COLORADO NEEDS ASSESSMENT

EXECUTIVE SUMMARY

JANUARY 30, 2024

THANK YOU

CAA, HDR, and Eunomia thank the Advisory Board, municipalities, waste haulers and processors, nonprofit organizations, and Colorado stakeholders who have provided valuable insight into the Needs Assessment. The Needs Assessment is stronger due to your input.

COLORADO NEEDS ASSESSMENT

On June 3, 2022, Colorado's Governor signed House Bill 22-1355, an ambitious extended producer responsibility (EPR) law that requires producers of packaging and paper products to fund and implement a program for statewide recycling. Under this law, the Colorado Department of Public Health and Environment (CDPHE) approved Circular Action Alliance (CAA) on May 1, 2023, as the Producer Responsibility Organization (PRO) responsible for administering and implementing an EPR program.

As the approved PRO, ultimately, CAA will work with companies that are defined as producers to collect packaging data for covered materials, fund recycling activities, and meet recycling performance targets.

CAA was required to select an independent third party to assess the recycling services currently provided in the State and evaluate recycling needs. Following a competitive procurement process, CAA selected HDR and Eunomia in August 2023 to carry out the Needs Assessment. In preparing the Needs Assessment, CAA has consulted with the Advisory Board, which is responsible for reviewing and providing technical feedback on the Needs Assessment and the PRO's proposed program plan.

PURPOSE OF NEEDS ASSESSMENT

The Needs Assessment aims to evaluate existing services and infrastructure in Colorado that manage single-use packaging and paper products at the end of their product life cycle. The CAA, HDR, and Eunomia team (referred to throughout as the "project team") analyzed the process from when packaging is collected curbside or at a drop-off collection to its management at transfer stations, material recovery facilities (MRFs) or compost sites, and its journey to in-state and out-of-state end markets.

The Needs Assessment also identified gaps in existing services and evaluated opportunities to improve systems to drive towards meeting and exceeding Colorado's statewide waste diversion rate. The Needs Assessment provides the analysis and data required to develop recycling system scenarios – one of which will be recommended to the Joint Budget Committee and, if approved, it will then be implemented by the PRO.

PROJECT TEAM

Circular Action Alliance (CAA) is a 501(c)(3) nonprofit Producer Responsibility Organization (PRO) dedicated to implementing effective Extended Producer Responsibility (EPR) laws for paper and packaging across the United States and is approved as the single PRO in California and Colorado. The organization is led by 20 companies from the food, beverage, consumer goods, and retail industries.

HDR was founded in 1917 and specializes in engineering, architecture, environmental, and construction services. With 65+ years of experience providing engineering, planning, and design solutions for public and private clients in Colorado, HDR had the depth of local staff and expertise necessary to conduct the Colorado Needs Assessment.

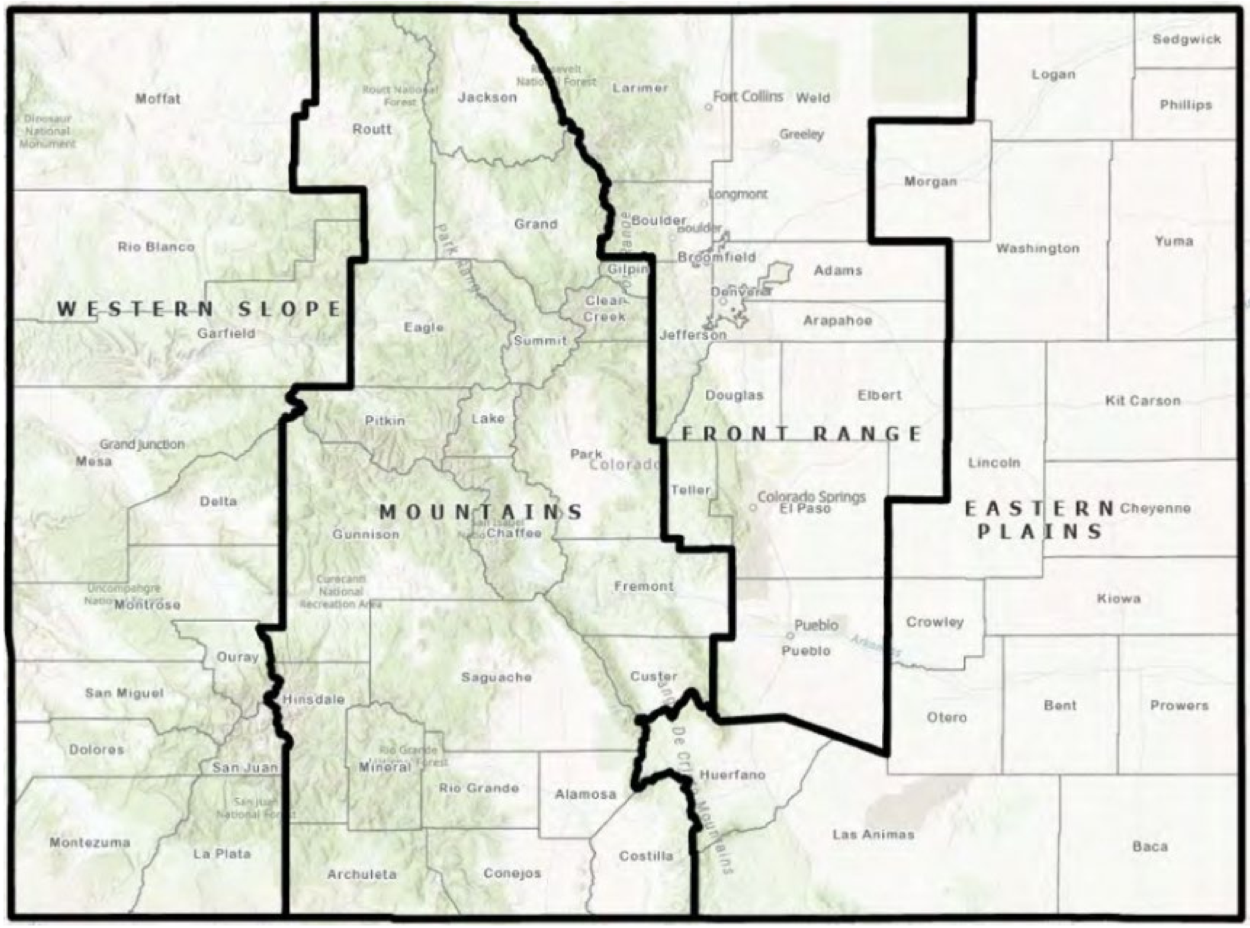
Eunomia has over 21 years of global experience designing EPR policy and modeling EPR and recycling systems for a broad range of materials and six years operating in North America working on EPR-related projects for Washington, and the provinces of British Columbia, Alberta, Ontario, Yukon, and Quebec.

APPROACH

The project team understands that Colorado has knowledgeable, passionate practitioners in the waste, recycling, and composting industries and has assembled an internal group of experts to support and inform the Needs Assessment. The team also met regularly with the Statewide Recycling Advisory Board (Advisory Board), on a schedule set by the Advisory Board, to provide regular updates on the project and seek feedback.

The project team evaluated the services provided through a statewide and regional lens. Colorado's 2016 Integrated Solid Waste and Materials Management Plan identified four Regions, shown in **Figure 1,** based on socioeconomic and geographic factors: the Western Slope, the Mountains, the Front Range, and the Eastern Plains. This lens was used to evaluate variations in recycling services in each Region.

Figure 1: Map of Colorado's Four Regions



The project team also evaluated data from municipalities, rural areas, and census-designated places (CDPs). Municipalities and CDPs have boundaries set by the US Census but only represent a small share of the area in the State. Outside of municipalities and CDPs, there are rural and remote areas. About 74% of the population live in municipalities, 12% live in CDPs, and 13% live in rural and remote areas. The breakdown between Colorado's four Regions is shown in **Table 1.**

Table 1: Regional Population Distribution

	Front Range	Mountains	Western Slope	Eastern Plains	Total
Percent of Total Population	84%	6%	7%	3%	100%
Number of Municipalities	92	71	42	67	272
Population Within Municipalities	78%	46%	59%	67%	74%
Number of CDPs	105	50	22	33	210
Population Within CDPs	13%	14%	12%	2%	12%
Population Within Rural Areas	9%	40%	29%	31%	13%

To understand Colorado's existing system and identify gaps, the project team conducted outreach and data-gathering activities, which produced more than 100,000 data points on Colorado's residential recycling and composting services. These include the following:

- Over 75 tours and interviews with Colorado service providers, end markets, and other key stakeholders;
- Receipt of 130 municipal surveys;
- Multiple webinars for various stakeholder groups within Colorado to seek feedback;
- Extensive desktop research (e.g., visiting and evaluating information from the websites for all 272 municipalities and 64 counties);
- Participated in 13 CDPHE Advisory Board meetings since the contract was awarded to provide updates and seek feedback;
- More than 200 comments received and responded to;
- On-going discussions with Colorado based stakeholders throughout the process to qualify inputs;
- Developed a webpage with frequently asked questions on Recycle Colorado's website and
- Distributed an interest form via multiple channels where interested parties could sign up for updates.



The data gathering and analysis results were used to develop a Minimum Recyclables List and an Additional Materials List. The Minimum Recyclables List is a list of materials that must be collected in a manner that is as convenient as the collection of solid waste, and the Additional Materials List is a list of materials that may collected in different geographic areas through curbside services, drop-off centers or other means.

The results also provided data inputs to develop three Scenarios, as required by law. The PRO is required to propose three different Scenarios for how recycling systems could be improved to increase Colorado's recycling rate and the anticipated costs associated with each. To develop these Scenarios, the project team had to understand and outline the cost and performance of the current system and consider the capital and operating cost, investment profile, and performance of three potential future systems over time. The Scenarios were built into a recycling system options model that allowed CAA to assess the implications of different service delivery and investment options.

PROJECT OUTCOMES

The project team developed the following summary of each component (Element) of the Needs Assessment, a Minimum Recyclables List, and three Scenarios for consideration. This Needs Assessment will be used to select an approach for the statewide recycling program and will inform CAA's program plan proposal.

Table 2 below shows the estimated performance of recycling in Colorado for the baseline year (2022) and for 2030 and 2035 for the low, medium, and high scenarios.

- At the baseline year (2022), it is estimated that Colorado had a recycling rate between 22% - 28% for covered packaging from covered entities.
- In the low Scenario, Colorado could achieve a recycling rate between 32%-38%in 2030 and 47%-53% in 2035.
- In the medium Scenario, Colorado could achieve a recycling rate between 34%-40% in 2030 and 51%-57% in 2035.
- In the high Scenario, Colorado could achieve a recycling rate between 39%-45% in 2030 and 54% - 60% in 2035.

Note there may be other factors that impact the ability of CAA to implement on a schedule that could affect performance. These include, but are not limited to:

- When CDPHE provides regulatory approval of the program plan; and
- The time necessary to implement collection and processing improvements (e.g., tender and receive new collection vehicles to service new residences; establish new drop-off sites; contract of servicing for new locations that may also need new carts or bins; establish agreements with various service providers and collection sites).

The scenarios are modeled based on achieving certain milestones, not on potential operational considerations.

Table 2: Estimated Recycling Outcomes per Scenario

		2022 (Baseline)	2030	2035
Low	Recycling Rate (%)	22% - 28%	32% - 38%	47% - 53%
	Recycling Tonnage (k tons)	~310	~450	~660
Medium	Recycling Rate (%)	22% - 28%	34% - 40%	51% - 57%
	Recycling Tonnage (k tons)	~310	~480	~710
High	Recycling Rate (%)	22% - 28%	39% - 45%	54% - 60%
	Recycling Tonnage (k tons)	~310	~550	~750

Table 3 outlines the estimated costs associated with each Scenario.

- At baseline (2022), the total system cost is estimated to be between $80 million and $140 million.
- In 2030, the estimated system cost could be between $130 and $200 million in the low Scenario, $130 and $ 210 million in the medium Scenario, and $150 and $240 million in the high Scenario.
- In 2035, the estimated system cost could be between $160 and $250 million in the low Scenario, $160 and $260 million in the medium Scenario, and $180 and $290 million in the high Scenario.

Table 3: Estimated Costs per Scenario ($ in millions)

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Total Annualized Cost ($ millions)	80	140	130	200	160	250
	Cost Per Household ($)	60	90	60	90	70	110
	Cost Per Household ($)	60	90	60	90	70	110
Medium	Total Annualized Cost ($ millions)	80	140	130	210	160	260
	Cost Per Household ($)	60	90	60	90	70	120
	Cost Per Ton Recycled ($)	260	430	260	430	230	370
High	Total Annualized Cost ($ millions)	80	140	150	240	180	290
	Cost Per Household ($)	60	90	70	110	80	130
	Cost Per Ton Recycled ($)	260	430	270	430	240	390

The system factors that contribute the most to increased recycling rates are:

- Providing residential households with recycling services equivalent to trash,
- Performance benefits due to education programming,
- Advanced sorting at MRFs, and
- Collecting materials on the additional materials list.

The system factors that contribute the most to cost increases are:

- Providing residential households with recycling service equivalent to trash,
- Investment in education programming, and
- MRF technology investment.

ELEMENT 1: RESIDENTIAL

PURPOSE

The purpose of Element 1 was to understand the recycling and waste services provided in Colorado based on property type, geographic area, and other factors, such as frequency of collection, method of collection, and payment mechanisms used in each of the four Regions of Colorado. In addition, the project team evaluated the type of recyclable materials collected in each Region through curbside and drop-off collection.

APPROACH

The project team used primary and secondary research to evaluate how waste and recycling services are provided to residential-covered entities. The approach included reviewing existing studies on waste and recycling in Colorado, a comprehensive survey of municipalities and counties in the State, desktop research and review of municipality websites and annual reports, and interviews with municipality staff. The project team promoted participation in the survey by hosting webinars to explain the survey to respondents, developing a webpage with frequently asked questions, hosting drop-in sessions with the project team, sending weekly reminders, and calling municipalities to encourage them to participate. One hundred twenty-one municipalities completed the survey, and respondents represented communities covering 60% of the total population.

FINDINGS

- Single-stream recycling is the most common curbside collection method, followed by dual-stream, with glass separated from other materials. Approximately two-thirds of the population live in municipalities that provide single-stream recycling. This data is provided in **Table 6.**
- The most common frequency for recycling collection was every other week. The second most common collection frequency was weekly.
- Larger multi-family structures are typically classified as commercial waste in city ordinances and are not commonly included in residential recycling programs.
- More than 95% of households in municipalities and approximately 90% of households overall have access to curbside garbage collection.
- Based on the convenience standard of the Producer Responsibility Program for Recycling, all households with curbside garbage collection are anticipated to receive curbside recycling collection following program implementation. Based on HB22-1355, approximately 500,000 additional households will receive curbside recycling in municipalities, and an additional 100,000 - 200,000 households will receive service in other areas (census-designated places and Rural Areas).

Table 4 represents the households and populations located within the 272 municipalities and their access to curbside trash and recycling. Approximately 74% of the population in Colorado lives within municipalities. **Table 5** breaks the data down further by dwelling units and region.

Table 4: Active Service for Waste and Recycling Services in Colorado

	Total		
	Single-family	Multi-family	Total
Number of Households Within Municipalities	1,119,375	522,927	1,642,302
Percent of Households With Curbside Trash	96%	98%	97%
Percent of Households With Curbside Recycling	68%	60%	66%

Table 5: Active Service for Waste and Recycling Services By Region

	Front Range		Mountains		Western Slope		Eastern Plains	
	Single-family	Multi-family	Single-family	Multi-family	Single-family	Multi-family	Single-family	Multi-family
Number of Households Within Municipalities	989,406	477,518	39,745	19,743	58,220	18,984	31,004	6,683
Percent of Households With Curbside Trash	98%	99%	87%	95%	94%	98%	39%	36%
Percent of Households With Curbside Recycling	71%	62%	50%	68%	69%	28%	18%	18%

Table 6: Recycling Collection Method by Region (Percent of Population)

	Front Range	Mountains	Western Slope	Eastern Slope
Single Stream	75%	62%	36%	5%
Dual Stream - Fiber and Containers	0%	2%	0%	0%
Dual Stream - Glass and all other material	0%	9%	43%	8%
Multi-Stream	0.2%	4%	1%	0%
Curbside service but unknown how it's collected	23%	5%	12%	11%
No curbside service	2%	19%	8%	76%

SCENARIO CONSIDERATIONS

1. The use of residential factors in the modeling, such as the method of collection (single stream or dual stream), frequency of collection (weekly or bi-weekly), and the types of materials that are collected in different recycling programs allowed the project team to analyze the differences in performance between different systems in Colorado.

2. Colorado's EPR legislation requires that recycling collection should be as convenient as trash collection in a jurisdiction, meaning that if a household has curbside trash collection, it should also have curbside recycling. Based on this standard, approximately 31% of households in the municipalities evaluated that do not have curbside recycling are expected to receive curbside recycling services following program implementation.
3. Additional recycling services would most significantly impact the Eastern Plains Region. Currently, only 18% of households receive curbside recycling services. Following the implementation of the modeled program, curbside recycling access could increase to an estimated 38% of households in municipalities in the Eastern Plains.

ELEMENT 2: SERVICE COSTS

PURPOSE

Element 2 memo outlines service costs for packaging and paper products collection service costs, including contractual terms, service option levels, frequency, and materials collected based on information provided by recycling service providers (haulers) servicing each Colorado Region. From large and nationwide to small and local, haulers are directly involved with collecting recycling from generators, transporting the materials to MRFs, and transporting recycled goods to end markets. Therefore, haulers have direct and in-depth knowledge of recycling infrastructure and can provide insight into the current State of recycling across each Region in Colorado.

APPROACH

The project team leveraged several engagement methods to learn from and engage with haulers, including a webinar targeted at the hauling community, an online survey, and individual emails and phone calls for detailed information-gathering interviews. Hauler engagement and information sharing are key to the project, and the team strived for authentic and open communication. The project team conducted an initial desktop review to identify which haulers are servicing the four Colorado Regions. The team then contacted fifty-one (51) haulers and completed fifteen (15) phone interviews, including three (3) large/national haulers, two (2) medium-sized regional haulers, and ten (10) small/local haulers.

FINDINGS

- Most of Colorado is serviced by subscription-based, cart-based, open-market hauling.
- Due to variable MRF tipping costs and volatility in recycling markets, financial planning is difficult for haulers, particularly in the long-term range (five or more years).
- Haulers who bring material to MRFs noted a recent rise in MRF tipping costs as a challenge, up by 50% in the last five years.
- Haulers reported that the State of Colorado has strict laws regarding truck weight-to-axle ratios on Mountain roads, which applies to recyclable commodities. These ratios reduce the amount of material transported per truck in these Regions.

- Mountain and Western Slope roads can be steep and rugged, increasing fuel usage and truck maintenance costs.
- High wildlife activity requires special containers (carts and dumpsters) and more frequent services. Animal-resistant containers add significant costs for rural haulers as opposed to more urban areas.
- Most hauling trucks in each of the four Regions use diesel fuel, with some compressed natural gas (CNG) and electric vehicle trucks (EVs) in the Front Range.
- Larger haulers typically use automated side-load trucks, and smaller haulers use rear-load trucks that require multiple employees for collection.
- Commodities are hauled directly to end markets via dump trucks, tractor trailers, and sometimes via rail from larger MRFs.
- In collaboration between the efforts of Element 1 and 2, the cost of services ranges significantly from a low of $5 per Household per month to more than $90 per Household per month when bundled with waste collected. Overall costs were found to be higher in the Mountains and lower in other regions.

SCENARIO CONSIDERATIONS

1. Data captured from municipalities and haulers were used in cost regression analysis to benchmark the modeled costs of curbside collection across jurisdictions.
2. The frequency of collection impacts the quantities of materials collected and the cost of collection. Research in Colorado found that when collection is provided more frequently, more material is collected overall.
3. Future scenarios consider the impact of more efficient collection routes on the total cost of the system. These efficiencies can potentially lead to fewer trucks or less fuel needed in the system, increasing its economic efficiency.
4. The enhancement of collection services was modeled through the rollout of trash equivalency and improvements to drop-off collection. These improvements result in capital and operational costs informed by this element's results.

ELEMENT 3: DEMOGRAPHICS

PURPOSE

Element 3 outlined the demographic data with an environmental justice focus to be considered part of the Colorado Needs Assessment. The data collected builds on the four Regions defined by the State of Colorado's 2016 Integrated Solid Waste Materials Management Plan (2016 ISWMMP). The environmental justice analysis dove deeper into the characteristics of the four Regions to encourage transparency and informed decisions surrounding policy, infrastructure, and access to services. These demographic factors are to be considered in developing reimbursement rates for service providers per subsection (4)(j) of section 25-17-705 of the Producer Responsibility Program for Statewide Recycling Act.

APPROACH

The project team began by conducting a desktop review of available demographic data. The evaluation included a desktop review of Colorado's solid waste planning regions and equity goals to assess the work that the State has completed historically. The project team then analyzed data from the U.S. Census Bureau, the EPA's Environmental Justice Screening and Mapping Tool, Colorado EnviroScreen, the Association of People Supporting Employment First, the County Health Rankings & Roadmaps program, and community analytics data on service access. The project team met with the Colorado CDPHE staff to vet the data findings. Additionally, the HDR project team worked with Eco-Cycle to conduct two stakeholder workshops with diverse recycling advocates and environmental organizations from across Colorado. The goals of these workshops were to (1) gather information regarding local package recycling programs accessible to the organizations' constituents/members and/or that the organizations directly implement, (2) seek input on strategies to enhance the reach of existing or upcoming services within their communities and among underserved demographics, and (3) to record how these organizations' see the implementation of Producer Responsibility for Recycling Packaging leveraging the successes in their areas and improving recycling in the ir areas and other similar parts of the state.

FINDINGS

- About 16% of Colorado's population and 77% of the landmass is considered Rural. However, 84% of Colorado's population and almost 80% of businesses exist in the Front Range.
- Spanish is the second most spoken language (11%) across all regions. The third and fourth most spoken languages are Chinese (including Cantonese and Mandarin) and German, which are spoken by less than 1% of the population each.
- Seasonal population fluctuations, including visitors and labor, peak in Summer (June-August) and Winter (December through March) for many Mountain communities.
- Significant urban and rural trends exist: The Front Range has the highest income per capita and is the "healthiest " Region. The Western Slope and Eastern Plains Regions exhibit higher poverty levels and have poorer health. Income and unemployment data is summarized in **Table 7**.
- The Front Range has the highest percentage of multi-family buildings, making up 30% of the housing. The majority of single-family homes are found on the Western Slope and Eastern Plains. Housing unit data is provided in **Table 8**.
- Over 70% of residents in the State of Colorado use a computer, and over 80% use a cellphone. Facebook is the most utilized social media platform, with over 60% of Colorado residents maintaining accounts.
- The highest concentration of businesses, nearly 70%, are located in the Front Range.
- The Front Range has the highest number of households and highest per capita income. The Eastern Plains has the highest low-income population, followed by the Western Slope and the Mountains. The unemployment rate is similar across the four Regions at approximately 5%.

- 11.6% of the population in Colorado has a disability. The Eastern Plains Region contains the highest percentage per capita of disabled people in the State at 17%.
- Recycling education should be tailored to the local geography, demographics, and most common recycling contaminants. Additional care should be taken to develop messaging and tactics to reach Environmental Justice (EJ) communities in coordination with community leaders and the Colorado Department of Public Health and Environment's (CDPHE) Environmental Justice Action Task Force.

Table 7: Income and Unemployment Summary

Region	Number of Households	Income per Capita	Low-Income Population	Unemployment Rate
Front Range	1,876,500	$44,360	22%	5%
Eastern Plains	59,140	$26,300	39%	5%
Western Slope	160,270	$35,600	29%	5%
Mountains	132,000	$39,128	27%	4%

Table 8: Housing Unit Breakdown

Region	Total Households	Percent Single Family Units	Percent 2-9 units	Percent 10+ units	Percent Mobile Home and all other types of units
Front Range	1,790,240	69%	9%	19%	2%
Eastern Plains	153,588	78%	7%	5%	9%
Western Slope	183,677	71%	10%	7%	11%
Mountains	100,427	67%	10%	17%	6%

SCENARIO CONSIDERATIONS

1. Scenario considerations focused on the impact of access and education on recycling performance. Specifically, the impact of providing equivalent opportunity and appropriate communication and dialogue pathways on the recycling collection services in each of the four distinct regions within Colorado on system performance. The following controls were developed for the modeling:
2. The EPR legislation requires that recycling access should be equivalent to trash, meaning that if a household has curbside trash collection, it should also have curbside recycling. This control relates to how quickly this equivalency is met. When more households have access to recycling, the overall number of households participating is likely to increase, which impacts the total volume of material collected and the cost of collection.

3. The equivalency impact for each of the four regions was modeled to be achieved by 2030, with the largest increase in access recognized by the areas in the State with the lowest income per capita.

ELEMENT 4: CONTAMINATION

PURPOSE

Contamination is a major operational issue for material recovery facilities (MRFs), compost facilities, and material end markets. Contamination can include incorrectly disposed of materials in recycling or composting, incorrectly sorted materials, soiled recyclable containers, and over-compacted materials. The purpose of the contamination element of the Colorado Needs Assessment was to estimate existing contamination rates at MRFs and compost sites in Colorado, identify challenges associated with contamination, identify common contaminants, and evaluate methods to improve the quality of material received by end markets to improve the overall efficiency of Colorado's material processing systems.

APPROACH

Project team members conducted site visits at MRF specialty recycling and compost facilities and asked facility staff questions about incoming and outgoing feedstock, the trends they have observed in contamination, and the impact of contamination on their operations and operational costs. The project team additionally reviewed past reports and studies to assess available information on contamination. Finally, the team conducted a desktop study to identify best management practices for limiting and handling contamination, thereby improving the end product's quality and quantity to align with the objectives of the Producer Responsibility Program for Statewide Recycling Act.

FINDINGS

- MRFs surveyed for the Needs Assessment reported between a 10% and 20% contamination rate. Estimated contamination rates were based on total contamination, not necessarily contamination associated with packaging materials.
- Compost facilities surveyed for the Needs Assessment reported a contamination rate below 10% by weight with most reporting <3% by weight. Estimated contamination rates included total contamination, not necessarily contamination associated with compostable plastics or packaging materials.
- The survey identified that confusion about which materials are recyclable or compostable, wishful recycling, and varying levels of commitment to recycling can impact contamination rates.
- MRF facilities reported that contamination causes equipment downtime, contaminated commodities, lost revenue, worker injuries, increased residue costs, reduced throughput, reduced efficiency, and equipment wear and tear. This data is displayed in **Figure 2**.

- Common contaminants at MRF facilities include non-recyclable plastics, ceramics, fabric, and medical waste.
- Plastics (rigid and flexible packaging) and glass were the most common contaminant reported by compost facilities.
- Recently, some compost facilities in Colorado have responded to contamination in incoming feedstocks by rejecting compostable service ware and other single-use materials. Data on contamination levels from residential and commercial streams at compost facilities is provided in **Figure 3.**

Figure 2: Impacts of Contamination on MRFs

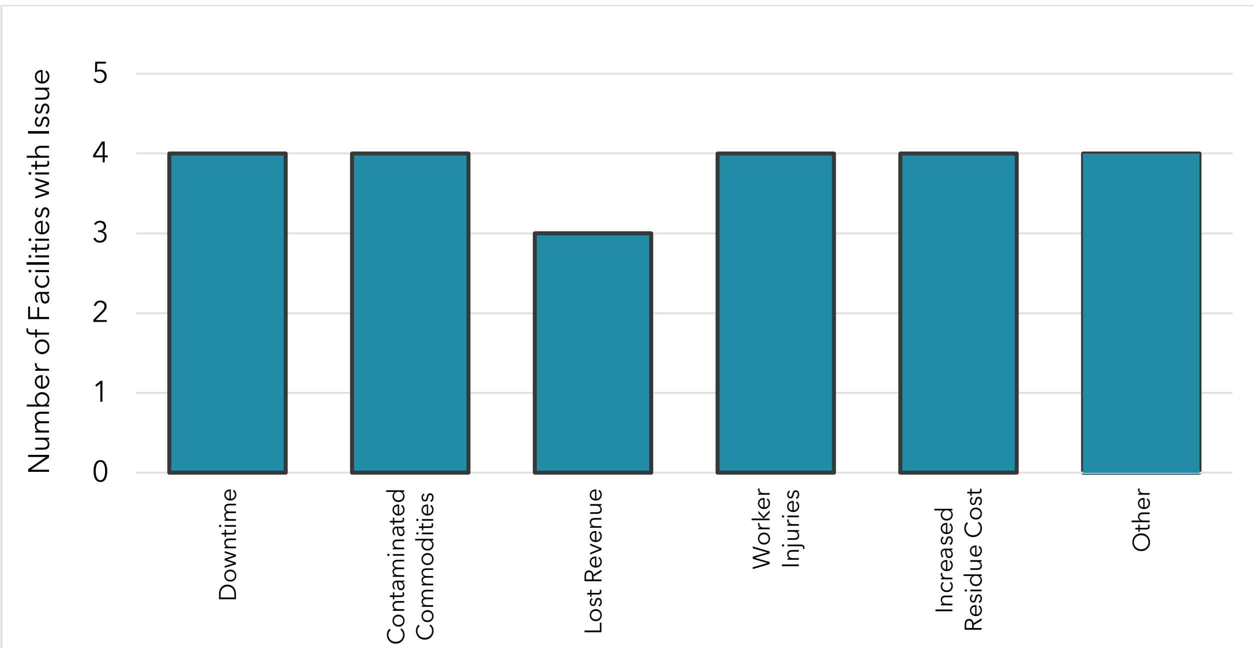
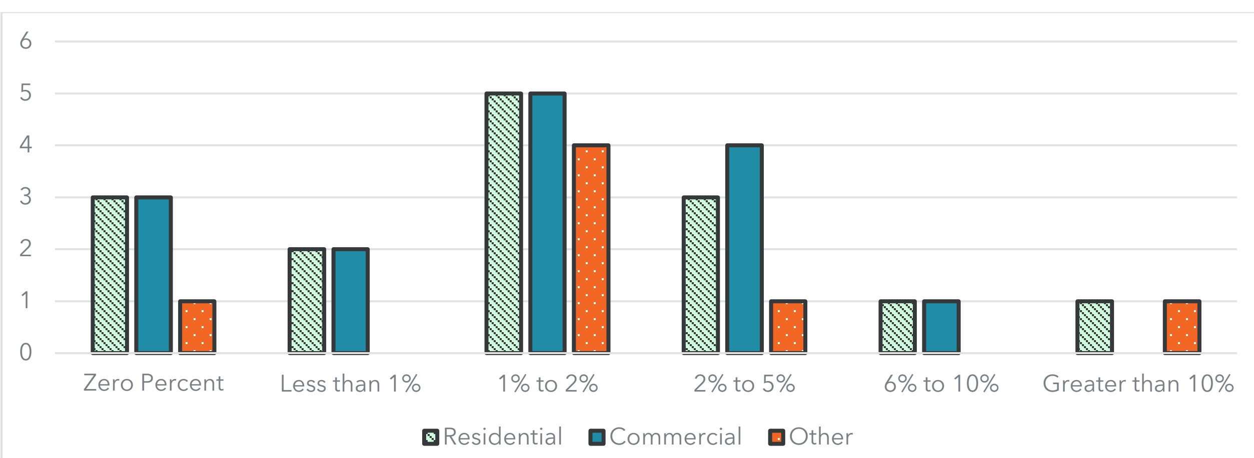


Figure 3: Contamination Rate by Feedstock Source at Compost Sites (percent by weight)



SCENARIO CONSIDERATIONS

1. This analysis found that contamination rates varied between regions within Colorado. Consequently, the contamination model was adjusted according to region-specific contamination rates that were influenced by collection and processing type. The average contamination rates were 15% at single-stream facilities and 7.5% for dual-stream or source separation. Contamination rates are modeled to stay consistent between Scenarios.

ELEMENT 5: NON-RESIDENTIAL

PURPOSE

The objective of the Element 5 memo was to understand service availability, gaps, and recycling services costs associated with providing recycling services to non-residential entities covered under the Colorado Needs Assessment. Non-residential covered entities, which are entities in the legislation that require collection, include hotels and other accommodations; event spaces and stadiums; food and drink establishments; small businesses; schools; outdoor and indoor public places; and government buildings. The project team evaluated how recycling services are currently provided to non-residential entities, the performance of the recycling programs, and their estimated costs.

APPROACH

The project team prepared and distributed a municipal survey that was sent to 272 municipalities in Colorado. While the survey included questions on non-residential entities, respondents provided limited information on the topic. The project team conducted desktop research to evaluate non-residential recycling collection, including using North American Industry Classification System (NAICS) codes to evaluate information and regional locations associated with the specified types of non-residential entities. The project team additionally conducted interviews with key stakeholders who provided more detailed information. Twenty-seven (27) total interviews were conducted with municipality officials, school district officials, nonprofits, an airport official, a hotel official, resort officials, an event venue manager, restaurant owners and managers, small business owners and employees, and a green business organization.

FINDINGS

- At hotel accommodations and ski resorts, recyclable materials ranged from 20% to 50% of the total waste generated. Resort accommodations often have ambitious sustainability goals.
- Events and stadiums frequently have recycling infrastructure and signage to help attendees properly sort materials. However, some technically recyclable materials get thrown out as garbage because they are too contaminated with food, as there is no infrastructure for rinsing containers.
- Restaurants typically collect materials such as cardboard and empty drink containers. They reported that, on average, approximately 35% of the total waste collected is recyclable.

- Compostable containers, particularly coffee cups, are often used in restaurants. However, these materials often end up in the garbage or as contaminated in compost bins, as many Colorado composters do not accept compostables.
- In 2023, there were 1,934 public schools with 883,264 students and 746 nonpublic schools with 56,821 students in Colorado. Waste in schools is mainly generated in cafeterias and classrooms. Cafeterias produce food waste and packaging, and classrooms generate paper, cardboard, and some food and plastic waste.
- Interviews with school districts representing about 26.5% of the student population indicate an average of 28 pounds of recycling per student annually, with diversion rates ranging from 17% to 42%.
- Reuse practices, particularly in cafeterias, involve reusable trays, cutlery, and food service ware. However, some schools face budgetary challenges and rely on disposable service ware.
- Streets, sidewalks, town squares, downtowns, plazas, and business development districts (BDD) are not often required to provide access to recycling services, even when there is a universal ordinance.

SCENARIO CONSIDERATIONS

1. Data collected from non-residential entities were used to estimate the volume of recyclables collected under future scenarios and the consequent cost of increasing recycling access across the State. Access to recycling to covered non-residential entities is modeled to start by 2028. This control relates to how quickly those covered entities will receive service. Modeling inputs included recycling service access to covered non-residential entities by 2030, which significantly impacts the total volume of material collected.

ELEMENT 6: PROCESSING CAPACITY

PURPOSE

Recycling facilities, commonly referred to as MRFs, are critical infrastructure for recycling. The capacity, type of feedstocks accepted, material processing capabilities, location, and proximity to end markets of Colorado's MRFs largely determine which materials are collected at curbside and depot or drop-off locations. The purpose of the Element 6 memo was to identify the MRFs currently operating in Colorado and their current permitted capacity, throughput, feedstocks accepted, contamination rates, equipment use, end-market products, costs, and potential expansion opportunities.

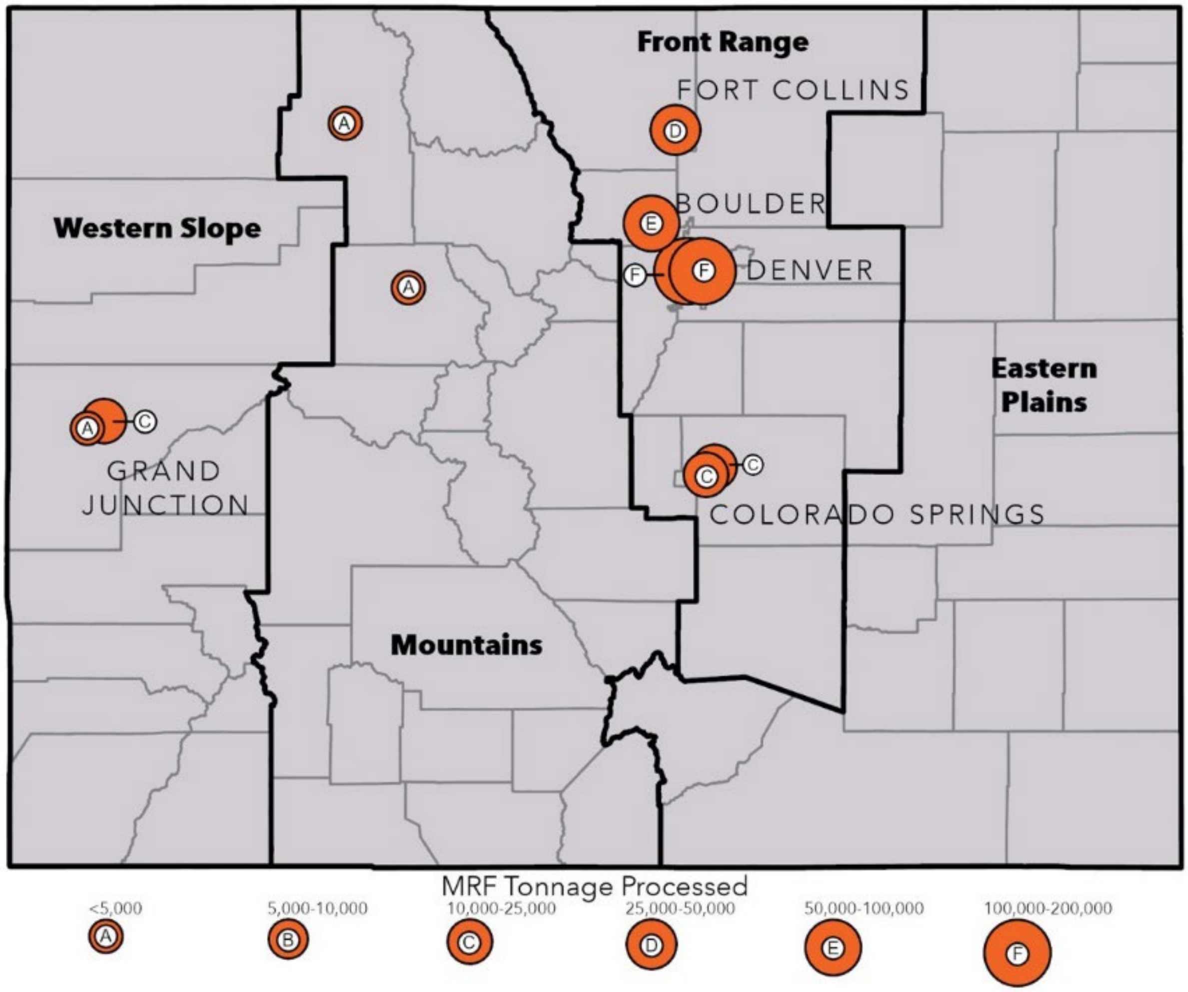
APPROACH

The project team reviewed CDPHE's list of registered recyclers to assess which facilities were subject to the Colorado Needs Assessment. The review was specifically focused on facilities with sorting and baling capabilities. The project team developed a survey to request information. The survey included questions on operations, cost, processing capacity, and expansion potential, among other topics. The project team selected representative MRFs from the State and conducted site visits and phone interviews to gather information. The project team also identified potential expansion opportunities at each site based on interviews and a visual assessment of site operations.

FINDINGS

- The project team visited nine (9) MRFs in Colorado that sort single- or dual-stream feedstocks. The MRFs visited both public and privately owned facilities.
- The project team surveyed three (3) additional MRFs in Colorado as part of the Needs Assessment.
- A majority of the MRF processing capacity in Colorado is located in the Front Range Region, as seen in Figure 4.
- In general, MRF operators were reluctant to share data on feedstock, end market contracts, revenues, specific contamination rates, capital costs, operating costs, or site layout with the project team due to the highly competitive nature of the solid waste industry in Colorado. The MRFs report data to the Colorado Department of Public Health and Environment (CDPHE), but that data is considered confidential and was only available to the project team in aggregate via the CDPHE website.
- Several owners and operators noted that Colorado has an "open market" arrangement and that establishing flow control and protecting a service area is very difficult.
- MRFs visited for this Needs Assessment indicated they could take more feedstock if packaging recycling increases due to the Producer Responsibility program. This could be accomplished via facility expansion, additional shifts, and equipment improvements.
- Some MRFs may require upgrades to existing equipment, incorporation of new sorting technologies, and/or process lines to expand capacity and adjust to current incoming feedstocks.
- A majority of the end markets are located out of State. Information on end markets is further captured in Element 9.

Figure 4: MRF Tonnage Processed in Colorado



SCENARIO CONSIDERATIONS

1. This element identified upgrade needs during site visits and interviews to handle the increase in throughput of feedstocks and increase end-market product quality. The scenario modeling used this information to estimate additional costs from upgrades to existing equipment at varying levels.

ELEMENT 7: OPPORTUNITIES AND COSTS

PURPOSE

The Element 7 memo used findings from other Element research within the Needs Assessment, including municipality surveys, hauler interviews, and material recovery facility (MRF) and compost facility site visits and interviews to evaluate the opportunities and costs of enhancing Colorado's existing recycling and composting infrastructure. The equipment and facility additions for recyclable and compostable packaging are expected to increase tonnage throughput capacity and material types for management. The estimated costs for these improvements inform the scenarios developed during the Needs Assessment.

APPROACH

The project team developed high-level estimates of the cost of expanding and/or improving existing MRF, compost facility, and transfer station infrastructure. The project team made the following assumptions to provide those costs.

- Each of the MRFs evaluated for the Needs Assessment has the ability to upgrade their facilities to process more material. Equipment recommendations also include technology improvements allowing MRFs to sort and process new materials.
- The compost facilities evaluated could accept compostable packaging in the future, with varying degrees of capital upgrades based on facility size.
- Transfer stations could be upgraded to manage more recyclables, compostables, or both. Cost ranges to upgrade a single transfer station were included in the analysis.

FINDINGS

- Based on survey data and industry knowledge, the project team estimates that the total cost of capital upgrades to the existing MRF infrastructure in Colorado is approximately $85M-$100M, also displayed in Table 9. These costs apply to the nine (9) MRFs that provided data for the Needs Assessment and represent the major recycling facilities in Colorado, yielding approximately 600,000 tons of estimated additional capacity for all-comingled recyclable materials (tonnage not specific to program covered materials). This would be accomplished via facility expansion, additional shifts, and equipment improvements.
- Three (3) new MRFs in the Front Range are planned to begin operation in 2025-2026. Two are currently permitted and expected to add 243,000 tons of processing capacity for all-comingled recyclable materials (tonnage not specific to program covered materials) in Colorado. This additional capacity is not included in the 600,000 tons estimated from upgrading existing facilities.
- Based on survey data and industry knowledge, the project team estimated that the total cost of capital upgrades to Colorado's existing compost facility infrastructure is approximately $49M for these sites to process additional food waste and compostable packaging.
- Capital upgrades for existing transfer stations will range between $1.3M and $2.3M per transfer station to add more recyclable materials (up to 70 additional tons/day) with varied levels of infrastructure and equipment improvements.
- Capital upgrades for existing transfer stations to begin accepting compostable materials, specifically food waste with compostable packaging, will range between approximately $1M-$2.3M per transfer station, depending on a range of infrastructure and equipment improvements.

Table 9: MRF Opportunities and Costs

Region	Current Material Processed (TPY)	Projected Total Capacity (TPY)	Estimated Cost Range
Front Range	394,500	700,000	$45M - $50M
Mountains	2,000	95,000	$6M - $12M
Western Slope	15,300	190,000	$35M - $40M
Eastern Plains	N/A	N/A	N/A
TOTAL	411,800	1,000,000	$85M - $100M

SCENARIO CONSIDERATIONS

1. The MRF upgrade costs are used in the modeling to estimate capital investments necessary under future scenarios to process the increased volume of material. This control is related to the technology available in all MRFs (new and existing) to sort incoming material properly. This control impacts the expected yield of the inbound collected material, which impacts the recycling rate. This control also impacts the cost of the system due to capital and operational investments.
2. Facility and equipment upgrades were modeled at varying levels for Class III level composting facilities to manage covered compostable packaging utilizing the capital insights from this element.

ELEMENT 8: MINIMUM RECYCLABLES LIST

PURPOSE

The purpose of the Element 8 Memo was to propose a list of covered materials, based on data collected through the research on the other Elements, that can be included in a minimum recyclable list (MRL) and an additional materials list (AML). The minimum recyclables list is a list of materials that must be collected in a manner that is as convenient as the collection of solid waste. The additional materials list includes materials that may be collected in different geographic areas through curbside services, drop-off centers, or other means.

House Bill 22-1355 stipulates that the list is based on the availability of recycling services, recycling collection and processing infrastructure, and recycling end markets for covered materials. These lists are required to be re-evaluated each year, which provides an opportunity to adjust the list as part of the program plan as new technologies or end markets become available.

APPROACH

The project team developed a list of materials to be evaluated, which was shared with and refined by the Colorado Producer Responsibility Advisory Board. Each material on the updated list was evaluated on the following criteria:

- Availability of Recycling Services
- Recycling Collection and Processing Infrastructure
- Sortability of Materials at the MRFs
- Recycling End Markets
- Detriments

The project team developed metrics to denote high performance (no issues), medium performance (some issues), and low performance (greater level of issues). The draft assessment criteria were shared with the Colorado Producer Advisory Board, and the project team adjusted criteria metrics based on feedback from the Board. Each was assigned a score after the materials were evaluated against the criteria. Lower scores were more favorable. The scoring threshold for each list is included in **Table 10** below.

Table 10: Material Scoring

Material Total Score	Recyclable List
4-6	Minimum Recyclable List
7-10	Additional Materials List
11-16	Not collected

FINDINGS

The following lists are proposed for the minimum recyclables list (**Table 11**), additional materials list (**Table 12**).

Table 11: Proposed Minimum Recyclables List

Packaging Type	Collection Method
Paper for General Use (uncoated)	Curbside
"Low grade" Printing and Writing Paper (e.g., bulk mail, envelopes, notebooks, cards)	Curbside
Other Printed Paper (e.g., flyers, calendars, brochures)	Curbside
Newspaper, Newsprint	Curbside
Magazines and Other Coated Paper (e.g., catalogs)	Curbside
Bound Directories (e.g., telephone)	Curbside
Packaging Paper	Curbside

Packaging Type	Collection Method
Corrugated Cardboard (except wax-coated)	Curbside
Kraft Packaging (e.g., paper-padded mailers, grocery bags)	Curbside
Paperboard Boxes and Packaging	Curbside
Molded Pulp Packaging excluding Food Serviceware (e.g., egg cartons, other protective packaging)	Curbside
Gable-Top	Curbside
Aseptic Cartons	Curbside
Non-Metalized Gift Wrap	Curbside
Clear PET Bottles, Jars, and Jugs (including Transparent Green or Blue)	Curbside
Clear PET Thermoform Containers (including Transparent Green or Blue)	Curbside
Natural HDPE Bottles, Jars, and Jugs	Curbside
Colored HDPE Bottles, Jars and Jugs	Curbside
Other Polyethylene (PE) Packaging (e.g., ice cream/butter containers) Except Pails and Lids and Squeezables	Curbside
Polypropylene (PP) Packaging, Except for Pails and Lids (e.g., deli containers, cleaning products)	Curbside
Large HDPE & PP Pails & Lids (e.g., cat litter)	Curbside
Steel Aerosol Containers (empty)	Curbside or drop-off
Steel Containers	Curbside
Aluminum Aerosol Containers (empty)	Curbside or drop-off
Aluminum Non-Beverage Containers	Curbside
Aluminum - Beverage Containers	Curbside
Clear or Colored Glass	Curbside or Drop-off

Table 12: Proposed Additional Materials List

Packaging Type	Collection Method
Shredded Paper (bagged)	Curbside, Drop off, or Other Means
Molded Pulp Food Serviceware (e.g., takeout "clamshells")	Curbside, Drop off, or Other Means
Paper Cups, Coated and Uncoated	Curbside, Drop off, or Other Means
Other Polycoated Packaging (e.g., some freezer and butter boxes)	Curbside, Drop off, or Other Means
Paper Laminate (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic-coated paper wrappers, including burger wraps)[1]	Curbside, Drop off, or Other Means
Paper "cans" (spiral-wound containers) with steel ends	Curbside, Drop off, or Other Means

[1] *Note there should be consideration in future assessments to create a separate category for flexible paper that meets the requirements for recycling.*

Packaging Type	Collection Method
Colored Opaque PET Bottles, Jars and Jugs	Curbside, Drop off, or Other Means
Colored opaque PET Thermoform Containers	Curbside, Drop off, or Other Means
PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens)	Curbside, Drop off, or Other Means
LDPE Colored Nursery Containers (e.g., pots, trays, etc.)	Curbside, Drop off, or Other Means
PP Nursery Containers (e.g., pots, trays, etc.)	Curbside, Drop off, or Other Means
LDPE/HDPE Film (e.g., monoPE recycle compatible pouches)	Curbside, Drop off, or Other Means
Other Aluminum Packaging (Foil and Foil Trays)	Curbside, Drop off, or Other Means
Other Metal Packaging	Curbside, Drop off, or Other Means

SCENARIO CONSIDERATIONS

1. The minimum recyclables list developed under this element determined the list of materials in the scope of the modeled scenarios. This impacted the quantity of materials estimated to be managed by the system and directly fed into the following controls: collection of minimum recyclables list and collection of additional materials list.

ELEMENT 9: END MARKETS

PURPOSE

The purpose of the Element 9 memo was to evaluate the current State of end markets for recyclable material collected in Colorado. Viable, sustainable end markets for recycled and sorted material are a critical component of the life cycle of recyclable material. The project team evaluated the main markets for materials collected in Colorado, whether materials are transported in-state or exported out-of-state for end market processing, potential challenges and weaknesses in current markets, and market development efforts.

APPROACH

The project team conducted primary and secondary research to identify the end market for materials. The evaluation included an internal processor database; the EPA's Recycling Infrastructure Market Opportunities map; Circular Colorado's member directory, University of Colorado Denver's Manufacturing, Associations, Organizations, and Company Information; surveys of material recovery facilities (MRFs); interviews with industry stakeholders such as brokers, MRFs, and recyclers; and the U.S. Census Bureau's USA Trade Online database. The project team attempted to identify which in-state and out-of-state end markets accept and process recyclable material generated in Colorado.

FINDINGS

Table 13 summarizes the end market feasibility for materials considered in this Needs Assessment. The RAG score labels most materials as green, where end markets are possible; yellow, where end markets are more difficult; and brown, where end markets are most difficult to find.

- Glass is the only collected material with a Colorado end market that could accommodate increased volume. Glass to Glass, O-I Glass Inc., and Rocky Mountain Bottling Company (RMBC) are Colorado's major glass end markets.
- Mills within the State do not accept steel or tin cans and instead tend to process scrap metal. The integrated steel mills in the US, which accept steel and tin can packaging material, are located in the Midwest. The nearest end market is approximately 850 miles from Denver.
- There are no local markets for aluminum in Colorado, but strong domestic markets exist. Material typically stays in the U.S. for processing due to its high market value and is generally shipped to the southeastern U.S.
- There are no paper mills in Colorado. End markets are currently located in the Midwest, South, and Western U.S. End markets can be relatively local to Colorado (i.e., neighboring states) if the material is sorted into ISRI standard bale grades. In contrast, lower-grade fibers may have to be sent to mills further away.
- End markets for post-consumer plastic material are limited in Colorado. There are only plastic recycling facilities for post-industrial materials. End markets for plastic are currently in the southeastern U.S. The cost to run non-bottle PET plastics through a recycling facility is high and could require the cost to be subsidized. PET thermoforms and bottles are, therefore, baled together. HDPE bottles are sorted into separate bales and sold to end markets across the US.

Table 13: End Market Evaluation by Material

Material	RAG Rating for End Markets	In State End Markets	Stable End Markets
Glass	Possible	Yes	Yes
Aluminum Packaging	Possible	No	Yes
Steel Packaging	Possible	No	Yes
Fiber – OCC	Possible	No	Yes
Fiber – Other Paper Products	Possible	No	Yes
Plastic – PET	Possible	No	Yes – for bottles
Plastic – HDPE	Possible	No	Yes
Plastic - PP	More Difficult	No	No
Plastic – Other #3-7	Most Difficult	No	No

SCENARIO CONSIDERATIONS

1. Due to the presence of strong local end markets for container glass, the scenarios will evaluate improvements in the recycling system to increase the quality of material to reduce downstream costs, increase the quantity of quality material by investing in glass cleanup equipment, and evaluate different collection methods for glass.
2. The insights from this element support the findings from Element 6 on the need to invest in MRF equipment to sort resin and format specific bales effectively. This could improve local end markets for used beverage containers and fiber.

ELEMENT 10: NEW TECHNOLOGIES

PURPOSE

The Element 10 report aimed to evaluate recycling solutions in North America and globally that can potentially expand or improve the collection, sorting, and processing of recyclable packaging materials through technology solutions. The processing technologies identified in this report are at the commercial stage. This means that the equipment or system has been in service at several operating facilities long enough to have gone through several operation cycles and proven it can reliably achieve the anticipated level of performance. While development risk is never eliminated, the risk of technology failure drops substantially once commercial operation is reached. Innovative collection and reuse options have also been identified to improve Colorado's existing recycling system.

APPROACH

The project team developed a list of technology options that not all facilities or haulers currently use in Colorado for consideration as part of this Needs Assessment. Technology gaps were determined through the surveys and site visits conducted during the Needs Assessment. The project team contacted reputable vendors for technology information, commercial availability, and cost estimations. The project team used the lens of new technologies to understand how the current Colorado infrastructure could be maximized to increase processing capacity, expand the accepted materials, and reduce the impact of contamination.

FINDINGS

- Benefits of new technologies in Colorado include increased safety, optimized efficiency, potential processing of additional material types, ability to adapt to changing markets, potential for increased diversion through more accurate capture, reduced contamination, and reduced staffing needs.
- The technologies identified are at the commercial stage, meaning they are in service at existing facilities and have proven performance in a commercial setting.
- Improved MRF technologies, such as optical sorting, glass cleanup systems, screening technology, robotics, artificial intelligence (AI), and fire detection systems, can optimize the efficiency and safety of existing MRFs. These technologies can also improve the quantity and quality of output materials and reduce contamination.
- New MRF technologies have the potential to expand the types of material accepted and adapt to changing feedstocks over time.
- Glass has a local end market in Colorado, so glass cleanup systems may be a priority. Some existing facilities complete some glass cleanup, but improved equipment could potentially achieve an 80-90% glass yield. This additional cleanup equipment would assist MRFs in removing fines (small glass pieces that are difficult to recover, grit, gravel, etc.), shredded paper, and other light material that normally contaminates the glass before selling to the end market.
- Fire detection systems can protect processing capacity at existing MRFs. Current systems and practices may be reviewed to protect against risks adequately.
- While dual-stream facilities tend to produce cleaner products, resident participation rates are typically higher in areas with single-stream collections. Thus, dual-stream facilities may consider converting to single-stream to increase material availability.
- Advancements such as contamination software, routing software, automated collection, and scheduling tools improve data collection, route efficiency, and worker safety.

SCENARIO CONSIDERATIONS

1. Current technology gaps were determined through surveys and site visits in Colorado to inform new technologies, commercial availability, and cost estimations. Findings informed potential advancements in the collection, sorting, and processing of recyclable packaging

materials. This helped inform the impact of access, collection, and materials controls in the model.

ELEMENT 11: REUSE AND REFILL

PURPOSE

Reuse and refill systems are gaining consumer and business interests as an alternative to single-use packaging models. The transition to reuse systems for packaging could significantly impact waste diversion targets, climate goals, and extended producer responsibility legislation. The purpose of the Element 11 effort was to understand the availability and scope of reuse and refill systems in Colorado that may affect the use of materials covered under this Needs Assessment. The project team documented the current deployment of reuse and refill services, formats available to residential and non-residential covered entities, and major packaging types. The project team also developed insights regarding trends and opportunities for migration to reusable and refillable product delivery and how that could potentially change the recyclable material stream.

APPROACH

The project team began by assembling a database of reuse and refill programs in Colorado, including the major types of packaging and paper formats impacted and the types of residential and non-residential entities to which they are available. The project team also interviewed internal and external reuse and refill experts, key Colorado stakeholders, and several reuse service providers to identify additional programs and to discuss trends, challenges, and opportunities for reuse and refill systems already in place in Colorado and systems that could be implemented in the future.

FINDINGS

- There are 52 existing reuse and refill operations in the State. These include packaging-free shops with bulk dispensing models, reusable cup and container programs run by restaurants, stadiums, schools, and campuses, and pre-filled refill systems for dairy products.
- The project team could not quantify these operations' current source reduction benefits, but source reduction is likely if there is continued expansion in reuse programs.
- Challenges to reuse and refill include the availability and cost of infrastructure such as washing facilities.
- Nationally, reusable cup and container programs and package-free shops are typically local (city- or town-based) initiatives rather than statewide or regional programs. They also capture a small portion of the market and have a negligible total impact on statewide waste streams.
- The number of reuse and refill companies and programs in Colorado fluctuates in this period of early growth. A few larger players in the reusable cup and container space are

gaining a firm foothold, including r. World and Deliver Zero. An interesting development is the collaboration between these companies, which speaks to the economic value of shared infrastructure.

- Colorado has two main funding initiatives that can be used to support reuse and refill initiatives. Recycling Resources Economic Opportunity (RREO) grant funding promotes economic development by managing materials that would otherwise be landfilled. The Front Range Waste Diversion (FRWD) enterprise fund provides funding and technical support to local governments, nonprofits, businesses, institutions, and other entities on the Front Range that contribute to waste diversion activities within the Front Range.

SCENARIO CONSIDERATIONS

1. The future scenarios consider the impact of increased reusable packaging on waste prevention and the generation of packaging materials.

ELEMENT 12: EDUCATION

PURPOSE

Education is critical to the success of recycling programs for packaging materials. Recycling collection and sorting rely on individual residents and businesses to place materials in the correct cart or bin, and recycling education can give residents the tools they need to sort material correctly. The education element of the Colorado Needs Assessment was to evaluate current recycling education programs in Colorado, evaluate the cost of recycling education, and identify best practices and recommendations for recycling education.

APPROACH

The project team reviewed existing reports and studies that address recycling education in Colorado and the U.S. The project team also reviewed Colorado municipalities to assess what, if any, recycling education is being offered on their website. As part of the Needs Assessment, the project team conducted a comprehensive survey of municipalities, material recycling facilities (MRFs), compost facilities, and collections companies in Colorado, which included questions about recycling education. Additionally, Eco-Cycle conducted two stakeholder workshops in coordination with the HDR project team. The goals of the workshops were to gather information on local recycling programs, seek input on strategies to enhance existing services and record each organization’s perspective on producer responsibility legislation. The information collected from stakeholder events and the sources mentioned above are summarized in the findings below.

FINDINGS

- Approximately two-thirds of municipal survey respondents noted that they provide recycling education.
- Material lists of what can and cannot be recycled were among municipalities' most commonly available educational tools.

- Survey respondents reported that websites or social media campaigns are most commonly used for recycling education. Still, municipalities also use print, radio, television, in-person events, and other methods to provide recycling education.
- Most recycling education was targeted toward single-family rather than multi-family households.
- The surveys and the project team's desktop research indicated that some recycling education was offered in multiple languages, primarily Spanish—these range from pre-translated printable materials to videos with Spanish narration. Several municipalities had websites that were translated into multiple languages via Google Translate.
- Survey respondents asked where they obtain solid waste and recycling educational materials. Most respondents said they develop materials in-house or partner with local recycling organizations.
- Several survey respondents commented that a third-party provider, contractor, or contracted hauler provided recycling education.
- Few municipalities have data on recycling rates and recycled material quantities readily available on their website.
- 26% of the municipalities surveyed had recycling coordinators on their staff.
- The amount spent on recycling education was reported to be between $500 (San Miguel County) and $1 million (City of Longmont) per year. Calculated per-Household cost ranged from less than $1 to $25 per household (City of Longmont).
- Nonprofit recycling and zero waste advocacy organizations in Colorado are also providing educational support for recycling programs and can continue to play a role in the future to improve outcomes. This includes assistance with communication in multifamily buildings, resort/destination communities, and underserviced communities. There are opportunities to leverage developed materials, specific understandings of local communities, and different communication channels.

SCENARIO CONSIDERATIONS

1. Education programs for recycling impact the likelihood that a household with access to recycling will participate in the program, how much material will be recycled from each Household, and the quality of the material collection. This impact is related to the investment in the education program modeled in each Scenario at a rate equivalent to the high-performing communities in the State and in alignment with The Recycling Partnership's recommended per-household investment of $10/household. This investment aligns with the high performing diversion communities in both the Front Range and Mountain regions within Colorado.
2. A common statewide Minimum Recyclables List with consistent education can help to improve participation rates, set- our rates, and reduce contamination.

ELEMENT 13: SCENARIOS

PURPOSE

The objective of this element is to estimate the impact of three (3) projected scenarios on the recycling rate and collection rate of covered materials in Colorado. This includes recycling rates and collection rates that the State can meet by 2030 and 2035, as well as the operating and capital costs to reach each Scenario, in accordance with House Bill 22-1355. The modeling conducted in this element is the culmination of the findings from the other elements of the Needs Assessment.

APPROACH

The model was developed according to a bottom-up approach and systematically considered variables across the waste and recycling value chain. The model flow is a comprehensive tracking of packaging materials, from generation through consumption to eventual recycling or disposal. Cost estimates focused on accumulated costs in each stage of the lifecycle of packaging waste.

As the model was developed, the project team identified factors that impact collection and costs. These factors fell into the following categories: access, collection, materials, education, infrastructure, and waste generation. Using these factors, a low, medium, and high Scenario were developed to understand the potential future performance and cost of EPR in Colorado. There are several controls that are the same across all three scenarios.

- **Access:** Recycling access is equivalent to trash collection for all residential households. This means if a household has access to curbside trash collection, they will have access to curbside recycling.
- **Access:** Recycling service is offered to all non-residential covered entities by 2030.
- **Collection:** All new curbside service is collected through single-stream processes
- **Materials:** All materials are collected on the minimum recyclables list at the start of the program
- **Education:** Recycling education is implemented across the State based on best practices
- **Generation:** The population is expected to grow similarly in all scenarios in addition to a 10% waste reduction by 2035

Low Scenario:

- **Collection:** New collection service is biweekly, and the current service collection frequency does not change
- **Collection:** There will be minor efficiencies made to collection routes
- **Materials:** Materials on the additional materials list will be collected by 2035

- **Materials:** Glass is collected in curbside for new service and remains the same for existing service
- **Infrastructure:** Additional MRF capacity growth based on new volume but no investment in advanced technology

Medium Scenario:

- **Collection:** New collection service is biweekly, and the current service collection frequency does not change
- **Collection:** There will be medium efficiencies made to collection routes
- **Materials:** Materials on the additional materials list will be collected by 2035
- **Materials:** Glass is collected curbside for new and existing service
- **Infrastructure:** Additional MRF capacity growth based on new volume, greater investment in infrastructure including drop off sites in addition to advanced technology upgrades at MRFs

High Scenario:

- **Collection:** New and existing collection service are weekly
- **Collection:** There will be major efficiencies made to collection routes
- **Materials:** Materials on the additional materials list will be collected by 2030, including curbside flexible plastic collection
- **Materials:** Glass is collected in curbside for new and existing service
- **Infrastructure:** Additional MRF capacity growth based on new volume, greater investment in infrastructure including drop off sites in addition to advanced technology upgrades at MRFs

FINDINGS

- At the baseline year (2022), it is estimated that Colorado had a recycling rate between 22% - 28% for covered packaging from covered entities.
- In the low Scenario, Colorado could achieve a recycling rate between 32%-38% in 2030 and 47%-53% in 2035.
- In the medium Scenario, Colorado could achieve a recycling rate between 34%-40% in 2030 and 51%-57% in 2035.
- In the high Scenario, Colorado could achieve a recycling rate between 39%-45% in 2030 and 54% - 60% in 2035.
- The recycling rate is the highest in the Front Range, followed by Mountains, Western Slope, and Eastern Plains.

- At baseline (2022), the total system cost is estimated to be between $80 million and $140 million.
- In 2030, the estimated system cost could be between $130 and $200 million in the low Scenario, $130 and $ 210 million in the medium Scenario, and $150 and $240 million in the high Scenario.
- In 2035, the estimated system cost could be between $160 and $250 million in the low Scenario, $160 and $260 million in the medium Scenario, and $180 and $290 million in the high Scenario.
- The system factors that contribute the most to increased recycling rates are providing residential households with recycling services equivalent to trash, performance benefits due to education programming, advanced sorting at MRFs, and collecting materials on the additional materials list.
- The system factors that contribute the most to cost increases are providing residential households with recycling services equivalent to trash, investment in education programming, and MRF technology investment.
- Efficiencies in collection routes have overall cost savings.

Table 14: Estimated Recycling Outcomes per Scenario

		2022 (Baseline)	2030	2035
Low	Recycling Rate (%)	22% - 28%	32% - 38%	47% - 53%
	Recycling Tonnage (k tons)	~310	~450	~660
Medium	Recycling Rate (%)	22% - 28%	34% - 40%	51% - 57%
	Recycling Tonnage (k tons)	~310	~480	~710
High	Recycling Rate (%)	22% - 28%	39% - 45%	54% - 60%
	Recycling Tonnage (k tons)	~310	~550	~750

Table 15: Estimated Recycling Rates by Region per Scenario

	Baseline (2022)	Low		Medium		High	
	2022	2030	2035	2030	2035	2030	2035
Front Range	24% - 30%	33% - 39%	49% - 55%	36% - 42%	52% - 58%	41% - 47%	56% - 62%
Mountains	17% - 23%	27% - 33%	39% - 45%	30% - 36%	44% - 50%	33% - 39%	46% - 52%
Western Slope	15% - 21%	25% - 31%	38% - 44%	29% - 35%	44% - 50%	32% - 38%	46% - 52%
Eastern Plains	8% - 14%	19% - 25%	31% - 37%	21% - 27%	34% - 40%	23% - 29%	36% - 42%

	Baseline (2022)	Low		Medium		High	
Front Range	24% - 30%	33% - 39%	49% - 55%	36% - 42%	52% - 58%	41% - 47%	56% - 62%

Table 16: Estimated Costs per Scenario

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Total Annualized Cost ($ millions)	80	140	130	200	160	250
	Cost Per Household ($)	60	90	60	90	70	110
	Cost Per Ton Recycled ($)	260	430	280	450	240	380
Medium	Total Annualized Cost ($ millions)	80	140	130	210	160	260
	Cost Per Household ($)	60	90	60	90	70	120
	Cost Per Ton Recycled ($)	260	430	260	430	230	370
High	Total Annualized Cost ($ millions)	80	140	150	240	180	290
	Cost Per Household ($)	60	90	70	110	80	130
	Cost Per Ton Recycled ($)	260	430	270	430	240	390

ELEMENT 14: COMPOSTING

PURPOSE

Composting diverts organic material from landfilling and produces a usable end product. The composting process is a way to manage compostable single-use packaging, including compostable service ware. The Element 14 memo outlined the capacity and feedstocks of composting facilities in Colorado. The Colorado Needs Assessment analysis evaluated whether facilities accept compostable packaging and service ware, the capacity of composting facilities, and the potential for expanded capacity.

APPROACH

The project team took a two-fold approach to assess existing capacity, organic trends, and associated costs. First, the project team conducted a literature review of existing studies and regulations impacting Colorado's composting programs. The team then developed and executed onsite assessments of representative composting facilities in Colorado. The assessments covered a range of factors related to the composting facility's operations, such as processing capacity and expansion opportunities, capital and operational costs, and feedstock types and sources.

FINDINGS

- Based on a high-level review of municipal codes from the most populated counties in the four (4) Colorado Regions, composting is not a clearly defined use. It is most often grouped up with solid waste facilities. This, in turn, may limit access to properly zoned land for composting facilities.
- Nearly all composting facilities surveyed accept a mixture of green and food waste. While only two (2) surveyed reported composition data for compostable packaging, several facilities currently accept or are willing to accept compostable packaging.
- The most common processing approach was windrow composting, although aerated static pile systems are currently being piloted or used in conjunction with windrow composting at a few facilities.
- The leading recommendation from feedstock generators was to focus on education to reduce contamination.
- Facility operators suggested that receiving pads, de-packagers, sortation lines, shredders, and associated operation buildings would be the primary need for facilities to process compostable packaging more effectively.
- The State of Colorado has a current organics processing capacity of roughly 400,000 tons per year and a potential capacity of roughly 1,100,000 tons per year. These values include weights of materials from residential and commercial generators, including feedstocks comprising green waste, food waste, wood waste, biosolids, and compostable packaging materials.
- Approximately one-quarter of the current processing capacity and potential capacity are associated with facilities currently accepting or willing to accept compostable packaging at the time of the survey. Additionally, approximately 20% by weight of that capacity is dedicated to feedstocks or generators that include compostable packaging products.
- Consistent end markets impact processing capacity, as it is necessary to move material to end markets to allow room for processing additional feedstock.

SCENARIO CONSIDERATIONS

1. Facility and equipment upgrades were modeled at varying levels for Class III level composting facilities to manage covered compostable packaging. Investments in facility upgrades varied by Scenario, with the low Scenario incorporating upgrades by 2035 and the medium and high Scenarios incorporating upgrades by 2030.

COLORADO NEEDS ASSESSMENT

ELEMENT 1: RESIDENTIAL COLLECTION

JANUARY 25, 2024

CONTENTS

TABLES

The Needs Assessment was undertaken according to Colorado's Producer Responsibility Program for Statewide Recycling. Any views expressed in this document do not necessarily reflect the views or positions of Circular Action Alliance's members.

1 EXECUTIVE SUMMARY

1.1 PURPOSE

The purpose of Element 1 is to understand in detail what recycling and waste services are provided and how they are provided to residential covered entities throughout Colorado, such as frequency of collection, method of collection, and payment mechanisms. In addition, this Element details the range of recyclables that are collected through both curbside and drop-off collection routes.

1.2 APPROACH

To understand and evaluate how waste and recycling services are provided to residential covered entities, the project team utilized both primary and secondary research, which included:

- **Survey**: the project team sent a comprehensive survey to each municipality and county in the state. The survey was open for a total of 5 weeks. To support survey implementation, the project team:
    - Advertised for and subsequently hosted two webinars to explain the survey to municipal respondents,
    - Developed a webpage with frequently asked questions and associated answers on Recycle Colorado's website,
    - Hosted two drop-in sessions for any municipality to ask questions,
    - Monitored a project-specific publicly accessible email to answer any questions from inquiring respondents.
    - Distributed weekly reminder emails to all respondents,
    - Called 100 municipalities to encourage them to fill out the survey.
- In total, 183 municipalities and counties started the survey, and 130 completed it. Not all questions were required, and on average, the survey received 70-90 responses per question.
- **Available Studies**: the project team utilized available research data, including:
    - The State of Recycling and Composting in Colorado[1]
    - Front Range Waste Diversion Baseline Assessment[2]
    - Greater Colorado Waste Diversion Baseline Assessment Report 2022[3]

[1] https://ecocycle.org/content/uploads/2022/11/State-of-Recycling-and-Composting-in-Colorado_2022_Eco-Cycle_CoPIRG_web-1.pdf

[2] https://drive.google.com/file/d/1B0wzgjba8bDy8Tznm0uK4YO6_dDtI-Sa/view

[3] https://drive.google.com/file/d/1_29VYDxuCRvLYyPHkmxRxXzLS5zAxmQu/view

   - CDPHE local solid waste and recycling dataset[4]

- **Desktop Research**: the project team reviewed municipality websites, annual reports, and when little data was available, called municipality staff to gather information on waste and recycling services.

Results from the different research methods are provided in aggregate in this report. If a municipality responded to the survey, then these responses were used, if a municipality did not respond to the survey, then the desktop research findings were used, if a municipality did not respond to the survey and no information was found during desktop research then the previously available studies were used. The desktop research and available studies were used to fill in the gaps in the survey.

Figure 1: Hierarchy of Research Findings

1.3 GEOGRAPHICAL SCOPE

The findings are presented based on geographical boundaries. The 2016 Integrated Solid Waste and Materials Management Plan (ISWMMP) divides Colorado into four Regions based on varying socioeconomic and geographic factors: the Western Slope, the Mountains, the Front Range, and the Eastern Plains. The 2016 ISWMMP recognized that solid waste service and hauling operations vary widely between the Regions due to the variation in infrastructure, density, markets, and services available. **Figure 2** shows the four regions that make up the State of Colorado.

[4] https://cdphe.colorado.gov/hm/local-sw-recycling-info

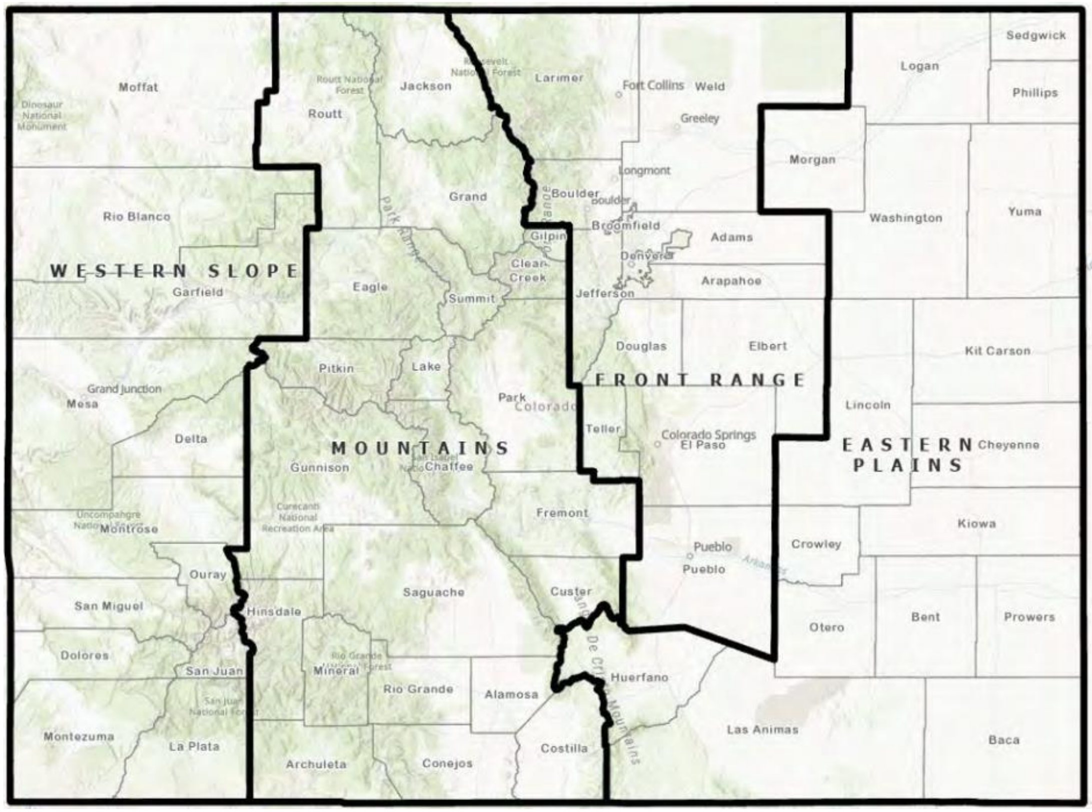


Figure 2: Four Regions of Colorado

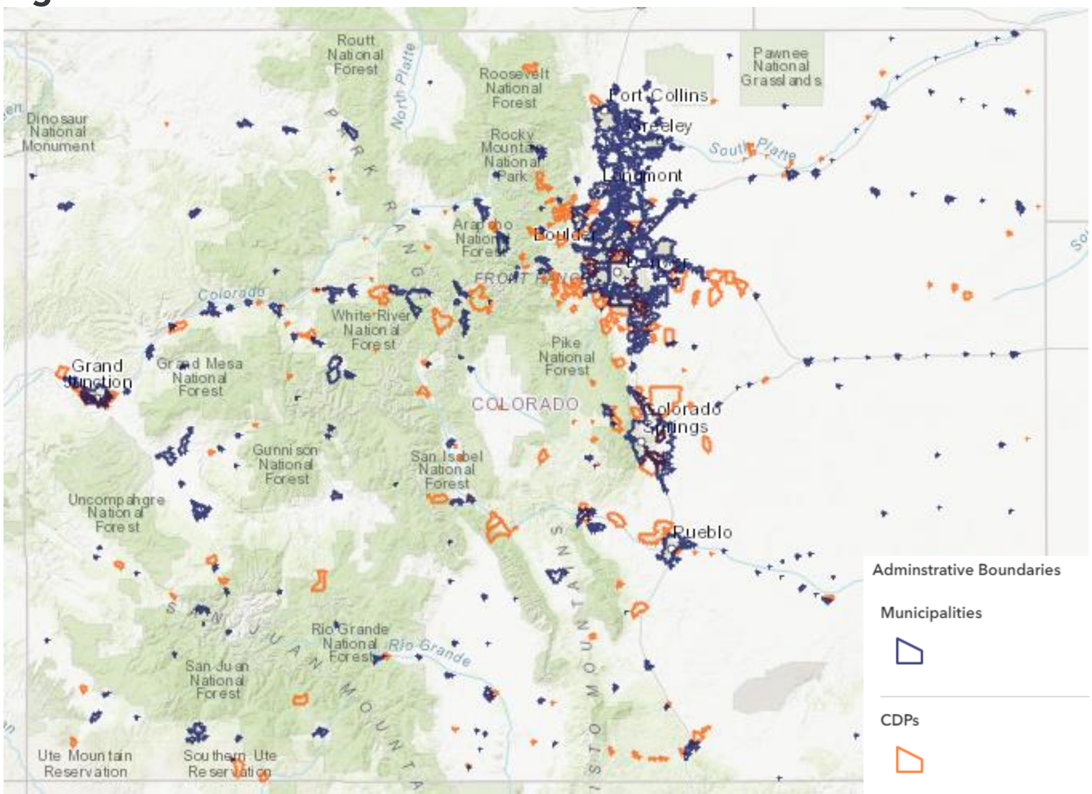
In addition to four regions, Colorado has 64 counties. Municipalities[5] and Census Designated Places (CDPs)[6] have set boundaries by the US census or government but only represent a small share of the land area in the state (see Figure 3). The areas outside of municipalities and CDPs are referred to as rural and remote areas for this report. About 74% of the population live in municipalities, 12% live in CDPs, and 13% live in rural and remote areas.

As there is limited information on CDPs and rural areas, the results in this memo are presented for the 272 municipalities throughout Colorado, and additional context is provided on CDPs and rural areas where possible.

[5] Also referred to as incorporated places. Municipalities are legally incorporated under state law, have a legally defined boundary, and an active functioning governmental structure. (US Census)

[6] Statistical equivalents of incorporated places and represent unincorporated communities that do not have a legally defined boundary or an active, functioning governmental structure. (US Census)

Figure 3: Administrative Boundaries in Colorado



Furthermore, as shown in **Table 1,** the population density ranges widely in the four regions:

- The Front Range has 84% of the total population in the state. Approximately 78% of the population live in municipalities, 13% in CDPs, and only 9% in rural areas.
- In the Mountains, 47% of the population live in municipalities while, 41% live in rural areas and 12% live in CDPs.
- In the Western Slope, 52% of the population live in municipalities, 14% in CDPs, and 28% in rural areas.
- The Eastern Plains region has the smallest population of any region, representing only three percent of the total population. Seventy-four (74%) percent of the population live within municipalities, 12% live in CDPs, and 13% live in rural areas.

Additionally, as shown in **Table 2,** 81% of the municipality population and 60% of the total population were represented through the survey. Only 29% of the total population in the Mountains and 14% in the Eastern Plains were represented.

Table 1: Population Distribution in Colorado

	Front Range	Mountains	Western Slope	Eastern Plains	Total
Total Population	**4,824,645**	**336,400**	**406,611**	**155,520**	**5,723,176**
Percent of Total Population	**84%**	**6%**	**7%**	**3%**	**100%**
Number of Municipalities	**92**	**71**	**42**	**67**	**272**
Population Within Municipalities	**3,784,354**	**157,670**	**213,218**	**107,888**	**4,263,130**
Percent of Population Within Municipalities	**78%**	**47%**	**52%**	**69%**	**74%**
Number of CDPs	**105**	**50**	**22**	**33**	**210**
Population Within CDPs	**609,108**	**40,004**	**55,762**	**3,538**	**708,412**
Percent of Population Within CDPs	**13%**	**12%**	**14%**	**2%**	**12%**
Population of Rural Areas	**431,183**	**138,726**	**137,631**	**44,094**	**751,634**
Percent of Population Within Rural Areas	**9%**	**41%**	**34%**	**28%**	**13%**

Table 2: Survey Response Rate

	Front Range	Mountains	Western Slope	Eastern Plains	Total
Number of Municipalities that undertook the Survey	**43**	**38**	**24**	**16**	**121**
Percent of Municipality Population Represented Through Survey	**84%**	**62%**	**68%**	**20%**	**81%**
Percent of Total Population Represented Through Survey	**66%**	**29%**	**36%**	**14%**	**60%**

1.4 FINDINGS

1.4.1 Municipality Findings

As shown in **Table 3**, twenty-seven (27) municipalities have legal requirements for recycling of common packaging materials, and more than half of these municipalities are located in the Front Range. A legal requirement to recycle mandates residents have an active collection service, whether the collection service is universal or subscription-based. Legal requirements are most common for single-family households. Only 13 municipalities reported legal requirements for large multifamily households. Seventy-seven (77) municipalities across Colorado reported having no legal requirement for residents to recycle. Of the municipalities that answered the survey, the majority reported having no legal requirement for residents to recycle.

Table 3: Legal Requirements for Curbside Recycling

	Front Range	Mountains	Western Slope	Eastern Plains
Legal Requirement	**14**	**9**	**4**	**0**
Legal Requirement: Residential Single-family	**12**	**7**	**4**	**0**
Legal Requirement: Residential Multi-family	**7**	**7**	**3**	**0**
Legal Requirement: Commercial Multi-family	**5**	**6**	**2**	**0**
No Legal Requirement	**25**	**21**	**20**	**11**
Did Not Answer Question	**4**	**8**	**0**	**5**
Did Not Answer Survey	**49**	**33**	**18**	**51**

Table 4 and **Table 5** provide an overview of households with active trash and recycling services. Note that the total number of single-family households combined with multi-family households is less than the total number of households. This is because there are some housing types, such as mobile homes, not currently included, therefore, the total number of households with survey is likely a lower estimate. A few key findings include:

- Active curbside recycling services are more common for single-family households than for multi-family households. The main reason for this is that larger multifamily structures are not included in residential recycling programs and are classified as commercial waste generators. It is generally cheaper to dispose of recyclable waste than contract recycling collection in large multi-family building residents.

- In Colorado, 68% of single-family households have active service for curbside recycling, and 60% of multifamily households have active service for curbside recycling (**Table 5**).
- Moreover, 96% of single-family households and 98% of multi-family households living in municipalities have active service for curbside trash (**Table 4**).
- Producers under the Act are required to provide residential single-family and multi-family residences in a manner that is as convenient as the collection of solid waste. As a result, approximately 507,000 households in municipalities will get access to curbside recycling (450,000 in the Front Range, 20,000 in the Mountains, 30,000 in the Western Slope, and 7,000 in the Eastern Plains). This is outlined in **Table 6**.

Table 4: Active Service for Trash in Colorado Municipalities

	Front Range		Mountains		Western Slope		Eastern Plains		Total		
	Single-family	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Total**
Number of Households Within Municipalities	**989,406**	**477,518**	**39,745**	**19,743**	**58,220**	**18,984**	**31,004**	**6,683**	**1,119,375**	**522,927**	**1,642,302**
Number of Households With Curbside Trash	**972,611**	**472,669**	**34,749**	**18,843**	**55,893**	**18,513**	**11,947**	**2,404**	**1,075,201**	**512,428**	**1,587,629**
Percent of Households With Curbside Trash	**98%**	**99%**	**87%**	**95%**	**94%**	**98%**	**39%**	**36%**	**96%**	**98%**	**97%**
Number of Households With Drop Off Trash (includes those that have drop-off and curbside)	**593,063**	**322,621**	**23,014**	**10,610**	**47,622**	**15,402**	**13,342**	**2,805**	**677,041**	**351,438**	**1,028,479**
Percent of Households With Drop Off Trash (includes those that have drop-off and curbside)	**60%**	**68%**	**58%**	**54%**	**80%**	**81%**	**43%**	**42%**	**60%**	**67%**	**63%**

Table 5: Active Service for Recycling in Colorado Municipalities

	Front Range		Mountains		Western Slope		Eastern Plains		Total		
	Single-family	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Total**
Number of Households Within Municipalities	**989,406**	**477,518**	**39,745**	**19,743**	**58,220**	**18,984**	**31,004**	**6,683**	**1,119,375**	**522,927**	**1,642,302**
Number of Households With Curbside Recycling	**698,861**	**294,647**	**20,034**	**13,443**	**41,055**	**5,335**	**5,451**	**1,202**	**765,402**	**314,626**	**1,080,028**
Percent of Households With Curbside Recycling	**71%**	**62%**	**50%**	**68%**	**69%**	**28%**	**18%**	**18%**	**68%**	**60%**	**66%**
Number of Households With Drop Off Recycling	**779,738**	**409,877**	**24,868**	**14,299**	**43,365**	**14,795**	**15,196**	**3,589**	**863,166**	**442,560**	**1,305,727**
Percent of Households With Drop Off Recycling	**79%**	**86%**	**63%**	**72%**	**73%**	**78%**	**49%**	**54%**	**77%**	**85%**	**80%**

Table 6: Expected Improvements in Curbside Recycling Based on Trash Equivalency

	Front Range		Mountains		Western Slope		Eastern Plains		Total		
	Single-family	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Single-family**	**Multi-family**	**Total**
Expected Number of Households to Get Curbside Recycling Who Currently Do Not Have it	**273,750**	**178,021**	**14,715**	**5,400**	**14,838**	**13,179**	**6,496**	**1,202**	**309,799**	**197,802**	**507,601**
Percent of Households to Get Curbside Recycling Who Currently Do Not Have it	**28%**	**37%**	**37%**	**27%**	**25%**	**69%**	**21%**	**18%**	**28%**	**38%**	**31%**

The table below shows the typical recycling collection method in Colorado municipalities. Of municipalities with curbside service, single-stream recycling is the most common collection method, followed by dual-stream with glass separated from other materials.[7] Multi-stream is the least common recycling collection method; the number of streams varies by municipality[8]. Approximately two-thirds of the municipality population live in municipalities that provide single-stream recycling.

