costs, fuel, maintenance, and operator salary costs) were assumed to be $100 per hour.
- Transfer costs were modeled based on trucking 20 tons of recyclables from transfer station to MRF. The transfer costs are composed of three factors:
    - Transfer station annualized construction costs and operations costs. These costs vary depending on the size of the transfer station – as the size of transfer stations increase, the cost per ton decreases, approaching a lower limit. Two formulae[xx] were used to calculate transfer station costs:

[xx] These formulae follow from a similar recyclables transfer and processing optimization study that a Reclay StewardEdge consulting team developed for residential PPP managed under Ontario's EPR system in 2012 ("A Study of the Optimization of the Blue Box Material Processing System in Ontario," June 2012). That analysis had extensive input by transfer station operators into the assumptions made by the study. The original formulae developed for this study had inputs of metric tonnes, which have been converted to short tons for this analysis. The 12 month currency exchange rate between the U.S. and Canadian dollars was 1.0004 in 2012 (http://www.bankofcanada.ca/rates/exchange/exchange-rates-in-pdf/) – because the two currencies were on par, modeled costs are recent, and inflation rates have been very low, no additional adjustments to the financial figures of the two formulae have been made. It should be noted that a single cost point for small transfer

        - Transfer stations handling 11,000 tons per year or less were modeled as having costs per this formula: cost/ton = 32.23 - 0.000646*(annual tons).
        - Transfer stations handling over 11,000 tons per year were modeled as having costs per this formula: 1188.8*(annual tons/1.102)^(-0.416).
    - Transportation costs associated with transferring loads of recyclables between two points, including annualized truck and trailer capital costs, fuel/maintenance costs, and personnel costs. These costs are directly proportional to the round trip road time between those two points. The following formula is used to describe the dollars per ton round trip cost used in the model: (one-way directional distance)*(1.25 road distance factor)*(2 round trip factor)*0.090909; and
    - Time-based costs associated with weighing in/out and unloading of transferred loads at the destination MRF, which was assumed to take 30 minutes per load, or $2.50 per ton.
- Direct delivery costs associated with route trucks delivering collected recyclables to a point other than a small recycling center or small transfer station modeled in the center point of a county (e.g., to a specific large MRF or to a large and efficient transfer station in an adjoining county) were modeled as the distance from the center point of each county to the nearest regional MRF or next closest county center point (for evaluating potential efficiencies of combined large transfer stations verses smaller but more numerous transfer stations).
- For this analysis, it was assumed that collection route trucks collect on average 3 tons of consumer PPP before traveling to unload (note that the maximum quantity of recyclables able to be collected by route trucks is 7 tons of residential PPP, although this quantity can only be collected by fast moving fully-automated compaction trucks collecting cart-contained recyclables on dense urban/suburban routes). Although hourly truck costs and speed/road distance factors are the same as for transfer scenario calculations, the lesser recyclables quantity results in this formula for direct delivery transportation cost per ton: (one-way directional distance)*(1.25 road distance factor)*(2 round trip factor)*0.60606. Because the route trucks need to unload regardless of whether they are direct delivering to a remote facility or a central county facility, there is no factor in this equation for off-loading time and expense because that cost is a necessary part of all scenarios and will not vary depending on option analyzed.
- MRF processing costs included in the model assume that all recyclables will be collected single stream. Large MRFs operated at their hourly capacity for two shifts per day have a much lower cost per ton processing efficiency compared to small MRFs or to MRFs that are not operated for a full two shifts per day. Like the transfer cost formulae, the model developed for this study relied on modeled processing costs from the Ontario optimization study as the comparative basis between different MRF sizes and utilizations. See Table 19 in Working Paper 2 for the assumed processing costs used.