Table 7: Typical Curbside Recycling Collection Method in Colorado (Percent of municipalities by region)

	Front Range	Mountains	Western Slope	Eastern Plains	Total
Single Stream	**49%**	**42%**	**26%**	**2%**	**87**
Dual Stream - Fiber and Containers	**0**	**3%**	**0**	**0**	**2**
Dual Stream - Glass and all other material	**0**	**4%**	**12%**	**2%**	**9**
Multi Stream	**1%**	**1%**	**2%**	**0**	**3**
Curbside service but unknown how it is collected	**37%**	**10%**	**14%**	**7%**	**52**
No curbside service	**13%**	**39%**	**45%**	**89%**	**119**

The most common frequency for collection was biweekly (every other week), with the second most common collection frequency being weekly. The cost of recycling services is summarized in Table 8 and Table 9. The cost of services ranges significantly from a low of $5 per household per month to more than $80 per household per month when bundled with waste collection. Overall costs were reportedly higher in the Mountains as compared to other regions, as distances traveled by collections vehicles tend to be longer, little opportunity for economies of scale, and overall higher cost of living. There were limited data points collected from the Eastern Plains, and results are less robust than in other regions.

[7] In single stream collection, recyclables are collected in a single container (no source separation is required). In a dual stream with glass separated, recyclables are collected in two containers, one for glass, and one for paper, metals, and multiple grades of plastic.

[8] In multi-stream collection, recyclables are collected in more than two containers.

Table 8: Monthly Household Cost of Curbside Recycling When Priced Individually

	Minimum ($)	95% Confidence Interval (Lower)	Mean ($)	95% Confidence Interval (Upper)	Maximum ($)
Front Range	**5**	**5**	**12**	**21**	**22**
Mountains	**22**	**22**	**39**	**65**	**69**
Westerns Slope	**10**	**10**	**17**	**31**	**34**
Eastern Plains	**7**	**7**	**12**	**24**	**25**

Table 9: Monthly Household Cost of Curbside Recycling When Bundled with Waste

	Minimum ($)	95% Confidence Interval (Lower)	Mean ($)	95% Confidence Interval (Upper)	Maximum ($)
Front Range	**12**	**13**	**21**	**34**	**35**
Mountains	**28**	**30**	**57**	**79**	**83**
Westerns Slope	**17**	**17**	**26**	**41**	**42**
Eastern Plains	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

1.4.2 CDP and Rural Area Findings

There are more than 200 census-designated places (CDPs) in Colorado that include many of the unincorporated areas in the state. Waste and recycling services are typically provided by Homeowners Associations (HOAs), as there are not active municipal governments. In Colorado, there are more than 8,000 HOAs, with 659 located in CDPs. Based on research, HOAs individually contract to provide waste and recycling services and do not provide public-facing information in a similar way to municipal governments. Details on HOA websites can only be accessed through a residential login. It is likely that many of these areas have waste and recycling similar to municipalities of the same size. Some CDPs, such as Highlands Ranch (Denver suburb), have over 100,000 people and have curbside recycling services, while many CDPs only have a few hundred people and likely do not have curbside recycling. It is likely that waste and recycling services in CDPs are provided in similar ways to municipalities.

Little information can be found on services to rural areas. According to informal interviews, some areas may have curbside recycling while a greater share has curbside waste collection. Based on satellite housing data, about 70% of the population that resides outside of a municipality or CDP boundaries live in higher-density areas. It is likely that many of these areas have access to curbside trash service and some to curbside recycling.

More details on access to curbside trash and recycling services in CDPs and rural areas, including figures used for scenario modeling, can be found in the Element 13 technical memorandum.

1.5 SCENARIO DEVELOPMENT IMPACT

Initial considerations from this memo for the future state scenario modeling are:

- **Curbside Access**:
  - Ninety-seven (97%) of households in municipalities have curbside access to trash. Approximately 500,000 additional households will receive curbside recycling in municipalities, and an additional 100,000 - 200,000 households will receive service in other areas.
  - The region whose household access to recycling would increase greatest would be the Eastern Plains, where currently only 18% of single-family and multi-family households in municipalities receive services and this would increase to approximately 40%.
  - Multi-family properties typically have the lowest levels of access, ranging from 18% in the Eastern Plains to 68% in the Mountains. The higher rate in the Mountains is likely due to services to accommodate multi-family complexes in resort communities. The Mountains also have a large number of HOAs, which will likely increase the modeled rate under the current state assessment.
- **Service Type**:
  - Currently, the majority of curbside recycling services are single-stream, and at least 44% of households will potentially be eligible for curbside service within the Producer Responsibility program plan. Therefore, there is the opportunity to consider in service expansion areas that single stream may be the most efficient and effective mechanism when considering future service costs as well as performance, considering the future minimum recyclables list.

2 FRONT RANGE

The Front Range has 92 municipalities and a population of 4.8 million. It is the most populous region of Colorado and home to its largest cities, such as Denver, Aurora, Colorado Springs, and Fort Collins.

2.1 ACCESS TO SERVICES

In the Front Range, 99% of municipal households have active service for curbside trash collection (**Table 10**). Furthermore, 62% of municipal households have access to trash drop-off locations (**Table 11)**. The lower access to drop-off locations is likely due to the widespread availability of curbside collection for residents.

Sixty-eight percent of municipal residents in the Front Range have active curbside recycling collection (**Table 12)**. This proportion is higher for residents in single-family households (71% have active curbside services) than multi-family households (62% have active curbside services). This is likely because multi-family buildings with eight units or more are typically categorized as commercial buildings for waste and recycling services. Multi-family buildings eight units and above subscribe to commercial recycling collection, which may lead to lower participation rates and, consequently, lower access for residents of multi-family buildings. Single-family and multi-family households have similar access to drop-off recycling facilities. Note that the total number of households does not include mobile homes, boats, RVs, vans, etc. While the services provided to these entities were not researched for Element 1, estimates were used to incorporate these entities in the **Element 13** modeling.

Table 10: Households Within Municipalities with Active Service for Curbside Trash

	Single-family Households	Multi-family Households	Total Households
Total Households	**989,406**	**477,518**	**1,466,924**
Households with Curbside Service	**972,611**	**472,669**	**1,445,280**
Percent With Curbside Service	**98%**	**99%**	**99%**

Table 11 shows that 62% of municipal residents also have active services for drop-off trash.

Table 11: Households Within Municipalities with Active Service for Drop-Off Trash

	Single-family Households	Multi-family Households	Total Households
Total Households	**989,406**	**477,518**	**1,466,924**
Households with Drop Off Access	**593,063**	**322,621**	**915,684**
Percent With Drop-Off Access	**60%**	**68%**	**62%**

Table 12 shows that 71% of single-family households have active curbside recycling services, and 62% of multi-family households have active curbside recycling services.

Table 12: Households Within Municipalities with Active Service for Curbside Recycling

	Single-family Households	Multi-family Households	Total Households
Total Households	**989,406**	**477,518**	**1,466,924**
Households with Curbside Service	**698,861**	**294,647**	**993,508**
Percent With Curbside Service	**71%**	**62%**	**68%**

Table 13 shows that 81% of municipal residents in the Front Range have active service for recycling drop-off.

Table 13: Households Within Municipalities with Active Service for Drop-Off Recycling

	Single-family Households	Multi-family Households	Total Households
Total Households	**989,406**	**477,518**	**1,466,924**
Households with Drop Off Access	**779,738**	**409,877**	**1,189,615**
Percent With Drop-Off Access	**79%**	**86%**	**81%**

Of the Front Range municipalities, 12 require residents of single-family households to recycle, 7 require residents of multi-family households under eight units to recycle, and 5 require commercial entities and multi-family buildings above eight units to recycle (**Table 14**).

Table 14: Legal Requirements for Residential Recycling in the Front Range

	Number of Municipalities	Population Percentage
Legal Requirement	**14**	**39%**
Legal Requirement – Residential SF	**12**	
Legal Requirement – Residential MF	**7**	
Legal Requirement – Commercial MF	**5**	
No Legal Requirement	**25**	**38%**
Did Not Answer Question	**4**	**6%**
Did Not Answer Survey	**49**	**16%**

Ninety-eight percent of the population in Front Range municipalities live in municipalities with access to either curbside recycling or both curbside and drop-off recycling (**Table 15**). This does not mean all households sign up for the service but that they live in an area where they could if desired.

Table 15: Access to Curbside and Drop-Off Recycling in the Front Range

	Number of Municipalities	Population of Municipalities
Curbside Only	**56**	**18%**
Drop Off Only	**2**	**0.01%**
Both	**24**	**80%**
No service	**10**	**2%**

Only 2% of municipal residents do not have trash services in the Front Range. Moreover, less than 1% only have drop-offs for trash. Therefore, 98% of the population in Front Range municipalities also has access to either curbside trash or both curbside and drop-off trash (**Table 16**).

Table 16: Access to Curbside and Drop Off Trash Service in the Front Range

	Number of Municipalities	Population Percentage
Curbside Only	**34**	**36%**
Drop Off Only	**2**	**0.04%**
Both	**41**	**62%**
No service	**7**	**2%**
Unknown	**8**	**0.3%**

Twenty-four municipalities (representing 31% of the population) in the Front Range have universal curbside recycling for single-family residents, which means that households automatically receive or are required to sign up for recycling collection (**Table 17**). However, only five municipalities (representing 28% of the population) have universal curbside recycling for multi-family residents (**Table 18**). There are significantly fewer municipalities with universal recycling for multi-family households than there are for single-family households.

Fifty-five municipalities (representing 61% of the population) have subscription curbside recycling for single-family residents, requiring households to opt-in to curbside recycling collection (**Table 17**). Twenty-six municipalities (representing 38% of the population) have subscription curbside recycling for multi-family residents (**Table 18)**.

Table 17: Typical Participation Method of Single-Family Curbside Recycling in the Front Range

	Number of Municipalities	Population Percentage
Universal	**24**	**31%**
Subscription	**55**	**61%**
No service	**12**	**2%**
Unknown	**1**	**0.01%**

Table 18: Typical Participation Method of Multi-family Curbside Recycling in the Front Range

	Number of Municipalities	Population Percentage
Universal	**5**	**28%**
Subscription	**26**	**38%**
No service	**12**	**2%**
Unknown	**49**	**32%**

2.2 SERVICE DELIVERY

2.2.1 Curbside

Approximately 60% of municipal residents in the Front Range are serviced by open market haulers, meaning they choose which company to subscribe to for curbside recycling collection (T**able 19**). Twenty-four municipalities (representing 10% of municipal Front Range residents) have a single contracted hauler, meaning a municipality awards a contract to a hauler who will provide residential curbside recycling (**Table 19**). Only five municipalities directly have their own hauling services for curbside recycling collection, primarily in larger cities, representing 28% of the Front Range population (**Table 19**).

Table 19: Typical Contracting Method for Curbside Recycling in the Front Range

	Number of Municipalities	Population Percentage
Municipal Delivered	**5**	**28%**
Municipal contracted to third-party service provider (no household choice of service provider)	**24**	**10%**
Household subscription (municipal approved list of service providers only)	**0**	**0%**
Household subscription (open market of service providers)	**50**	**60%**
No service	**12**	**2%**
Unknown	**1**	**0.01%**

Single-stream recycling is the most prevalent method of collection, used in 45 municipalities for 75% of the regional population (**Table 20**).

Table 20: Typical Curbside Recycling Collection Method in the Front Range

	Number of Municipalities	Population Percentage
Single Stream	**45**	**75%**
Dual Stream - Fiber and Containers	**0**	**0%**
Dual Stream - Glass and all other material	**0**	**0%**
Multi-Stream	**1**	**0.2%**
Curbside service but unknown how it's collected	**34**	**23%**
No curbside service	**12**	**2%**

Of the single-family municipal residents in the Front Range, 65% benefit from either weekly or biweekly curbside recycling collection; 40 municipalities collect every other week, and six municipalities have weekly collection (**Table 21**).

Table 21: Typical Collection Frequency of Curbside Recycling for Single-family in the Front Range

	Number of Municipalities	Population Percentage
Twice a week or more	**1**	**0.001%**
Weekly	**6**	**25%**
Biweekly	**40**	**40%**
Monthly	**0**	**0%**
Unknown	**33**	**34%**
No service	**12**	**2%**

Weekly curbside trash collection is available to single-family households in 50 municipalities, representing 69% of municipal residents in the Front Range (**Table 22**).

Table 22: Typical Collection Frequency of Curbside Trash for Single-family in the Front Range

	Number of Municipalities	Population Percentage
Twice a week or more	**0**	**0%**
Weekly	**50**	**69%**
Biweekly	**0**	**0%**
No service	**9**	**2%**
Unknown	**33**	**30%**

In 38 municipalities with curbside recycling for single-family households, residents use carts to store their recyclable waste for pickup (**Table 23**). Nineteen of these municipalities use 96-gallon recycling carts (**Table 24**).

Table 23: Typical Containers Used for Single-family Curbside Recycling in the Front Range

	Number of Municipalities	Population Percentage
Carts	**38**	**64%**
Dumpsters	**0**	**0%**
Roll-off container	**0**	**0%**
Carts, Dumpsters	**7**	**11%**
Carts, Roll off containers	**1**	**1%**
Dumpsters, Roll off containers	**1**	**1%**
All Container Types	**1**	**3%**
Unknown	**32**	**20%**
No service	**12**	**2%**

Table 24: Typical Dimensions for Recycling Carts in the Front Range

	Number of Municipalities	Population Percentage
95 gallon	**5**	**21%**
96 gallon	**19**	**13%**
Multiple	**5**	**8%**
Unknown	**50**	**56%**
No carts	**1**	**1%**
No service	**12**	**2%**

Materials Collected

The most common materials accepted for curbside recycling in the Front Range are high-grade fiber (clean office paper, newsprint, and paperboard), aluminum, clear or transparent colored PET, and glass. The least commonly collected materials in the Front Range are plastic film, pallet wrap, wood containers, pressurized cylinders, and PLA/PHA. Table 100 provides an estimate of the percent of municipalities that collect materials for recycling through curbside collection.

2.2.2 Drop off

The most common materials accepted for recycling drop-off in the Front Range are high-grade fiber (clean office paper, newsprint, paperboard, and corrugated cardboard), aluminum, PET, and glass.

Nine municipalities, accounting for 50% of the population, have single-stream sorting at drop-off locations (**Table 25**).

Table 25: Typical Sorting Requirements at Drop Off Sites in the Front Range

	Number of Municipalities	Population Percentage
Single Stream	**9**	**50%**
Dual Stream - Fiber and Containers	**1**	**2%**
Dual Stream - Glass and all other material	**0**	**0%**
Multi-Stream	**1**	**2%**
Cardboard Only	**0**	**0%**
No service	**66**	**20%**
Unknown	**15**	**26%**

Seven municipalities, representing 28% of the Front Range population, provide access to drop-offs exclusively to their own residents (**Table 26**). Two small municipalities grant access to county residents (**Table 26)**. Furthermore, eight municipalities, making up 29% of the population, extend access to both residents and non-residents (**Table 26**).

Table 26: Access to Drop-Off Sites by Waste Generator in the Front Range

	Number of Municipalities	Population Percentage
Municipality Residents	**7**	**28%**
County Residents	**2**	**13%**
Residents and Non-Residents	**8**	**29%**
No service	**66**	**20%**
Unknown	**9**	**10%**

2.3 PERFORMANCE AND COST

Seventeen Front Range municipalities reported that 177,404 tons of recycling was collected from households through curbside services (**Table 27**). The 17 municipalities cover 46% of the municipal population of the Front Range and 36% of the entire population of the Front Range.

Table 27: Reported Levels of Curbside Performance in the Front Range

Municipalities within the Region	**92**
Number of municipalities that reported curbside recycling tonnages	**17**
Tons of curbside recycling collected (reported)	**177,404 tons**

Twelve Front Range municipalities reported that 55,565 tons of recycling was collected from drop-offs (Table 28). The 12 municipalities cover 40% of the municipal population of the Front Range and 31% of the entire population of the Front Range.

Table 28: Reported Levels of Drop-Off Performance in the Front Range

Municipalities within the Region	**92**
Number of municipalities that reported drop off recycling tonnages	**12**
Tons of drop-off recycling collected (reported)	**55,565 tons**

The most common payment method for curbside trash and recycling collection is a subscription (**Table 29**). A growing number of municipalities have adopted pay-as-you-throw (PAYT), where residents are charged for the disposal of their trash based on the amount they generate, encouraging waste reduction, recycling, and composting.

Table 29: Payment for Curbside Trash in the Front Range

	Number of Municipalities	Population Percentage
PAYT	**11**	**34%**
Utility Bill	**6**	**1%**
Property Tax	**4**	**6%**
Subscription	**41**	**43%**
No Service	**9**	**2%**
Not Sure	**21**	**14%**

Table 30: Payment for Curbside Recycling in the Front Range

	Number of Municipalities	Population Percentage
PAYT	**8**	**30%**
Utility Bill	**5**	**4%**
Property Tax	**6**	**3%**
Subscription	**32**	**46%**
No Service	**12**	**2%**
Not Sure	**29**	**15%**

In the survey, municipalities reported recycling contamination levels ranging from 5% to 20% for single-family buildings, while contamination levels increased to 20% to 30% in commercial multi-family buildings and 20% to 40% in residential multifamily buildings (**Table 31**).

Table 31: Reported Recycling Contamination Levels in the Front Range

	Minimum Reported Recycling Contamination	Maximum Reported Recycling Contamination
Residential Single-family	**5%**	**20%**
Residential Multifamily	**20%**	**40%**
Commercial Multifamily	**20%**	**30%**

2.4 ADDITIONAL INFORMATION

2.4.1 Voluntary Programs

- Fort Collins provides litter pickup and collection of trash and recycling bins in the downtown area, funded by the Downtown Development Authority. While this service is limited to the downtown area, most public trash and recycling bins are located in parks or natural areas.
- Many municipalities highlighted the hurdles of placing recycling bins in public areas. For instance, Centennial previously offered recycling services at its park. Unfortunately, due to issues with contamination, the recycling bins were removed.

- Some municipalities organize recycling events aimed at tackling hard-to-recycle items like paint and expanded polystyrene, typically occurring once or twice a year. This is the case for the Town of Erie, which holds biannual Clean Up Day events.
- There are various retail flexible film drop-off sites in Colorado many of which are located in the Front Range. These include Albertsons City Market, Individual Dynamics, King Soopers, Kohl's, Safeway, Sprouts Farmers Market, and Whole Foods.[9]

2.4.2 Special Considerations

- In municipalities with an open market hauler system for collection, it can be challenging to determine the services offered to residents by private waste management companies. This is further complicated by the fact that some private companies declined to provide information regarding their services.
- In municipalities with large university student populations, extra collection may be necessary around move-in and move-out days as the amount of packaging increases during these events. In Boulder, specific student-inhabited areas of the city have an additional trash requirement during move-in and move-out time periods in the spring and fall. This "6-Day Review" regulation aims to reduce unwanted materials overflow and illegal dumping during these periods. Property owners in these areas are required to subscribe to six days per week of trash and recycling collection for a specified number of days in the second and third quarters, incurring the cost themselves.

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[9] /https://nextrex.com/jsfapp/cdocs/20231201223810_9_jsfwd_493_q2_1.pdf

3 MOUNTAINS

The Mountains region of Colorado is home to the continental divide, a mostly continuous north/south running ridge of mountains that delineates waste sheds, or how materials like recyclables, travel within the state. This area has remote locations, often with steep roads or driveways, that are difficult to reach. There are many mountain passes, and much of this region sees extreme weather, which can hinder the flow of materials. Given these constraints, waste handling in this region can be challenging.

Mountain communities often include seasonal residences that may be empty for a portion of the year. Tourism is high in resort areas of the Mountains region, leading to seasonal fluctuations in their population, which can more than double during the busy summer and winter months. The resort areas tend to have a higher transient population, with employees moving in for a season and leaving once a resort closes. The transient population, along with the seasonal influx of tourists, presents unique challenges to ensuring that waste materials are properly managed.

3.1 ACCESS TO SERVICES

While other regions have more than twice as many single-family households as multifamily households, the Mountains region has a more equal distribution of single-family to multi-family. This is likely because Colorado's mountain communities are tourist destinations, so they have a large number of condominium-type rental units. Housing tends to be more expensive in resort communities, while single-family homes are more expensive to build.

In the Mountains region, 90% of total households have active service for curbside trash (Table 32). Multi-family households have a higher proportion of active service for curbside trash (95%) than single-family households (87%). The lower percentage of single-family households with active service for curbside trash could be indicative of remote mountain communities that mostly have single-family houses not serviced by a trash hauler. Note that the total number of households does not include mobile homes, boats, RVs, vans, etc. While the services provided to these entities were not researched for **Element 1**, estimates were used to incorporate these entities in the **Element 13** modeling.

Table 32: Households Within Municipalities Active Service for Curbside Trash in Mountains

	Single-family Households	Multi-family Households	Total Households
Total Households	**39,745**	**19,743**	**59,488**
Households with Curbside Service	**34,749**	**18,843**	**53,592**

Percent With Curbside Service	**87%**	**95%**	**90%**

Access to drop-off locations for trash in the mountains is less common than curbside service for trash. Of the 59,4888 total households in the Mountains region, only 33,624 have active trash drop-off services, representing 57% of total households (**Table 33**). Trash drop-offs are often located at landfills or transfer stations, which are rarely sited within municipalities.

Table 33: Households Within Municipalities Active Service for Drop Off Trash in Mountains

	Single-family Households	Multi-family Households	Total Households
Total Households	**39,745**	**19,743**	**59,488**
Households with Drop Off Access	**23,014**	**10,610**	**33,624**
Percent With Drop-Off Access	**58%**	**54%**	**57%**

Fifty-six percent of Mountains region households have active curbside recycling services, which is below the 90% of Mountains households with active curbside trash services (**Table 32** and **Table 34)**

Table 34: Households Within Municipalities Active Service for Curbside Recycling in Mountains

	Single-family Households	Multi-family Households	Total Households
Total Households	**39,745**	**19,743**	**59,488**
Households with Curbside Service	**20,034**	**13,443**	**33,477**
Percent With Curbside Service	**50%**	**68%**	**56%**

Drop-off is often how Mountain communities first start recycling programs. Sixty-six percent of households have active drop-off recycling services (**Table 35**).

Table 35: Households Within Municipalities Active Service for Drop-Off Recycling in Mountains

	Single-family Households	Multi-family Households	Total Households
Total Households	**39,745**	**19,743**	**59,488**

Households with Drop Off Access	**24,868**	**14,299**	**39,167**
Percent With Drop-Off Access	**63%**	**72%**	**66%**

Of the Mountains municipalities that completed the survey, nine report having legal requirements for residential recycling (**Table 36**). Seven also report having legal requirements for residential single-family and residential multifamily, while only six municipalities have legal requirements for commercial multifamily (**Table 36**). Twenty-one municipalities reported no legal requirements, eight did not answer the question, and 33 municipalities did not take the survey (**Table 36**).

Table 36: Legal Requirements for Residential Recycling in Mountains

	Number of Municipalities	Population Percentage
Legal Requirement	**9**	**27%**
Legal Requirement - Residential SF	**7**	
Legal Requirement - Residential MF	**7**	
Legal Requirement - Commercial MF	**6**	
No Legal Requirement	**21**	**29%**
Did Not Answer Question	**8**	**6%**
Did Not Answer Survey	**33**	**38%**

The majority of the population in mountain municipalities, 93%, have access to some form of recycling (Table 37). Twenty-two of the Mountains municipalities, representing 26% of the municipal population, have access to curbside recycling (**Table 37**). Only 21 municipalities representing 54% of the Mountains area population have access to both curbside and drop-off recycling (Table 37). Moreover, only ten municipalities have drop-off recycling, and 18 municipalities have no recycling service at all, representing 19% of the mountain municipality population (**Table 37**).

Table 37: Access to Curbside and Drop-Off Recycling in Mountains

	Number of Municipalities	Population of Municipalities
Curbside Only	**22**	**26%**
Drop Off Only	**10**	**12%**
Both	**21**	**54%**
No service	**18**	**7%**

Access to trash service in the mountain region is widespread, with 92% of the municipality population reporting access, while only 8% of the population had either no access or their status was unknown **(Table 38**).

Table 38: Access to Curbside and Drop-Off Trash Service in Mountains

	Number of Municipalities	Population Percentage
Curbside Only	**15**	**34%**
Drop Off Only	**3**	**2%**
Both	**33**	**55%**
No service	**16**	**7%**
Unknown	**4**	**1%**

Subscription service is the primary method of single-family curbside recycling in the Mountains, serving 69% of municipalities' populations **(Table 39**). Eight municipalities, representing 11% of the population, have universal recycling. Twenty-eight municipalities have no service (**Table 39).**

Table 39: Typical Participation Method of Single-family Curbside Recycling in Mountains

	Number of Municipalities	Population Percentage
Universal	**8**	**11%**
Subscription	**34**	**69%**
No service	**28**	**19%**
Unknown	**1**	**1%**

Twenty-six Mountain municipalities have universal or subscription recycling for multi-family households (Table 40). Seventeen municipalities' method of multifamily curbside participation is unknown, representing 21% of the population (**Table 40**). Twenty-eight municipalities representing 19% of the mountain municipal population report having no recycling service for multi-family units (**Table 40**).

Table 40: Typical Participation Method of Multi-family Curbside Recycling in Mountains

	Number of Municipalities	Population Percentage
Universal	**10**	**33%**
Subscription	**16**	**28%**

No service	**28**	**19%**
Unknown	**17**	**21%**

3.2 SERVICE DELIVERY

3.2.1 Curbside

Most municipalities in the Mountains region (33 municipalities, 69% by population) have the option of choosing their curbside recycling service provider (**Table 41**). Nine municipalities, representing 11% of the Mountains municipality population, have municipal contracted or delivered recycling services (**Table 41)**. Twenty-nine municipalities' contracting method is either unknown, or there is no service (**Table 41**). These municipalities represent 20% of the municipality population in the Mountains region (**Table 41**).

Table 41: Typical Contracting Method for Curbside Recycling in Mountains

	Number of Municipalities	Population Percentage
Municipal Delivered	**2**	**6%**
Municipal contracted to third-party service provider (no household choice of service provider)	**7**	**5%**
Household subscription (municipal approved list of service providers only)	**8**	**27%**
Household subscription (open market of service providers)	**25**	**42%**
No service	**28**	**19%**
Unknown	**1**	**1%**

Single stream is the most prevalent collection method in the Mountains region, employed in 30 municipalities representing 62% by population (Table 42). This is followed by a dual stream with glass separate from all other materials in three municipalities (**Table 42**). Two municipalities employ dual stream with fiber separate from containers (**Table 42**). The remaining 35 municipalities were either unknown or had no curbside recycling service (**Table 42**).

Table 42: Typical Curbside Recycling Collection Method in Mountains

	Number of Municipalities	Population Percentage
Single Stream	**30**	**62%**
Dual Stream - Fiber and Containers	**2**	**2%**
Dual Stream - Glass and all other material	**3**	**9%**
Multi-Stream	**1**	**4%**
Curbside service but unknown how it's collected	**7**	**5%**
No curbside service	**28**	**19%**

Twenty-three municipalities in the Mountains region receive biweekly pickup of recycling materials at single-family homes (**Table 43**). Nine municipalities have weekly pickup service for recyclables at single-family homes. Only one municipality has pickup more than once a week. For 38 municipalities, it is unclear how often, or whether, recycling is picked up at single-family homes.

Table 43: Typical Collection Frequency of Curbside Recycling for Single-family in Mountains

	Number of Municipalities	Population Percentage
Twice a week or more	**1**	**5%**
Weekly	**9**	**13%**
Biweekly	**23**	**53%**
Monthly	**0**	**0%**
Unknown	**10**	**11%**
No service	**28**	**19%**

The majority of curbside trash pickup in mountain municipalities is serviced weekly (in 35 municipalities), followed by biweekly (two municipalities), then twice or more per week (one municipality). For 33 municipalities, trash pickup frequency is unknown, or there is no service (**Table 44**).

Table 44: Typical Collection Frequency of Curbside Trash for Single-family in Mountains

	Number of Municipalities	Population of Municipalities
Twice a week or more	**1**	**5%**
Weekly	**35**	**66%**
Biweekly	**2**	**2%**
No service	**19**	**9%**
Unknown	**14**	**18%**

Twenty-three municipalities in the Mountains region collect single-family curbside recyclables in carts (**Table 45**). The container type for many municipalities in the Mountains region (47) is unknown.

Table 45: Typical Containers Used for Single-family Curbside Recycling in Mountains

	Number of Municipalities	Population of Municipalities
Bags	**0**	**0%**
Carts	**23**	**50%**
Dumpsters	**0**	**0%**
Roll-off Container	**0**	**0%**
Carts, Dumpsters	**1**	**5%**
All Container Types	**0**	**0%**
Not applicable/No service	**19**	**27%**
Not sure/Unknown	**28**	**19%**

The most common size of recycling carts in mountain region municipalities is 96 gallons, followed by 90 gallons, 32 gallons, and 18 gallons (**Table 46**). However, it is unclear what size recycling carts are used in the majority of municipalities (29).

Table 46: Typical Dimensions for Recycling Carts in Mountains

	Number of Municipalities	Population of Municipalities
18-gallon	**1**	**1%**
90-gallon	**1**	**2%**
96-gallon	**6**	**15%**
Multiple	**12**	**31%**
Unknown	**22**	**32%**
No carts	**0**	**0%**
No service	**28**	**19%**

Common Curbside Accepted Covered Materials in Mountains

The five **most** commonly accepted materials in curbside recycling in the mountain region are:

1. Paperboard boxes and packaging
2. High-grade office paper (uncoated)
3. Newspaper and newsprint
4. Low-grade printing and writing paper (i.e., bulk mail, envelopes, notebooks, and cards)
5. Aluminum beverage containers

The five **least** commonly accepted materials in curbside recycling in the mountain region are:

1. Wood containers
2. Rubber packaging
3. Pressurized cylinders (not including aerosols) (i.e., propane tanks, CO2 cylinders)
4. Pesticide and paint containers
5. Pallet wrap and PVC film (i.e., linen packaging, labels)

Table 100 provides an estimate of the percent of municipalities that collect materials for recycling through curbside collection.

3.2.2 Drop Off

Common Drop-Off Accepted Covered Materials in Mountains

The five **most** commonly accepted materials in drop-off recycling in the mountain region are:

1. Newspaper and newsprint, magazines, and other coated paper (i.e. catalogs)

2. Aluminum beverage and food containers
3. High and low-grade office paper (uncoated)
4. Paperboard boxes and packaging and corrugated containers (except wax-coated)
5. Low-grade printing and writing paper (i.e., bulk mail, envelopes, notebooks, and cards)

The five **least** commonly accepted materials in drop-off recycling in the mountain region are:

1. Antifreeze, pesticide, solvent, paint, and motor oil containers
2. Pressurized cylinders (not including aerosols) (i.e., propane tanks, CO2 cylinders)
3. Wood containers
4. Textile packaging and rubber packaging
5. PET film and PVC film (i.e., linen packaging, labels)

Drop-off sites in Mountains municipalities are mostly single-stream (30 municipalities). Dual stream drop-off sites with glass separate from other materials are found in three municipalities and cardboard-only drop-offs are reported in two municipalities. Twenty-eight municipalities report no drop-off service, while seven municipalities are unknown (**Table 47**).

Table 47: Typical Sorting Requirements at Drop-Off Sites in Mountains

	Number of Municipalities	Population Percentage
Single Stream	**30**	**62%**
Dual Stream – Fiber and Containers	**2**	**2%**
Dual Stream – Glass and all other materials	**3**	**9%**
Multi-Stream	**1**	**4%**
Unknown	**7**	**5%**
No service	**28**	**19%**

Seventeen drop-off sites in the Mountain region are accessible to both residents and non-residents (**Table 48).** Some municipalities' drop-off sites are restricted, allowing use by county residents only (10) or only municipality residents (three). Most mountain municipalities (40) have no drop-off sites.

Table 48: Access to Drop-Off Sites by Waste Generator in Mountains

	Number of Municipalities	Population Percentage
Municipality Residents	**3**	**4%**
County Residents	**10**	**21%**
Residents and Non-Residents	**17**	**36%**
No service	**35**	**24%**
Unknown	**6**	**16%**

3.3 PERFORMANCE AND COST

Only four Mountains municipalities provided data on the amount of recycling collected by curbside services and only three municipalities reported the amount of recycling collected via drop-off. Four municipalities, representing 15% of the municipal population in the Mountains region, reported collecting 10,897 tons of recycling from curbside collection (T**able 49**). Three municipalities, representing 14% of the municipal population in the Mountains region, reported collecting 984 tons of recycling from drop-off services (**Table 50**).

Table 49: Reported Levels of Curbside Performance in Mountains

Municipalities within the Region	**71**
Number of municipalities that reported curbside recycling tonnages	**4**
Tons of curbside recycling collected (reported)	**10,897 tons**

Table 50: Reported Levels of Drop-Off Performance in Mountains

Municipalities within the Region	**71**
Number of municipalities that reported drop off recycling tonnages	**3**
Tons of drop-off recycling collected (reported)	**984 tons**

Curbside services for both trash and recycling in the mountain region is primarily subscription-based (**Table 51** and **Table 52)**. Utility bills are the second most common form of payment for services, followed by pay as you throw (PAYT). Some municipalities still have no curbside service for trash (19), while many have no curbside service for recycling (28). Payment methods are not known in 17 municipalities for curbside trash and eight municipalities for curbside recycling.

Table 51: Payment for Curbside Trash in Mountains

	Number of Municipalities	Population Percentage
PAYT	**2**	**8%**
Utility Bill	**8**	**20%**
Property Tax	**0**	**0%**
Subscription	**25**	**49%**
No Service	**19**	**9%**
Unknown	**17**	**14%**

Table 52: Payment for Curbside Recycling in Mountains

	Number of Municipalities	Population Percentage
PAYT	**3**	**9%**
Utility Bill	**7**	**14%**
Property Tax	**1**	**1%**
Subscription	**24**	**52%**
No Service	**28**	**19%**
Unknown	**8**	**5%**

Recycling contamination reported in the mountain region ranges from 15% to 25% (**Table 53)**. Multifamily recycling reports higher levels of contamination, five percent more, than single-family recycling. Several mountain communities' waste ordinances allow loads with greater than 25% contamination to be landfilled, so this may be why contamination rates consistently max out at 25%.

Table 53: Reported Recycling Contamination Levels in Mountains

	Minimum Reported Recycling Contamination	Maximum Reported Recycling Contamination
Residential Single-family	**15%**	**20%**
Residential Multifamily	**20%**	**25%**
Commercial Multifamily	**20%**	**25%**

3.4 ADDITIONAL INFORMATION

3.4.1 Voluntary Programs

Voluntary programs in mountain communities are plentiful and varied. See below for some examples outlined in the municipal surveys,

- Walmart and City Market (grocery stores) are common drop-off locations for plastic films, bags, and wraps.
- Frisco and Dillon marinas partner to collect plastic film from boats and transport the material to recyclers, which vary from year to year.
- Most mountain municipalities have cleanup days where the community helps pick up trash on roadsides and other common spaces. Some communities try to recycle what they can, while others consider this material trash.
- Many communities report that recycling containers in public spaces are too contaminated to be recycled.
- Events in resort communities are often zero waste, with non-profit or for-profit service providers doing the sorting.

3.4.2 Special Considerations

There are several special considerations for mountain community waste handling, some of which have been mentioned already but are outlined again here.

- Bears are prevalent in mountain communities, so wildlife-resistant carts are often required by municipal ordinances. In many cases, the carts must be Interagency Grizzly Bear Committee (IGBC) certified.
- Mountain municipalities often have ordinances requiring enclosures for all waste containers with specific specifications for the enclosures. Oftentimes, existing enclosures were sized for trash only, and amending the enclosures is a significant expense.
- As previously mentioned, many communities in the mountains are resorts with seasonal implications. This seasonality is accompanied by significant second home ownership, with homes that sit empty for part of the year.
- There are many waste ordinances in the mountains of interest. For instance, Summit County has a designated disposal district and requires that all waste generated in that district be channeled through their county-owned waste and recycling facilities.
- Municipalities report that the haulers have more information because they are the ones providing services, sometimes with little to no input from municipalities.

4 WESTERN SLOPE

The Western Slope of Colorado is located on the western side of the Continental Divide. It is known for its beautiful natural landscapes and its distinct geographical location, which is defined by the Rocky Mountains, which dominate the landscape.

The Western Slope region accounts for almost 38% of Colorado's land but is home to less than 10% of the state's population. It is known for its relatively smaller and more dispersed communities when compared to the state's more densely populated eastern regions. The Western Slope is comprised of 12 counties, 42 municipalities, and several unincorporated areas. The region's counties include Mesa, Delta, Montrose, Garfield, San Miguel, Ouray, La Plata, Dolores, Montezuma, San Juan, Moffat, and Rio Blanco. Each of these counties contributes to the diverse and unique character of the Western Slope.

4.1 ACCESS TO SERVICES

There are 78,203 households in Western Slope municipalities, comprising both single and multi-family households. Out of these, 74,406 households, or 95%, have active curbside trash services (Table 54). This indicates that the vast majority of households in the region, whether they are single-family or multi-family, benefit from curbside trash services. Note that the total number of households does not include mobile homes, boats, RVs, vans, etc. While the services provided to these entities were not researched for Element 1, estimates were used to incorporate these entities into the **Element 13** modeling.

Table 54: Households Within Municipalities with Active Service for Curbside Trash

	Single-family Households	Multi-family Households	Total Households
Total Households	**59,220**	**18,984**	**78,203**
Households with Curbside Service	**55,893**	**18,513**	**74,406**
Percent With Curbside Service	**94%**	**98%**	**95%**

Within the Western slope region, 80% of single-family households and 95% of multi-family households have active drop-off trash services (**Table 55**).

Table 55:Households Within Municipalities with Active Service for Drop Off Trash

	Single-family Households	Multi-family Households	Total Households
Total Households	**59,220**	**18,984**	**78,203**
Households with Drop Off Access	**47,622**	**15,402**	**63,025**
Percent With Drop-Off Access	**80%**	**95%**	**81%**

Fifty-nine percent of total households in Western Slope municipalities have active curbside recycling services **(Table 56**). The availability of curbside recycling is well below that of curbside trash (95%, see Table 54).

Table 56: Households Within Municipalities with Active Service for Curbside Recycling

	Single-family Households	Multi-family Households	Total Households
Total Households	**59,220**	**18,984**	**78,203**
Households with Curbside Service	**41,055**	**5,335**	**46,389**
Percent With Curbside Service	**69%**	**28%**	**59%**

Among households in the Western Slope, 74% of total households have active drop-off recycling services in the municipality (**Table 57**). The data reveals there is a high level of availability for drop-off recycling for both single and multi-family households. However, it should be noted this below data does not take into account the distance between such drop-off facilities and their convenience.

Table 57: Households Within Municipalities with Active Service for Drop-Off Recycling

Recycling - Drop-off	Single-family Households	Multi-family Households	Total Households
Total Households	**59,220**	**18,984**	**78,203**
Households with Drop Off Access	**43,365**	**14,795**	**58,161**
Percent With Drop-Off Access	**73%**	**78%**	**74%**

Table 58 was compiled using the municipality survey data collected. It is noted that legal recycling requirements exist in four municipalities, encompassing 13% of the total

population in those areas. There are legal recycling requirements for residential single-family households in four municipalities, while only three municipalities have legal requirements for residential multi-family households and only two municipalities have requirements for commercial multi-family households. In contrast, 20 municipalities, constituting 65% of the municipal population, have no legal recycling requirements.

Table 58: Legal Requirements for Residential Recycling in the Western Slope

Legal Requirement	Number of Municipalities	Population of Municipalities
Legal Requirement	**4**	**13%**
Legal Requirement - Residential SF	**4**	
Legal Requirement - Residential MF	**3**	
Legal Requirement – Commercial MF	**2**	
No Legal Requirement	**20**	**55%**
Did Not Answer the Question	**0**	**0%**
Did Not Answer Survey	**18**	**32%**

Table 59 categorizes municipalities based on their access to recycling services. Among the municipalities, 11 offer curbside pickup services exclusively while providing drop-off options only. Twelve municipalities, representing 71% of the population, offer both curbside and drop-off services. However, 15 municipalities have no access to recycling services, indicating a lack of formal recycling in those areas.

Table 59: Access to Curbside and Drop-Off Recycling in the Western Slope

	Number of Municipalities	Population of Municipalities
Curbside Only	**11**	**21%**
Drop Off Only	**4**	**1%**
Both	**12**	**71%**
No service	**15**	**7%**

Curbside-only trash services are available in 11 municipalities, serving 16% of the population (Table 60). Four municipalities only provide drop-off trash services. Twenty municipalities provide both drop-off and curbside trash services, representing 79% of the Western Slope municipal population. Four municipalities have no services, and three municipalities have an unknown trash service status.

Table 60: Access to Curbside and Drop Off Trash in the Western Slope

	Number of Municipalities	Population of Municipalities
Curbside Only	**11**	**16%**
Drop Off Only	**4**	**1%**
Both	**20**	**79%**
No service	**4**	**3%**
Unknown	**3**	**0.5%**

Twelve municipalities, representing 38% of the Western Slope municipal population, have universal curbside recycling services for single-family households (**Table 61**). Eleven municipalities, representing 54% of the region's municipal population, have subscription services. In contrast, 19 municipalities have no service, and 1 has an unknown participation method.

Table 61: Typical Participation Method of Single-family Curbside Recycling in the Western Slope

	Number of Municipalities	Population of Municipalities
Universal	**12**	**38%**
Subscription	**11**	**54%**
No service	**19**	**8%**
Unknown	**0**	**0%**

The typical participation method rates of multifamily curbside recycling in the Western Slope differ significantly from the participation method of single families (**Table 61**). Only two municipalities have universal services for multi-family households, while 19 municipalities have no services (**Table 62**). In 11 municipalities, multi-family households can subscribe to curbside recycling services (**Table 62**).

Table 62: Typical Participation Method of Multi-family Curbside Recycling in the Western Slope

	Number of Municipalities	Population of Municipalities
Universal	**2**	**9%**
Subscription	**9**	**25%**
No service	**19**	**8%**
Unknown	**12**	**58%**

4.2 SERVICE DELIVERY

4.2.1 Curbside

As outlined in Table 63, 12 municipalities contract a third-party service provider for curbside recycling. Four municipalities, representing over half of the Western Slope municipal population, directly haul curbside recycling for their residents. Seven municipalities have open-market subscription. Nineteen municipalities do not have any curbside recycling services.

Table 63: Typical Contracting Method for Curbside Recycling in the Western Slope

	Number of Municipalities	Population of Municipalities
Municipal Delivered	**4**	**53%**
Municipal contracted to third-party service provider (no household choice of service provider)	**12**	**27%**
Household subscription (municipal approved list of service providers only)	**0**	**0%**
Household subscription (open market of service providers)	**7**	**13%**
No service	**19**	**8%**
Unknown	**0**	**0%**

Eleven municipalities have single-stream recycling, accounting for 36% of the Western Slope's municipal population (**Table 64**). Five municipalities have dual stream with separate glass, accounting for 43% of the population. One municipality has multi-stream, and six municipalities have curbside recycling but the collection method was unknown.

Table 64: Typical Curbside Recycling Collection Method in the Western Slope

	Number of Municipalities	Population of Municipalities
Single Stream	**11**	**36%**
Dual Stream - Fiber and Containers	**0**	**0%**
Dual Stream - Glass and all other material	**5**	**43%**
Multi-Stream	**1**	**1%**
Curbside service but unknown how it's collected	**6**	**12%**
No curbside service	**19**	**8%**

The collection frequency of curbside recycling for single-family varies between municipalities. Ten municipalities have weekly recycling collection, five municipalities have biweekly recycling collection, and one municipality has a monthly recycling collection (**Table 65)**.

Table 65: Collection Frequency of Curbside Recycling for Single Family in the Western Slope

	Number of Municipalities	Population of Municipalities
Twice a week or more	**0**	**0%**
Weekly	**10**	**25%**
Biweekly	**5**	**45%**
Monthly	**1**	**1%**
Unknown	**7**	**20%**
No service	**19**	**8%**

Twenty-six municipalities, representing 93% of the population, have weekly collection for curbside trash for single-family households (**Table 66**).

Table 66: Typical Collection Frequency of Curbside Trash for Single Family in the Western Slope

	Number of Municipalities	Population of Municipalities
Twice a week or more	**0**	**0%**
Weekly	**26**	**93%**
Biweekly	**0**	**0%**
No service	**8**	**4%**
Unknown	**8**	**3%**

Eleven municipalities have carts for recycling collection for single-family households (**Table 67**). One municipality has no containers, and single-family residents just bag their recyclables for collection (**Table 67**).

Table 67: Typical Containers Used for Single-family Curbside Recycling in the Western Slope

	Number of Municipalities
Bags	**1**
Carts	**11**
Dumpsters	**0**
Roll-off Container	**0**
Carts, Dumpsters	**2**
All Container Types	**1**
No service	**8**
Unknown	**19**

For most Western Slope Municipalities, the recycling cart dimensions are unknown, or there are no recycling services. Three municipalities have 96-gallon carts, and five municipalities have varying cart sizes (**Table 68**).

Table 68: Typical Dimensions for Recycling Carts in the Western Slope

	Number of Municipalities	Population of Municipalities
8-gallon	**1**	**5%**
96-gallon	**3**	**16%**
Multiple	**5**	**10%**
Unknown	**13**	**60%**
No carts	**1**	**1%**
No service	**19**	**8%**

Within the Western Slope, there is a clear pattern of widespread acceptance of specific covered materials. Notable among these are High-Grade Office Paper (uncoated), Newspaper, Newsprint, Paperboard Boxes and Packaging, Molded Pulp Packaging (excluding Food Serviceware such as egg cartons and protective packaging), "Low grade" Printing and Writing Paper (encompassing bulk mail, envelopes, notebooks, and cards), and Aluminum Beverage Containers. These materials are consistently and extensively accepted in the majority of municipalities. Table 100 provides an estimate of the percent of municipalities that collect materials for recycling through curbside collection.

Three of the most common materials not accepted in curbside programs include textile packaging, paint containers and pressurized cylinders (not including aerosols) (e.g., propane tanks, carbon dioxide cylinders). In addition to these, Pallet Wrap, PVC Film (e.g., linen packaging, labels), and PET Film are highly disregarded in curbside collection in the Western Slope.

4.2.2 Drop off

From the survey and secondary research, the most commonly accepted drop-off covered materials are High-Grade Office Paper (uncoated) and Newspaper, Newsprint. Both materials are accepted by 12 municipalities. As well as this, Aluminum Beverage Containers, Clear Glass, and Colored Glass are most frequently accepted in 11 different municipalities in the region, highlighting their importance in local recycling programs.

In stark contrast, there are several covered materials that are not commonly accepted for drop-off in the surveyed/researched areas. These include PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens), Ceramic, Porcelain, Pyrex, and other infusible glass material, Paint Containers, Motor Oil Containers, Solvent Containers, and Pesticide Containers.

Table 69 details the sorting requirements at drop-off sites within the region. The most common sorting requirement is multi-stream, which is present in seven municipalities. Apart from this, there appears to be very limited sorting requirements at drop-off sites in the region. Twenty-six municipalities were recorded as having no services, and six were unknown.

Table 69: Typical Sorting Requirements at Drop Off Sites in the Western Slope

	Number of Municipalities	Population Percentage
Single Stream	**1**	**1%**
Dual Stream - Fiber and Containers	**0**	**0%**
Dual Stream - Glass and all other materials	**2**	**6%**
Multi-Stream	**7**	**51%**
Cardboard Only	**0**	**0%**
No service	**26**	**27%**
Unknown	**6**	**14%**

The data in **Table 70** highlights the type of access each municipality provides to residents, non-residents, and county residents. Four municipalities were found to serve only their resident population. An additional three municipalities extend services to the entire county. The most prevalent approach, aside from no service, involves nine municipalities offering services to both residents and non-residents. There were no municipalities with unknown service status.

Table 70: Table: Access to Drop-Off Sites by Waste Generator in the Western Slope

	Number of Municipalities	Population Percentage
Municipality Residents	**4**	**10%**
County Residents	**3**	**9%**
Residents and Non-Residents	**9**	**54%**
No service	**26**	**27%**
Unknown	**0**	**0%**

4.3 PERFORMANCE AND COST

Only nine Western Slope municipalities, representing 56% of the region's municipal population, reported the amount of recycling collected curbside, and only four reported the amount of recycling collected from drop-off locations, representing 35% of the region's municipal population. Those municipalities reported collecting 7,037 tons of recycling through curbside collection and 1,939 tons via drop-off locations (**Table 71** and **Table 72)**.

Table 71: Reported Levels of Performance: Curbside

Curbside	Recycling Tons
Municipalities within the Region	**42**
Number of municipalities that reported curbside recycling tonnages	**9**
Tons of curbside recycling collected (reported)	**7,037 tons**

Table 72: Reported Levels of Performance: Drop-Off

Drop-off	Recycling Tons
Municipalities within the Region	**42**
Number of municipalities that reported drop off recycling tonnages	**4**
Tons of drop-off recycling collected (reported)	**1,939 tons**

The most common method of payment for curbside trash and recycling collection in Western Slope municipalities is via utility bill (**Table 73** and T**able 74**). Nine municipalities have subscription recycling services, and eight have subscription trash services available to residents.

Table 73: Payment for Curbside Trash in the Western Slope

	Number of Municipalities	Population Percentage
PAYT	**5**	**44%**
Utility Bill	**13**	**29%**
Property Tax	**0**	**0%**
Subscription	**8**	**15%**
No Service	**8**	**4%**
Unknown	**8**	**7%**

Table 74: Payment for Curbside Recycling in the Western Slope

	Number of Municipalities	Population Percentage
PAYT	**2**	**3%**
Utility Bill	**9**	**53%**
Property Tax	**1**	**10%**
Subscription	**9**	**22%**
No Service	**19**	**8%**
Not Sure	**2**	**5%**

Table 75 shows that residential single families have the highest maximum reported recycling contamination in comparison to commercial multifamily.

Table 75: Reported Recycling Contamination Levels in the Western Slope

	Minimum Reported Recycling Contamination	Maximum Reported Recycling Contamination
Residential Single-family	**35%**	**100%**
Residential Multifamily	**n/a**	**n/a**
Commercial Multifamily	**60%**	**60%**

4.4 ADDITIONAL INFORMATION

4.1.1 Voluntary Programs

This summary provides insights into voluntary programs related to recycling and litter management, as reported by various communities and organizations. These initiatives play a vital role in promoting environmental sustainability and cleanliness within communities in the Western Slope.

Recycling Programs

- Four Corners Recycling: This initiative is a non-profit that provides free drop-off recycling for different communities in Montezuma.

- Town of Ignacio: Recycling in Ignacio is voluntary, and residents are charged a monthly fee to participate in the recycling service.
- Town of Ridgway: The Public Works Department collects recycling from outdoor spaces, consolidating materials for weekly pickup by a hauling service.
- Town of Telluride: The Town of Telluride organizes a Spring Clean-Up program that recycles various items, including car batteries, appliances, metal, and corrugated cardboard.

Litter Management Programs

- Ordinance-based Litter Management: Some areas manage litter through local ordinances enforced by government employees.
- Volunteer Organizations: In several locations, volunteer organizations, such as the Telluride Association of Realtors, San Miguel Watershed Coalition, and Telluride Ecology Commission, participate in annual litter cleanup efforts.
- Electronic Recycling: EcoAction Partners organizes electronic recycling events twice a year.
- Used Equipment and Clothing Program: The Mountain Club leads a program to collect used outdoor equipment and clothing once a year in the spring.
- Hazardous Waste Collection: San Miguel County, with assistance from a private contractor and volunteers, organizes an annual hazardous waste collection program in the spring.
- School Recycling Initiatives: Schools play a role in promoting recycling within their institutions, likely through internal programs.

Supportive Services

- Municipal Support: Municipal services, including parks, police (code enforcement), and parking enforcement, actively contribute to ongoing litter clean-up efforts in many of the municipalities.
- Bear-Proof Trash Cans: Bear-proof trash cans are provided in various parks to mitigate wildlife-related litter issues.

4.1.2 Special Considerations

Trash and recycling services in the Western Slope come with special considerations.

- Seasonal property owners face a unique challenge as some towns preferred service provider contract do not allow them to easily suspend services during their absence. To address this issue, many seasonal property owners opt for separate contracts with local service providers, allowing them to activate and deactivate services as needed when they are present or away.

- Some areas have significant bear population, which adds an extra dimension of importance to proper trash and recycling management to prevent wildlife encounters.
- The Western Slope is characterized by mountainous terrain. In some remote mountain communities, the landscape can make trash and recycling services more difficult to access and expensive.
- The region experiences a range of weather conditions, including heavy snowfall in the winter. Severe weather can disrupt curbside trash and recycling collection schedules, leading to delays or the need for additional snow removal efforts to access collection points.

5 EASTERN PLAINS

There are 67 municipalities within the Eastern Plains region of Colorado, with an overall population of 161,504 residents.

There is limited data available on waste and recycling services offered to the Eastern Plains region of Colorado. As only 14% of the municipal population was represented in the survey, much of this information came through secondary research.

For waste services, curbside collections are the most popular method of service delivery, are typically picked up weekly, and are most often paid for via utility bill or subscription. For recycling services, drop-off locations are quite prevalent as compared to curbside pick-up, these locations typically sort at a multi-stream level, and no municipalities reported any legal requirement for recycling services.

5.1 ACCESS TO SERVICES

This section reports on the share of households by type (Single and Multi-family) that have access to curbside waste and recycling collections services or have drop-off waste and recycling locations within the municipality. Additionally, it covers the share of municipalities within the region that have these collection services available to their residents and the method of delivery (i.e., is there a universal service obligatorily offered throughout the municipality, or are there subscriptions that could be opted into).

Only 38% of total households located in municipalities of the Eastern Plains have active service for curbside trash collection (**Table 76)**. Similarly, 43% of total households located in Eastern Plain municipalities have active service for trash drop-off (**Table 77**). Note that the total number of households does not include mobile homes, boats, RVs, vans, etc. While the services provided to these entities were not researched for Element 1, estimates were used to incorporate these entities into the **Element 13** modeling.

Table 76: Households Within Municipalities with Active Service for Curbside Trash in Eastern Plains

	Single-family Households	Multi-family Households	Total Households
Total Households	**31,004**	**6,684**	**37,687**
Households with Curbside Service	**11,947**	**2,404**	**14,351**
Percent With Curbside Service	**39%**	**36%**	**38%**

Table 77: Households Within Municipalities with Active Service for Drop Off Trash in Eastern Plains

	Single-family Households	Multi-family Households	Total Households
Total Households	**31,004**	**6,684**	**37,687**
Households with Drop Off Access	13,342	2,805	16,147
Percent With Drop-Off Access	**43%**	**42%**	**43%**

Around 18% of total households in the Eastern Plains have active curbside recycling services (**Table 78**). Active curbside recycling services are 20 percentage points lower than access to curbside trash services (**Table 76** and **Table 78**).

Table 78: Households Within Municipalities with Active Service for Curbside Recycling in Eastern Plains

	Single-family Households	Multi-family Households	Total Households
Total Households	**31,004**	**6,684**	**37,687**
Households with Curbside Service	**5,451**	**1,202**	**6,653**
Percent With Curbside Service	**18%**	**18%**	**18%**

Table 79 offers the insight that drop off is the more accessible method for recycling collections for households in the Eastern Plains. Around 50% of total households have active service for drop-off recycling, compared to only 18% of households with access to curbside recycling.

Table 79: Households Within Municipalities with Active Service for Drop-Off Recycling in Eastern Plains

	Single-family Households	Multi-family Households	Total Households
Total Households	**31,004**	**6,684**	**37,687**
Households with Drop Off Access	**15,196**	**3,589**	**18,784**
Percent With Drop-Off Access	**49%**	**54%**	**50%**

There were no survey responses indicating any legal requirements for recycling services to residents from municipalities in this region (**Table 80**).

Table 80: Legal Requirements for Residential Recycling in Eastern Plains

Recycling	Number of Municipalities	Population Percentage
Legal Requirement	**0**	**0%**
Legal Requirement - Residential SF	**0**	
Legal Requirement - Residential MF	**0**	
Legal Requirement - Commercial MF	**0**	
No Legal Requirement	**11**	**15%**
Did Not Answer Question	**5**	**5%**
Did Not Answer Survey	**51**	**80%**

Table 81 indicates the number of municipalities within the region that have curbside recycling available to residents a drop-off recycling site within the municipality, both of these, or neither of these. Drop-off is much more prevalent than curbside for recycling in this region; however, more municipalities have no service at all than either total curbside or total drop off recycling services. The population percentages are calculated with the total population of each municipality per category weighed against the region's population residing within the municipalities total population.

Table 81: Access to Curbside and Drop-Off Recycling in Eastern Plains

Recycling	Number of Municipalities	Population Percentage
Curbside Only	**2**	**8%**
Drop Off Only	**19**	**44%**
Both	**5**	**16%**
No service	**41**	**42%**

Table 82 indicates the number of municipalities within the region that have curbside waste collection available to residents and a drop-off site for waste within the municipality, both or neither of these. Access to trash collection is greater than access to recycling collection; eighteen municipalities have curbside trash and both curbside and drop-off trash services available to residents, while only seven municipalities have curbside recycling and both curbside and drop-off recycling.

Table 82: Access to Curbside and Drop-Off Trash Service in Eastern Plains

Trash	Number of Municipalities	Population Percentage
Curbside Only	**11**	**14%**
Drop Off Only	**21**	**22%**
Both	**7**	**20%**
No service	**18**	**34%**
Unknown	**10**	**10%**

Table 83 details whether the curbside recycling services for single-family households are offered universally throughout the municipality or by opt-in subscriptions. While most municipalities have no curbside recycling services for single-family households, services by subscription are greater than those offered universally.

Table 83: Typical Participation Method of Single-family Curbside Recycling in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
Universal	**1**	**5%**
Subscription	**6**	**19%**
No service	**60**	**76%**
Unknown	**0**	**0%**

Table 84 details whether the curbside recycling services for multi-family households are offered universally throughout the municipality or by opt-in subscriptions. While most municipalities have no curbside recycling services for multi-family households or there is no available information to confirm, five municipalities have subscription curbside recycling, and only one municipality has universal curbside recycling for multi-family households.

Table 84: Typical Participation Method of Multi-family Curbside Recycling in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
Universal	**1**	**5%**
Subscription	**5**	**19%**
No service	**60**	**76%**
Unknown	**1**	**0%**

5.2 SERVICE DELIVERY

This section explores various features of curbside and drop-off recycling and waste collection service delivery (i.e., collections frequency, container type, dimensions, sorting methods/requirements, etc.) by share of municipalities in the region.

5.2.1 Curbside

There is limited data available for the contracting method for curbside recycling services offered in municipalities within this region. Of the few municipalities that offer these services. Table 85 shows that, of the few municipalities that offer these services, the most common contracting method is household subscriptions offered through an open market of service providers.

Table 85: Typical Contracting Method for Curbside Recycling in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
Municipal Delivered	**1**	**5%**
Municipal contracted to third-party service provider (no household choice of service provider)	**0**	**0%**
Household subscription (municipal approved list of service providers only)	**1**	**8%**
Household subscription (open market of service providers)	**4**	**11%**
No service	**60**	**76%**
Unknown	**1**	**0%**

Table 86 reports the sorting level in which curbside recycling is typically collected in the region. While very few municipalities have access to curbside recycling (seven), even fewer have available information on their sorting levels. From this limited data, the various collection methods in the region seem evenly dispersed.

Table 86: Typical Curbside Recycling Collection Method in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
Single Stream	**1**	**5%**
Dual Stream - Fiber and Containers	**0**	**0%**
Dual Stream - Glass and all other material	**1**	**8%**
Multi-Stream	**0**	**0%**
Curbside service but unknown how it's collected	**5**	**11%**
No curbside service	**60**	**76%**

Table 87 indicates the collection frequencies of municipalities that have curbside recycling within the region. There is limited data available to draw conclusions on collection frequency.

Table 87: Typical Collection Frequency of Curbside Recycling for Single-family in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
Twice a week or more	**0**	**0%**
Weekly	**1**	**5%**
Biweekly	**3**	**11%**
Monthly	**0**	**0%**
Unknown	**3**	**8%**
No service	**60**	**76%**

Table 88 indicates the collection frequencies of municipalities that have curbside waste services within the region. There is limited data available, yet the majority of those who receive service seem to do so on a weekly basis, with one municipality collecting more frequently than this.

Table 88: Typical Collection Frequency of Curbside Trash for Single Family in Eastern Plains

Trash - Curbside	Number of Municipalities	Population Percentage
Twice a week or more	**1**	**1%**
Weekly	**9**	**12%**
Biweekly	**0**	**0%**
No service	**39**	**56%**
Unknown	**18**	**31%**

Table 89 shows the type of containers used to store curbside recycling materials for pick-up in single-family households. There is limited data available for this region; only one municipality reported the use of carts in their curbside recycling collections.

Table 89: Typical Containers Used for Single-family Curbside Recycling in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population of Municipalities
Bags	**0**	**0%**
Carts	**1**	**5%**
Dumpsters	**0**	**0%**
Roll-off Container	**0**	**0%**
All Container Types	**0**	**0%**
Unknown	**6**	**19%**
No service	**60**	**76%**

Table 90 reveals the dimensions of the one municipality that reported using a 55-gallon cart to store curbside recycling materials for pick-up in single-family households.

Table 90: Typical Dimensions for Recycling Carts in Eastern Plains

Recycling - Curbside	Number of Municipalities	Population of Municipalities
50 gallon	**1**	**5%**
Multiple	**0**	**0%**
Unknown	**7**	**20%**
No carts	**0**	**0%**
No service	**59**	**75%**

Common Curbside Accepted Covered Materials in Eastern Plains

The five most commonly collected materials in the region by number of municipalities surveyed who accept the material in their curbside recycling collections of the 16 municipalities who completed the survey are:

1. Newspaper, Newsprint
2. Paperboard boxes and Packaging
3. Aluminum – Beverage Containers
4. Clear Glass
5. Magazines and Other Coated Paper

Table 100 provides an estimate of the percentage of municipalities that collect materials for recycling through curbside collection.

The five most commonly excluded materials in the region by number of municipalities surveyed who explicitly state that they do not accept this material in their curbside recycling services are:

1. Wood Containers
2. Rubber Packaging
3. Textile Packaging
4. Paint Containers
5. Motor Oil Containers

5.2.2 Drop Off

Common Drop-Off Accepted Covered Materials in Eastern Plains

The five most commonly collected materials in the region by number of municipalities surveyed who accept the material in their curbside recycling collections of the 16 municipalities who completed the survey are:

1. Clear Glass
2. Newspaper, Newsprint

3. High-Grade Office Paper (uncoated)
4. Telephone Directories
5. Aluminum – Beverage Containers

The five most commonly excluded materials in the region by number of municipalities surveyed who explicitly state that they do not accept this material at their recycling drop-off locations are:

1. PE Squeezable Tubes
2. LDPE/PS/PP Colored Nursery Containers
3. PLA, PHA, PHB
4. Pallet Wrap
5. PVC Film

There is little information available on the sorting requirements for the municipalities that have drop-off recycling sites within the region. However, **Table 91** shows that all of those with reported sorting level requirements are multi-stream.

Table 91: Typical Sorting Requirements at Drop-Off Sites in Eastern Plains

Recycling – Drop Off	Number of Municipalities	Population Percentage
Single Stream	**0**	**0%**
Dual Stream - Fiber and Containers	**0**	**0%**
Dual Stream - Glass and all other materials	**0**	**0%**
Multi-Stream	**12**	**17%**
Cardboard Only	**0**	**0%**
No service	**43**	**50%**
Unknown	**12**	**32%**

Table 92 shows the accessibility limitations of drop-off recycling sites in the region. While many municipalities do not have a recycling facility with drop-off available within it, two have one that is available exclusively to municipality residents, eight are open to municipality residents and non-residents alike, and 12 are available to all county residents.

Table 92: Access to Drop-Off Sites by Waste Generator in Eastern Plains

Recycling – Drop Off	Number of Municipalities	Population Percentage
Municipality Residents	**2**	**4%**
County Residents	**12**	**35%**
Residents and Non-Residents	**8**	**8%**
No service	**43**	**50%**
Unknown	**2**	**3%**

5.3 PERFORMANCE AND COST

Only one Eastern Plains municipality, representing 0.4% of the region's municipal population, reported the tonnage of recycling collected from curbside services **(Table 93**). No municipalities reported the amount of recycling collected from drop-off locations.

Table 93: Reported Levels of Performance of Curbside Recycling in Eastern Plains

Curbside Recycling	Recycling Tons
Municipalities within the Region	**67**
Number of municipalities that reported curbside recycling tonnages	**1**
Tons of curbside recycling collected (reported)	**521 tons**

There is no data available on the reported levels of performance based on the number of tons recycled for drop-off facilities in this region.

Table 94 shows the payment methods for residential curbside recycling by number of municipalities. While there is limited data available on municipalities that have this service available to their residents within the region, the most common payment method is via utility bill, with subscriptions to service providers in a close second.

Table 94: Payment for Curbside Trash in the Eastern Plains

Trash - Curbside	Number of Municipalities	Population Percentage
PAYT	**0**	**0%**
Utility Bill	**7**	**20%**
Property Tax	**0**	**0%**
Subscription	**4**	**11%**
No Service	**39**	**56%**
Unknown	**17**	**13%**

Table 95 shows the payment methods for residential curbside recycling by number of municipalities. While there is limited data available on the few municipalities that have this service available to their residents within the region, the most common payment method is via utility bill.

Table 95: Payment for Curbside Recycling in the Eastern Plains

Recycling - Curbside	Number of Municipalities	Population Percentage
PAYT	**0**	**0%**
Utility Bill	**3**	**11%**
Property Tax	**1**	**5%**
Subscription	**1**	**8%**
No Service	**60**	**76%**
Unknown	**2**	**0%**

Recycling Contamination Levels in Eastern Plains

There is insufficient data available to draw reasonable conclusions on the state of contamination in recycling collection in Eastern Plains.

5.4 ADDITIONAL INFORMAITON

5.4.1 Voluntary Programs

Survey responses collected from municipalities and counties within Eastern Plains revealed the extent of its voluntary programs. Four geographies reported some instances of voluntary waste collections ranging from services offered directly through the municipality, small community groups organizing ad-hoc waste pick-up days, and volunteer groups organizing litter picks and unwanted item pick-up.

5.4.2 Special Considerations

Two municipalities reported special considerations within their waste management operations via survey: fee-based pick-up separate from typical collections for mattresses and other furniture and a waste service that solely consists of communal dumpsters placed in alleyways.

6 STATEWIDE FINDINGS

6.1 COST OF SERVICES

The cost of recycling services are summarized in **Table 96** and **Table 97.** The cost of services ranges significantly from a low of $5 per household per month to more than $90 per household per month when bundled with waste collected. Overall costs were found to be higher in the Mountains and lower in other regions. Very few data points were collected from the Eastern and these results are less robust than in other regions.

Table 96: Monthly Household Cost of Curbside Recycling When Priced Individually

	Min	95% Confidence Interval (Lower)	Mean	95% Confidence Interval (Upper)	Max
Front Range	**5**	**4**	**15**	**25**	**40**
Mountains	**15**	**16**	**32**	**48**	**69**
Westerns Slope	**4**	**9**	**17**	**26**	**35**
Easter Plains	**7**	**7**	**7**	**7**	**7**

Table 97: Monthly Household Cost of Curbside Recycling When Bundled with Waste

	Min	95% Confidence Interval (Lower)	Mean	95% Confidence Interval (Upper)	Max
Front Range	**7**	**11**	**20**	**28**	**37**
Mountains	**28**	**39**	**57**	**76**	**91**
Westerns Slope	**11**	**7**	**28**	**49**	**92**
Eastern Plains	**n/a**	**n/a**	**n/a**	**n/a**	**n/a**

6.2 WASTE COMPOSITIONS

The waste compositions that were compiled during this research were used to estimate regional average waste compositions (**Table 99**). This is compared to the 2018 Statewide composition from the Colorado Department of Public Health &

Environment.[10] These averages are based on waste compositions for residential and MSW due to a deficit in residential-only analyses across each region.

Table 98: Waste Composition Sources

Front Range	Mountains	Western Slope	Eastern/Southeastern
• Boulder County[11] • Larimer County[12]	• Eagle County[13] • Routt County[14] • Gunnison County[15] • Grand County[16] • Summit County[17] • Pitkin County[18]	• Garfield County[19] • Mesa County[20] • Delta County[21] • Montrose County[22]	• Huerfano County[23] • Las Animas County[24] • Baca County[25]

Glass: Regional estimates for glass composition in the disposal stream are within 0.5 percentage points of the Statewide estimate of 4.2%, except for the Front Range, which suggests 2.1%.

Metals: Like Glass, regional estimates for metal composition in the disposal stream are within 0.5 percentage points of the Statewide estimate of 4.7%, except for the Front Range at 2.5%.

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[10] https://oitco.hylandcloud.com/cdphermpop/docpop/docpop.aspx
[11] Boulder County 2017 Waste Composition
[12] LarimerCounty.pdf - Google Drive
[13] NorthwestColorado.pdf - Google Drive
[14] NorthwestColorado.pdf - Google Drive
[15] DEHS_RREO_WesternStudy.pdf - Google Drive
[16] GrandCounty.pdf - Google Drive
[17] Summit County_Waste Diversion Study_2019.pdf
[18] PitkinCounty.pdf - Google Drive
[19] NorthwestColorado.pdf - Google Drive
[20] DEHS_RREO_WesternStudy.pdf - Google Drive
[21] DEHS_RREO_WesternStudy.pdf - Google Drive
[22] DEHS_RREO_WesternStudy.pdf - Google Drive
[23] Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).
[24] Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).
[25] Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).

Plastics: Plastics estimates are more varied, with the Statewide estimate looking to be on the lower end of estimates at 13.2%, while the Western Slope is the highest at 17.2%.

Paper: Paper estimates have a range of 15.6% between the highest (Western Slope) and lowest (Front Range) estimate.

Organics: Organics represent the largest category of waste by far across all regions, with a Statewide average of 37.1%. Front Range attributes it the largest proportion at 39%.

Of note, Front Range estimates rely most on residential waste compositions, whereas the other regions rely more on MSW. Consequently, this may account for a portion of the differences that it exhibits between the other regional averages and the Statewide estimates.

Table 99: Waste Composition in Colorado

Materials	Statewide	Front Range	Mountains	Western Slope	Eastern/Southeastern
Glass Containers	3.5%	1.9%	3.6%	3.8%	3.6%
Other Glass	0.7%	0.2%	0.6%	0.6%	0.9%
Total Glass	4.2%	2.1%	4.2%	4.4%	4.5%
Aluminum	1.0%	0.5%	0.9%	1.3%	0.8%
Steel/Tin	1.2%	1.8%	0.8%	1.1%	0.9%
Other Metal	2.5%	0.2%	2.6%	2.5%	2.9%
Total Metals	4.7%	2.5%	4.4%	4.9%	4.6%
#1 Bottles	1.7%	0.8%	1.6%	3.0%	1.4%
#2 Bottles	1.4%	0.6%	1.1%	1.3%	1.8%
Rigids #3-7	1.1%	1.6%	1.3%	1.7%	1.3%
Films, Bags & Wrap	3.5%	4.4%	5.1%	4.6%	2.0%
Other Plastic	5.4%	5.2%	5.0%	6.7%	6.7%
Total Plastics	13.2%	12.6%	14.1%	17.2%	13.2%
Cardboard/ Kraft	6.5%	1.9%	7.8%	8.1%	7.2%
Newspaper	1.4%	0.6%	1.2%	1.3%	0.3%
Office Paper	1.6%	0.3%	1.5%	1.1%	1.1%
Chip/Paperboard	2.5%	0.0%	2.3%	2.7%	2.7%
Junk Mail/Aseptics	1.5%	0.1%	1.3%	1.8%	0.5%
Magazines	1.6%	0.5%	1.6%	1.8%	0.7%
Other Paper	4.3%	5.0%	6.2%	7.1%	1.4%

Materials	Statewide	Front Range	Mountains	Western Slope	Eastern/Southeastern
Total Paper	19.2%	8.3%	21.8%	23.9%	13.8%
Food Waste	18.2%	12.8%	23.4%	14.9%	13.4%
Yard Waste	10.5%	15.0%	3.9%	13.4%	16.2%
Clean Wood	0.9%	1.5%	1.0%	0.4%	0.9%
Other Organics	7.6%	9.7%	4.4%	5.7%	8.4%
Total Organics	37.1%	39.0%	32.6%	34.3%	38.8%
Textiles	5.4%	8.9%	7.6%	5.3%	5.2%
Electronics	1.3%	4.5%	0.8%	0.5%	0.8%
Batteries	0.2%	0.0%	0.1%	0.1%	0.1%
Paint	0.0%	0.0%	0.4%	0.6%	0.0%
Motor Veh Waste	0.8%	0.3%	0.8%	0.4%	2.4%
C&D (non-industrial)	8.6%	15.8%	10.4%	7.0%	11.3%
Other HHW/Special	1.7%	0.1%	0.8%	1.0%	5.4%
Total Other	17.5%	29.7%	20.8%	14.9%	25.2%
Waste/Residue	4.2%	5.8%	1.9%	0.3%	0.0%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

6.3 MATERIAL ACCEPTANCE

Based on the survey data provided by municipalities, the acceptance of different covered materials was calculated. This figure was calculated as follows:

- Municipalities responded to the survey, which asked both:
    - Are the following materials accepted for recycling by at least one curbside recycling collection service provider in this jurisdiction?
    - Are the following materials accepted for recycling by at least one of the drop-off sites?
- They could respond with "Yes," "No", or "Not Sure."
- Municipalities that did not provide curbside service were removed from the curbside responses, and municipalities that did not have a drop-off site within their municipal boundaries were removed from the drop-off responses.
- Responses of "Not Sure" were removed.

- In total, there were approximately 40-70 Yes or No responses per material.
- The total number of Yes responses was divided by the total number of Yes and No responses.

The percentage in **Table 100** represents the estimated percent of municipalities with service that collect the material. It does not represent the percentage of the total population with access to recycle these materials. Based on the estimated 64% of households with curbside recycling, the following curbside acceptance figures could be multiplied by 0.64 to estimate the population access. For example, as 88% of municipalities collect PET bottles, it is likely that approximately 56% of households in municipalities have access to curbside recycling of PET bottles.

Table 100: Percent of Municipalities With Service That Collected Covered Materials

	Curbside Acceptance	Drop Off Acceptance
High-Grade Office Paper (uncoated)	96%	96%
Newspaper, Newsprint	94%	96%
Magazines and Other Coated Paper (e.g., catalogs)	92%	92%
Telephone Directories	86%	92%
Tissue Paper (packaging)	68%	71%
Shredded Paper (bagged)	43%	57%
Corrugated Containers (except wax-coated)	87%	91%
Other Multi-Layer Kraft Packaging (e.g., paper padded mailers)	72%	68%
Single-Wall Kraft Packaging (e.g., grocery bags)	69%	73%
Paperboard Boxes and Packaging	96%	91%
Molded Pulp Packaging, excluding Food Serviceware (e.g., egg cartons, other protective packaging)	85%	74%
Paper Cups, Coated and Uncoated	59%	45%
Gable-Top and Aseptic Cartons	61%	59%
Pizza Boxes	40%	62%
Non-Metalized Gift Wrap	57%	60%
"Low grade" Printing and Writing Paper (e.g., bulk mail, envelopes, notebooks, cards)	92%	94%
Old Corrugated Containers (OCC) – wax coated	38%	55%
Molded Pulp Food Serviceware (e.g., take-out "clamshells")	32%	39%
Other Polycoated Packaging (e.g., some freezer and butter boxes, ice cream containers)	24%	28%
Paper "cans" (spiral-wound containers) with steel ends	45%	31%
Napkins, tissues and paper toweling	33%	38%

	Curbside Acceptance	Drop Off Acceptance
Paper laminates	28%	30%
Clear and Translucid Green or Blue PET Bottles, Jars and Jugs	88%	82%
Colored Opaque PET Bottles, Jars and Jugs	85%	81%
Clear and Translucid Green or Blue PET Thermoform Containers	65%	62%
Colored opaque PET Thermoform Containers	62%	61%
Natural HDPE Bottles, Jars and Jugs	85%	86%
Colored HDPE Bottles, Jars and Jugs	85%	85%
Other Polyethylene (PE) Packaging Except Pails and Lids	56%	50%
Polypropylene (PP) Packaging Except Pails and Lids	62%	56%
White EPS	21%	24%
Other Expanded PS	15%	21%
Non-Expanded PS	17%	19%
PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens)	14%	14%
LDPE/PS/PP Colored Nursery Containers (e.g., pots, trays, etc.)	33%	35%
Large HDPE & PP Pails & Lids	38%	58%
PLA, PHA, PHB	14%	10%
Certified Compostable Rigid Packaging	25%	29%
Undetectable Plastics (e.g., black plastic)	24%	26%
Plastics less than 5 inches on at least 1 side	67%	58%
Plastics less than 2 inches on at least 1 side	42%	46%
LDPE/HDPE Film (include monoPE recycle compatible pouches) Except Pallet Wrap	3%	17%
PLA, PHA, PHB - Plastic Film	3%	16%
PP Film (including woven PP bags and monoPP recycle compatible pouches)	3%	13%
Multimaterial Films, Non-monomaterial Pouches, Other Flexible Packaging	3%	13%
Pallet Wrap	2%	22%
PVC Film (e.g., linen packaging, labels)	5%	14%
PET Film	2%	17%
Certified Compostable Film	16%	11%
Steel Aerosol Containers	59%	63%
Steel Containers	75%	77%
Aluminum Aerosol Containers	66%	67%
Aluminum Food Containers	92%	92%
Other Aluminum Packaging (Foil and Foil Trays)	85%	83%
Aluminum - Beverage Containers	94%	96%
Other Metal Packaging	79%	85%
Clear Glass	89%	93%
Colored Glass	88%	92%

	Curbside Acceptance	Drop Off Acceptance
Ceramic, Porcelain, Pyrex and Other Infusible Glass Material	18%	25%
Wood Containers	9%	18%
Rubber Packaging	7%	11%
Textile Packaging	11%	17%
Paint Containers	16%	23%
Motor Oil Containers	20%	24%
Solvent Containers	17%	23%
Pesticide Containers	18%	24%
Pressurized Cylinders (not including aerosols) (e.g., propane tanks, carbon dioxide cylinders)	6%	21%
Antifreeze Containers	13%	26%

6.4 RECYCLING SERVICES IN RURAL AREAS

Currently, approximately 13% of the population resides in rural areas within counties outside municipal or CDP boundaries. Using satellite building data, population density metrics, and street-view observations, it was determined that a lot of this population lives directly outside a municipality or CDP and live in relatively high-density areas. Figure 4 shows housing density in the Denver region. As shown, many of the highly dense areas (purple) are outside both municipal boundaries (dark blue) and CDP boundaries (orange).

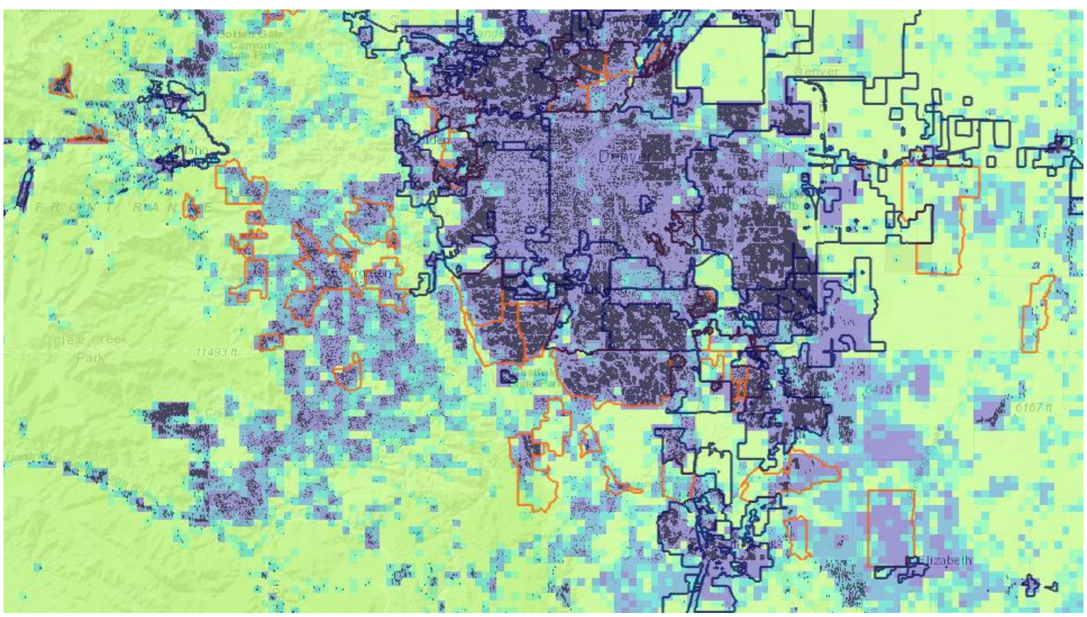

Figure 4: Housing Density in Denver Area

Satellite imagery confirms that many of these communities have curbside trash service. The project team used GIS mapping software to split the state into 1 km square blocks, and each block was assigned a housing density. The densities were then split into five quintiles. The project team then calculated the total population living in rural and remote areas with the highest density. In total, 70% of the population lives in these areas, and it is assumed that many of these households have curbside trash. Details on the exact percentages used in the scenario modeling is included in the **Element 13** memo.

COLORADO NEEDS ASSESSMENT

ELEMENT 2: SERVICE COSTS

JANUARY 25, 2024

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FIGURES

APPENDICES

The Needs Assessment was undertaken according to Colorado's Producer Responsibility Program for Statewide Recycling. Any views expressed in this document do not necessarily reflect the views or positions of Circular Action Alliance's members.

1 EXECUTIVE SUMMARY

1.1 PURPOSE

This memo outlines data gathered specifically for packaging recycling collection service costs, including contractual terms, service option levels and frequency, and materials collected based on information from recycling service providers (haulers) servicing each Colorado Region. Data was collected through existing Colorado reports and direct hauler outreach via surveys, a webinar, and direct interviews. Additional research completed as part of **Element 1 Technical Memorandum** includes municipal ordinance assessment to further detail recycling collection services and materials collected.

Haulers, both public and private, are an important piece of the recycling infrastructure. Without a robust hauler network, statewide recycling in Colorado would be difficult. From large and nationwide to small and local, haulers are directly involved with collecting recycling from generators, transporting the materials to material processing facilities (MRFs), and transporting recycled goods to markets. Therefore, haulers have very direct and in-depth knowledge of recycling infrastructure and can provide insight into the current state of recycling across every Region of Colorado. Haulers can give insight into the present and provide valuable feedback on what needs to happen to ensure that every resident in Colorado has access to recycling.

1.2 APPROACH

The project team leveraged several different engagement methods to learn from and engage haulers, including a webinar, online survey, and individual emails and phone calls for detailed information-gathering interviews. Hauler engagement and information sharing are key to the project, and the team strived for authentic and open communication.

The project team conducted a desktop review of haulers servicing the four distinct Colorado Regions as identified in the 2016 Integrated Solid Waste and Materials Management Plan (ISWMMP).[1] Then, three (3) national hauling providers, five (5) regional hauling providers, and fifteen (15) privately owned local haulers were selected for the targeted outreach interviews. The project team ensured haulers of each size were identified in each Region to provide a representative sample of services provided throughout the state.

Hauler outreach included direct emails and email invitations to participate in the Colorado Needs Assessment data gathering to the entities identified in the dataset.

A hauler survey questionnaire was developed in coordination with the Advisory Team to collect valuable data from haulers on a voluntary basis, including contractual terms,

[1] Burns McDonnell, SERA (2016). *Colorado Integrated Solid Waste & Materials Management Plan*.

cost of services, service option levels and frequency, and material types collected. The hauler survey was shared with interested haulers and used for interview discussions. The survey is included in **Appendix A Hauler Questionnaire**.

A webinar to share information with haulers was held on September 21, 2023, with fifty-three (53) participants from the industry. The webinar was conducted by Circular Action Alliance, HDR, and Eunomia Research and Consulting Inc. The webinar provided an overview of the Colorado Producer Responsibility Law and the associated Needs Assessment. In addition, haulers were educated on the information being sought by the project team and their role in the Needs Assessment. It is important that the producer responsibility organization (PRO) understands the true costs, challenges, and existing recycling infrastructure in order to establish a path forward to an improved system.

The project team contacted forty-six (46) haulers (Eastern Plains – 5, Front Range, - 17, Mountains – 12, and Western Slope – 9) identified through the webinar response, internal Advisory Group, and NAICs codes. The team received a response from fifteen (15) that were interested in providing feedback. The project team completed fifteen (15) phone interviews, including three (3) large/national haulers, two (2) medium-sized regional haulers, and ten (10) small/local haulers. The large/national haulers provide service in each of the four regions within Colorado. One (1) medium-sized regional hauler provides services primarily in the Front Range, and one (1) provides services to the Western Slope. Of the small/local haulers interviewed, three (3) were from the Western Slope, two (2) were from the Mountains Region, and the remaining five (5) were from the Front Range. The project team reached out to five (5) local haulers from the Eastern Plains Region; however, the local haulers did not respond to the requests. Therefore, our team is relying upon interviews with the large/national haulers who serviced the Region for data.

Gathering data was challenging as many haulers were unwilling to share specific information or were difficult to coordinate with for interviews. Additional information was received via online surveys or direct emails from some haulers. Non-disclosure agreements (NDA) were required by some haulers to protect confidential information, which delayed interviews and created additional challenges in gathering information. Interviews and the online survey were both limited by concerns from haulers regarding sharing information in a highly competitive hauling market throughout the state.