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stations of 2,500 metric tonnes was modeled in the study, but a cost curve for medium-to-large transfer stations over 10,000 metric tonnes (11,000 short tons) was developed. For the purposes of this project, we have assumed a linear relationship between costs and tons exists over the tonnage range from 0 to 11,000 for small transfer stations (passing through the 2,500 metric tonne data point). Assumptions for small transfer stations include compacting 10 tons of recyclables into a compactor shell using roll-off type waste compactor equipment at a compaction ratio not to exceed 2:1, and tandem transfer of two shells (total of 20 tons of recyclables) to a regional MRF. Assumptions for medium/large transfer stations include loading recyclables under compaction into a single large transfer trailer, again producing a payload of 20 tons of recyclables under a 2:1 compaction ratio.

The Study Team first used the transfer and processing model to evaluate whether system costs would be lower using consolidated regional transfer stations and having route trucks travel further distances, or using smaller and more numerous transfer stations with route trucks traveling shorter distances. Because of the relatively small tonnages in each route truck (three tons when collection is complete, on average), the Study Team found that it was virtually never the case that the system cost would be reduced by consolidating transfer station locations from each county into regional transfer stations. Only in the case where a regional MRF was in the same county, or in some cases in a nearby adjoining county, was the cost of direct delivery justified because the cost of transfer could be avoided. The result of this analysis confirmed that it is generally worthwhile for each county to have either a MRF or a recyclables transfer station within its limits in order to minimize system costs.

Once this result was identified, three scenarios were tested in the model under the additional tonnages projected to be collected under EPR:

Baseline. The baseline scenario was modeled by applying the processing and transfer cost estimates to existing material flow arrangements, but with the higher consumer PPP recovery quantities projected to be collected under the modeled EPR system. These existing flow relationships were estimated from annual data on quantities and destinations of transferred and marketed recyclables that MRFs report to the Minnesota Pollution Control Agency as part of their annual permit renewals. This scenario assumes that a significant quantity of collected PPP is still processed at small local MRFs where sorting is primarily manual, with an estimated average cost of $163 per ton.

Optimized transfer and processing at existing regional MRFs. A second scenario was modeled so that all collected tons would either be direct delivered or transferred to one of nine existing larger regional single stream MRFs so that the system cost was minimized. Under this approach, the utilization of these existing regional MRFs would increase to 87 percent of target processing rates (based on full two shifts per day, five days per week), and resulting in significantly more efficient processing, even though transportation costs increase over the baseline scenario.

Optimized transfer and processing at optimally located regional MRFs. The third scenario modeled included the construction of new single-stream MRFs in regions of the state where sufficient population and tonnage of PPP collected exist to support cost-effective MRF operations, with savings on transfer cost from traveling further distances to existing MRFs (currently clustered around the Twin Cities metro area) offsetting the cost of new MRF construction and operation. The modeled scenario recommended the construction of two new 20 ton per hour single-stream MRFs, one in Crow Wing County to serve as a processing location for northern counties, and a second MRF in Rochester. These two facilities would replace MRF capacity in the Twin Cities metro area, maintaining a processing system with the same capacity utilization as modeled under the second scenario (87 percent of target processing rates based on full two shifts per day, five days per week).[xxi]

[xxi] Note that this scenario was not conducted as a complete greenfield analysis where a general theoretical optimal number, size, and locations of MRFs would be calculated. Instead it was conducted as a more specific analysis of the invested capital in the existing system of MRFs, and where long-term savings could be realized by thoughtfully locating new facilities and repurposing existing consumer PPP capacity to processing ICI recyclable material or other uses so that total system costs could be reduced.

Appendix B. USDA Rural-Urban Continuum Classification of Minnesota Counties

For this study, Minnesota counties were classified into three groups, using the Rural-Urban Continuum (RUC) codes established by the USDA.[xxii] Counties with RUC codes 1-3 were classified as "Urban"; counties with RUC codes 4-6 were classified as "Suburban"; counties with RUC codes 7-9 were classified as "Rural." The USDA defines nine RUC codes, as follows:

USDA RUC	USDA RUC Description
1	Metro - Counties in metro areas of 1 million population or more
2	Metro - Counties in metro areas of 250,000 to 1 million population
3	Metro - Counties in metro areas of fewer than 250,000 population
4	Nonmetro - Urban population of 20,000 or more, adjacent to a metro area
5	Nonmetro - Urban population of 20,000 or more, not adjacent to a metro area
6	Nonmetro - Urban population of 2,500 to 19,999, adjacent to a metro area
7	Nonmetro - Urban population of 2,500 to 19,999, not adjacent to a metro area
8	Nonmetro - Completely rural or less than 2,500 urban population, adjacent to a metro area
9	Nonmetro - Completely rural or less than 2,500 urban population, not adjacent to a metro area

The following table lists all Minnesota Counties classified into the three groups used for this study.

Table B-1. Classification of Minnesota Counties by USDA 2013 RUC Codes

Urban			
County	2011 Population	2011 Households	USDA RUC Code
Anoka	334,053	122,151	1
Benton	38,558	15,155	3
Blue Earth	64,383	24,634	3
Carlton	35,492	13,586	2
Carver	92,104	33,202	1
Chisago	53,929	19,537	1
Clay	59,644	22,516	3
Dakota	401,221	153,098	1
Dodge	20,243	7,528	3
Fillmore	20,868	8,580	3
Hennepin	1,163,060	480,754	1
Houston	18,933	7,860	3
Isanti	38,209	14,128	1
Le Sueur	27,655	10,772	1
Mille Lacs	26,003	10,155	1
Nicollet	32,949	12,318	3
Olmsted	145,379	57,595	3
Polk	31,489	12,708	3
Ramsey	510,810	203,818	1
Scott	131,556	45,656	1
Sherburne	88,954	30,439	1
Sibley	15,193	6,039	1
St. Louis	200,143	84,993	2
Stearns	150,996	56,514	3
Wabasha	21,589	8,827	3
Washington	240,640	88,921	1

[xxii] For more information about USDA Rural-Urban Continuum codes, see http://www.ers.usda.gov/data-products/rural-urban-continuum-codes.aspx#.UYJuVEpZRvY

Wright	126,033	44,955	1

Suburban			
County	2011 Population	2011 Households	USDA RUC
Becker	32,770	13,372	6
Brown	25,756	10,781	6
Crow Wing	62,745	26,193	4
Douglas	36,240	15,498	6
Faribault	14,506	6,246	6
Goodhue	46,168	18,803	4
Itasca	45,034	18,847	6
Kanabec	16,170	6,419	6
Kandiyohi	42,118	16,769	4
Koochiching	13,221	5,859	6
Lake	10,822	4,831	6
McLeod	36,489	14,628	6
Meeker	23,242	9,181	6
Morrison	33,212	13,142	6
Mower	39,281	15,891	4
Otter Tail	57,243	24,125	6
Pennington	14,018	5,879	6
Pine	29,647	11,369	6
Pipestone	9,525	4,038	6
Rice	64,717	22,423	4
Rock	9,644	3,915	6
Steele	36,530	14,343	5
Todd	24,823	9,777	6
Waseca	19,166	7,326	6
Watonwan	11,197	4,525	6
Wilkin	6,584	2,708	6
Winona	51,386	19,609	4

Rural			
County	2011 Population	2011 Households	USDA RUC
Aitkin	16,202	7,330	8
Beltrami	45,212	17,163	7
Big Stone	5,240	2,285	9
Cass	28,396	11,926	9
Chippewa	12,332	5,214	7
Clearwater	8,774	3,561	8
Cook	5,216	2,521	9
Cottonwood	11,682	4,860	7
Freeborn	31,160	13,195	7
Grant	5,993	2,608	9
Hubbard	20,439	8,714	7
Jackson	10,203	4,422	7
Kittson	4,528	1,984	9
Lac qui Parle	7,195	3,145	9
Lake of the Woods	4,011	1,777	9
Lincoln	5,819	2,552	9
Lyon	25,951	10,265	7
Mahnomen	5,441	2,031	8
Marshall	9,473	4,000	8
Martin	20,716	9,017	7
Murray	8,640	3,701	9
Nobles	21,365	7,970	7
Norman	6,859	2,872	8
Pope	10,896	4,721	8
Red Lake	4,105	1,747	8
Redwood	15,986	6,579	7
Renville	15,540	6,516	8
Roseau	15,536	6,301	7
Stevens	9,749	3,724	7
Swift	9,677	4,216	7
Traverse	3,530	1,519	9
Wadena	13,709	5,663	7
Yellow Medicine	10,331	4,260	9