1.3 FINDINGS

The project team directly contacted fifty-one (51) haulers from September 22 to October 20 via phone and email. The project team received responses from eighteen (18) haulers and was limited to scheduling interviews with fifteen (15) haulers. Multiple haulers were not willing to participate in providing information or provided limited responses to questions. The findings are based on the best available data gathered from interviews with haulers willing to voluntarily provide their information and insight into recycling in the state of Colorado.

While the limited quantitative data made it challenging to draw conclusions, the results of the interviews provided valuable details regarding service levels, route characteristics, challenges, and differences across the four Regions of Colorado. The analysis of the data indicates the following.

- Some haulers were apprehensive or unwilling to share data on their market share, capital costs, operating costs, or route information with the project team due to the highly competitive nature of the solid waste industry in Colorado. Estimating overall hauling capacity and cost in the state was challenging due to these factors.
- Local haulers are concerned that the extended producer responsibility (EPR) program implementation will favor large hauling companies.
- Most of the state is serviced by subscription-based, cart-based, open-market hauling. When contracted service is present, it was often found to be coordinated through homeowner associations (HOAs) in the Front Range or by cities in the Western Slope. Haulers also service drop-off sites throughout the state (see **Element 1 Technical Memorandum)** and provide collection for seasonal events.
- Bi-weekly curbside recycling is the most common way for Coloradans to recycle at home if they live in a single-family home.
- Due to variable MRF tipping costs and variability in recycling markets, financial planning is difficult for haulers, particularly in the long-term range (five or more years).
- Haulers who bring material to MRFs noted a recent rise in MRF tipping costs as a challenge, up by 50% in the last five years. Haulers cited potential explanations for rate increases, including general inflation, increase in transportation, fuel, and labor costs, decrease in end markets, and increase in contamination at MRFs driven by municipal diversion goals that do not align with acceptable materials. EPR may help to provide greater financial stability and consistency of specific materials.
- Existing infrastructure, including the MRF networks, is scarce in the Mountain, Eastern Plains, and Western Slope Regions, as most of the MRFs in the state reside in the Front Range. A map of existing MRFs is provided in the **Element 6 Technical Memorandum.** Material from the Mountain Region is typically transported to Denver or Colorado Springs. Material from the Western Slope Region is either transported out of state to Utah or New Mexico or to the Front Range.
- End-markets for packaging materials are typically located out of state, with glass processed in Colorado. Haulers noted decreased revenue for raw materials due to increased transportation costs but did not provide supporting data to the project team. Revenue-sharing agreements with haulers do not exist at this time. Additional discussion of end markets is included in the **Element 9 Technical Memorandum**.

- Haulers reported that the state of Colorado has strict laws regarding truck weight-to-axle ratios on Mountain roads, and this law applies to recyclable commodities. This reduces the amount of material that can be transported per truck in these Regions. Haulers did not provide data on the difference in truck weight limits between Regions.
- Mountain and Western Slope roads can be rugged and lead to increased maintenance costs for trucks.
- High wildlife activity requires special containers (carts and dumpsters) and frequent service. Animal-resistant containers add significant costs for rural haulers in areas where wildlife is a larger concern compared to container costs in urban areas.
- Most hauling trucks in every Region use diesel fuel, with some compressed natural gas (CNG) and a few electric vehicle trucks (EVs) in the Front Range.
- Larger haulers typically use automated side-load trucks, and smaller haulers typically use rear-load trucks that require multiple employees for collection.
- Commodities are hauled by direct end market customers, dump trucks, tractor trailers, and sometimes via rail for larger MRFs.

1.4 RECOMMENDATIONS FOR SCENARIO DEVELOPMENT

- Less densely populated areas (municipalities, CDPs, and rural areas) may be considered for recycling service expansions due to current limited service as documented by the hauler interviews and municipality surveys.
- Transfer station and MRF networks may be updated or expanded to provide additional capacity and more convenient options statewide, as discussed in the **Element 7 Technical Memorandum**.
- Drop-off depots may provide additional recycling access to Regions with less infrastructure. Information about existing depot locations is included in the **Element 1 Technical Memorandum**.

2 BACKGROUND DATA

The project team reviewed readily available information on recycling access and service costs in Colorado. The reports referenced below were reviewed to obtain an understanding of what information has already been collected by other entities and to identify data gaps. The Needs Assessment is informed by existing data and is intended to collect detailed, recent information on some of the data included in previously written reports. Updated information is included in later sections of this report and in the **Element 1 Technical Memorandum**.

2.1 THE FOUR REGIONS

The 2016 ISWMMP divides Colorado into four Regions based on varying socioeconomic and geographic factors: the Western Slope,[2] the Mountains,[3] the Front Range,[4] and the Eastern Plains.[5] The 2016 ISWMMP recognized that solid waste service and hauling operations vary widely between the Regions due to the variation in infrastructure, density, markets, and services available. **Figure 1** shows the four Regions that make up the State of Colorado.

Data gathered during the Needs Assessment process is organized by the same four Regions to provide a comparison against other Needs Assessment Memos. The information gathered from haulers in each of these Regions reiterates the importance of Region-specific planning in Colorado, given the vast differences in existing services based on Regions.

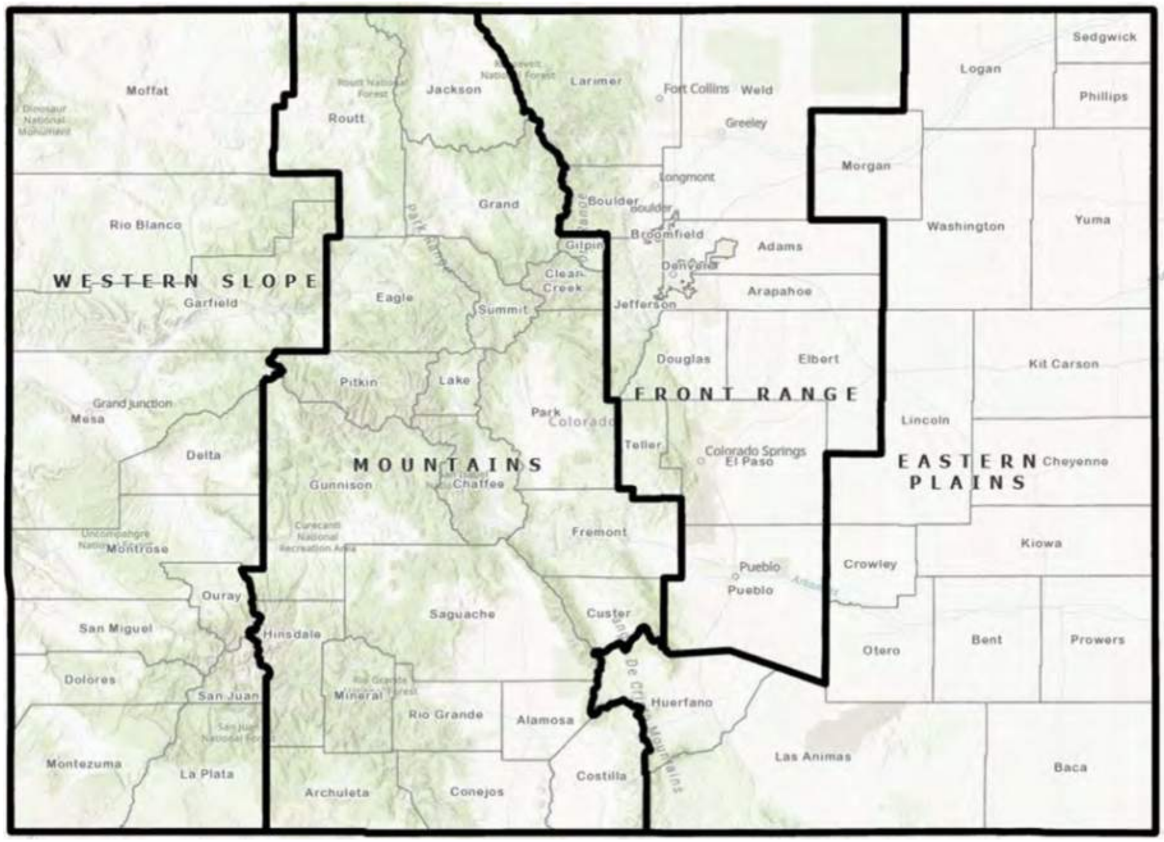
[2] Western Slope Region Counties: Moffat County, Rio Blanco County, Garfield County, Mesa County, Delta County, Montrose County, Ouray County, San Miguel County, Dolores County, San Juan County, Montezuma County, and La Plata County.

[3] Mountains Region Counties: Jackson County, Routt County, Grand County, Eagle County, Summit County, Clean Creek County, Pitkin County, Lake County, Park County, Gunnison County, Chafee County, Fremont County, Hinsdale County, Saguache County, Custer County, Mineral County, Rio Grande County, Alamosa County, Archuleta County, Conejos County, and Costilla County.

[4] Front Range Region Counties: Larimer County, Weld County, Boulder County, Bloomfield County, Adams County, Jefferson County, Denver County, Arapahoe County, Douglas County, Elbert County, Teller County, Colorado Springs County, and Pueblo County.

[5] Eastern Slope Counties: Baca, Bent, Cheyenne, Crowley, Huerfano, Kiowa, Kit Carson, Las Animas, Lincoln, Logan, Morgan, Otero, Phillips, Prowers, Sedgewick, Washington, Yuma.

Figure 1: Four Regions of Colorado



2.2 SUMMARY OF EXISTING DATA

2.2.1 State of Recycling 2022[6]

The 2022 State of Recycling and Composting in Colorado report identifies existing data in the state, including service limitations. The report concluded that only one-third of residents throughout the state have guaranteed access to recycling through municipal hauling, contracts, or ordinances. The percentage drops further for residents living in multi-family housing and rural areas. The waste diversion rate in the Front Range Region is 16%, and the diversion rate in Greater Colorado is 12%. Lack of access to convenient recycling programs was the main reason for the current diversion rate. The diversion rate discussed in the 2022 State of Recycling and Composting in Colorado report includes materials that are not covered under the Needs Assessment.

[6] Setzke, Rachel & Katz, Danny, Eco-Cycle (2022). *2022 State of Recycling & Composting In Colorado: 6th annual report*

2.2.2 Front Range Baseline[7]

Eco-Cyle completed the Front Range Waste Diversion Baseline Assessment in 2021, which includes recycling programs, services, and challenges specific to the Front Range. The report found that curbside recycling is widely available to over 99% of residents living in cities and towns. Less than half of municipal residents receive universal curbside recycling services with their trash services, and about half have subscription-based, opt-in programs for curbside recycling collection. Curbside recycling is mainly provided through an open market system with service by private haulers, representing about 60% of residents in Front Range cities and towns. About 10% of residents have city-contracted organized recycling collection, and 28% have municipal recycling collection programs.

Multi-family residents are about 15% of the Front Range population, and very little is known about recycling and composting services available to those residents. Additionally, 22% of Front Range residents live in unincorporated areas where there is not enough data to calculate access to recycling services for these residents.

Over 70% of residents in the Front Range have access to drop-off depots for common recyclables; however, these are predominantly operated by local governments, and only a small number have drop-off depots managed by private businesses.

Curbside composting collection is very limited, with only 20% of Front Range residents having access to either optional or universal curbside composting collection. The project team collected data from municipalities to obtain updated information on recycling and composting access in the Front Range. Data from that evaluation is included in the **Element 1 Technical Memorandum**.

2.2.3 Greater Colorado Baseline[8]

Eco-Cycle also completed the Greater Colorado Waste Diversion Baseline Assessment Report 2022, which includes the Western Slope, Mountains, and Eastern Plains Regions. This area faces many challenges, including geographical location, transportation costs, lower population densities, limited infrastructure, and lack of service, making recycling more costly and complex.

The report includes data from thirty-nine (39) municipalities and twenty-six (26) counties across Greater Colorado to provide a snapshot of existing systems in this region. Based on data from this select group, 80% of the populations surveyed have access to curbside recycling, but many pay more for subscription-based programs. The surveyed population had drop-off depots only available to 12% of residents, and 8% had no access to recycling.

Additional challenges in Greater Colorado include high operational costs, the influx of tourists needing seasonal service, low opt-in rates for voluntary programs, and

[7] Eco-Cycle, December 2021, *Front Range Waste Diversion Baseline Assessment.*

[8] Eco-Cycle, June 2022, *Greater Colorado Waste Diversion Baseline Assessment Report 2022.*

confusion about proper recycling and funding for recycling collection. Interviews also found that this Region is specifically interested in expanded drop-off depot recycling, including reopening recently closed locations, adding new locations, and expanding capacity.

The project team collected data from municipalities to obtain updated information on recycling and composting access in Greater Colorado for this Needs Assessment. Data from that evaluation is included in the **Element 1 Technical Memorandum**.

2.2.4 State Solid Waste and Recycling Data 2020[9]

The state of Colorado completed significant research in 2020 related to solid waste and recycling services for 272 municipalities. For consistency, the available data is again evaluated based on the four (4) Regions of the state. The data collected found that 43% of cities had curbside recycling available. The Front Range had the highest available at 86%, and the Eastern Slope had the lowest at 6%. Curbside compost was available to 3% of cities in the state, while the Front Range had the highest again at 7%, and no cities had availability in the Eastern Slope. Updated data was collected by the project team for this Needs Assessment, which can be found in the **Element 1 Technical Memorandum**.

Table 1: Percentage of Municipalities with Curbside Recycling/Compost by Region (2020)[10]

Region	Percentage of Cities With Curbside Service	
	Recycling	Compost
Front Range	86%	7%
Mountains	17%	3%
Eastern Plains	9%	0%
Western Slope	21%	2%
Statewide	**43%**	**3%**

Solid waste collection was provided by private haulers on a subscription basis to 56% of cities statewide. About 27% of cities have more oversight over the services in their community, where recycling services are coordinated on behalf of residents through a municipal program that contracts with a private hauler. The remaining 17% of cities provide their own services. The Front Range had the highest percentage of city-contracted services at 34%. The Mountains had the highest percentage of private hauling (subscription-based) at 74%.

[9] https://cdphe.colorado.gov/hm/local-sw-recycling-info

[10] https://cdphe.colorado.gov/hm/local-sw-recycling-info

Table 2: Percentage of Municipalities with each Type of Hauling Contract by Region (2020)[11]

Region	Hauling Contract Types by City		
	Private	City Contract	Municipal Service
Front Range	60%	34%	6%
Mountains	74%	13%	13%
Eastern Plains	40%	23%	37%
Western Slope	40%	40%	20%
Statewide	**56%**	**27%**	**17%**

The pay structure for all of the above collection services includes pay-as-you-throw (PAYT) volume-based pricing, private hauler-determined pricing, fixed-fee, and unlimited disposal pricing. Recycling is included in some pay-as-you-throw models (regardless of who is providing the service) and in some municipal-provided services. The majority of cities, 58%, had private pay structures, 27% had PAYT, 14% had flat fees, and only 1% reported unlimited disposal. For more information on bundled services, see the **Element 1 Technical Memorandum**.

Table 3: Percentage of Municipalities by Pay Structure by Region (2020)[12]

Region	Hauling Pay Structure by City			
	PAYT	Private	Fixed-Fee	Unlimited
Front Range	21%	64%	15%	0%
Mountains	19%	75%	6%	0%
Eastern Plains	31%	41%	28%	1%
Western Slope	49%	43%	8%	0%
Statewide	**27%**	**58%**	**14%**	**1%**

[11] https://cdphe.colorado.gov/hm/local-sw-recycling-info

[12] https://cdphe.colorado.gov/hm/local-sw-recycling-info

2.3 IDENTIFICATION OF HAULERS FOR DIRECT ENGAGEMENT IN NEEDS ASSESSMENT

Currently, the State of Colorado does not maintain a comprehensive list of haulers operating in the state. Haulers are licensed in only four counties in the state: Boulder, Denver, La Plata, and Pitkin. Hauler reporting is required in only five counties: Boulder, Denver, Larimer, Pitkin, and Routt.[13]

Hauling in Colorado consists of mostly private haulers who provide services through subscription-based contracts in an open market. There are exceptions where HOAs or municipalities will enter into contracts with private haulers to provide services to their residents.

HDR selected specific waste haulers based on the details identified in the proposal, including three (3) national hauling providers, five (5) regional hauling providers (medium), and fifteen (15) privately owned local haulers (small). Efforts were made to capture representative information from the four Regions in Colorado and identify haulers for outreach equally throughout the four Regions.

In addition to the three (national haulers), the project team was able to identify the following number of small or medium-sized haulers in each Region:

- Western Slope: 9.
- Mountains: 12.
- Front Range: 17.
- Eastern Plains: 5.

HDR completed research to identify licensed waste haulers based on the above criteria, including small, local, and privately owned local waste haulers. Haulers were selected at random to provide broad representation. Additionally, we identified municipal haulers that service local regions via contracted hauling for specific cities.

HDR did not include specialty haulers (such as construction and demolition-only or "junk" haulers). HDR did not include haulers identified as subsidiaries of national waste haulers. HDR intentionally included small haulers that do not currently offer recycling collection services, as they may provide insight into reasons why haulers do not offer recycling collection in certain areas at this time.

[13] https://cdphe.colorado.gov/hm/local-sw-recycling-info

3 HAULER FEEDBACK ANALYSIS

3.1 FINDINGS

Waste hauling in Colorado is a difficult feat, from the rugged terrain of the Mountains Region to the sparse network of recycling transfer stations and MRFs in the rural Regions of the Western Slope and Eastern Plains. This analysis is based on surveys and interviews conducted with haulers specifically. Additional information from the municipal perspective is available in the **Element 1 Technical Memorandum**.

Bi-weekly curbside recycling is the most common way for Coloradoans to recycle at home if they live in a single-family home. Residents living in larger multi-family dwellings are considered commercial customers to most haulers and municipalities, and therefore, recycling access for those residents is subject to whether or not their property manager chooses to subscribe to a recycling service. There were noted exceptions of cities that require recycling services to be offered to all residents, regardless of housing type.

In a competitive open market like Colorado, haulers are protective of their proprietary information, such as market share and cost information, making gathering such data difficult. The resulting data has gaps as haulers were not forthcoming with all requested information. The survey and interviews discussed numerous topics, and haulers provided the information they were willing to share.

Materials collected by haulers are dictated by what the MRFs they haul material to will accept. Since there are a limited number of MRFs in the state, the materials accepted are similar across the state.

3.2 SERVICES PROVIDED

3.2.1 Curbside Recycling

Waste hauler interviews and surveys provided insight into services provided to residential and commercial customers in the four (4) Regions of the state. Because the information sharing was voluntary, some information was not provided or only partially defined by haulers. The data is summarized based on identified trends to protect the identity of the individual haulers.

Residential curbside recycling is typically serviced bi-weekly with the few exceptions of more frequent service options offered by a smaller hauler or in cities where weekly pickup of recycling is mandated, such as Grand Junction. The total number of customers electing to have curbside recycling was found to be dependent on the municipality and/or contract for service and if service is provided in coordination with waste collection. The **Element 1 Technical Memorandum** provides further details on recycling participation differences between communities with subscription-based services and municipally required/provided services. There are also differences in subscriptions for recycling services between single-family and multi-family homes. For example, in the Front Range, 43% of single-family homes in municipalities offering subscription-based services *chose* to include curbside recycling service, while only 26% of multi-family buildings subscribed to recycling service.

For customers with recycling services, haulers reported a participation rate (set-out rate) above 90% across all Regions. Seasonal changes also impact participation and collection, particularly in the mountains and areas with significant resort populations. Only 2-5% of residential customers in the Mountains require special seasonal collections.

Route density for the collection was also found to vary significantly depending on Region and the type of area, including urban, suburban, rural, or mountain. Route density in the Front Range ranged from 700 to 1000 stops per route, while routes in the Western Slope and Mountains Regions ranged from 150 to 220 stops per route, depending on the makeup of the type of housing density and size of cities or towns. The typical route length was found to be 50 to 80 miles in the Front Range and up to 120 to 150 miles in the Western Slope and Mountains Regions. While the Front Range is on par with the industry standard of 700 to 1000 stops per route, the more rural Regions of the state expectedly lag behind.[14] This data applies to various types of contracts, including city-provided or contracted and subscription-based services. No direct costs were provided for this information.

3.2.2 Curbside Organics

Haulers' ability to offer curbside organics collection was found to be very dependent on the availability and locations of compost sites in the area. Haulers identified the need for a convenient option to bring organic materials in order to offer that service. A small number of haulers did express an interest in offering organics collection for packaging waste but noted limitations due to available compost sites. One hauler shared that they are beginning to collect organics and are starting the program with commercial customers with plans to expand to residential customers in the future. Generally, curbside organics collection was more commonly available in the Front Range; the Western Slope and Mountains are beginning to develop more programs and services. From the limited data gathered from the Eastern Slope Region, it does not seem that any organics collection (curbside or drop-off) is currently planned.

3.2.3 Drop-Off Depot Recycling

As noted, some areas of the state do not have curbside recycling readily accessible, but drop-off depot recycling (depots) offer additional recycling collection services.

[14] https://wasteadvantagemag.com/solid-waste-routing/#:~:text=For%20automated%20collection%2C%20the%20maximum,1%2C000%20for%2010%2Dhour%20day

Depots were found to typically be managed by municipalities or counties as a local option for recycling specified materials.

A number of haulers reported that some drop-off depots closed during the pandemic that have never been reopened. Haulers typically provide service to sites through roll-off pickups. The project team was unable to find existing data on all current depot locations in the state. Creating an inventory of depot locations could provide a better understanding of what areas of the state currently do not have convenient access to depots. Additional information obtained from municipalities about drop-off depots can be found in the **Element 1 Technical Memorandum.**

3.3 HOUSEHOLDS

3.3.1 Single-Family

Haulers were reluctant to provide data on the number of households they serviced to keep the information confidential from competition. Some haulers provided statistics on how many of their total single-family residential customers have recycling services. In open markets in the Front Range, an average of approximately 75% of customers who have curbside hauling services for trash also have curbside hauling services for recycling. In open markets in the Mountains Region, the average was approximately 25% of residents with trash service also had recycling services. The haulers did not provide data for the Western Slope and Eastern Plains.

Additional information regarding municipal contracts for waste and recycling curbside service is further detailed in the **Element 1 Technical Memorandum**.

3.3.2 Multi-Family & Commercial

Similar to single-family services, haulers were reluctant to provide information regarding the number of commercial customers they service. Multi-family service is included as commercial customers; however, the definition of multi-family buildings varies by municipality. Some municipalities define multi-family as four units or more, while others categorize buildings with eight or more units as multi-family. Haulers typically distinguish between residential and commercial service depending on whether the customer is serviced by a cart for residential or with a dumpster for commercial collection.

Multi-family and commercial customers have services available through the open market and can choose to subscribe to recycling services. As the open market is the most common way that commercial and multi-family customers receive recycling services, it depends on the individual customer whether they sign up for recycling services or not. It is not guaranteed that residents will have the same provider for recycling and trash services. Some municipalities mandate that recycling be available to multi-family residents, which then forces property managers to provide recycling for their residents. Further information is available in the **Element 1 Technical Memorandum**.

3.4 COST OF SERVICE

Through interviews and surveys, the project team did not receive details regarding pricing and fee structure from haulers due to the competitive open market in Colorado. Municipalities were the most transparent in sharing their cost data, and details can be found in the **Element 1 Technical Memorandum.**

Based on limited data gathered from haulers, recycling services costs were found to range from $10 to $20 per month for single-family residents when combined with trash services. In cases where recycling collection was provided without trash, the average cost was approximately $42 per month for recycling services. Cost data specific to multi-family and commercial collection was not provided. Data indicated that prices vary greatly depending on the Region in the state and the size of the hauler. Larger haulers have the benefits of an economy of scale and are able to offer lower prices, as confirmed by the data collected. Many smaller and local haulers are subject to the landscape and density of the smaller specific Regions, resulting in higher costs to customers. These values are based on limited data provided and should be considered approximations. Additional information collected from municipalities is included in the **Element 1 Technical Memorandum**.

The majority of hauling services are provided to residents through an open-market option where residents select their haulers for subscription-based service. Data was not provided on average subscription length. The open market is dominated by larger national haulers in the most populated Regions of the state. Smaller local haulers provide service in more sparsely populated Regions like the Mountains, Western Slope, and Eastern Plains. The project team was only able to identify a small number of medium-sized regional haulers who provide services in the Front Range and Western Slope.

Alternatively, municipalities oversee “organized collection” by contracting with the hauler for their community. Data found that contracted service through municipalities was common in more rural areas of the state. Additionally, contracted service is also managed through HOAs and found to be most common in the Front Range. Organized collection contract pricing was not provided by the municipalities. More information can be found in the **Element 1 Technical Memorandum**.

According to survey findings in the **Element 1 Technical Memorandum**, it is possible that households with curbside waste collection will get curbside recycling collection as part of the EPR implementation process. This means that 824,000 (424,000 single-family and 400,000 multi-family) households are expected to get curbside recycling through EPR.

Table 4 summarizes high-level estimates of some costs associated with adding collection services, including trucks, carts, infrastructure, and staff.

Table 4: Hauling Expansion Cost Estimates

	Equipment	Low-Range Cost	Medium-Range Cost	High-Range Cost
Capital Upgrades	Residential Cart[15]	$55/cart	-	$60/cart
	Automated Side-Loader Truck	$200,000	$300,000	$500,000
	Vehicle Depot	$2,000,000	-	$7,000,000
Operations and Maintenance	Drivers	$29,120	$49,520	$64,390
	Supervisors	-	$119,490	-
	Administrative Staff	-	$44,130	-
	Maintenance Staff	$47,840	$79,040	-
	Executive Staff	-	$121,220	-
	Truck Maintenance	$27,000	$75,000	$150,000
	Tipping fees[16]	-	$45/ton	$60/ton
	Fuel (unit cost)	-	$5.54	-

3.5 COLLECTION VEHICLES

The type of collection truck used for service often depends on the size of the hauler and its operations. Data collected indicated that larger haulers typically use automated side-load trucks with only one driver, and smaller haulers typically use rear-load trucks that require multiple employees for collection. Haulers reported that the average capital cost of a collections vehicle ranges between $100,000 to $400,000 depending on the levels of automation for diesel and CNG trucks, while electric trucks were

[15] This does not consider wildlife resistant carts, which typically cost $245/cart.

[16] Data received from the hauler survey. Trash or recycling was not specified.

reported to cost closer to $600,000. The cost to operate and maintain collection vehicles ranges between $27,000 and $150,000 per year.

3.6 ROUTE SPECIFICS

Route density is directly tied to population and service demand density. Less populated areas such as the Western Slope, Mountain, and Eastern Plains Regions were found to have less dense routes and thus are likely to have higher operating and collection costs for service. More densely populated areas, such as the Front Range Region, are likely to have higher route density and more efficient and cost-effective collections. Routes in the highly dense Front Range are often more likely to use a transfer station as there are more available for use, while routes in more rural areas end their routes with a long drive to a recycling center or MRF.

3.7 DROP-OFF DEPOTS

3.7.1 Materials

The list of accepted materials at drop-off depots aligns with recyclables collected curbside because these materials are taken to the same MRFs servicing the state. In general, depots accept glass, ferrous metals, non-ferrous metals, plastic bottles and containers, mixed paper, and cardboard. The **Element 6 Technical Memorandum** provides further details on specific materials accepted at the MRFs.

3.7.2 Service Levels

Drop-off depots are often located at the local recycling center or transfer station, which removes the need for hauling services. One hauler reported that one rural drop-off depot that was run by a county and privately hauled closed during the pandemic and has not since reopened. The **Element 1 Technical Memorandum** provides further details on drop-off locations and accessibility.

3.8 TRANSFER STATIONS AND MATERIAL RECOVERY FACILITIES

3.8.1 Transfer Stations

Transfer stations are mainly owned and operated by large national haulers and are used by most other haulers for the management of waste collected from customers. Haulers choose to use specific transfer stations depending on their location and the proximity to the areas in which they are providing service. Transfer stations are most often located in areas with a higher density of populations because operations are more economically viable due to more material available. Data collected by the project team indicated that areas with lower population density had further distances to travel to transfer stations, making collection and hauler services more costly to customers. **Element 7 Technical Memorandum** provides more detail on data collected for transfer stations.

3.8.2 Material Recovery Facilities

MRFs often follow the same economic models as transfer stations and are typically located in areas with enough density of recyclable materials collected to be profitable. This again leads to a disparity of facilities in the rural Regions of the state, not having comparable access to more urban Regions. The data collected also identified cases where a hauler collected single-stream recyclables, but the closest MRF was running a dual-stream system, causing the hauler to transport the material further to a MRF that accepted single-stream recyclables.

MRFs are also subject to the location of their end markets for recyclables. Data collected indicated that the end markets identified in hauler interviews were located almost entirely out of state. Glass is the only material where the end market is located in the state based on interviews. More information on the current state of MRFs in Colorado and available end markets is included in the **Element 6 Technical Memorandum** and **Element 9 Technical Memorandum**.

APPENDIX A.

Hauler Questionnaire

EPR Colorado Needs Assessment

Hauler Survey

All information will be kept confidential and anonymized.

NDA is available upon request - please email: [illegible]

Contact Info: Name

Contact Info: Email

example@example.com

Contact Info: Phone Number

What is the name of your company?

List the community(s) (city/county) you provide services in:

Community	Region	Type
	Please Select	Please Select

+ Add Row

Do you use a transfer station?

- Yes
- No

Do you own/operate a Material Recovery Facility (MRF)?

- Yes
- No

Do you offer organics/compost services?

- Yes
- No

Would you be interested in providing organics services in the future?

- Yes
- No

Do you have an estimate of how much it would cost to provide organics services?

Do you offer recycling services? *

- Yes
- No

Would you be interested in providing recycling services in the future?

- Yes
- No

Do you have an estimate of how much it would cost to provide recycling services?

Which recycling services do you offer? ("multi-family" = 8 units or more)

- [ ] Residential (excluding multi-family)
- [ ] Residential (including multi-family)
- [ ] Commercial
- [ ] Drop-Off

Do you offer commercial trash services?

- ○ Yes
- ○ No

Are multi-family customers included in residential or commercial service? ("multi-family" = 8 units or more)

- ○ Residential
- ○ Commercial

If you have an internal database you are willing to share that could provide more detail on any of the following questions, please check the box below.

- [ ] Yes - I am willing to share our internal data

Next

Residential Recycling Services

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many multi-family households do you provide curbside service to? ("multi-family" = 8 units or more)

How many single-family households do you provide curbside service to?

Of the households you provide trash service to, how many do you provide recycling services to? (estimate % if needed)

How often do you pickup recycling?

- ○ Weekly
- ○ Bi-Weekly
- ○ Monthly
- ○ Other

How is recycling collected curbside?

- ○ Single Stream/Comingled (one cart)
- ○ Dual Stream (two carts)
- ○ Multi Stream (multiple bins for each material type)

What is the estimated participation or set-out rate for households with recycling services?

- ◯ Less than 50%
- ◯ 50%-60%
- ◯ 60%-70%
- ◯ 70%-80%
- ◯ 80%-90%
- ◯ 90%-100%

What percentage of households are "seasonal"?

How do you define a "seasonal" household?

What size bins do you offer? (select all that apply)

- ☐ 80+ Gallon
- ☐ 50-80 Gallon
- ☐ 20-50 Gallon
- ☐ 20 Gallon
- ☐ Less than 20 Gallons

What is the average cost to residents per household to provide recycling services?

What is the average cost to your business per household to provide recycling services?

What is the mechanism of cost for single family households?

- ☐ Property Tax
- ☐ Utility
- ☐ Pay as you throw (PAYT)
- ☐ Subscription

Is the single family service provided through open-market (subscription) or municipal contract?

- ◯ Open-Market (Subscription)
- ◯ Municipal Contract

Is the multi-family service provided through open-market (subscription) or municipal contract?

- ◯ Open-Market (Subscription)
- ◯ Municipal Contract

Is single family curbside recycling included as a part of regular trash service?

- ◯ Yes
- ◯ No
- ◯ Other

What materials are currently accepted?

- ☐ Glass
- ☐ Ferrous Metals
- ☐ Non-Ferrous Metals
- ☐ Plastics
- ☐ Mixed Paper
- ☐ Cardboard

How many trucks do you have servicing curbside recycling routes?

What type of vehicle services residential curbside recycling?

- ◯ Front Load
- ◯ Rear Load
- ◯ Side Load

Does the vehicle compact? If yes, what is the compaction ratio?

If no, leave blank. Answer with compaction ratio only.

How many stops are on each route on average?

How long is the collection route? (Distance in miles)

How many times does the truck tip per day?

Where do your trucks tip?

- ☐ Transfer Station
- ☐ Recycler
- ☐ Material Recovery Facility (MRF)
- ☐ Other

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Commercial Recycling Services

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many commercial customers do you have?

How many of each type of business are on your commercial collection routes?

Office Buildings

Hospitality

Retail

Schools

Government Buildings

Public Spaces

Medical Facilities

Apartments

Other

How often do you pickup for commercial customers?

- ☐ Twice a Week
- ☐ Weekly
- ☐ Bi-Weekly
- ☐ Monthly
- ☐ Other

If different, how often do you pickup multifamily commerical customers?

- ☐ Twice a Week
- ☐ Weekly
- ☐ Bi-Weekly
- ☐ Monthly
- ☐ Other

How much do you charge businesses per yard for curbside pickup?

How many trucks do you have servicing commercial recycling routes?

What type of vehicle services commercial recycling customers? (select all that apply)

- ☐ Front Load
- ☐ Rear Load
- ☐ Side Load
- ☐ Roll-off

What is the capacity of the vehicle? (Volume in yd3)

What is the capacity of the vehicle? (Weight in lbs.)

Does the vehicle compact? If yes, what is the compaction ratio?

If no, leave blank. Answer with compaction ratio only.

How many stops are on each route on average?

How many times does the truck tip per day?

Where do your trucks tip?

- ☐ Transfer Station
- ☐ Recycler
- ☐ Material Recovery Facility (MRF)
- ☐ Other

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Drop Off Services

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many drop off sites do you service?

How many drop-off recycling routes do you have running per week?

How often are the drop off sites serviced?

- ☐ Twice a week
- ☐ Weekly
- ☐ Bi-Weekly
- ☐ Monthly
- ☐ Other

How many containers are picked up?

What size are the containers?

What materials are collected at the drop-off site?

- ☐ Glass
- ☐ Metal
- ☐ Plastics
- ☐ Mixed Paper

How many households are served by the drop-off site?

What is the mechanism of cost for the drop-off site?

Does the drop-off site accept residential and non-residential trash?

- ○ Yes
- ○ No

How many routes/trucks service drop-off sites?

What type of vehicle services the drop-off site?

- ○ Front Load
- ○ Rear Load
- ○ Roll-off

Does the vehicle compact? If yes, what is the compaction ratio?

If no, leave blank. Answer with compaction ratio only.

How many drop-off sites are serviced on each route?

Where do you bring the recycling from the drop-off site?

[ ]

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General Recycling Questions

How many total tons of recycling to you collect per year? (estimate)

[ ]

What does the breakdown of the composition of recyclables currently look like? by %)

Plastic [ ]

Ferrous Metals [ ]

Non Ferrous Metals [ ]

Glass [ ]

Mixed Paper [ ]

Cardboard [ ]

Aseptic Containers [ ]

Where do you currently take your recycling to be processed?

[ ]

Are recycling services bundled with trash collection contract?

[ ]

Do you receive any revenue sharing through recyclables?

- ○ Yes
- ○ No

Can you describe your revenue sharing agreement?

[ ]

Do you have any changes in servicing being planned in the next year?

[ ]

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Residential Trash Collection

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many households do you provide curbside trash service to?

How often do you collect residential curbside trash?

- ☐ Weekly
- ☐ Bi-Weekly
- ☐ Monthly
- ☐ Other

What size bins do you offer? (select all that apply)

- ☐ 96 Gallon
- ☐ 54 Gallon
- ☐ 32 Gallon
- ☐ Other

How many curbside trash routes do you have running per week?

What is the typical type of vehicle that you have servicing residential curbside collection?

- ○ Front Load
- ○ Rear Load
- ○ Side Load

What is the capacity of the vehicle? (Volume in yd3)

What is the capacity of the vehicle? (Weight in lbs.)

Does the vehicle compact? If yes, what is the compaction ratio?

If no, leave blank. Answer with compaction ratio only.

How many stops are on each route on average?

How long do collection routes take on average?

Where do your trucks tip at the end of their routes?

How many times does the truck tip per day?

How full is the truck when it does tip? (Estimate)

- ◯ Less than 50%
- ◯ 50-60%
- ◯ 60-70%
- ◯ 70-80%
- ◯ 80-90%
- ◯ 90-100%

What is the estimated miles per gallon (MPG) of the truck?

- ◯ 1-2
- ◯ 2-4
- ◯ 4-6
- ◯ 6-8
- ◯ More than 8

How many miles per year does the truck travel?

How many total tons of trash do you haul per year?

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Commercial Trash Service

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many commercial customers do you have?

How many of each type of business are on your commercial collection routes?

- Office Buildings
- Hospitality
- Retail
- Schools
- Government Buildings
- Public Spaces
- Medical Facilities
- Apartments
- Other

How much do you charge businesses per yard for commercial pickup?

How often do you collect commercial trash?

- [ ] Weekly
- [ ] Bi-Weekly
- [ ] Monthly
- [ ] Other

If different, how often do you collect multifamily commercial trash?

- [ ] Weekly
- [ ] Bi-Weekly
- [ ] Monthly
- [ ] Other

How many trucks do you have servicing commercial trash routes?

What type of vehicle services commercial trash customers? (select all that apply)

- [ ] Front Load
- [ ] Rear Load
- [ ] Side Load
- [ ] Roll-off

What is the capacity of the vehicle? (Volume in yd3)

What is the capacity of the vehicle? (Weight in lbs.)

Does the vehicle compact? If yes, what is the compaction ratio?

If no, leave blank. Answer with compaction ratio only.

How many stops are on each route on average?

How many times does the truck tip per day?

Where do your trucks tip?

- [ ] Transfer Station
- [ ] Recycler
- [ ] Material Recovery Facility (MRF)
- [ ] Other

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Compost Questions

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

Is compost picked up curbside or at a drop-off site?

- ◯ Curbside
- ◯ Drop-off

If drop-off, what size dumpster is collected?

If curbside, what size bins do you offer? (select all that apply)

- ☐ 96 Gallon
- ☐ 54 Gallon
- ☐ 32 Gallon
- ☐ Less than 20 Gallons

What types of compost do you accept? (select all that apply)

- ☐ Food Scraps
- ☐ All Yard Waste
- ☐ Yard Waste (leaves only)
- ☐ Compostable Paper
- ☐ Compostable Packaging

Where do you tip your compost routes?

- ☐ Transfer Station
- ☐ Compost Site
- ☐ Other

Where does the compost go to be processed?

How much does it cost for households to sign up for compost services?

How much does it cost you to provide compost services per household?

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Transfer Station

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

What do you use the transfer station for?

- [ ] Trash
- [ ] Recycling
- [ ] Compost/Organics

How much does it cost to use or operate transfer station per year?

Who operates the transfer station?

Who owns the transfer station?

Where is the transfer station located?

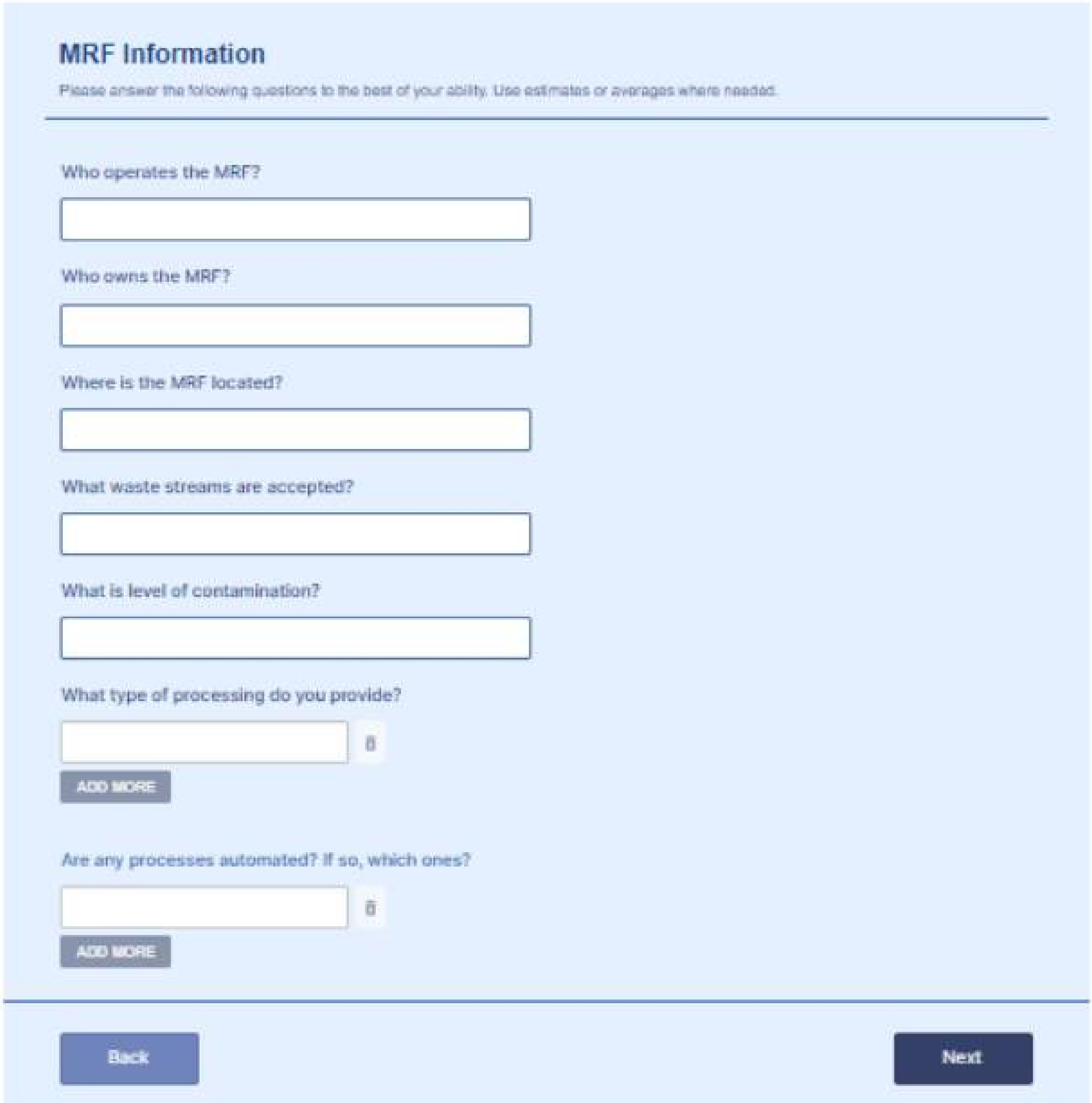
Is the material prepped or processed in any way at the transfer station? (ex: bailed)

Where are recyclables taken from the transfer station?

Where is trash taken from the transfer station?

Do you use any additional transfer stations?

- ○ Yes
- ○ No



MRF Information

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

Who operates the MRF?

Who owns the MRF?

Where is the MRF located?

What waste streams are accepted?

What is level of contamination?

What type of processing do you provide?

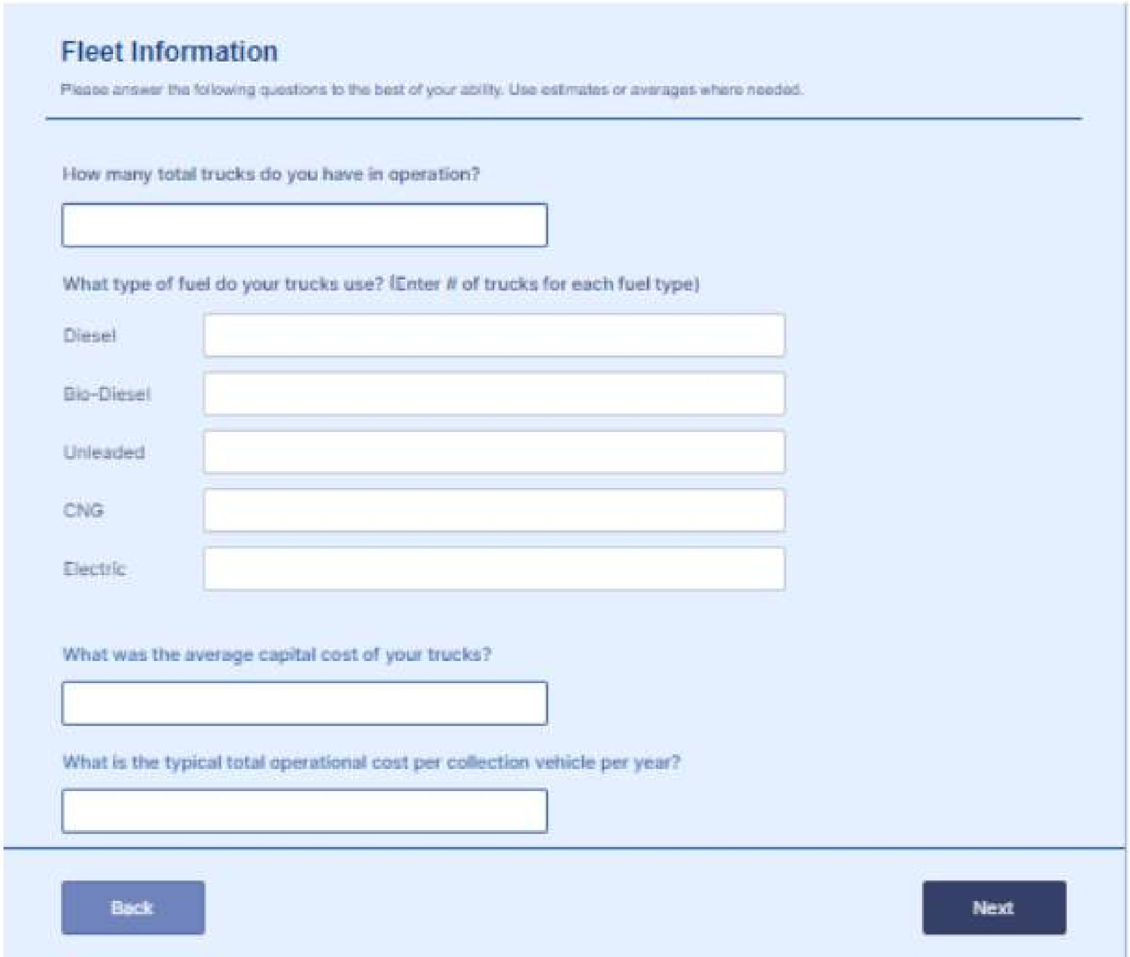
ADD MORE

Are any processes automated? If so, which ones?

ADD MORE

Back

Next



Fleet Information

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

How many total trucks do you have in operation?

What type of fuel do your trucks use? (Enter # of trucks for each fuel type)

Diesel

Bio-Diesel

Unleaded

CNG

Electric

What was the average capital cost of your trucks?

What is the typical total operational cost per collection vehicle per year?

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Next

Financial and Payroll Information

Please answer the following questions to the best of your ability. Use estimates or averages where needed.

Please list each position on your payroll and how much is spent annually on each.

ADD MORE

How much do you spend annually on payroll and associated taxes?

How much do you spend on each of the following sectors annually:

Administrations

Marketing

Education

Operations

Other (please list)

What is your annual profit margin?

How much do you spend on container purchases per year?

How much do you spend on container washing per year?

If applicable, how much do you spend on tip fees annually?

What are some revenue reduction factors you face?

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APPENDIX B.

Grand Junction Accepted Materials

Glass

Glass bottles, jars, and jugs of any color. Rinse them out and remove all lids.

Paper

Newspapers, magazines, catalogs, junk mail, paperback books, white or pastel office-quality paper, paper egg cartons.

Single-layer Chipboard

Flattened cereal boxes, paper towel tubes, construction paper, and poster board.

Aluminum, Steel & Plastics

Aluminum & steel cans/lids, and #1, #2, & #5 plastic bottles, jars, and jugs.

Corrugated Cardboard

Clean, unwaxed corrugated cardboard. It will have two layers of fibrous paper separated by a ruffle/wavy piece of cardboard; look at a cross-section to verify.

Prohibited Items

- Electronics/E-waste
- Batteries of any kind
- Hazardous materials: asbestos, chemicals, oils, paints, cleaners, needles, etc.
- Yard waste
- Construction debris/wood
- Medical waste: used gloves/masks, medicine

APPENDIX C.
Denver Accepted Materials

» Empty Containers. Remove & Discard Caps and Lids. Do Not Flatten. «

Aluminum Cans, Foil & Pie Plates

- Remove as much food residue as possible.

Glass Bottles & Jars

- Food and beverage glass only.
- Large metal lids can be recycled, but must be removed from bottle or jar.

Steel Cans & Aerosol Cans

- Aerosol cans must be empty.

Food & Beverage Cartons

Products commonly packaged in cartons include:

- Milk (dairy, soy and almond)
- Juice
- Soup, broth and wine
- Protein drinks and juice boxes
- Ice cream and frozen yogurt

Plastics

Rigid plastics marked with a number ♳ through ♷:

- Milk jugs
- Soda and water bottles
- Detergent and cat litter jugs
- Shampoo bottles
- Yogurt, sour cream, cottage cheese and butter tubs
- Peanut butter and mayonnaise jars
- "To-go" plastic drinking cups
- **Plastic** trays like those used for microwave dinners
- "Clamshell" containers like those used to package berries and baked goods

» Remove & Discard Plastic Films and Bags. «

Corrugated Cardboard

- Flatten and cut cardboard into pieces no larger than 2 ft. x 2 ft.
- Only broken down boxes inside the cart will be collected for recycling.

Office Paper & Junk Mail

- Limit shredded paper and place in a closed paper bag labeled "shredded paper."

Paperboard

- Cereal and soda boxes, paper towel rolls, paper egg cartons, etc.
- Flatten all paperboard.

Newspaper, Magazines & Catalogs

- Remove plastic bags.

Paper Bags

- Remove food wrappings and food.

Phone Books

- Remove and discard magnets.

DON'T PUT THESE ITEMS IN YOUR PURPLE CART

- **NO** Garbage
- **NO** Bubble wrap or envelopes with bubble wrap inside
- **NO** Candy or food wrappers
- **NO** Ceramics
- **NO** Microwave popcorn bags
- **NO** Paper cups or plates
- **NO** Plastic bags
- **NO** Plastic shrink wrap
- **NO** Plastic tubes, such as toothpaste tubes
- **NO** Styrofoam® of any kind
- **NO** Toys
- **NO** Waxed cardboard
- **NO** Plastic containers marked as "Compostable" or "PLA"

COLORADO NEEDS ASSESSMENT

ELEMENT 3 DEMOGRAPHICS

JANUARY 25, 2024

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APPENDICES

1 EXECUTIVE SUMMARY

1.1 PURPOSE

This memo outlines the demographic data, with an environmental justice focus, to be considered as part of the Colorado Needs Assessment. The data collected builds on the four Regions defined by the State of Colorado's 2016 Integrated Solid Waste Materials Management Plan (2016 ISWMMP). This environmental justice analysis dives deeper into the characteristics of the four Regions to encourage transparency and informed decisions surrounding policy, infrastructure, and access to services. These demographic factors are to be considered in the development of reimbursement rates for service providers in accordance with subsection (4)(j) of section 25-17-705 of the Producer Responsibility Program for Statewide Recycling Act.

1.2 APPROACH

The project team conducted a desktop review of available demographic data. The evaluation included a desktop review of Colorado's solid waste planning regions and equity goals to assess the work that the State has already completed. The project team then analyzed data from the U.S. Census Bureau, the EPA's Environmental Justice Screening and Mapping Tool, Colorado EnviroScreen, the Association of People Supporting Employment First, the County Health Rankings & Roadmaps program, and community analytics data on service access. The analysis included a demographic and environmental data review including population, household, race and ethnicity, education, digital access, English proficiency, disabilities, economic factors, health, and environmental indicators.

1.3 FINDINGS

- About 16% of Colorado’s population and 77% of the landmass is considered Rural (predominately located in the Western Slope, the Mountains, and the Eastern Plains Regions); however, 84% of Colorado's population and almost 80% of businesses exist in the Front Range, the densest of the four Regions.
- The Front Range and Eastern Plains are the most diverse Regions, with Spanish being the second most spoken language (11%) across all regions. The third most spoken languages are Chinese (including Cantonese and Mandarin) and German at less than 1% of the population each.
- The Front Range population has the densest 20-40 age category at 31% of their population. About 19% of the rural population is 65 and over, compared to 14% in the Front Range.
- Seasonal population fluctuations, including visitors and labor, peak in Summer (June-August) and Winter (December through March) for many Mountain communities.

- Significant urban and rural trends exist: The Front Range has the highest income per capita and is the "healthiest" Region.[1] At the same time, the Western Slope and Eastern Plains exhibit higher poverty levels and have poorer health.
- The Front Range has the highest percentage of multi-family buildings, making up 28% of the housing.
- Over 70% of residents in the State of Colorado use a computer, and over 80% use a cellphone. Facebook is the most utilized social media platform, with over 60% of Colorado residents using it.
- The highest concentration of businesses, nearly 70%, are located in the Front Range. Most businesses (approximately 80%) report less than $5 million in annual sales. The proportion of businesses with sales higher and lower than $5 million was similar in all four regions.
- The Front Range has the highest number of households, per capita income, and smallest low-income population. The Eastern Plains has the highest low-income population, followed by the Western Slope and the Mountains. The unemployment rate is similar across the four Regions at about 5%.
- The Colorado Department of Public Health & Environment (CDPHE) reached out to tribal communities for information on their recycling programs. Participants noted that recycling services are typically not provided, but there may be a limited quantity of self-haul recycling.

1.4 RECOMMENDATIONS

- Educational materials and outreach plans should be translated into Spanish, with options for additional languages.
- Seasonal population and tonnage fluctuations will require customized capacity planning, contamination monitoring, and education for transient populations.
- Disabilities throughout the population in each region should be better understood in order to prevent barriers to recycling and have a more inclusive recycling system.
- System upgrades, including collection programs, processing facilities, drop-off, and transportation, should not unfairly impact low-income areas.

[Note: The recommendation list will be refined upon finalization of Scenarios. This draft-final list will be modified as needed.]

[1] According to the County Health Rankings & Roadmaps program health behaviors and health outcomes were assessed and considered to determine a County Health Ranking for every County in the United States.

2 STATE GOALS AND EXISTING DATA

2.1 THE FOUR REGIONS

The 2016 ISWMMP divides Colorado into four Regions based on varying socioeconomic and geographic factors: the Western Slope,[2] the Mountains,[3] the Front Range,[4] and the Eastern Plains.[5] The 2016 ISWMMP recognized that solid waste planning efforts look very different within the Region due to the variation in infrastructure and programming. These Regions are also referenced in the 2022 Colorado Statewide Organics Management Plan (2022 SOMP).[6]

Figure 1 shows the four Regions that make up the State of Colorado. The Organics Management Plan reiterates the importance of region-specific planning in Colorado, providing high-level demographic characteristics.

As of 2022, 84% of the State's population lived in the Front Range, as opposed to 3% in the Eastern Plains and 6-7% in the Mountains and Western Slope.[7]

Both reports make the case for developing regional recommendations due to the differences in the population and geographic characteristics across the State; therefore, this Colorado Needs Assessment will continue to utilize the same regional boundaries previously referenced. Neither of the previous studies conducted a strong demographic data analysis nor provided an environmental justice assessment, which will be provided in this Memo.

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[2] Western Slope Region Counties: Moffat County, Rio Blanco County, Garfield County, Mesa County, Delta County, Montrose County, Ouray County, San Miguel County, Dolores County, San Juan County, Montezuma County, and La Plata County.

[3] Mountains Region Counties: Jackson County, Routt County, Grand County, Eagle County, Summit County, Clean Creek County, Pitkin County, Lake County, Park County, Gunnison County, Chafee County, Fremont County, Hinsdale County, Saguache County, Custer County, Mineral County, Rio Grande County, Alamosa County, Archuleta County, Conejos County, and Costilla County.

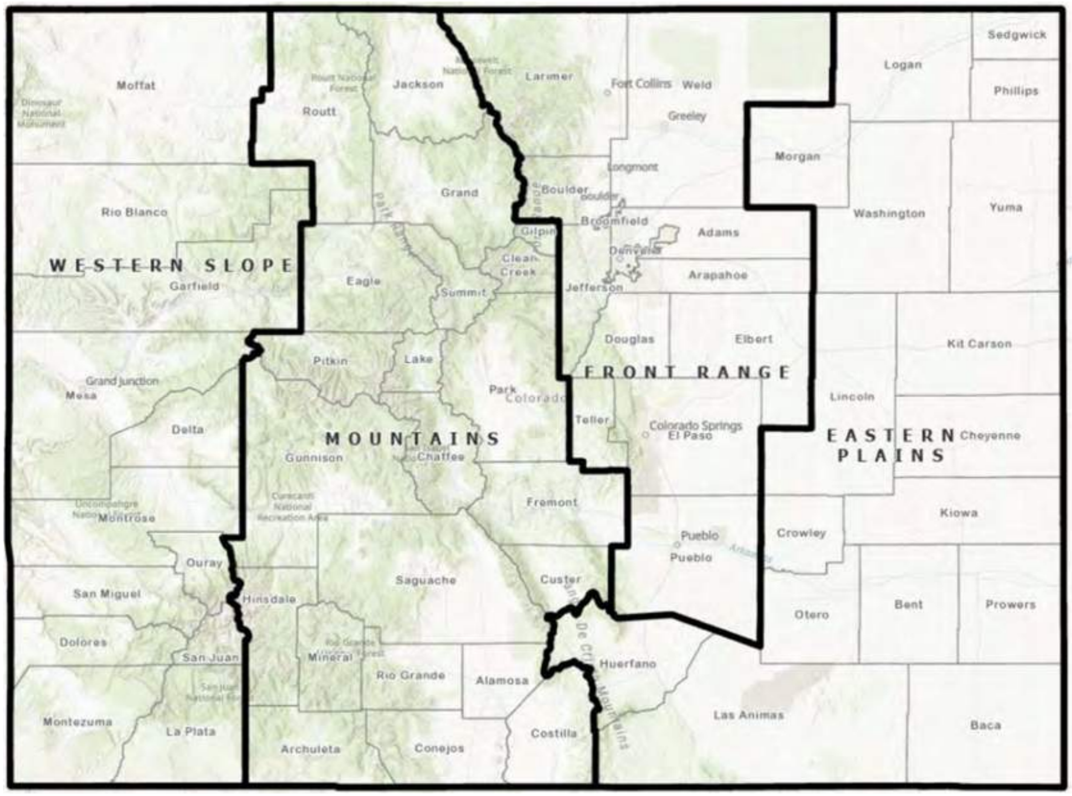
[4] Front Range Region Counties: Larimer County, Weld County, Boulder County, Bloomfield County, Adams County, Jefferson County, Denver County, Arapahoe County, Douglas County, Elbert County, Teller County, Colorado Springs County, and Pueblo County.

[5] Burns McDonnell, SERA (2016). *Colorado Integrated Solid Waste & Materials Management Plan*.

[6] RRS, SERA, Tetra Tech (2022). *Colorado Statewide Organics Management Plan: A Framework for Regional Organics Opportunities*.

[7] RRS, SERA, Tetra Tech (2022). *Colorado Statewide Organics Management Plan: A Framework for Regional Organics Opportunities*.

Figure 1: Colorado Regions



The 2016 ISWMMP summarizes the nature of solid waste operations in each Region, highlighting how demographic and physical differences affect services.

2.1.1 Western Slope Region

The Western Slope consists of all counties touching the Utah border and the counties of Delta, Ouray, San Juan, and La Plata. The Region's title refers to its geographic placement, west of Colorado's Rocky Mountains. The majority of the population lives in the Tri-County area, containing Grand Junction, Montrose, and Delta. Grand Junction is the largest city between Denver and Salt Lake City, Utah. On the Western Slope, waste generally stays within each county or is transported in a north/south direction to other counties instead of going east due to transportation limitations through the Mountains Region. Many recyclables are sent east to Denver or west (Utah) for processing. Transportation connectivity within the Region is also limited by mountain passes such as Red Mountain Pass, isolating the southwestern corner of the State, including Durango, from the rest of the Western Slope.

2.1.2 Mountains Region

The Mountains Region includes counties along the continental divide and the San Luis Valley. The San Luis Valley has a different socioeconomic and infrastructural landscape but is included in this Region for consistency with other Colorado reports. The Mountains Region populations also fluctuate as tourism and seasonal work increases in the winter ski season. Materials in the mountain communities are generally not transported far due to weather impacting travel most of the year. Most of the mountain population lives along the highway corridors, allowing materials to be hauled directly from these communities.

2.1.3 Front Range Region

The Front Range includes all the counties along the I-25 corridor from Pueblo County to Larimer County. With the highest population and density, the Front Range has more infrastructure, programs, and services. Therefore, materials also do not travel outside the Region until they are exported to end markets.

2.1.4 Eastern Plains Region

The Eastern Plains Region consists of the counties along Colorado's eastern border and the lower population counties neighboring the Front Range counties. Due to low population density and large geographic areas in the Eastern Plains, there is a higher number of landfills servicing these counties and a great need for recycling and composting infrastructure.[8]

2.2 EQUITY GOALS

The State of Colorado has various data collection and outreach resources that will be useful for the Needs Assessment and future phases of the EPR Program Implementation. The CDPHE Environmental Justice Unit stems from the Colorado Environmental Justice Act (HB21-1266). The Act prioritized reducing environmental health disparities in disproportionately impacted communities and created an Advisory Board, Environmental Justice Action Task Force, and Ombudsperson to carry out the work. The Advisory board oversees the Colorado Environmental Justice Grant Program: Community Solutions to Improve Environmental Health, also implemented through this Act, which provides funding for measuring, preventing, or reducing pollution in these communities.[9] In 2023, Governor Polis directed CDPHE to adopt a new definition of disproportionately impacted communities that would apply to all state agencies, as recommended by the Environmental Justice Action Task Force (HB23-1233). Communities that meet this definition are represented in Colorado EnviroScreen, an interactive environmental justice mapping and health screening tool developed for CDPHE by Colorado State University.

[8] Burns McDonnell, SERA (2016). *Colorado Integrated Solid Waste & Materials Management Plan.*

[9] https://cdphe.colorado.gov/environmental-justice

Disproportionately impacted communities are defined at the census block group scale and include:

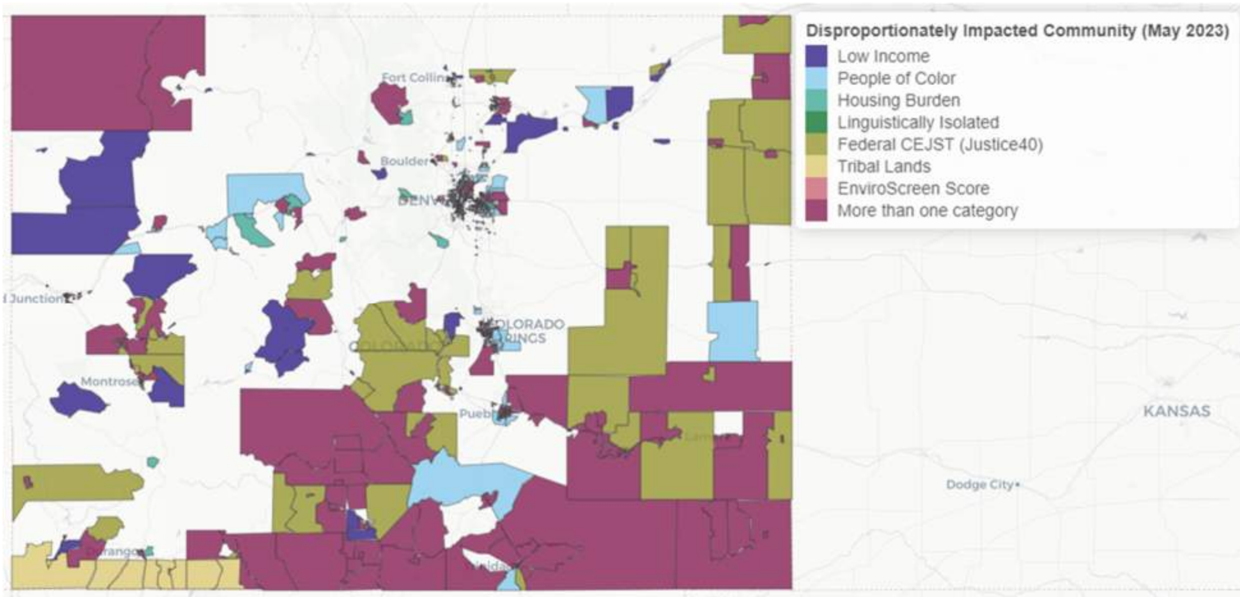
- **Low-income communities:** Census block groups where more than 40% of households are at or below 200% of the federal poverty line.
- **Communities of color:** Census block groups where more than 40% of the population identify as anything other than non-Hispanic White.
- **Housing cost-burdened communities:** Census block groups where more than 50% of households spend more than 30% of their income on housing costs like rent or mortgage payments.
- **Linguistically isolated communities:** Census block groups where more than 20% of the population live in households where all adults speak a language other than English and speak English less than very well.
- **Historically marginalized communities:** Communities with a history of environmental racism created through redlining or anti-Black, anti-Hispanic, anti-immigrant, or anti-Indigenous laws, policies, or practices that continue to experience present-day environmental health disparities.
- **Cumulatively impacted communities:** Communities where multiple factors, including socioeconomic stressors, vulnerable populations, disproportionate environmental burdens, vulnerability to environmental degradation or climate change, and lack of public participation, may act cumulatively to affect health and the environment and may contribute to persistent environmental health disparities. Cumulatively impacted communities can be presumptively identified in one of two ways:
    - They are in a census block group with a Colorado EnviroScreen score above the 80th percentile, or
    - They are in a census tract that the federal Council on Environmental Quality's Climate and Economic Justice Screening Tool identifies as disadvantaged.
- **Tribal lands:** The Southern Ute and Ute Mountain Ute Reservations.
- **Mobile Home Communities:** Areas that meet the Department of Local Affairs' definition of a Mobile Home Park.

The areas that fall within the definition of Disproportionately Impacted Communities are highlighted in **Figure 2** below. The map also identifies areas considered disadvantaged at the Federal level using data from the Climate and Economic Justice Screening Tool (CEJST). The CEJST builds on lessons from the Environmental Protection Agency's (EPA) EJScreen tool. It was specifically developed to provide a uniform government-wide definition of disadvantaged communities for Federal agencies to target Justice40 investment benefits.[10] State tools such as EnviroScreen

[10] https://www.whitehouse.gov/wp-content/uploads/2022/02/CEQ-CEJST-QandA.pdf

can utilize state agency data that is not available nationally since the CEJST and EJScreen tools require nationally consistent data.

Figure 2: Disproportionately Impacted Communities

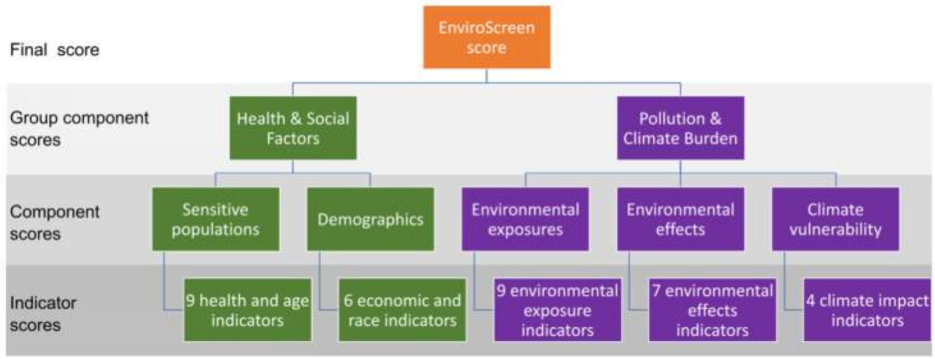


2.2.1 Colorado EnviroScreen

The Colorado EnviroScreen tool helps users advocate for funding, interventions, and policy changes to prevent, decrease, and mitigate environmental health risks. The tool highlights areas with current and past environmental inequities and where disproportionately impacted communities have a greater health burden or face more environmental risks. Specifically, the tool identifies areas that meet the new definition of disproportionately impacted communities under Colorado law, H.B. 23,1233. Population and environmental factors are used to calculate an "EnviroScreen score" by county, census tract, and census block group.

Figure 3 displays how the ultimate EnviroScreen score combines individual indicators into topic-based subcomponents such as health and social factors or pollution and climate burden. A higher EnviroScreen score means the area is more likely to be affected by environmental health injustices. Areas under the Mountain Ute and Southern Ute tribal jurisdictions are not currently represented on the map.

Figure 3: EnviroScreen Factors



2.2.2 Colorado Office of Health Equity

The Colorado Office of Health Equity has resources available for equity work in the State. Its mission is to build partnerships to mobilize community power and transform systems to advance health equity and environmental justice.[11] This Office is advised by the Health Equity Commission, which focuses on alignment, education, and capacity-building for state and local health programs and community-based organizations. This Commission also advises the Health Disparities and Community Grant Program and collaborates with the Colorado Department of Public Health and Environment (CDPHE) and the Governor's Office to develop a statewide equity report and strategic plan outlined in Senate Bill 21-181.[12] The final equity report and strategic plan are not yet available. The Office of Health Equity also oversees the Colorado Equity Alliance, which comprises representatives from state agencies and community organizations. Their mission is to ensure state-funded efforts create equitable systems for all Coloradans to thrive through collaboration between communities and state agencies. This organization also provides tools for advancing Equity, Diversity, and Inclusion (EDI).[13]

2.2.3 Accessibility

Throughout the Colorado Needs Assessment, the HDR and Eunomia team will ensure compliance with the Colorado Revised Statute (CRS) 24-85-101 and the Accessibility Standards for Individuals with a Disability, as established by the Office of Information Technology under Section §24-85-103 (2.5), CRS and all State of Colorado technology standards related to technology accessibility and with Level A.A. of the most current version of the Web Content Accessibility Guidelines (WCAG), incorporated in the State of Colorado technology standards.

After reviewing the State's reports on waste generation and diversion, there appears to be no clear connection between solid waste and the State's EDI initiatives. This Memo will strive to outline the socioeconomic and environmental factors that should be considered throughout the Colorado Needs Assessment and beyond.

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[11] https://cdphe.colorado.gov/about-office-health-equity

[12] https://cdphe.colorado.gov/health-equity-commission

[13] https://sites.google.com/state.co.us/colorado-equity-alliance/home

3 DEMOGRAPHICS ANALYSIS

3.1 ENVIRONMENTAL JUSTICE ANALYSIS

Environmental Justice (E.J.) is the fair and inclusive involvement of all individuals, regardless of race, color, national origin, or income, in creating, implementing, and enforcing environmental laws and policies. It acknowledges that certain communities, particularly minority and low-income populations, face disproportionate environmental impacts. Environmental justice ensures equal protection from environmental and health risks and equal access to decision-making processes, promoting a healthy living and working environment. An environmental justice review is considered a best practice in planning development and construction projects. Furthermore, the 2021 U.S. Infrastructure Bill mandates that infrastructure projects receiving federal funding must conduct an environmental justice assessment.

3.1.1 Methodology

This E.J. assessment of potential disproportionate impacts builds on existing census and regional health data by utilizing the EPA's Environmental Justice Screening and Mapping Tool Version 2.2 (EJScreen) and the Colorado EnvrioScreen tool. The assessment compares environmental and demographic factors across Colorado's four Regions (Western Slope, Mountains, Front Range, and Eastern Plains) against national data. EJScreen allows users to evaluate environmental and demographic indicators with a nationally consistent data set and approach. At the same time, the EnviroScreen tool uses similar datasets but also includes state-specific information that national tools cannot use. EnviroScreen utilizes data from the Environmental Protection Agency, Centers for Disease Control and Prevention, CPDHE, and the Colorado Oil and Gas Conservation Commission. EnviroScreen also incorporates community engagement from over 200 stakeholders through interviews, focus groups, and community meetings. Engagement included federal, State, local, and tribal governments, environmental justice organizations, community organizations, and businesses.

The EJScreen and EnviroScreen data was compiled by county to represent the Regions as defined by the State's Integrated Solid Waste Materials Management Plan since it is not readily available in that format. Census data from 2020 and 2021 (estimated) was used for this report.[14] The Community Analytics Tool is another source in this section, providing data on access to technology and social media platforms utilized in Colorado .[15]

Colorado's demographic data reveals many socioeconomic patterns and geographical influences that are helpful tools for making informed program and policy decisions. When considering existing and increasing access to recycling infrastructure, this demographic data will aid in understanding current systems and should inform program roll-out strategy.

[14] https://data.census.gov/profile/Colorado?g=040XX00US08

[15] Developed by the HDR Strategic Communications Team

3.2 REGIONALIZED ENVIROSCREEN

The Colorado EnviroScreen score ranges from 1 to 100, with the higher score representing a higher environmental burden on the respective community. **Table 1** summarizes the average EnviroScreen scores and average percentile. The Front Range has the highest average percentile at 61, meaning its EnviroScreen score is higher than 61% of all counties in Colorado. A higher EnviroScreen score also implies that there is a higher disproportionately impacted population. The lowest EnviroScreen score is in the Mountains Region with an average percentile of 32, meaning this is the least burdened community where 68% of census tracts in Colorado are more likely to be affected by environmental health injustices than the selected census tracts in this region. These four Regions will be further analyzed through census data and the EPA's EJ Screen tool to understand the demographic and socioeconomic variations using nationally consistent datasets.

Table 1: EnviroScreen Scores by Region

Region	Average Score	Average Percentile
Front Range	40	61%
Eastern Plains	41	59%
Western Slope	34	48%
Mountains	26	32%

3.3 STATE POPULATION

Colorado has an estimated population of 5,812,000, with 81% of the population living in the Front Range. There are 64 counties across the State and 210 census-designated places (CPD), which the United States Census Bureau uses to define unincorporated communities. According to the State Office of Rural Health, 47 of Colorado's 64 counties are considered rural or frontier, or 77% of Colorado's landmass.[16] About 16% of the State's population lives in rural areas as population growth increases along the Front Range.[17] The Front Range Region represents 84% of the State's population; however, it is the smallest Region in size. In addition, the Front Range Region contains the County of Denver, the most densely populated county in the State.

The State's population, throughout all regions, is distributed evenly through four age categories (under 20, 20-40- 41-65, 65+).[18] The Front Range population has the densest 20-40 age category at 31% of their population. About 19% of the rural

[16] Colorado Rural Health Center, 2023

[17] https://geodata.colorado.gov/datasets/municipal-boundaries/explore?location=39.003019%2C-105.568015%2C10.77

[18] U.S. Census Bureau, 2023

population is 65 and over, compared to 14% in the Front Range.[19] **Table 2** below summarizes the difference in population size across the four Regions.

Table 2: Demographic Summary by Region

Characterization	Western Slope	Mountains	Front Range	Eastern Plains
Population	406,000	336,000	4,825,000	156,000
% of Colorado Population	7%	6%	84%	3%
# of Counties	12	22	13	17
# of Cities	42	72	92	67
# of Census-designated Places	27	42	91	50

The majority of Colorado residents identify as white across all four Regions. According to the U.S. Census Data, 70.6% of Colorado's population is classified as White alone, 23% as Hispanic/Latino alone, and 3.9% as Black or African American alone.[20]

Table 3 displays how the data differs when analyzed by Region, showing that the Eastern Plains has the highest Hispanic/Latino population at 43.7% and the lowest White population at 50%.

Table 3: Race and Ethnicity Data by Region

Race and Ethnicity	Western Slope	Mountains	Front Range	Eastern Plains
White	76.1%	78.4%	63.8%	50.0%
Black	0.7%	0.5%	5.0%	1.7%
Native	1.3%	0.2%	0.3%	0.7%
Asian	1.1%	1.1%	3.8%	0.6%
Islander	0.1%	0.2%	0.1%	0.1%
Other	0.4%	0.2%	0.3%	0.4%
Two or More Races	2.7%	3.4%	3.5%	2.8%
Hispanic/Latino	17.7%	15.9%	23.1%	43.7%

According to the Migration Policy Institute, approximately 10% of the population in Colorado is "foreign-born" as of 2021, meaning naturalized U.S. citizens, lawful permanent immigrants, and green card holders, immigrants with student visas or other temporary visas, refugees and asylees, and those who are residing in the country without authorization.[21] Immigrants make up one out of every ten residents, while another one in ten residents is a native-born U.S. citizen with at least one immigrant

[19] https://data.census.gov/table/ACSDP1Y2021.DP05?q=Colorado

[20] https://data.census.gov/table?q=Colorado&tid=ACSDP1Y2021.DP05

[21] https://www.migrationpolicy.org/data/state-profiles/state/demographics/CO

parent.[22] The immigrant population is increasing rapidly in Colorado as Denver has seen a surge in migrants in the last year after traveling to the U.S. from Central and South America.[23] Since December 2022, Denver has served over 25,000 migrants directly.[24] As the migrant effort is ongoing, data is not yet available on how many people will stay in the Denver area or travel elsewhere in the United States. This potential increase in Central and South American residents will impact the proportion of Spanish translation services needed in Colorado. Spanish translation will already be in high demand statewide as it is the second most spoken language.

3.4 LIMITED ENGLISH PROFICIENCY

The census data revealed that the majority of the population in Colorado identifies as white, with the second highest population identifying as Hispanic or Latino. The EJScreen Tool reports the percentage of people who speak one or more languages at home. As shown in **Table 4** below, 83.8% of people speak only English at home. Across all Regions, Spanish (10.9%) is the non-English language spoken most often at home. Statewide, the third most spoken languages are Chinese (including Cantonese and Mandarin) and German, but this data is not available at the regional level.[25]

Table 4: Language Breakdown

Region	English	Spanish	Other[26]
Front Range	83%	11%	4%
Eastern Plains	85%	13%	1%
Western Slope	88%	9%	1%
Mountains	87%	10%	1%

The denser, more urban areas within the Front Range have the most diversity in languages spoken, with 83% of the population proficient in English as compared to the other regions where English proficiency is higher. In the Front Range, 11% of the population speaks Spanish. More rural areas, such as the Mountains Region, report an English language proficiency at 87%, with Spanish being the second highest utilized language at 10%. It will be important to ensure that information on the recycling system can be readily communicated non-English speaking population..

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22 https://www.americanimmigrationcouncil.org/sites/default/files/research/immigrants_in_colorado.pdf

23 https://denvergov.org/Community/Assistance-Programs/Migrant-Support/Migrant-Sheltering/September-25-Update-on-Denvers-Migrant-Sheltering-Response

24 https://www.denvergov.org/Community/Assistance-Programs/Migrant-Support#section-2

25 https://datausa.io/profile/geo/colorado#languages

26 Other: Russian, Polish, or Other Slavic; Other Indo-European; Other Asian and Pacific; German or other West Germanic.

3.5 POPULATION DENSITY

Population density will significantly impact the infrastructure and transportation needed to support increased recycling efforts throughout Colorado. The trends in population density differ between the four Regions, with rural communities being more spread out than denser urban areas (**Table 5**). The Front Range has the highest population and contains 19 of the 20 most densely populated cities in the State. The largest cities by land size, Colorado Springs and Aurora, covering over 100,000 acres each, are also in the Front Range and are included in the top 30 densest cities. **Table 5** shows the average population count per square mile per Region, with the Front Range as the densest and the Mountains the least dense.

Table 5: Population Density by Region

Region	Density[27]
Front Range	2,043.1
Eastern Plains	1,173.4
Western Slope	1,048.6
Mountains	846.3

The cost-effectiveness and efficiency of operations will differ across various population densities. Highly populated and dense areas may need additional infrastructure and education to manage container storage, contamination, and recycling access in multi-family structures. Population size and density are low in rural communities; however, the land area coverage is high, creating challenges when establishing collection routes.

3.6 SEASONAL POPULATIONS

Colorado's outdoor recreation industry accounted for $8.6 billion in direct travel-generated earnings, contributing to over 176,000 direct jobs in 2021.[28] Seasonal tourism creates significant population fluctuations in the Mountain and Western Slope communities. Traditional population data collection methods do not capture seasonal fluctuation of visitors and labor, so availability depends on the specific community's local survey data. For example, Summit County, home to large ski resorts such as Keystone, Breckenridge, and Copper Mountain, has a year-round population of 30,000 residents that swells to over 150,000 people during high season.[29] Employment can also show fluctuations; for example, Eagle County's labor force tends to increase by 5.5% (roughly 1,800 workers) in the winter season compared to the rest of the year. The lowest month is May, when the labor force contracts by 7% (or about -2,400 workers). **Figure 4** summarizes the total labor force by month from January

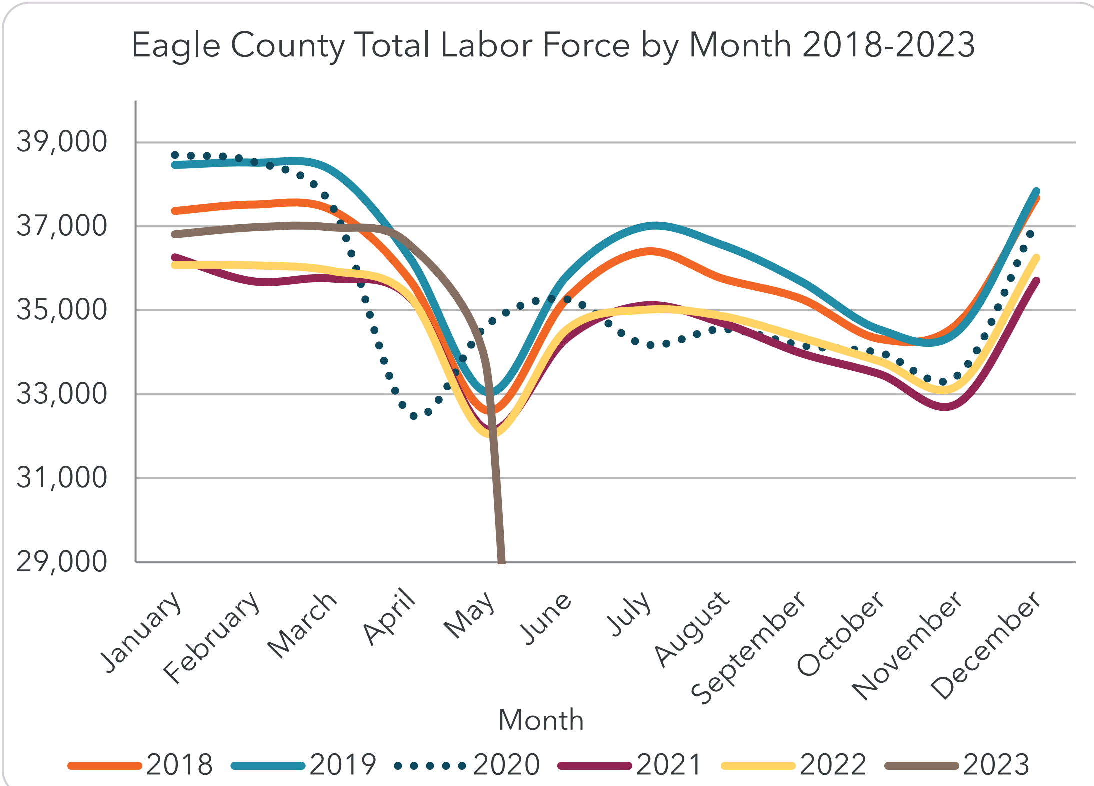
[27] Average population count per square mile per Region.

[28] Dean Runyan Associates (2022), *The Economic Impact of Travel in Colorado*

[29] Eco-cycle (2022), *Greater Colorado Waste Diversion Baseline Assessment Report*

2018 to May 2023 in Eagle County due to tourism primarily for resorts such as Vail and Beaver Creek.[30]

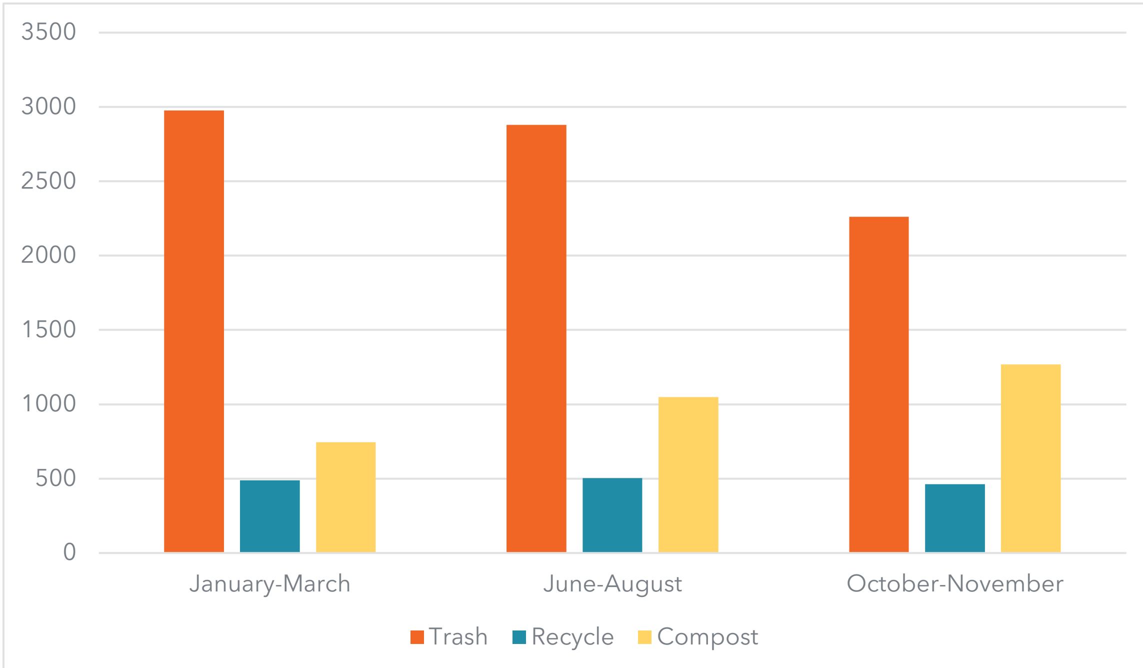
Figure 4: Eagle County Total Labor Force by Month



Along with population increases, the Mountain Region also experiences some increases in tonnage during peak months, which fall generally within summer and winter. Summit County and Pitkin County provided the project team with monthly tonnage data as a sample of how tonnage fluctuates in counties with large ski resorts and tourist populations. Summit County reported 25-30% less trash in their lowest months, which are May and October/November, the transitional months between winter and summer tourism. **Figure 5** visualizes the spikes in seasonal tonnage for trash, increasing by 25-30% on average between peak winter tourism and non-peak months. Recycling remains generally constant with a slight increase in the summer, while compost is at its highest in the fall. Pitkin County, home to Aspen and Snowmass ski resorts, reported a 6% increase for trash, 29% increase for recycle, and 138% increase for compost between their lowest (October) and peak month (December).

[30] Larbor Market Information Gateway, Colorado Department of Labor and Employment: https://www.colmigateway.com/vosnet/lmi/default.aspx?plang=E

Figure 5: Average Summit County Seasonal Tonnage (2022)



Tourism-based communities are challenged with educating tourists on recycling and composting correctly during their short stay. Haulers are also challenged with right-sizing operations to accommodate seasonal volumes and must closely monitor for contamination during peak months. They require more collections in the high season and adequate collections in the low season. Another common challenge is tourists camping or in remotely parked R.V.s without access to publicly available trash and recycling drop-off sites, creating illegal dumping opportunities.[31] These challenges in educating fluctuating populations and managing seasonal material volumes will need to be considered when implementing a state-wide recycling program. Contamination mitigation should be prioritized in regions with higher tourism. Recycling capacity at MRFs and transfer stations should reasonably consider the year's peak months due to tourism.

3.7 NONRESIDENTIAL COVERED ENTITIES

The legislation requires the includes small businesses the consideration of providing recycling services to nonresidential covered entities which includes public places, small businesses, and hospitality locations. The project team evaluated the total number of businesses with annual sales greater than or less than $5 million from the North American Industry Classification System (NAICS)[32], based on relevant business codes for nonresidential covered entities defined in the legislation. The data is regionalized below in **Table 6,** showing that the highest concentration of businesses, nearly 70%, are located in the Front Range. Most businesses report less than $5 million

[31] Eco-cycle (2022), *Greater Colorado Waste Diversion Baseline Assessment Report*

[32] Wholesale trade, retail, elementary and secondary schools, arts and recreation, food (dining), food (grocery), accommodations.

in annual sales, based on available NAICS data. The proportion of businesses with sales higher and lower than $5 million, as was similar in all four regions.

Table 6: Number of Businesses and Sales

Region	Total Number of Businesses	Percent of Total	Percent of Businesses with Sales >$5M	Percent of Business with Sales <$5M
Front Range	22,248	69%	21%	79%
Eastern Plains	2,715	8%	17%	83%
Western Slope	4,294	13%	21%	79%
Mountains	3,035	9%	22%	78%

Business location varies regionally and is impacted by Colorado's tourism industry. Regionally, the Mountains have the most Arts and Recreation and Accommodations businesses in the State due to the high tourism. The Mountains has the least wholesale trade, retail, elementary schools, and grocery options in the State. The Front Range leads in having the most food (dining and grocery) options in the State, likely due to population density and ease of transportation. The Eastern Plains leads in the highest wholesale trade and retail concentration, tying with the Front Range for grocery options. **Table 7** summarizes this data below.

Table 7: Types of Businesses by Percentage and Region

Region	Wholesale Trade	Retail	Elementary and Secondary Schools	Arts and Recreation	Food (Dining)	Food (Grocery)	Accommodations
Front Range	16%	15%	10%	20%	16%	16%	6%
Eastern Plains	17%	17%	13%	13%	13%	16%	11%
Western Slope	15%	13%	9%	23%	11%	13%	16%
Mountains	6%	12%	6%	29%	15%	10%	22%

Although EPR implementation is only required for residential services initially, it is important to consider all users of recyclable packaging. These diverse businesses will require industry-specific education and service levels. Further stakeholder engagement will be necessary to understand commonly purchased materials, current collection services, and barriers to successful participation.

3.8 HOUSEHOLD DATA

The U.S. Census Bureau reports housing data per municipality in Colorado by number of housing units and occupancy type. The legislation requires collection services to be provided to all residences (single family or multi-family) in a manner that is as convenient as solid waste collection.

Data pertaining to the multi-family building unit counts will impact the cost associated with increasing recycling services for these residences. It is important to note that individual municipalities have their own definitions of residential vs commercial solid waste customers, for example the City and County of Denver defines "residential" customers as single family homes and multi-family buildings up to 7 units and provides service to these homes. This implies that throughout the state, certain residences will have access to services organized by their municipality, as opposed to independently contracted service between a resident and a private hauler. **Table 8** summarizes the housing unit breakdown between 2-9 units and over ten units per building by Region. The Front Range, being the densest region, has the highest percentage of multi-family buildings, making up 28% of the housing. The majority of single family homes are found on the Western Slope and Eastern Plains.

Table 8: Housing Unit Breakdown

Region	Total Households	Percent Single Family Units	Percent 2-9 units	Percent 10+ units	Percent Mobile Home and all other types of units
Front Range	1,790,240	69%	9%	19%	2%
Eastern Plains	153,588	78%	7%	5%	9%
Western Slope	183,677	71%	10%	7%	11%
Mountains	100,427	67%	10%	17%	6%

Table 9 provides a breakdown of the occupancy type throughout each Region, with the majority being homeowners. Homeownership doesn't vary greatly across the Regions but is much higher than the average in the United States, with the average Colorado ownership at about 63% and average rentership at 37%. In the United States, a bigger share of homeowners (41.6%) than renters (28.7%) had a bachelor's degree or higher. They also earned more, with a median household income of $78,000 compared to renters' $41,000.

Table 9: Housing Ownership by Unit

Region	Owners	Renters
Front Range	67%	33%
Eastern Plains	71%	29%
Western Slope	70%	30%
Mountains	75%	25%

Table 10 describes the familial characteristics of each housing unit, showing how many units contain families/non-families, with or without children, across each Region.

The Mountains Region has the highest concentration of married couples, single parents, and non-families. The Front Range has the highest concentration of married couples with children under eighteen. The Eastern Plains has the lowest concentration of married couples but the highest concentration of single parents.

Table 10: Family Characteristics

Region	Married Couples	Married Couples with children under 18	Single parent	Single parent with children under 18	Non-Families
Front Range	36.4%	15.5%	11.2%	5.9%	31.1%
Eastern Plains	30.9%	12.2%	15.3%	8.5%	33.2%
Western Slope	35.5%	13.9%	11.2%	6.1%	33.4%
Mountains	38.1%	13.7%	8.8%	5.3%	34.1%

3.9 EDUCATION

The EJScreen tool provides data on the percentage of people aged 25 or older whose education is short of a high school diploma. **Table 11** provides the breakdown across Colorado's four Regions, highlighting how every Region, excluding the Eastern Plains, is equivalent to the State's average (7% of people aged 25 or older whose education is short of a high school diploma) according to the U.S. Census Bureau.[33]

Table 11: Regional Education Levels

Region	% Less than High School Education
Front Range	7%
Eastern Plains	13%
Western Slope	8%
Mountains	7%

Education levels should be considered when educating the public on new recycling services and programs. It is important to make sure content is written at a reading level appropriate for the audience, given some of the population does not have a high school diploma. Education levels can also influence individual motivations for recycling and exposure to recycling programs, as schools can be used to teach students about the importance of recycling or at least encourage recycling in the classroom. Thoughtful education and outreach planning can help prevent contamination and encourage higher participation rates despite low education levels.

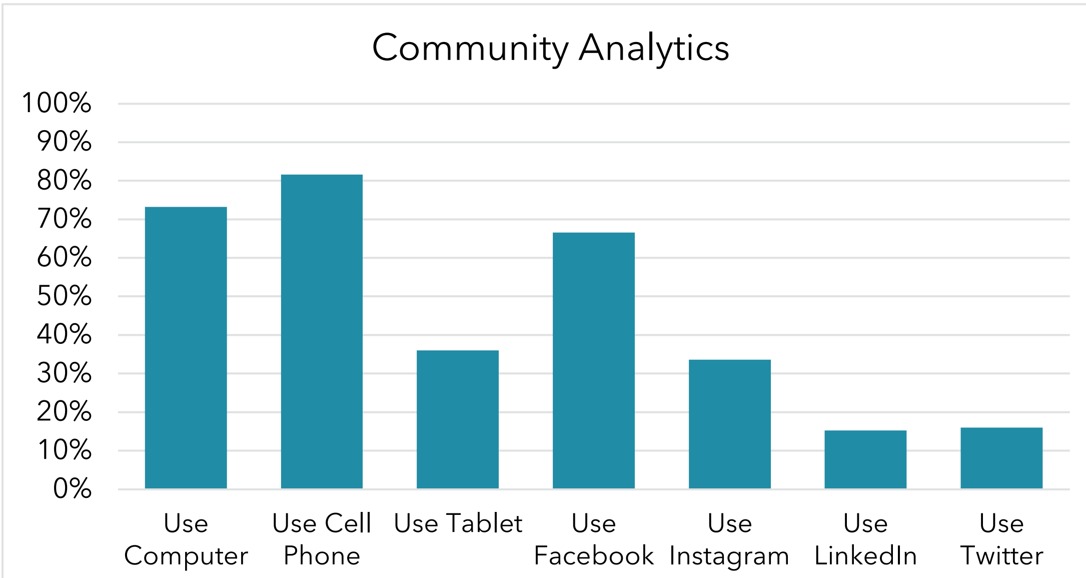
3.10 DIGITAL ACCESS

The ability to spread information digitally has become beneficial for the success of program implementation. Using the internet and social media platforms helps facilitate the spread of necessary information to communities throughout the United

[33] https://data.census.gov/table?q=education&t=Employment&g=040XX00US08

States and globally. **Figure 6** summarizes results from the Community Analytics Tool regarding internet access and social media usage in the State of Colorado. Internet access includes the percentage of people who use a computer, cell phone, and tablet. Social media usage includes people who use Facebook, Instagram, LinkedIn, and Twitter. According to the information provided, over 70% of Colorado residents used a computer in 2020, and over 80% of residents used a cellphone. In addition, Facebook was observed to be the most used social media platform, with over 60% of residents utilizing it.

Figure 6: Internet Access and Social Media Usage (2020 Data)



Based on this data, utilizing digital platforms for educating Colorado residents statewide would be an effective form of communication, but other methods should be incorporated as the entire population does not have access to a computer. Alternatively, about 16% of Colorado residents read a daily print newspaper, and 40% have access to cable television. All these methods and access should be considered when developing education and outreach plans for Colorado.

3.11 DISABILITY CHARACTERISTICS

The EJScreen tool considers six disability types in its data: hearing difficulty (deaf or having serious difficulty hearing), vision difficulty (blind or having serious difficulty seeing, even when wearing glasses), cognitive difficulty (due to a physical, mental, or emotional problem, having difficulty remembering, concentrating, or making decisions), ambulatory difficulty (having serious difficulty walking or climbing stairs), self-care difficulty (having difficulty bathing or dressing), and independent living difficulty (due to a physical, mental, or emotional problem, having difficulty doing errands alone such as visiting a doctor's Office or shopping). Respondents who report any of the six disability types are considered to have a disability.[34] The EJScreen tool utilizes census data in which the United States Census Bureau reports disability characteristics based on the "total civilian noninstitutionalized population." Based on

[34] https://www.epa.gov/ejscreen/ejscreen-map-descriptions

the United States Census Bureau, 11.6% of the population in Colorado has a disability.[35] Using the EJScreen tool, this data can be divided into four Regions, as seen in **Table 12** below.

Table 12: Regional Disability Characteristics

Region	% Disabled
Front Range	11%
Eastern Plains	17%
Western Slope	14%
Mountains	11%

According to the EJScreen Tool, the Eastern Plains Region contains the highest percentage of disabled people in the State at 17%, and the Mountains Region contains the least at 11%. When assessing the current recycling and composting infrastructure in Colorado, accessibility for disabled populations is important for both existing and future services.

3.12 ECONOMIC FACTORS

The U.S. Census Bureau provides detailed information on economic factors, including household income and poverty levels. Using the EJScreen tool, **Table 13** below summarizes household income, specifically low-income and unemployed households. According to the EJScreen tool, low income is defined as "the percent of a block group's population in households where the household income is less than or equal to twice the federal "poverty level." According to the Association of People Supporting Employment First (APSE), in 2021, the average income per capita in each of the individual Regions was above the poverty guidelines listed.

Table 13: Income and Unemployment Summary

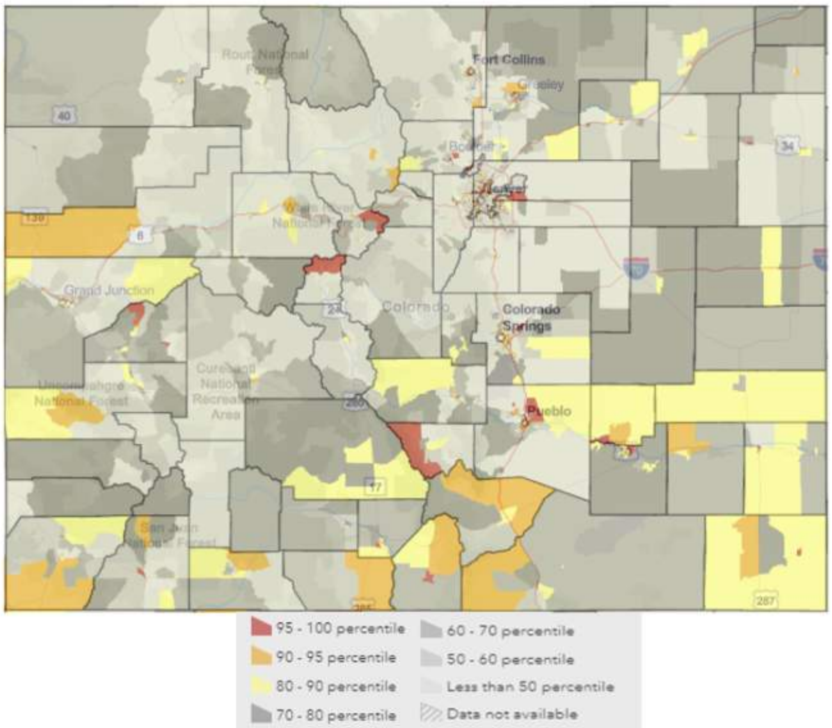
Find	Number of Households	Income per Capita	Low-Income Population	Unemployment Rate
Front Range	1,876,500	$44,360	22%	5%
Eastern Plains	59,140	$26,300	39%	5%
Western Slope	160,270	$35,600	29%	5%
Mountains	132,000	$39,128	27%	4%

The Front Range has the highest number of households, per capita income, and smallest low-income population. The Eastern Plains has the highest low-income population, followed by the Western Slope and the Mountains. The unemployment rate is similar across the four Regions at 5%, with the Mountains slightly lower at 4%. Income data can be helpful when assessing the correlation between low-income

[35] https://data.census.gov/table/ACSST1Y2022.S1810?q=disability&t=Employment&g=040XX00US08

communities and lack of infrastructure. As seen in **Figure 7,** low-income communities are located across the State, concentrated in more rural locations. Municipalities and service providers should also consider this data if any increases in service or other elements of the EPR program will financially impact low-income populations.

Figure 7: Low Income based on the State Percentiles[36]



This map provides statewide data on the population in households where the household income is less than or equal to twice the federal "poverty level." High concentrations of the highest low-income percentile households exist in major cities along the Front Range such as Denver, Colorado Springs, and Pueblo. There are also high concentrations in pockets of the Mountain Regions. The largest low-income populations exist primarily in the Western Slope, Eastern Plains, and southern section of the Mountains region.

Example: Lake County, CO is noted as red (95-100 percentile). This means the percent of people in Lake County that identifies as low-income is equal or 95% to 100% higher than the rest of the State.

[36] EJScreen (Version 2.2)

To provide a nationwide perspective, according to the U.S. Census Bureau, **Table 14** below shows household income in the United States compared to Colorado in 2022. The average household income in 2022 in the United States was $105,555, and $119,039 in Colorado. The median household income in the United States was $74,755, and $89,302 in Colorado.

Table 14: Household Income in the Past 12 Months (In 2022 Inflation-Adjusted Dollars)[37]

Income	United States (Estimated %)	Colorado (Estimated %)
Less than $10,000	5.5%	4.1%
$10,000 to $14,999	3.7%	2.5%
$15,000 to $24,999	6.8%	5.4%
$25,000 to $34,999	7.3%	5.8%
$35,000 to $49,999	10.7%	9.2%
$50,000 to $74,999	16.2%	15.1%
$75,000 to $99,999	12.8%	13.4%
$100,000 to $149,999	16.9%	19.0%
$150,000 to $199,999	8.7%	10.7%
$200,000 or more	11.5%	14.7%

The ASPE published poverty guidelines for the 48 contiguous states and the District of Columbia in 2021, showing an income of $12,880 for an individual and $26,500 for a family of four. [38] At that time, 9.7% of the population of Colorado was below the poverty level. To put the ASPE poverty guidelines into context, Colorado consistently ranks higher in household income compared to the United States. **Table 15** expands on this comparison to show the poverty level of various population types in Colorado compared to the United States over the last 12 months.

[37] https://data.census.gov/table/ACSST1Y2022.S1901?q=income&t=Employment&g=010XX00US_040XX00US08

[38] https://aspe.hhs.gov/topics/poverty-economic-mobility/poverty-guidelines

Table 15: Poverty Status

Poverty	United States	Colorado
Total Population	12.8%	9.7%
Under 18 years	16.9%	11.8%
18 to 64 years	11.9%	9.5%
Male	11.6%	8.8%
Female	13.9%	10.6%
White alone	9.8%	8.1%
Black or African American alone	21.4%	17.8%
American Indian or Alaskan Native alone	21.7%	27.9%
Asian alone	10.1%	9.0%

In 2021, the total poverty level in the United States was 12.8%, and the total poverty level in the State of Colorado was 9.7%. Census data indicated economic disparities by race in Colorado; 27.9% of individuals who identified themselves as American Indian or Alaskan Native were below the poverty level, while 17.7% of individuals who identified as Black or African American were below the poverty level. In addition, 8.1% of individuals who identified themselves as White were below the poverty level, and 9.0% of individuals who identified themselves as Asian were below the poverty level.

The regional poverty-specific data in Colorado correlates with the low-income data above. According to the U.S. Census data, **Table 16** provides the regional breakdown of families experiencing poverty.

Table 16: Poverty by Region

Region	Family Poverty Percentage
Total Population	9.7%
Front Range	5.8%
Eastern Plains	13.5%
Western Slope	9.2%
Mountains	6.5%

3.13 HEALTH DATA

The County Health Rankings & Roadmaps program, developed by the University of Wisconsin Population Health Institute in collaboration with the Robert Wood Johnson Foundation, has calculated a County Health Ranking for every county in the United States.[39] This program aims to raise awareness about the various factors that impact health, provide local communities with reliable data, engage local leaders in driving

[39] https://www.countyhealthrankings.org/

community change, and support and empower leaders working towards health improvement. The ranking is determined by considering both health factors and health outcomes. Additionally, the program comprehensively assesses health outcomes and behaviors specific to the State of Colorado.

The health factors included in the County Health Rankings report include health behaviors (e.g., smoking, access to exercise opportunities, % of excessive drinkers, adult obesity, teen births); clinical care (e.g., insurance status (insured vs. uninsured), the ratio of population to health care providers, preventable hospital stays by using outpatient treatment, % of mammography screenings, % of flu vaccinations); social and economic factors (e.g., level of education, income inequality (ratio of households in 80^{th} percentile vs. 20^{th} percentile), children in poverty, deaths due to injury); and physical environment (e.g., air pollution, drinking water violations, % of people driving alone with long commutes)).

The health outcome factors included in the County Health Rankings report include premature death, poor or fair health, number of poor physical and mental health days in the past 30 days, and low birth weight. Additional health outcomes not included in the ranking include life expectancy, child and infant mortality, frequent physical and mental distress, and prevalence of diabetes and HIV.

Table 17 below shows the average ranking for the health factors and health outcomes by Region for Colorado in 2023. The lowest ranking represents good health, while the higher ranking represents poor health.

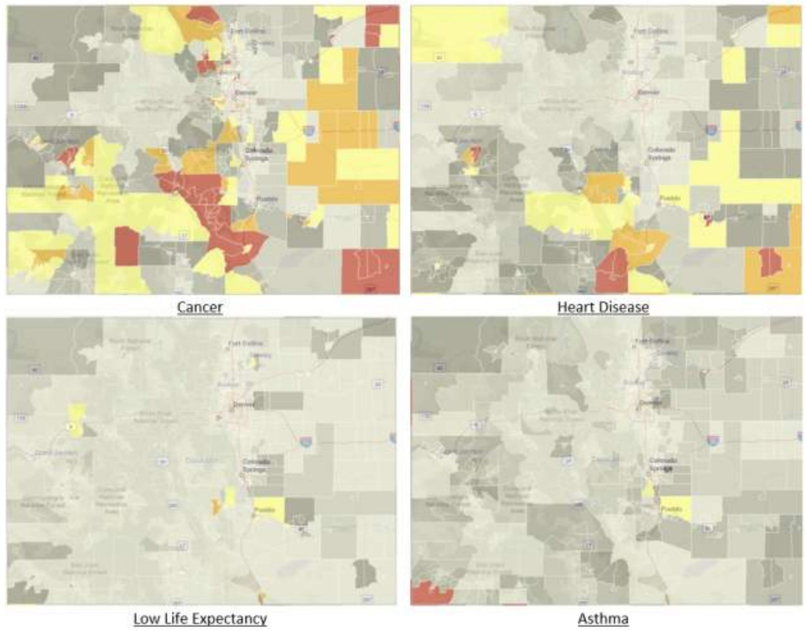
Table 17: Ranking Health Factors and Outcomes by Region

Region	Health Factors	Health Outcomes
Western Slope	29th Rank	31st Rank
Mountains	27th Rank	28th Rank
Front Range	20th Rank	19th Rank
Eastern Plains	43rd Rank	41st Rank

The Front Range ranks lowest (healthiest) in health factors and outcomes compared to the other Regions. The Eastern Plains ranks the highest (least healthy) in health factors and outcomes. Douglas County, located in the Front Range, is the healthiest county in terms of health factors and outcomes. The least healthy county in terms of health factors is Costilla County, located in the Mountains Region. The least healthy county regarding health outcomes is Otero County, located in the Eastern Plains.

The County Health Rankings were also compared to the EJScreen for cancer, heart disease, low life expectancy, and asthma. **Figure 8** below shows a heat map for comparing each County to the State of Colorado. Counties in the highest percentile are most at risk for health disparities, and counties in the lower percentiles are less at risk.

Figure 8: Health Disparities (State Percentiles)[40]



This map provides data on the counties based on health disparities (cancer, heart disease, low life expectancy, and asthma). The percentiles compare each county to the state average. Communities at the highest risk for cancer disparities exist along the southern border of the Mountains Range and Front Range. High concentrations of cancer disparities are also located in the center and southern portions of the Eastern Plains. The area with the highest heart disease disparity southeast of the Mountain Range and heart disparities in the 80th-95th percentile are located along the southern border of the Mountains and Front Range and the southeast border of the Eastern Plains. The largest low-income populations exist primarily in the Western Slope, Eastern Plains, and southern section of the Mountains region. Health risks for low life expectancy and asthma are low in all Regions. Montezuma County is in the highest percentile for Asthma and the area around Pueblo city is at a high risk for both low life expectancy and asthma.

Example: Pueblo County, CO is noted as yellow in the low life expectancy map (80-90 percentile). This means the percent of people in Pueblo County that are at risk for low life expectancy is equal or 80% to 90% higher than the rest of the State.

Less than 50%ile | 50-60%ile | 60-70%ile | 70-80%ile | 80-90%ile | 90-95%ile | 95-100%ile

[40] EJScreen (Version 2.2)

The County Health Rankings correspond with data from the EJScreen, noting the Front Range Region as the healthiest in the State. According to County Health Rankings, the Region that appeared to be at the highest risk for health reasons was the Eastern Plains, which is also shown to have higher health disparities related to cancer. The County Health Rankings ranked the Mountains Region and Western Slope Region in the middle compared to the other two Regions, which is consistent with what's provided by the EJScreen; however, the southern portion of the Mountains Region was noted to have higher health risks compared to the rest of the Region.

3.14 ENVIRONMENTAL INDICATORS

The EJScreen tool also assesses communities' exposure to various environmental pollutants, as seen in **Table 18** below. These indicators vary widely in what they indicate according to the EJScreen tool. Some indicators quantify proximity to and the numbers of certain potential sources of exposure to environmental pollutants, such as nearby hazardous waste sites or traffic. The lead paint indicator indicates the presence of older housing, which often, but not always, indicates the presence of lead paint and the possibility of exposure. In some cases, the term "exposure" is used broadly here to refer to potential exposure. Still others are actual estimates of air toxics-related cancer risk or a hazard index.[41]

Table 18: Summary Table of Environmental Indicators and Data Sources

Key Medium	Indicator	Details
Air	Particulate matter 2.5	PM2.5 levels in air, µg/m3 annual avg.
Air	Ozone	Ozone summer seasonal average of daily maximum 8-hour concentration in air in parts per billion
Air	Diesel particulate matter	Diesel particulate matter level in air, µg/m3
Air	Air toxics cancer risk	Lifetime cancer risk from inhalation of air toxics
Air	Air toxics respiratory hazard index	Ratio of exposure concentration to the health-based reference concentration
Air	Toxic releases to air	Toxicity-weighted concentrations in air of TRI-listed chemicals.
Air/other	Traffic proximity and volume	Count of vehicles (AADT, average annual daily traffic) at major roads within 500 meters, divided by distance in meters (not kilometers)

[41] https://www.epa.gov/ejscreen/overview-environmental-indicators-ejscreen

Out of the four Regions, the Front Range Region and the Eastern Plains Region have higher pollutant source variable values than the State of Colorado overall. The Front Range Region exceeds or meets the State's values for particulate matter 2.5 ($PM_{2.5}$), ozone, and wastewater discharge. The Eastern Plains Region exceeds the State's value for lead paint. The Front Range Region had higher pollutant variables in almost every category compared to all regions.

Figure 9 below shows the percent of each pollutant source variable compared to the state average (pollutant source variables that exceed the State's average are displayed as being higher than 100%).

Figure 9: Environmental Indicators (Regions vs. State)

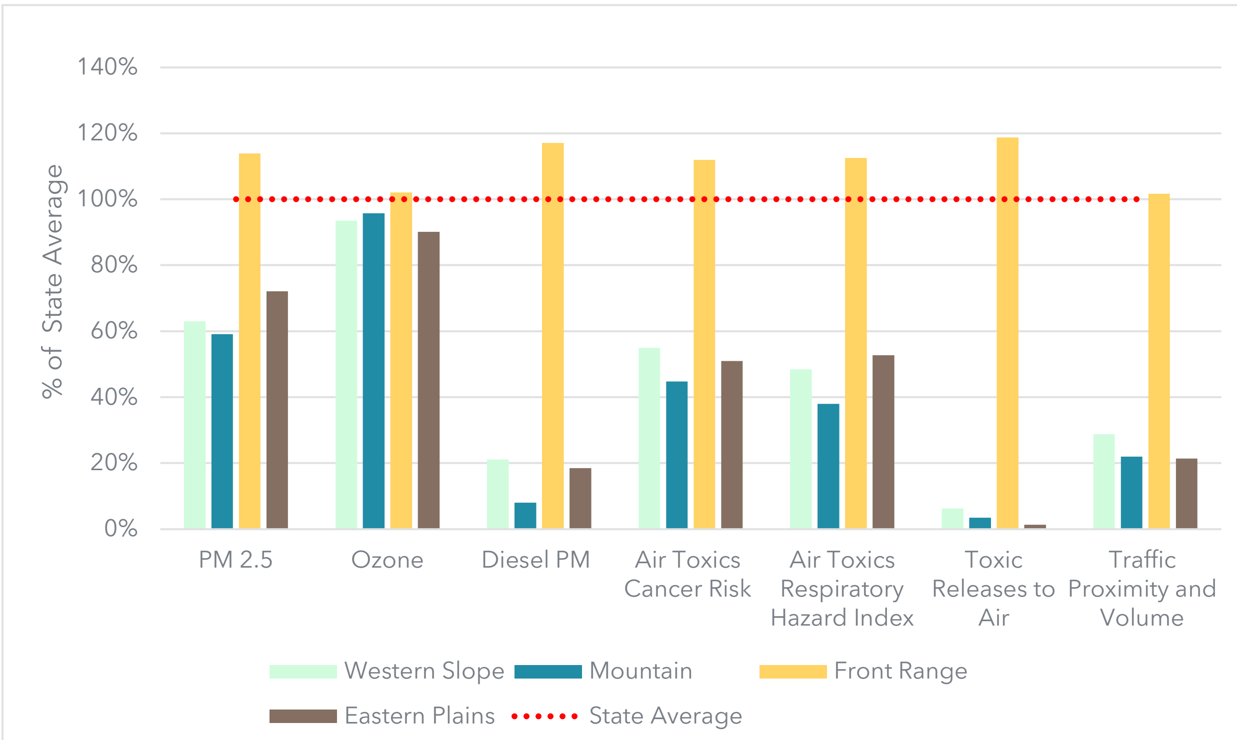
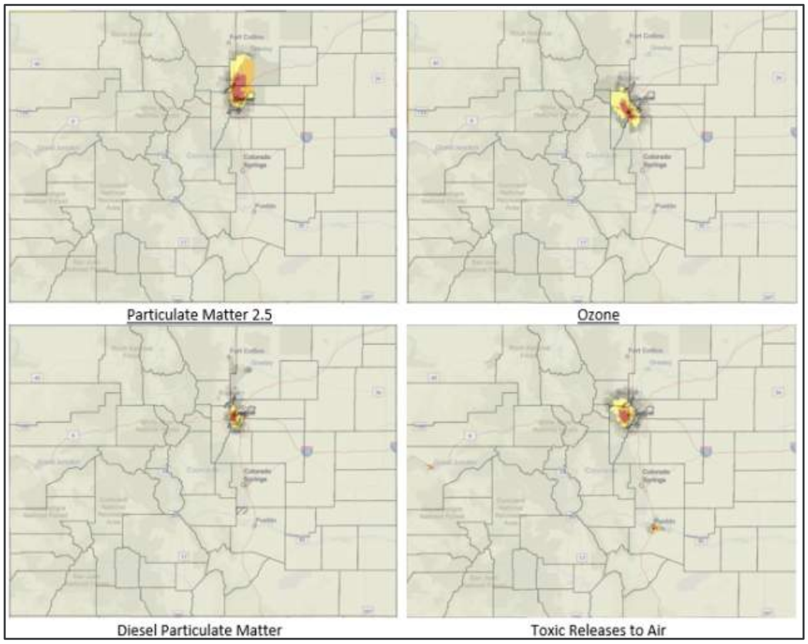


Figure 10 shows Colorado state percentile maps representing the areas most and least affected by pollutant sources.

Figure 10: Pollution Sources (State Percentiles)[42]



This map provides data on the counties based on pollution sources (particulate matter (PM) 2.5, ozone, diesel particulate matter, and toxic releases to air). The percentiles compare each county to the state average. High concentrations of pollution sources exist in major cities such as Boulder and Denver.

Example: Denver County, CO is noted as yellow in the PM 2.5 map (80-90 percentile). This means the annual average of PM 2.5 levels in the area in Denver County is equal to or 80% to 90% higher than the rest of the State.

According to the EJScreen, the Front Range Region has the most pollution sources compared to the rest of the State. This corresponds with the Region consisting of the County of Denver, the most densely populated county in the State. Despite the higher concentrations of pollutants and population, according to the County Health Ranking, the Front Range Region had the highest ranking (most healthy) compared to the other regions. In addition, the Front Range Region has the lowest percentage of the population classified as low-income.

With just one pollutant parameter exceeding the State's average, the Eastern Plains Region has the highest percentage of its population classified as low-income. According to the Center for Disease Control and Prevention (CDC), data shows that racial and ethnic minority groups throughout the United States experience higher rates of illness and death across a wide range of health conditions when compared to their White counterparts.[43] According to the EJScreen, the Front Range Region has the highest percentage of its population classified as Black or African American (5%) compared to the other regions. This correlates with the CDC's analysis as the Front Range Region has the highest value of pollutant source variables. Conversely, the Front Range Region is considered one of the healthier regions in terms of health

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[42] EJScreen (Version 2.2)

[43] https://www.cdc.gov/minorityhealth/racism-disparities/index.html#:~:text=The%20data%20show%20that%20racial,compared%20to%20their%20White%20counterparts.

factors and health outcomes, as discussed in Section 3.13. The Colorado Needs Assessment scenarios should consider any potential increases in these environmental pollutants, especially in these more high-risk regions.

Appendix A. Population Density

Municipality	Population	Land Area (sq. mi)	Population Density
Acres Green CDP, Colorado	2,922	0.60	4860.28
Aetna Estates CDP, Colorado	1,496	0.13	11442.07
Aguilar town, Colorado	456	0.39	1162.36
Air Force Academy CDP, Colorado	6,608	9.99	661.50
Akron town, Colorado	1,757	2.77	633.78
Alamosa city, Colorado	9,806	7.90	1241.49
Alamosa East CDP, Colorado	1,453	3.25	447.11
Allenspark CDP, Colorado	568	11.94	47.58
Alma town, Colorado	296	0.43	682.59
Alpine CDP, Colorado	169	1.05	160.86
Altona CDP, Colorado	512	1.69	303.70
Amherst CDP, Colorado	47	0.45	103.54
Antonito town, Colorado	647	0.43	1516.99
Applewood CDP, Colorado	7,833	4.06	1927.07
Arapahoe CDP, Colorado	102	0.28	367.85
Arboles CDP, Colorado	308	5.16	59.74
Aristocrat Ranchettes CDP, Colorado	1,715	1.87	918.76
Arriba town, Colorado	202	0.50	404.86
Arvada city, Colorado	124,402	38.91	3197.20
Aspen city, Colorado	7,004	3.86	1815.56
Aspen Park CDP, Colorado	810	2.46	328.72
Atwood CDP, Colorado	138	1.03	133.47
Ault town, Colorado	1,887	1.74	1086.39

Municipality	Population	Land Area (sq. mi)	Population Density
Aurora city, Colorado	386,261	159.96	2414.70
Avon town, Colorado	6,072	8.35	727.24
Avondale CDP, Colorado	594	0.63	945.78
Bark Ranch CDP, Colorado	202	0.86	234.36
Basalt town, Colorado	3,984	1.99	2000.53
Battlement Mesa CDP, Colorado	5,438	11.46	474.58
Bayfield town, Colorado	2,838	1.65	1721.39
Bennett town, Colorado	2,862	5.81	492.24
Berkley CDP, Colorado	12,536	3.60	3482.61
Berthoud town, Colorado	10,332	12.93	798.87
Bethune town, Colorado	183	0.16	1129.50
Beulah Valley CDP, Colorado	518	2.57	201.43
Black Forest CDP, Colorado	15,097	100.64	150.01
Black Hawk city, Colorado	127	2.99	42.44
Blanca town, Colorado	322	1.83	175.69
Blende CDP, Colorado	788	0.84	939.45
Blue River town, Colorado	877	2.43	360.36
Blue Sky CDP, Colorado	65	0.04	1815.94
Blue Valley CDP, Colorado	173	1.05	164.44
Bonanza Mountain Estates CDP, Colorado	127	0.17	754.58
Bonanza town, Colorado	17	0.44	38.88
Boone town, Colorado	305	0.38	805.27
Boulder city, Colorado	108,250	26.34	4109.65
Bow Mar town, Colorado	853	0.66	1288.72
Brandon CDP, Colorado	21	0.12	178.74
Branson town, Colorado	57	0.24	232.85

Municipality	Population	Land Area (sq. mi)	Population Density
Breckenridge town, Colorado	5,078	6.05	839.74
Brick Center CDP, Colorado	105	5.78	18.17
Briggsdale CDP, Colorado	134	0.65	206.20
Brighton city, Colorado	40,083	21.28	1883.49
Brook Forest CDP, Colorado	622	1.39	447.89
Brookside town, Colorado	236	0.47	497.98
Broomfield city, Colorado	74,112	32.97	2248.01
Brush city, Colorado	5,339	2.83	1886.13
Buena Vista town, Colorado	2,855	3.48	821.48
Burlington city, Colorado	3,172	2.15	1473.73
Byers CDP, Colorado	1,322	11.45	115.45
Calhan town, Colorado	762	0.83	914.53
Campo town, Colorado	103	0.14	713.88
Cañon City city, Colorado	17,141	12.39	1383.25
Capulin CDP, Colorado	134	0.95	141.50
Carbonate town, Colorado	0	0.99	0.00
Carbondale town, Colorado	6,434	2.02	3182.09
Cascade-Chipita Park CDP, Colorado	1,628	13.41	121.41
Castle Pines city, Colorado	11,036	9.59	1150.29
Castle Pines Village CDP, Colorado	4,327	4.45	971.85
Castle Rock town, Colorado	73,158	34.29	2133.51
Cathedral CDP, Colorado	15	21.28	0.70
Catherine CDP, Colorado	235	0.86	273.77
Cattle Creek CDP, Colorado	662	1.30	511.05

Municipality	Population	Land Area (sq. mi)	Population Density
Cedaredge town, Colorado	2,279	1.96	1162.29
Centennial city, Colorado	108,418	29.72	3647.92
Center town, Colorado	1,929	0.86	2232.90
Central City city, Colorado	779	2.16	360.69
Chacra CDP, Colorado	331	0.95	349.94
Cheraw town, Colorado	237	0.18	1314.17
Cherry Creek CDP, Colorado	11,488	1.67	6880.33
Cherry Hills Village city, Colorado	6,442	6.20	1038.81
Cheyenne Wells town, Colorado	758	1.07	708.70
Cimarron Hills CDP, Colorado	19,311	5.92	3261.67
City of Creede town, Colorado	257	0.95	270.60
Clifton CDP, Colorado	20,413	6.02	3393.02
Coal Creek CDP, Colorado	2,494	9.39	265.64
Coal Creek town, Colorado	364	1.19	304.88
Coaldale CDP, Colorado	343	31.05	11.05
Cokedale town, Colorado	127	0.20	619.72
Collbran town, Colorado	369	0.56	660.97
Colona CDP, Colorado	36	0.06	594.46
Colorado City CDP, Colorado	2,237	15.01	149.05
Colorado Springs city, Colorado	478,961	195.84	2445.72
Columbine CDP, Colorado	25,229	6.63	3805.74
Columbine Valley town, Colorado	1,502	0.98	1529.43
Comanche Creek CDP, Colorado	442	21.69	20.38

Municipality	Population	Land Area (sq. mi)	Population Density
Commerce City city, Colorado	62,418	36.39	1715.07
Conejos CDP, Colorado	46	0.48	95.01
Cope CDP, Colorado	53	1.80	29.52
Copper Mountain CDP, Colorado	650	32.06	20.28
Cortez city, Colorado	8,766	6.23	1407.08
Cotopaxi CDP, Colorado	44	0.29	153.96
Craig city, Colorado	9,060	5.07	1786.09
Crawford town, Colorado	403	0.25	1604.55
Crested Butte town, Colorado	1,639	0.87	1891.20
Crestone town, Colorado	141	0.38	366.55
Cripple Creek city, Colorado	1,155	1.52	759.11
Crisman CDP, Colorado	179	1.46	122.83
Crook town, Colorado	133	0.13	987.07
Crowley town, Colorado	166	0.23	736.17
Dacono city, Colorado	6,297	9.27	678.95
Dakota Ridge CDP, Colorado	33,892	9.39	3609.56
De Beque town, Colorado	493	2.78	177.53
Deer Trail town, Colorado	1,068	1.15	929.82
Del Norte town, Colorado	1,458	0.98	1482.61
Delta city, Colorado	9,035	13.27	680.68
Denver city, Colorado	715,522	153.07	4674.35
Derby CDP, Colorado	8,407	1.75	4804.20
Dillon town, Colorado	1,064	1.49	715.31
Dinosaur town, Colorado	243	0.93	261.34
Divide CDP, Colorado	143	0.34	426.09
Dolores town, Colorado	885	0.66	1332.11
Dotsero CDP, Colorado	1,172	1.36	864.48
Dove Creek town, Colorado	635	0.57	1109.20

Municipality	Population	Land Area (sq. mi)	Population Density
Dove Valley CDP, Colorado	5,640	3.58	1575.79
Downieville-Lawson-Dumont CDP, Colorado	527	0.78	677.67
Durango city, Colorado	19,071	14.72	1295.23
Eads town, Colorado	672	0.48	1406.62
Eagle town, Colorado	7,511	5.81	1293.56
East Pleasant View CDP, Colorado	333	0.11	3002.91
Eaton town, Colorado	5,802	3.16	1835.94
Echo Hills CDP, Colorado	313	0.57	550.67
Eckley town, Colorado	232	0.47	490.52
Edgewater city, Colorado	5,005	0.69	7205.24
Edwards CDP, Colorado	11,246	26.64	422.21
El Jebel CDP, Colorado	4,130	5.30	778.58
El Moro CDP, Colorado	216	11.09	19.48
Elbert CDP, Colorado	188	0.47	396.75
Eldora CDP, Colorado	140	4.16	33.69
Eldorado Springs CDP, Colorado	559	2.58	216.36
Elizabeth town, Colorado	1,675	2.00	837.75
Ellicott CDP, Colorado	1,248	10.92	114.27
Empire town, Colorado	345	0.27	1284.85
Englewood city, Colorado	33,659	6.56	5130.36
Erie town, Colorado	30,038	20.52	1463.56
Estes Park town, Colorado	5,904	6.84	863.04
Evans city, Colorado	22,165	10.21	2171.18
Evergreen CDP, Colorado	9,307	11.52	807.73
Fairmount CDP, Colorado	9,324	6.08	1533.40
Fairplay town, Colorado	724	1.15	631.16

Municipality	Population	Land Area (sq. mi)	Population Density
Federal Heights city, Colorado	14,382	1.78	8082.88
Firestone town, Colorado	16,381	13.67	1198.20
Flagler town, Colorado	567	1.37	414.00
Fleming town, Colorado	428	0.49	874.79
Florence city, Colorado	3,822	4.28	893.74
Florissant CDP, Colorado	128	0.52	248.22
Floyd Hill CDP, Colorado	1,048	6.29	166.63
Fort Carson CDP, Colorado	17,693	27.97	632.59
Fort Collins city, Colorado	169,810	57.22	2967.50
Fort Garland CDP, Colorado	464	0.38	1235.37
Fort Lupton city, Colorado	7,955	12.49	637.08
Fort Morgan city, Colorado	11,597	5.33	2174.20
Fountain city, Colorado	29,802	22.30	1336.53
Four Square Mile CDP, Colorado	22,872	2.70	8466.30
Fowler town, Colorado	1,253	0.56	2241.09
Foxfield town, Colorado	754	1.32	569.77
Franktown CDP, Colorado	409	2.94	138.93
Fraser town, Colorado	1,400	3.46	404.98
Frederick town, Colorado	14,513	15.09	961.52
Frisco town, Colorado	2,913	1.67	1744.17
Fruita city, Colorado	13,395	7.89	1697.37
Fruitvale CDP, Colorado	8,271	2.91	2846.43
Fulford CDP, Colorado	0	0.22	0.00
Garden City town, Colorado	254	0.11	2249.77
Gardner CDP, Colorado	106	2.47	42.88
Garfield CDP, Colorado	27	0.34	79.21

Municipality	Population	Land Area (sq. mi)	Population Density
Genesee CDP, Colorado	3,610	6.62	545.27
Genoa town, Colorado	153	0.31	493.17
Georgetown town, Colorado	1,118	1.00	1121.06
Gerrard CDP, Colorado	264	1.20	220.37
Gilcrest town, Colorado	1,029	0.81	1268.88
Glendale CDP, Colorado	64	1.26	50.99
Glendale city, Colorado	4,613	0.57	8118.97
Gleneagle CDP, Colorado	6,649	2.34	2839.94
Glenwood Springs city, Colorado	9,963	5.84	1707.34
Gold Hill CDP, Colorado	218	2.07	105.07
Golden city, Colorado	20,399	9.63	2117.35
Goldfield CDP, Colorado	63	0.14	447.26
Granada town, Colorado	445	0.69	649.35
Granby town, Colorado	2,079	12.68	163.94
Grand Junction city, Colorado	65,560	40.40	1622.71
Grand Lake town, Colorado	410	1.03	397.41
Grand View Estates CDP, Colorado	689	1.00	690.50
Greeley city, Colorado	108,795	48.93	2223.34
Green Mountain Falls town, Colorado	646	1.10	587.60
Greenwood Village city, Colorado	15,691	8.27	1898.00
Grover town, Colorado	157	0.60	263.67
Guffey CDP, Colorado	111	8.67	12.80
Gunbarrel CDP, Colorado	9,554	6.25	1529.58
Gunnison city, Colorado	6,560	4.85	1352.99
Gypsum town, Colorado	8,040	8.85	908.37
Hartman town, Colorado	56	0.27	204.05
Hartsel CDP, Colorado	38	0.20	189.99

Municipality	Population	Land Area (sq. mi)	Population Density
Hasty CDP, Colorado	182	2.75	66.10
Haswell town, Colorado	71	0.80	88.47
Haxtun town, Colorado	981	0.60	1647.64
Hayden town, Colorado	1,941	3.28	592.15
Heeney CDP, Colorado	74	0.23	325.52
Hidden Lake CDP, Colorado	24	0.61	39.26
Highlands Ranch CDP, Colorado	103,444	24.27	4262.50
Hillrose town, Colorado	312	0.19	1654.76
Hoehne CDP, Colorado	80	3.11	25.75
Holly Hills CDP, Colorado	2,683	0.58	4622.42
Holly town, Colorado	837	0.72	1156.99
Holyoke city, Colorado	2,346	2.47	949.93
Hooper town, Colorado	81	0.25	321.40
Hot Sulphur Springs town, Colorado	687	0.77	893.21
Hotchkiss town, Colorado	875	0.93	944.64
Howard CDP, Colorado	852	16.74	50.89
Hudson town, Colorado	1,651	5.90	280.01
Hugo town, Colorado	787	0.91	863.09
Idaho Springs city, Colorado	1,782	2.24	795.97
Idalia CDP, Colorado	97	0.08	1142.15
Idledale CDP, Colorado	244	0.28	880.94
Ignacio town, Colorado	852	0.51	1664.88
Iliff town, Colorado	246	0.19	1287.85
Indian Hills CDP, Colorado	1,474	5.42	271.71
Inverness CDP, Colorado	2,226	1.12	1992.85
Jackson Lake CDP, Colorado	131	3.06	42.82
Jamestown town, Colorado	256	0.57	445.93
Jansen CDP, Colorado	101	1.17	86.20

Municipality	Population	Land Area (sq. mi)	Population Density
Joes CDP, Colorado	82	2.09	39.32
Johnson Village CDP, Colorado	299	0.30	1000.48
Johnstown town, Colorado	17,303	13.79	1254.56
Julesburg town, Colorado	1,307	1.51	864.33
Keenesburg town, Colorado	1,250	7.55	165.63
Ken Caryl CDP, Colorado	33,811	9.83	3438.63
Kersey town, Colorado	1,495	2.02	739.50
Keystone CDP, Colorado	1,369	41.40	33.07
Kim town, Colorado	63	0.38	166.34
Kiowa town, Colorado	725	0.86	841.51
Kirk CDP, Colorado	61	4.10	14.87
Kit Carson town, Colorado	255	0.58	436.58
Kittredge CDP, Colorado	1,308	1.88	694.25
Kremmling town, Colorado	1,509	1.31	1153.33
La Jara town, Colorado	730	0.41	1790.00
La Junta city, Colorado	7,322	3.19	2293.85
La Junta Gardens CDP, Colorado	123	0.53	230.61
La Salle town, Colorado	2,359	0.96	2463.16
La Veta town, Colorado	862	1.37	630.81
Lafayette city, Colorado	30,411	9.22	3297.42
Laird CDP, Colorado	46	0.15	306.25
Lake City town, Colorado	432	0.83	521.89
Lakeside town, Colorado	16	0.19	85.27
Lakewood city, Colorado	155,984	43.47	3588.06
Lamar city, Colorado	7,687	5.21	1474.79
Laporte CDP, Colorado	2,409	6.12	393.87
Larkspur town, Colorado	206	1.59	129.51
Las Animas city, Colorado	2,300	1.63	1414.25

Municipality	Population	Land Area (sq. mi)	Population Density
Lazear CDP, Colorado	168	1.60	104.86
Lazy Acres CDP, Colorado	957	5.29	180.93
Leadville city, Colorado	2,633	1.17	2243.68
Leadville North CDP, Colorado	1,892	2.45	772.55
Lewis CDP, Colorado	257	3.11	82.62
Leyner CDP, Colorado	40	0.20	204.64
Limon town, Colorado	2,043	3.16	646.05
Lincoln Park CDP, Colorado	3,934	3.79	1039.34
Littleton city, Colorado	45,652	12.62	3617.47
Lochbuie town, Colorado	8,088	3.68	2195.14
Log Lane Village town, Colorado	913	0.20	4658.79
Loghill Village CDP, Colorado	617	6.21	99.31
Loma CDP, Colorado	1,314	10.89	120.67
Lone Tree city, Colorado	14,253	9.81	1453.17
Longmont city, Colorado	98,885	28.81	3432.52
Louisville city, Colorado	21,226	7.97	2663.06
Louviers CDP, Colorado	293	1.58	185.39
Loveland city, Colorado	76,378	34.48	2215.19
Lynn CDP, Colorado	11	0.72	15.34
Lyons town, Colorado	2,209	1.35	1636.54
Manassa town, Colorado	947	0.93	1016.99
Mancos town, Colorado	1,196	0.64	1875.61
Manitou Springs city, Colorado	4,858	3.15	1542.79
Manzanola town, Colorado	341	0.28	1199.35
Marble town, Colorado	133	0.36	369.71
Marvel CDP, Colorado	68	0.13	510.89
Matheson CDP, Colorado	79	1.72	46.04
Maybell CDP, Colorado	76	0.52	144.85

Municipality	Population	Land Area (sq. mi)	Population Density
Maysville CDP, Colorado	173	12.42	13.93
McClave CDP, Colorado	129	1.91	67.41
McCoy CDP, Colorado	30	0.29	102.04
Mead town, Colorado	4,781	13.60	351.45
Meeker town, Colorado	2,374	3.59	661.48
Meridian CDP, Colorado	4,786	2.56	1867.07
Meridian Village CDP, Colorado	3,202	0.51	6285.45
Merino town, Colorado	281	0.15	1853.40
Midland CDP, Colorado	182	1.72	105.73
Milliken town, Colorado	8,386	12.82	654.39
Minturn town, Colorado	1,033	8.02	128.84
Moffat town, Colorado	108	1.67	64.84
Monte Vista city, Colorado	4,247	2.64	1610.20
Montezuma town, Colorado	74	0.08	938.63
Montrose city, Colorado	20,291	18.48	1098.20
Monument town, Colorado	10,399	6.96	1495.09
Morgan Heights CDP, Colorado	298	0.29	1044.41
Morrison town, Colorado	396	1.64	240.74
Mount Crested Butte town, Colorado	941	2.07	455.11
Mountain Meadows CDP, Colorado	237	1.72	137.57
Mountain View town, Colorado	541	0.09	5818.48
Mountain Village town, Colorado	1,264	3.30	383.03
Mulford CDP, Colorado	259	0.67	387.52
Nathrop CDP, Colorado	288	0.72	398.22
Naturita town, Colorado	485	0.62	788.02
Nederland town, Colorado	1,471	1.48	994.09

Municipality	Population	Land Area (sq. mi)	Population Density
New Castle town, Colorado	4,923	2.52	1955.74
Niwot CDP, Colorado	4,306	4.00	1077.61
No Name CDP, Colorado	117	0.18	654.66
Norrie CDP, Colorado	7	0.19	37.19
North La Junta CDP, Colorado	482	1.36	354.40
North Washington CDP, Colorado	733	5.20	141.07
Northglenn city, Colorado	38,131	7.36	5180.55
Norwood town, Colorado	535	0.28	1891.07
Nucla town, Colorado	585	0.69	843.34
Nunn town, Colorado	504	3.98	126.66
Oak Creek town, Colorado	889	0.37	2429.29
Olathe town, Colorado	2,019	1.50	1344.40
Olney Springs town, Colorado	315	0.24	1309.35
Ophir town, Colorado	197	0.24	838.18
Orchard CDP, Colorado	76	0.16	475.51
Orchard City town, Colorado	3,142	11.52	272.71
Orchard Mesa CDP, Colorado	6,688	3.67	1823.35
Ordway town, Colorado	1,066	0.77	1381.96
Otis town, Colorado	511	0.41	1236.68
Ouray city, Colorado	898	0.86	1040.90
Ovid town, Colorado	271	0.16	1740.34
Padroni CDP, Colorado	75	0.81	92.45
Pagosa Springs town, Colorado	1,571	5.03	312.12
Palisade town, Colorado	2,565	1.19	2158.61
Palmer Lake town, Colorado	2,636	3.09	854.04
Paoli town, Colorado	51	0.30	172.37

Municipality	Population	Land Area (sq. mi)	Population Density
Paonia town, Colorado	1,447	0.82	1762.22
Parachute town, Colorado	1,390	1.81	769.48
Paragon Estates CDP, Colorado	975	1.68	581.67
Park Center CDP, Colorado	2,953	6.55	450.90
Parker town, Colorado	58,512	22.33	2619.77
Parshall CDP, Colorado	42	0.30	140.48
Peetz town, Colorado	213	0.22	953.68
Penrose CDP, Colorado	3,685	17.85	206.49
Peoria CDP, Colorado	153	13.76	11.12
Perry Park CDP, Colorado	1,932	8.55	225.92
Peyton CDP, Colorado	214	2.30	93.15
Phippsburg CDP, Colorado	234	1.19	197.29
Piedra CDP, Colorado	31	11.62	2.67
Pierce town, Colorado	1,097	1.86	590.49
Pine Brook Hill CDP, Colorado	975	3.03	322.13
Pine Valley CDP, Colorado	363	0.82	440.81
Pitkin town, Colorado	72	0.26	279.13
Placerville CDP, Colorado	362	0.77	468.71
Platteville town, Colorado	2,955	3.07	961.49
Poncha Springs town, Colorado	925	2.98	309.98
Ponderosa Park CDP, Colorado	3,334	14.58	228.73
Portland CDP, Colorado	136	3.20	42.48
Pritchett town, Colorado	112	0.23	480.59
Pueblo city, Colorado	111,876	56.18	1991.52
Pueblo West CDP, Colorado	33,086	49.69	665.88
Ramah town, Colorado	111	0.25	436.92

Municipality	Population	Land Area (sq. mi)	Population Density
Rangely town, Colorado	2,299	4.30	534.11
Raymer (New Raymer) town, Colorado	110	0.78	140.26
Red Cliff town, Colorado	257	0.24	1053.88
Red Feather Lakes CDP, Colorado	426	9.12	46.73
Redlands CDP, Colorado	9,061	12.91	702.11
Redstone CDP, Colorado	127	0.44	290.06
Redvale CDP, Colorado	172	4.68	36.75
Rico town, Colorado	288	0.68	424.64
Ridgway town, Colorado	1,183	1.85	640.01
Rifle city, Colorado	10,437	7.03	1483.74
Rock Creek Park CDP, Colorado	68	0.27	256.03
Rockvale town, Colorado	511	2.05	249.14
Rocky Ford city, Colorado	3,876	1.68	2308.84
Rollinsville CDP, Colorado	194	1.41	137.37
Romeo town, Colorado	302	0.23	1293.93
Roxborough Park CDP, Colorado	9,416	9.23	1019.91
Rye town, Colorado	206	0.09	2190.92
Saddle Ridge CDP, Colorado	66	0.17	379.40
Saguache town, Colorado	539	0.39	1367.01
Salida city, Colorado	5,666	2.79	2029.61
Salt Creek CDP, Colorado	507	0.43	1172.47
San Acacio CDP, Colorado	56	1.26	44.56
San Luis town, Colorado	598	0.57	1054.99
Sanford town, Colorado	879	1.46	601.88
Sawpit town, Colorado	38	0.03	1265.17
Security-Widefield CDP, Colorado	38,639	12.89	2997.29

Municipality	Population	Land Area (sq. mi)	Population Density
Sedalia CDP, Colorado	177	1.36	129.82
Sedgwick town, Colorado	172	0.39	442.14
Segundo CDP, Colorado	100	0.69	144.10
Seibert town, Colorado	172	0.34	501.69
Seven Hills CDP, Colorado	129	0.49	263.85
Severance town, Colorado	7,683	9.10	844.48
Shaw Heights CDP, Colorado	5,185	0.70	7402.04
Sheridan city, Colorado	6,105	2.23	2741.85
Sheridan Lake town, Colorado	55	0.31	177.11
Sherrelwood CDP, Colorado	19,228	2.44	7880.99
Sierra Ridge CDP, Colorado	3,490	0.51	6893.23
Silt town, Colorado	3,536	1.66	2136.11
Silver Cliff town, Colorado	609	15.46	39.40
Silver Plume town, Colorado	207	0.26	800.57
Silverthorne town, Colorado	4,402	4.06	1083.80
Silverton town, Colorado	622	0.83	745.00
Simla town, Colorado	601	0.62	975.33
Smeltertown CDP, Colorado	88	0.15	602.75
Snowmass Village town, Colorado	3,096	27.78	111.44
Snyder CDP, Colorado	136	0.35	384.04
Somerset CDP, Colorado	55	0.19	289.60
South Fork town, Colorado	510	2.50	204.15
Southern Ute CDP, Colorado	158	15.96	9.90

Municipality	Population	Land Area (sq. mi)	Population Density
Springfield town, Colorado	1,325	1.13	1176.40
St. Ann Highlands CDP, Colorado	325	1.39	233.72
St. Mary's CDP, Colorado	333	1.44	231.49
Starkville town, Colorado	62	0.07	849.57
Steamboat Springs city, Colorado	13,224	9.89	1337.41
Stepping Stone CDP, Colorado	2,780	0.74	3774.94
Sterling city, Colorado	13,735	7.58	1811.19
Sterling Ranch CDP, Colorado	1,789	5.53	323.57
Stonegate CDP, Colorado	9,072	1.83	4951.54
Stonewall Gap CDP, Colorado	66	1.92	34.37
Strasburg CDP, Colorado	3,307	20.80	158.95
Stratmoor CDP, Colorado	6,518	2.65	2463.67
Stratton town, Colorado	656	0.51	1276.11
Sugar City town, Colorado	259	0.38	672.96
Sugarloaf CDP, Colorado	274	2.18	125.82
Sunshine CDP, Colorado	198	1.73	114.44
Superior town, Colorado	13,094	3.93	3329.02
Swink town, Colorado	604	0.28	2157.54
Tabernash CDP, Colorado	401	4.83	82.98
Tall Timber CDP, Colorado	185	0.57	322.31
Telluride town, Colorado	2,607	2.22	1173.24
The Pinery CDP, Colorado	11,311	10.38	1089.79
Thornton city, Colorado	141,867	35.90	3951.83
Timnath town, Colorado	6,487	7.05	920.78

Municipality	Population	Land Area (sq. mi)	Population Density
Todd Creek CDP, Colorado	5,028	9.89	508.52
Towaoc CDP, Colorado	1,120	3.58	312.44
Towner CDP, Colorado	18	0.04	483.00
Trail Side CDP, Colorado	157	0.72	219.10
Trinidad city, Colorado	8,329	9.38	887.52
Twin Lakes CDP (Adams County), Colorado	8,226	1.64	5003.79
Twin Lakes CDP (Lake County), Colorado	204	6.73	30.29
Two Buttes town, Colorado	34	0.25	137.12
Upper Bear Creek CDP, Colorado	984	3.79	259.97
Upper Witter Gulch CDP, Colorado	380	0.91	417.34
Vail town, Colorado	4,835	4.71	1027.49
Valdez CDP, Colorado	46	1.61	28.60
Valmont CDP, Colorado	64	0.27	237.31
Vernon CDP, Colorado	38	1.13	33.56
Victor city, Colorado	379	0.29	1319.76
Vilas town, Colorado	98	0.13	766.58
Vineland CDP, Colorado	269	0.57	474.91
Vona town, Colorado	95	0.22	429.22
Walden town, Colorado	606	0.34	1807.68
Walsenburg city, Colorado	3,049	2.99	1019.81
Walsh town, Colorado	543	0.45	1213.97
Ward town, Colorado	128	0.54	239.02
Watkins CDP, Colorado	682	24.74	27.56
Welby CDP, Colorado	15,553	3.70	4199.11
Weldona CDP, Colorado	113	0.16	721.06
Wellington town, Colorado	11,047	3.63	3043.40

Municipality	Population	Land Area (sq. mi)	Population Density
West Pleasant View CDP, Colorado	4,327	1.54	2804.83
Westcliffe town, Colorado	435	1.23	352.32
Westcreek CDP, Colorado	120	1.22	98.65
Westminster city, Colorado	116,317	31.59	3682.64
Weston CDP, Colorado	53	3.10	17.10
Wheat Ridge city, Colorado	32,398	9.34	3467.39
Wiggins town, Colorado	1,401	1.32	1059.24
Wiley town, Colorado	437	0.31	1404.10
Williamsburg town, Colorado	731	3.53	206.97
Windsor town, Colorado	32,716	25.63	1276.53
Winter Park town, Colorado	1,033	16.89	61.16
Wolcott CDP, Colorado	20	0.37	54.16
Woodland Park city, Colorado	7,920	6.61	1197.89
Woodmoor CDP, Colorado	9,536	6.09	1566.68
Woody Creek CDP, Colorado	290	0.61	473.39
Wray city, Colorado	2,358	3.46	680.99
Yampa town, Colorado	399	0.24	1660.29
Yuma city, Colorado	3,456	3.16	1093.17

COLORADO NEEDS ASSESSMENT

ELEMENT 4: CONTAMINATION

JANUARY 25, 2024

CONTENTS

FIGURES

1 EXECUTIVE SUMMARY

1.1 PURPOSE

Contamination is a major operational issue for material recovery facilities (MRFs), compost facilities, and material end markets. Contamination can include materials that were incorrectly disposed of in recycling or composting, incorrectly sorted materials, soiled recyclable containers, and over-compacted materials. The purpose of the contamination element of the Colorado Needs Assessment was to estimate existing contamination rates at MRFs and compost sites in Colorado, identify challenges associated with contamination, identify common contaminants, and evaluate methods to improve the quality of material received by end markets to improve the overall efficiency of Colorado's material processing systems.

1.2 APPROACH

The project team reviewed past reports and studies to assess available information on contamination. Project team members also conducted site visits at MRFs and specialty recycling facilities (see **Element 6 Technical Memorandum**) and compost facilities (see **Element 14 Technical Memorandum**) and asked facility staff questions about incoming and outgoing feedstock, the trends they've observed in contamination, and the impact of contamination on their operations and operational costs. Finally, the team conducted a desktop study to identify best management practices for limiting and handling contamination, thereby improving the end product's quality and quantity to align with the objectives of the Producer Responsibility Program for Statewide Recycling Act.

1.3 FINDINGS

Key findings of this report include the following:

- Most MRFs surveyed for the Needs Assessment reported a contamination rate between 10% and 20%. Estimated contamination rates were based on total contamination, not necessarily contamination associated with packaging materials.
- Most compost facilities surveyed for the Needs Assessment reported a contamination rate ranging from 2% to 5% by weight. Estimated contamination rates included total contamination, not necessarily contamination associated with compostable plastics or packaging materials.
- Contamination impacts operations at both MRFs and compost facilities and can result in lost time and revenue and pose health and safety risks. Some of the more concerning contaminants are materials that can damage the equipment (e.g., materials that can get tangled in the equipment) or can pose risks to workers (e.g., health and hygiene materials, sharps, flammables, or containers under pressure).

- Some compost facilities in Colorado have responded to contamination in incoming feedstocks by rejecting compostable service ware and other single-use materials.
- Confusion about which materials are recyclable or compostable, wishful recycling, and varying levels of commitment to recycling can impact contamination rates.
- Key reasons for higher contamination rates can include unstaffed recycling depots, issues with labeling, lack of education, particularly for seasonal populations and tourists, lack of enforcement, and over-compaction of materials during collection.

1.4 RECOMMENDATIONS

- Implement a Minimum Recyclables List, to be developed as part of this Needs Assessment, to reduce confusion on what is recyclable throughout Colorado.
- Upgrades to existing MRFs to process additional material types, improve throughput efficiency, improve accuracy of processing lines, and reduce contamination in material outputs at existing MRFs (see the **Element 6 Technical Memorandum, Element 7 Opportunities and Costs,** and **Element 10 Technical Memorandum** for more information).
- Provide targeted education on common contaminants (e.g., plastics not accepted at the MRF facility, textiles, ceramics, medical waste), including information on where the materials can be recycled or disposed of instead of being placed in curbside recycling carts or at drop-off sites.
- Recognize that individual residents may have different levels of commitment to recycling and consider tagging or rejecting carts to educate residents while reducing contamination at processing facilities.
- Create policies requiring data collection on quantities and types of contamination. Provide methodology to promote consistency in data collection statewide.

2 BACKGROUND DATA

Contamination is a major operational issue for material recovery facilities (MRFs), compost facilities, and material end markets. Contamination can include materials that were incorrectly disposed of in recycling or composting bins (e.g., garden hoses or non-compostable or non-recyclable packaging); incorrectly sorted materials (e.g., containers in the paper stream); soiled recyclable containers; and over compacted materials that cannot be sorted by MRF sorting technology. High levels of contamination in feedstock materials can cause significant issues for facilities, such as:

- **Operational efficiency and maintenance:** High contamination levels can impact the accuracy of sorting materials. Furthermore, facility equipment not designed to process certain materials may be damaged or temporarily disabled by a high quantity of contaminants. For example, holiday lights, hoses, and chains can get caught in sorting equipment.
- **Safety:** Some contaminants received at MRFs or compost facilities, such as aerosol containers, needles, medical waste, diapers, or dog waste, can be safety hazards to employees. Maintenance associated with disabled equipment can also pose risks to workers.
- **Operational costs:** Contamination can result in higher operational costs due to lost time, equipment maintenance, and worker injuries.
- **Residue quantity and cost:** Residue is material that is not able to be sorted into commodity materials and is instead disposed of at the landfill. High contamination and inefficient sorting equipment at MRFs can result in increased residue and, therefore, increased disposal costs at the landfill.
- **End markets:** Entities that purchase sorted commodities prefer less contaminated material and have purity standards for accepted materials. Higher contamination in inbound material typically results in higher contamination in outbound material. End markets may charge a fee or reduce the commodity price if contamination levels are above certain thresholds. Furthermore, facilities with consistently high contamination may have difficulty maintaining partnerships with end markets.

The Recycling Partnership's (TRP) 2020 State of Curbside Recycling Report estimated that the national average rate of curbside recycling contamination was 17% by weight.[1] The Solid Waste Association of North America (SWANA) Applied Research Foundation estimated that $166 million is spent in the United States each year to process contaminants before they are transported to the landfill as residue.[2]

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[1] The Recycling Partnership (2020). *State of Curbside Recycling*.

[2] SWANA Applied Research Foundation (2021). *Reducing Contamination in Curbside Recycling Programs*.

The project team reviewed contamination data from readily available resources. The reports obtained information from a variety of sources, such as stakeholder interviews and facility data collection. Several of the reports discussed staffing, education, and outreach as potential solutions to reduce contamination in Colorado's recycling and composting streams.

2.1 CONTAMINATION IMPACTS ON POLICY

Contamination has a significant impact on recycling infrastructure and end markets. Prior to 2017, much of the recyclable material produced in the United States was exported to China.[3] In 2017, China responded to high contamination in imported materials by implementing the Operation National Sword policy, which heavily restricted recyclable waste imports. This policy significantly disrupted the United States recycling market and resulted in a steep decrease in market prices for recyclable commodities.[3] This disruption was the result of low-quality commodity bales being generated.

Contamination has also directly impacted businesses in Colorado. In February 2023, A1 Organics, Colorado's largest organics recycler, notified customers that it was reducing its accepted material list to exclude compostable packaging, service ware, paper towels, napkins, shredded paper, and pizza boxes.[4] A1 Organics noted that compostable service ware does not necessarily break down as fully or quickly as the other feedstocks and, therefore, remains in the finished compost as visual contamination. Furthermore, non-compostable lookalike items end up in the compost as well and do not break down. A1 Organics attributed the change in accepted items as a first step in eliminating contamination.

Understanding the existing contamination of feedstocks for MRFs and compost facilities and the amount and composition of MRF residues and compost overs is an important first step in identifying improvement methods, which could include educational opportunities or process modifications to address contaminants.

2.2 ROLE OF CDPHE IN CONTAMINATION POLICY

MRFs and compost facilities in Colorado are subject to Colorado Department of Public Health and Environment (CDPHE) Regulations Pertaining to Solid Waste Sites and Facilities, 6 Code of Colorado Regulations (CCR) 1007-2, Part 1, Section 14. The **Element 6 Technical Memorandum** and **Element 14 Technical Memorandum** include more detail on applicable regulations.

CDPHE does not quantitatively regulate contamination of feedstock, but there are regulations in place for MRFs and compost facilities that ensure individual facilities are

[3] SWANA Applied Research Foundation (2019). *Resetting Curbside Recycling Programs in the Wake of China*.

[4] https://a1organics.com/acceptables

conscious of contamination. CDPHE requires that all MRFs have an operations plan that includes the following:

- A physical description of the facility and the types of recyclable materials managed.
- Methods to control public access and prevent unauthorized vehicle traffic and illegal dumping by adequate fencing or other security means.
- Procedures for preventing receipt of unauthorized waste.

For composting facilities, CDPHE provides a list of universally prohibited wastes, which includes asbestos or asbestos-containing materials, infectious waste, hazardous waste, Polychlorinated biphenyl waste, or lead-acid batteries. Facilities are also required to have an approved Engineering Design and Operations Plan (EDOP) that defines operation requirements, including accepted materials and facility access control.

2.3 SUMMARY OF DESKTOP DATA REVIEW

2.3.1 Annual Recycling Facility Reports

CDPHE has a list of 173 registered recycling facilities, which includes MRFs, end users, and industrial facilities.[5] These facilities manage a variety of materials, including single-stream recycling (e.g., cardboard, paper, plastics, metals, glass, etc.), electronics, green waste, wood waste, and other materials. However, many of those materials are beyond the scope of the Needs Assessment, and therefore, the review of available data focused on packaging products, single-stream and dual-stream recyclables, and specialty recycling materials.

CDPHE provides recycling data on a statewide basis and does not publish recycling processed by individual facilities. Recycling, composting, and diversion data from 2018 through 2021 is available on CDPHE's website.[6] Between 2018 and 2021, Colorado's diversion rate for municipal solid waste (MSW) ranged from 15.3% to 17.2%, and its total diversion rate (including materials generated by the industrial sector) ranged from 31.2% to 35.8%.[7] CDPHE does not collect contamination data but does collect voluntary information on residue collected at compost and MRF facilities.

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[5] https://cdphe.colorado.gov/hm/registered-recyclers

[6] https://cdphe.colorado.gov/hm/colorado-recycling-totals

[7] The MSW diversion rate includes the percentage of materials recycled from residential and commercial sources of solid waste, recyclables, and compostable materials. The total diversion rate includes waste and materials generated by the industrial sector, including construction & demolition (C&D) debris, manufacturing waste, energy production waste, and other non-hazardous industrial wastes. For end user or organics recycling materials, the diversion rate is based on outbound materials from processing facilities. Both MSW and total diversion rates include materials that are not included in the Needs Assessment.

2.3.2 2019 MRF Contamination Survey

In 2019, The Recycling Partnership created a MRF survey to assess which contaminants pose the biggest challenge to recycling facilities, which was then distributed by CDPHE's Materials Management Unit (MMU).[8] CDPHE MMU staff sent the survey to twenty-two (22) MRFs that process residential recyclables using curbside collection. Twelve (12) facilities responded to the survey and reported that plastic bags are the most problematic contaminant across facilities. Food or liquids and tanglers (such as hoses or strings of light) were also reported as highly problematic. At that time, CDPHE developed educational materials specific to plastic bags and food and liquid to remind residents not to place those materials in recycling bins.

2.3.3 2022 Statewide Organics Management Plan

The Colorado Statewide Organics Management Plan (2022 SOMP) was commissioned by CPDHE to serve as "a framework to identify key elements, options, and recommendations to increase organic waste diversion opportunities throughout the State," which can be used by policymakers, counties, and municipalities to develop organics programs.[9] Research and recommendations are presented on a statewide level and on more focused levels by region (Mountains, Western Slope, Eastern Plains, and Front Range). The report recommends tailoring organics management solutions to each region due to the many differences found in urban and rural regions. A more detailed summary of the 2022 SOMP is included in the **Element 14 Technical Memorandum**.

The 2022 SOMP included a compost processor survey and stakeholder engagement meetings. Contamination was a key topic of discussion. Though the results were not statistically representative, they provided insight into the role that contamination plays in the success of current and planned organics management systems.

Seventeen (17) facility operators responded to the compost processor survey. Contamination was commonly listed as a significant barrier to composting. The report states that "contamination typically refers to plastics but can also include glass, metal, and other visible contaminates." Issues with contamination in feedstock have led facilities to restrict what materials they accept, excluding certain material streams and groups of generators. Alternatively, facilities may invest in systems to remove the contamination, causing an increase in capital and operations costs.

When asked specifically about processing challenges, contamination was the challenge most featured in responses from stakeholders. Approximately 24% of all stakeholders surveyed thought contamination of incoming material was a challenge. Across the regions, this was highest in the Mountains (45%) and lowest in the West (14%).

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[8] CDPHE Hazardous Materials and Waste Management Division (2019). *Colorado Material Recovery Facility Survey, Spring 2019*.

[9] RRS, SERA, Tetra Tech (2022). *Colorado Statewide Organics Management Plan: A Framework for Regional Organics Opportunities*.

When asked specifically about limitations to using finished compost, contamination was a common answer. Statewide, the contamination was not the most noted limitation (17%); however, in the Eastern Plains, it was the most common limitation identified by stakeholders (50%). It was not identified as a limitation for use by stakeholders from the Mountains and Western Slope regions.

The 2022 SOMP also discusses the concern that end markets have with contamination ending up in the finished compost. Contamination is listed as a top concern for the landscaping market, the agriculture and horticulture markets, and the residential (direct sales) market, which are estimated to account for a combined 40% to 80% of the market demand for compost in Colorado.

The 2022 SOMP includes statewide and regional recommendations to address contamination. The plan recommends supporting the regulation of finished compost quality through the U.S. Composting Council Seal of Testing Assurance (STA) program. Compost manufacturers participating in the STA Certified Compost program are held to high standards for using quality labs, testing frequently, disclosing specific information about their products, and following regulations.

This type of certification program ensures that end markets receive compost products with a consistent level of quality. The 2022 SOMP also recommends that CDPHE provide training and education to organic waste collectors and processors on contamination reduction strategies. Labeling requirements for certified compostable products are discussed as part of a strategy for reducing contamination but are not included as a formal recommendation.

2.3.4 Front Range Waste Diversion Baseline Assessment Report

The 2021 Front Range Waste Diversion Baseline Assessment was commissioned by the Front Range Waste Diversion (FRWD) Enterprise and prepared by Eco-Cycle.[10] The report was intended to identify current recycling, composting, and waste diversion programs and services along the Front Range and identify barriers to diversion. The report included results from phone interviews with seventy-five (75) municipalities. The report found that most drop-off centers that are managed by municipalities and counties struggle with high contamination rates and illegal dumping at their unstaffed locations. Several locations reported that the increasing operational costs due to illegal dumping and contamination at unstaffed locations resulted in the closures of drop-off sites. While additional staff would be beneficial to decrease contamination rates, residents throughout the community reported that expanding educational material on accepted wastes would help encourage recycling and compost rates while also reducing their contamination. The report noted that municipalities typically do not have data on recycling, composting, or contamination rates and noted that contamination rates may be better captured at the MRF level.

[10] Eco-Cycle, FRWD Enterprise (2021). *Front Range Waste Diversion Baseline Assessment.*

2.3.5 Greater Colorado Waste Diversion Baseline Assessment Report

The 2022 Greater Colorado Waste Diversion Baseline Assessment was commissioned by CDPHE and the (Recycling Resources Economic Opportunity) RREO grant program and prepared by Eco-Cycle.[11] The goal of the project was to evaluate current waste diversion programs in Colorado to measure future progress. The report discussed several anti-contamination programs that have been attempted in greater Colorado, including efforts to tag contaminated bins and refusing pick-up bins for repeat offenders.

The report discussed contamination challenges specific to Colorado, including seasonal tourism. Seasonal tourists are not necessarily familiar with proper recycling and composting behaviors or the services provided in the community they visit. Some communities reported that they did not have sufficient staff to enforce recycling ordinances, which can result in increased contamination. Furthermore, quantities of waste, recycling, and composting can vary seasonally, which is a challenge for right-sizing containers and identifying hauler schedules.

2.3.6 Eco-Cycle Survey on SB23-253

Eco-Cycle prepared a survey of compost facilities in response to SB23-253: Standards for Products Represented as Compostable, which was introduced in the 2023 Regular Session of the Colorado General Assembly and approved by the Governor in May 2023.[12] The Act creates standards for products that are represented, marketed, or advertised as compostable. The survey was distributed before SB23-253 was passed and requested data on contamination potentially associated with plastics.

Twenty-one (21) businesses associated with composting, including composters, haulers, third-party certifiers, producers of compostable plastics, and other interested parties responded to the survey. Fourteen (14) of the twenty-one (21) facilities noted that they see material with misleading labels or lookalike "compostable" materials that cannot be broken down or composted in the piles. Several facilities reported spending thousands of dollars per year inspecting incoming loads for contamination and removing materials. Facilities also reported costs associated with transferring rejected loads and excess contamination to the landfill and lost value of contaminated finished compost.

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[11] Eco-Cycle, CDPHE, RREO (2022). *Greater Colorado Waste Diversion Baseline Assessment*.

[12] https://leg.colorado.gov/bills/sb23-253

3 MRF SURVEY RESULTS

In collaboration with Element 6 activities, the team conducted the 2023 MRF Needs Assessment Survey (2023 MRF Survey) at select MRFs across Colorado. Responses to the 2023 MRF Survey were gathered at in-person site visits for five (5) facilities and through virtual meetings with three (3) additional MRFs.

Contamination data was collected as part of the 2023 MRF Survey. The survey included information on the number of rejected loads per month due to high contamination, common contaminants, additional fees associated with high contamination, and challenges handling contamination. Some of the facilities elected not to share some information requested in the survey, as the survey was voluntary.

A description of the full methodology and survey results is included in the **Element 6 Technical Memorandum**.

3.1 MRF CONTAMINATION RESULTS

The facilities surveyed indicated that they reject less than one (1) load per month due to high contamination. Facilities were asked whether they had a protocol in place if loads are rejected. Several of the facilities noted that they audit loads and photograph loads with high contamination. They typically discuss with the hauler and provide warnings if needed. One (1) of the facilities noted that they accept materials from unattended drop-off facilities and, therefore, typically do not reject loads based on contamination.

The survey asked whether MRF staff had noted patterns in loads rejected for high contamination. Two (2) of the facilities surveyed indicated that they had not noticed a pattern. Two (2) facilities noted that they had observed patterns by industry types and household types. Specifically, they stated that food service and the medical industry had high contamination rates, and both noted that multi-residential properties had elevated contamination rates. Facility staff from one site observed that they received material with elevated contamination from mobile home parks and other economically disadvantaged areas. This may be due to a lack of access to recycling infrastructure or educational materials. They noted that when services are introduced to new areas, contamination is typically low at first and increases over time, even with continuing education.

Most of the facilities that responded to the 2023 MRF Survey indicated that the contamination rates in inbound materials ranged from 10% to 20%, as shown in **Figure** 1. Some facilities elected to report exact contamination rates, which ranged from 7% to 15%.

Figure 1: Percent Contamination at MRFs

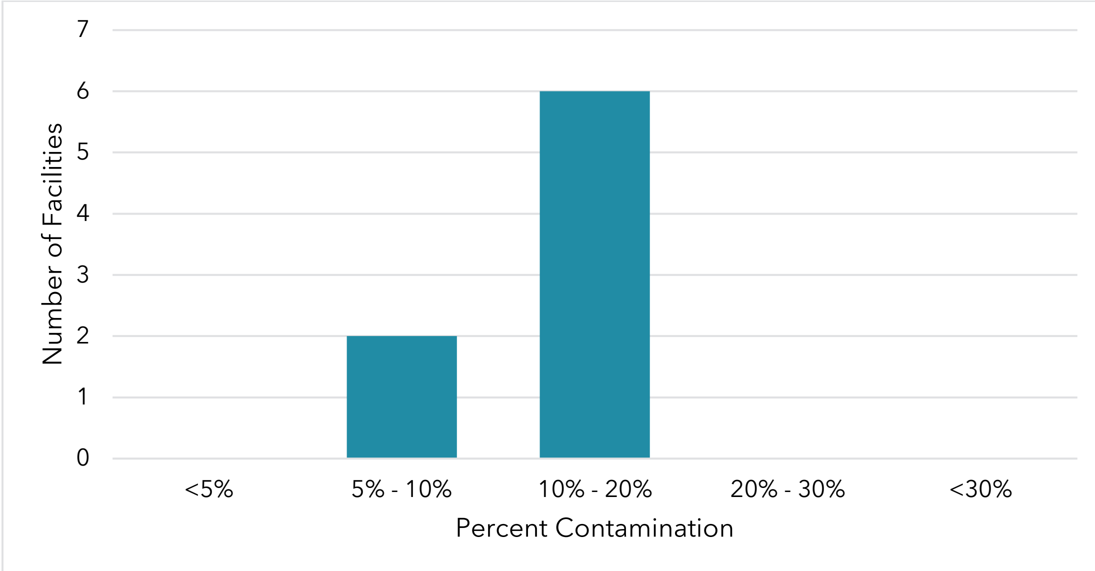
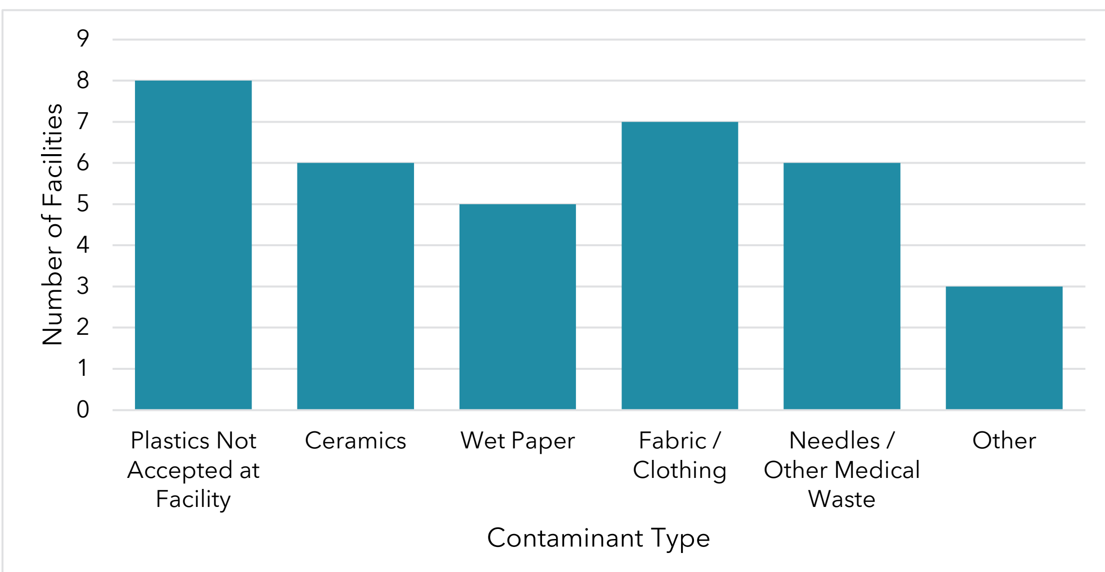


Figure 2 provides a list of common contaminants identified by the surveyed facilities. Plastics not accepted at the facility, fabric, clothing, and other were reported as common contaminants for most of the facilities. Some of the materials currently received at MRFs as contaminants, such as types of plastic not currently accepted at the facilities, could potentially be processed as commodities if end markets are identified and additional processing equipment is purchased. See the **Element 6 Technical Memorandum** for additional information.

Figure 2: Common Contaminants at MRFs



Facility staff had the option to share which “other” contaminants they received, which included the following materials:

- Diapers
- Engine blocks
- Dog waste
- Yard waste
- Christmas lights
- Chains
- Propane tanks
- Expanded polystyrene
- Non-soda lime Glass (or sites that capture glass separately
- Large high-density polyethylene (HDPE) materials
- Scrap metal
- Garden hose
- Wire
- Pallets
- Wood
- Food
- Wire
- Straps
- Construction & Demolition (C&D) material
- Oversized old, corrugated cardboard (OCC)

3.2 COSTS ASSOCIATED WITH CONTAMINATION AT MRFS

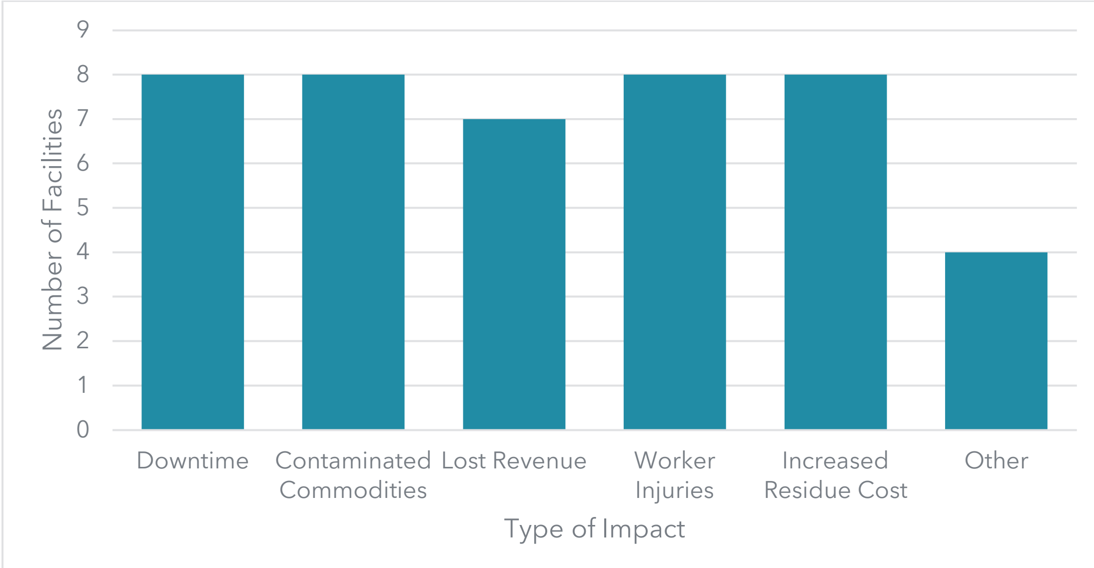
The MRFs surveyed noted that there are costs associated with contamination. The surveyed facilities were given a list of the impacts of contamination and asked which of those impacts facility staff had observed onsite. As shown in

Figure 3, most of the facilities selected every impact on the provided list, which included downtime, contaminated commodities, lost revenue, worker injuries, and increased residue costs.