Appendix C. Municipalities Included in Municipal Program Analysis

Table C-1. Municipalities Included in Municipal Program Analysis

Counties	Municipalities			
	Included in Current Average Program Analysis	*collection cost reported	*P&E spending reported	Included in Best Practices Program Analysis
Anoka	Anoka	✔	✔	
	Blaine	✔		
	Centerville	✔	✔	✔
	Circle Pines	✔	✔	
	Columbia Heights	✔	✔	
	Fridley		✔	
	Ham Lake	✔	✔	
	Hilltop	✔	✔	
	Ramsey	✔	✔	
	Spring Lake Park	✔	✔	✔
Dakota	Farmington			✔
	Hastings			
Hennepin	Brooklyn Park	✔	✔	✔
	Champlin	✔		
	Corcoran	✔		
	Dayton	✔	✔	
	Deephaven	✔	✔	✔
	Edina	✔	✔	
	Excelsior	✔		
	Golden Valley	✔	✔	
	Greenfield	✔		✔
	Greenwood	✔		✔
	Hanover	✔		
	Hassan	✔		
	Hennepin Recycling Group (Brooklyn Center, Crystal, New Hope)	✔	✔	
	Hopkins	✔	✔	
	Independence	✔	✔	
	Long Lake	✔		
	Loretto	✔	✔	
	Maple Grove	✔		✔
	Maple Plain	✔		
	Medicine Lake	✔		✔
	Medina	✔	✔	
	Minneapolis	✔	✔	
	Minnetonka	✔	✔	
	Minnetonka Beach	✔		✔
	Minnetrista	✔	✔	✔
	Mound	✔	✔	
	Orono	✔		
	Osseo	✔	✔	
	Plymouth	✔	✔	
	Robbinsdale	✔	✔	

Counties	Municipalities			
	Included in Current Average Program Analysis	*collection cost reported	*P&E spending reported	Included in Best Practices Program Analysis
Ramsey	Rockford	✔	✔	
	Rogers	✔		
	Shorewood	✔	✔	✔
	Spring Park	✔		
	St. Bonifacius	✔	✔	
	St. Louis Park	✔	✔	
	Tonka Bay	✔		✔
	Wayzata	✔		
	Woodland	✔		✔
	Arden Hills	✔	✔	
	Falcon Heights	✔	✔	✔
	Gem Lake	✔		
	Lauderdale	✔	✔	
	Little Canada	✔	✔	
	Maplewood	✔	✔	
	New Brighton	✔	✔	
	North St. Paul	✔	✔	
	Roseville	✔	✔	
	Shoreview	✔	✔	
	St. Paul	✔	✔	
	Vadnais Heights	✔		✔
	White Bear Lake	✔	✔	
	White Bear Township	✔	✔	
Washington	Afton	✔	✔	✔
	Bayport		✔	
	Baytown Township	✔	✔	
	Birchwood	✔	✔	✔
	Dellwood	✔	✔	✔
	Forest Lake	✔	✔	
	Grant	✔		✔
	Grey Cloud Island Township	✔	✔	✔
	Lake St. Croix Beach	✔	✔	✔
	Lakeland	✔	✔	
	Lakeland Shores	✔	✔	
	Mahtomedi	✔	✔	
	Oak Park Heights	✔	✔	
	Scandia	✔	✔	
	Stillwater	✔	✔	
	West Lakeland Township	✔	✔	✔
	White Bear Lake	✔	✔	