Facilities also reported other impacts and provided the following list;

- Reduced throughput.
- Lower efficiency.
- Increased costs.
- Increased residue.
- Marketability of materials.
- Long-standing reputation with end markets.
- Wear and tear on equipment.
- Slower processing times.

Figure 3: Impacts of Contamination on MRFs



Facilities were also asked to estimate costs associated with contamination. The facilities were allowed to provide the cost estimates in the format they wished, and the reported answers included the following:

- Injuries, maintenance, and process impacts.
- \$10,000 - \$50,000 per month.
- Lost time to clean lines – typically 1 hour per day out of 6.5 potential hours, or 15% lost time.

Most of the facilities surveyed reported that they must comply with threshold contamination rates set by end markets. Facilities typically reported that end markets use Institute of Scrap Recycling Industries (ISRI) standards or market-specific thresholds and that end markets will charge a fee or reduce the commodity price if contamination levels are above those thresholds. Most of the facilities reported that they had been penalized for contamination.

4 COMPOST FACILITY SURVEY RESULTS

In collaboration with **Element 14: Compost** activities, the team conducted the 2023 Compost Processor Needs Assessment Survey (2023 Compost Survey) at select composting operations across the four (4) distinct Colorado regions (Eastern Plains, Front Range, Mountains, and Western Slope). Responses to the 2023 Compost Survey were gathered at in-person site visits for eight (8) facilities and through virtual meetings with nine (9) additional compost facilities that are representative of the four geographic regions and the four levels of compost facility permitting at the state level (Class I, Class II, Class III, and Conditionally Exempt Small Quantity [CESQ] composting operations).

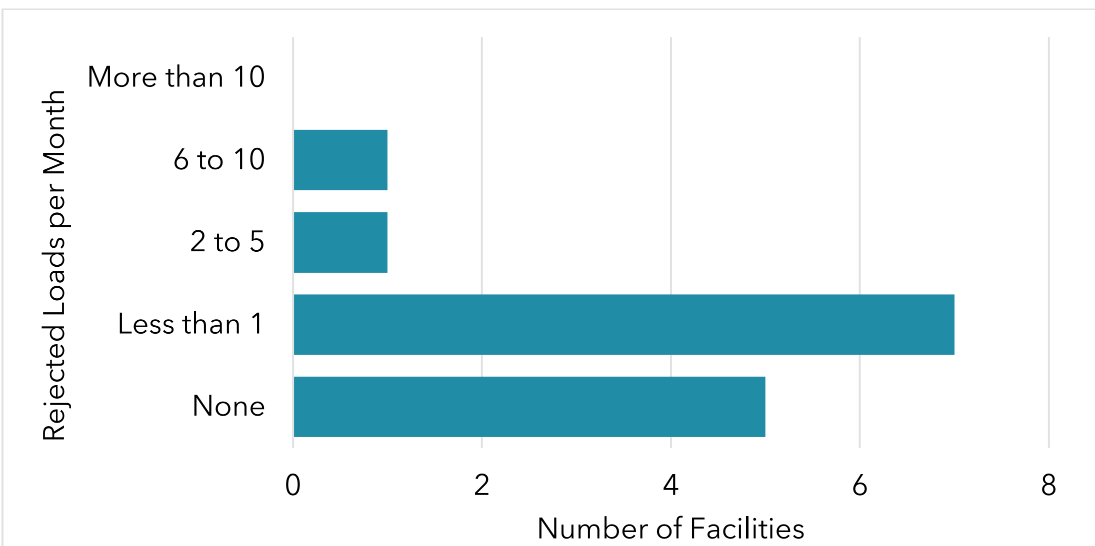
Contamination data was collected as part of the 2023 Compost Survey. The survey included information on the number of rejected loads per month due to high contamination, common contaminants, additional fees associated with high contamination, and challenges handling contamination. Some of the facilities elected not to share some information requested in the survey, as the survey was voluntary.

A description of the full methodology and survey results is included in the **Element 14 Technical Memorandum**.

4.1 COMPOST CONTAMINATION RESULTS

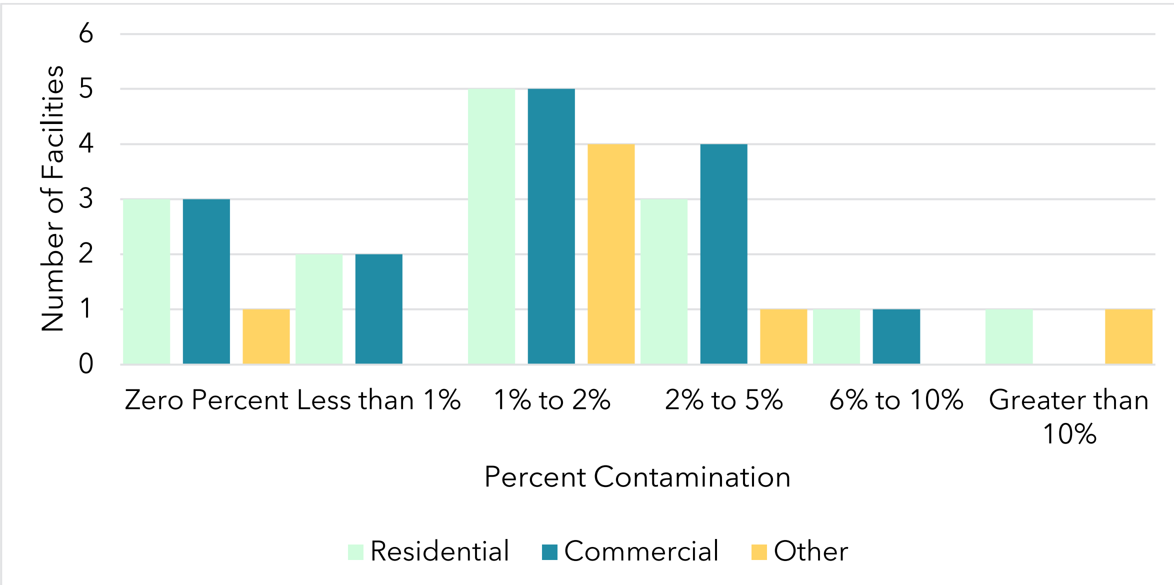
Figure 4 shows the average number of loads rejected per month due to high contamination rates. Most survey respondents indicated that their facility rejects less than one (1) load per month. Each load received is approximately 20 tons of material.

Figure 4: Rejected Loads per Month at Compost Facilities



Contamination rates by feedstock type were collected and are shown in **Figure 5**. Most of the facilities reported a 1% to 5% contamination rate by volume in the 2023 Compost Survey. Several facilities reported a 0% contamination rate by volume. The surveyed facilities were asked which contaminants were most common. Plastic waste was the most common contaminant identified.

Figure 5: Contamination Rate by Compost Feedstock Source



4.2 COSTS ASSOCIATED WITH CONTAMINATION AT COMPOST SITES

The surveyed facilities also provided data regarding the disposal costs for the residue. Two (2) facilities noted disposal was free because both sites were on the same campus as landfills that have the same owner or operator. Most of the facilities that responded noted a disposal cost of approximately $25 to $75 per ton of trash. There was significant variation in responses from other sites: disposal costs ranged from $10 per load, $50 per year, and $50 per month for disposal of a 2 C.Y. trash bin.

Contamination charges are used to deter customers from bringing in contaminated loads, as contaminants can cause equipment challenges and lost revenue. The 2023 Compost Survey requested information on contamination charges. Fifty-four percent (54%) of the facilities surveyed enforce a charge on contaminated loads. Contamination charges typically ranged from $50 to $200 per load and were reported as high as $2,000 per load.

64% of the survey respondents noted that contamination had caused equipment damage. 82% of surveyed facilities noted other impacts, including equipment downtime, contaminated commodities, lost revenue, and increased residue disposal costs.

The 2023 Compost Survey requested data on end-market contamination limits. 42% of the surveyed facilities noted limits in place.

5 DISCUSSION

SWANA's Applied Research Foundation prepared the 2021 Reducing Contamination in Curbside Recycling Programs report, which addresses the reasons that contamination occurs and potential solutions.[13] The project team reviewed findings from readily available reports and interviews with compost facilities and MRFs to identify areas for system improvements that could potentially reduce contamination. Contributors to contamination and potential solutions are discussed below.

- **Confusion on what is recyclable:** Residents can become confused about which materials are recyclable. Since there is not currently a minimum recyclables list in Colorado, different municipalities may recycle different materials. This can cause confusion when residents move or travel to other parts of the state and is particularly a concern in areas with tourism.
  - The implementation of a minimum recyclables list and supporting educational materials, which will be developed as part of this Colorado Needs Assessment, may reduce confusion and result in reduced contamination throughout the state over time. The 2021 Reducing Contamination in Curbside Recycling Programs report notes that "ideally, states, provinces, and localities would all have the same items on their list of acceptable curbside recyclables."
- **Wishful recycling:** Some residents place items in their recycling bins that are not recyclable, but residents either believe that the items are recyclable or wish that they were, a process referred to as "wishcycling" or "wishful recycling." This can cause significant contamination, particularly with items that can wind around MRF equipment, such as holiday lights and metal chains.
  - Increased education based on specific contaminants can be distributed to households, particularly if the item is seasonal. If there are local programs that recycle the items, providers of recycling education can direct residents to those programs. For example, the City of Fort Collins' website has a section noting sites where residents can drop off holiday lights. The website notes that holiday lights should not be placed in curbside recycling bins, as they can damage MRF equipment.[14]
- **Different levels of commitment to curbside recycling:** the 2021 Reducing Contamination in Curbside Recycling Program report notes that "Recycling and sustainability program managers often overestimate the commitment of certain residents and mistakenly assume that contamination issues can be resolved through increased spending on recycling public education programs." The report notes that recycling requires effort and that not all residents

[13] SWANA Applied Research Foundation (2021). *Reducing Contamination in Curbside Recycling Programs*.

[14] https://www.fcgov.com/recycling/atoz/items/?item=135

will be willing to put in that effort. The report divides recyclers into three categories based on their curbside contamination rates: High Performers, Learners, and Under Performers, and suggests that each group may respond differently to educational efforts.

  - "Oops tag" reminders and mail inserts can remind High Performers and Learners to remove certain items from their recycling bins.
  - Cart rejections can be a useful tool in addressing higher levels of contamination in the bin.
  - If residents continue to place contaminants in the recycling bin even after receiving tag reminders and cart rejections, haulers or municipalities may elect to suspend recycling services to problem households to reduce the impacts on the MRF.

- **Confusion on what is compostable:** Composting facilities have noted challenges with plastics in food waste feedstocks. The 2023 Eco-Cycle Survey, discussed in Section 2, indicated that misleadingly labeled or lookalike "compostable" materials that are not actually compostable can cause contamination issues in compost.
  - SB23-253, which was passed in 2023, introduced new requirements for compostable plastics and is expected to address this issue. However, additional education may be required to teach consumers which items are compostable. At this point, it is unclear whether SB23-253 will impact whether some composting sites elect to take compostable service ware or continue to prohibit those items.
- **Impacts of Pay as You Throw (PAYT):** PAYT fee structures attempt to encourage recycling by charging residents the cost of waste collection based on the size of the waste container selected. Residents are not directly charged for recycling and/or organics collection services. The City of Denver currently offers PAYT services. However, PAYT can sometimes result in increased contamination in recycling bins, as residents can elect to pay for a small garbage container and use their recycling or organics cart to dispose of garbage. At least one facility staff member surveyed stated the opinion that PAYT can increase contamination at processing facilities.
  - Tagging or rejecting carts can reduce curbside contamination that arrives at processing facilities. The Recycling Partnership has anti-contamination kits for both curbside and drop-off sites, which provide tools for planning, measurement, outreach and communication, and staffing and training tools.[15] However, staff time can potentially be a barrier to tagging or rejecting carts.

[15] https://recyclingpartnership.org/fight-contamination/

    - Some communities are considering or implementing artificial intelligence (A.I.) systems to identify contaminants and reduce the burden on drivers to make decisions about cart rejections.

- **Limited data on contamination:** MRFs, compost facilities, and haulers are not required to report data on contamination to CDPHE or other entities. Limited information on the quantity and types of contamination makes it difficult to evaluate sources and potential solutions for contamination in Colorado.
    - Detailed reports on the total amount of contamination, common contaminants, and sources of contamination (such as household or business type) could be used to develop targeted policies or educational strategies for certain residents or material types. Education is discussed in more detail in the **Element 12 Technical Memorandum**.

COLORADO NEEDS ASSESSMENT

ELEMENT 5: NON-RESIDENTIAL COLLECTION

JANUARY 25, 2023

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1 EXECUTIVE SUMMARY

1.1 PURPOSE

The objective of this element is to understand service availability, gaps, and recycling services costs associated with providing recycling services to nonresidential covered entities. This involved identifying how services are currently provided to nonresidential entities, the performance of the recycling programs, and their estimated costs.

1.2 APPROACH

The availability of information on nonresidential entities across Colorado is limited and the available information is scattered across various stakeholders, as there is not one central database for information on nonresidential entities.

The municipal survey that was sent by the project team to all 272 municipalities included questions on nonresidential entities. Although some qualitative information was provided by respondents through the survey, compared to the data submitted regarding residential entities, the data on nonresidential was minimal. Additionally, the project team researched each municipality seeking data on nonresidential recycling collection, but publicly facing information is generally focused on the services provided to residents, not businesses.

To find the necessary information for this element, the project team relied on interviews with key stakeholders who were able to provide more detailed information. In total 28 interviews were conducted, including:

- Three municipality officials
- Five school district officials
- Three non-profits
- One airport official
- One hotel official
- Four resort officials
- One event venue manager
- Four restaurant owners/managers
- Five small business owners/workers
- One green business organization

As much of the information provided was sensitive to business financials and strategy, the information provided was generally anonymized and summarized in this memo.

1.3 FINDINGS

Key findings from the various types of nonresidential covered entities are as follows.

1.3.1 Accommodations

- Hotel accommodations report that recyclable materials collected, including packaging and paper, are estimated to range from 20% to 50% of total waste generated.
- Ski resorts report that 25% to 32% of materials collected at their properties, including packaging and paper, are recycled. These properties typically include large outside recreational acreage, as well as restaurants, both on the mountain and off, and hotel-type accommodations.
- Resort accommodations often have ambitious sustainability goals, such as zero waste to landfills by 2030.

1.3.2 Events and Stadiums

- Events frequently employ zero waste services that help attendees properly sort materials, including well-marked bins with extensive signage and sometimes incorporating staff at the waste stations.
- Recyclable material collected at events typically include service ware and containers and range from 0% to 68% of total waste generated at reported events. Some event materials that are recyclable get thrown out as trash because they are too contaminated with food, as there is no infrastructure for rinsing containers.
- One event venue reports that 27% (3.4 tons) of their annual waste is recycled paper products and packaging.

1.3.3 Food and Drink Establishments

- Restaurants typically collect materials such as cardboard and empty drink containers and report that on average 35% of their total waste collected is recyclable paper products and packaging.
- Restaurants are often located in shopping complexes, or downtown areas, which commonly have shared containers for collecting their waste. Arrangements for shared containers are sometimes made by the businesses themselves, but in some cases the arrangement is though the municipality and may be mandated. In these situations, determining fees for each entity can be tricky.
- Compostable containers are often used in restaurants, particularly coffee cups; however, these materials often end up in the trash or as contamination in compost bins, as multiple compost sites, particularly in the front range, do not accept compostables at their facilities.

1.3.4 Small Businesses

- Small business waste is like restaurants in that often times the containers are shared with other businesses.
- Municipalities, particularly those in resort communities, often have requirements for waste enclosures that can be very expensive to build and may not be sized properly to accommodate recycling bins.
- Recyclables collected from small business are assumed to be similar in composition to residential recycling.
- Business recycling varies widely according to the type of business and is reported to range by business from 11% to 83% of total waste collected from that entity. Some small businesses, such as those that are offices, utilize carts instead of dumpsters, so their waste may be collected along residential routes.

1.3.5 Schools

- In 2023, there were 1,934 public schools with 883,264 students and 746 nonpublic schools with 56,821 students in Colorado. The majority of schools and students are located in the Front Range region.
- Waste in schools is mainly generated in cafeterias and classrooms, with cafeterias producing food waste and packaging, and classrooms generating paper, cardboard, and some food and plastic waste.
- Interviews with school districts representing about 26.5% of the student population indicate an average of 28 pounds of recycling per student annually, with diversion rates ranging from 17% to 42%.
- Effective recycling education programs are crucial for fostering environmental awareness. Multiple programs exist in Colorado, such as the Eco-Cycle's Green Star School program and Green Up Our Schools, aiming to reduce waste through education and engagement. Interviewed school districts conveyed a need for enhanced education and training in recycling and composting for both students and staff.
- Reuse practices, particularly in cafeterias, involve the use of reusable trays, cutlery, and food service ware. However, some schools face challenges, like not having the capacity to sanitize reusables, so they rely on disposable service ware.

1.3.6 Outdoor Public Places

- There are many outdoor public places that are natural areas used for public recreation which have socioculturally adopted a "Pack it in, Pack it out" philosophy which places the onus on visitors for waste to be managed off-site and individually.
- There is an emphasis on individual waste disposal for preventing unwanted or dangerous human-wildlife encounters. Some parks have employed the use of

wildlife-proof containers for trash and with the equivalency requirement could have recycling infrastructure follow suit.

- There are 45 state parks which see about 16.5 million visitors annually. Based on average waste generation across all US state parks, it can be estimated that Colorado state parks generate about 2,052 tons of solid waste annually including about 1,642 tons of plastic, 164 tons of metal, 133 tons of paper, and 26 tons of glass. This is about 0.21 pounds of waste per visitor.

1.3.7 Indoor Public Places

- Transportation facilities such as airports and bus and train stations are mostly privately owned, they do not typically receive municipal or county level services.
- There are 18 airports in Colorado. Denver International Airport (DEN) is the largest and diverted 2,514 tons of recycling which made up 19.85% of its total waste volumes in 2022 (Note: deplaned material from international flights is not recycled and therefore is not included in this calculation). Although DEN is a public facility, they separately contract with a hauler instead of receiving municipal services due to infrastructure limitations.
- Deplaned waste from international flights which includes materials that could be diverted must be incinerated, or otherwise separated (buried or quarantined), from domestic waste to safeguard against foreign pests and illnesses.
- Buses and train stations in Colorado are mainly operated by Amtrak, for longer distance train rides, and Regional Transportation District (RTD) for local buses, trains, and shuttles in and around Denver. Union Station in Denver is a central point for both. There is little information on waste management specific to buses and train stations, but it can be assumed that generation is similar in volume and composition to that of regional airports.

1.3.8 Government Buildings

- It can be estimated that there are at least 300 local and state buildings within Colorado.
- Typically, waste generated from various types of government buildings are collected on the same route as non-government businesses, so the material is combined with other commercial waste streams. Therefore, it is difficult to quantify generation for government waste, but it is assumed to be similar in composition to other business-type waste.
- Streets and sidewalks as well as town squares/downtowns/plazas/business development districts (BDD) are not often required to have access to recycling services, even when there is a universal ordinance. However, BDDs typically release bids for private haulers in the few cases where there is service.

2 HOSPITALITY AND SMALL BUSINESSES

Hospitality for the purpose of the needs assessment is focused on accommodations, events, stadiums, and food and drink establishments. Small business, in the context of the needs assessment, is defined as small businesses that generate under $5M in gross revenues. Hospitality and small business, for the purpose of the needs assessment, are assumed to generate the same kinds and amounts of covered materials that residential covered entities typically generate. However, of note, some small businesses like construction and landscaping companies, produce waste that will vary from residential covered entities.

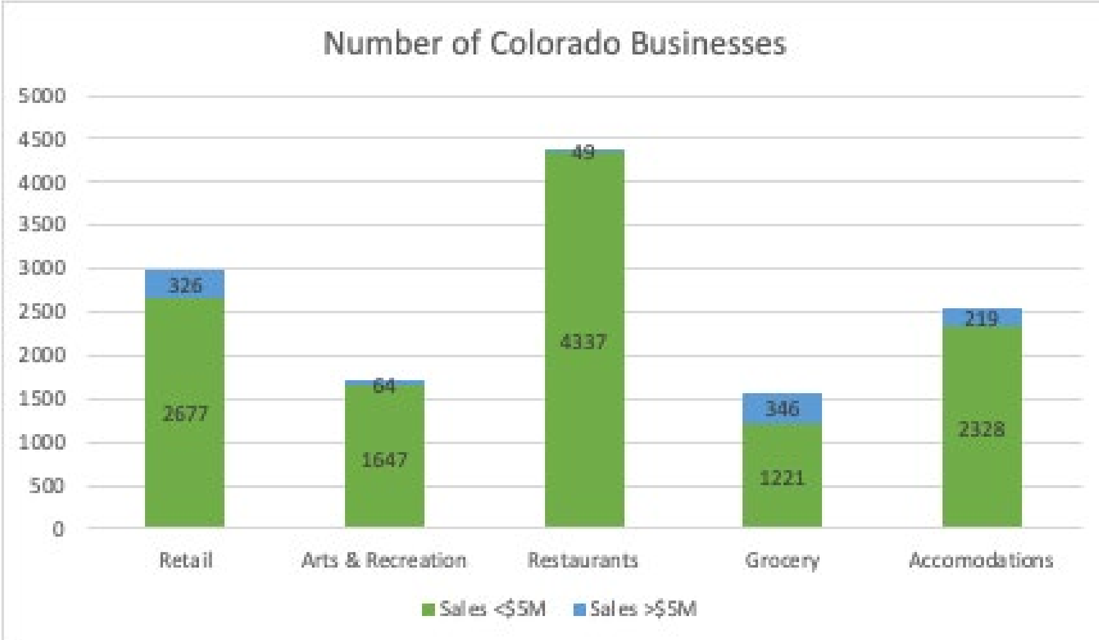
2.1 OVERVIEW

Data regarding the number of businesses in each category was obtained through a NAICS search for Colorado businesses with a sales volume of less than $5 million and those greater than $5 million (Figure 1).

The largest category of businesses identified is restaurants, at 4,386. This includes all businesses with NAICS code 722, categorized as food services and drinking places. A high-level analysis was performed on the restaurant data to determine how many of the restaurants are likely franchises and found that an estimated 1,601 of them are likely franchises.

The second largest category of businesses is retail with 3,003 entities. This list includes businesses with NAICS code 44 and 45, categorized as retail merchandising. The next largest category is accommodations, at 2,547 entities. Included in this list are businesses with NAICS code 721, including lodging and other short-term accommodations. Some of these entities provide lodging only, while others provide meals and recreational facilities along with lodging. The next category is arts and recreation, with 1,711 businesses. These businesses have NAICS code 71 and include a wide range of arts, entertainment, and recreational facilities. The last category is groceries, at 1,567 businesses. These have a NAICS code of 4451 and include grocery and convenience stores.

Figure 1: Number of Colorado Businesses by Category



Business waste is serviced by local haulers that are primarily contracted at the discretion of the business. One exception to that is that at least one municipality requires use of communal enclosures in their downtown location, in which case the business does not get to choose their waste provider. Even municipalities with residential single hauler contracts typically allow businesses to contract their waste with whichever hauler they choose. Single hauler contracts are often specific to residential hauling only.

Of the municipalities that answered the municipal survey, several reported that they currently mandate recycling for small businesses (16 municipalities) and hospitality (13 municipalities). Typically, ordinances lump all commercial entities together, so the difference between those that report requiring small business recycling versus those that report requiring hospitality recycling could overlap. Communities that mandate recycling for commercial entities often require that the recycling container be a certain proportion as compared to trash container, such as 33% or 50% of the size of the trash container.

2.2 ACCOMMODATIONS

The accommodations category includes hotels and resorts. Many Colorado communities are travel destinations with resorts that include amenities like hotels and restaurants alongside outdoor recreational activities like skiing and biking. There are numerous accommodations in Colorado, estimated by NAICS codes to be approximately 2,547.

2.2.1 Waste Generation and Composition

Of hotels that are independent from larger ski area resorts and for which waste data was acquired; the weight of recyclable materials ranged from 20% to 50% of the total waste generated. The smaller hotels, ranging in size from 1,300 square feet to 36,200 square feet, reported 0.12 to 1.35 tons per year of recyclables collected, which is 20% to 50% of their total waste generated. A larger hotel, estimated to be 158,700 square feet in size, reported 51.9 tons per year of recyclables collected, which is 34% of their total waste generated.

One comparatively small to medium sized ski resort, with several onsite restaurants, no hotels, and less than 2,000 acres of skiable terrain reports collecting 62 tons of recyclables from October 2022 through September 2023, which is 32% of their total waste generated (Table 1).

Table 1: Example Annual Small to Medium Sized Ski Resort Waste Data

Waste Type	Tons	Percent by Weight
Compost	32	17%
Landfill	100	51%
Comingled Recycling	52	27%
Glass	10	5%
Total Tons	194	

A comparatively large ski resort with three times as many onsite restaurants as the small resort, several hospitality properties (hotel-like accommodations), and more than 2,000 acres of skiable terrain reports collecting 223 tons per year of recyclable paper and packaging materials, which is 25% of their total waste generated (Table 2). While sufficient data is not available to determine the portion of packaging material that is not captured and recycled, ski area representatives report that it is significant.

Table 2: Example Annual Large Ski Resort Waste Data

Waste Type	Tons	Percent by Weight
Compost	115	13%
Landfill	554	62%
Recycling	223	25%
Total Tons	892	

At least one large ski resort switched in 2023 to collecting aluminum only for recycling to capture more of that material. This decision was made in part because they noticed a significant amount of aluminum was ending up in trash, so a strategic decision was made to focus solely on aluminum. Given that aluminum is highly recyclable, they determined this was their best strategy to make the highest impact from a greenhouse gas emissions reductions standpoint.

2.2.2 Collection

Hotels typically report collecting trash and recycling in dumpsters that are emptied multiple days a week. Some smaller hotels located in downtown areas share dumpsters with neighboring businesses.

Resorts collect their materials in multiple ways using roller carts, various sized dumpsters and roll-offs that are emptied as often as daily during the busiest times of the year. The busy season for Mountain communities is typically eight to nine months. The low season is generally April and May through the beginning of June, and October through the beginning of November.

At least one ski resort participates in Cirqu, a partnership through the Mountain Collaborative for Climate Action with PepsiCo and Replenysh, which entails collecting source separated drinking bottles and cans that are transferred to super sacks and backhauled by PepsiCo to markets for recycling. Data, such as material destinations, are reported to the resort and made available to the public via QR codes on collection bins. The resort's other co-mingled materials are recycled through various local haulers.

2.2.3 Cost

Costs for recycling at resorts range from $14K/year (an estimated $226/ton) at the small to medium sized resort mentioned above to $35K/year (an estimated $157/ton) at the large resort. Note that it is difficult to ensure that costs are comparable and inclusive of all the same expenses.

Personnel costs are not included in the above-listed costs. The large ski resort has one full-time sustainability manager along with 8-10 staff that support waste hauling throughout the resort.

One of challenges that ski resorts face is getting materials off the mountain. Many of their restaurants are located on the mountains, so the material must be transported via snow-machines and ski lifts.

2.2.4 Goals and/or Trends

Many of Colorado's mountain ski resorts have ambitious waste diversion goals, such as:

- Carbon neutral and 75% diversion by 2025 (currently at 49.9%)
- Zero waste to landfills by 2030 (currently landfilling 38% of total waste generated)

Many Colorado resorts participate in the Mountain Collaborative for Climate Action, mentioned above, which considers waste one of the three pillars of efficient resource consumption. Through this affiliation, resorts strive to reduce waste through reduction, recapture, reuse, recycling, and elimination. The Collaborative specifically calls out drinking bottle and plastic film recycling as areas of emphasis.

2.3 EVENTS AND STADIUMS

2.3.1 Waste Generation and Composition

Waste generated at events is typically food and drink related materials, such as bottles, cans, cups, various food containers, and service-ware. Often food containers, especially at events with sorters, are deemed too contaminated with food to be recycled. Some communities have compost facilities that will accept compostable food ware, however, many including the state's largest composter, stopped processing compostable materials in 2023 due to contamination concerns. More details on this can be found in the Element 14 Compost Memo.

Event recycling rates vary greatly depending on the event, the level of effort to encourage correct sorting, and the amount of attention given to recycling during the planning phase. Table 3 provides event data for several medium to large sized events, serving approximately 2,000 - 10,000 people.

Table 3: Event Waste Data

Event Type	Trash Tons	Recycling Tons	Recycling % by Weight
Music Festival	6.13	2.27	37.03%
Sport Event	5.727	1	17.46%
Sport Event	0.345	0.175	50.72%
Music Festival	1.656	0.63	38.04%
Music Series (5)	2.07	1.41	68.12%
Food and Drink Festival	0.69	0.24	34.78%
County Fair	2.07	0	0.00%

One small event venue, 33,465 square feet, reports that 27% (3.4 tons) of their annual waste is recycled.

2.3.2 Collection

Events are usually required to have permits through the local jurisdiction and those permits often have requirements related to trash and recycling, sometimes stating that recycling is required. Events in some communities are incentivized to have onsite zero waste services which instruct attendees with signage and/or staff to properly sort materials.

Event haulers report collecting materials in various containers, such as 96-gallon roller carts, 6-yard dumpsters and 30-yard dumpsters at large multi-day events.

2.3.3 Cost

Events are unique in that they typically involve delivery of bins prior to an event and removal afterward. One event producer in the Mountain region reports that a 6-yard dumpster for events costs $325 each time that it's emptied, while a 30-yard dumpster costs $700 each time that it's emptied. There is also a $75 delivery fee for events within ten miles of the hauler's facility and $100 fee if the distance is greater than ten miles. The hauler interviewed is a significant distance from a recycling facility, so they also bill $125 per hour for the time it takes to transport the recyclables, which averages four hours round trip. Smaller events that use 96-gallon carts for recycling are billed a flat fee of $25 per cart. The flat fee for carts includes delivery.

2.3.4 Goals and/or Trends

Zero waste, as described above, is the latest trend for events. This service is often provided by an outside vendor or a non-profit and can be a significant cost for the event producer. Historically, zero waste services were provided with the help of volunteers, but the trend has been towards paid labor in the past several years, post pandemic.

2.4 FOOD AND DRINK ESTABLISHMENTS

There are an estimated 4,337 restaurants with sales volumes less than $5M in Colorado, many of which are fast food chains. The restaurants interviewed for this assessment were a combination of quick-serve and fine dining.

2.4.1 Waste Generation and Composition

Data reported by the restaurants indicates that on average about 35% of waste from restaurants is recyclable. Restaurant recyclables are largely cardboard used to ship food to the restaurant, empty food containers from kitchens, and empty beverage containers from patrons.

2.4.2 Collection

Restaurants report collecting their waste materials in a variety of containers, from roller carts (mostly for recycling) to 4- and 6-yard dumpsters. Several communities reported having communal waste enclosures, specifically in downtown locations. These enclosures are typically managed by the local municipality and restaurants and other businesses pay a fee for using them. In some municipalities, use of communal waste enclosures is optional, while in at least one municipality, use is required by the local jurisdiction. In either case, the municipality sets the fees for use, which are typically based on the estimated volume of waste generated by each business.

The Town of Breckenridge, a resort community, has a shared trash enclosure program, whereby businesses located within a designated district, mostly downtown, are required to use shared enclosures for their trash and recycling. Enclosures are close to all businesses in the district, reported as 100-150 yards away, and described as, "across a sidewalk and down an alley." The enclosures have key card access and video surveillance. If the recycling bin has contamination greater than 20%, the hauler is allowed to dispose of it as trash and charge all businesses using that enclosure a contamination fee.

2.4.3 Cost

Costs for restaurant recycling are estimated to range from $54.74 per ton to $73.08 per ton in one Mountain resort community. This cost was provided by a restaurant group in a Mountain community that shares containers with neighboring businesses at its locations, so the cost assumes a portion of each container is allotted to their restaurants and is reported in dollars per cubic yard and converted assuming 140 pounds per cubic yard. Another business with 13 restaurants in the Front Range estimates that they pay an average of $85.78 per ton for recycling.

The Town of Breckenridge trash enclosure program requires that haulers bill businesses according to a waste generation ratio, which is based on business type and size. The ratio is likened to the Town's water plant investment fee ratios. There is also an administrative fee that helps cover the costs of administering the program, maintaining and cleaning the buildings, and helps to fund future expansions, as needed.

One Breckenridge restaurant required to use a Town enclosure (open seven days a week with 40-60 tables) reports that their current fee is $500 per month for trash and recycling. Due to using the enclosures, they did not know their trash and recycling weights but report composting 2.5 to 4 tons a month. Compost service is contracted and paid separately.

2.4.4 Goals and/or Trends

In discussions with restaurants, they are trying to reduce the amount of waste they generate by using durables as much as possible and by eliminating unnecessary items, like straws, or by making them available only upon request.

Many restaurants have incorporated compostable items, like coffee cups, into their operations, but often these materials end up in the trash, or contamination in compost bins because local compost facilities may not accept them.

2.5 SMALL BUSINESSES

There is little data specific to businesses with sales volumes of less than $5M per year. Many communities report their diversion rates broken down by residential and commercial, but it's not broken down by sector.

2.5.1 Waste Generation and Composition

Business waste varies widely depending on the type of business. Waste data for a sample of Colorado businesses (104) was obtained from the Colorado Department of Public Health and Environment's (CDPHE's) Colorado Green Business Network (CGBN). These businesses were categorized into 23 types, and waste diversion rates were averaged for each business type. CGBN stressed that these are often estimates based on bin sizes and frequency of pickups, as businesses do not typically have exact weights. Also note that this list is inclusive of all CGBN businesses with waste data, so some of these businesses may not be covered entities, however this data is informational and may provide insight into entities that generate recyclable materials that could be considered for inclusion.

An analysis of the CGBN data was performed, and it was determined that 14 of the reporting entities are considered small businesses with a weighted average of 33% recyclables generated at an average of 19.35 pounds per square foot. Business square footage is the only data collected that could be correlated to waste generation.

Table 4: Summary of Colorado Green Business Network Waste Data

Business Type (number)	Recycling % of Total Waste Generated
Business – Moving (1)	41%
Clothing (1)	83%
Coffee & Tea (2)	22%
Construction (4)	35%
Consulting (9)	40%
Engineering (10)	39%
Entertainment (4)	20%
Event Venue (1)	27%
Farm (3)	11%
Goods – Various (4)	42%
Government (5)	16%
Hotel (3)	35%
Manufacturing (8)	50%
Marketing (3)	29%
Medical (6)	37%
Multifamily Homeowner Associations (4)	36%
Non-profit (5)	34%
Resort (1)	35%
Restaurant (5)	25%
Schools (2)	38%
Tech (4)	61%
Waste & Recycling (5)	36%
Water Supply & Treatment (4)	16%
Wholesale Food & Beverage (10)	34%

2.5.2 Collection

Small business waste collection varies based on the size and type of business, as well as the location of the business. Businesses with large volumes of waste generally use large containers like dumpsters, while smaller businesses may be able to use only roller carts. The location of a business also dictates what containers are used and whether the container may be shared with a neighboring business. For instance, waste collected in crowded alleyways is often stored in shared containers. Many communities require waste enclosures like the one pictured in the photo below. Waste enclosure requirements vary according to codes and ordinances in the local jurisdiction.

2.5.3 Cost

Costs for business recycling vary across the state. A hauler in the Mountain region, specifically a ski resort community, provided their rates for businesses. A four cubic yard dumpster was quoted as $280 per month for weekly service and $160 per month for every other week service. This price is comparatively higher than their trash service, which was quoted as $130 per month for a four-yard dumpster serviced every other week. These rates are likely on the high side of rates throughout the state.

2.5.4 Goals and/or Trends

More and more businesses are looking to be sustainable and as a result are interested in tracking and reducing waste by recycling, reducing, reusing, and composting. This trend is likely going to continue to gain momentum as more consumers become interested in knowing what a business' sustainability record is and as businesses seek out certifications like CGBN (green business) and B Corporation.

2.6 SPECIAL CONSIDERATIONS

- The requirement to service small businesses (i.e., businesses with sales less than $5 million) will be challenging for service providers or the producer responsibility organization to identify.
- Many businesses share containers with neighboring businesses, particularly in downtown business districts and large commercial and shopping complexes. In these cases, fees are shared, which may also be hard to track.
- Commercial recycling costs often go beyond collection. For instance, bear proof bin enclosures required by local governments cost upwards of $60,000 to construct. Also, many were constructed prior to recycling requirements, so sizing may be an issue.

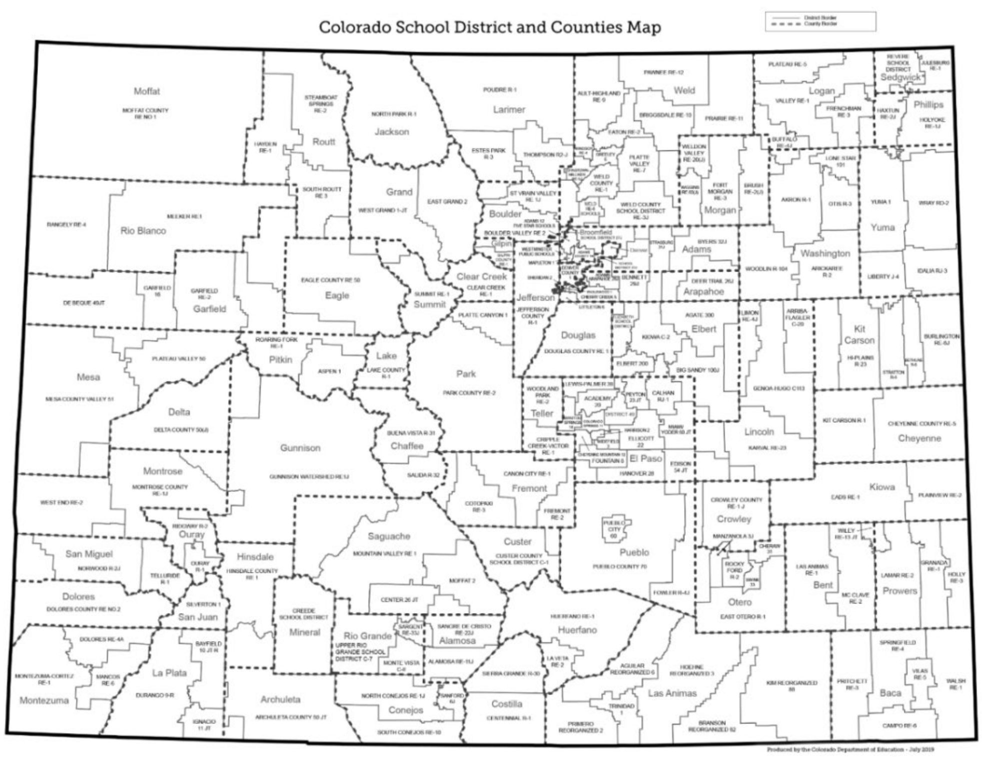
3 SCHOOLS

3.1 OVERVIEW

Colorado's EPR Law defines schools as "a public school in the state that enrolls students in any of grades kindergarten through twelfth grade, including a traditional public school of a school district; a charter school of a school district; an institute charter school; or an approved facility school, as defined in section 22-2-402(1); or a nonpublic school that enrolls students in any of grades kindergarten through twelfth grade".[1] Following this definition, preschools and universities are not considered covered entities.

In Colorado, schools are structured within districts, and the state has a total of 179 school districts (Figure 2). Out of these, 110 districts are classified as meeting the criteria for small rural districts, which means they have fewer than 1,000 students. Additionally, 36 districts meet the definition of rural, meaning they have fewer than 6,500 students.[2] Collectively, these 146 rural and small rural districts make up 81.5% of the overall districts, but account for only 15% of the total student population.[3]

Figure 2: School Districts and Counties Map



In 2023, there were 1,934 public schools in

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[1] Section 22-1-132 - Seizure safe schools - action plan - training - rules - short title - definitions, Colo. Rev. Stat. § 22-1-132 | Casetext Search + Citator

[2] Rural_Small-Rural-Info_Terry.pdf (state.co.us)

[3] Colorado Education Facts and Figures | CDE (state.co.us)

Colorado with 883,264 students enrolled.[4] There were also 746 nonpublic schools with 56,821 students enrolled.[5] The majority of schools and students are in the most populous region, which is the Front Range (Table 5).

Table 5: Number of Schools and Students Per Region

Region	Number of Schools*	Number of Student
Eastern/Southeastern	170	26,065
Front Range	1,899	794,371
Mountains	236	43,775
Western Slope	270	63,498

* The school count in this table encompasses institutions listed as having 0 students in Colorado's Department of Education database.

3.2 GENERATION AND COLLECTION

3.2.1 Waste Composition

Waste at school is generated in two main locations: cafeterias and classrooms. The majority of waste generated in cafeterias is food waste, with some food packaging. In cafeteria kitchens, this is packaging associated with large-scale food preparation, for example, pallets, plastic pallet wrap, canned goods, and frozen plastic bags, among others. In the cafeteria, most waste is consumer packaging such as beverage bottles, milk cartons, snack packaging, and disposable food service ware in schools lacking reusable trays and cutlery. In classrooms, most waste is paper and cardboard, with some food waste, packaging, and other plastic waste.

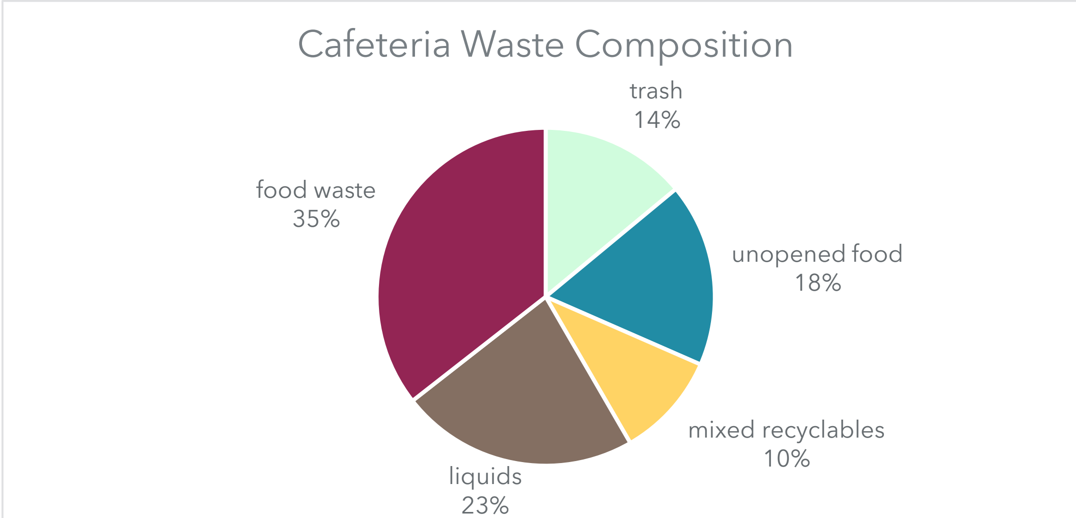
Multiple school districts indicated they lacked waste composition data, hindering monitoring of efforts to improve diversion of recyclables and the reduction of contamination. A district shared data obtained from a waste composition study conducted at an elementary school cafeteria (Figure 3). This breakdown was

[4] https://www.cde.state.co.us/cdereval/2022-2023schoolmembershipgrade

[5] https://www.cde.state.co.us/node/66538/

corroborated by anecdotal information from schools, indicating that approximately 60%-80% of the waste consists of food waste, while recyclables make up 10%-20%.

Figure 3: Elementary School Cafeteria Waste Composition



3.2.2 Waste Generated

Interviews with five school districts representing approximately 650 schools and 26.5% of the student population in Colorado provided information on waste and recycling tonnage. Table 6 indicates there is an average of 28 pounds of recycling per student annually. Table 7 shows that diversion rates range from 17% to 42%. Since all material is collected by haulers and processed in material recovery facilities, it is assumed that all recycled material is paper and packaging.

Table 6: Quantity of Recycling per student in a Sample of School Districts

School District	Recycling (lbs)	Recycling per Student (lbs)
Front Range School District 1	1,104,000	17.6
Front Range School District 2	2,796,000	31.1
Front Range School District 3	511,572	18.0
Western Slope School District	252,000	12.1
Front Range/Mountain School District	1,802,000	59.9
		Average 28 lbs./student

Table 7: Diversion Rates in a Sample of School Districts

School District	Recycling (lbs)	Waste (lbs)	Diversion rate (%)
Front Range School District 1	1,104,000	2,593,000	17.6
Front Range School District 2	2,796,000	N/A*	17

School District	Recycling (lbs)	Waste (lbs)	Diversion rate (%)
Western Slope School District	252,000	348,000	42.0
Front Range/Mountain School District	1,802,000	3,352,000	35.0

*The trash data was not provided; recycling tonnage and the diversion rate were.

3.2.3 Recycling Requirements

Certain municipalities mandate that schools engage in recycling, as indicated in Table 8. In numerous municipalities, recycling at schools is not mandatory, yet many of those schools have recycling. This is due to recycling collection being contracted at the school district level. School districts typically oversee schools in various municipalities within a region, including those in unincorporated areas. Consequently, school districts may provide recycling collection to their schools regardless of whether it is mandatory in each municipality.

Table 8: Does the municipality mandate recycling for schools?

Survey Answer	Number of Schools located in these municipalities	Number of Students	Proportion of student population
Yes	431	143,845	15.51%
No	1,270	480,995	51.85%
Unknown	166	125,848	13.57%
Municipality did not fill out survey	514	177,021	19.08%

For a more accurate determination of the number of schools practicing recycling, the presence of residential recycling collection in a municipality can be used as an indicator (Table 9). A municipality is considered to have recycling for residents if it has haulers responsible for collecting recyclables from residents, whether this service is carried out by a municipal hauler, a single hauler, or multiple haulers, and whether the service is universally available, or subscription based. From interviews with stakeholder and municipal survey responses, the project team used the presence of residential recycling in a municipality to mean that schools are likely to have recycling collection services. Under this assumption, 2,093 schools representing 86% of students are in municipalities that have residential recycling and are likely to have recycling collection services.

Table 9: Does the municipality offer curbside recycling to residential households?

	Number of Schools located in these municipalities	Number of Students	Proportion of student population
Yes	2,093	799,095	86.14%
No	282	61,317	6.61%
Unknown	194	67,297	7.25%

3.2.4 Recycling Collection

Based on 58 responses from municipalities and counties in a survey and five interviews with school districts, most schools have single-stream recycling. Some schools have dual-stream recycling and separate cardboard and fiber or separate glass.

Contamination in recycling remains a concern for schools, especially in cafeterias where food waste and liquids easily contaminate bins. A school district stated their goal of maintaining contamination levels below 5%. The district receives notifications from the hauler if contamination exceeds the 5% threshold.

Schools are serviced by various haulers. Denver Public Schools receive waste collection through the city. Boulder Valley School District receives recycling collection through Eco-Cycle. Other school districts contract collection through private haulers such as Waste Management and Republic Services.

Schools contracting independently from residential or commercial entities may be served on different routes, with the decision at the discretion of the hauler. There is no standardized collection approach. Some schools are serviced alongside residential entities. This is the case in Denver, where the city hauls for both residents and schools and likely collects on the same routes.

3.2.5 Containers and Cost

There is no standardized container used uniformly across schools; the choice often depends on the quantity of waste generated. Different schools use various containers, including carts, dumpsters, and roll-off containers.

Cost information was limited. Calculations based on tonnage demonstrated that one school district pays approximately $150 per ton for combined trash and recycling, while another school district pays $194 per ton specifically for recycling. It is worth noting that several school districts determine collection costs based on volume and frequency and could not provide aggregate data. One district provided this data for recycling, indicating that the cost for a 96-gallon bin is $2.25 per pick up, a 3-yard dumpster is $15.00 per pickup, a 6-yard dumpster is $30.00 per pickup, and an 8-yard dumpster is $40.00 per pickup.

3.2.6 Reuse

The main application of reuse in schools is in cafeterias. While some schools have fully equipped kitchens with commercial dishwashers for cleaning reusable trays, cutlery, and other food service ware, others face challenges. It should be noted that some schools indicated that they faced some problems with reusable cutlery ending up in trash cans.

In certain locations, the absence of dishwashers forces cafeterias to rely on disposable service ware for lunch. This limitation may stem from logistical issues such as inadequate drainage systems and electrical constraints, or it could be driven by cost concerns. Amid the Covid-19 pandemic, many schools temporarily shifted to disposable options, including polystyrene, but this practice is being phased out in most schools. This has been or is being phased out in most schools. Schools still opting for disposable service ware typically use paper-based or compostable alternatives. The schools that use compostable alternatives stressed that these were ending up in the trash as there seems to be little to no capacity to collect compostable packaging in most of the State. Table 10 estimates the number of students with reusable trays in five school districts.

Table 10: Estimated Number of Students with Reusable Trays

School District	Schools Using Reusable trays	Estimated % of students using reusable trays in schools	Number of students using reusable trays
School District 1	Most	95%	64,092
School District 2	All	100%	31,585
School District 3	Most	95%	20,241
School District 4	Most	95%	29,137
School District 5	Some	70%	66,656
			211,711

Boulder Valley School District indicated that their schools have bulk milk dispensers. This provides cafeterias with the ability to provide milk to students using reusable glasses, thereby replacing milk cartons. Milk cartons are among the largest amount of packaging generated in school lunches.[6] To meet nutrition standards set by the US Department of Agriculture (USDA), schools are required to offer fluid milk during school breakfast and lunches.[7] Switching to bulk milk in reusable glasses allows schools to meet USDA requirements while reducing waste and contamination from liquids in recycling bins. There is little infrastructure in the state to support recycling of flexible packaging, like bulk milk bladders, but flexible packaging from bulk milk dispensers likely creates less waste than providing individual milk cartons.

3.2.7 School Programs

Multiple school districts indicate that investing in recycling education in schools yields significant benefits, as it serves as a cost-effective strategy with valuable downstream effects for both residential areas and businesses. Multiple programs exist in Colorado to foster recycling education in schools.

Eco-Cycle's Green Star School program, launched in 2005 in Boulder County, supports waste reduction, compostables, and recyclables collection in schools, serving 26,400 students and 3,400 staff across 59 participating schools. It is currently offered in Boulder Valley School District, Saint Vrain Valley School District, City and County of Broomfield, and Boulder and Weld Counties with active potential to expand. This program aims to minimize waste by conducting activities such as waste audits,

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[6] Abandoning the carton: how bulk milk dispensers can help schools reduce waste | Stories | WWF (worldwildlife.org)

[7] Meal Requirements Under the NSLP & SBP: Q&A for Program Operators Updated to Support the Transitional Standards Effective July 1, 2022 | Food and Nutrition Service (usda.gov)

contests, and Zero Waste School Events, while promoting the use of reusable options. It encourages schools to enhance recycling rates by providing additional collection bins for drink containers. It also aims to improve environmental awareness, focusing on educating participants through activities like field trips, presentations, and projects. In addition, Eco-Cycle offers a free resource for schools, the Zero Waste Schools Activity Guide as a resource for schools across the state and nation.

Green Up Our Schools is a 501(c)3 non-profit organization dedicated to providing elementary schools with guidance for waste reduction programs. The organization offers financial support and tailored sustainability consulting services to elementary schools. Green Up Our Schools aims to reduce the amount of waste sent to landfills through education and engagement activities in schools. Participating schools have achieved up to 70% waste diversion, through the implementation of recycling programs, composting practices, and waste reduction projects.

While these programs provide support to schools, multiple school districts expressed a desire for increased education and training on recycling and composting, both for students and staff. However, they face challenges due to a shortage of resources and insufficient dedicated staff to facilitate this essential training.

3.3 SPECIAL CONSIDERATIONS

- Schools are obligated to provide milk and various food components during school breakfasts and lunches in accordance with USDA requirements. For schools that rely on disposable service ware and carton milk, this often translates to the use of one disposable item or packaging per school breakfast and lunch component, resulting in a significant amount of waste.
- Many school districts expressed reluctance or cited a lack of support in adopting bulk milk primarily due to concerns related to the potential spillage of milk. During the COVID-19 pandemic, there was an increased use of polystyrene for serving breakfasts and lunches. School districts reported that polystyrene has now been phased out to comply with state requirements. In instances where schools with reusable service ware faced staffing shortages, there was a tendency to revert to disposable service ware to streamline meal service as well as cleaning.
- Limited official waste data is available. Some schools have undertaken waste audits as part of sustainability programs, especially those actively involved in composting. Furthermore, informal waste audits involving custodial staff are conducted to assess whether adjustments to waste collection schedules are necessary.

Staff training and activities to educate children about recycling are somewhat limited. Some teachers carry out recycling and compost projects for students. One district mentioned conducting staff training, onsite Material Recovery Facility (MRF) tours, and classroom presentations. Typically, teachers request these opportunities by sending an email to the district. A district indicated it was looking to provide yearly custodial staff training on recycling as well as provide training for new hires.

4 PUBLIC PLACES AND GOVERNMENT BUILDINGS

4.1 OVERVIEW

There is little to no data publicly available on waste management or recycling in public places and government buildings. The information below was compiled using secondary research, a survey that engaged about 180 municipalities in Colorado, and interviews with key stakeholders. According to the survey, there are 18 municipalities and counties which reported mandatory recycling requirements applying to public places or government buildings including Boulder, Morrison, Mountain Village, Erie, Fort Collins, Lake County, Summit County, Frisco, Vail, Avon, Hayden, City and County of Denver, Telluride, Breckenridge, Dillon, Aspen, Longmont, and Steamboat Springs.

4.2 OUTDOOR PUBLIC PLACES

There are many outdoor public places that are natural areas used for public recreation such as state parks, forests, wildlife areas, and bodies of water. These locations and their attendees have socioculturally adopted a "Pack it in, Pack it out" philosophy which places the onus on visitors for waste to be managed off-site and individually; thus, promoting conservation and preventing unwanted or dangerous human-wildlife encounters. There we no incidences found of mandatory recycling within outdoor public places regulated at the municipal or county level, however some more progressive towns have taken up the responsibility of filling in this gap.

There are 45 State Parks in Colorado,[8&9] thirteen of which are located in unincorporated communities, and twenty of which have a "dump station" for waste.[10] The dumpsites are often free to campers, while others can use them for a fee.[11] There is no available data information on recycling practices within the State Park system.

There are also various other outdoor sites used by the public for recreation such as State Forests, State Wildlife Areas, National Parks, National Forests, National Historic Landmarks, National Monuments, National Wildlife Refuges, and National Recreation Areas in Colorado.[12] Often times, these natural areas have bodies of water within them also used for recreation.[13] Similar to state parks, if an outdoor area includes campgrounds, they may provide waste service via communal dump stations, but these

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[8] https://cpw.state.co.us/placestogo/parks

[9] https://cpw.state.co.us/placestogo/parks/Pages/parkMap.aspx

[10] https://cpw.state.co.us/Documents/RulesRegs/Brochure/ParksBrochure.pdf

[11] https://cpw.state.co.us/placestogo/parks/ArkansasHeadwatersRecreationArea/Documents/Admin/Publications/CamperUtilities.pdf

[12] https://www.stateparks.com/colorado_parks_and_recreation_destinations.html

[13] https://www.nps.gov/grca/learn/management/statistics.htm

are few and far between. Recycling is rarely mentioned: an exception is Curecanti National Recreation Area which lists "year-round" "trash/recycling collection" at their campsites with no further detail provided.[14]

There is an emphasis on individual trash diversion ("Pack it in, pack it out") arguably in the name of preventing human-wildlife interactions. While proper recycling should not contain food scraps that attract wildlife, some level of contamination in post-consumer waste streams are inevitable and enough of it could pose a risk for unwanted and potentially dangerous human-wildlife interactions.[15]

On average, Colorado state parks see about 16.5 million visitors per year.[16] A year-to year breakdown is outlines in Table 11.

Table 11: Colorado State Park Visitation

Year	Number of Visitors
2016	13,457,440
2017	14,653,879
2018	14,914,904
2019	14,891,412
2020	19,474,382
2021	19,937,946
2022	18,179,965

Paolo Zialcita/CPR News Source: Colorado Parks and Wildlife: https://www.cpr.org/2023/02/01/colorado-state-park-visitation-2022/

Much of this visitation seems to be concentrated in the most popular and accessible parks, in and around Front Range.[17] In US national and state parks, waste (specifically that which could be diverted through recycling) has increasingly become a problem – 80,000 tons of solid waste was generated at state parks in 2020 by visitors[18] of which 81% was plastic, 8% metal, 6.5% paper, and 1.3% glass.[19] In 2020, US state parks saw over 759 million visitors. It can be estimated that Colorado state parks generate about 2,052.6 tons of solid waste annually including about 1642.1 tons of plastic, 164.2 tons of metal, 133.4 tons of paper, and 26.7 tons of glass. This is about 0.21 pounds of waste per visitor.

[14] https://www.nps.gov/cure/planyourvisit/camping.htm

[15] https://cpw.state.co.us/Documents/ResourceStewardship/WildlifeProofTrashPrescription.pdf#search=recycling

[16] https://www.cpr.org/2023/02/01/colorado-state-park-visitation-2022/

[17] https://www.cpr.org/2022/03/21/managing-crowded-colorado-parks-raises-questions-about-access-and-equity/

[18] https://www.waste360.com/plastics/new-report-examines-waste-generation-and-reduction-national-parks

[19] https://static1.squarespace.com/static/5522e85be4b0b65a7c78ac96/t/635ff5d2f634f81b7143c4eb/1667233443661/Plastic-Free+Parks+TrashBlitz+Report+2022.pdf

From interviews and survey responses it can be gleaned that, for local playgrounds and mountain parks, it is likely that trash and recycling are either self-hauled by the parks department or contracted out.

Case: City of Fort Collins

The City of Fort Collins is the largest and most populated city in Larimer County within the Front Range region. In an interview with a Fort Collins waste reduction and recycling official, it was indicated that while their universal Community Recycling Ordinance does not apply to parks and public places, recycling bins were added next to each trash bin within Fort Collins' town parks and natural areas a few years ago. The waste and recycling materials from the bins are collected by park officials, combined into dumpsters at the park's shop, and amalgamated with the waste streams from city buildings which are subject to the city's mandatory recycling ordinance and collected by a hauler contracted by the city on the commercial pick-up routes. Fort Collins' Community Recycling Ordinance is unique in that, within its licensed open market, it regulates the haulers rather than the waste generators as haulers who provide trash services are obligated to charge customers for baseline recycling service which means having at least 33% of their waste volume be recycling.[20] From government buildings and public places, the City of Fort Collins diverted 172.3 tons of recycling (or 21.7% of total waste) in 2022 and has already diverted 124.6 tons of recycling (or 22.3% of total waste) by August of 2023.

4.3 INDOOR PUBLIC PLACES

Transportation facilities such as airports and bus and train stations are mostly privately owned. There is a large presence of Amtrak in the train system as well as Regional Transportation District (RTD) for train and buses in and around Denver. The central point of the transit map is Union Station in Denver. These all have limited information available on recycling within them. Denver International Airport is the largest and perhaps the most progressive of these types of public place facilities, operating a comprehensive recycling system guided by a sustainability strategy.

4.3.1 Airports

There are 18 airports in Colorado.[21&22] Passenger volumes have increased in the past two years as post-pandemic travel ramps up.

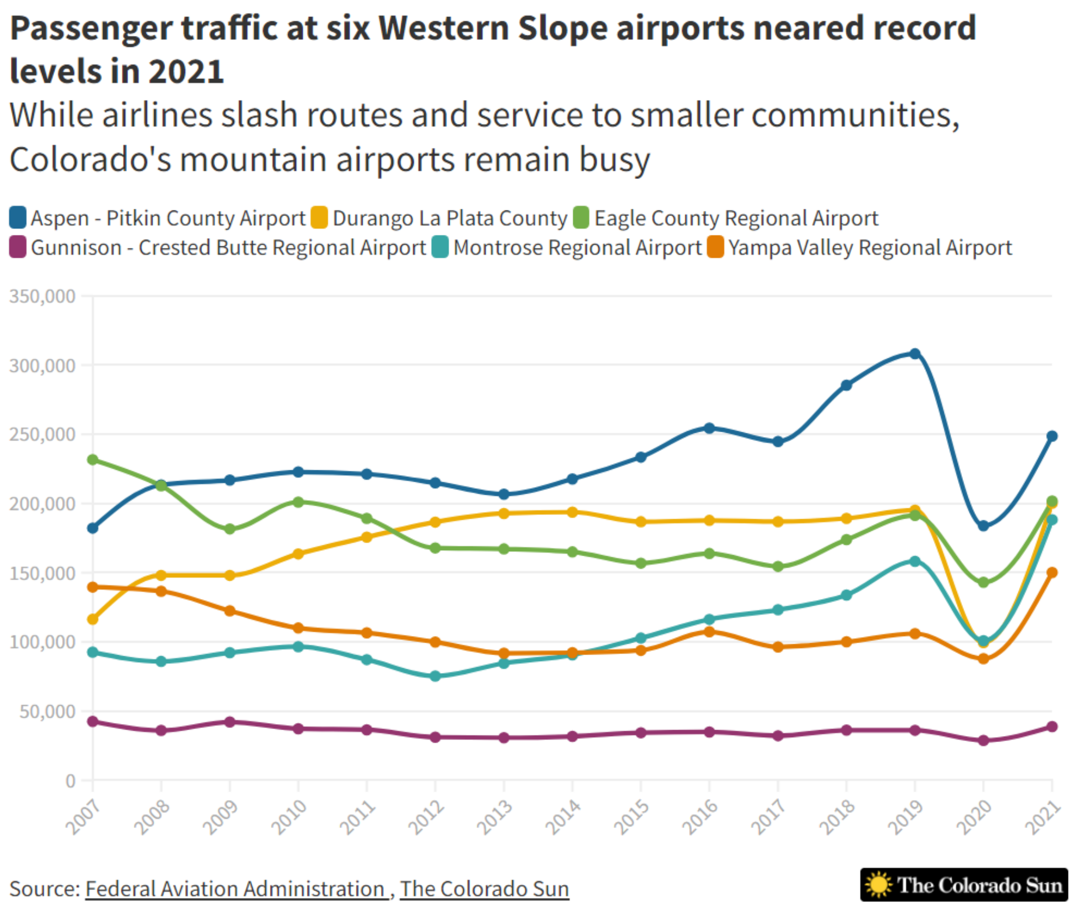
[20] https://www.fcgov.com/recycling/community-recycling-ordinance

[21] https://www.colorado.com/co/transportation/airports

[22] https://www.uncovercolorado.com/airports/

Figure 4 shows airports on the Western Slope seeing record passenger rates in 2021, which kept up in 2022.[23]

Figure 4: Year-to-Year Western Slope Airport Passenger Traffic



https://coloradosun.com/2022/08/02/colorado-mountain-airports-busy-2022/

The Colorado Department of Transportation has an Airport Sustainability Program which conducted three case studies in 2016.[24] Fremont County Airport did not have a recycling program to audit[25], Centennial Airport reported recycling 48 cubic yards of waste at a cost of $816 in 2014[26], and Rifle Garfield County Airport stated that community corrections come once a week to pick up recycling in a 45 gallon container with no other data available.[27]

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[23] https://coloradosun.com/2022/08/02/colorado-mountain-airports-busy-2022/

[24] https://codot.gov/programs/aeronautics/programs/coairportsustainability

[25] https://drive.google.com/file/d/1UAfDhnj4wHfSnvh7zlrNKTnSjMyynrwv/view

[26] https://drive.google.com/file/d/1U6t75nd_qPg-T476B-7vRuJD5wPwC4y6/view

[27] https://drive.google.com/file/d/1UCiXVxMSIodVsCouavhUYCx8xbZmiWzB/view

Generally, approximately 75% of airport waste is recyclable or compostable, with paper being the largest single category of waste generated by the airline industry.[28] Deplaned waste collected from passengers makes up about 1/5 of an airport's total waste[29] and the waste composition of deplaned waste is about 17% recyclable and 23% compostable.[30] US airports are estimated to generate 1.28 tons of waste each year[31] and see about 1 billion passengers per year.[32] This means that US airports generate about 435.2 tons of recyclable material each year. An important consideration is that deplaned waste from international flights which includes materials that could be diverted must be incinerated, or otherwise separated (buried or quarantined), from domestic waste to safeguard against foreign pests and illnesses.[33]

Case: Denver International Airport (DEN)

Denver International Airport (DEN) is the largest airport in the west and the second largest and one of the busiest in the world. In 2022, it served over 69 million passengers.[34] With its size and influence, DEN has made commitments to sustainability which include a recycling program.[35] Table 12 gives a breakdown of the types of materials being recycled at DEN.

Table 12: Average Recycling Totals by Material Category

	Recycling Totals
Metals	0.68%
Fibers	50.65%
Plastics	15.78%
Glass	9.00%
Organics	10.15%
Waste	1.75%
Liquid	7.45%
Residue	4.58%

DEN Waste Audit Data 2019:

[28] https://www.icao.int/environmental-protection/documents/waste_management_at_airports_booklet.pdf

[29] https://trashcansunlimited.com/blog/airports-and-trash-the-fascinating-world-of-airport-waste-management/

[30] https://www.iata.org/en/programs/environment/cabin-waste/

[31] https://www.iata.org/en/programs/environment/cabin-waste/

[32] https://www.tsa.gov/travel/passenger-volumes

[33] https://www.iata.org/en/pressroom/2022-releases/2022-08-16-01/

[34] https://www.flydenver.com/about

[35] https://www.flydenver.com/about/administration/sustainability

In an interview with DEN's sustainability manager, it was found that they successfully diverted 2,514.5 tons of recycling which made up 19.85% of total waste in 2022. As of September 2023, there have been 1,953 tons of recycling diverted. There are three waste streams in the airport: domestic deplaned waste which generates a majority and is collected from planes by airport staff or by airline staff for some larger airlines (all international deplaned waste is incinerated), general public waste from the communal bins in the concourses, and office waste. These single-stream sources are combined and stored in compactors for street level pick-up by the hauler contracted for curbside services by DEN. Although DEN is a public entity, they do not receive service from the city as it does not have the infrastructure to collect from compactors. This highlights the airports need for a special route which is coordinated with the hauler and therefore, material is not combined with either commercial or residential. The collection frequencies vary, oftentimes multiple trucks are needed for pick-ups in a single night. The recycling program used to include a separate stream for glass, but it was discontinued this year as they transitioned to a new hauler.

4.3.2 Train and Bus stations

Colorado has 9 Amtrak Stations that serve two lines.[36] The California Zephyr route had 290,423 riders in 2022 and Southwest Chief had 223,654.[37] Amtrack provides recycling bins on board their trains.[38] Some Amtrak train stations are mostly outdoors – "platform with shelter" (e.g., Fraser-Winter Park Station) or "platform only (no shelter)" (Lamar & Trinidad stations) as opposed to "station building" (all others).[39&40] There is no information available on whether there is recycling in these stations.

The Regional Transportation District (RTD) is a light rail system that runs through Boulder, Broomfield, Denver, Jefferson, Adams, Arapahoe, Douglas, and Weld counties with 10 different passenger lines, 2 free ride paths from Union Station to the Civic Center Station, and the "Flatiron Flyer" which is a "Bus Rapid Transit (BRT) service" going from the Civic Center Station to Union Station to Downtown Boulder. RTD also runs a bus service with local and regional routes.[41] Ridership in 2022 for RTD rail boardings was 21,540,452, while total annual boardings for their bus, rail, and access-a-ride transit systems was 61,602,568.[42] There is a note in RTD's 2015 Sustainability Report that they intend to develop a recycling program.[43] There is

[36] https://amtrakguide.com/stations/amtrak-stations-in-colorado/

[37] https://media.amtrak.com/wp-content/uploads/2022/11/FY22-Year-End-Revenue-and-Ridership.pdf

[38] https://blog.amtrak.com/2015/04/amtrak-keeping-america-running-green/

[39] https://www.amtrak.com/stations/wip

[40] https://www.amtrak.com/stations/tri

[41] https://www.rtd-denver.com/services/rail/rail-system-map

[42] https://www.rtd-denver.com/reports-and-policies/facts-figures

[43] https://www.rtd-denver.com/sites/default/files/files/2017-06/2014-2015-sustainability-report.pdf

another Sustainability Report from 2020 that does not mention recycling.[44] RTD recycles newspapers, office papers, computer paper, and aluminum cans in their offices and has "special bins" set up at "major bus stations" which collect newspapers.[45]

The central point is Union Station in Denver as Amtrack and RTD both run through this station. Although this station is a large hub with eateries and a hotel, there is no available information on recycling within it.[46]

There are also many historic railroads which run as tourist attractions throughout Colorado.[47] Similarly, it is unclear if recycling is offered within these stations.

4.4 GOVERNMENT BUILDINGS

Government buildings are not defined specifically in the Producer Responsibility Program for Statewide Recycling Act. The concentration of this element is on "government owned-land for recreation or public use" or "public-facing buildings that predominantly generate the same kinds and amounts of covered materials that residential covered entities do" including city and state department offices, streets and sidewalks, and town squares/downtowns/plazas/business development districts. While not much is known about recycling within these facilities, it can be gleaned from interviews with city and county officials as well as survey responses that typically these waste streams are collected together (and later combined with residential or commercial waste) and that recycling is typically offered if there is a town recycling mandate or ordinance and if infrastructure allows.

4.4.1 Government owned land for recreation or public use

Streets, Sidewalks, Plazas, and Town Squares

There are 272 municipalities in Colorado, and some are much more populous than others. It can be assumed that there is a similar number of town squares/downtowns/plazas/business development districts as some more remote towns will not have one and larger cities may have multiple. Denver's Waste No More mandatory commercial recycling ordinance requires apartment complexes, restaurants, office buildings, and other businesses in Denver to offer recycling and composting services[48] and from an interview with a Denver official coordinating waste management, it was discovered that this extends to "municipal facilities" (i.e., botanical gardens, city offices, fire stations, museums, recreation centers, etc.). The City and County of Denver services around 200 of these buildings, collecting all three waste

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[44] https://www.rtd-denver.com/sites/default/files/files/2020-10/Quality-of-Life_Sustainability-Report_2020_0.pdf

[45] https://www.rtd-denver.com/sustainability/environmental-programs

[46] https://www.denverunionstation.com/

[47] https://www.colorado.com/articles/complete-guide-colorado-train-trips

[48] https://sdb-denver.com/2023/the-construction-industry/denvers-waste-no-more-ordinance/

streams where possible. Streets and sidewalks as well as town squares/downtowns/plazas/business development districts (BDD) are not required to have access to recycling services under Waste No More and generally there are no recycling bins on the streets unless contracted from the open market of licensed haulers through a bid put forth by BDDs. These are collected on the same routes as residential curbside collections and therefore tonnage data is an amalgamation of both.

State and Local Government Buildings

There are 29 state departments in Colorado[49] and 272 municipalities. There are government buildings commonly found in most municipalities such as town halls, police stations, fire departments, and libraries. There are also less common buildings such as corrections facilities or local department level government buildings. As the legislation does not provide a definition of government building an exact number of buildings is not estimated, but it is likely that there are several thousand government buildings based on common buildings found in most municipalities. According to a recent report there is approximately 30,000 classified government employees in the state.[50]

Table 4 outlines waste data for a sample of Colorado businesses (104) obtained from the Colorado Department of Public Health and Environment's (CDPHE's) Colorado Green Business Network (CGBN). The 5 businesses categorized as "Government" recycled 16% of the total waste generated.

Under the City of Fort Collins universal Community Recycling Ordinance, waste streams from city buildings (not state buildings) are collected by a single hauler contracted by the city. About 61% of commercial entities had recycling services in the City of Fort Collins in 2021. In the commercial stream, from government buildings and public places, the City of Fort Collins diverted 172.3 tons of recycling (or 21.7% of total waste) in 2022 and has already diverted 124.6 tons of recycling (or 22.3% of total waste) by August of 2023.

4.5 SPECIAL CONSIDERATIONS

- Many public places are in unincorporated communities and may require special routes or other considerations due to their oftentimes remote locations.
- Outdoor public places such as parks and lakes should consider wildlife-proof bins, as there will inevitably be contamination which could lead to unwanted and/or dangerous human-wildlife interactions.
- Denver International Airport has contracted a special route which serves the area multiple times or with multiple vehicles per night to accommodate the needs of the business and the ample volumes of waste generated.

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[49] https://www.sos.state.co.us/CCR/NumericalDeptList.do

[50] https://dhr.colorado.gov/sites/dhr/files/documents/DPA%20DHR%20Workforce%20Report%202020-2021_Final.pdf

- Deplaned waste from international flights which includes materials that could be diverted must be incinerated, or otherwise separated (buried or quarantined), from domestic waste to safeguard against foreign pests and illnesses. Alternative disposal methods which would allow for recycling can be explored as a consideration for airport waste.
- In Fort Collins, although there is a mandatory recycling ordinance which spans across the residential and commercial sectors, over 100 variances needed to be given to businesses and some public entities for lack of space for recycling bins or another infrastructure limitation.

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COLORADO NEEDS ASSESSMENT

ELEMENT 6: PROCESSING CAPACITY

JANUARY 25, 2024

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1 EXECUTIVE SUMMARY

1.1 PURPOSE

Recycling facilities, commonly referred to as material recovery facilities (MRFs), are critical infrastructure for recycling. The capacity, type of feedstocks accepted, material processing capabilities, location, and proximity to end markets of Colorado's MRFs largely control which materials are collected at curbside and drop-off locations. This effort aims to identify the current state of MRF operations in Colorado, including operations and capital costs. The baseline assessment will be used to recommend operational, equipment, and/or processing improvements that will be incorporated into the Scenarios developed for this Needs Assessment.

1.2 APPROACH

The project team developed a survey to request information from MRFs across Colorado. The survey included questions on operations, cost, processing capacity, and expansion potential, among other topics. The project team selected representative MRFs from the state and conducted site visits and phone interviews. The available time was limited, and it was not possible to have detailed discussions with all the MRF facilities.

1.3 FINDINGS

- The project team visited nine (9) MRFs in Colorado as part of the Needs Assessment.
- The project team surveyed three (3) additional MRFs in Colorado as part of the Needs Assessment.
- In general, MRF operators were reluctant to share data on feedstock, end market contracts, revenues, specific contamination rates, capital costs, operating costs, or site layout with the project team due to the highly competitive nature of the solid waste industry in Colorado. The MRFs report data to the Colorado Department of Public Health and Environment (CDPHE), but that data is considered confidential and was only available to the project team in aggregate via the CDPHE website.
- Several of the owners and operators noted that Colorado has an "open market" arrangement and that it is very difficult to establish flow control and protect a service area.
- Estimating overall recycling capacity and cost in the State was challenging due to the factors listed above.
- In general, MRFs visited for this Needs Assessment indicated that they could potentially take more feedstock if packaging recycling increases due to the

Colorado Producer Responsibility process. This could be accomplished via facility expansion or additional shifts.

- Some MRFs may require upgrades to existing equipment or process lines to expand capacity and adjust to current incoming feedstocks.
- The majority of the end markets are located out of state, as presented in the technical memo associated with Element 9 End Markets.

1.4 SCENARIO CONSIDERATIONS

- Upgrade existing equipment to process enhanced throughput of feedstocks and increase end-market product quality.
- Add shifts to process additional feedstock when and where needed.
- Improve fire detection and protection systems. Newer systems can detect fires when they are just beginning to form and protect the equipment and facility from devastating fires that can shut down a facility for months. As processing increases, the likelihood of fires increases, which adds risk to recycling operations in Colorado.
- Add glass cleanup systems to existing MRFs, where appropriate, to improve the purity of glass products and increase revenue due to the local available market.
- Monitor residue streams routinely to check for materials that should be captured. This information should be used to correct equipment shortcomings and evaluate processing system changes that could be implemented to improve capture rates.
- Create educational materials in alignment with locations or facilities with high-performance metrics that focus on major issues for MRF facilities, such as the dangers and proper management of lithium batteries and hypodermic needles and what components are targeted. See **Element 12 Technical Memorandum** for more information on education.
- Expand local end markets for MRF outputs. See **Element 9 Technical Memorandum** for further discussion on end markets.

2 BACKGROUND DATA REVIEW

Prior to initiating the survey, the project team reviewed publicly available information and previously published reports to gather data on recycling infrastructure and diversion rates in Colorado. The review was used to obtain what recycling data was available for recycling facilities, identify potential facilities to interview, and evaluate data gaps that the project team could address in the survey questions.

2.1 STATE OF RECYCLING IN COLORADO

The Colorado Department of Public Health and Environment (CDPHE) is responsible for overseeing and collecting information related to recycling in the State of Colorado. CDPHE's efforts focus on increasing education on waste minimization, recycling, and reuse, providing grants and other support for recycling opportunities, and applying incentives to reduce single-use items. While access to recycling services has improved over time, it is not universally available within the state. The highly populated Front Range generally has greater access to recycling compared to the Mountain Region, Western Slope, and Eastern Plains Regions due to geographic barriers and low population density in those regions.[1]

The 2022 State of Recycling and Composting in Colorado report anticipates that the recently passed Extended Producer Responsibility (HB22-1355) legislation will close statewide recycling gaps.[2] This Colorado Needs Assessment will be the first step in determining what the current recycling landscape looks like in Colorado and is expected to guide decision-making to address gaps in recycling access and increase recycling.

In 2016, the Solid and Hazardous Waste Commission established statewide diversion goals. The goals targeted a diversion rate of 28% by 2021 and 45% by 2036. Colorado has not yet achieved its statewide diversion goals.[3] Statewide, the municipal solid waste (MSW) diversion rate has ranged from 15.3% in 2020 to 17.2% in 2018, as shown in **Table 1**. The diversion rate includes recycling and composting, and recycling accounts for most of the total diversion. CDPHE reports annual diversion data on its website and currently provides data from 2018 through 2021.[4]

[1] Eco-Cycle, FRWD Enterprise (2021). *Front Range Waste Diversion Baseline Assessment.*

[2] Eco-Cycle, Colorado Public Interest Research Group (2022). *2022 State of Recycling & Composting in Colorado.*

[3] https://drive.google.com/file/d/1-y9l2ZyZnjtTDH3a-zdLhNgYpIoH32Re/view

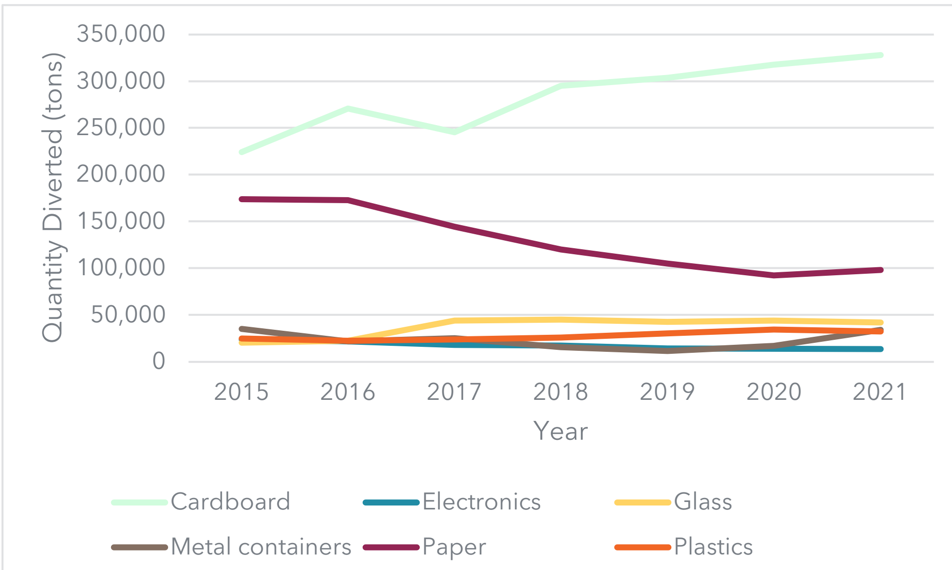
[4] 2018 – 2021 Program Reports to General assembly: https://cdphe.colorado.gov/hm/swreports

Table 1: Recycling Diversion – Statewide

Reporting Year	Recycling & Composting (Tons)	Diversion Rate
2018	850,537	17.2%
2019	851,736	15.9%
2020	756,154	15.3%
2021	807,265	16.0%

The CDPHE also reports trends on certain types of diverted material. **Figure 1** summarizes available tonnage data for materials of specific interest to this Needs Assessment.[5]

Figure 1: MSW Diversion for Selected Materials



Analysis of the material diversion trends is limited, as data is only available through 2021. While analysis over a longer term and a more detailed breakdown may refine the apparent trends, the following trends were observed.

- **Cardboard** represents the largest diversion category by weight. There has been a significant increase in material captured during the period shown because that component maintained the highest value.
- **Paper,** such as newspapers, office paper, junk mail, and other paper, has been trending down since approximately 2016.
- **Glass** diversion has increased since 2015-2016. This may be due to expanded access to in-state end markets.
- **Metal** container diversion volumes decreased between 2015 and 2019 but appears to be rebounding.

[5] https://cdphe.colorado.gov/hm/colorado-recycling-totals

- **Plastics** recycled, including all types of containers (No. 1 through No. 7), have gradually increased in volume since 2015.

2.1.1 Front Range Waste Diversion

Due to the varying geographic and socioeconomic demographics across the state, the State of Colorado established different diversion goals for the Front Range and the other Colorado Regions. In 2021, the Front Range achieved a diversion rate of 16%, falling short of its diversion goal of 32%. **Table 2** summarizes the Front Range diversion rates (recycling and composting) and recycling tonnage between 2018 and 2021. The low diversion rate may be due to a predominant subscription-based recycling culture in the Front Range, as opposed to programs that automatically include recycling services with trash. Approximately half of the residents in the Front Range have subscription service, where recycling is generally provided at an added cost. Organized and bundled programs are typically driven by policy, such as universal recycling or Pay as You Throw ordinances. Some cities, such as Boulder, Fort Collins, and Denver, have universal recycling ordinances in place.[6]

Table 2: Recycling Diversion – Front Range[7]

Reporting Year	Recycling & Composting (Tons)	Diversion Rate
2018	783,678	18.0%
2019	761,941	16.2%
2020	703,040	16.2%
2021	686,223	15.8%

The Front Range Baseline Assessment also indicated varying service levels based on household type. Approximately 15% of residents in the Front Range live in multifamily residences, but they may have limited access to recycling services. Colorado Revised Statute (CRS) 30-15-401 prohibits municipalities from compelling commercial or multifamily buildings of 8 more units to contract with government-provided services instead of a private company. The **Element 1 Technical Memorandum** provides updated information on municipality ordinances and mandates relative to collection services in Colorado. There are only a few Front Range municipalities that actively engage with multifamily collections (MFCs): the City of Boulder, Fort Collins, Longmont, Loveland, Golden, Glendale, and Denver.[8] The **Element 3 Technical Memorandum** provides updated information on multifamily housing units in Colorado.

Drop-off centers are available throughout the Front Range. However, drop-off centers require residents to travel to them and are therefore less accessible than curbside programs. Furthermore, illegal dumping is a common issue at unstaffed drop-off sites

[6] Eco-Cycle, FRWD Enterprise (2021). *Front Range Waste Diversion Baseline Assessment.*

[7] https://cdphe.colorado.gov/hm/swreports

[8] Eco-Cycle, FRWD Enterprise (2021). *Front Range Waste Diversion Baseline Assessment.*

and may require additional oversight or enforcement. Education and adequate program staffing and funding were also reported as challenges to diversion in the Front Range.[8]

2.1.2 Greater Colorado Waste Diversion

Greater Colorado, as defined in the Greater Colorado Waste Diversion Baseline Assessment Report, includes the Western Slope, Mountains, and Eastern Plains Regions.[9] These Regions have relatively low population density, which presents significant logistical challenges to recycling. Transportation costs and program operational costs can be higher due to longer driving distances and low population density, and there is a reduced population base to pay those costs. Recycling facilities in these areas also tend to be smaller compared to those located in the Front Range. Consequently, some areas have no or very limited recycling access. Due to these limitations, the Greater Colorado diversion goal for 2021 was 10%, which is significantly lower than the Front Range's diversion goal of 32%. Despite logistical challenges, the Greater Colorado area has achieved its diversion goal every year between 2018 and 2021, as shown in **Table 3**.[10]

Table 3: Recycling Diversion – Greater Colorado

Reporting Year	Recycling & Composting (Tons)	Diversion Rate
2018	59,741	10.7%
2019	74,003	12.0%
2020	64,707	10.6%
2021	68,260	10.0%

Nearly half of the population of Greater Colorado lives in unincorporated areas, which can reduce access to services.[11] Curbside recycling is available for an additional cost in approximately two-thirds of the communities, but participation rates are low. Approximately one-third of Greater Colorado residents have curbside recycling included in their waste collection services. Drop-offs are common throughout Greater Colorado and most commonly found in the Eastern Plains Region.

As the demand for recycling increases, there have been recent developments in infrastructure growth in the Mountain Region. The US EPA recently granted Chaffee County, Colorado, a Solid Waste Infrastructure for Recycling (SWIFR) grant to partially fund the construction of a regional transfer station for recyclables and a MRF on its landfill site near Salida, Colorado. The facility will provide drop-off options for recycling for the County's residents to supplement existing programs. The project has the potential to divert approximately 45,000 tons per year of material from the landfill.[12]

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[9] Eco-Cycle, CDPHE, RREO (2022). *Greater Colorado Waste Diversion Baseline Assessment.*

[10] https://cdphe.colorado.gov/hm/swreports

[11] Eco-Cycle, CDPHE, RREO (2022). *Greater Colorado Waste Diversion Baseline Assessment.*

[12] https://www.epa.gov/system/files/documents/2023-09/Chaffee_County_SWIFR.pdf

2.1.3 End Market Development

Improving recycling in Colorado is expected to increase demand for local end markets to promote improved circularity. In 2022, the Colorado legislature adopted House Bill 22-1159, which created a Waste Diversion and Circular Economy Development Center (CEDC).[13] The purpose of the CEDC is to support businesses in Colorado that use recycled materials to make new products. Specifically, the CEDC will help businesses use recycled materials, develop new markets, expand recycling facilities, and otherwise provide the needed support and technical assistance to increase diversion and recycling in Colorado. The goal of the CEDC is to expand three end markets that already exist in Colorado and create three new end markets in Colorado. Additional information on end markets is included in the **Element 9 Technical Memorandum**.

[13] https://leg.colorado.gov/bills/hb22-1159

3 RECYCLING FACILITY PERMITTING REQUIREMENTS

Permitting for recycling facilities in Colorado is less complicated than for other municipal solid waste facilities. In general, most owners and operators interviewed did not perceive permitting as a significant challenge, and complying with permitting requirements was also usually perceived to be straightforward.

3.1 PERMITTING SUMMARY

A number of smaller permits are generally required in order to successfully permit a full MRF. A stormwater permit is required for the facility with quarterly and rain event sampling, which is a standard requirement for any industrial-type facility. Few issues were reported with sampling. Facilities with outdoor storage of feedstock and commodities or limited control of run-off may face greater challenges than those with fully enclosed tipping floors, covered bale storage, and well-designed stormwater management systems. Facilities may be required to obtain an air emissions permit depending on the facility's potential to emit air pollutants. Facilities did not report concerns with air reporting or emissions. Similarly, city and county local zoning and use permits are generally required. Once obtained, these permits require limited attention for ongoing operation.

In some cases, new facilities or facility expansions in highly populated areas may require greater effort with "good neighbor" zoning and local ordinance issues than more rural facilities. However, issues with permitting were not reported as a limiting factor for current operations or potential expansion plans. In some cases, MRFs may be co-located with a larger facility that provides other services such as composting, household hazardous waste disposal, and/or waste transfer. In those cases, reporting and recordkeeping requirements may be combined and applicable to the whole facility.

3.2 CDPHE REPORTING

CDPHE requires annual reporting of commodities produced for their tracking records. This information is aggregated for State purposes to track diversion and recycling levels and reported on CDPHE's website.[14]

[14] https://cdphe.colorado.gov/hm/colorado-recycling-totals

4 RECYCLING FACILITIES IN COLORADO

CDPHE collects data from recycling facilities across the State of Colorado and maintains a list of registered recyclers. There are currently approximately 170 facilities on the list, but not all the facilities are material recovery facilities (MRFs). Most of these facilities are specialty recycling operations that may collect and/or process one or more materials for reuse and landfill diversion. Facilities on the registered recyclers list process materials such as cardboard, concrete, textiles, tires, and single-stream recyclables, among others. Not all these materials are subject to this Needs Assessment.

4.1 IDENTIFICATION OF RECYCLING FACILITIES

MRFs, sometimes called material recycling or reclamation facilities, are plants that separate and prepare recycling materials to be sold and shipped to end buyers. MRFs can process a wide variety of materials, including the following:

- Containers: Bottles, aluminum cans (sometimes referred to as Used Beverage Cans or UBCs), and tin cans.
- Paper: Includes various paper products, such as cardboard (Old Corrugated Cardboard (OCC), chipboard, boxboard, office paper, junk mail, and newspaper (Old Newspaper (ONP).
- Glass containers
- Cartons
- Aluminum

Some MRFs may process other material types, such as plastic containers, plastic film, expanded polystyrene (EPS), other metals, shredded paper, specialty paper materials, commercial and industrial scrap, and other materials that can be identified, separated, and have a readily available market.

To narrow focus when assessing recycling facility capacity, this Needs Assessment specifically focused on facilities with sorting and baling capabilities. The project team reviewed the CDPHE registered recyclers list and identified nine (9) facilities that met these criteria at the time that the Needs Assessment was conducted, as shown in Table 4.

- Republic Services MRF - Denver, CO, formerly known as Altogether Recycling
- Boulder, Colorado Recycling – Boulder, CO
- Eagle County Recycled Materials Recovery Facility - Wolcott, CO

- Twin Enviro NW Colorado Recycling – Milner, CO
- WM Recycle America – Colorado Springs, CO
- WM – Grand Junction, CO
- WM Recycle America – Denver, CO
- Republic Services MRF - Colorado Springs, CO, formerly known as Bestway
- Howard Disposal Service LLC – Cañon City, CO

4.2 MRFS CONSIDERED IN NEEDS ASSESSMENT

The facilities considered for the purposes of this study are shown in **Figure 2** and **Table 4** below. Facility processing capacities vary widely, from facilities that process less than 5,000 tons per year (tpy) to large facilities capable of processing more than 100,000 tpy. Many were originally designed for receipt of dual-stream feedstock but have since been modified to process single-stream materials. The facilities also vary in the processing operations, condition, and age of processing lines and equipment, types of equipment used, baling capabilities, bale storage and shipping capabilities, and site layout.

As shown in **Figure 2**, five (5) of the facilities were located in the Front Range. Most of the recyclable material is generated in the Front Range, as that is where approximately 80% of the population is located. Front Range facilities tend to be larger, and additional facilities are reported to be in development in the area. Three (3) of the MRFs were in the Mountain Region, and one (1) facility in the Western Slope Region was on the original list. There were not currently operating MRF facilities identified in the Eastern Plains Region. This region is sparsely populated compared to other areas in the state.

Figure 2: Map of Current Recycling Facilities in Colorado

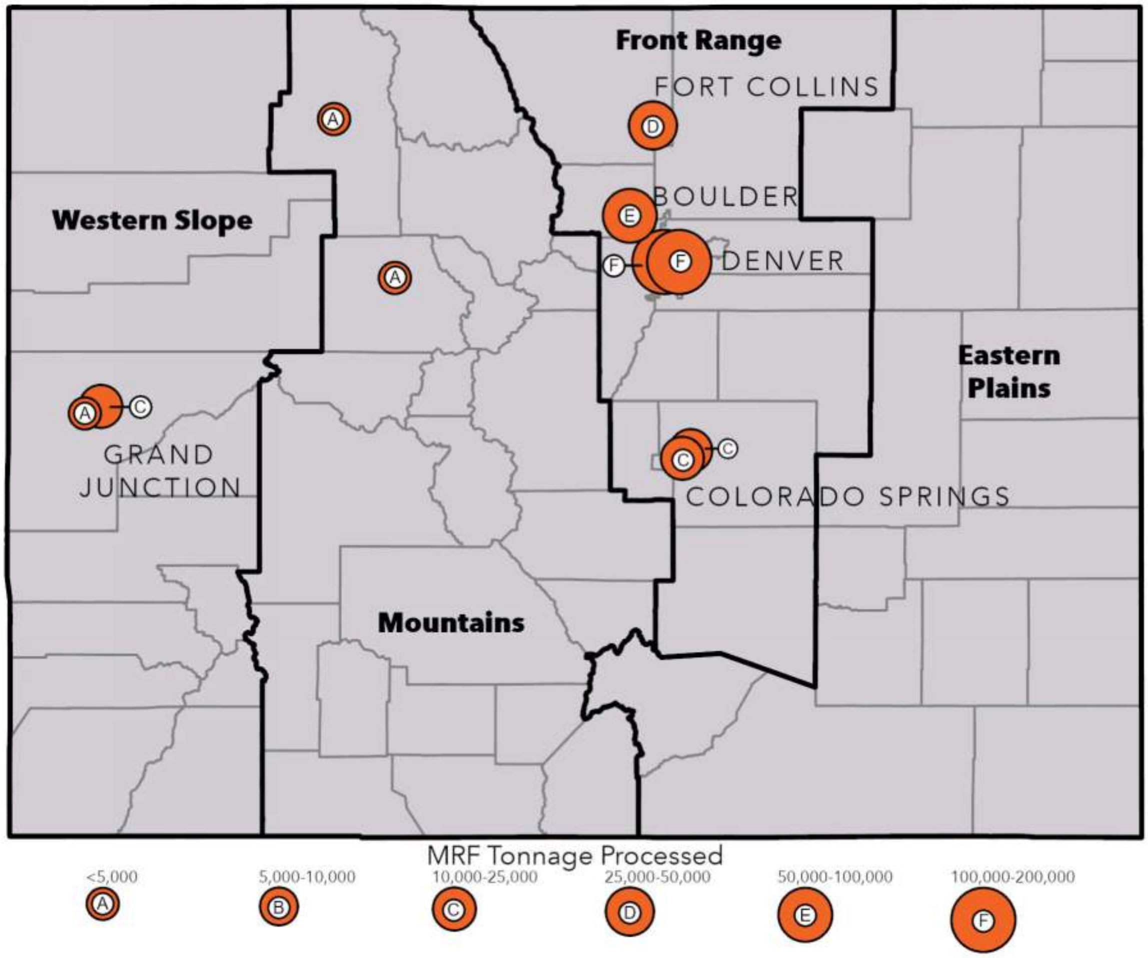

Table 4: MRFs Considered in Needs Assessment

Region	Name of Facility	Address	Throughput or TPY (comingled stream)	Feedstock	Public/Private
Front Range	Republic Services MRF	645 W 53rd Place Denver, CO 80216	100,000 – 200,000 tpy	Single stream (OCC, paper, plastics, metals, glass, polystyrene.)	Private (Republic Services)
Front Range	Republic Services MRF	4005 Interpark Dr. Colorado Springs, CO 80907	10,000 – 25,000 tpy	Single stream (OCC, paper, plastics, metals, glass)	Private (Republic Services)
Front Range	Boulder County Recycling Center	1901 63rd St, Boulder, CO 80301	50,000 – 100,000 tpy	Single stream material recovery facility. Mechanized and manual sorting techniques to separate glass; steel/tin containers, #1 PET through #7 plastic containers; and aluminum beverage containers	Public Owner; Private Non-Profit Operator
Front Range	WM Recycle America - Denver	5395 Franklin St., Denver, CO 80216	100,000 – 200,000 tpy	Single stream (paper, cardboard, metal, plastic, glass)	Private (WM)
Front Range	WM Recycle America – Colorado Springs MRF	602 E 4th St., Colorado Springs, CO 80907	10,000 – 25,000 tpy	Single stream (paper, cardboard, metal, plastic, glass)	Private (WM)
Western Slope	WM – Grant Junction	1227 Winters Ave., Grant Junction, CO 81504	< 5,000 tpy	Dual stream (paper, cardboard, metal, plastic, glass)	Private (WM)
Mountains	Eagle County Recycled Materials Recovery Facility	605 Ute Creek Rd., Wolcott, CO 81655	< 5,000 tpy	Dual stream material recovery facility. Mechanized and manual sorting techniques to separate glass; steel/tin containers; #1 PET through #7 plastic containers; and aluminum beverage containers	Public
Mountains	Twin Enviro NW Colorado Recycling Expansion	20650 Routt County Rd 205, Milner, CO 80478	< 5,000 tpy	Single Stream (cardboard, paper, plastics, bottles, aluminum, and metals)	Private
Mountains	Howard Disposal Services LLC	2100 Forge Rd, Cañon City, CO 81212	–	Single stream (OCC, paper, plastics, metals, glass)	Private (Republic Services)

5 MRF FACILITY INTERVIEWS

The project team developed a survey to evaluate MRF processing capacity, equipment, operations, and site arrangement. The survey was intended to evaluate the current capacity and expansion potential for materials covered under the Needs Assessment. The assessment included questions on costs for processing, gaps in transfer and processing capacity, and logistics associated with transferring materials to existing processing. The team used CDPHE's list of recycling facilities to identify which MRFs would be targeted for interviews, as discussed in **Section 4.1**. The project team contacted selected MRFs to set up site visits and phone interviews.

5.1 INITIAL SITE SELECTION PROCESS

Nine (9) facilities with processing systems and baling operations were initially identified for possible site visits. The project team used the following process to select sites:

- Reviewed MRFs on Google Earth to verify site location and appearance of an active operation.
- Where possible, reviewed industry information to identify approximate facility size and potential range of feedstocks accepted, targeting a variety of sizes and feedstocks.
- Sorted sites by region (Western Slope, Mountains, Front Range, Eastern Plains), targeting at least one facility per region.
- Reviewed ownership and operating arrangement (public vs. private), targeting a mix of publicly and privately owned and operated facilities.
- Reviewed private ownership facilities and included as many different private owners and operators as practical.

Six (6) facilities were selected by the project team and vetted by key project advisors. The following facilities were presented to the Circular Action Alliance (CAA) as recommendations for site visits. The remaining three (3) MRF locations were listed at alternate sites.

Selected Sites:

- Republic Services MRF - Denver, CO
- Boulder, Colorado Recycling – Boulder, CO
- Eagle County Recycled Materials Recovery Facility - Wolcott, CO
- Twin Enviro NW Colorado Recycling – Milner, CO

- WM Recycle America – Colorado Springs, CO
- WM – Grand Junction, CO

Alternate Sites:

- Bestway Recycling - Colorado Springs, CO
- Howard Disposal Service LLC – Cañon City, CO
- WM Recycle America – Denver, CO

The recommended list included facilities from all regions except for the Eastern Plains Region, as there was not a qualifying MRF identified in this region. There were only two (2) publicly owned MRFs identified for the survey, so both were included. The remaining sites were privately owned and operated. The selected facility list also included facilities that process single-stream and dual-stream sorting systems, use rail and truck transport, collect organics, and were reported to process some less common and source-separated feedstocks.

5.2 SURVEY OUTREACH AND FINAL SITE LIST

The project team attempted to schedule site visits with the approved six (6) facilities. The HDR team used both email and phone to contact the target facilities. The short timeline made facility availability critical for scheduling the interviews. While arranging a site visit with Republic Services in Denver, it was determined that Republic had recently acquired the recycling interests of Bestway Recycling and Howard Disposal Service LLC.

5.2.1 Site Visits Conducted

Due to scheduling conflicts with some sites and ownership changes, the list of MRFs visited was modified to include the following:

- Republic Services MRF - Denver, CO
- Boulder, Colorado Recycling – Boulder, CO
- Eagle County Recycled Materials Recovery Facility - Wolcott, CO
- Republic Services MRF - Colorado Springs, CO (formerly Bestway Recycling)
- City of Grand Junction MRF – Grand Junction, CO (formerly Curbside Recycling, Inc.)
- WM Colorado Springs MRF - Colorado Springs, CO
- WM Franklin St. - Denver, CO
- WM Denver East - Denver, CO
    - This facility is planned but not currently operational. It was included in this Needs Assessment as it represents future recycling capacity in Colorado.

- WM Denver (48th Street) - Denver, CO
    - This facility is currently operational but will be closed and repurposed. This site was interviewed for completeness but does not provide future recycling capacity.

5.2.2 Phone Interviews Conducted

Not all of the facilities were available for a site visit. When possible, phone interviews were scheduled instead. The following facilities were interviewed by phone:

- WM Grand Junction MRF - Grand Junction, CO
- WM Larimer County MRF - Fort Collins, CO
- Twin Enviro NW Colorado Recycling - Milner, CO

5.2.3 Facilities Not Surveyed

The following site was not able to be interviewed.

- Howard Disposal Service LLC. - Cañon City, CO
    - The facility was reported as no longer in operation. Recyclables previously accepted at this facility are now transported to Republic Services' Colorado Springs MRF.

5.3 SURVEY APPROACH

The survey included questions on each facility's throughput (including design capacity, actual capacity, and expansion capacity); service areas; customer types (e.g., commercial, multifamily residential, single-family residential); incoming feedstock; outgoing commodities; contamination (discussed further in the **Element 4 Technical Memorandum**); processing equipment; material flow through the facility; number of staff onsite; permitting process; and capital and operational costs.

Prior to sharing the MRF Survey with selected facilities, the HDR team consulted with CAA on survey content. Revisions to the survey were made, as needed, based on CAA guidance. A copy of the MRF Survey is included in **Appendix A**.

Facilities were provided with a high-level summary of the project and the purpose of the survey. Participants were provided the survey prior to the interview to review via the body of an email. Surveys were not attached as separate documents to comply with ADA requirements. When available, at least two (2) HDR team members were present for each site visit or interview.

5.4 SURVEY RESULTS

Qualitative and quantitative data were collected from each facility visit. As discussed below, Colorado's solid waste market is highly competitive, and therefore, data collected from the MRFs is provided in aggregate to protect owner and operator interests. Information obtained was provided by owners and operators and site observations. Site assessment interviews were limited in duration, with the interview and facility walkdown lasting up to half a day. No extended facility records or files were provided to support the performance statements offered. However, some owners and operators verbally provided performance data for several years. In some cases, questions were asked in more than one way to help verify the statements.

Guided site tours were completed for all facility visits. If allowed, photos were taken during facility tours to document equipment arrangements and condition. Approximately half of the facilities allowed photos to be taken but typically limited which areas or processes could be photographed. No process flow diagrams, general arrangements, or other drawings were provided by any of the facilities.

Equipment was observed for general functionality. In most cases, the processing equipment was in service, although not all conditions observed were representative of typical operating conditions. Site tours primarily served the purpose of seeing the facility in operation to gain a general understanding of processing capabilities and capacity.

5.4.1 Survey Limitations

The Colorado solid waste market is highly competitive, and nearly all the MRF operators and owners surveyed noted the importance of protecting business interests and assets. Several of the operators and owners requested a non-disclosure agreement (NDA) before providing site-specific information. For some facilities, completion of the facility assessment survey and site visits or phone interviews were significantly delayed by the NDA process.

The facility's hesitation to share the requested information provides valuable insights into the Colorado recycling market, including the challenges of owning or operating a MRF. Key findings include the following:

- In many cases, sections of the survey could not be completed for various reasons. In general, sites reported that the requested information:
  - Was considered to be proprietary business knowledge;
  - Was previously provided to and requested to be obtained from the CDPHE;
  - Was not routinely collected or pre-dated the facility staff interviewed and thus not available; and/or
  - It was related to agreements between the facility and various parties and, therefore, could not be shared.
- Several of the owners and operators noted that Colorado has an" open market" arrangement and that it is very difficult to establish flow control and protect a service area.

  - Facilities noted that there is significant competition for feedstock.
  - Sources of feedstock, material mix, commodities generated, and business arrangements were closely guarded secrets.
- Competition was strongest within the Front Range but extended throughout the State.
- Both private and public owners and operators were driven to increase profit or revenue in almost all cases.
- Cost components for both capital and operating and maintenance costs were generally not provided.
- Identification of most commodity outlets, terms of sale, and tipping fees were not provided.
- Much of the recycling capacity in the state is in the Front Range. The Eastern Plains region does not currently have recycling processing capacity. Material from that region is shipped elsewhere for processing.
- There is some material that crosses state boundaries into or from neighboring states. However, facility operators reported that these transfers are irregular and de minimis in nature.

5.4.2 Site Assessment

Facility capacity varied from facility to facility. The owners and operators have found ways to utilize the available space. Some of the sites had some outdoor commodity storage along with covered and indoor storage. Products that were more susceptible to weather were stored in protected areas. In general, added site bale storage capacity and features would be beneficial for all locations observed as a means of improving operational efficiency. The ability to expand the site, however, varied, with some of the owners and operators expressing challenges due to neighbors and limited site expansion capability. Some land use and permitting issues were noted as potential challenges with zoning and other governmental oversight. All of the owners and operators have considered potential site changes within their current property boundaries with varying levels of implementation.

Some of the MRFs were located at sites where other solid waste services are provided. Other co-located services included activities such as a landfill, transfer station, household hazardous waste collection, and composting operations. In some cases, these other operations impacted survey results for topics such as permitting.

The existing MRFs that reported a site size generally have sites in the 5-to-10-acre size range, with some smaller MRFs in the 2-to-5-acre range. At least one (1) facility was on a site larger than 10 acres. Most sites were in developed areas with similar industrial facilities nearby. Most of the surveyed MRFs are located in buildings in the 50,000-square-foot to 100,000-square-foot range. There is a mix of buildings that have been repurposed for the MRF operation buildings and those constructed specifically for the original MRF facility. Some of the process lines have been updated and retrofitted to the existing building and, therefore, may not be as optimal as new construction. Additional changes to the processing lines will further complicate operation and maintenance.

Tipping floors were generally undersized, although that is not the case for all facilities. Increasing throughput will stress receipt and management of feedstock at many of the facilities and may result in the need for more space.

5.4.3 Throughput Capacity

The MRF processing system and baling capacity varied. Facilities located in the Front Range tend to be larger, as they serve larger population centers and process material coming from other Regions. The current capacity of the MRF facilities for throughput of comingled stream materials ranged from less than 5,000 tpy to between 100,000 and 200,000 tpy.

Feedstock Collection

Generally, the service provided included single-family single-stream and commercial single-stream service. Commercial single-stream recycling generally includes multifamily collection. However, multifamily facilities may need to contract service, and thus, the service may not be provided universally where recycling services are available. There are a few areas in the State with dual-stream collections. Almost all the MRFs observed or surveyed process a high percentage of residential feedstock, reportedly greater than two-thirds of the material received. Two of the facilities surveyed process primarily commercial feedstock (approximately 80%).

All the facilities receive some material collected through drop-off stations, and one gets nearly all its feedstock in this manner. Unmanned drop-off centers can be a source of contamination and illegal dumping, so most of the facilities prefer to receive feedstock in other ways. Typically, drop-off feedstock is only a small percentage of the total material processed. Some drop-off centers collect all materials, and some only collect certain materials or combinations of materials, such as all containers or all containers with glass collected separately.

Processing Type

Several of the facilities were originally designed for dual-stream processing. However, most have been modified to primarily process single-stream feedstock. One MRF facility currently processes only dual-stream feedstock, and a second is capable of processing dual-stream containers bypassing the fiber/container separation screening. Another facility that is currently arranged for dual-stream processing is studying alternatives and potential facility modifications. One of the facilities noted that measures were taken during re-design to allow increased flexibility. This allows the facility to accept single-stream and dual-stream and have partial processing capabilities for certain feedstock, so the facility can continue partial operation if the equipment is down or source-separated material for direct baling is received. All the facilities are capable of receiving direct bale feedstock.

Most of the facilities had the capability to send source-separated materials directly to a baler, bypassing the sort line. At least one facility reported a design flaw in the original equipment layout that limited certain capabilities with sorting equipment. This limitation could be corrected, but due to current operating needs, a workaround had been completed, and correction of the deficiency was not necessary. If increased demand occurred, the facility could modify the processing system to correct the design flaw.

5.4.4 Feedstock

Each of the MRF facilities interviewed accept containers and paper materials typical for recycling systems. Some of the facilities accept additional types of containers, such as cartons. Some of the facilities reported that they have experimented with accepting EPS and film, but typically, these materials have limited acceptance.

Most facilities reported accepting the following commingled material stream:

- Plastic Containers
  - PET (No. 1) bottles
  - PET thermoform containers
  - HDPE (No. 2) natural containers
  - HDPE (No. 2) colored containers
  - Mixed plastic containers (No. 3 – 7)
  - Over-sized HDPE containers, buckets, toys
- Paper
  - Cardboard
  - Chipboard (particle board)
  - Office paper
  - Newspaper
  - Magazines
  - Cartons
  - Junk mail and similar types of paper that are not waxed, shredded, laminated, tissue, or similar paper materials
- Glass
- Metals
  - Aluminum cans

- Used Beverage Cans (UBC)
- Steel cans
- Empty aerosol cans and similar metal materials
- Other types of aluminum, such as foils, cat food containers, and food service aluminum

A few facilities process the following materials:

- Squeezable HDPE containers
- Black or other hard-to-detect plastics
- Film plastic (only source-separated)
- Shredded paper (source-separated material or in limited quantities)
- Pulp packaging, coffee cups, and similar materials
- Very small plastic containers (less than two inches)

MRF facilities interviewed did not report processing the following:

- PVC
- Degradable or compostable plastics
- Multilayer plastics
- Paper that is waxed, laminated, multi-layered, polycoated, etc. (e.g., cartons)
- Napkins and tissues
- Non-container glass such as Pyrex or other cooking glass, plate glass, windshields, leaded glass, picture tubes, and scientific glass containers
- Batteries

- Wood, rubber, or textile packaging.
- Expanded polystyrene (EPS) as clamshells, cups, or packing materials
- Most facilities do not process very small-sized plastic containers, less than two inches on a side.

Accepted feedstocks by MRF varies based on reported data. The values may vary based on the split of residential and commercial feedstock sources. Furthermore, some facilities interviewed only process certain portions of the material received and send the remaining materials to another facility to complete processing. This may occur when facilities are being modified, have equipment out of service, or are not equipped to sort specific material streams.

5.4.5 Contamination

All facilities surveyed indicated that contamination can be an issue. The average contamination was reported to vary from less than ten percent to between ten and twenty percent. This information was self-reported, and records were not shared with the project team. However, City & County of Denver staff shared audit reports from summer 2023, which showed the results of various loads. The audit results indicated that loads vary from less than five percent to well above thirty percent contamination. Several MRF operators noted that feedstock from much of Denver was particularly contaminated and stated that the Denver area may benefit from recycling and contamination education. Additional information on contamination is included in the **Element 4 Technical Memorandum**.

Contamination can cause risks to worker safety and facility protection. Lithium batteries improperly disposed of as recycling can cause fires and shut down facilities for extended repairs. Hypodermic needles are sometimes placed in recyclables and can result in serious injury and lost production. Even when these materials represent a small portion of contaminants entering a facility, the lost production and danger to workers warrant special focus in education campaigns.

Facility staff identified other challenging contaminants, including long stringy materials like garden hoses, chains, cables, and fabrics that can wrap around equipment. This can force shutdowns to remove the material and may damage the equipment. Special education campaigns should focus on materials that cause major issues for MRF facilities. Focusing on a limited number of key issues with an explanation of the dangers and problems those materials can pose could potentially help reduce contamination. Additional information on recycling education is included in the **Element 12 Technical Memorandum**.

5.4.6 Equipment

Nearly all the facilities used equipment that is readily available from most major MRF vendors. Some of the facilities use processing equipment that is designed to separate select commodities, such as large cardboard and glass, from single-stream feedstock, leaving a residual blend that is shipped to another facility to complete processing. Nearly all the facilities can accept source-separated feedstock and send it directly to the baler, bypassing the primary sorting system. Some facilities may not use all the equipment at the facility, as their operation can be completed without that equipment at this time. At least one facility in the State has a special system designed for smaller MRF operations.

Many of the State's MRFs were built more than 15 years ago, often for a dual-stream feedstock common at that time. Most of those systems have since been retrofitted by adding front-end screens, which allow the processing line to accept single-stream feedstock. Most of the facilities have been modified multiple times over the years by adding modern equipment to upgrade processing capabilities. However, most of the facilities still have some original equipment, and one or two of the facilities have nearly all original equipment.

Typically, MRF equipment at larger MRFs begins to show its age after about ten (10) years. Technology has advanced rapidly, with new and better equipment developed for the current feedstock. In addition, controls, electrical components, and other replacement parts for older equipment may be difficult to find. The smaller MRFs tend to use older systems with fewer upgrades. In some cases, this may be due to the system being designed for greater capacity than they are currently operating, resulting in reduced wear and tear on equipment. Equipment that is routinely operated at or near its design capacity is likely to need repairs more often than equipment operating below its design capacity. Larger systems that have been retrofitted more frequently tend to have equipment and process lines with components from various manufacturers. In those cases, the design capacity and bottlenecks for the overall processing system are harder to identify.

Screens

All the surveyed MRFs have screens of various types. Star screens are the most common type of screen and are used to separate paper (fiber) materials from containers. The primary processing facilities (4-5 facilities statewide) have a cardboard or OCC screen designed to separate large cardboard from the smaller fiber and containers. These screens often have two or three screen decks to get a cleaner OCC product. The smaller non-OCC material falls through the screen, often onto a glass-breaking screen designed to crush glass and separate all the materials less than two inches. The remaining material often passes over a series of fiber screens where the remaining paper is separated from the containers that fall through the screen.

Some systems may use vibrating screens for some applications. Ballistic screens may be used to separate glass fines and containers from fiber in one step. Another newer concept is to use an auger screen at the beginning of the sorting process to separate oversized material from smaller material as a means of reducing the number of sorters. This is completed for cost savings as well as for safety reasons. Screens are replaced as they wear out, or better arrangements are developed. No significant issues were noted at the surveyed facilities.

Optical Sorters

Optical sorters have been introduced to MRF processing systems as a labor-saving device. The optical sorters can make hundreds of picks per minute and are much more efficient than manual sorters. The technology was first used in container sorting and, more recently, for fiber sorting. All of the MRFs visited had at least one optical sorter, although at least one facility was not currently using their optical sorter. The larger MRFs use several optical sorters for container and fiber products.

Robotics and AI

Robotics and Artificial Intelligence (AI) are newer technologies at MRF facilities. Most of the facilities surveyed have at least one robot. Robotic technology and AI continue to advance but are still in development. Some issues still remain with the grabbing function as well as the speed of the robots. Modern robots can make an attempted pick faster than a human, but not every pick results in a successful grab of a target. They are helpful in quality control applications and residual cleaning of process residue lines. AI is helpful in monitoring the processing line to identify missed commodities, which can provide an early alert to operators to adjust a screen or sorter. They can also be used to balance processing speed for maximum processing rates. Robotics and AI will continue to improve and be used in more MRF processes.

Magnets

Magnets are used to capture tin cans and other ferrous (magnetic) materials. They are highly reliable and often have a long life span. Additional magnets could be used in some facilities to help clean up the glass stream or otherwise capture additional ferrous materials that are missing.

Eddy Current Separators

Eddy current separators (ECS) are used to capture aluminum and certain other nonferrous metals. Some of the ECS units noted during site visits have been in the facilities for many years. However, ECS units can be damaged by stray ferrous metals, have torn belts, and lose efficiency in other ways. The units should be assessed to determine their collection efficiency and adjusted or refurbished accordingly. ECS units can miss material in two ways: 1) flattened aluminum cans (as well as valuable PET) are often mis-sorted into the fiber line as flattened cans behave more like 2-dimensional fiber than 3-dimensional uncrushed cans. 2) Often, the fines and glass that drop out of the system as MRF glass can be high in aluminum. It was reported to HDR that in some cases, whole cans end up in the glass material sent to Glass to Glass for reprocessing. In this case, repairs should be completed on the glass breaker to limit the size of material falling through the screen.

Balers

Balers are critical for keeping processing lines operating and achieving desired truck and rail load ratings. Some of the MRFs have replaced balers or have plans to do so, but some of the smaller facilities still have original equipment that is performing well. However, as feedstock increases and systems are pushed to design capacities, it is likely that some facilities will need to replace aging balers. Careful selection and arrangement to maximize facility productivity are important. Less-expensive single ram and lighter-duty balers may not have the processing capacity that is needed over the long term.

Conveyors

Conveyors are used to move material through the processing system and between sorting equipment. Conveyors at MRF are usually maintained as belts, idlers, drives, pulleys, and other components wear out. As processing lines are modified, conveyors may be modified to provide proper alignment and spacing between equipment components. Older systems or facilities generally have a larger conveyor system between sorting locations. Picking stations may be designed with enclosures to avoid noise and provide heating, ventilation, air conditioning (HVAC), and lighting as required. None of the systems observed were noted to have sorter housing, although Colorado's temperate climate reduces the need for HVAC during much of the year.

Control Systems

As processing systems are pushed to maximize throughput and efficiency, advanced control systems, potentially with AI features, will be helpful. At least one larger facility has recently reported replacing its control systems. While the operators were not fully trained and used to the system, it was noted that the increased capability to control and monitor the processing line was providing benefits.

Fire Protection Systems

MRF facilities are at high risk for the potential for devastating fires. Often, lithium batteries are found in facilities and, under the right conditions, can result in fires that are difficult to extinguish. Fires can also be caused by equipment overheating or other factors. The feedstock needs to stay dry and loose for processing, which maximizes its combustibility.

Fires can put workers at risk and put MRFs out of service for long periods of time. For these reasons, the fire protection systems should be evaluated and updated with the latest technology to monitor the facility from the tipping floor to bale storage and to proactively address any fires.

Other Equipment

The various MRFs each have other support and processing equipment. Examples include but are not limited to metering drums; commodity storage bins; loading docks; air compressor systems; concrete wear surfaces; building components; operator support facilities such as lockers, breakrooms, training, and offices; truck scales; parking lots; parts storage; and maintenance shops. All these components are needed for operation and, in some cases, could be upgraded for efficient future operation.

Mobile Equipment

Each MRF had the mobile equipment necessary for its current operation and has developed a replacement program to maintain operation. However, the quantity and type of equipment may need to change as throughput increases.

5.4.7 Product

The larger MRFs in the Front Range produced typical single-stream commodities. Some of the smaller MRFs only produced certain commodities and then produced a modified single-stream product for further processing at the larger MRFs in the Front Range. The MRF operators felt their commodities were of appropriate quality for the available markets. All reported that sometimes they have some material rejected, which is typical for MRF operations.

Many of the facilities have limited bale storage. Where possible, adding covered or enclosed storage may maintain and raise commodity yield and help stabilize pricing. Consistent commodity quality may result in better sales pricing or agreements.

Most commodities are currently shipped out of State. However, there is an in-state market for glass. Colorado has at least two major bottle companies in the state and a secondary glass processor that services these facilities. Additional information on glass recycling is included in **Section 6**.

5.4.8 Costs

Information was requested in the surveys for all the facilities. However, due to the highly competitive nature of the industry, nearly all the facilities declined to provide any information related to costs. Some capital costs are estimated here based on discussions with equipment suppliers and the project team's industry knowledge. Additional information on cost is included in the **Element 7 Technical Memorandum**.

Capital Costs

Most of the facilities were initially constructed years ago. Often, the current facility management interviewed did not know the cost of the original construction. Cost information for upgrades also were not provided or even clearly defined for competitive reasons. Additional cost information was obtained from past projects and various equipment suppliers who provided project costs for typical retrofits to supplement the lack of information gathered in the interviews. The costs provided are for the installation of equipment and associated retrofit and modification. However, none of the costs are for a specific facility, and every MRF is unique. Due to the complexity of work required for the project at a particular facility, the actual costs indicated may be outside the indicated range. In addition, lost production time is not included in the estimates, and those costs for some projects may be substantially more than the equipment installation costs. Lost production costs for some facilities may be as much as $100,000 to $200,000 per day. Some example costs with facility retrofit are provided below.

- Optical sorter
  - Fiber Sorter - $1,500,000 - $2,000,000 per sorter. Potentially a very complicated project that may result in major downtime.

    - Container Sorter - $800,000 - $1,000,000 per sorter.
- Robotics - $400,000.
- Glass Cleanup System- $200,000 - $400,000 depending on existing facility equipment and arrangements.
- Screens
    - Auger Screen - $800,000 - $1,000,000. Projects are usually complicated and can mean extended downtime.
    - Ballistic Separator - $600,000 - $1,000,000. Project may result in decreased throughput and can be complicated with extended downtime.
    - OCC Screen – $400,000 - $1,000,000 per deck. Projects designed to increase the number of OCC screen decks can be complicated. Refurbishment instead of replacement is often possible.
    - Fiber Screen - $450,000 - $600,000 per screen.
- ECS - $300,000 - $400,000. Often, it can be refurbished and returned to required performance.
- Magnet - $100,000 - $120,000. Usually, it only requires repairs and not replacement.
- Fire Detection and Protection Systems - $75,000 - $200,000 (pending size of the facility). Systems that provide advanced detection and control throughout the facility (tipping floor, bale storage, processing equipment, and other areas) provide better protection. There may be additional annual monitoring costs.
- Control Systems - $1,500,000 - $2,000,000. Extended downtime is often required for installation.
- Building expansion cost - $200 - $400 per square foot.
- Balers - $500,000 - $1,000,000.

Costs for replacement or addition of equipment are provided only for general order of magnitude comparison purposes. Each facility and installation situation will be unique, and a specific review has not been completed for any project or facility. Costs will vary based upon numerous factors such as constructability, ancillary equipment that also needs to be replaced, equipment size and features, schedule constraints, economic and supply chain issues, structural changes, maintainability, building modifications, and infrastructure capacity.

Operational Costs

Operating costs were also closely guarded. Most operators were not willing to provide a tipping fee for single-stream feedstock received. Sources of feedstock were not offered, nor were sales price arrangements for commodities when pricing was requested. Generally, the number of sorters was offered in round terms, if at all.

Requests for site layouts and flow diagrams were declined, as was information on the specific equipment components.

Most sites observed appeared to be maintained in reasonable condition for an operating facility. With one or two exceptions, the equipment appeared to be in operating condition. If throughput is increased, maintenance will become more challenging both for the equipment and the facility. Maintenance costs will also increase if additional shifts are added. Finding quality operators for the second shift and completing maintenance will be more difficult. The costs associated with increased staffing and maintenance are addressed in the **Element 7 Technical Memorandum**.

5.4.9 Expansion Opportunities

Existing Facility Expansion

Each of the facilities surveyed reported that they were operating at less than the equipment supplier's stated capacity. While some facilities operated well below this capacity for varying reasons, others routinely approached the stated capacity. The facility staff interviewed indicated they have considered expansion and facility modification alternatives. All the operators and owners interviewed felt there were steps they could take or were taking to increase throughput, improve commodity quality, or otherwise improve and maintain their facility. Some have active plans for equipment and process upgrades and routinely make changes, but some facilities have not had to significantly modify their original equipment to-date. Significant potential for increased capacity and commodity quality improvement is possible within the existing MRFs, particularly among the smaller facilities that are not processing all materials received. Detailed information on expansion capacity is included in the **Element 7 Technical Memorandum**.

New Facilities

The US EPA recently granted Chaffee County, Colorado, a SWIFR grant for the construction of a regional transfer station for recyclables and a MRF. The project has the potential to divert approximately 45,000 tons per year of material from the landfill.

The project team also interviewed a development company that is assisting a private entity with creating a waste complex, including an MRF, compost facility, and construction and demolition (C&D) processing facility in the Front Range region. The private entity also plans to offer hauling services in the region. The compost facility is planned to process 100,000 tons annually at max capacity, and the MRF and C&D are "significantly sized." The entity is in the process of permitting the proposed facility, and it is expected to be in operation in 2025 or 2026. While details on the materials processed and quantities were not available at this time, the facility will provide additional capacity for processing single stream and C&D materials.

As noted above, WM is planning for a new facility in Denver that is not currently operational, which represents future recycling capacity in Colorado. Some stakeholders noted that additional facilities may be in development within the State.

6 SPECIALTY RECYCLING

The project team interviewed entities that are involved in specialty recycling, including specific sites and industry representatives. Specialty recyclers may process materials that aren't accepted at most MRFs or may process a single material rather than a single stream feedstock. These interviews were conducted to provide a more comprehensive view of recycling in Colorado. In general, the interviews conducted with specialty recycling facilities focused on qualitative rather than quantitative data.

6.1.1 Glass

Glass is one of the few commodities that have an in-state recycling market. Colorado has at least two major bottle companies in the state and a secondary glass processor that services these facilities. The project team interviewed an industry representative who is familiar with glass recycling operations in Colorado. Two glass processing facilities accept sorted materials from Colorado MRFs and source-separated glass.

Most of the facility operators and owners reported that they would prefer to process glass separately from other containers. Because Colorado has in-state re-processing facilities, facilities generally process most glass as mixed crushed glass. A few facilities handle some source-separated glass that may be color-sorted. The processing technology used at one facility is not well suited to process glass, so source-separated glass is the best way to manage glass at that facility. In some cases, lower-quality glass is used for alternative daily cover at some facilities.

Glass containers have been color-sorted at some MRFs in the past, but color sorting is now generally left to a secondary processing facility, Glass-to-Glass. In a few cases, some glass may go directly to Molson Coors or to Owens-Illinois (O-I) in Windsor, Colorado.

The quality of glass collected from dual-stream and single-stream facilities varies widely. The age of the MRF and the type of equipment used for glass cleaning can impact the quality, as can contamination levels in incoming feedstock. The Glass Recycling Coalition (GRC) has MRF certification standards based on contamination levels, which are based on ISRI specifications. However, the industry representative noted that glass recyclers are dependent on incoming feedstock from MRFs and, therefore, typically do not reject even highly contaminated loads from MRFs. Contamination from some MRFs can be as high as 30% to 50%. Problem materials for glass processors include ceramics, Pyrex, test tube glass, windshield glass, Bora-silica glass, tempered glass, and film-covered glass. Small plastic caps can also be a problem.

The industry representative suggested MRF upgrades to clean their outgoing glass recycling stream, which can increase material recovery rates at the glass processing facility.

6.1.2 Mesa County HHW Facility

The Mesa County Hazardous Waste Collection Facility is a drop-off site for household hazardous waste (HHW) located on the Mesa County Solid Waste Management Landfill campus. The drop-site is available to all of Mesa County, which includes Grand Junction, Fruita, Palisade, Clifton, Redlands, Collbran, Orchard Mesa, De Beque, Loma, and Fruitvale. Drop-off services are free to Mesa County residents, except for electronic waste (e-waste) and material from very small quantity generators (VSQG) of hazardous waste. In 2023, the facility started taking waste from outside of Mesa County for a fee.

The facility has been in operation for approximately ten (10) years. It currently accepts less than 5,000 tpy of material. Approximately 80% of the material collected is residential, and the remaining material is commercial.

The facility is currently the only facility in Mesa County that accepts all types of e-waste. Another e-waste facility in the area was previously operational but is now shut down, and the Mesa County facility has observed a 66% increase in e-waste since then. The facility is currently planning a $25,000 expansion to accept the additional material. Facility staff noted that the expansion would not fill the need for e-waste recycling in the area, but it will take the facility some time to assess and plan a larger expansion. The facility is also planning to expand its services to take refrigerators and air conditioners.

The following materials are accepted at the facility:

- Paint, such as latex, oil-based, spray paint, stain, craft and hobby paint
- Ammunition
- Fireworks and road flares
- Automotive products, such as antifreeze, oil, gasoline, brake fluid
- Batteries
- Electronics, think "e" for entertainment, computers, stereos, TVs, video game consoles.
- Light Bulbs, such as fluorescent tubes, Christmas lights, HID bulbs
- Garden products, such as insecticides, herbicides, fertilizers
- Spa and pool chemicals
- Cleaning products
- Used syringes.
- Over-the-counter medications

The following materials are not accepted at the facility:

- Explosives other than ammunition and Class C fireworks

- Radioactive materials
- Bio-hazardous materials other than sharps
- Controlled substances

Some of the material, including marine flares, latex paint, and some used oil, is used onsite. Propane tanks and bulbs are partially processed onsite and then sent to vendors or secondary recyclers for final disposal or processing. Sharps, flammables, e-waste, and medicines are sent to vendors offsite. Some of the accepted materials are sold in a reuse area onsite.

7 RECOMMENDATIONS

Surveyed MRFs reported that they have the capacity to accept additional feedstock by adding additional processing equipment or shifts. If additional feedstock collected as a result of the Colorado Extended Producer Responsibility legislation is primarily single stream, facilities that process dual stream feedstock may need to convert to single stream processing.

Much of the equipment at the various facilities has been in operation for a very long time, often past its expected lifespan. In some cases, existing equipment design and sizing may not be suitable for current feedstocks. Equipment upgrades, refurbishments, and replacements will occur and, in some cases, may result in the total replacement of a processing line or facility. Accepting additional feedstock and increased use of existing equipment is expected to result in increased wear and tear on equipment and increased maintenance costs. Capital and operational costs associated with the expansion of additional facilities are included in the **Element 7 Technical Memorandum**.

Recommendations for expansion and improvement of existing MRF infrastructure include the following:

- Upgrade existing equipment to process additional feedstocks and increase end-market product quality.
- Add shifts to process additional feedstock.
- Improve fire detection and protection systems. Newer systems can detect fires when they are just beginning to form and protect the equipment and facility from devastating fires that can shut down a facility for months. As processing increases, the likelihood of fires increases, which adds risk to recycling operations in Colorado.
- Add glass cleanup systems to improve the purity of glass products and increase revenue.
- Monitor residue streams routinely to check for materials that should have been captured but were missed. This information should be used to correct equipment shortcomings and evaluate processing system changes that could be implemented to improve capture.
- Create educational materials that focus on major issues for MRF facilities, such as the dangers and proper management of lithium batteries and hypodermic needles. See the **Element 12 Technical Memorandum** for more information on the recommended educational enhancements.

Appendix A. MRF Survey

HDR Surveyor: ______________________________
Date:

Site Contact Name: _________________________
Email: ___________________________
Phone #: _________________________
Address: _____________________________________

Alternate Contact: _______________________________

Are you a:

- Hauler
- MRF
- Composter

What services are provided at site or by your organization?

- Collection: MSW
- Collection: Green Waste
- Collection: Recycling
- Collection: Food Waste
- Collection: Other
- Transfer Station
- Landfill
- MRF
- Composting Facility
- Other

MRF Questions

1) Site Throughput: What is the facility's permitted/designed capacity? (Inbound tonnage)?

    - <5,000 tpy
    - 5,000 tpy - 10,000 tpy
    - 10,000 tpy - 25,000 tpy
    - 25,000 tpy - 50,000 tpy
    - 50,000 tpy - 100,000 tpy
    - >100,000 tpy

2) Site Throughput: What is the facility's actual capacity now? (Inbound tonnage)

    - <5,000 tpy
    - 5,000 tpy - 10,000 tpy
    - 10,000 tpy - 25,000 tpy
    - 25,000 tpy - 50,000 tpy
    - 50,000 tpy - 100,000 tpy
    - >100,000 tpy

3) How many rejected loads are there per month, on average?

    - < 1 per month
    - 2 - 5 per month
    - > 5 per month

4) What is the Contamination rates of incoming material

- <5%
- 5% - 10%
- 10% - 20%
- 20% - 30%
- >30%

5) Please describe the facility service area noting areas and communities served. Indicate which service is provided for which city(ies), County (ies), and other or unincorporated area(s).

- What is the population of the areas served?
  - <25,000 citizens (households)
  - 25,000 – 50,000 citizens
  - 50,000 – 100,000 citizens
  - 100,000 - 250,000 citizens
  - 250,000 - 1,000,000 citizens
  - >1,000,000 citizens

Does your MRF process waste from:

- Single family: Single stream
- Single family: Dual Stream
- Multifamily: Single stream
- MultifamilY: Dual Stram

Do you collect the following materials from Commerical Clients?

- OCC
- Other Paper
- Metals
- Containers
- Plastics
- Other

Indicate type of drop off stations

- Glass
- Contaimers
- Metals
- Green Waste
- Food Waste
- Green Waste and Food Waste
- Other

Indicate number of drop off Stations

- Glass #_______________
- Containers #_____________
- Metals #___________

- Green Waste #______________
- Food Waste #______________
- Green and Food Waste #______________
- Other #_________________

Describe other collection arrangements
____

Please indicate the percentage by weight with types of commodities collected from residential and non-residential feedstock.
- Percent Residential ____
- Percent Non-Residential ____

What is the permitted facility processing line capacity (Tons per hour)?

What is the permitted facility processing capacity for source separated materials (Tons per year)?

What was the actual annual (average of last five years) facility processing capacity (Tons per year)?

Site Throughput – residential quantities
- <5,000 tpy
- 5,000 tpy – 10,000 tpy
- 10,000 tpy – 25,000 tpy
- 25,000 tpy – 50,000 tpy
- 50,000 tpy – 100,000 tpy
- >100,000 tpy

Outgoing commodities

Output Commodities	Annual Tons	Processor /Broker	Shipped In-state	Known Use Mill, Sec. sort, Kiln, etc.	ISRI Bale Grade	Custom Requirements					Reason for Use of Processor/ Other Comments
						% Target Commod. (Yield)	% Mois.	% Resid.	% Non-Target Commod.	Other (Add Note)	
#1 PET Bottles Only											
#1 PET Thermoform											
#1 All PET											
#2 HDPE- N Bottles											
#2 HDPE- C Bottles											
#2 HDPE Other											
#2 All HDPE											
#5 PP Rigids											
Mixed Tubs and Lids #2, #5, etc.											
Mixed #3 - #7											
Mixed #1 - #7											
#6 PS											
Film											
Other (describe)											
Multilayer/Multi-resin film											
UBC											
Other Al											
Steel Cans											
Scrap Metal											

Output Commodities	Annual Tons	Processor /Broker	Shipped In-state	Known Use Mill, Sec. sort, Kiln, etc.	ISRI Bale Grade	Custom Requirements					Reason for Use of Processor/ Other Comments
						% Target Commod. (Yield)	% Mois.	% Resid.	% Non-Target Commod.	Other (Add Note)	
Other Metal Packaging (describe)											
Mixed Glass Bottles and Jars											
Flint Glass											
Green Glass											
Amber Glass											
Other Glass (describe)											
OCC											
Office Paper											
Mixed Residential Paper											
Newspaper (ONP)											
Cartons											
Coffee Cups											
Other											

Describe current plans to expand operations

- Upgrade/replace equipment. Yes/ No Describe
- Add a processing line. Yes/ No Describe
- Increase/overhaul building space (Capacity). Yes/ No Describe
- Expand site or alter site arrangement . Yes/ No Describe
- Expand service area or sources of feedstocks. Yes/ No Describe
- Describe plans to add collection routes. Yes/ No Describe
- Describe any planned changes to collection infrastructure, such as new containers, trucks, signature, staffing, sites, contamination management, others . Yes/ No Describe
- Describe current plans to accept or process new material types
- Describe any other possible expansion opportunities you might consider.

Feedstocks: What Material types and quantities are accepted at the facility?

Incoming Material	**Explic. Accept**	**Implic. Accept**	**Explic. Do not Accept**	**Reasons Not Accepted**	**Measures to allow acceptance**					**Other Comments**
					Tech. upgrades	**Markets**	**Lower Contam.**	**Higher Autom.**	**Other**	
#1 PET Bottles										
#1 PET Non-bottles										
#2 HDPE- N Bottles										
#2 HDPE- C Bottles										
#2 HDPE Other										
#3 PVC										
#4 LDPE Rigid										
#5 PP Bottles										
#5 PP Other Containers										
#6 PS										
#7 Other										
PE Film										
Multilayer/Multi-resin film										
UBC										
Other Al										
Aerosol Cans										
Steel Cans										
Batteries										
Other Metal Packaging										
Glass Bottles and Jars										
Other Glass										
OCC										
Chipboard/boxboard										
Office Paper										
Mixed Residential Paper/Newspaper										
Cartons										

Incoming Material	**Explic. Accept**	**Implic. Accept**	**Explic. Do not Accept**	**Reasons Not Accepted**	**Measures to allow acceptance**					**Other Comments**
					Tech. upgrades	**Markets**	**Lower Contam.**	**Higher Autom.**	**Other**	
Magazines										
Coffee Cups										
Other										

What is the mix of materials received (approx. percentage by weight)?

- % OCC ____
- % Other Paper ____
- % Containers ____
    - % Plastics ____
    - % Aluminum ____
    - %Magnetic ____
    - % Glass ____
- % Residue ____
- % Other ___ _______________

Are there any trends in feedstocks you've observed?

____

Product: How are products moved offsite?

- ___Customer Haul Yes / No
- ___Dump Truck Yes / No
- ___Tractor Trailer Yes / No
- ___Railcar Yes / No

How are commodities sold and transported.

Incoming Material	**Commodity is baled**	**Commodity is shipped loose**	**Sold in-state**	**Sold out of state**	**You pay to ship to market**	**Buyer pays for transportation**
#1 PET Bottles						
#1 PET Non-bottles						
#2 HDPE- N Bottles						
#2 HDPE- C Bottles						
#2 HDPE Other						
#3 PVC						
#4 LDPE Rigid						
#5 PP Bottles						
#5 PP Other Containers						
#6 PS						
#7 Other						
PE Film						
Multilayer/Multi-resin film						
UBC						
Other Al						
Aerosol Cans						
Steel Cans						
Batteries						
Other Metal Packaging						
Glass Bottles and Jars						

Other Glass						
OCC						
Chipboard/boxboard						
Office Paper						
Mixed Residential Paper/Newspaper						
Cartons						
Magazines						
Coffee Cups						
Other						

Contamination: How does contamination impact your operations and sale of commodities?

- Do you charge extra if contamination is over a certain threshold? Yes / No If so, what is the rate? _________
- Provide any sort data for types of contaminants (percentage by weight) ____
- Provide any sort data for residue indicating by commodity type percentage by weight of missed commodities. ____
- Are there common contaminants that you observe? Are they materials that look recyclable but are not
    - ___types of plastic that aren't accepted at your facility,
    - ___ceramics,
    - ___blue glass,
    - ___wet paper
    - ___fabric/clothing
    - ___Needles/other medical waste
    - ___ Other ______________________
- Are there any materials that are challenging to handle or cause issues with the equipment? _______________________________________
- What are the impacts of this?
    - ___Downtime
    - ___Contaminated commodities
    - ___Lost revenue
    - ___Worker injuries
    - ___Increase residue costs
    - ___Other
- What are the estimated costs associated with dealing with contamination?
    - <$1,000 per month
    - $1,000 - $5,000 per month
    - $5,000 - $10,000 per month
    - $10,000 – $50,000 per month
    - >$50,000 per month
- Have you noticed any patterns in which loads you're rejecting
    - ___certain municipalities,
    - ___routes,
    - ___industry types
    - ___Other ______________________
- Do you have a protocol or SOP for when you reject loads? If so, request copy or brief description.____

- What are your end market contamination requirements by commodity?
  - ________________________
  - ________________________
  - ________________________
- Do you have to keep contamination below a certain level to send it to end markets? If so, what is it? ____
- Do end markets charge a fee or reduce the price if contamination levels are above a certain point? Yes / No
- Has your facility ever been penalized for contamination? Yes / No

Operations: Discuss process equipment, material flow, and site-specific equipment operations.

- Please provide a simple layout diagram, floor plan, or list of major equipment.
- Please indicate the age and condition of major equipment.
  - Original process line installation year ________
  - Equipment added/replaced/upgraded Year/Age <add text box for answer for each piece of equipment>
    - Screen(s) _____ _____ _____ _____ _____
    - Magnet(s) _____ _____ _____ _____ _____
    - Eddy Current Separator(s) _____ _____ _____ _____ _____
    - Ballistic Separator(s) _____ _____ _____ _____ _____
    - Optical Sorter(s) _____ _____ _____ _____ _____
    - Air Classifier(s) _____ _____ _____ _____ _____
    - Robotic Sorters(s) _____ _____ _____ _____ _____
    - Baler(s) _____ _____ _____ _____ _____
    - Scale(s) _____ _____ _____ _____ _____
    - Other _____ _____ _____ _____ _____
  - Baler design capacity/operating capacity, tph/tpd ___________/_____________
- Please discuss any facility limitations impacting operations and maintenance. ____
- How many FTEs are onsite, _____FTE and is staffing a limitation? Yes / No Please list number by job title.
  - Equipment operators _____
  - Sorters ____
  - Scale operators _____
  - Maintenance _____
  - Supervisors _____
  - Office/Support staff _____
- Please provide storage/staging capacity for incoming and outgoing materials indicating approx. square footage, tons, or days processing.
- ____
- Please list rolling stock and age of equipment used at the site.

Equipment	Year/Age
Frontend loader(s)	_____
Forklift(s)	_____
Skidsteer(s)	_____
Roll-off Truck(s)	_____
Trucks	_____
Other	_____

Permitting: Discuss process to permit facility.

- Was the permitting process stringent or cumbersome? Yes / No
- How long did it take to get the facility permitted?
    - < 3 months ____
    - 3 months to 6 months ____
    - 6 months to 1 year ____
    - > 1 year ____
- What was the construction timeline for constructing the facility?
    - <1 year ____
    - 1 year to 2 years ____
    - >2 years ____
- What are your ongoing compliance and reporting requirements?
    - Quarterly reporting ____
    - Semi-annual reporting ____
    - Annual reporting ____
    - Other ________________________
- How many years has the facility been operating?
    - < 1 year ____
    - 1 - 5 years ____
    - 5 - 10 years ____
    - > 10 years ____

Capital Costs

- Overall Capital Cost at the time of development ______________________________
    - Year of development _______
    - Major improvements since original development
        - Year ________
        - $ __________
        - Description ____
- Site Development Costs _________________________
    - Total size of site
        - _____< 2 acres
        - _____ 2 – 5 acres
        - _____ 5 – 10 acres
        - _____ 10 – 20 acres
        - _____ >20 acres
- Building Costs ___________________
    - Total square foot
        - _____< 10,000 SF
        - _____ 10,000 – 25,000 SF
        - _____ 25,000 – 50,000 SF
        - _____50,000 – 100,000 SF
        - _____100,000 – 150,000 SF
        - _____ > 150,000
    - Total square foot of the tipping floor
        - _____ <2,000 SF
        - _____ 2,000 – 5,000 SF
        - _____ 5,000 – 10,000 SF

        - _____ 10,000 – 15,000 SF
        - _____ 15,000 – 20,000 SF
        - _____ >20,000 SF
- Stationary Equipment Purchase Number / Cost / Year / Expected Life
    - Sorting system _____ / _____________ / ________ / __
- Replacement
    - Screens _____ / _____________ / ________ / __
    - Optical Sorters _____ / _____________ / ________ / __
    - Magnets _____ / _____________ / ________ / __
    - Eddy Current Sep. _____ / _____________ / ________ / __
    - Ballistic Sep. _____ / _____________ / ________ / __
    - Robots _____ / _____________ / ________ / __
    - Baler _____ / _____________ / ________ / __
    - Scale _____ / _____________ / ________ / __
    - Other Upgrades and Replacements _____ / _____________ / ________ / __
- Mobile Equipment Purchase Number / Cost / Year / Expected LIfe
    - Frontend Loader(s) _____ / _____________ / ________ / __
    - Fork lift(s) _____ / _____________ / ________ / __
    - Skid Steer(s) _____ / _____________ / ________ / __
    - Roll-off Truck(s) _____ / _____________ / ________ / __
    - Trucks(s) _____ / _____________ / ________ / __
    - Pickup(s) _____ / _____________ / ________ / __
    - Other _____ / _____________ / ________ / __
- Land Lease

O&M

- Building Replacement/Repair Cost Fund __________________
- Stationary Equipment Replacement Cost Fund
    - _____% of total capital cost per year
- Mobile Equipment Replacement Cost Fund
    - _____% of total capital cost per year
- Labor
    - # of shifts ____ # days/week _____
    - Total annual labor cost $_______________________
    - # of sorters/laborers ____
    - # of equipment operators ____
    - # of maintenance operators ____
    - # of support staff ____
        - # of marketing staff ____
    - # of site/shift supervisors ____
- Utilities Cost
    - Internet/Phones/Radios/IT ______________
    - Electricity ______________ kWh/yr _____________ Demand kWh _________
    - Diesel ______________gal / yr
    - HVAC (for buildings) $/yr ______________

- Product Revenue
    - Quantity ________________$ / yr
    - Sales price per product type/material
        - OCC _________ $_____/ton
        - Mixed paper $_____/ton
        - Other paper $_____/ton
        - No. 1 PET $_____/lb
        - No. 2 HDPE Natural $_____/lb
        - No. 2 HDPE Colored $_____/lb
        - No. 5 PP $_____/lb
        - No. 6 PS $_____/lb
        - Mixed plastics 3 - 7 $_____/lb
        - Mixed plastics 1 - 7 $_____/lb
        - UBC $_____/lb
        - Other Aluminum $_____/lb
        - Tin cans $_____/ton
        - Scrap metal $_____/ton
        - Mixed MRF Glass $_____/ton
        - Clear Glass $_____/ton
        - Green Glass $_____/ton
        - Amber/Brown Glass $_____/ton
        - Batteries Cost or Revenue? $ _________
        - Other $________
- Residue
    - Disposal Costs ______________ $/t
    - Haul distance or disposal facility _____________miles

COLORADO NEEDS ASSESSMENT

ELEMENT 7: OPPORTUNITIES & COSTS

JANUARY 25, 2024

CONTENTS

TABLES

1 EXECUTIVE SUMMARY

1.1 PURPOSE

This memo uses findings from Elements 1, 2, 4, and 6 to evaluate the opportunities and costs of expanding Colorado's existing recycling and composting infrastructure to increase recycling rates. The equipment and facility additions for recycling and compostable packaging will increase tonnage throughput capacity and material types for management. These estimated costs will inform the scenarios provided in **Element 13**.

1.2 APPROACH

The project team made the following assumptions to provide high-level opinions of cost for expanding and/or improving existing material recovery facility (MRF), compost facility, and transfer station infrastructure.

- **MRFs:** Based on touring and interviewing nine (9) out of ten (10) MRFs in Colorado (as discussed in the **Element 6 Technical Memorandum**, potential facility upgrades and correlating opinions of cost for implementing these upgrades are provided by project team engineers and industry experts. The MRFs chosen for this Needs Assessment are either single stream or dual stream facilities. These recommendations assume that all MRFs can upgrade their facilities to accept more material, more efficiently. Equipment recommendations also include technology which would allow MRFs to accept new materials. Improvements were identified for each facility and aggregated into regional costs for MRF expansions.
- **Compost facilities:** Based on touring and interviewing a representative sample of compost facility class types, potential facility upgrades, and correlating opinions of cost are provided by project team engineers and industry experts. Potential upgrades are considered for the various types of compost facilities to accept more certified compostable packaging. Total opinions of cost for upgrading compost infrastructure are aggregated into small facilities (CESQs managing less than 10 tons on site and Class I facilities managing less than 2,500 tons on site of compostable packaging and food waste) and large facilities (various Class III sizes) as those are the only facility permits relevant to this Needs Assessment.
- **Transfer stations:** Currently, there is no permitting or tracking system for transfer stations in Colorado. The project team utilized survey data discussed in the Element 1 Technical Memorandum and relied on supplemental internet research to create a database of forty-three (43) transfer stations in Colorado. Potential facility expansion options and high-level opinions of cost were provided by project team engineers to describe various levels of improvements to these facilities. Due to the lack of data surrounding transfer stations, this memo provides

the estimated cost range of upgrading a single transfer station to manage more recyclables, compostables, or both.

1.3 FINDINGS

Based on survey data and industry knowledge, the project team estimates that the total cost of capital upgrades to the existing MRF infrastructure in Colorado is approximately $86M-$100M. These costs apply to the nine (9) MRFs that provided data for this Needs Assessment and represent the major recycling facilities in Colorado. The upgrades are estimated to yield approximately 600,000 tons of additional capacity for all-comingled recyclable materials (tonnage not specific to program covered materials). This investment could significantly increase Colorado's recycling capacity.

Three new MRFs in the Front Range are slated to come online in 2025-2026. Two are currently permitted and are expected to add an additional 243,000 tons of processing capacity of comingled recyclable materials for Colorado. This additional processing capacity is not included in the 600,000 tons of all-comingled recyclable materials estimated from upgrading existing facilities.

Based on survey data and industry knowledge, the project team estimated that the total cost of capital upgrades to Colorado's existing compost facility infrastructure for small facilities (CESQs and Class I permits) is approximately between $700K-$3.25M per facility. The larger, Class III facilities (managing more than 2,500 TPY on site at once) may consider adding equipment and building improvements costing between $7M and $28.2M depending on facility size. The majority of the compost facilities that accept compostable packaging today fall within the small facility range and lower end of the Class III spectrum, costing between approximately $700K-$7M per facility for improvements for these sites.

Capital upgrades for existing transfer stations will range between $1.3M-$2.3M per transfer station to add more recyclable materials (up to 70 additional tons/day) with varied levels of infrastructure and equipment improvements.

1.4 SCENARIO CONSIDERATIONS

- The Scenarios may consider whether the new MRFs that are already planned for construction in the Front Range, with processing capacity of at least 243,000 tons per year capacity, are sufficient to manage the additional materials collected through the EPR program. Tonnage will be impacted by participation, education, collection frequency, contamination, and other factors.
- The scenarios will consider the differences in MRFs (e.g., size, type and location) and what improvements might be necessary for each.
- The scenarios will consider how investments in compost infrastructure may be scaled.

2 EXPANSION AND IMPROVEMENT OPPORTUNITIES FOR EXISTING INFRASTRUCTURE

Below is an analysis of the potential to increase and improve current capacity to manage recycling and compostable packaging in Colorado if all the existing facilities were expanded to the maximum extent possible at its current site. The equipment additions made for recycling and compostable packaging will increase overall tonnage throughput capacity and targeted material components for recycling.

2.1 RECYCLING FACILITIES

2.1.1 Increasing Processing Capacity and Site Expansions

The project team gathered survey data and conducted site visits at MRFs throughout Colorado as identified in the **Element 6 Technical Memorandum**. The recycling facilities surveyed in **Element 6** reported operating at less than the equipment supplier's stated capacity but did not provide specific data relating to remaining capacity. While some facilities operated well below this capacity for varying reasons, others routinely approached the stated capacity. Facility staff interviewed indicated consideration for expansion and facility modification. In general, the operators and owners interviewed identified steps taken or being evaluated to increase throughput, improve commodity quality, or otherwise improve and maintain the facility. Some have active plans for equipment and process upgrades and routinely make changes, but there are some facilities that have not significantly modified the original equipment. The potential for significant increase in capacity and commodity quality is possible within the existing MRFs, particularly among the smaller facilities. In all interviews, operators felt if they had more feedstock, they could find a way to process it. Even the larger facilities generally felt they could process more tonnage, particularly if material contamination levels were reduced.

Most facility operators indicated that the building or site had room for some expansion; however, building and site retrofits can be more expensive and have more challenges compared to building new facilities, especially if construction pauses site operations to incorporate new building walls and structural columns and beams. New sites may result in higher capital investments than building expansions or retrofits; however, the price per ton is much more efficient with a new facility because it does not impact the ongoing operations and revenue of the existing facility. A lower cost option for some facilities may be to increase bale storage by using canopies instead of an enclosed building addition or expansion.

For this analysis, the project team's recommendations on facility upgrades will improve the existing statewide MRF infrastructure through equipment and infrastructure expansions. The project team utilized the approximated costs listed in **Table 1** to generate high-level opinions of capital upgrade costs by equipment type. These estimates stem from discussions with vendors and represent an engineer's opinion of cost based on similar projects in other states or Colorado. Not every facility requires an upgrade for every type of equipment; this list represents the full array of options. Some equipment requires a retrofit with installation; other equipment do not.

Table 1: MRF Capital Costs

Capital Upgrades	Equipment Cost (Procured and Installed)	Total Facility Retrofit Cost (Equipment and Required Facility Upgrades)	Number of MRFs Needing this Equipment
OCC Screen (per deck)	$500K	$1M	6
Paper Screen	$350K	$550K	4
Additional Conveyor Changes w/ Screens	-	$100K-$200K	6
Eddy Current Separator	$200K	$350K	4
Magnets	$150K	-	3
Optical Sorter - Container Line, ea.	$500K	$1M	5
Optical Sorter - Fibers Line, ea.	$1M	$1.75M	3
Optical Sorter - Residue Line	$500K	$1M	2
Robotics Sorter	$300K	$325K-$500K	1
Baler (small)	$600K	-	2
Incidental Recovery System (Flexible Plastic Packaging)	$300K	$500K	4
New Full Recovery System (Flexible Plastic Packaging)	$500K	$1M	1

Capital Upgrades	Equipment Cost (Procured and Installed)	Total Facility Retrofit Cost (Equipment and Required Facility Upgrades)	Number of MRFs Needing this Equipment
Glass Cleanup System[1]	$300K-$600K	$600K-$800K	8
Early Fire Protection Systems (4 or 8 thermal cameras)	$70K-$125K	-	9
Controls Upgrades[2]	-	$1.5M-$2M	4
Outdoor Covered Bale Storage	-	$50/sq. ft.	1
Building Expansion[3]	-	$400/sq. ft.	4

Depending on facility location and end markets, ongoing operations and maintenance costs will vary. These costs, outlined in

Table 2, include staffing (various shift levels) and building and equipment maintenance. The project team provided generalized estimates that will not be included in the total cost to upgrade the State's infrastructure. Some MRFs in Colorado may also need to transfer the commingled recyclables from the facility to a larger one in the Front Range. The transfer costs for loose, compacted, and baled recyclables may also be relevant to the Transfer station operating cost estimates in **Section 2.3.**

[1] When the glass is crushed and removed from the process line, it is removed based on size; therefore, it still contains other materials less than about 2 inches in size (rocks, dirt, bottle caps, corks, shredded paper, small plastic, etc.). This technology further separates non-glass material less than a certain size (~ 1 inch), to remove the smaller dirt, gravel, and small glass shards that can't be recycled. Next, light material such as shredded paper is removed, leaving behind a high concentration of glass by weight. These systems are added for glass clean up and are not part of the basic glass separation process. The number of MRFs upgraded with this technology may be reduced based current transportation of materials to select facilities for processing. Modeling for the upgrades was based on the single-stream MRFs in the state.

[2] Includes cost of downtime for 3 months.

[3] Building expansions are dependent on what is being added to the facility. Costs may vary.

Table 2: MRF Operations and Maintenance Costs[4]

Operations and Maintenance	Annual Cost
1st Shift Labor FTE	$1.3M - $1.5M (17-20 FTE)
2nd Shift Labor FTE	$1.0M - $1.2M (13-15 FTE)
Maintenance[5]	$1M - $1.2M
Mobile Equipment[6]	$200K - $250K
Fire Detection System Monitoring	$3,200
Transfer (Opentop)	$0.40 - $0.55 /ton-mile
Transfer (Compactor Loaded)	$0.26 - $0.35/ton-mile
Transfer (Baled)	$0.27 - $0.35/ton-mile

Most MRF operators interviewed noted that some additional material could be processed within their current shift arrangement. Most facilities operated one (1) shift per day, five (5) days per week. However, some routinely operate for two (2) shifts and/or different operating hours. Survey information, where provided, indicated that most of the smaller facilities have been operating a single shift. Significant throughput increases can be achieved for those facilities by extending operating hours and, ultimately, adding a second shift. Adding a second shift is a significant step change and will require a commitment of feedstock and staffing.

2.1.2 Additional Commodities

Several of the smaller single stream and dual stream facilities only separate certain materials, such as cardboard, and send the remaining material to other central facilities to complete processing. As feedstock quantities grow, the central facilities may reach capacity. In that case, the smaller facilities could consider adjusting to a more complete processing system. These changes may require additional equipment and facility modifications, which are included in the potential upgrade cost estimates. These potential upgrades include transitioning dual stream facilities to single stream, and also increasing capacity of smaller single stream facilities.

[4] Assuming a 25-30 TPH MRF.

[5] Includes 1% of Equipment and Retrofit cost found in Table 1, plus increase in 2nd shift.

[6] Forklifts and roll-offs (varies by facility needs)

Operators were asked about whether they were open to separating other commodities. The general response was that they could add other materials if an established market was available with sufficient revenue to cover all costs. Materials that could be considered include items such as flexible plastic packaging, polystyrene, or other types of containers not currently captured. In several cases, additional commodity bunker storage before baling may be needed. Revenue would need to address capital costs for changes to processing systems and facility physical modifications required in addition to increasing operating costs. New facilities are an opportunity for recovering new material types, such as flexible plastic packaging, because it is more challenging to add this equipment to existing MRFs. The equipment recommendations in this memo include technologies that would support adding new materials, such as flexible plastic packaging, into the MRF's sorting capabilities.

2.1.3 New Facilities

The US EPA recently granted Chaffee County, Colorado, a SWIFR grant for constructing a regional transfer station for recyclables and a MRF. The project can potentially divert approximately 45,000 tons of material from landfill disposal annually.

The project team also interviewed a development company that is currently assisting a private entity with developing a waste complex, including a MRF, compost facility, and construction and demolition (C&D) processing facility in the Front Range region. The private entity also plans to offer hauling services to the complex. The compost facility will process 100,000 tons annually at maximum capacity, and the MRF and C&D are "significantly sized." The entity is in the process of permitting the proposed facility and it is expected to be in operation in 2025 or 2026. While details on the materials processed and quantities were unavailable, the facility will provide additional capacity for processing single stream and C&D materials.

Two (2) additional MRFs are slated to come online in 2025, adding a total increased processing capacity of 243,000 tons annually for the Front Range. Some stakeholders noted that additional facilities may be in development within the State. This Needs Assessment specifically focusing on costs associated with expanding existing infrastructure, not building new facilities, and therefore these new facilities are not included in the total cost to upgrade the system.

2.1.4 Tonnage and Estimated Cost Summary

Based on survey data and industry knowledge, the project team estimates that the total cost of capital upgrades to the existing MRF infrastructure in Colorado is approximately \$86M - \$100M. These costs apply to the nine (9) MRFs that provided data for this Needs Assessment, yielding an estimated 600,000 tons of additional capacity for all-comingled recyclable materials (tonnage not specific to program covered materials). This investment could significantly increase Colorado's recycling capacity. This is a high-level opinion of cost, not including ongoing operations and maintenance, engineering services, contingency, and inflationary costs. **Table 3** summarizes the estimated ranges for capital upgrade costs to the existing MRFs that were interviewed by the project team, by Region, along with potential increases in MRF capacity if these facility improvements are achieved. The project team provided recommended upgrades and subsequent capacity increases for each of the nine (9) MRFs evaluated in the Needs Assessment and aggregated the data by Regions. There are no existing single stream or dual stream MRFs in the Eastern Plains. The potential tons per year (TPY) is based on the project team's site tours and an engineering estimate for the additional material each MRF could process with the recommended equipment and facility upgrades.

Table 3: Estimated Regional Tonnage Opportunities and Capital Upgrade Costs[7]

Region	Current Material Processed (TPY) (All Comingled Materials)	Projected Total Capacity (TPY) (All Comingled Materials)	Estimated Cost Range
Front Range	356,400	700,000	\$45M - \$50M
Mountains	3,500	95,000	\$6M - \$12M
Western Slope	14,740	190,000	\$35M - \$40M
Eastern Plains	N/A	N/A	N/A
TOTAL	374,640	1,000,000	\$86M - \$100M

2.2 COMPOST FACILITIES

According to the composting survey information (discussed in detail in the **Element 14 Technical Memorandum**, the seventeen (17) surveyed facilities are currently processing approximately 400,000 tons per year combined. The project team estimated that the sites have the potential to expand to process roughly three (3) times that much material. Most sites can at least double in processing capacity. Six (6) of those facilities currently accept compostable packaging. The following recommendations assume that the surveyed facilities are a representative sample size of Conditionally Exempt Small Quantity (CESQ) and Class I-III facilities in Colorado. According to Colorado regulation, compostable packaging falls under Type 2 feedstock as "source separated organics." Source separated organics are accepted in very small amounts (under 10 cubic yards in volume or 5 tons) at CESQ facilities. The Colorado Department of Public Health and Environment's (CDPHE) Solid Waste

[7] The ongoing operations and maintenance costs (including staffing) are not included in these cost estimates.

Program is currently considering proposed changes that would increase the level of Type 2 feedstock being processed at CESQ sites from 5-10 cubic yards to 20 cubic yards (10 tons) at any given time.[8] Class I facilities can manage up to 5,000 cubic yards or 2,500 tons per year,[9] and Class III facilities do not have a regulatory cap on quantities of compostable packaging. The project team developed an estimate of capital costs based on upgrading the existing infrastructure to be able to accept compostable packaging at various facility sizes. For this Needs Assessment, facility upgrade recommendations are intended for processing only compostable packaging to align with EPR legislative requirements; however, the recommendations assume that food waste is included in the feedstock as data on quantities of compostable packaging alone are not available. The compost facilities are broken into "small" and "large" groups to separate the small quantity facilities (less than 2,500 tons per year) and the large facilities that do not have a processing quantity requirement.

2.2.1 Small Facility Opportunities

As identified in the **Element 14 Technical Memorandum**, there are twenty-two (22) CESQ facilities permitted in Colorado. Based on the project team's interviews with CESQ facilities, there are some facilities that do accept compostable packaging, compostable paper, or both. Interviews and input from the Colorado Composting Council (COCC), stated CESQs are fundamental in the compost processing infrastructure, and will especially be critical in the early years of implementing the EPR program, since many facilities are relatively new but offer a decentralized network of processing options statewide. The project team considered the inclusion of screening screening equipment and a grinder for CESQ and Class I facilities, if not already on site, to effectively manage increased compostable packaging and food waste. Class I facilities may require some additional site improvements regarding grading and drainage. **Table 4** summarizes the estimated capital costs and ongoing operations and maintenance costs associated with improving an individual existing CESQ facility. Estimated costs for equipment operators are not provided as this will vary by region. These estimates are for capital upgrades that will assist only with processing additional food waste and compostable packaging. Estimates do not include ongoing operations and maintenance, engineering services, contingency, and inflationary costs.

Table 4: Small Compost Facility Upgrade Estimated Costs10

Capital Upgrades		
Equipment	**CESQ (up to 10 tons on site)**	**Class I (up to 2,500 tons on site)**
Screen	$200K	$750K

[8] https://cdphe.colorado.gov/hm/sw-proposed-rulemakings-stkh-proc

[9] Assuming approximately 1,000 lbs per cubic yard of compost according to the EPA: https://www.epa.gov/sites/default/files/2016-03/documents/conversions.pdf

Capital Upgrades		
Grinder	$500K	$1.5M
Site Improvements[10]	N/A	$1M
TOTAL	**$700K**	**$3.25M**
Operations and Maintenance		
Additional FTE - Equipment Operators	1	1.5
Additional Maintenance	$25K[11]	$37.5K[12]

2.2.2 Large Facility Opportunities

Class III compost facilities represent the largest permitted facility size in Colorado. As discussed in the **Element 14 Technical Memorandum**, the project team identified seventeen (17) Class III facilities. In order to effectively manage compostable packaging at Class III facilities in Colorado, the project team recommends considering equipment that will further support the composting process when more packaging is introduced, such as a water truck or hydroseeder to wet the compost piles and a well or leachate treatment plant and water storage infrastructure. Other facility upgrades could include a sort line, a new building, and lined detention pond with some additional site improvements to each facility. **Table 5** outlines the opinions of costs associated with capital upgrades for three (3) different Class III facility sizes, and ongoing operations and maintenance costs. The majority of Colorado's class III compost facilities are smaller (less than 50,000 TPY) and would require upgrades on the lower end of the spectrum in the table. These estimates are for upgrades that will assist only with processing additional food waste and compostable packaging. This high-level opinion of cost does not include ongoing operations and maintenance, engineering services, contingency, and inflationary costs.

Table 5: Large Compost Facility Upgrade Estimated Costs

Capital Upgrades			
Equipment	**Class III (up to 50,000 TPY)**	**Class III (up to 100,000 TPY)**	**Class III (up to 500,000 TPY)**
Screen	Assumed on site	Assumed on site	Assumed on site
Grinder	Assumed on site	Assumed on site	Assumed on site

[10] Includes site security and fencing, lighting, grading, drainage, utilities, and administrative costs.

[11] Equipment maintenance and fuel at $15/hour and 5 TPH flow assumed.

[12] Equipment maintenance plus fuel at $15/hour and 25 TPH flow assumed.

Capital Upgrades			
Depackager	$900K	$900K	$2.50M
Water Truck or Storage Tank[13]	$250K	$250K	$250K
Fencing	$25K	$25K	$35K
Lined Detention Pond[14]	$800K	$800K	$2M
New Building[15]	$3M	$6M	$18M
Site Improvements[16]	$500K	$1M	$1.5M
TOTAL	**$5.75M**	**$9.1M**	**$25.6M**
Operations and Maintenance			
Additional FTE - Equipment Operators	4	6	6
Additional FTE - Sorters	2	4	4
Additional Maintenance[17]	$150,000	$275,000	$800,000

2.2.3 Estimated Cost Summary

In summary, capital upgrade costs will vary between small and large compost facilities. The smaller facilities, managing at most 2,500 tons on site of food waste and compostable packaging, may consider adding equipment and building improvements, costing approximately between $700K-$3.25M per facility. The larger Class III facilities do not have a cap on Type II feedstock processing and may consider adding equipment and building improvements costing between $5.75M and $25.6M depending on facility size. The majority of the compost facilities who accept compostable packaging today fall within the 50K TPY range, costing between approximately $700K and $5.75M per facility for improvements. This estimate includes the estimated capital cost to expand all sites, with the proper equipment and

[13] If not already on site, or if additional water storage capacity needed.

[14] Assuming storm water and compost leachate can be reused into the system.

[15] At existing site. Do not include land acquisition, site work, drainage, permitting, engineering, or construction inspection.

[16] Includes site security and fencing, lighting, grading, drainage (detention pond development separate line item), utilities, and administrative costs.

[17] Equipment maintenance and building maintenance with utilities.

infrastructure needed to process compostable packaging. Estimated increased tonnage is not provided as the percentage of packaging compared to total feedstock is minimum and not currently available. This high-level estimate does not include ongoing operations and maintenance, engineering services, contingency, and inflationary costs.

2.3 TRANSFER STATIONS

2.3.1 Summary of Findings

According to the municipal survey conducted as part of **Element 1** of this Needs Assessment and additional internet research, there are an estimated forty-three (43) transfer stations in Colorado. Transfer stations are not permitted at the state level; therefore, the project team compiled a database to track all locations, materials accepted, and general size. While the project team attempted to identify all transfer stations in the State, the lack of a statewide database means that the list of transfer stations is an estimate based on the best available information. **Table 6** summarizes the transfer station count by region. According to the **Element 1** survey and internet research, almost all of the transfer stations are transferring recyclables and trash. Currently, the largest MRF infrastructure in Colorado is in the Front Range, and most materials are shipped throughout the State to be processed in those facilities. With this current system, transfer stations will be essential in effectively transporting increased volumes of recyclable and compostable material across the State.

Table 6: Transfer Stations by Region

Region	Transfer Station Count
Front Range	13
Mountains	17
Western Slope	12
Eastern Plains	1

2.3.2 Expansion Opportunities and Estimated Costs

The project team provided high-level opinions of cost associated with upgrading the current transfer station infrastructure to be able to manage increased quantities of recyclable materials. Contingency, permitting, design, and construction administration were not included in the costs. **Table 7** outlines the capital upgrades, such as building modifications and equipment, as well as the ongoing operations and maintenance costs for upgrading a transfer station. Various levels of upgrade options are provided, ranging from strictly adding more material, to building expansions. The upgrades could include adding recycling transfer to a previously trash-only transfer station or just adding more capacity to manage recyclables at a recycling transfer station. Loads can be transferred loose and compacted or baled. Many of the smaller MRFs in the Mountains and Western Slope regions bale comingled single stream material to be processed by the larger MRFs on the Front Range. If that model continues, adding baling technology at transfer stations should be considered.

Table 7: Transfer Station Upgrade Costs for Recycling

Equipment	Upgrade Scenarios				
	Add Transfer Only[18]	Add Bale and Transfer[19]	Add Compactor and Transfer[20]	Add Tipping Floor[21]	Add Baling and Storage[22]
Capital Upgrades					
Baler	N/A	$1M	N/A	N/A	$1M
Forklift	N/A	$60K	N/A	N/A	$60K
Compactor	N/A	N/A	$2M	N/A	N/A
Building Modifications	N/A	$200K	$500K	N/A	N/A
Building Expansions	N/A	N/A	N/A	$720K	$1.2M
TOTAL	**N/A**	**$1.26M**	**$2.5M**	**$720K**	**$2.26M**
Operations and Maintenance					
Labor (FTE)	0.1 FTE per 1,000 TPY	0.3 FTE per 1,000 TPY	0.2 FTE per 1,000 TPY	0.1 FTE per 1,000 TPY	0.3 FTE per 1,000 TPY

[18] Add Transfer Only = Physical space does not need to be expanded, only increasing recyclable material at existing site and adding staff and opentop transfer costs.

[19] Add Bale and Transfer = Physical space needs to be slightly adjusted to accommodate a baler for increased materials. Increased costs for staffing and transferring additional baled materials.

[20] Add Compactor and Transfer = Physical spaces needs to be slightly adjusted to accommodate a compactor for increased materials. Increased costs for staffing, maintenance, and transferring.

[21] Add Tipping Floor = Physical space expands without adding additional equipment. Increased costs for staff and opentop transfer.

[22] Add Baling and Storage = Physical space expands to include additional tipping floor and equipment. Increased cost for staffing and baled transfer.

Equipment	Upgrade Scenarios				
	Add Transfer Only[18]	Add Bale and Transfer[19]	Add Compactor and Transfer[20]	Add Tipping Floor[21]	Add Baling and Storage[22]
Maintenance	$2K[23]	$13K[24]	$22K[25]	$31K[26]	$61K[27]
Transfer (Opentop)	$0.40 - $0.50/ton-mile	N/A	N/A	$0.40 - $0.50/ton-mile	N/A
Transfer (Compacted)	N/A	N/A	$0.26 - $0.35/ton-mile	N/A	N/A
Transfer (baled)	N/A	$0.27-$0.35/ton-mile	N/A	N/A	$0.27-$0.35/ton-mile

Transportation costs associated with recyclables vary due to the unknown tonnage quantities to be hauled, length of travel route, and market conditions.

In order to capture additional recyclables from the MSW stream, infrastructure could be added at transfer stations to divert recyclable materials before waste is sent to the landfill. Costs associated with this process are not included in this Needs Assessment but could be provided later if needed. This strategy could be helpful in a scenario where the EPR program is not diverting as many materials as anticipated. The **Element 10 Technical Memorandum** includes more details on new technologies. The expansion estimates for drop-off facilities are not provided in this memo; however, the cost to transfer enclosed roll-off containers with loose recyclables to haul to a local or regional MRF costs approximately $1.25-$1.50 per ton-mile. Additional drop-off sites may be considered in areas where curbside trash collection is not already provided.

2.3.3 Estimated Cost Summary

In summary, capital upgrades for existing transfer stations will cost approximately between $1.3-$2.3M per transfer station to add more recyclable materials (up to 70 additional tons/day per transfer station) with varied levels of infrastructure and equipment improvements. This is a high-level cost estimate that does not include ongoing costs associated with operations, maintenance, and transportation. The project team's analysis of existing transfer station sites indicated that a total cost

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[23] Loader maintenance and fuel at $30/hour multiplied by an average of 1 hour/load.

[24] Baler and forklift maintenance and supplies.

[25] 1% of compactor cost, building maintenance, utilities, and loader operations.

[26] Building maintenance, utilities, and loader operations.

[27] Baler and forklift maintenance, building maintenance, utilities, loader operations.

estimate for expansion potential of the existing forty-three (43) transfer stations cannot be calculated, as some exist in denser areas with limited physical space and others exist next to land that might be unavailable for purchase (private or protected). Due to space constraints, not all the existing transfer stations will be able to expand to accept more materials.

COLORADO NEEDS ASSESSMENT

ELEMENT 8: MINIMUM RECYCLABLES LIST

JANUARY 25, 2024

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Tables

1 PURPOSE

The purpose of this element is to propose a list of covered materials that can be included in a minimum recyclable list (MRL) and an additional materials list (AML). The minimum recyclables list is a list of materials that must be collected in a manner that is as convenient as the collection of solid waste, and the additional materials list includes materials that may collected in different geographic areas through curbside services, drop-off centers, or other means.

House Bill 22-1355 stipulates that the list is based on the availability of recycling services, recycling collection and processing infrastructure, and recycling end markets for covered materials. These lists are required to be re-evaluated every year, and there is an opportunity to adjust the lists as part of the program plan if new information comes to light.

2 APPROACH

2.1 MATERIAL LIST

The first step in the MRL process is to develop a list of the materials which will be evaluated. Based on the description of covered materials within House Bill 22-1355, the project team developed a long list of materials to evaluate.

On October 25, 2023, the initial list was presented to the Colorado Producer Responsibility Advisory Board.1 Based on the feedback from the advisory board, some changes were made. For example, in the original long list of materials, "Gable-Top and Aseptic Cartons" were one material type, but based on feedback, this was split into two separate materials. The final list of materials that were evaluated is located in **Table 1.**

Table 1: List of Covered Materials Evaluated

1. PAPER	
Paper includes material of any type of cellulosic fiber source, including but not limited to wood, wheat, rice, cotton, bananas, eucalyptus, bamboo, hemp, and sugar cane (bagasse) fiber sources.	
1.1	**Paper for General Use (uncoated)**
1.2	**"Low grade" Printing and Writing Paper** (e.g., bulk mail, envelopes, notebooks, cards)
1.3	**Other Printed Paper** (e.g., flyers, calendars, brochures)
1.4	**Newspaper, Newsprint**
1.5	**Magazines and Other Coated Paper** (e.g., catalogs)
1.6	**Bound Directories** (e.g., telephone)

[1] https://cdphe.colorado.gov/hm/epr-advisory-board

1.7	**Packaging Paper**
1.8	**Shredded Paper (bagged)**
1.9	**Corrugated Cardboard** (except wax coated)
1.10	**Wax Coated Corrugated Cardboard**
1.11	**Kraft Packaging** (e.g., paper padded mailers, grocery bags)
1.12	**Paperboard Boxes and Packaging**
1.13	**Molded Pulp Packaging excluding Food Serviceware** (e.g., egg cartons, other protective packaging)
1.14	**Molded Pulp Food Serviceware** (e.g., take-out "clamshells")
1.15	**Paper Cups, Coated and Uncoated**
1.16	**Other Polycoated Packaging** (e.g., some freezer and butter boxes)
1.17	**Paper Laminate** (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic coated paper wrappers, including burger wraps)[2]
1.18	**Gable-Top**
1.19	**Aseptic Cartons**
1.20	**Non-Metalized Gift Wrap**
1.21	**Paper "cans" (spiral-wound containers) with steel ends**
1.22	**Paper tea bags or coffee filters**
2. RIGID PLASTIC	
2.1	**Clear PET Bottles, Jars and Jugs (including Transparent Green or Blue)**
2.2	**Colored Opaque PET Bottles, Jars and Jugs**
2.3	**Clear PET Thermoform Containers (including Transparent Green or Blue)** (e.g., berry containers, clamshells)
2.4	**Colored opaque PET Thermoform Containers**
2.5	**Natural HDPE Bottles, Jars and Jugs**
2.6	**Colored HDPE Bottles, Jars and Jugs**
2.7	**Other Polyethylene (PE) Packaging** (e.g., ice cream / butter containers) **Except Pails and Lids and Squeezables**
2.8	**Polypropylene (PP) Packaging Except Pails and Lids** (e.g., deli containers, cleaning products)
2.9	**White EPS** (e.g., television or electronics packaging, takeout food containers and cups)
2.10	**Colored Expanded PS** (e.g., meat trays, egg cartons)
2.11	**Non-Expanded PS** (e.g., egg cartons, clamshell containers, cups/plates/bowls, yogurt containers, clear rigid trays)
2.12	**PE Squeezable Tubes** (e.g., toothpaste, lotions/sunscreens)
2.13	**LDPE Colored Nursery Containers** (e.g., pots, trays, etc.)
2.14	**PS Nursery Containers** (e.g., pots, trays, etc.)
2.15	**PP Nursery Containers** (e.g., pots, trays, etc.)
2.16	**Large HDPE & PP Pails & Lids** (e.g., cat litter)
2.17	**PLA, PHA, PHB (non-certified compostable)**
2.18	**Plastic packaging less than 2 inch on at least 2 dimensions** (e.g., small food/personal hygiene containers, unattached lids)
3. FLEXIBLE PACKAGING	
3.1	**LDPE/HDPE Film** (e.g., monoPE recycle compatible pouches)
3.2	**PLA, PHA, PHB - Plastic Film (not-certified compostable)**

[2] Note there should be consideration in future assessments to create a separate category for flexible paper that meets the requirements for recycling.

3.3	**Multimaterial Films, Non-monomaterial Pouches, Other Flexible Packaging**
3.4	**PVC Film** (e.g., linen packaging, labels)
3.5	**PET Film**
3.6	**PP Film (includes monoPP recycle compatible pouches)**
3.7	**PP Woven Film** (e.g., pet food bags)
3.8	**Plastic tea bags**
3.9	**Plastic packaging less than 2 inch on at least 2 dimensions (e.g., candy wrapper)**
4. METAL	
4.1	**Steel Aerosol Containers**
4.2	**Steel Containers**
4.3	**Aluminum Aerosol Containers**
4.4	**Aluminum Non-Beverage Containers**
4.5	**Other Aluminum Packaging (Foil and Foil Trays)**
4.6	**Aluminum - Beverage Containers**
4.7	**Other Metal Packaging**
5. GLASS	
5.1	**Clear or Colored Glass**
6. COMPOSTABLE PACKAGING MATERIAL	
6.1	**Rigid plastic (certified compostable)**
6.2	**Flexible plastic (certified compostable)**
6.3	**Paper (certified compostable)**
7. OTHER	
7.1	**Ceramic, Porcelain, Pyrex and Other Glass-Like Material**
7.2	**Wood Packaging** (e.g., clementine box)
7.3	**Rubber Packaging** (e.g., stopper)
7.4	**Textile Packaging** (e.g., cloth bags, burlap sacks)
7.5	**Paint Containers**
7.6	**Motor Oil Containers**
7.7	**Solvent Containers**
7.8	**Pesticide Containers**
7.9	**Pressurized Cylinders (not including aerosols)**
7.10	**Antifreeze Containers**

2.2 DEVELOPMENT

Based on section 25-17-706 of House Bill 22-1355, criteria were developed to evaluate covered materials. The legislation requires that at least three criteria are used as part of the evaluation. These include:

- Criteria 1: Availability of recycling services
- Criteria 2: Recycling collection and processing infrastructure
- Criteria 3: Recycling end markets

Based on the criteria requirements within the legislation, the project team conducted an additional review of possible criteria that could be used to evaluate materials to decide their inclusion in the MRL. This process involved reviewing the criteria used in similar evaluations in other jurisdictions, such as Oregon[3] , and conducting internal working groups to evaluate the important factors impacting a material's recyclability.

Based on this review, an initial list of criteria was developed. This initial list included more detailed sub-criteria with metrics that can more clearly be evaluated and enhance the mandated criteria. In addition to the three mandated criteria, the project team added a fourth criterion on the detriments a material may have at different stages of the recycling value chain. For each of the sub-criteria, metrics were developed into three tiers associated with the material having high performance or no issues associated with the criteria, medium performance or some issues associated with the criteria, or low performance or serious issues associated with the criteria. These were then assigned a red, yellow, or green color for ease of review and understanding.

Table 2: Broad Metrics for Evaluation Criteria

Low performance or a greater level of issue	**The medium performance or some issues**	**High performance or no issues associated**

The initial draft assessment criteria were presented to the Colorado Producer Responsibility Advisory Board on October 25, 2023. The criteria were again discussed with the Advisory Board on November 15, 2023, during a technical working session.[4] Based on the feedback provided by the Advisory Board, adjustments were made to the criteria metrics, such as adjusting the sorting efficiency, which would be considered high performance vs medium performance.

2.2.1 Criteria 1: Availability of recycling services

Criteria Relevance

The minimum recyclables list is a list of materials that must be collected in a manner that is as convenient as the collection of solid waste, and the additional materials list includes materials that may collected in different geographic areas through curbside services, drop-off centers, or other means.

Therefore, evaluating their current access will help understand how the MRL could be similar or different from what is collected today and how the MRL may change access to recycling for different materials. Additionally, some materials may have issues with collection. The access metrics were chosen based on the Federal Trade Commission’s Green Guides, which states that “Marketers should qualify recyclable claims when

[3] https://www.oregon.gov/deq/recycling/Pages/Material-Lists.aspx

[4] https://cdphe.colorado.gov/hm/epr-advisory-board

recycling facilities are not available to at least 60 percent of the consumers or communities where a product is sold."[5]

Table 3: Criteria 1

1.1 Are there any identified issues with collecting materials (curbside, drop-off, or other)?	Greater level of issues	Some issues	No issues
1.2 What is the availability of services to collect the materials?	<20% access	20% – 60% access	60% - 100% access

Evaluation Method

For Criteria 1, the project team utilized the results from the municipality survey, which was sent to all 272 municipalities and described in more detail in the technical memo associated with Element 1: Residential Collection. Survey questions inquired about whether covered materials were accepted in their curbside or drop-off programs. Respondents could select Yes, No, or Not Sure for each material. On average, there were over 100 responses per material. The project team did not include any responses of "not sure" in the evaluation or responses from municipalities that did not have curbside or drop-off service. Access was then calculated as follows:

(number of municipalities who responded yes) / (the number of municipalities who responded yes + the number of municipalities who responded no)

This provides an estimate for the percentage of municipalities that have collection services that collect each material.

2.2.2 Criteria 2: Recycling collection and processing infrastructure

Criteria Relevance

After packaging material is collected, it is typically sent to a Material Recovery Facility (MRF) for further processing and sorting before being sent to its intended end market for recycling.

Packaging can be made from different types of materials (paper, plastic, metal, etc.) and come in various formats (rigid plastic vs plastic film). These characteristics can impact how effectively the material can be sorted and separated into an individual end-market commodity. If it is not sorted correctly, then it may be sorted into the wrong end market commodity, impacting its quality or a residual stream that is sent to landfill. The higher the sorting efficiency for different materials the more material that ends up in the correct end market commodity and is recycled.

The value ranges for each of the criteria were developed in consultation with industry experts and experts on the CDPHE Advisory Board. Additionally, Institute of Scrap Recycling Industries, Inc. (ISRI) commodity output specifications were reviewed to understand acceptable levels of non-target material. This criteria is used to assess the

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[5] https://www.ftc.gov/sites/default/files/attachments/press-releases/ftc-issues-revised-green-guides/greenguidessummary.pdf

majority of the MRF operations in Colorado having the ability to sort at or above the criteria range. This is important to ensure that materials collected at the inception of the program can be effectively sorted for their intended end-market commodity stream. For these criteria, sortability refers to the portion of targeted material that is sorted into the correct commodity by the MRF.

Table 4: Criteria 2

2.1 Sortability (majority of MRF capacity can meet % sort rate) Single Stream MRF	<70% sort rate	70% - 85% sort rate	85% - 100% sort rate
2.2 Sortability (majority of MRF capacity can meet % sort rate) Dual Stream MRF	<70% sort rate	70% - 85% sort rate	85% - 100% sort rate
2.3 Sortability (majority of MRF capacity can meet % sort rate) Separate Collection	<70% sort rate	70% - 85% sort rate	85% - 100% sort rate

Evaluation Method

The project team interviewed and visited MRFs across the state and summarized the findings in Element 6: Processing Capacity. Additionally, the CDPHE Advisory Board provided information collected from interviews with MRF operators. Using the information gathered from these interviews and site visits in addition to project team experts understanding of sorting technologies and capabilities of MRFs, each material was evaluated on whether it could be sorted by MRFs in the state, which represent a majority of processing capacity.

2.2.3 Criteria 3: Recycling end markets

Criteria Relevance

Material may be collected and sorted properly, but it will only be recycled if there are end markets willing to purchase the material for reprocessing into a product. Therefore, these criteria evaluate the end markets available for the materials list. A material is considered to have an end market if it has its own commodity stream or if it is part of but not majority of a different materials commodity's stream. If a material has multiple end markets, then it scores higher overall. For this evaluation, buyers do not refer to brokers but instead, reclaimers that use the commodities.

Table 5: Criteria 3

3.1 Can the material be sorted into at least one commodity output that has an existing responsible end market?	Does Not Sort	Sorts Moderately Well	Sorts Well
3.2 Number of current responsible end markets with sufficient capacity	0	1	>1

Evaluation Method

The project team conducted primary and secondary research to understand the availability of end markets for recyclable materials collected in Colorado. These findings are summarized in **Element 6: Processing Capacity** and **Element 9: End Markets.** This information was then used to evaluate covered materials and whether responsible end markets exist.

2.2.4 Criteria 4: Detriments

Criteria Relevance

The final criteria are about the detriments that the material may cause at different stages of the recycling value chain. The characteristics of certain materials may create health and safety issues during the collection and sorting processes, which need to be considered when evaluating whether the material should be part of a recycling system. Additionally, if the packaging impacts the quality of the commodity stream it will lower the end market opportunities of other materials; therefore, some materials inclusion may lower the total quality of the recycling system. Finally, there are some materials that may typically be sorted into a commodity output that would be considered prohibitive and, therefore, would reduce the quality of the recycling stream.

Table 6: Criteria 4

4.1 Does the collection or processing of the materials in a commingled stream create any potential health and safety issues?	Greater level of issues	Some issues	No issues
4.2 Could the contents of the packaging (even when empty) create contamination issues and reduce end-market opportunities?	Greater level of issues	Some issues	No issues
4.3 Is the packaging considered prohibitive in the commodity outputs it predominantly ends up in?	greater level of issues	Some issues	No issues

Evaluation Method

For this criteria, subject matter experts were assigned to review the sub criteria against the long list of materials. For each of the materials, they reviewed relevant literature or reviewed findings from previous interviews that were conducted with operators of recycling systems as part of this project or previous engagement. Based on the material reviewed, the experts evaluated the materials against the red, yellow, and green metrics for each of the sub-criteria.

For all criteria, the evaluation was reviewed by additional internal and external experts to receive additional feedback.

3 RESULTS

3.1 SCORE RESULTS

After each material was evaluated against the sub-criteria, a single criteria score (1-4) was given for each material. One (1) was the highest score and related to little or no issues for that criterion, and the lowest score was four (4), which meant there were serious issues for that criterion. The summarized scores for each of the materials against the four criteria are provided in **Table 7.**

Table 7: Evaluation Results

CATEGORY	Sub-Category	Collection Score	Sorting Score	End Market Score	Detrimental Score	Total Score
1. PAPER						
Paper includes material of any type of cellulosic fiber source, including but not limited to wood, wheat, rice, cotton, bananas, eucalyptus, bamboo, hemp, and sugar cane (bagasse) fiber sources.						
1.1	**Paper for General Use (uncoated)**	1	1	1	1	4
1.2	**"Low grade" Printing and Writing Paper** (e.g., bulk mail, envelopes, notebooks, cards)	1	1	1	1	4
1.3	**Other Printed Paper** (e.g., flyers, calendars, brochures)	2	1	1	1	5
1.4	**Newspaper, Newsprint**	1	1	1	1	4
1.5	**Magazines and Other Coated Paper** (e.g., catalogs)	1	1	1	1	4
1.6	**Bound Directories** (e.g., telephone)	1	1	1	1	4
1.7	**Packaging Paper**	1	1	1	1	4
1.8	**Shredded Paper (bagged)**	2	3	1	1	7
1.9	**Corrugated Cardboard** (except wax coated)	1	1	1	1	4
1.10	**Wax Coated Corrugated Cardboard**	3	2	3	3	11
1.11	**Kraft Packaging** (e.g., paper padded mailers, grocery bags)	1	1	1	2	5
1.12	**Paperboard Boxes and Packaging**	1	1	1	1	4
1.13	**Molded Pulp Packaging excluding Food Serviceware** (e.g., egg cartons, other protective packaging)	1	1	1	1	4

CATEGORY	Sub-Category	Collection Score	Sorting Score	End Market Score	Detrimental Score	Total Score
1.14	**Molded Pulp Food Serviceware** (e.g., take-out "clamshells")	3	2	1	1	7
1.15	**Paper Cups, Coated and Uncoated**	2	2	2	2	8
1.16	**Other Polycoated Packaging** (e.g., some freezer and butter boxes)	3	2	2	2	9
1.17	**Paper Laminate** (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic coated paper wrappers, including burger wraps)	3	2	2	2	9
1.18	**Gable-Top**	1	1	1	2	5
1.19	**Aseptic Cartons**	1	1	1	2	5
1.20	**Non-Metalized Gift Wrap**	2	1	2	1	6
1.21	**Paper "cans" (spiral-wound containers) with steel ends**	3	1	2	2	8
1.22	**Paper tea bags or coffee filters**	3	4	4	3	14
2. RIGID PLASTIC						
2.1	**Clear PET Bottles, Jars and Jugs (including Transparent Green or Blue)**	1	1	1	1	4
2.2	**Colored Opaque PET Bottles, Jars and Jugs**	1	1	3	3	8
2.3	**Clear PET Thermoform Containers (including Transparent Green or Blue)**	1	1	2	2	6
2.4	**Colored opaque PET Thermoform Containers**	1	1	3	3	8
2.5	**Natural HDPE Bottles, Jars and Jugs**	1	1	1	1	4
2.6	**Colored HDPE Bottles, Jars and Jugs**	1	1	1	1	4
2.7	**Other Polyethylene (PE) Packaging** (e.g., ice cream / butter containers) **Except Pails and Lids and Squeezables**	2	1	1	1	5
2.8	**Polypropylene (PP) Packaging Except Pails and Lids** (e.g., deli containers, cleaning products)	1	1	1	1	4
2.9	**White EPS** (e.g., television or electronics packaging, takeout food containers and cups)	3	4	3	1	11

CATEGORY	Sub-Category	Collection Score	Sorting Score	End Market Score	Detrimental Score	Total Score
2.10	**Colored Expanded PS** (e.g., meat trays, egg cartons)	3	4	4	1	12
2.11	**Non-Expanded PS** (e.g., egg cartons, clamshell containers, cups/plates/bowls, yogurt containers, clear rigid trays)	4	2	4	1	11
2.12	**PE Squeezable Tubes** (e.g., toothpaste, lotions/sunscreens)	4	2	2	1	9
2.13	**LDPE Colored Nursery Containers** (e.g., pots, trays, etc.)	3	2	2	2	9
2.14	**PS Nursery Containers** (e.g., pots, trays, etc.)	3	2	4	2	11
2.15	**PP Nursery Containers** (e.g., pots, trays, etc.)	3	2	1	2	8
2.16	**Large HDPE & PP Pails & Lids** (e.g., cat litter)	2	2	1	1	6
2.17	**PLA, PHA, PHB (non-certified compostable)**	4	4	4	2	14
2.18	**Plastic packaging less than 2 inch on at least 2 dimensions** (e.g., small food/personal hygiene containers, unattached lids)	2	4	N/A	2	
3. FLEXIBLE PACKAGING						
3.1	**LDPE/HDPE Film** (e.g., monoPE recycle compatible pouches)	3	3	2	1	9
3.2	**PLA, PHA, PHB - Plastic Film (not-certified compostable)**	4	3	4	2	13
3.3	**Multimaterial Films, Non-monomaterial Pouches, Other Flexible Packaging**	4	3	4	2	13
3.4	**PVC Film** (e.g., linen packaging, labels)	4	3	4	2	13
3.5	**PET Film**	4	3	4	2	13
3.6	**PP Film (includes monoPP recycle compatible pouches)**	4	3	3	2	12
3.7	**PP Woven Film** (e.g., pet food bags)	4	3	3	2	12
3.8	**Plastic tea bags**	3	4	4	2	13
3.9	**Plastic packaging less than 2 inch on at least 2 dimensions (e.g., candy wrapper)**	4	4	N/A	2	
4. METAL						
4.1	**Steel Aerosol Containers (empty)**	1	1	2	2	6

CATEGORY	Sub-Category	Collection Score	Sorting Score	End Market Score	Detrimental Score	Total Score
4.2	**Steel Containers**	1	1	1	1	4
4.3	**Aluminum Aerosol Containers (empty)**	1	1	2	2	6
4.4	**Aluminum Non-Beverage Containers**	1	1	1	2	5
4.5	**Other Aluminum Packaging (Foil and Foil Trays)**	1	3	2	2	8
4.6	**Aluminum - Beverage Containers**	1	1	1	1	4
4.7	**Other Metal Packaging**	1	3	1	2	7
5. GLASS						
5.1	**Clear or Colored Glass**	1	1	1	1	4
6. COMPOSTABLE PACKAGING MATERIAL						
6.1	**Rigid plastic (certified compostable)**	3	4	4	3	14
6.2	**Flexible plastic (certified compostable)**	4	4	4	3	15
6.3	**Paper (certified compostable)**	3	2	4	2	11
7. OTHER						
7.1	**Ceramic, Porcelain, Pyrex and Other Glass-Like Material**	3	4	4	3	14
7.2	**Wood Packaging** (e.g., clementine box)	4	4	4	2	14
7.3	**Rubber Packaging** (e.g., stopper)	4	4	4	2	14
7.4	**Textile Packaging** (e.g., cloth bags, burlap sacks)	4	4	4	2	14
7.5	**Paint Containers**	3	3	3	3	12
7.6	**Motor Oil Containers**	3	3	3	3	12
7.7	**Solvent Containers**	3	3	3	4	13
7.8	**Pesticide Containers**	3	3	3	4	13
7.9	**Pressurized Cylinders (not including aerosols)**	3	3	3	3	12
7.10	**Antifreeze Containers**	3	3	3	3	12

3.2 LIST PLACEMENT

Based on the total score, materials were placed on the MRL, AML, or the not collected list. The project team developed a draft for the MRL and AML, which was presented to the Advisory Board on December 7, 2023. Some of the feedback received included that the MRL should include a smaller but stronger set of materials so there is time for improvements to be made to the recycling system. Then, materials can be moved from the AML to the MRL as the program improves. Additionally, the board provided feedback that materials on the AML should have flexibility in how they are collected, for example, through curbside or drop-off programs.

Based on this feedback, a score threshold was developed for the different lists. A score of 4 -6 is a near-perfect score, and materials with this score were included in the proposed MRL. Next, materials with a score of 7-10 were included in the proposed AML. Finally, materials with a score of 11-16 were included on the not collected list.

Table 8: Scoring Threshold for Lists

Material Total Score	Recyclable List
4-6	Minimum Recyclable List
7-10	Additional Materials List
11-16	Not collected

There were a few exemptions to how materials were placed on the different lists. This includes materials 7.5-7.10. These materials are all household hazardous waste, and although scored between 12-13, they were included on the additional materials list. There are already household hazardous waste collection sites and facilities across the state. It is suggested that they remain on the additional materials list to further evaluate how these materials can continue to be collected through these programs.

Rigid and flexible plastic less than two inches on two dimensions were not given a final score as the end market criteria could not be completed based on this material type not having a specific resin associated with it. As the material scored low in other categories, it was added to the not collected list.

3.3 PROPOSED LISTS

The following section includes the proposed MRL and AML. For each material, a collection method is provided.

3.3.1 Proposed Minimum Recyclables List

Based on the evaluation, the following materials can be included on a minimum recyclables list.

Table 9: Proposed Minimum Recyclables List

	Packaging Type	Collection Method
1.1	Paper for General Use (uncoated)	Curbside
1.2	"Low grade" Printing and Writing Paper (e.g., bulk mail, envelopes, notebooks, cards)	Curbside

	Packaging Type	Collection Method
1.3	Other Printed Paper (e.g., flyers, calendars, brochures)	Curbside
1.4	Newspaper, Newsprint	Curbside
1.5	Magazines and Other Coated Paper (e.g., catalogs)	Curbside
1.6	Bound Directories (e.g., telephone)	Curbside
1.7	Packaging Paper	Curbside
1.9	Corrugated Cardboard (except wax coated)	Curbside
1.11	Kraft Packaging (e.g., paper padded mailers, grocery bags)	Curbside
1.12	Paperboard Boxes and Packaging	Curbside
1.13	Molded Pulp Packaging, excluding Food Serviceware (e.g., egg cartons, other protective packaging)	Curbside
1.18	Gable-Top	Curbside
1.19	Aseptic Cartons	Curbside
1.20	Non-Metalized Gift Wrap	Curbside
2.1	Clear PET Bottles, Jars and Jugs (including Transparent Green or Blue)	Curbside
2.3	Clear PET Thermoform Containers (including Transparent Green or Blue)	Curbside
2.5	Natural HDPE Bottles, Jars and Jugs	Curbside
2.6	Colored HDPE Bottles, Jars and Jugs	Curbside
2.7	Other Polyethylene (PE) Packaging (e.g., ice cream / butter containers) Except Pails and Lids and Squeezables	Curbside
2.8	Polypropylene (PP) Packaging Except Pails and Lids (e.g., deli containers, cleaning products)	Curbside
2.16	Large HDPE & PP Pails & Lids (e.g., cat litter)	Curbside
4.1	Steel Aerosol Containers (empty)	Curbside or drop off
4.2	Steel Containers	Curbside
4.3	Aluminum Aerosol Containers (empty)	Curbside or drop off

	Packaging Type	Collection Method
4.4	Aluminum Non-Beverage Containers	Curbside
4.6	Aluminum - Beverage Containers	Curbside
5.1	Clear or Colored Glass	Curbside or Drop off

3.3.2 Proposed Additional Materials List

Based on the evaluation the following materials can be included on an Additional Materials List.

Table 10: Proposed Additional Materials List

	Packaging Type	Collection Method
1.8	Shredded Paper (bagged)	Curbside, Drop off, or Other Means
1.14	Molded Pulp Food Serviceware (e.g., take-out “clamshells”)	Curbside, Drop off, or Other Means
1.15	Paper Cups, Coated and Uncoated	Curbside, Drop off, or Other Means
1.16	Other Polycoated Packaging (e.g., some freezer and butter boxes)	Curbside, Drop off, or Other Means
1.17	Paper Laminate (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic coated paper wrappers, including burger wraps)	Curbside, Drop off, or Other Means
1.21	Paper “cans” (spiral-wound containers) with steel ends	Curbside, Drop off, or Other Means
2.2	Colored Opaque PET Bottles, Jars and Jugs	Curbside, Drop off, or Other Means
2.4	Colored opaque PET Thermoform Containers	Curbside, Drop off, or Other Means
2.12	PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens)	Curbside, Drop off, or Other Means
2.13	LDPE Colored Nursery Containers (e.g., pots, trays, etc.)	Curbside, Drop off, or Other Means

	Packaging Type	Collection Method
2.15	PP Nursery Containers (e.g., pots, trays, etc.)	Curbside, Drop off, or Other Means
3.1	LDPE/HDPE Film (e.g., monoPE recycle compatible pouches)	Curbside, Drop off, or Other Means
4.5	Other Aluminum Packaging (Foil and Foil Trays)	Curbside, Drop off, or Other Means
4.7	Other Metal Packaging	Curbside, Drop off, or Other Means

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Appendix A. Example Photos of Materials

1.0 PAPER

1.1 Paper for General Use (uncoated)

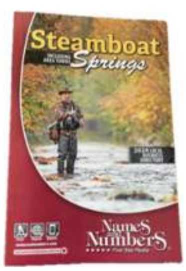
1.2 "Low grade" Printing and Writing Paper (e.g., bulk mail, envelopes, notebooks, cards)

1.3 Other Printed Paper (e.g., flyers, calendars, brochures)

1.4 Newspaper, Newsprint

1.5 Magazines and Other Coated Paper (e.g., catalogs)

1.6 Bound Directories (e.g., telephone)



1.7 Tissue Paper (for packaging purposes)

1.8 Shredded Paper (bagged)

1.9 Corrugated Cardboard (except wax coated)

1.10 Wax Coated Corrugated Cardboard

1.11 Kraft Packaging (e.g., paper padded mailers, grocery bags)

1.12 Paperboard Boxes and Packaging

1.13 Molded Pulp Packaging excluding Food Service ware (e.g., egg cartons, other protective packaging)

1.14 Molded Pulp Food Service ware (e.g., take-out “clamshells”)

1.15 Paper Cups, Coated and Uncoated

1.16 Other Polycoated Packaging (e.g., some freezer and butter boxes)

1.17 Paper Laminate (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic coated paper wrappers, including burger wraps)

1.18 Gable-Top

1.19 Aseptic Cartons

1.20 Non-Metalized Gift Wrap

1.21 Paper "cans" (spiral-wound containers) with steel ends

1.22 Tea bags or coffee filters

2.0 RIGID PLASTIC

2.1 Clear PET Bottles, Jars and Jugs (including Transparent Green or Blue)

2.2 Colored Opaque PET Bottles, Jars and Jugs

2.3 Clear PET Thermoform Containers (including Transparent Green or Blue)

2.4 Colored opaque PET Thermoform Containers

2.5 Natural HDPE Bottles, Jars and Jugs

2.6 Colored HDPE Bottles, Jars and Jugs

2.7 Other Polyethylene (PE) Packaging (e.g., ice cream / butter containers) Except Pails and Lids and Squeezable

2.8 Polypropylene (PP) Packaging Except Pails and Lids (e.g., deli containers, cleaning products)

2.9 White EPS (e.g., television or electronics packaging, takeout food containers and cups)

2.10 Colored Expanded PS (e.g., meat trays, egg cartons)

2.11 Non-Expanded PS (e.g., egg cartons, clamshell containers, cups/plates/bowls, yogurt containers, clear rigid trays)

2.12 PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens)

2.13 LDPE Colored Nursery Containers (e.g., pots, trays, etc.)

2.14 PS Nursery Containers (e.g., pots, trays, etc.)

2.15 PP Nursery Containers (e.g., pots, trays, etc.)

2.16 Large HDPE & PP Pails & Lids (e.g., cat litter)

2.17 PLA, PHA, PHB (non-certified compostable)

2.18 Plastic packaging less than 2 inch on at least 2 dimensions (e.g., small food/personal hygiene containers, unattached lids)

3.0 FLEXIBLE PACKAGING

3.1 LDPE/HDPE Film (e.g., monoPE recycle compatible pouches)

3.2 PLA, PHA, PHB - Plastic Film (not-certified compostable)

3.3 Multimaterial Films, Non-monomaterial Pouches, Other Flexible Packaging

3.4 PVC Film (e.g., linen packaging, labels)

3.5 PET Film

3.6 PP Film (includes monoPP recycle compatible pouches)

3.7 PP Woven Film (e.g., pet food bags)

3.8 Tea bags

3.9 Plastic packaging less than 2 inch on at least 2 dimensions (e.g., candy wrapper)

4.0 METAL

4.1 Steel Aerosol Containers

4.2 Steel Containers

4.3 Aluminum Aerosol Containers

4.4 Aluminum Non-Beverage Containers

4.5 Other Aluminum Packaging (Foil and Foil Trays)

4.6 Aluminum - Beverage Containers

4.7 Other Metal Packaging

5.0 GLASS

5.1 Clear or Colored Glass

6.0 COMPOSTABLE PACKAGING MATERIAL

6.1 Rigid plastic (certified compostable)

6.2 Flexible plastic (certified compostable)

6.3 Paper (certified compostable)

7.0 OTHER

7.1 Ceramic, Porcelain, Pyrex and Other Glass-Like Material

7.2 Wood Packaging (e.g., clementine box)

7.3 Rubber Packaging (e.g., stopper)

7.4 Textile Packaging (e.g., cloth bags, burlap sacks)

7.5 Paint Containers

7.6 Motor Oil Containers

7.7 Solvent Containers

7.8 Pesticide Containers

7.9 Pressurized Cylinders (not including aerosols)

7.10 Antifreeze Containers

COLORADO NEEDS ASSESSMENT

ELEMENT 9: END MARKETS

JANUARY 25, 2024

CONTENTS

TABLES

FIGURES

The Needs Assessment was undertaken according to Colorado's Producer Responsibility Program for Statewide Recycling. Any views expressed in this document do not necessarily reflect the views or positions of Circular Action Alliance's members.

1 EXECUTIVE SUMMARY

1.1 PURPOSE

As Colorado looks towards EPR, a better understanding of the post-collection landscape for recycled materials is needed. This memo discusses:

- The current state of end markets for Colorado collected material, with special attention to whether materials are recycled in or out of state and if and where materials are exported to.
- The main markets for the types of materials collected in Colorado, both geographically and the end product type (e.g., insulation, drainpipes).
- Potential challenges and weaknesses in current markets.
- Analysis of market development efforts.

This memo focuses on material that is under consideration for the Minimum Recyclables List. Because this list is broad, the memo categorizes material and includes analysis for more granular categories within each section.

1.2 APPROACH

The project team performed both primary and secondary research to identify end markets for packaging and paper products. The sources used were:

- An internal processor database.
- The Environmental Protection Agency's (EPA) Recycling Infrastructure Market Opportunities map.[1]
- Circular Colorado's Member Directory.[2]
- University of Colorado Denver's Manufacturing, Associations, Organizations, and Company Information.[3]
- Primary MRF Surveys with 10 Colorado MRFs.
- Interviews with eight industry stakeholders (brokers, MRFs, recyclers).
- U.S Census Bureau's USA Trade Online database.[4]

[1] Recycling Infrastructure and Market Opportunities Map | US EPA

[2] 22_23 Directory - Sheet1.pdf (recyclecolorado.org)

[3] manufacturing - 2021.pdf (ucdenver.edu)

[4] USA Trade Online * Home (census.gov)

As much as possible, the project team looked to narrow down where packaging and paper products currently collected for recycling in Colorado are being sent; however, this information was not openly shared by MRF operators in CO during interviews and surveys. Therefore, the project evaluated the end markets through a variety of in-state and industry channels.

1.3 FINDINGS

The table below grades the end markets for post-consumer material for Colorado collected material. The scale is given on a "red, amber, green" basis, which is determined by a qualitative assessment considering the following factors:

- Whether in-state end markets were identified, with end markets referring to recycling processes after sorting, which produce a new product for manufacturing or use. Processes that consume the sorted material but do not produce a new product (e.g., waste-to-energy) were not considered end markets. End markets include both closed and open-loop recycling outlets.
- Whether domestic markets were identified.
- Whether MRFs explicitly state they accept and market the material.
- Whether MRFs identified stable and easily accessible markets for the material.

Table 1: Summary Table of End Markets for Post-Consumer Material

Material	RAG Rating for End Markets	In State End Market	Stable End Markets
Glass		Y	Y
Aluminum Packaging		N	Y
Steel Packaging		N	Y
Fiber – OCC		N	Y
Fiber – Other Paper Products		N	Y
Plastic – PET		N	Y – for bottles
Plastic – HDPE		N	Y
Plastic – PP		N	N

Material	RAG Rating for End Markets	In State End Market	Stable End Markets
Plastic – Other #3-7 & film		N	N

- **Glass:** Glass is the only material that has a Colorado end market. The end market could accommodate increased volume. Glass to Glass, O-I Glass Inc., and Rocky Mountain Bottling Company (RMBC). From a collection standpoint, initiatives have tried to expand glass collection in areas that currently don't have recycling services. However, there has been difficulty in finding haulers which choose to participate in the program. The levels of contamination reported in the glass stream post-MRF sorting varied. Examples provided were of different sorted glass commodities that contained between 55% and 85% glass upon delivery to the secondary glass processor (i.e., glass to glass). The remaining 45%-15% is non-glass residue (NGR) and other contamination.
- **Steel Cans**: Mills within the state do not accept steel cans as they have electric arc furnaces (EAF) rather than integrated steel mills. EAF furnaces tend to take scrap metal rather than tin can packaging material. All integrated steel mills in the U.S. are in the Midwest, with the closest being 850 miles from Denver (Granite City Steel Works in Granite City, Illinois). It is not known whether Colorado steel cans go to the mill that is closest to Denver specifically, but the cans must be sent to mills within the Midwest to be recycled.
- **Aluminum:** There are no local markets within Colorado, although there are strong domestic markets. The high market value means that the material does stay in the U.S., generally shipping to the southeastern U.S.
- **Paper**: There are no paper mills in Colorado. End markets are currently in the Midwest, South, and Western US. End markets can be relatively local to Colorado (neighboring states) if the material is sorted into ISRI standard bale grades, while lower-grade fibers may have to be sent to mills further away and with potentially less circular outputs.
- **Plastic**: End markets for post-consumer material are limited in Colorado.
  - There is one plastic recycling facility in Colorado that almost exclusively uses an input feedstock of post-industrial material (Direct Polymers in Denver). One reason for this is due to the lack of manufacturing in the state of Colorado. To find more local end markets, there may need to be additional manufacturing capacity brought into the state. In the absence of this happening, end markets for plastic in the U.S. are currently in the southeastern U.S. There are also markets in Canada.

- The cost to run non-bottle PET plastics through a recycling facility is high and could require the cost to be subsidized. PET thermoforms and bottles are, as a result, currently baled together.
- HDPE bottles are sorted into their own bales and sold to end markets across the U.S.
- MRFs that take multi-stream material seem to be able to sell certain plastics, primarily rigids #2-#5, to local markets. These MRFs can send mixed tubs and lids (HDPE, PP) to local end markets in the state (only one MRF has confirmed they can do this). Other MRFs are producing tubs and lids bales as well as rigids #3-7 to sell to out-of-state markets in the southeastern U.S.

- **All materials:** There appears to be relatively little material exported from the U.S., according to both MRF surveys & interviews as well as U.S. Census trade data. There are potential limitations to Census trade data in the traceability of goods to states; however, trends in the same Colorado data over time show exports decreasing.

  Manufacturing, in general, is limited in Colorado. According to the Bureau of Economic Analysis 2021 data, among all states, Colorado ranks 37th in manufacturing employees per capita and 40th in manufacturing GDP per capita.[5] There also seem to be potential end users within the state who could take recycled material; however, the recycling step between sorting and product usage (e.g., filling beverages, shaping cans, constructing boxes) is not present in the state.

1.4 SCENARIO CONSIDERATIONS

Recommendations and considerations for modeling and considering the three future state scenarios.

Glass: Due to the presence of strong local end markets for container glass considered within the future state analysis, improvements in the recycling system are considered that will:

1. Increase the quality of material to reduce downstream costs.

2. Increase the quantity of quality material; this could include investment in MRF glass cleanup equipment to remove contamination, better separate out, and more effectively capture glass collected curbside. This would consider how glass collected in curbside programs can maintain its quality and produce purities > 80%.

Aluminum: Used Beverage Containers UBCs have strong domestic markets. Keeping UBC bales as contamination-free as possible should be strived for by MRFs and through investment in MRFs. Non-UBC aluminum is tolerated but not always explicitly accepted by MRFs. It is also baled and included in aluminum can bales at certain thresholds.

[5] Eunomia Calculations with BEA : Regional Economic Accounts: Download

Paper: Old Corrugated Containers (OCC) can continue to find end markets in surrounding states. Some higher-grade materials may be going to cellulose insulation facilities and tissue paper. The future state modeling can consider.

1. Maintaining the quality of fiber, which is sorted through MRFs by producing bales that are up to ISRI specifications, is critical to supply end markets. [6]

2. Capturing additional paper is also important for the future recycling system as it comprises such a large share of the waste stream. It is likely additional fiber could be captured from both the residential and non-residential sectors, particularly if there is no current requirement for commercial enterprises to recycle in the state.

Plastic: Rigid plastics should be sorted into resin and format-specific bales as much as possible. Currently, the bales produced are a combination of the following:

- #1 PET bales, bottles, and thermoforms.
- #2 HDPE Natural Bottle bales.
- #2 HDPE Colored Bottle bales.
- Mixed Tubs and Lids (#2, #5, #4 rigid).
- Mixed #3-7 bales.

Plastics #1 and #2 have the highest value and tend to be sorted individually. This is different from some of the other resins, which are more likely to be sorted into a mixed bale, which an end market will further separate. The future system modeling will have to consider the following:

1. Less lucrative markets for rigids #3-7 and non-bottle PET when sorted into an individual bale. While recycling markets for non-bottle PET do exist, such as Global Plastics Recycling in California, it can be cost-prohibitive under current markets.
2. Plastic recyclers will consider accepting more material if it is already sorted into the resins and formats they're seeking, particularly for PET, HDPE, and PP. The future state modeling may have to reflect sorting improvements at the MRFs to produce these bales.
3. Incorporation of flexible plastics will require subsidizing sorting centers to upgrade equipment to handle flexible plastic capture. Flexible plastics would eventually have to be sorted into resin-specific bales prior to being sent to existing end markets. This could occur at a sorting facility or a secondary operation specifically for flexible plastics before entering the recycling facilities.

[6] scrap2.org/specs/34/

2 CURRENT STATE OF END MARKETS FOR MATERIAL COLLECTED IN COLORADO

This section considers the state of end markets for Colorado collected material on a material-by-material basis. There are discussions on the sorting, recycling, remanufacturing, and exports for each material. All export figures are based on the U.S. Census Bureau's Origin of Movement state-level database.[7] Under the recycling and remanufacturing sections, profiles of end markets that might potentially receive Colorado material are given. A full table summary of the facilities is given in Section 3 (Table 14).

2.1 GLASS

Glass has the most in-state demand for recycled material of the materials evaluated. The state has two true end markets for recycled glass: Rocky Mountain Bottle Company (RMBC) and OI-Windsor. Owens Illinois fully owns the OI-Windsor facility and has a stake in RMBC. The state also has a secondary glass MRF called Glass to Glass, which is a wholly-owned subsidiary of O-I Glass.

Below is a summary of the recycling and end markets for different glass commodities in Colorado.

Table 2: Glass End Market Summary by Material

Material	Recycler in State	In State End market - Identified	Domestic End Market	End Market Output	Has Spare Capacity for more Tonnage
Clear Glass	Y – Glass to Glass	Y –RMBC	Y	New Bottles	Y
Amber Glass	Y – Glass to Glass	Y - RMBC	Y	New Bottles	Y
Green Glass	Y – Glass to Glass	Y - RMBC	Y	New Bottles	Y
3-mix glass	Y – Glass to Glass	Y - OI	Y	New Bottles	Y
Fines	Y – Glass to Glass	Y – tentative (recently found market)	Y	Roofing substitute	Y

[7] USA Trade Online - Choose members (census.gov)

Sorting and Summary of End Markets provided by MRFs

From the data gathered in **Element 6,** we understand that:

- Four large MRFs and two smaller MRFs sort glass into a 3-mix commodity and send it to Glass to Glass for additional cleaning, color separation, and sizing.
- The smaller, more rural facilities do not sort and send glass directly to end markets but instead transfer their glass to their larger MRFs in Denver. This facility then sends material to in-state end markets.
- The levels of contamination reported in the glass stream after sorting at a MRF varied. Examples provided were of different sorted glass commodities that contained between 55% and 85% glass upon delivery to the secondary glass processor (i.e., glass to glass). The remaining 45%-15% is non-glass residue (NGR) and other contamination. It was reported that the large single-stream MRFs generally have more elevated contamination or non-glass residue in their glass stream.
- While MRF glass generally has a negative value in the South-Central U.S. (~-$30/ton), MRFs in Colorado generally report end markets covering the cost of transportation. However, MRFs with higher contamination sell glass at a lower profit margin, making the commodity less valuable.[8] The local end market enables transportation costs to be more manageable.
- MRFs with higher contamination rates report having to pay for the transportation of glass. However, the local end markets allow transportation costs to be manageable so that the revenue for glass recognized by MRFs creates more of a break-even program for the facilities.

Recycling & Processing End Markets

There is one glass recycler in the state to which six MRFs send material, which is Glass to Glass, Denver, CO, which is owned by O-I Glass.

Glass to Glass is a secondary MRF dedicated to cleaning glass streams for furnace-ready applications. The facility receives MRF-sorted glass from four large MRFs within Colorado and two smaller-scale facilities. While the facility receives some glass material from other sources, including from out of state, the CO MRFs are Glass to Glass's biggest provider of glass material. The facility receives 200-350 tons per day and sorts through this material four days a week. The main functions of the facility for glass cleanup are to:

- Dry out and remove any non-glass material from incoming glass commodities, including paper, plastics, organics, and metals.
- Sort the material into four separate color types: flint, green, amber, and 3-mix glass.

[8] Colorado MRF Survey Data

- Crush glass into sizes between 1/8-3/8 of an inch or 3/8-1½ of an inch (3/8 of an inch is the smallest size which Glass to Glass color sorts into).

The facility produces 30,000 to 35,000 tons of glass annually delivered to end markets. The color-separated glass is sent to RMBC, while the 3-mix is sent to OI-Windsor. The breakdown of outputs from the facility are shown below:

Table 3: Breakdown of Glass-to-Glass Outputs

Commodity	% of Output	Destination
Color separated glass (flint, amber, green)	60-70%	RMBC
3-mix glass	20-30%	OI-Windsor
Fines (3mm – 8mm)	10-15%	Landfill or roof-substitute

The facility could process 80,000 tons of the current contaminated material or 100,000 tons of higher quality (lower contamination) material. Contamination from incoming material is one of the greatest challenges for Glass to Glass. The facility is currently not running every day of the week, so there is spare capacity.

The higher the contamination, the costs to process increase and fines output increases. It has been difficult for the facility to find an end market for fines, as it is not a high enough quality output to produce remelt products from, such as containers or fiberglass. In the past, it was going to alternate daily cover (ADC). The fines are currently up to specification to be used as a roofing substitute; however, there are no outlets for this in Colorado.

From a collection standpoint, the facility has attempted to expand glass collection in areas of the state where recycling services are not provided. However, it has been challenging to secure haulers that want to participate in the program. These mountain areas can be dangerous for drivers, particularly in the winter, limiting the supply of truck drivers.

Re-Manufacturers

There are two glass bottling facilities in Colorado that take recycled glass. The two facilities are Rocky Mountain Brewery Company (RMBC) and OI-Windsor. Glass to Glass ships all their glass commodities (excluding fines) to these two facilities.

Color separated glass is sent to RMBC to manufacture new bottles, while the 3-mix product from Glass to Glass is sent to OI-Windsor to manufacture new 12 oz beer bottles. Similar to the glass processors, both RMBC and OI-Windsor do not receive enough material from in-state sources to fulfill its need for recycled glass. Both facilities receive additional recycled glass material via rail from other states, including deposit material from Oregon. Facility representatives suggested they could receive twice as much clean glass material without requiring additional facilities or expansion of existing facilities.

OI-Windsor, Windsor, CO. Owned by Owens-Illinois

OI-Windsor is a glass bottle manufacturer located in Windsor, CO. The facility opened in 2006 and produces about 1 million bottles per year, or 850 tons per day (~250,000-300,000) tons per year). It does not rely solely on Colorado-sourced material for this production, but it does take material that has been cleaned at Glass to Glass. OI-Windsor receives a 3-mix glass commodity from Glass to Glass, as well as glass that has been shipped via rail from other states, including deposit-collected glass from Oregon.

The facility only receives the 3-mix commodity from Glass to Glass (rather than color-separated commodities) as it is the smallest size commodity that Glass to Glass produces. OI-Windsor requires the smaller size material as the bottling plant assesses whether it can handle the level of plastic within the incoming stream. The smaller glass commodities are less likely to have plastic residuals at a level that the bottler is not able to process. OI-Windsor cannot accept plastic content that is greater than about 0.5% by weight of the incoming material. RMBC can accept a slightly higher level of plastic, and thus, RMBC receives the larger, color-separated streams, and O-I receives the 3-mix. This will be discussed in further detail in the following section focused on RMBC.

The OI-Windsor facility can accept as much as twice the volume of Colorado material without the need for additional capacity building. The challenges for OI-Windsor production are primarily related to contamination and the limited availability of clean material.

Rocky Mountain Bottling Company (RMBC), Wheat Ridge, CO. Co-owned by Owens-Illinois and Coors.

Rocky Mountain Bottling Company is a bottler in Wheatridge, Colorado. The facility produces between 650-850 tons of 12-oz beer bottles per day. RMBC receives color-separated glass and can produce various colors and types of beer bottles. It produces less volume of bottles than the OI-Windsor facility, however it takes in a greater proportion of the Colorado collected glass, relying on less glass from out of state.

The facility takes in color-separated, post-consumer recycled glass from the local Glass to Glass facility in Denver. The facility also has a smaller cleanup operation at the front end of the operation. This cleanup line is suitable for glass that has been collected in source-separated streams and cannot handle glass that has been collected single-stream and sorted at a MRF. The front-end cleanup does not have color sortation or ceramics detection. The glass arriving from drop-off programs is generally 95% pure. Due to the front-end cleanup operation, RMBC can handle a slightly higher tolerance of plastic in the incoming stream. The facility has similar challenges to OI-Windsor in that it can receive a greater volume of clean glass, but additional volumes of material are not available.

In 2017, the facility settled an air pollution claim with the U.S. Environmental Protection Agency (EPA). [9]

Exports

Due to the presence of recyclers and remanufacturers in Colorado, which can take more collected materials, there were no reported exports of recycled glass from Colorado.

2.2 ALUMINUM

There are no end markets in Colorado for recycled aluminum and thus must be sent out of state to end-use markets. MRFs can find aluminum end markets that are willing to pay for the transportation of the material, even though end markets are located in the southeast U.S. When sorting aluminum, MRFs mentioned the need to reduce their plastic content in aluminum bales as much as possible, below 4%. Ball Corp is a manufacturer within the state of Colorado that uses aluminum sheets with recycled content to manufacture beverage cans; however, their facilities do not accept raw recycled feedstock.

Table 4: Material Summary - Aluminum

	Recycler in State	Recycler Domestic – End Market Identified	Remanufacturer in State	End Market Outputs
Aluminum Cans	N	Y – Novelis, Alcoa	Y – Ball Corporation	Beverage containers, other aluminum packaging
Other aluminum packaging	N	Y	N	Aluminum sheet

Sorting and Summary of End Markets provided by MRFs

- Each of the MRFs interviewed or surveyed in Colorado accepts and bale aluminum cans in UBC bales.
- MRFs surveyed stated that they sell their aluminum material out of state.
- One Colorado MRF stated that they ship their aluminum material to Novelis for recycling (Grand Junction).
- One Colorado MRF stated they are shipping their aluminum material to the Midwest (Eagle).

[9] Rocky Mountain Bottle Company, LLC Settlement | US EPA

- Seven Colorado MRFs stated they send their aluminum bales out of state, while two MRFs did not provide information on their end market.
- Metals were the only material category in which all MRFs stated that transportation of their material is paid for by the buyer.
- All MRFs in Colorado accept and bale aluminum cans in UBC bales. Seven MRFs state they accept non-can aluminum, while two reject them.
- Two of the eight MRFs interviewed stated they follow ISRI specifications when sorting. Additionally, more emphasis was placed on plastic content within aluminum bales during the interviews. MRF operators stated that if there is more than 2% plastic within their bales, they can see a price downgrade from their purchasers. This 2% is separate from the industry standard for moisture within an aluminum bale, which is also to have less than 2%.

Recycling & Processing End Markets

As mentioned in the paragraphs above, there are no aluminum recyclers in Colorado. There are end markets for aluminum domestically, centered around the southeastern U.S. An end market identified (Novelis) is profiled below.

Novelis, Greensboro, Georgia.

Novelis is the world's largest aluminum recycler.[10] Novelis's main UBC recycling facility is in Greensboro, Georgia. The facility takes both automotive aluminum and aluminum beverage cans. As of 2012, the facility was recycling 1 million pounds of aluminum per day (~200,000 tons/year).[11] UBC bales have an industry standard of 2% moisture and should not have any non-target material; however, mills generally expect 2% of the content within bales to be non-target material (e.g., garbage, steel). To deal with moisture and non-target material, bales are shredded and dried, and non-target metals are removed with a magnet. Aluminum UBCs are then melted to become raw material. The facility will then create an aluminum ingot, which is transferred to a rolling mill to become an aluminum sheet.

Aluminum sheets are then sent for usage by the packaging industry. This includes can manufacturers such as Ball Corporation, which has a can manufacturing plant in Golden, Colorado.

Due to the relatively high prices of aluminum UBC bales, as compared to other commodities, specifications from end markets for aluminum bales can be very strict. Recyclers are not willing to pay such a high price per ton if there is too much non-aluminum material within a bale. One example of a contaminant that can lower the price of a UBC bale is PE film wrappings around aluminum containers. These wrappings are difficult to remove and can end up contaminating the UBC bale as they

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[10] Novelis-Sustainability-Report-2023.pdf

[11] Novelis builds on its footprint (ajc.com)

result in too high of a plastic proportion within the delivered commodity. Too many of these PET film wrappings within a UBC bale can result in a price decrease.

Plastics are a particular concern for aluminum recyclers, as they will get fed into the furnace along with the UBC material. Feeding plastic into the furnace can cause the furnace to overheat.

Re-Manufacturers

There are remanufacturing end markets in-state in Colorado for recycled aluminum, most notably Ball Corporation, which receives recycled aluminum sheets and produces aluminum beverage cans. These end markets take recycled material and produce new products.

Ball Corporation

Ball Corporation's beverage container manufacturing facility is located in Golden, Colorado. The facility receives post-consumer aluminum sheets from outside of Colorado, as there are no aluminum recycling facilities within Colorado. The facility then turns the post-consumer aluminum sheet into aluminum beverage containers to be filled by a third party.

Ball Corporation is one of the leading suppliers of aluminum beverage packaging in the world, with a focus on sustainability.[12] They produce aluminum packaging for beverages in Colorado[13], including:

- 12oz and 16oz beverage bottles.[14]
- 12oz and 19.2oz "standard" beverage cans/ 7.5oz, 8oz, and 12oz "sleek" beverage cans/ 5.5oz and 8.4oz "slim" beverage cans/ 24oz, 25.4oz, and 32oz "king" beverage cans/ 24oz capped cans/ 32oz "Crowler" cans.[15]
- Beverage ends and tabs.[16]
- Aluminum slugs.[17]

Ball recently sold its Broomfield Ball Metalpack site to Sonoco, which started as a joint venture between Ball and Platinum Equity in 2018 with the aim of producing sustainable packaging.[18] Their facilities in Colorado now consist of corporate and

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[12] https://www.ball.com/getattachment/03cb556b-9ace-4d8d-9b96-94c68079e06b/Ball-2021-Combined-Report.pdf

[13] https://www.ball.com/

[14] https://www.ball.com/packaging/beverage-bottles

[15] https://www.ball.com/packaging/beverage-cans

[16] https://www.ball.com/packaging/beverage-ends-tabs

[17] https://www.ball.com/packaging/aluminum-slugs

[18] https://www.prnewswire.com/news-releases/platinum-equity-and-ball-corporation-to-sell-ball-metalpack-to-sonoco-for-1-35-billion-301448119.html

packaging locations in Westminster[19] and Golden[20], Colorado. There is no data available on either location's production capacity. However, Ball has a goal of 85% recycled content for aluminum products by 2030[21] and are a potential end user for recycled aluminum streams in Colorado.

Exports

U.S. Census data shows that in 2021, Colorado exported just over 23,000 metric tonnes of aluminum waste and scrap, primarily to Asia. This data is not specific to packaging, so it is likely that this material is scrap metal and not UBCs or other aluminum packaging.

2.3 STEEL CANS

The MRFs interviewed or surveyed in Colorado accept and sort steel cans; however, there are no end markets for this material in Colorado. Steel cans are shipped to several integrated steel mills located in the Midwest to be melted together with other recycled steel. The buyers of material are paying for transportation of the material, enabling MRFs to economically find end markets.

Table 5: Steel Can Summary of End Markets

Material	Recycler in State	Recycler Domestic – End Market Identified	Remanufacturer in State	End Market Outputs
Steel Cans	N	Y – TMS International	Y - Sonoco	New tinplate, rebar, railroad equipment

Sorting

Steel cans are generally sorted and baled through MRFs within the state (MRF Survey). There are also a few steel scrap yards that will accept loose dropped-off cans as well, including:

- Atlas Metal & Iron in Aurora and Denver, Colorado[22] and Pacific Steel & Recycling, Grand Junction, Colorado.[23]

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[19] https://www.ball.com/our-company/colorado-campus

[20] https://www.bing.com/maps?osid=746fc6df-f160-452a-a133-f25d1d579c4a&cp=39.785746~-105.308105&lvl=12&imgid=a242c1fc-5fa9-451e-9d0c-67eba646af6b&v=2&sV=2&form=S00027

[21] https://www.ball.com/getattachment/03cb556b-9ace-4d8d-9b96-94c68079e06b/Ball-2021-Combined-Report.pdf

[22] Metals we Recycle | Atlas Metal (atlasmetalandiron.com)

[23] Pacific Steel & Recycling >> Home ~ Pacific Steel and Recycling (pacific-steel.com)

- Six MRFs stated that they sell steel outside of Colorado.
- Seven MRFs stated that the buyer pays for transportation.
- MRFs appear able to find out of state end markets for steel.

Recycling & Processing End Markets

Steel cans have limited recycling end markets within the state of Colorado. Steel cans that are collected in Colorado are generally sent out of state to be recycled.

While there are steel mills within the state of Colorado, such as Evraz Steel, they do not use steel or tin cans in their melting operations. Steel cans are generally sent to integrated mills for recycling rather than smaller "mini" steel mills, which might be using electric arc furnaces.

Because of the lack of integrated mills in Colorado, steel cans are shipped to the Midwest, where the integrated steel mills in the U.S. are located. One direct-to-market recycler states that the steel that is being sent to the Midwest is being converted into steel rods.[24]

With electric arc furnaces becoming more common, the number of integrated steel mills in the U.S. have declined over the past few decades, decreasing the number of common outlets for steel cans from Colorado.[25]

In 2022, there were nine integrated steel mills operating in the U.S.[26] [27] There appear to be two companies operating the integrated steel mills in the U.S.:

- United States Steel
- Cleveland-Cliffs Inc.

The integrated steel mills are located in the Midwest, with the closest in proximity to Colorado located in Granite City Steel Works in Granite City, Illinois.[28] This facility is owned by U.S. Steel and has two basic oxygen process (BOP) vessels, another term for integrated steel mills. The facility has a production capacity of 2.8 million tons per year. The facility is situated on the Mississippi River with a barge dock for imports and exports.

Below is a table of each of U.S. Steel's integrated mills.

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[24] How recycling works at the Gunnison County facility – The Crested Butte News

[25] The growth of EAF steelmaking - Recycling Today

[26] mcs2022-iron-steel.pdf (usgs.gov)

[27] U.S. Steel Plant Trump 'Saved' Slated to End Steelmaking Forever - Bloomberg

[28] About Us - Locations - www.ussteel.com

Table 6: U.S. Steel Flat-Rolled Operations Table - Mills[29]

Facility	Location	Annual Production Capability	Principal Products and/or Services
Gary Works	Gary, Indiana	7.5 million tons	Strip mill plate in coil, hot rolled and cold rolled sheets, tin mill products
Mon Valley Works	5 locations within Pennsylvania	2.9 million tons	Hot rolled, cold rolled, and coated sheets; Coke and Coke by-products
Granite City Works	Granite City, Illinois	2.8 million tons	Slabs and hot-rolled, cold-rolled and coated sheets

Additionally, Cleveland Cliffs runs the other integrated steel mills within the U.S., which are shown in the table below.

Table 7: Cleveland-Cliffs Integrated Steel Mills

Facility	Location	Annual Production Capability	Principal Products and/or Services
Burns Harbor[30]	Burns Harbor, Indiana	5 million tons	Hot-rolled, cold-rolled, and hot-dip galvanized coils and as-rolled and heat-treated plate
Cleveland Works[31]	Cleveland, Ohio	3 million tons	Hot-rolled, cold-rolled, and hot-dip galvanized sheet and semi-finished slabs
Indiana Harbor[32]	East Chicago, Indiana	5.5 million tons	Advanced high-strength steel (AHSS), American Petroleum Institute pipe skelp, motor laminations, automotive exposed and martensitic grades

[29] 2022-Annual-Report.pdf (d1io3yog0oux5.cloudfront.net)

[30] CLF_FactSheet_BurnsHarbor_082023.pdf (d1io3yog0oux5.cloudfront.net)

[31] CLF_FactSheet_Cleveland_032023.pdf (d1io3yog0oux5.cloudfront.net)

[32] Indiana Harbor :: Cleveland-Cliffs Inc. (CLF) (clevelandcliffs.com)

Facility	Location	Annual Production Capability	Principal Products and/or Services
Middletown Works[33]	Middletown, Ohio	3 million tons	Hot-rolled and cold-rolled carbon steels, electrogalvanized steels, hot-dip galvanized products, and aluminized carbon and stainless-steel sheets

Re-Manufacturing

Sonoco

Similar to aluminum, there are true end users of steel packaging in Colorado; however, they must source recycled content from out of state. Sonoco has its metal packaging headquarters in Broomfield, Colorado. Sonoco purchased this facility in 2021 from Ball Metalpack (a joint venture between Platinum Equity and Ball Corp).[34] Sonoco manufactures aerosol, food, and nutritional packaging products, including steel cans. Several smaller companies incorporate the steel and tin cans produced by Sonoco into their product line, such as Stephen Gould in Aurora, Colorado.

Western Steel Inc.

Western Steel Inc. is a family-owned business and is one of the largest metal suppliers in Colorado with 60,000 square feet of inventory. The facility is located in southeast Colorado Springs.[35] Western Steel Inc. produces steel and aluminum supplies, including angles, beams, channeling, flats, grating, expanded metal, piping, rebar, rounds, sheets, and tubing. They specifically source their materials from the U.S.[36]

There are multiple additional steel and/or metal product manufacturers and distributors in Colorado, which could equate to an end market for metal with demand and competition. Additional manufacturers include Brown Strauss Steel Inc. in Aurora[37], Ryerson Inc. in Commerce City[38], Altitude Steel in Denver[39], and various others.[40]

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33 CLF_FactSheet_MiddletownWorks_32023.pdf (d1io3yog0oux5.cloudfront.net)

34 Sonoco Agrees to Acquire Ball Metalpack (globenewswire.com)

35 https://www.westernsteelcs.com/about/

36 https://www.westernsteelcs.com/products/

37 https://brownstrauss.com/about-us/

38 https://www.ryerson.com/locations

39 https://altitudesteel.com/

40 https://www.thomasnet.com/colorado/steel-79740205-1.html

Exports

There aren't consistent volumes of steel foreign exports from Colorado. In 2022, 830 tons of tin waste and scrap were exported to Asia, while 13 tons were exported to Europe. No tin waste and scrap were reported as being exported in 2021, according to the U.S. Census Trade database, and only 33 tons were exported in 2020. It is likely some of the steel exports are inclusive of scrap, non-packaging steel.

2.4 FIBER

There are no fiber mills in Colorado. MRFs accept mixed paper and cardboard from municipal collections, as well as some commercial direct bales (e.g., fiber bales, which are baled at the source of collection and delivered to the MRF). MRFs tend to sort to #11 OCC and different variations of mixed paper bales. Because there are no end markets in Colorado, all fiber material is sold out of state, either to mills across the U.S. or some alternative end markets, such as insulation for higher grade or commercial direct materials. Smaller MRFs report using brokers (one of which is Centennial Recycling), while one larger MRF reported using majority direct sales and reserving 25% of the output for spot prices with brokers. The final destination of recycled fiber can depend on the strength of the market, and recent fluctuations in price have resulted in shifting where bales are sent, both domestically and abroad.

Table 8: Fiber Markets in Colorado

Grade	Recycler in State	Recycler Domestic - End Market Identified	Remanufacturer in State	End Market Outputs (in-state)
OCC	N	Y – Republic Paperboard, Applegate	Y	Tubes and cores
Mixed Paper	N	Y - Republic Paperboard, Applegate	Y	Tubes and cores
Office Paper	N	Y - Republic Paperboard, Applegate	Y	Tubes and cores
Polycoated Paper	N	Y – Great Lakes Tissues, Sustana, Wisconsin	N	N/A

Sorting and Summary of End Markets provided by MRFs

- The nine MRFs interviewed stated they accept OCC and mixed paper.
- The nine MRFs interviewed stated they sell OCC and mixed paper bales out of state.
- Four MRFs stated that their buyers pay for the transportation of material, while the four others said it varies. One did not respond.

- Two MRFs explicitly accept cartons, four implicitly accept them, and three explicitly reject cartons. Occasionally, MRFs have sorted a carton-only bale however, they are most frequently added to mixed-paper bales.
- Bales produced from single stream in Colorado seem to be a combination of a 54 or 56 mixed paper bale and a #11 OCC bale.
- MRFs also receive bales directly from commercial sources. When this occurs, MRFs can sell a sorted-office paper bale in addition to the OCC and mixed paper bales.

The specifications for each of these bales are shown below, along with the typical end product for each:

Table 9: ISRI Bale Specifications Mentioned for Fiber in Colorado[41]

Bale	ISRI Description	Prohibited Materials Limit	Outthrow limit	Potential End Product
# 11 OCC	Consists of corrugated containers having liners of either test liner or kraft	1%	5%	Recycled linerboard
# 54 Mixed Paper	Consists of all paper and paperboard of various quality not limited to the type of fiber content	2%	3%	Insulation, linerboard
#56 Sorted Residential Papers & News	Consists of sorted newspapers, mail, magazines, printing, and writing paper. Containerboard and brown grades will be considered "outthrows"	2%	3%	Containerboard, tissues, other paper grades
#58 Sorted Clean News (delivered from commercial sources)	Consists of sorted newspapers from source-separated collection programs, converters, drop-off centers, and paper drives. May contain inserts that would normally be included in the newspaper in the proper proportions	0.5%	1.5%, 10% of other papers	Containerboard, tissues, other paper grades

[41] ISRI-Scrap-Specifications-Circular-updated-1.pdf (isrispecs.org)

Bale	ISRI Description	Prohibited Materials Limit	Outthrow limit	Potential End Product
# 37 Sorted Office Paper	Consists of paper, as typically generated by offices, containing primarily white and colored groundwood-free paper.	1%	5%	Tissues

It could not be confirmed whether all lower grades of paper were exported rather than recycled domestically.

There are currently limited end markets for polycoated paper (e.g., cartons, waxed paper), and only two MRFs who participated in the Element 6 study state that they explicitly accept cartons. Mills often view polycoated paper as a contaminant, as it is difficult to release the fibers from the plastic lining. One MRF mentioned they occasionally produce a carton-specific bale; however, this material will primarily be sorted into mixed paper bales. MRFs will need a dedicated polycoated end market to begin accepting this material. There are currently limited end markets that take cartons for purposes other than being filler material with other fibers.

Material quality challenges include sun-bleaching of fibers, resulting in degraded material. This is caused when fiber is stockpiled and stored outdoors in anticipation of potential market changes. Additionally, if stored outside, precipitation can impact the bale quality as the moisture content increases.

Recycling & Processing End Markets

There are no paper mills or other recycled fiber end markets within Colorado. This means that all fiber that is collected and sent for recycling must leave the state to find an end market. Fiber leaves the state to become both new packaging and paper products, as well as alternative outputs like cellulose insulation.

While all material is shipped out of state and no end markets were given as an end market by Colorado MRFs or brokers, the end markets are likely to be a combination of the facilities listed below in this report section. OCC appears to have markets that are slightly closer to Colorado, while mixed paper outlets are around the southeast U.S. and Midwest.

Additionally, some stakeholders mentioned that single-stream recycling makes the range of potential end markets narrower for fiber.

International Paper, Cedar Rapids, IA

International Paper Company is the largest containerboard manufacturer in the United States[42]. They have two facilities, which are potential end markets for fiber collected in Colorado.

The second IP mill within potential shipping distance of Colorado is its Cedar River mill in Cedar Rapids, Iowa. The Cedar River facility has a capacity of just over 1 million tons.[43]

International Paper states they receive OCC, mixed, and white paper through their 16 recycling facilities, one of which is in Salt Lake City, Utah. These recycling facilities do not actually convert the collected fiber into new products but are the location of baling before shipping material to a recycling outlet like a mill.[44] The materials that are reaching the containerboard mills to be recycled are most likely OCC with some mixed paper. The products sold from recycled material from International Paper are recycled linerboard and recycled medium. IP states that 80% of its production is converted into corrugated packaging by its North American corrugated packaging plants.[45] The remainder of the board is sold on the open market, with about half staying in domestic markets. No information was found on yields.

Greif, Santa Clara and Los Angeles, CA

Greif has two paper mills in California. One in Santa Clara and one in Los Angeles. The Santa Clara mill produces recycled paperboard. The Los Angeles mill produces recycled containerboard. Greif states that its recycled paperboard is made from OCC, recycled newspapers, and recycled boxboard clippings.[46] The containerboard is produced from OCC and recycled boxboard.[47]

Direct products from the Santa Clara mill are:

- Recycled corrugated medium.
- Recycled WS medium.
- Recycled HP Medium.
- Recycled HS WS medium.
- Recycled linerboard.
- These outputs are primarily used for conversion into corrugated boxes for transporting goods.

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[42] roadshow-handout_external_website.pdf (q4cdn.com)

[43] Ibid.

[44] 2022 Annual Report.pdf (internationalpaper.com)

[45] ibid

[46] https://investor.greif.com/static-files/2e60b604-b95f-49d9-a7ec-0da34e1ffcef

[47] https://www.greif.com/product/crb/

Outputs from the Los Angeles paperboard mill include:

- Coated Kraft Back.
- Uncoated boxboard.

Coated recycled paperboard is used for book covers, magazines, and other glossy finished printing applications. Uncoated paperboard is used for packaging purposes.

No details were found on the capacities or yields of these two mills.

Republic Paperboard Company, Lawton, OK

Republic paperboard company is in Lawton, Oklahoma. It is the closest mill identified to Denver (500 miles) that takes recycled fiber as feedstock. The mill takes OCC, unprinted newspapers, and lightly printed office paper as feedstock. These are higher quality fibers and do not include the lower grade mixed residential papers. Republic Paperboard Company has a listed capacity of 275,000 tons. The process at Republic includes cleaning feedstock with coarse screens for plastics, dirt, and metal. The material is then screened for finer contaminants, refined, and formed into a paper sheet. The outputs of the process are paper rolls that are generally gypsum wallboard face or backliner. Outputs from the facility go into either container markets or the construction industry. No information was found on yield.

Smurfit Kappa – Forney, TX

Smurfit Kappa's Forney, Texas mill creates kraft linerboard and kraft medium from recycled fibers. The mill takes in primarily corrugated packaging. [48] In 2012, the mill had a production capacity of 300,000 metric tonnes.[49] The facility receives OCC.

Liberty Paper Incorporated, Becker, MN

Liberty Paper Incorporated is a paper recycling facility that produces linerboard to be converted into boxes by their partner packaging facility, Liberty Carton. The main input for the recycling system is OCC. The facility has a feedstock of 220,000 tons of OCC per year. [50]OCC bales are first brought into a "hydra pulper" which cleans the bales of contaminants. The fiber material is then mixed with water, and a slurry is created. The slurry then gets fed through additional cleaning via screens and a "cyclone," which separates pieces of plastic using a centrifuge, where the plastic pieces float to the top, and the heavier fiber strands sink to the bottom. The slurry then gets pulped and sent through a paper machine to produce two-ply sheets. At this point, paper can be sent to box plants, including Liberty's own Liberty Carton facility.

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[48] Smurfit_Kappa_Sustainable_Development_Report_2022.pdf (smurfitkappa.com)

[49] Smurfit Kappa_Sustainable_Development_Report_2012.pdf (SECURED)

[50]

Pratt Industries

Pratt Industries has a mixed-paper recycling mill in Shreveport, Louisiana. One broker in Colorado mentioned this facility; however, it was not clear how much material is sent from Colorado to this facility. The facility accepts mixed paper and produces recycled containerboard.

Georgia-Pacific – Muskogee, OK

Georgia-Pacific's mill in Muskogee, Oklahoma, produces tissue paper for napkins, paper towels, and toilet tissue. The facility accepts mixed paper as feedstock and, in 2020, began accepting PE-lined paper cups within the mixed paper bales.[51] In May of 2022, Georgia-Pacific announced it planned to upgrade this facility and invest $50 million in new equipment.[52] The mill employed 700 people as of October 2023.[53] The facility has an estimated capacity of 435,000 tons of input material.[54]

Westrock – Dallas, TX

Westrock has a coated recycled paperboard mill in Dallas, Texas, which accepts mixed paper.[55] The facility has an annual production capacity of 127,000 tons.[56] Westrock also has the following coated recycled paperboard facilities, which are further from Colorado:

Table 10: Select Westrock Recycled Paperboard Mills[57]

Mill Location	Annual Production Capacity of Recycled Paperboard
St. Paul, MN	170,000
Battle Creek, MI	160,000
Guadalajara, MX	123,000
Stroudsburg, PA	80,000
Shelton Springs, VT	111,000

Greenfiber – Salt Lake City

Greenfiber is a cellulose insulation manufacturer that sources its raw materials from post-consumer recycled fibers. One multi-stream MRF on the western side of the

[51] Georgia-Pacific Is Recycling 'Impossible To Recycle' Single-Use Cups (forbes.com)

[52] $50 million Investment in Georgia-Pacific's Muskogee Mill | Georgia-Pacific News (gp.com)

[53] $50 Million Transformation in the Works at Muskogee | Georgia-Pacific News (gp.com)

[54] Georgia-Pacific Tissue Mill in Muskogee, OK, Back up after May 13 Ffire (naylornetwork.com)

[55] The+State+of+Paper+Cup+Recycling+-+Moore+and+Associates+2022.pdf (squarespace.com)

[56] 2023-Annual-Report-and-2024-Proxy-Statement.pdf (q4cdn.com)

[57] Ibid

Rocky Mountains confirmed that they send their mixed residential paper to Greenfiber as its primary end market. While not listed exactly what types of recycled fibers Greenfiber sources, it is likely to be bale grades other than OCC.

Re-Manufacturing

While the mills mentioned in the recycling & processing section could be considered true end markets for new fiber material, there are a few companies within Colorado that may utilize the recycled fiber from these mills.

Neway Packaging Corp.

Neway Packaging Corporation is a provider of industrial and commercial packaging products with a full-service facility located in Commerce City.[58] Their products are comprised of mostly paper, cardboard, and flex film packaging solutions.[59] Neway offers products made from recycled content, such as recycled natural Kraft carton sealing tape with a water-activated adhesive that contains at least 50% recycled fibers, and has made other efforts in providing clients with more sustainable cardboard and paper packaging options.[60] This presents a possible end-user for paper and corrugated fibers, which already has the capability to process recycled content. However, potential volumes of recycled material are difficult to quantify as there is no data available on their current production or inventory capacity.

Greif Packaging Corp.

Greif has a tubes and cores manufacturing facility located in Denver, Colorado. Greif uses recycled paperboard for some of its tubes and cores. Tubes and cores, which are made of recycled paperboard, are used in tape, carpet, and gift-wrapping applications.

Exports

U.S. Census trade data reports that about 16,500 tons (15,000) metric tonnes of waste and scrap of paper or paperboard (including OCC) was exported to Asia in 2021. This is 4% of the total diverted paper and cardboard tonnage, which the Colorado Department of Public Health and Environment (CDPHE) reported for Colorado in 2021 (427,000 tons).[61] The 16,500 tons may also include some pre-consumer material as well.

Exports for wastepaper have dropped 80% since 2015, with the most dramatic decrease occurring around 2018 when China instituted a waste paper import ban.[62]

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[58] https://www.newaypkgshop.com/aboutus/areas-we-serve

[59] https://www.newaypkgshop.com/catsearch/1/root/

[60] https://www.newaypkgshop.com/blog/37/why-partner-with-an-environmentally-conscious-packaging-company

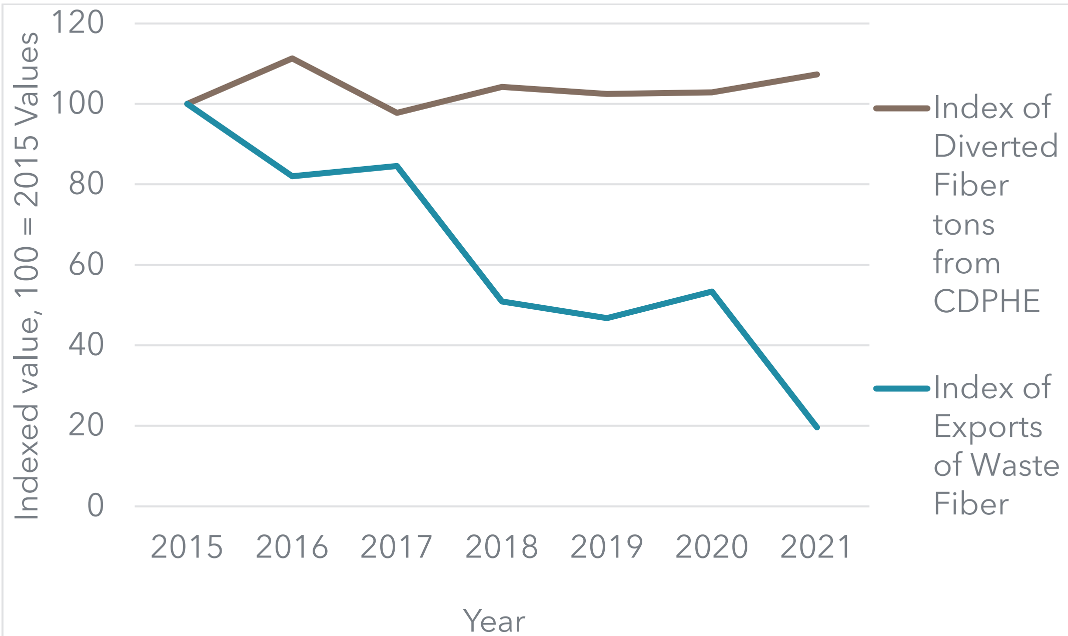
[61] 2021 Colorado recycling totals | Department of Public Health & Environment

[62] The Chinese Banned Our Recyclables: What Happened Next (waste360.com)

Rather than getting exported to other countries to be recycled, fibers have found domestic outlets from Colorado.

The chart below shows the comparison of diverted paper material reported by CDPHE since 2015 with the weight of waste and scrap of paper or paperboard exported from Colorado over the same period. The values have been indexed to 2015 (i.e., 2015 = 100 for both diversion and exports) to align the scale of each data point.

Figure 1: Comparison of Colorado-Asia Wastepaper Exports with Colorado Diverted Tons over time



The figure above shows that while the total quantity of fiber diverted has remained around the same since 2015, the quantity of waste fiber exports over the same time has dropped by 80%. It would appear then that the decrease in exports to Asia is not due to lower levels of fiber being collected for recycling but rather a shift in collected fiber being sent to domestic markets for recycling.

2.5 PLASTICS

There are no end markets for post-consumer plastic in Colorado. The exception is when material is collected using a multi-stream (3+ stream) collection system. Direct Polymers accepts some material that is collected in multi-stream. Plastics are generally shipped to end markets in the southeast U.S. for recycling. The remanufacturing sector within Colorado is also very limited for plastics currently; however, this could be changing in the future for PET bottles.

Table 11: Summary of Post-Consumer End Markets for Plastic

Material	Recycler in State	In State End market	Domestic End Market – End Market Identified	Remanufacturing Output
#1 PET	N	N	Y – Mohawk, Indorama	Mohawk has vertical integration of PET to carpet recycling
#2 HDPE	N	N	Y – KW	KW produces pellets for the automotive, paint container, and packaging industries
#3 PVC	N	N	N	N/A
#4 LDPE Rigid	N	N	Y – KW up to 20% of bale	KW produces pellets for the automotive, paint container, and packaging industries
#5 PP	N	N	Y – KW	KW produces pellets for the automotive, paint container, and packaging industries
#6 PS	N	N	Y – but not sourced from Colorado MRFs	N/A
#7 Other	N	N	N	N/A
PE Film	N	N	Y – Natura PCR, EFS (Pennsylvania), commercial only	Recycled plastic
Multi-Material Film	N	N	N	N/A

Sorting and Summary of End Markets provided by MRFs

There are virtually no end markets for post-consumer residentially collected material in Colorado. The one end market for material in the state mainly accepts industrial feedstock; however, it has also accepted source-separate post-consumer plastics from multi-stream programs. The end market has said it is preparing a line for post-consumer material, particularly for colored HDPE and PP. This line would be between 20-50 million lbs per year.

- Six of the MRFs interviewed stated that post-consumer plastic material is sold out of state, one MRF stated they sell material in-state, and two MRFs did not respond.
- All MRFs accept PET bottles explicitly. 5 MRFs either explicitly or implicitly accept clear PET thermoforms, while four explicitly reject them.
- The cost to run non-bottle PET plastics through a recycling facility is high, when accepted PET thermoforms are therefore baled together with bottles. MRFs did not provide a tolerance for PET thermoforms with their PET bales; however, one large PET bottle recycler stated that, on average, they received about 10% thermoforms in their bales.
- MRFs that take multi-stream material are able to sell certain plastics, primarily rigids #2-#5, to local markets. These MRFs can send mixed tubs and lids (HDPE, PP) to local end markets in the state. All other post-consumer plastic from MRFs is sent out of state for recycling.
- Flexible plastics are not accepted by the MRFs interviewed. One MRF stated that a recycler in Houston accepted flexible plastics but requires them to be separated by resin, which may not be economically viable in Colorado due to volumes that could be accepted at the MRFs. Direct Polymers accept some commercial flexible plastics (grocery chains, agriculture, PVC films from medical fields) but focus on pre-consumer scrap.
- MRFs stated that #6 PS does not have markets and, therefore, is not accepted by any of the nine MRFs surveyed.
- For smaller sorting facilities, brokers are used to find end markets.
- MRFs reported either sorting to ISRI standards or end-market specifications. KW is the largest PP and HDPE recycler in the U.S. and dominates the market for this reclaimed material. KW takes sorted HDPE and PP packaging in multiple forms. because they take in so much PP and HDPE from across North America, it is likely that Colorado MRFs are sorting to similar specifications as shown below, no data from MRFS could confirm this.

Table 12: KW Bale Purchase Specifications[63]

Bale	Contamination limit	Other Limits
HDPE Natural Bales	Greater than 2% non-plastic material	Not mentioned
HDPE Pigmented Bales	Greater than 2% non-plastic material	No more than 4% automotive oil containers. Any insecticide or chemical bottles.
HPDE Bulky Rigid Bales	Greater than 2% non-plastic material	More than 4% of the bale weight of plastic not of the specified type

[63] Scrap Plastic Buyers | HDPE Scrap | PP Scrap - KW Plastics

KW's PP bale purchase specifications are shown below:

Table 13: KW PP Bale Purchase Specifications

Bale	Contamination limit	Other Limits
PP tubs, Lids & Bottle Bales – Food Grade only	Greater than 2% non-plastic material	Accept up to 20% LDPE. No more than 5% of bale weight of plastic not of specified type. No non-food grade PP.
PP Bulky Rigid Bales	Greater than 2% non-plastic material	No more than 4% of bale weight of plastic not of specified type

Recycling & Processing End Markets

Like other materials aside from glass, there are limited end markets within Colorado for post-consumer plastics. Post-consumer plastic is currently being shipped out of state. Direct Polymers states that in Colorado, there is a lot of warehousing and distribution of products but very little manufacturing of those goods.

Additionally, some MRFs have received funding for taking on the separation and sortation of flexible plastic.[64] First Star Fiber's Integrated Plastic Waste Management System creates a vertically integrated plastic pre-processing, plastic remanufacturing, and additional bolt-on plastic manufacturing. This process produces plastic lumber as its output.

Even in cases where recycling is collected through very specific source separation, such as the municipality of Gunnison, Colorado, which has seven-stream recycling, plastics #3-7 are having difficulty finding end markets. This suggests that even when collected in systems that produce higher quality material, rigid #3-7s are still lacking end markets.

Common end markets in the U.S., and some mentioned by stakeholders in Colorado, include Mohawk Industries and KW Plastics, located in Georgia and Alabama, respectively.

Mohawk Industries – Summerville, GA – PET

Mohawk has a facility in Summerville, GA, which receives collected PET bottles and turns them into fibers for carpeting. The facility processed 6.6 billion bottles of PET in 2019.[65] The facility uses MRF bales and source-separated PET. The facility receives both clear and colored PET bottles.[66] Bales are broken and cleaned to remove contaminants like flexible plastics, metals, and glass. The bottles are separated into

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[64] Plastic Innovations – First Star Recycling

[65] Major PET recycler reports worsening carpet sales (resource-recycling.com)

[66] Live Exploration: Reduce, Reuse, Recycle | Georgia Public Broadcasting (gpb.org)

clear and green streams before they are flaked and washed. The flakes are then washed and put into a sink-float separation. Flakes are separated into three color streams:

- Clear
- Green
- Mint

Clear flakes are used for light-colored carpets, while mint and green are used in darker-shaded carpets. Bottle caps that are made of PP are accepted by the facility and used for the backing of carpets.

KW Plastics – Troy AL – HDPE and PP

One of the largest mechanical recyclers in the US, KW Plastics in Alabama, takes in most of the HDPE packaging in the United States.

KW takes in this material and produces six different recycled HDPE resins, which vary based on their color and physical properties. The six different HDPE resins KW produces are shown in **Table 14**.

Table 14. Resin codes for KW Plastics

Resin Code	Resin Description	Characteristics	Applications
KWR101-150	Natural Homopolymer HDPE Resin	Natural color, high stiffness, impact resistance	Blow molding, extrusion, blown film
KWR102	Mixed Color Copolymer HDPE Resin	Good impact strength, includes 7% PP	Not given
KWR102-8812	Copolymer HDPE Resin, pre-colored black	High strength, stiffness, pre-colored dark black	Large part blow molding and extrusion, approved for Chrysler, Ford Motors, General Motors, Toyota, Hyundai, Kia, Mistubishi, Nissan vehicles
KWR105-7252	Copolymer HDPE Resin	Good impact strength	Injection molding
KWR105M2	Copolymer HDPE resin	"Superior toughness", available as mixed color and pre-colored black	Injection molding
KWR105M4	Copolymer HDPE Resin	"Exceptional toughness", mixed color and pre-	Injection molding

Resin Code	Resin Description	Characteristics	Applications
		colored black, 15% PP.	

Of the resins shown above, three are for injection molding, two for blow molding and extrusion, and one does not list its applications. As KW Plastics has most of the market share in the US, most of the HDPE packaging prepared for recycling is likely going into one of these six different types of resins.

Like HDPE rigid packaging, a majority of sorted PP rigid packaging is recycled by KW plastics. KW has a letter of no objection (LNO) from the US Food and Drug Association (FDA) for one of its recycled PP pellets. However, KW requires PP to be sorted out from the rest of a rigid #3-7 bale before it accepts the material. PP packaging, therefore, must either be sorted into its own commodity at the MRF to be accepted by KW, or a third party would be required to separate the PP from a rigid #3-7 bale. KW plastics had a rigid PP capacity of about 250,000 tons. [67]

Re-Manufacturing

The current state of plastic manufacturing with recycled content in Colorado is limited. However, there are a few planned projects which could influence additional end markets in the state.

Swire CocaCola

Swire Coca-Cola is a subsidiary of Coca-Cola and distributes beverages throughout Colorado. It currently has various facilities in the state.[68] Swire's Colorado Springs sales facility has a warehouse with the capacity to store 200,000 cases of Coca-Cola beverages.[69] Swire Coca-Cola is seeking to develop a bottling facility via a 75-year ground lease on Denver International Airport (DIA) land.[70] The Denver City Council approved the lease as proposed in an April 5 meeting this year.[71]

Coca-Cola Company reportedly used 25% of recycled material in their packaging globally, with 15% of PET used being rPET in 2022, and has goals surrounding the reduction of virgin material generation by 2025.[72]

Both Swire Coca-Cola and PepsiCo have announced plans to open bottling plants within Colorado. The plastic used in these operations would be PET. While neither of

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[67] Committed to reinvestment - Recycling Today

[68] https://www.swirecc.com/Colorado

[69] https://www.swirecocacola.com/newsletter/en/2022-01/Corporate/Bigger-Greener-Facility-In-Colorado-Springs.html

[70] https://www.denverpost.com/2023/04/01/coca-cola-bottling-plant-denver-airport-dia/

[71] https://denverite.com/2023/04/17/coca-cola-could-soon-land-a-new-bottling-plant-at-dia/

[72] https://www.coca-colacompany.com/content/dam/company/us/en/reports/coca-cola-business-sustainability-report-2022.pdf#page=38

these companies produce plastic bottles themselves, it could incentivize the establishment of a bottle manufacturer in the state to feed both facilities.

For other rigid plastics, there are very limited potential end users in the state.

Exports

Census data reports relatively small quantities of waste plastic exported from Colorado. In 2021, the data shows only 300 tonnes of plastic were exported. This is 1% of the total plastic material CDPHE reported as diverted in 2021.

Similar to paper, recovered plastic exports have decreased over the past half-decade in Colorado. In 2014, 11,000 tonnes of waste plastic waste were exported to Asia. Over seven years, exports have decreased by 97%.

No plastic waste in the census data was exported to Mexico or Canada.

3 APPENDIX OF FACILITIES

Table 15: Appendix of Profiled Facilities

Facility	Operator	County	State	Feedstock - High Level Material Category	Feedstock - Detailed Material Category	Facility Point in Supply Chain	Capacity (tons/year)	Throughput (tons/year)	Facility Output
International Paper Company - Cedar River	International Paper Company	Cedar Rapids	Iowa	Paper	OCC, mixed paper	Paper mill	1 million	300,000	Containerboard
Greif Packaging - Santa Clara	Greif Packaging	Santa Clara	California	Paper	OCC, boxboard	Paper mill	Not found	Not found	Containerboard, linerboard
Greif Packaging - Los Angeles	Greif Packaging	Los Angeles	California	Paper	OCC, newspapers, boxboard clippings	Paper mill	Not found	Not found	Paperboard
Republic Paperboard Company	Republic Paperboard Company	Comanche	Oklahoma	Paper	OCC, unprinted newspapers, lightly printed office paper and forms	Paper recycling facility	Not found	275,000	Gypsum wallboard face and back liner.
Smurfit Kappa Forney Mill	Smurfit Kappa	Kaufman	Texas	Paper	Waste paper	Paper Mill	Not found	Not found	Kraft linerboard and kraft medium
Liberty Paper	Liberty Paper	Hennepin	Minnesota	Paper	Primarily OCC, some other fibers	Paper recycling facility	Not found	220,000	Containerboard, linerboard
Applegate/Greenfiber	Greenfiber	Salt Lake	Utah	Paper	Waste paper	Paper recycling facility	Not found	Not found	Cellulose insulation
Georgia Pacific - Muskogee	Georgia-Pacific	Muskogee	Oklahoma	Paper	Mixed Paper	Paper Mill	435,000	Not found	Tissue paper

Facility	Operator	County	State	Feedstock - High Level Material Category	Feedstock - Detailed Material Category	Facility Point in Supply Chain	Capacity (tons/year)	Throughput (tons/year)	Facility Output
Westrock - Dallas	WestRock	Dallas	Texas	Paper	Mixed Paper	Paper Mill	Not found	127,000	Coated paperboard
Glass to Glass Inc.	O-I	Denver	Colorado	Glass	MRF glass	Glass recycling facility	80,000-100,000	30,000-40,000	Color separated and mixed glass cullet
Rockey Mountain Bottling Company	O-I, Coors	Jefferson	Colorado	Glass	Color separated cullet	Remanufacturer	Potentially double current throughput	250,000	Glass bottles for beverage industry
OI-Windsor	O-I	Larimer	Colorado	Glass	3-mix cullet	Remanufacturer	Potentially double current throughput	300,000	Glass bottles for beverage industry
Novelis - Greensboro	Novelis	Larimer	Colorado	Aluminum	UBCs	Aluminum recycling facility	Not found	200,000	Aluminum sheet ingot
Ball - Golden Colorado	Ball Corp.	Jefferson	Colorado	Aluminum	Aluminum sheet	Remanufacturer	Not found	Not found	Aluminum beverage cans
Burns Harbor	Cleveland-Cliffs	Porter	Indiana	Steel	Steel	Integrated steel mill	5 million	Not found	Coils, steel plate
Cleveland Works	Cleveland-Cliffs	Cuyahoga	Ohio	Steel	Steel	Integrated steel mill	3 million	Not found	Sheet
Indiana Harbor	Cleveland-Cliffs	Burns	Indiana	Steel	Steel	Integrated steel mill	5.5 million	Not found	High strength steel
Middletown Works	Cleveland-Cliffs	Butler	Ohio	Steel	Steel	Integrated steel mill	3 million	Not found	Carbon steel, stainless steel sheets
Gary Works	U.S. Steel	Lake	Indiana	Steel	Steel	Integrated steel mill	7.5 million	Not found	Sheet plate, tin mill products
Mon Valley Works	U.S. Steel	Various	Pennsylvania	Steel	Steel	Integrated steel mill	2.9 million	Not found	Coated sheets

Facility	Operator	County	State	Feedstock - High Level Material Category	Feedstock - Detailed Material Category	Facility Point in Supply Chain	Capacity (tons/year)	Throughput (tons/year)	Facility Output
Granite City Works	U.S. Steel	Madison	Illinois	Steel	Steel	Steel recycling facility	2.8 million	Not found	Coated sheets
Mohawk - Summerville	Mohawk	Chattanooga	Georgia	Plastic	PET	Plastic recycling facility & manufacturer	Not found	6.6 billion bottles	Recycled flake for carpetting
KW Plastics	KW Plastics	Pike	Alabama	Plastic	HDPE, PP	Plastic recycling facility	250,000	Not found	Pellets

COLORADO NEEDS ASSESSMENT

ELEMENT 10: NEW TECHNOLOGY

JANUARY 25, 2024

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TABLES

FIGURES

The Needs Assessment was undertaken according to Colorado's Producer Responsibility Program for Statewide Recycling. Any views expressed in this document do not necessarily reflect the views or positions of Circular Action Alliance's members.

1 EXECUTIVE SUMMARY

1.1 PURPOSE

This report aims to evaluate recycling solutions in North America and across the globe to identify opportunities for technologies that can expand or improve the collection, sorting, and processing of materials covered under the Colorado Extended Producer Responsibility (EPR) legislation. The processing technologies identified in this report are at the commercial stage. This means that the equipment or system has been in service at several operating facilities long enough to have gone through several operation cycles and proven it can reliably achieve the anticipated level of performance. While development risk is never eliminated, the risk of technology failure drops substantially once commercial operation is reached. Innovative collection and reuse options have also been identified to improve Colorado's existing recycling system.

A discussion of existing material recovery facility (MRF) infrastructure in Colorado is included in the **Element 6 Technical Memorandum**.

1.2 APPROACH

The project team developed a list of MRF and Collections technology that not all facilities or haulers are utilizing in Colorado for consideration as part of this Needs Assessment. These technology gaps were determined through the surveys and site visits conducted in **Element 2 and Element 6 Technical Memorandums**. The project team contacted various reputable vendors for technology information, commercial availability, and cost estimations.

Many of the technologies identified below were used in the **Element 7 Technical Memorandum** as part of understanding how the current infrastructure in Colorado could be maximized to increase processing capacity, expand materials accepted, and reduce the impact of contamination. It is important to note that the technologies employed may be different based on the type, size and throughput of each MRF.

1.3 FINDINGS

- Improved MRF technologies, such as optical sorting, glass cleanup systems, screening technology, robotics, artificial intelligence (AI), and fire detection systems, can optimize the efficiency and safety of existing MRFs. These technologies can also improve the quantity and quality of output materials and reduce contamination.
- New MRF technologies have the potential to expand the types of material accepted and adapt to changing feedstocks over time.
- As glass has a local end market in Colorado, glass cleanup systems may be a priority. Some existing facilities complete some glass cleanup, but improved

equipment could potentially achieve an 80-90% glass yield. This additional cleanup equipment would assist MRFs in removing fines (small glass pieces that are difficult to recover, grit, gravel, etc.), shredded paper, and other light material that normally contaminates the glass before selling to the end market.

- Fire detection systems can protect processing capacity at existing MRFs. Current systems and practices may be reviewed to ensure they adequately protect against risks.
- Collections advancements such as contamination software, routing software, automated collection, and scheduling tools all improve data collection, route efficiency, and worker safety.

1.4 SCENARIO CONSIDERATIONS

- **[Note: The scenario considerations will be refined upon finalization of Scenarios. This draft-final list will be modified as needed.]**

2 PROCESSING TECHNOLOGIES

2.1 IMPROVED MRF TECHNOLOGIES

Improved MRF technologies can optimize the efficiency of a MRF by improving the quantity and quality of output materials and reducing contamination. The composition of packaging materials that MRFs need to process has rapidly changed which necessitates the need for technologies and processes in the MRF to adapt. The consideration of new technologies includes the ability to develop of new materials markets; improve yield rates and the quality of outputs; and the need to sort new material, formats, sizes, and colors.

The technologies described in **Section 2.1** of this memo are included in the current system expansion opportunities and costs in the **Element 7 Technical Memorandum**. The technologies assessed provide potential opportunities to improve outputs and increase the types of materials that can be recycled in Colorado. Of the MRFs surveyed in this Needs Assessment, six (6) are single stream and three (3) are dual stream. While dual-stream facilities tend to produce cleaner products, resident participation rates are typically higher in areas with single-stream collections. The types of technologies used at a single stream MRF will often differ from a dual stream MRF.

Nearly all the MRFs in Colorado have one or more robotic sorters. Still, additional robot and artificial intelligence (AI) technology can be leveraged to minimize residuals and increase materials accepted at a MRF. Facilities can conduct site-specific assessments to identify quality control locations where robotics and AI might be employed to increase recovery rate and product quality. AI can provide additional information to the facility operators useful for facility management. Adding robotics also supplements labor, where some facilities might be short-staffed.

As glass has a local end market in Colorado, glass cleanup systems may be a priority. Some existing facilities complete some glass cleanup, but improved equipment could potentially achieve an 80%-90% glass yield. This additional cleanup equipment would assist MRFs in removing fines (small glass pieces that are difficult to recover, grit, gravel, etc.), shredded paper, and other light material that normally contaminates the glass before selling to the end market.

Fire protection systems can protect processing capacity at existing MRFs. Current systems and practices may be reviewed to ensure they adequately protect against the possible risks. Options to improve safety at the presort location could also be considered. Customer education on materials that can cause safety hazards in the MRF could protect against some hazards. Additional education information is included in the **Element 12 Technical Memorandum**.

The following MRF technologies, together or independently, can be added to an existing MRF or considered for a new MRF to adjust to current and future material streams. Equipment and retrofit estimates are provided in **Table 1** below, also found in **Element 7 Technical Memorandum**. The retrofits are part of the required facility upgrades for installing the equipment, which may require re-arranging conveyors and other existing equipment to fit or modifying a building with extra concrete or bolted steel plates to support the new equipment. The cost estimates do not consider structural changes to the building, if any may be necessary. The investments for each facility will be vary based on each MRFs individual needs. These technologies are described in further detail in the sections throughout this memo.

Table 1: MRF Equipment and Retrofit Estimates

Capital Upgrades	Equipment Cost (Procured and Installed)	Total Facility Retrofit Cost (Equipment and Required Facility Upgrades)
Auger Screen	$250K	$1M
OCC Screen (per deck)	$500K	$1M
Ballistic Screen (3 sort)	$500K	$1M
Paper Screen	$350K	$550K
Additional Conveyor Changes w/ Screens	-	$100K-$200K
Eddy Current Separator	$200K	$350K
Magnets	$150K	-
Optical Sorter - Container Line, ea.	$500K	$1M
Optical Sorter - Fibers Line, ea.	$1M	$1.75M
Optical Sorter - Residue Line	$500K	$1M
Robotics Sorter	$300K	$325K-$500K
Baler (small)	$600K	-
Baler (large)	$1M	-
Incidental Recovery System (Film)	$300K	$500K
New Full Recovery System (Film)	$500K	$1M
Glass Cleanup System	$300K-$750K	$600K-$1M
Early Fire Protection Systems (4 or 8 thermal cameras)	$70K-$125K	-

Capital Upgrades	Equipment Cost (Procured and Installed)	Total Facility Retrofit Cost (Equipment and Required Facility Upgrades)
Controls Upgrades[1]	-	$1.5M-$2M

2.1.1 Optical Sorting

Optical sorters are a common technology found at MRFs. Optical sorters use reflected light and high-tech sensors to analyze products based on their composition, shape, size, color, and damage. Materials are then sorted to their appropriate locations, as shown in **Figure 1.** Optical sorters have historically been used to sort plastics, and sometimes metals, at MRFs. However, more innovative optical sorters, sometimes integrated with AI, are used for sorting fibers, glass, cartons, organics, e-scraps, C&D recycling, and other applications.[2]

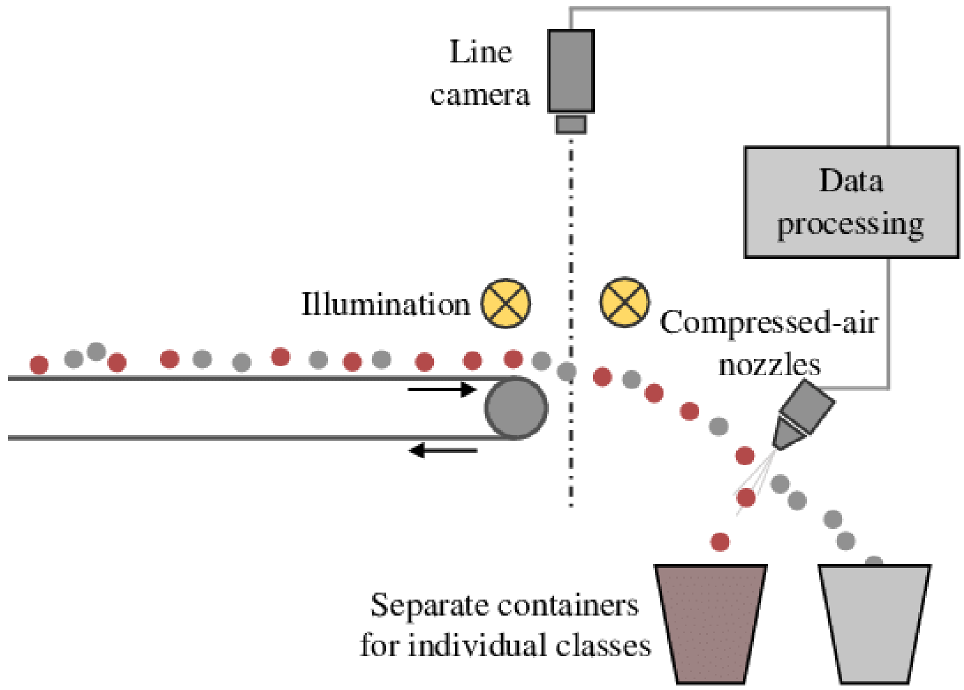
Many optical sorters in Colorado are older and may not have the same performance of newer versions. Upgrading them with newer technology, as well as coupling optical sorters with AI and robotics technology, can have a positive impact on the overall recycling system at a MRF. Companies such as TOMRA, Machinex, and AMP Robotics have developed advanced optical, AI, and robotic sorting systems to detect and sort targeted materials.[3] More information on Robotics and AI can be found in **Section 2.1.4**.

[1] Includes cost of downtime for 3 months. Controls upgrades may include technology enhancements regarding keypads, cloud-based systems, data collection, performance status updates, communication around operational issues such as fires or conveyor loading, more feedback on equipment performance status, production information, or potentially even market and pricing information. Upgrades may also involve ability to adjust equipment settings such as conveyor angles and speeds, start and stop balers, etc.

[2] https://www.recyclingproductnews.com/article/35838/optical-sorting-advances-are-driving-the-mrf-of-the-future

[3] https://companiesfornetzero.com/waste-sorting-technology-optical-sorting

Figure 1: Optical Sorter Schematic[4]



2.1.2 Glass Systems

Glass breakers and glass cleanup systems can be incorporated into MRF processing lines. Glass breakers are a common technology at MRFs. In contrast, complete glass cleanup systems are not. Glass breakers were often used to protect the purity of other commodities and prevent wear and tear by keeping glass out of the system. Removing glass from a MRF system early in the sort line can increase efficiency by reducing equipment wear and glass carry-over into other products. The goal of a glass breaker is to crush and remove glass and fines, usually smaller than approximately two inches, with a minimum. A glass cleanup system aims to clean and concentrate the glass stream to be more valuable to end users by removing fines and non-glass residue (bottle caps, gravel, organics, dirt, etc.) and light material such as shredded paper. Innovative glass systems can turn a break-even commodity into a revenue generator.

In a single-stream process, glass breakers are usually located at the beginning of the MRF system, either before, under, or after the Old Corrugated Cardboard (OCC) screen. The incoming stream drops onto the breaker screen, usually made of cast steel alloy discs that rotate, breaking the glass and allowing it and other fines to fall beneath the screen. At the same time, the rest of the material continues through the sorting system.

[4] Pfaff, Florian & Baum, Marcus & Noack, Benjamin & Hanebeck, Uwe & Gruna, Robin & Längle, Thomas & Beyerer, Jürgen. (2015). *TrackSort: Predictive tracking for sorting uncooperative bulk materials.*

Advanced glass cleanup is a more innovative system that is less commonly implemented at MRFs but can help increase end-market revenue. Advanced cleaning includes the removal of metals from the glass stream, advanced sizing of glass, removal of ceramics, and color sorting. A magnet and eddy current separators can be used to separate ferrous and non-ferrous metals, respectively, from the uniform glass stream, creating a cleaner product. Creating several different sizes of glass can allow MRFs to optimize glass outputs for different end markets. Separating glass by color is another way to increase value.[5]

The best and most efficient way to optimize a MRF's glass system is to understand the end market options available to determine the best technology needed. As Colorado has local end markets for glass, MRFs should highly consider advanced technologies to capture quality glass and support circularity within the State.

2.1.3 Newer Screening Technology

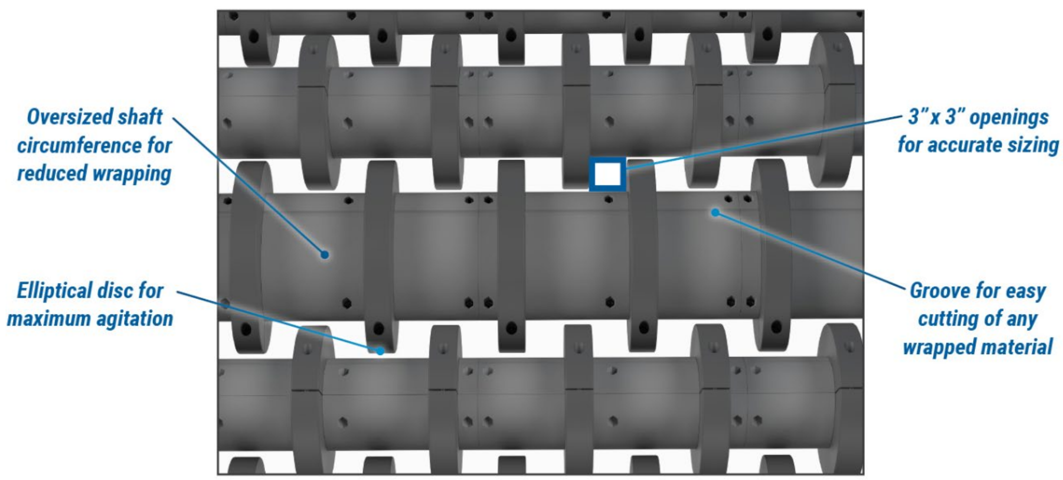
Traditional MRF screens separate two-dimensional materials (plastic films, paper, cardboard, and fibers) from three-dimensional materials (containers, plastic bottles, and cans). Although efficient, traditional disk or star screens require a high level of maintenance and upkeep. Newer screening technology can help the MRF system in several ways, with the introduction of auger screens, anti-wrapping screens, and ballistic separators. Auger screens can be a key player in the presort position because they can potentially reduce the need for humans at high risk for injury at this location. Sharps, biohazards, glass, needles, and other materials hidden under a large burden depth of material moving quickly can pose risks to workers. An auger screen can bypass up to 60% of material from the traditional presort. An example of an auger screen can be seen in **Figure 2** below. The large pieces roll over the screen and onto the post-sort, and the smaller, undersized pieces fall beneath the screen and bypass the presort. Sorters may need to separate oversized materials by type and be exposed to strains and similar risks. Fires may be more difficult to detect if caused by smaller materials that drop through the auger screen.

[5] https://static1.squarespace.com/static/61b12c4e31f2761943c9622d/t/61c3958bc48f172ea9a0c2eb/1640207755634/mrf-best-practices.pdf

Figure 2: Auger Screen (CP Group)[6]

Anti-wrapping screens, shown in **Figure 3**, are a newer screening technology. High-agitation disks flip and toss the materials to help keep smaller materials from "surfing" over the screen, and oversized shaft circumferences help to mitigate the wrapping of long stringy materials and reduce jamming.

Figure 3: Anti-Wrap Screen Disks (CP Group)[7]



Ballistic separators, also known as elliptical screens, are similar to the auger screen in the sense that they can sort more than one material at a time; however, they do not have to include shafts; therefore, there is little area for items to get wrapped, as shown in **Figure 4**. Small glass and residue fall through the holes. Containers and other three-dimensional materials get tossed forward. Paper and other two-dimensional materials slide on the screen, separating from the containers. Ballistic screens are effective at separation, particularly for lower and mid-range capacity processing lines.

[6] https://www.recyclingtoday.com/news/cp-auger-screen-anti-wrapping-nonbinding/

[7] https://www.cpgrp.com/antiwrapscreen/

Figure 4: Ballistic Separator (Machinex)[8]

2.1.4 Incidental and Full Film Recovery Systems

Incidental Film Recovery Systems are used to address film plastic. There are various types and techniques, but they often consist of a pneumatic system with intakes above a sort line, where a sorter simply grabs a piece of plastic film and holds it near the intake hood and it is sucked through a duct to a collection bin. In other cases, a sorter simply grabs the film and places it in a bin as opposed to the residue line. These manual processes are not as efficient compared to some optical sorting systems that accomplish a similar task more efficiently, particularly a high end three optical sorter fiber system. Unfortunately, these types of systems are not designed for recovery of all the types, sizes and quantity of film that might come into a MRF accepting plastic films. These systems do not work well for large sheets of film, which may need to be sorted at the presort.

A "New Full Recovery System" describes a MRF that is rearranged and designed to specifically receive and recover film in large quantities. These systems may include technologies that open bags and otherwise accommodate the large amount of film that could come to the facility. Since the end market value of film is currently low and the technology is new, innovations and refinements are still being made to these systems. Retrofitting an existing MRF to add the technology may be cost prohibitive. At this time, this technology may be more useful for protecting the quality of other commodities rather than a revenue generating commodity.

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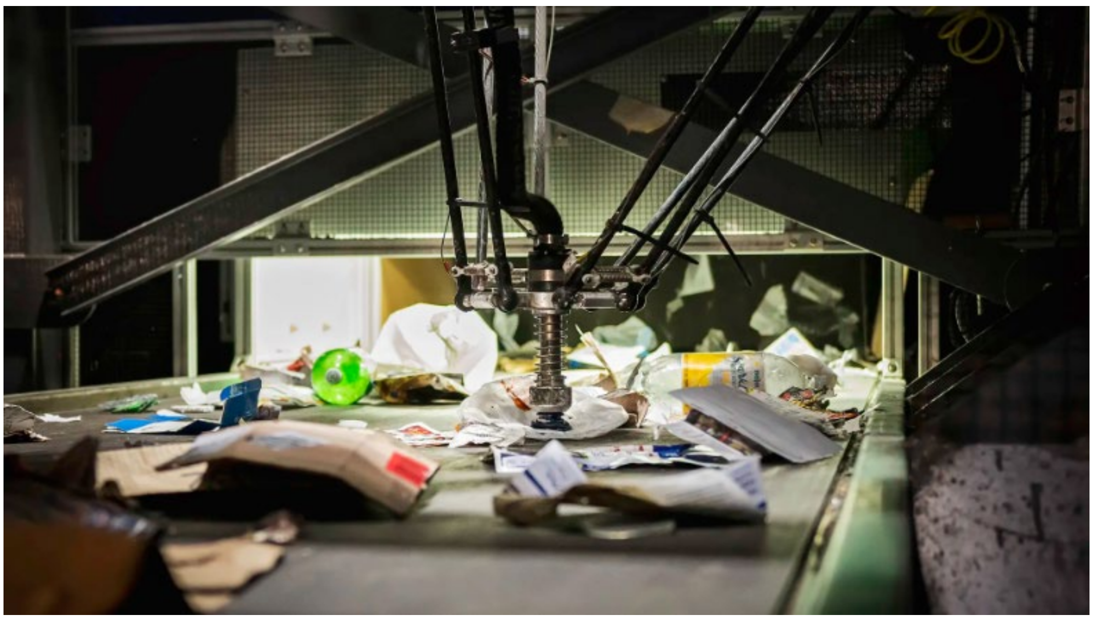
[8] https://www.machinexrecycling.com/sorting/equipment/screening-separators/#:~:text=MACH%20Ballistic%20separators%20are%20designed,the%20optional%20variable%20screen%20openings

2.1.5 Robotics and Artificial Intelligence

The implementation of AI and robotics can improve the overall efficiency of a MRF, including cost and labor effectiveness, equipment efficiency, and reduced human error. Robotics and AI can assist in improving diversion rates, saving money, and reducing the need for jobs that pose high risks to employees. The quality of sorting at a MRF is paramount to a MRF's efficiency, and the introduction of robotics and AI can improve sorting quality. Modern robotics and AI technology are designed to take up a small footprint and can be placed virtually anywhere in a MRF. The addition of this technology does not require any retrofitting and can be installed in a short period of time to avoid downtime.

Figure 5: Recycling Facility Robotics System[9]

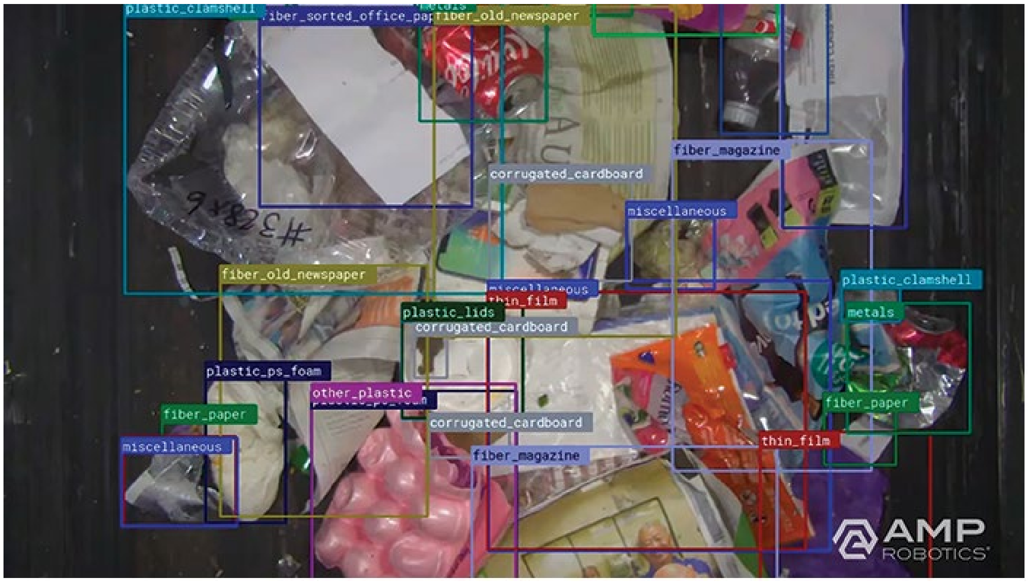


Many MRFs use humans to sort recyclable materials on the conveyor belt, and although humans can be very efficient, finding staffing for this work is becoming increasingly scarce, expensive, and inconsistent. In addition, humans may not be able to recognize certain products on a fast-moving belt when deformed or confidently identify the material composition. Robotics and AI can lower employment costs while improving safety by keeping humans away from heavy machinery. AI technologies use Near-Infrared (NIR) or Hyperspectral (HYS) scanning to differentiate different products and improve the quality of picks. Robotics and AI may have a 90% pick success rate for targeted materials in the system. The number of picks per minute (ppm) between AI and humans also varies (up to 80 ppm versus 40 ppm, respectively); however, this is only one benefit of using the technology.[10]

[9] https://www.axios.com/2023/04/04/recycling-robots-ai-landfill

[10] https://awre.com.au/machinery-and-vehicles/robotic-waste-sortation-the-picks-per-minute-illusion/

Figure 6: AI Material Identification[11]



AI technology can also capture valuable data and "learn" to optimize sorting. The machines can be programmed to understand recycling trends, such as the highest and lowest priority materials based on market returns, which can be adjusted to fit current conditions and maximize financial returns.

AI and robotics work best in combination with other MRF technologies. To maximize the use of AI and robotics, AI and robotics are most efficiently used for quality control and at the residue lines to make a last-chance recovery of commodities missed earlier on the sorting line. This technology can also monitor system performance by providing advanced notice that something might be wrong with the sorting equipment. The improved access to performance information can be used to identify and evaluate other system improvements and to demonstrate to residents the benefits of recycling and avoiding placing the wrong materials with their recyclables.

Impact Assessment

AI and robotic systems may have a 95% accuracy for identifying targeted recyclable materials and a 90% pick success rate for robotic cells. These success rates are dependent on (but not limited to) material, material condition, how the material is defined within the technology, where the robot is located, and what is considered success.

Opinion of Probable Cost

The costs of AI technology and robotics, including the implementation, engineering, and on-site services, can total approximately $500,000 per robot. Costs vary based on the type of robot and application.

[11] AMP Robotics

Table 2: Estimated Costs for Robotics

Equipment/Service	Cost (Low)	Cost (High)
Robot	$280,000	$420,000
Implementation Services	$12,000	$18,000
Engineering Services	$24,000	$36,000
On-Site Services	$16,000	$24,000
Total	$332,00	$498,000

Commercial Availability

Robotics and AI technology can be found in many MRFs nationwide and in nearly all the existing Colorado MRFs where the multiple materials are processed and baled for end market sales. Various technology providers have reached commercial-scale viability and are operating in the US today. Below is an example of three technology vendors with commercially available systems.

AMP Robotics, headquartered in Colorado, has its systems in over 80 North American, European, and Japanese facilities. Their technologies include AI and robotic sorting for film removal, quality control, positive and negative sorting, material characterizations, and performance measurements. The Cedar Avenue Recycling and Transfer Station (CARTS) in Fresno, California, partnered with AMP Robotics to increase recovery. The CARTS facility added a robot to sort polypropylene as well as two (2) robots on the "last chance" line to pick HDPE natural and color, PET, film, and aluminum. Napa Recycling and Waste Services in California incorporated three (3) AMP Robotic robots to target PET, HDPE, aseptic cartons, and polypropylene. Recycling and Disposal Solutions (RDS) in Roanoke, Virginia, also uses AMP robots to sort PET, HDPEM plastic film, cups, and metals.

EverestLabs, founder of RecycleOS, has its technology in several locations, including the largest commingled recycling facility in North America, the Sims Municipal Recycling MRF in Brooklyn, NY. The RecycleOS technology uses AI, cameras, and robotics to identify and sort recyclables at MRFs. The robotic system can operate in more places, such as inclined conveyors, than other robots.

Bulk Handling Systems (BHS) Max AI® technology is in MRFs throughout the United States and Europe.[12] The technology begins with a Visual Identification System to identify materials and directs robotic sorters to pick targeted materials. The Max AI® fleet contains several variations of robotic sorters to improve efficiency.

[12] https://bulkhandlingsystems.com/

2.1.6 Fire Detection Systems

Implementing fire detection systems is an important safety consideration for MRFs, and it has become required in most areas to receive insurance. Fires at MRF facilities have also become an increasingly common problem nationwide. Since the State of Colorado is highly dependent on the handful of larger capacity MRFs on the Front Range, fire damage or destruction could be detrimental to the system, and recovery could take months.

State of the art fire detection and suppression systems include remote-operated firewater cannons and infrared cameras to detect hot spots in the incoming and stored materials and within the processing area. Lithium batteries have caused many recent fires, but other materials can become hazardous. Traditional fire protection systems are designed to allow for the safe exit of facility operators and protect equipment; however, these systems do not work as well in identifying a battery fire or other fires that might travel up a conveyor or be rooted in a screen or other location. Recyclable materials are dry and low-density, allowing airflow into a feedstock pile. Newer infrared thermal detectors and specialized systems are more effective at detecting and analyzing possible fires in a MRF environment. With modern systems, operators can view real-time information, allowing for a more effective and rapid response to the fire before it can spread and cause damage, improving safety and material recovery.

2.1.7 Additional Storage

Additional storage, although not innovative, can positively impact the value of commodities. Outdoor storage can result in wet bales, and dry bales have higher yields and better value.

2.2 MIXED WASTE PROCESSING

2.2.1 Technology Description

MRFs sort and capture select recyclables for sale, reprocessing, and returning to the market, that would otherwise be sent to a landfill. There are two types of MRFs: clean MRFs, which accept source-separated recyclables, and mixed waste processing facilities (MWPFs). MWPFs accept a mixed municipal solid waste (MSW) stream. This technology solution is often called second chance recycling as it removes recyclables that remain in the trash.

Clean MRFs can have single or dual-stream processing systems, usually determined by the collection programs implemented in the area. A single-stream processing facility accepts all collected recyclable materials commingled. In contrast, a dual-stream processing facility has two (2) processing lines and is used when communities separate mixed paper from containers (glass, metals, and plastics). These facilities capture select materials depending on the feedstock and established markets.

The process of both a clean MRF and MWPF begins by unloading materials onto a tipping floor. The tipping floor of a clean MRF handling dual stream materials usually has designated areas to separate the mixed paper and container streams coming in. Each stream is then pushed onto an incline conveyor and fed into the processing system designed for the target materials. Single-stream MRFs may inspect incoming loads but usually stage all materials in a common area. Single stream systems have a single infeed conveyor for all materials. Larger clean MRFs may have two (2) parallel feed sorting systems to increase capacity. MRFs may also receive source-separated materials that consist of only one material type, such as cardboard, office paper, or a commercial feedstock. These materials will be processed separately in most cases.

The tipping floor of an MWPF may have a combination of mobile and fixed equipment, along with manual labor, to sort the materials. This involves removing or breaking up larger or bulky items such as appliances, dimensional wood, metal, cardboard, or large pieces of plastics that are readily separable or could clog or disrupt the processing system. Loaders or grapples then transfer the material to a conveyor or surge hopper, which transports it to one or more sort lines and mechanical equipment for further separation. To screen and sort the waste, bags, and containers are either opened using mechanical devices or by manual labor. These systems can be adapted to handle construction and demolition (C&D) waste or other mixed waste materials. MWPFs may sort different materials than a clean MRF, such as wood or C&D waste, and often have a primary objective of landfill diversion.

The material in a clean MRF and MWPF undergoes a multi-stage screening and sorting process to separate components such as fiber (cardboard, newspaper, and mixed paper), plastic, metal, and glass containers, and small contaminants. This separation is typically achieved using mechanical, optical, or sometimes pneumatic screening equipment and manual labor to classify materials based on size and weight. Fiber is sorted with screens, optically or manually, on elevated conveyor platforms and placed into storage bunkers as commodities. Containers are processed through various methods, including ferrous magnets, optical sorters, robotic sorters, manual sorting, and eddy current separators (ECS). The fines, typically smaller than two inches and consisting of dirt, rocks, broken glass, ceramics, bottle caps, etc., may undergo further processing using magnets, ECS, and pneumatic sorting steps to recover metals, fiber, and a glass-rich stream. The equipment used at a MWPF must be designed for the wide range of materials in MSW or the target material steams. Different types of screens, such as trommel screens that handle the variable material, may be used. In some cases, more manual labor may be used. Often, the materials recovered may be of lower value, with a higher volume of materials such as film plastic or wood recovered because of being more visible.

2.2.2 Impact Assessment

MWPFs may be an option to capture more recyclables that remain in the MSW once the recycling system has been optimized.

Clean MRF

Clean MRFs can recover more than 90% of the original target feedstock. A very small clean MRF may process up to 50 tons daily, larger facilities process from 200 to 300 tons per line per shift, and some very large MRFs may process more than 400 tons per line per shift. Like MWPFs, clean MRFs can have a useful operating life of 20 to 30 years if proper maintenance is provided, and clean MRFs often are retrofitted throughout their life with new processing equipment and technology, as needed.

MWPF

MWPFs usually recover 10 to 25% percent of the original feedstock. However, some facilities have reported recovery of 50% or more when fines can be used for landfill cover or producing a fuel product. Due to contact with other MSW, the quality of recovered materials such as cardboard may be lower. The optimal capacity is between 200 tons per day (TPD) and 1,500 TPD using multiple sort lines and operating multiple shifts. MWPFs can have a useful operating life of 20 to 30 years if proper maintenance is provided. Many MWPFs are retrofitted throughout their life with new processing equipment and technology, as needed.

2.2.3 Commercial Availability

Clean MRF technology is widely available and utilized nationwide as it is the most common type of processing facility. Several commercial-scale MWPFs have been implemented in North America. Notable examples include facilities in Ramsey-Washington Counties, Minnesota; Montgomery County, Alabama; San Jose, California; and Edmonton, Alberta, Canada. Fluctuations in commodity pricing, types of materials most easily recovered, quality of materials recovered, and the acceptance of the processing approach can impact the financial feasibility of these projects.

Ramsey/Washington Recycling & Energy (R&E) is a joint county waste management organization in Minnesota. The Counties jointly purchased the R&E Center in 2015 and works to recover value from the waste stream. The R&E Center has a recyclable recovery system to sort out high value materials from garbage that comes to the facility. Conveyor belts carry garbage through a series of shredders, screens and magnets that recover recyclable materials in the trash. In 2022, nearly 13,000 tons of metal were recovered for recycling.[13]

[13] https://recyclingandenergy.org/about-re-center/

3 COLLECTION TECHNOLOGIES

3.1 CONTAMINATION SOFTWARE

New technologies are emerging to identify contamination in various collection containers, before or after pick-up, using artificial intelligence. The contaminants can be reported to the hauler, the resident, and the business responsible for the container. In the case of residential collection, some companies are attaching cameras and AI-enabled computers to the hopper of automated side-loader trucks to monitor materials as they are emptied into the truck.[14] If non-accepted materials are identified, notifications can typically be sent via text, e-mail, or postcard to the resident.

Alternatively, other companies offer camera installations on commercial dumpsters to notify employees to remove contamination before collection.[15] Depending on the municipality or hauler protocol, these customer notifications can be leveraged to educate further and potentially lead to enforcement, such as fines for contamination. Haulers benefit from identifying contamination at the source because of the opportunity to educate the customer directly and increase material quality, and therefore profit, in the long run.

3.2 TRUCK AUTOMATION

Converting from a rear loader to an automated side-loader (ASL) or an automated front-loader (AFL) truck has demonstrated improvements in route efficiency, driver safety, fuel consumption, and customer service. Automated side-loader (ASL) trucks are typically the first step towards modernizing residential services, depending on housing density. Solid waste collection health and safety is significantly improved with automated collection, especially compared to full manual collection operations.[16] This improved safety is due to significantly reduced lifting and the ability to serve most customers from inside the truck cab using the ASL controls, avoiding the hazards of getting in and out of the truck, which exposes employees to traffic and varying weather conditions.

Automated systems are generally operated with one crew member and do not need a second crew member to serve as the helper. A second crew member may have additional safety risks of being outside the truck when it is being operated. The amount of exposure to hazards in the waste is dramatically reduced with automated systems. There are typically direct savings in reduced accidents, injuries, and lost time.

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[14] https://www.waste360.com/fleets-technology/artificial-intelligence-ai-game-changer-waste-contamination-detection-0

[15] https://www.recyclingtoday.com/news/contamination-solutions-to-improve-recycling-systems-college-campuses/

[16] https://wasteadvantagemag.com/whats-the-best-type-of-garbage-truck-to-own/#:~:text=An%20Automated%20Side%20Loader%20only,due%20to%20repetitive%20heavy%20lifting

An additional advantage of converting fleets to automated trucks is the option of switching to compressed natural gas (CNG) fuel, and in some cases, such as in Heil's CNrG, having the option of tailgate-mounted CNG tanks versus roof-mounted, which reduces the overall height of units. It also increases each unit's total diesel gallon equivalency (DGE). The vehicles go up to 105 DGE without additional body height, allowing longer routes and less refueling time, which could be valuable for the long-haul routes in rural Colorado.[17]

3.3 ROUTING SOFTWARE

According to the SWANA Applied Research Foundation, modernized routing software has been the most impactful transformation in solid waste collection since the invention of the automated refuse collection truck. Residential waste collection typically involves regularly scheduled and on-demand services. Many collection service providers use automated routing software ("Static Routing" software) to design their fixed residential and commercial collection routes. Additionally, many organizations use automated software to provide on-demand services to residential and commercial customers. This software is referred to as "Dynamic Routing" software. Dynamic Routing systems also allow for modifying routes based on changing conditions such as collection service needs, weather impacts, and staff absences. [18]

Routing software is also beneficial for improving customer service as communication between the driver, dispatch, and customer service agents is streamlined through cloud-based and real-time work order management and issues reporting. For example, blocked roads, inaccessible carts, or overflowing carts can all be documented on the account if a customer is unable to be collected. Drivers can also notify residents of contamination, similar to the technology described in **Section 3.1**.[19]

Haulers can also optimize routes for efficiency and track tonnage through weight ticket reporting with modern routing software. Valuable data such as mileage, route completion, asset management, and driver performance can all be leveraged to improve route management.[20]

3.4 PHONE APPLICATIONS

Phone applications (apps) are a great tool to communicate and educate the community on recycling. One of the biggest issues with recycling is contamination. Contamination is due to residents not knowing what is recyclable and not knowing how to handle recyclables, such as cleaning out jars and containers. In addition, many residents "wish cycle," hoping a material is recyclable when it is not. Additional

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[17] https://www.waste360.com/automation/automating-fleets-can-bring-safety-and-savings

[18] SWANA Applied Research Foundation, 2020, *Efficient Management of Waste and Recycling Collection Resources*

[19] https://www.rubicon.com/wp-content/uploads/RubiconPro-SmartCity-Techsheet-Multivehicle.pdf

[20] https://www.rubicon.com/wp-content/uploads/RubiconPro-SmartCity-Techsheet-Multivehicle.pdf

discussion of recycling contamination is included in the **Element 4 Technical Memorandum**.

One innovative way for communities to educate residents on recycling is through phone apps. Companies such as WasteConnect use an app to help residents find the proper way to dispose of certain items. ReCollect is another similar app already used in Denver, Colorado, and other cities such as Austin, Phoenix, and Vancouver. The City of Dallas, Texas Sanitation Service Department launched an app with a personalized collection calendar and information on how to reuse, recycle, compost, and dispose of materials. Additional information on recycling education is available in the **Element 12 Technical Memorandum**.

COLORADO NEEDS ASSESSMENT

ELEMENT 11: REUSE

JANUARY 25, 2024

CONTENTS

TABLES

APPENDICES

1 INTRODUCTION

1.1 PURPOSE

CAA seeks to understand the availability and scope of reuse or refill systems in Colorado affecting the use of covered materials. Specifically, CAA asked the project team to document the current deployment of reuse or refill services and reuse or refill formats available to residential and nonresidential covered entities, by major packaging and paper format type. CAA requested insights regarding trends and opportunities for migration to reusable and refillable product delivery and how that would change the recyclable material stream.

1.2 APPROACH

The project team began by assembling a database of reuse and refill programs in Colorado, including the major types of packaging and paper formats impacted and the types of residential and nonresidential entities to whom they are available. The project team also interviewed internal and external reuse and refill experts, key Colorado stakeholders, and several reuse service providers to identify additional programs and discuss trends, challenges, and opportunities for reuse and refill systems already in place in Colorado and those that are not yet in Colorado.

1.3 SCENARIO MODELLING CONSIDERATIONS

The core findings relative to the modelling of the future are as follows:

- There are approximately 52 existing reuse/refill operations in the state, which include the following:
    - Packaging free shops which include bulk dispensing models – 44 individual operations
    - Reusable cup and container programs which includes restaurant on the go services (2 providers), reuseable programs in stadiums/events 1 provider, 85 unique sites), schools and campuses (seven Colorado and university campuses five managed by Sodexo etc.)
    - Pre-filled refill systems which are limited to dairy.
- No data could be obtained from these existing operations to enable an assessment of the current source reduction benefits of these operations, but if there is continued expansion in reuse programs, source reduction is likely.

Challenges to reuse and refill include:

- Investment necessary to develop infrastructure such as washing facilities.

- Legislation to enable market adoption, investment and to provide mechanisms such as deposit that can maximize return rates for reusable packaging materials.

Due to the lack of data on the source reduction impacts of the small number of reuse/refill activities in the state, it is proposed that within the scenario model we consider a source reduction percentage that could be achieved through reuse/refill in line with targets that are being set in other jurisdictions globally and scaled at a timescale necessary to enable investment and infrastructure development. This scaling may need to be catalyzed by additional policy measures.

2 COLORADO REUSE AND REFILL

The project team began by reviewing the most comprehensive, publicly available list of reuse and refill systems, which is the Living Landscape of Reusable Solutions maintained by non-profit Perpetual.[1] The list documents more than 1,100 different reuse and refill solutions globally and identifies more than 300 with operations in the United States but does not identify solutions state by state. To narrow the search to Colorado, the project team relied on existing expertise, review of the reuse and refill programs mentioned in the municipal survey, desktop research, and interviews of several Colorado stakeholders.

2.1 CATEGORIZING REUSE AND REFILL SOLUTIONS

There are a wide variety of reuse and refill solutions available to businesses and consumers. To focus the research on what is relevant, the project team relied upon the reuse and refill categories, descriptions, and definitions used in the most thorough global reuse and refill landscape analysis available (see Appendix A).[2]

Typically, reuse and refill systems can be categorized into four main models developed by the Ellen MacArthur Foundation (see Figure 1).[3] These include the following:

- **Refill at home**: users refill their reusable containers at come (e.g. refills delivered through a subscriptions service)

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[1] Perpetual. Living Landscape of Reusable Solutions: https://www.reuselandscape.org/

[2] Moss E, Gerken K, Youngblood K and Jambeck JR (2022) Global landscape analysis of reuse and refill solutions. *Front. Sustain.*3:1006702 doi: 10.3389/frsus.2022.1006702

[3] Ellen MacArthur Foundation. Reuse Rethinking Packaging: https://www.ellenmacarthurfoundation.org/reuse-rethinking-packaging

- **Refill on the go:** users refill their reusable containers away from home (e.g. at an in store dispensing system)
- **Return from home:** packaging is picked up from home by a pick-up service
- **Return on the go:** users return the packaging at a store or drop off point (e.g. in a deposit return machine)

Figure 1: Reuse and Refill Models

The project team further refined the definition of formal reuse and refill systems to require **third-party involvement**. For example, the project team did not attempt to capture every restaurant that has switched from single-use foodware to durable plates for on-site dining because doing so typically does not require involvement of a service provider. This also excludes most "bring your own" (e.g., Bring Your Own Cup or Bring Your Own Container) initiatives. These are both reuse and refill initiatives that exist in Colorado, but there was not an effort to quantify them.

2.2 COLORADO REUSE AND REFILL

2.2.1 Overall Results

Similar to the results of the international reuse and refill landscape study (see Appendix A, Table 2), package-free shops emerged as the most frequently identified solution existing in Colorado, followed by reusable cup and container programs. Most reuse and refill programs are in the Front Range.

Table 1: Identified Colorado reuse and refill solutions by category

Category	Number Solutions Identified
Package-free shops	44
Reusable cup & container programs	5*
Pre-filled refill systems	3

*This is a count of solution operators, not total locations.

2.2.2 Package-Free Shops: 44 Solutions Identified

Package-free shops in Colorado are primarily comprised of boutique brick and mortar retail stores selling home and personal care products, like shampoos and laundry soaps, and small grocery or co-op stores selling bulk grains, beans, nuts, etc. One business in Denver does not have a storefront but offers delivery and the option to pick up products at two partner locations.[4] Several locations are standard grocery stores with bulk foods sections that allow people to bring their own reusable containers.

The number and locations of package-free shops broadly aligns with the geographic distribution of Colorado's population, with approximately two-thirds of them located in the Front Range.

Table 2: Package-Free Shops by Location[5]

Location	Number Identified
Denver*	12
Boulder*	6
Durango	5
Colorado Springs*	3
Fort Collins*	3
Lafayette*	2
Longmont*	2
Manitou Springs	2
Louisville*	2

[4] https://www.thebetterworldcompany.com/

[5] Most package-free shops were found on litterless.com.

Location	Number Identified
Brighton	1
Loveland	1
Littleton*	1
Carbondale	1
Grand Junction	1
Berthoud	1
Granby	1
Parker	1
Glenwood Springs	1
Golden*	1

* Front Range

This list does not include larger Colorado supermarket chains that may offer bulk food aisles as that information was not readily available. King Soopers, Whole Foods, and Natural Grocers were mentioned by an interviewee as stores with a statewide presence that may offer bulk food.

Case Study. Nude Foods Market is a notable example of a recent Colorado market entrant attempting to overcome some of these barriers. Founded in Boulder in 2020, the company offers the traditional brick and mortar grocery shopping experience in addition to e-commerce, but in both cases, everything is packaged in glass jars, cloth, or unpackaged. The market offers next day delivery for a $7 fee to Boulder, Superior, Gunbarrel, Lafayette, and Louisville via bike or electric vehicle, and opened a second physical location in Denver in October 2023.

Nude Foods is a prefill and refill shop. Consumers can refill their own containers with about 40 products but over 1,000 products are pre-filled by the store. Shoppers are charged $1.50 for each store-owned container and receive $1.00 back upon return. The $0.50 difference is used toward container cleaning and sanitizing. The market offers modern options, like subscription for regularly purchased products and the ability to check out via mobile phone rather than waiting for a cashier.

Two additional innovations might help Nude Foods Market capture even more of the market: 1) collecting reusable containers from shoppers' homes; and 2) only charging a deposit for reusable products not returned to reduce the upfront financial burden on shoppers to participate.

Covered Entities: These solutions primarily serve the residential market, but it is possible that small businesses and hospitality establishments (e.g., restaurants) purchase food and supplies from these types of shops.

Impact on Covered Materials. Switching to bulk foods and reusable packaging in grocery stores would reduce the amount of paperboard (e.g., pasta boxes and cereal boxes) and rigid plastic in the recyclable material stream. There is also the opportunity to reduce plastic film materials (e.g., plastic bags, pouches, etc.). that are hard to recycle and tend to contaminate the streams of more valuable materials. Lastly, depending on how bulk foods are delivered to the retail location from the producer, this could result in a reduction in cardboard shipping boxes and stretch film.

2.2.3 Reusable Cup and Container Programs: 5 Solutions Identified

Five programs at least loosely fall into the reusable cup and container category. Like package-free shops, formal reusable cup and container programs also tend to be concentrated in the Front Range, especially in the Boulder and Denver areas.

Restaurant to-go container service. Deliver Zero is the only service identified in Colorado that empowers customers to order takeout or delivery food from restaurants in reusable containers. Founded in New York City, Deliver Zero joined forces with a similar Colorado startup, Repeater, and began serving Colorado restaurants in October 2022. The service currently works with 24 restaurants and three Whole Foods locations (two in Boulder and one in Longmont). Most of the restaurants are in Boulder and Denver, with a few others in Arvada (2), Longmont (1), and Wheat Ridge (1). Deliver Zero shared that in approximately one year since it began operating in Colorado it has replaced 24,605 single-use containers resulting in: 3,079 kg greenhouse gas emissions avoided; 6,763 gallons of water saved; and 2,010 lbs of waste diverted from landfill.

Reusable cup service for events and venues. The largest of these types of services is r.Cup. which was recently rebranded as r.World. A nationwide reusable cup provider with dishwashing facilities in several major cities such as Seattle, Los Angeles, and Denver, the service has been activated at 85 unique client sites in Colorado since November 2021. In the two years since then it has provided approximately three million reusable cups (as of the end of October 2023). Clients include both brick and mortar locations, primarily music venues, in addition to music festivals, street fairs, and one-off events at places like the Denver Zoo. Concert promoter AEG Presents partnered with r.World in 2022 and installed the service at Bluebird Theater, Gothic Theatre, Mission Ballroom and Ogden Theatre. The City of Edgewater contracted with r.World for a beer garden event and the Town of Breckenridge is pilot-testing the service for events, in addition to exploring other reusable cup models. r.World is expanding its product line to include reusable to-go containers and is piloting with at least one corporate cafeteria in the Denver area.

The other two services are smaller in scope. Nude Foods Market (Boulder and Denver) provides “Party Packs” with durable items to replace single-use food and beverage wares at small events. Non-profit Sustainable Crested Butte’s “Waste Free Events" program (launched in 2016) rents reusable plates, silverware, and cups for events smaller than 300 people. For larger events, they also provide zero-waste consulting services. Their website says they have diverted 117,361 single-use products from the waste stream.

University and college campus reusable to-go container programs. Seven Colorado university and college campuses were identified as having reusable to-go container programs for at least one of their dining facilities. Five of these are managed by international foodservice provider, Sodexo. Fort Lewis College in Durango appears to manage its own foodservice operation and reusable container program. Colorado State University in Fort Collins uses ReusePass, a platform developed by Topanga.io. This platform allows students to order food through GrubHub and choose the “ReusePass” option if they would like their food served in a reusable container.

Covered Entities. Reuseable container programs are typically available to hospitality businesses, specifically restaurants, and any large campuses or buildings with large foodservice operations, which could include educational settings and government buildings. Reusable cup programs are available to hospitality businesses, specifically stadiums and music venues, and are a fit for events in public spaces.

Impact on Covered Materials. Reusable container programs replace primary single-use packaging in a several material categories, including metal (e.g., aluminum foil takeout containers or trays), rigid plastics (e.g., takeout containers and lids made from PP, EPS, rigid PS, PLA, etc.), paper (e.g., kraft and paperboard boxes, molded pulp food serviceware). Cup programs typically replace rigid PS and PP cups and lids given the venues in which they are typically used. They may also replace paper coffee cups if they able to gain traction in the coffee shop market. Both types of programs typically transport products in reusable totes, and thus would replace a lot of cardboard shipping boxes and potentially plastic film packaging.

2.2.4 Pre-Filled Refill Systems: 3 Solutions Identified

Milk delivery. The project team identified three dairies delivering milk in refillable glass containers: Royal Crest Dairy (Denver); Morning Fresh Dairy (Bellvue); and Longmont Dairy (Longmont). Following the traditional “milkman” model, the businesses deliver, collect used milk containers, sanitize, and refill. These dairies also offer a variety of other dairy and non-dairy food products. Morning Fresh Dairy also sells products in retail locations primarily in the Front Range, from Fort Collins to Colorado Springs.

Covered Entities. These solutions primarily serve the residential market, unclear if these dairies have small business (e.g., offices) and hospitality (e.g., restaurant) accounts but, if so, they would have a similar impact on those waste streams.

Impact on Covered Materials. The primary impact of these programs will be to reduce the amount of plastic and paper milk cartons in the residential waste stream. Since milk is typically delivered to retail locations in reusable plastic crates, Morning Fresh is not likely impacting cardboard or other material streams at the retail locations where it sells its milk.

2.2.5 Other Programs

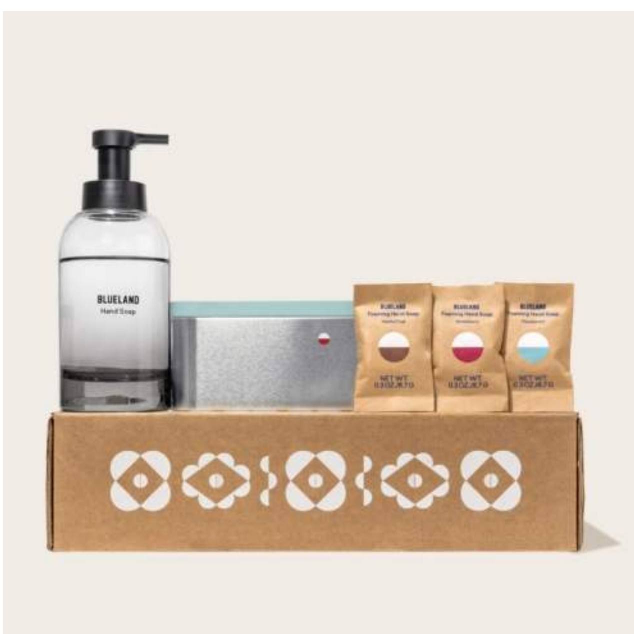
Reusable Shipping & Logistics. The project team was able to confirm that one reusable shipping and delivery packaging solutions company, Returnity, provides custom-designed reusable bags and boxes products to companies doing business in Colorado. Returnity suggested that its competitors are also probably doing business in Colorado. Liviri, an Otter Products company, is a reusable shipping container and tote company headquartered in Fort Collins, CO. Their specialty is thermal control, and they offer insulated boxes and provide reusable, sustainable cold chain solutions for online grocers, meal kit services, wine and more.

It is unclear what share of B2B and B2C shipping in Colorado utilizes reusable packaging, including bags, mailers, containers, pallets, pallet wraps and so on. If these solutions were to become mainstream, they would drastically reduce cardboard in the commercial and residential recycling streams, and potentially stretch wrap currently captured by commercial film recovery programs.

Refill via Single-Use Plastic Free Pouches/Compostables. It is likely Coloradoans purchase at least some products from companies in this category either directly via e-commerce or at sustainability-oriented grocery or package-free shops, but it is unclear what share of the market this solution captures. Several large brands offer personal care products in this category, especially refillable deodorant systems (e.g., Secret and Old Spice refillable deodorants from Procter & Gamble and Dove refillable deodorant from Dove). Smaller brands, like Beautycounter and Humankind, offer refillable cosmetic products and personal care products (e.g., toothpaste, floss, shampoo, body wash and mouthwash).

These refill systems primarily replace smaller, rigid plastic packaging. Widespread adoption of home delivery of refill pouches could reduce the number of these harder to recycle packaging products from the residential recycling stream (e.g., deodorant cases and toothpaste tubes). At the same time, it might increase paper or compostable packaging, as well as cardboard boxes for shipping.

Concentrate-Based Refill. Similar to the "refill via single-use plastic free pouches/compostables" category, it is likely Coloradoans purchase products from these companies directly via e-commerce or at sustainability-oriented grocery or package-free shops, but is the participation rate is unclear. Examples of these companies include Blueland, Meloria, and Dazz Cleaning Tablets (Dazz Cleaning Tablets is based in Bloomfield, CO). Blueland concentrated cleaning products refills are even available at Target.



These products are reducing rigid plastic bottles used for cleaning products and primarily found in the residential waste stream. They will also reduce cardboard shipping boxes found in commercial streams (e.g., retail stores) because the concentrate takes up much less space. On other hand, consumers purchasing via e-commerce will have more cardboard boxes in their waste stream.

Refill Vending / Dispensing Stations. This category includes equipment and systems such as water refill stations (e.g., Aguavida), food and beverage dispensing (e.g., Purcell bulk container system and PepsiCo's Beyond the Bottle mobile-enabled hydration platform), and home and personal care refill systems (e.g., Bathing Culture Refills). Several of these solutions are in concept phase (e.g., PepsiCo's solution) or pilot phase (e.g., Aguavida). None of them seem to have much market penetration other than the water dispensing solutions. For example, Primo Water claims to have water refill stations in 25,000 retail locations across the U.S. and Canada. FloWater, based in Denver, was founded in 2013 and lists clients including Four Seasons, Hyatt, PGA Tour, Red Bull, Apple, and Google. Their website claims their refill stations have saved over 400 million plastic water bottles from oceans, lakes, rivers, and landfills since the company launched.

Water and beverage refill stations primary eliminate PET bottles from the recycling stream and, potentially, single-use plastic cold cups. It is unclear which covered entities would be impacted the most, but the stations appear to be well-suited for businesses, hospitality (e.g., hotels), schools, and events.

GreenSheen Paint's reusable paint bucket program. GreenSheen Paint, based in Denver, is Colorado's main recycler of paint through the state's PaintCare program. While the fees collected under the PaintCare program cover the collection and recycling of paint, they do not cover the paint containers. GreenSheen receives about 400 tons of plastic paint cans and buckets per year, a number they expect to increase as manufacturers are phasing out metal cans. The company purchased a shredder and was shipping shredded plastic to Troy, Alabama for recycling. The owner then came up with the idea to wash buckets. GreenSheen applied for a grant under Colorado's RREO program and was awarded $143,000 in May 2022 to build a first of its kind, paint bucket wash line enabling them to wash and reuse 5-gallon buckets. The system was completed in June 2023. They estimate they can wash about 540 to 720 buckets per day, or approximately 140 to 187 tons of plastic buckets per year. GreenSheen uses clean white buckets to package its own recycled paint and sell other colors of buckets at about half the price of a brand-new buckets sold at retail stores. Boulder County is using the buckets for a compost collection program.

This case is notable in that a company was able to set up a self-sufficient reuse program with a relatively small upfront investment to overcome the barrier of access to the necessary infrastructure.

2.3 CHALLENGES

Based on interviews with Colorado stakeholders and reuse program operators, the challenges to implementing and scaling reuse and refill program in Colorado are similar to those faced across the United States.

Economic. The entire value chain has been optimized for single-use and is extremely cost efficient. While switching to durable products (e.g., plates) in closed environments (e.g., on-site dining for restaurants) typically requires relatively small capital investment with a payback period of less than a year,[6,7] reuse programs in open systems (e.g., to-go containers, refillable beer bottles) have a hard time achieve cost-parity with single-use until they achieve full-scale operations. Third-party operators, like r.World and Deliver Zero, must pay for reverse logistics and reconditioning (e.g., dishwashing) of products and, until scale is achieved, those costs are often passed along to customers.

Investment. Traditional start-up investors (e.g., angel and VC) are only now beginning to take risks on reuse and refill programs. The market is often still considered unproven in the United States, as there are few or no large-scale demonstrations of return on investment and proof of consumer demand and pilots are usually of insufficient scale to demonstrate financial or environmental benefits.

Infrastructure. Shifting to reuse and refill will in most cases requires new infrastructure for collection (e.g., new bins or reverse-vending machines) and reconditioning (e.g., industrial-scale washing equipment).

Transportation. Reverse logistics are also required for reuse and refill systems, a cost that is one of the reasons brands shifted to single-use in the first place. This is also closely tied to infrastructure. For example, if a service like r.World is activated at a Summit County event it will have to transport products to and from its Denver facility at a significant cost, financially and environmentally as compared to washing and storing products in Summit County.

Convenience. Convenience is critical to any consumer facing reuse system in which reuse is an option as opposed to mandatory. Bringing reusable or refillable containers back to a retail location from home is an inconvenience that has stifled adoption of reuse across sectors (e.g., restaurant delivery).

Geography. While the concentration of population Colorado's Front Range provides advantageous density for potential reuse and refill programs, the mountains between the Front Range and Western slope with rural communities distributed across state likely make statewide logistics more challenging than they would be in less mountainous states, with more evenly distributed populated areas, and transportation routes on a grid pattern.

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[6] Reuse Wins, Upstream: https://upstreamsolutions.org/reuse-wins-report

[7] Rethink Disposable: https://cleanwater.org/author/rethink-disposable-case-studies

Policy. It was reported to the project team that the State of Colorado is generally supportive of reuse and refill programs for food and beverage. The challenge has seemingly more to do with the level of understanding of the pertinent health and food safety codes at the local level. For example, a coffee shop employee might not know whether or not they can refill a customer's travel mug. This speaks to the need for more training and education of stakeholders at the local level.

Equity. Equity, accessibility, and environmental justice were also consistently raised as concerns regarding where and how reuse or refill programs are implemented in Colorado. The three issues are combined here as a challenge not to minimize any one of them, but because they are so closely intertwined and should all be considered simultaneously. For example, one concern is that a program may add substantial costs for consumers (e.g. deposits on refillable containers) subsequently excluding underprivileged people and communities, which is an equity issue. Another example is K-12 schools, many of which are considered underfunded and overburdened, may not have the resources to support the programs. A blanket mandate for on-site reusables in cafeterias would be inequitable without accompanying financial support to purchase and install equipment. Lastly, simply excluding remote communities from reuse and refill plans because of small population size and transport distance is not an equitable path forward. Stakeholders want Colorado to ensure these issues are all taken into account to the extent possible in any future planning for reuse and refill systems in the state.

2.4 TRENDS

The team conducted a literature review and internal and external expert interviews to identify any relevant trends specific to Colorado and those across the United States that could inform future reuse and refill strategies in the state.

2.4.1 National

Reuse and Refill Solutions. Reusable cup and container programs and package-free shops are typically city- or town-based initiatives, rather than statewide or regional programs. They also capture a small portion of the market, and, therefore, have negligible total impact on statewide waste streams.

While package-free shops follow a traditional retail model in most regards, reusable cup and container models are relatively immature and service providers are still experimenting and refining their systems to overcome the many challenges outlined in this document.

Several reusable cup and container services are approaching growth phase. A few examples include:

- r.World now has washing facilities in Denver, Los Angeles, and Seattle.
- Bold Reuse is operating in Portland (OR), Seattle, and is part of a pilot with Loop and Walmart in Arkansas.

- Deliver Zero is now operating in New York City, Colorado, and Los Angeles.
- Re:Dish now has washing facilities and providers reusable products to institutional settings in the New York City and Philadelphia metropolitan areas.

It is unclear whether any of these businesses have captured, or will capture, sufficient market share in these locations to become profitable. Starbucks has also piloted reusable cup programs in several markets and has made some ambitious commitments to serving drinks in reusable cups, but it is unclear what its next steps will be.

Loop is piloting the pre-filled reuse model for grocery and home care products with Walmart in Arkansas. Partners providing products in reusable packaging for the pilot have included Procter & Gamble, Nestlé, PepsiCo, Unilever, Mars, Clorox, Coca-Cola, Mondelēz, Danone, and others.

To provide much-needed data from reuse programs at scale, non-profit Perpetual is in the process of designing and launching city-scale reuse programs in Galveston, TX, Hilo, HI, Ann Arbor, MI, and Savannah, GA. They are involving community stakeholders in the design of these programs, which could provide a model methodology for approaching statewide reuse and refill planning in Colorado.

Milk delivery, also in the pre-filled refill system category, also tends to be local programs run by small- to medium-sized dairies. The largest pre-filled refill system in the U.S. might be Oregon's refillable beer bottle program, BottleDrop Refillable Bottles, run by non-profit OBRC. The program has more than two million bottles in circulation. Key enablers of this program are the high redemption rates for deposit bottles and ability to return refillable bottles through the same redemption pathway as other containers with Oregon's $0.10 deposit.

Federal Policy. The Climate Pollution Reduction Grant program is currently the only national program that offers an opportunity for funding to support reuse and refill in the State of Colorado. The program provides $5 billion in grants to states, local governments, tribes, and territories to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. Authorized under Section 60114 of the Inflation Reduction Act, this two-phase program provides $250 million for noncompetitive planning grants, and approximately $4.6 billion for competitive implementation grants. Reuse and refill programs should be eligible for implementation funding if they are submitted as part of a Priority Climate Action Plan (due March 1, 2024).

State Policy. EPR laws are still relatively new, and states are working out how to incorporate reuse and refill. Oregon's law requires that a minimum of $10 million in EPR fees be invested in reuse, but the state is still working out how to spend that money. The State of Washington is currently working on setting reuse targets. California's single-use packaging and plastic food service ware EPR law set the first specific source reduction goal in U.S. history and producers must meet this target in part by switching to reusable packaging. In New York State's proposed bill, reusables will be exempted from PRO requirements, which would mean producers will pay into the PRO for recyclables but not for reusables. According to one reuse service provider, this seems to be something both producers and environmentalists were able to agree on.

These policy developments are relevant in that Colorado can learn from and build upon the reuse and refill EPR policy discussions in these other states instead of starting from scratch. Additionally, because EPR is still new, Colorado is well positioned to lead the country in supporting reuse and refill activities should it choose to do so.

Local Policy. City and county governments continue to pass a variety of ordinances supportive of reuse and refill, especially in California. For example, by the end of 2022 there were 15 California municipalities with ordinances in place to require reusables for on-site dining. Other ways local governments are supporting reuse, include:

- mandating reuse in government facilities;
- requiring single-use food and drinkware are provided only upon request;
- banning single-use accessories altogether; and
- placing charges on disposable containers. [8]

City governments are also supporting reuse to curb waste generated by events. For example, permitted events in San Francisco with over 100 attendees must ensure that at least 10% of attendees have reusable cups.

Grants are another way local governments are supporting the transition to reuse. In California, Stop Waste is a public agency governed by the Alameda County Waste Management Authority, the Alameda County Source Reduction and Recycling Board, and the Energy Council. The agency offers a reusable foodware infrastructure grants generally in the range of $5,000 to $50,000 to support innovative projects that replace single-use, disposable foodware with reusable systems.

Reuse Advocacy. In the past few years, non-profit organizations like Upstream have organized and fostered grassroots support for reuse in cities across the country. They have also developed principles for EPR and DRS policies and model policies for accessories only on request (e.g., Skip the Stuff), only reusables for dining on site, bringing reuse into take-out, and making reusable cups the norm at events and in government facilities. It is worth considering whether to formally bring such an organization into discussion in Colorado and potentially future states in which CAA is the PRO.

2.4.2 Colorado

Reuse and Refill Solutions. Reuse and refill companies and programs continue to appear (and disappear) in period of experimentation and early growth. A few larger plays in the reusable cup and container space are gaining a firm foothold, including

[8] Upstream: https://upstreamsolutions.org/blog/policy-wins-2022

r.World and Deliver Zero. An interesting development is the collaboration between these companies, which speaks to the economic value of shared infrastructure.

Deliver Zero utilizes r.World's washing capacity, which benefits both companies. Deliver Zero need not invest in its own infrastructure and r.World extracts greater value from its capital investment in the washing facility. Deliver Zero is also working with companies like The Happy Beetle and Ridwell to collect products from customers. The Happy Beetle's primary business is to provide residential and commercial pickups of hard-to-recycle and donation items that cannot go in curbside recycling bins. Rather than invest in its own home collection service, Deliver Zero is able to take advantage of a service already in place and, like r.World, The Happy Beetle is able find another revenue stream to support its existing service.

Policy. Colorado has two main funding initiatives that can be used to support reuse and refill initiatives: RREO and FWRD.

RREO grant funding promotes economic development through the management of materials that would otherwise be landfilled. Funds are typically available to support source reduction, recycling, composting, anaerobic digestion, and beneficial use/reuse projects for a wide variety of materials. Funding for the RREO program is generated by tipping fees on solid waste at Colorado landfills.[9]

The Front Range Waste Diversion (FRWD or "forward") enterprise fund collects an increased user fee at Front Range landfills to provide funding and technical support to local governments, nonprofits, businesses, institutions, and other entities on the Front Range that contribute to waste diversion activities within the Front Range. The FRWD grant program funds a range of applicants and projects that divert materials and organics from landfills through recycling, composting, waste reduction, and reuse.[10]

More recently, the City a of Boulder began working with Partners for A Clean Environment (PACE) to offer reuse incentives to small, local businesses. The incentives aim to help businesses replace disposable utensils, cups, plates and to-go containers with reusable items. They also intend to support businesses as they adjust to changes in local composting rules, which no longer allow compostable or paper products in compost bins across the Front Range. The two current incentives include:

- a one-time refund of up to $2,000 for buying reusable solutions like dishwashers, durable dishware, and other in-house reuse solutions; and
- $1500 worth of free reusable takeout container services to restaurants.[11]

Important, the City is partnering with Deliver Zero and r.World. Both r.World and Deliver Zero said the incentives were helping grow their reusable services.

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[9] https://cdphe.colorado.gov/recycling-resources-economic-opportunity

[10] https://www.stopwaste.org/at-work/stopwaste-grants/grant-types/reusable-foodware-infrastructure-grants

[11] https://bouldercolorado.gov/news/city-funds-reuse-incentives-local-businesses

The City of Denver is currently recruiting 35 restaurants for similar program. They will offer $600 for reusable products but are also providing consulting services to the restaurants to develop cost-benefit analyses and to help select products.

2.5 SCENARIO IMPACT

There are opportunities to expand reuse and reduce the use of covered materials in the state. This expansion of reuse, in addition to other factors can be represented in the modelling through a source reduction percentage. This can be in line with targets that are being set in other jurisdictions globally and for this to be scaled at a timescale necessary to enable investment and infrastructure development.

2.5.1 Reusable Containers

Package free shops encourage consumers to bring reusable containers to fill with various products therefore reducing single use packaging types.

Switching to bulk foods and reusable packaging in grocery stores would reduce the amount of paperboard (e.g., pasta boxes and cereal boxes) and rigid plastic in the recyclable material stream. There is also the opportunity to reduce plastic film materials (e.g., plastic bags, pouches, etc.).

2.5.2 Refillable Beverage

Refillable beverage bottles represent a strong opportunity in Colorado for both alcoholic and non-alcoholic beverages. Coca-Cola has a bottler in Denver and PepsiCo is building or has already built its largest U.S. bottling facility in the Denver area. Coors Brewery is in nearby Golden, Colorado and the Front Range is home to numerous craft breweries.

While washing and refilling reusable bottles would require modifications to existing equipment and investment in new equipment, this type of solution and related equipment already exist in places like Oregon, Alberta, British Columbia, Ontario, and Germany. In other words, there is more that is known than is unknown about refillable bottle programs, which is an advantage compared to other reuse and refill systems. For example, switching mainstream grocery stores to all reusable packaging would require hundreds or thousands of brands and packagers to develop reusable packaging or bulk food delivery methods.

One challenge is that Colorado does not have a deposit return scheme (DRS). Having a DRS in place is helpful, as the return infrastructure is already place and consumers are in the habit of returning bottles. Allowing refillable bottles to be returned through the DRS systems seems to be a solution that works elsewhere.

Appendix A. Reuse and Refill Categories and Descriptions

Table 3. Reuse and refill solution categories[12]

Category	Sub-Categories	Description	Examples
Apps and digital rewards	• Reusable bag rewards • Water app/rewards	Apps and digital rewards facilitate reuse behavior by giving users information on avoided environmental impacts, identifying reuse and refill opportunities, and/or providing discounts or rewards.	Goodbag's reusable bags have near field communication (NFC) chips that are scanned in store to give users a choice of planting a tree, cleaning up plastic waste or receiving a discount.
Concentrate-based refill systems	• Personal care • Home care • Perfume and cosmetics	Concentrate-based refill systems remove water from the product for transport and users reconstitute the product at home.	Blueland's home cleaning and hand soap products are reconstituted at home with a branded tablet and tap water.
Package-free shops	• Food and beverage • Home and personal care • Multiple	Package-free shops sell goods to consumers through bulk dispensers into owned or borrowed reusable containers. Package-free shops may have retail storefronts or exist solely online.	Das Gramm provides zero waste grocery items both in store and *via* local delivery. Products that require packaging are available in either paper bags or returnable jars.
Pre-filled refill systems	• Multi-brand pooling • Single brand program • Reusable bag pooling	Pre-filled refill systems use reusable packages that are filled with product by producers prior to being offered for purchase. Customers pay a deposit and receive their deposit back when they return the container.	The GermanWells cooperative provides mineral water producers with reusable glass and plastic bottles. Customers pay a bottle deposit, refunded on return. The cooperative washes and inspects the bottles before providing them to the brands to be refilled.

[12] *Source:* Moss E, Gerken K, Youngblood K and Jambeck JR (2022) Global landscape analysis of reuse and refill solutions. *Front Sustain.* 3:1006702 doi: 10.3389/frsus.2022.1006702

Category	Sub-Categories	Description	Examples
Refill vending and dispensing stations	• Food and beverage • Home and personal care • Water	Refill vending and dispensing stations allow users to refill their own packaging. Some of these programs use proprietary technology to track bottle fills.	Cozie charges users e1.50 for a proprietary container on their first purchase, then credits them e1.50 on their next refill. Customers refill using a proprietary refill station.
Refill *via* single-use plastic free pouches or compostables	• Home care • Perfume and cosmetics • Personal care	Refill *via* single-use plastic free pouches or compostables allows users to refill their product using plastic-free pouches or compostable packaging. Most of these systems deliver refills through the mail.	Above and beyond sells lip balm in an aluminum case. Refills ship in compostable pods that insert into the case.
Reusable cup and container programs	• Cup programs • Container programs	Reusable cup and container programs offer reusable cups or takeout containers either for dine-in or takeaway. Programs typically charge either a deposit up front or charge a fee if it is not returned, though some use a membership model.	Billie cup charges users an e1 deposit to ensure cups stay in the system. The deposit is refunded to the customer when they return the cup.
Reusable shipping and logistics	• B2B • B2C	Reusable shipping and logistics includes both B2B and B2C transport. Reusable B2B shipping solutions include reusable pallets, pallet wrap, crates, and totes. B2C reusable shipping services replace single-use plastic or paper mailers and cardboard boxes with reusable packaging.	IFCO's smart cycle program pools plastic containers amongst many parties in the produce supply chain. Olive users shop from hundreds of e-commerce sites and receive deliveries in reusable shipping boxes, which are later picked up.
Reuse advocacy	• Accelerator program/innovation challenge • Outreach and education • Policy advocacy and standard setting	Reuse advocacy encompasses campaigns and programs that encourage reuse.	Habits of waste #CutOutCutlery campaign works to make food delivery services provide disposable cutlery to customers only if they request it.

Category	Sub-Categories	Description	Examples
	• Research • Technical assistance • Advocacy by for-profit businesses		Mission reuse helps businesses and municipalities with their reuse efforts through interactive webinars.

The Moss et al. study identified 1,196 distinct solutions across the globe as of as of June 10, 2022. Package-free shops were by far the largest category, with 557 such operations identified. The authors also pointed out that these are likely undercounted given the difficulty in identifying every local shop offering package-free options. Reusable cup and container programs were the next largest individual category, with approximately 155 solutions identified. When limiting the publicly available database to solutions with operations in the United States, the total number drops to about 300. Therefore, the expectation would be that we would find much fewer than that number of total solutions in Colorado.

Table 4: Global reuse and refill solutions by category

Category	Number Solutions Identified
Package-Free Shops	557
Reusable Cup & Container Programs	155
Refill Vending / Dispensing Stations	86
Pre-Filled Refill Systems	86
Reusable Shipping & Logistics	46
Refill via Single-Use Plastic Free Pouches/Compostables	41
Concentrate-Based Refill	35
App/Digital Rewards	21

Appendix B. Identified Reuse and Refill Solutions in Colorado

Type of Solution	Primary Covered Entity Waste Stream Impacted	Primary Covered Packaging Categories	Solution Name	Geography
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Apothecary Tinctura	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Aspire Colorado	Golden
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Brighton Refillery	Brighton
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Cedar & Hyde	Boulder
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Cedar & Sage Mercantile	Fort Collins
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Conscious Living Shop	Colorado Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Cream Bean Berry	Durango
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Durango Natural Foods	Durango
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Fill & Refill	Edwards
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Homefill	Denver

Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Hömsted	Glenwood Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Joy Fill	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Juniperseed Mercantile	Littleton
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Khala & Co	Boulder
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Ku Cha House of Tea	Boulder
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Little Herbal Apothecary	Lafayette
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Lucky's Market	Fort Collins
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Mana Foods	Carbondale
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Minimal Market	Loveland
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Mountain Avenue Market	Fort Collins
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Mountain Mama Natural Foods	Colorado Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Mudd House Mercantile	Denver

Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Nature's Oasis	Durango
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	New Moon Refillery	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	New Way Refillery	Grand Junction
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Nude Foods Market	Boulder and Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Off the Bottle	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Ozo Coffee	Boulder and Longmont
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Rececca's Apothecary	Boulder
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Refillary	Parker
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Salus Bath & Body	Manitou Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Simple Body Products	Colorado Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Simply Bulk Market	Longmont
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Balanced Exchange	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Better World Company	Denver

Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Conscious Merchant	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Olive Tap	Manitou Springs
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Source Zero	Berthoud
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	The Zero Market	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Three Arrows Gallery	Denver
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	Two Pines Supply	Granby
Package Free Store	Residential	Rigid Plastic, Flexible Plastic, Paper	WeFill	Durango
Reusable Cup & Container Program	Residential	Rigid Plastic, Paper, Metal	DeliverZero	Front Range
Reusable Cup & Container Program	Residential and Commercial	Rigid Plastic	GreenSheen Paint	Colorado
Reusable Cup & Container Program	Hospitality, Public Spaces	Rigid Plastic	r.World	Front Range
Reusable Cup & Container Program	Residential	Rigid Plastic, Paper, Metal	Nude Foods Market	Boulder/Denver
Reusable Cup & Container Program	Hospitality, Public Spaces	Rigid Plastic	Sustainable CB	Crested Butte
Reusable Cup & Container Program	Educational	Rigid Plastic, Paper	Fort Lewis College	Durango
Reusable Cup & Container Program	Educational	Rigid Plastic, Paper	Sodexo	Multiple
Pre-Filled Refill	Residential	Rigid Plastic, Paper	Royal Crest Dairy	Denver

Pre-Filled Refill	Residential	Rigid Plastic, Paper	Morning Fresh Dairy	Bellvue
Pre-Filled Refill	Residential	Rigid Plastic, Paper	Longmont Dairy	Longmont

Appendix C. Acknowledgements

The project team would like to acknowledge the following organizations for providing information for this project (listed alphabetically):

City of Boulder

City of Denver

Deliver Zero

Eco-Cycle

GreenSheen Paint

Recycle Colorado

Returnity

r.World

Start Consulting

COLORADO NEEDS ASSESSMENT

ELEMENT 12: EDUCATION

JANUARY 25, 2024

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1 EXECUTIVE SUMMARY

1.1 BACKGROUND AND PURPOSE

Education is critical to the success of recycling programs for packaging materials. Recycling collection and sorting rely on individual residents and businesses to place materials in the correct cart or bin, and recycling education can give residents the tools they need to sort material correctly. However, there are challenges to educating residents on the correct way to recycle. Materials accepted by local recycling programs can vary by municipality. Recyclable material may be collected curbside at single-family residences, via dumpster at multifamily residences and schools, and at drop-off or depot sites, among others, and the material accepted may vary by location.

Confusion about what can be recycled can result in opposite outcomes: residents may place recyclable material in the garbage bin, thus reducing the amount of material that can be processed and beneficially reused, or material that cannot be recycled is placed in the recycling bin, which can cause contamination at material recovery facilities (MRFs) and may impact material value to end markets. The purpose of the education element of the Colorado Needs Assessment was to evaluate current recycling education programs in Colorado, evaluate the cost of recycling education, and identify best practices and recommendations for recycling education.

1.2 APPROACH

The project team reviewed existing reports and studies that address recycling education in Colorado and the U.S. The project team also conducted a review of municipalities in Colorado to assess what, if any, recycling education is being offered on their website. As part of the Needs Assessment, the project team conducted a comprehensive survey of municipalities in Colorado, which included questions about recycling education. Lastly, the project team reached out to various stakeholders, including haulers, MRF operators, compost operators, and local nonprofits, to request information on a variety of topics, including education. The information collected from those sources is summarized in this technical memorandum.

1.3 FINDINGS

- Key findings from the municipality desktop research review include the following:
    - Material lists of what can and cannot be recycled were among the most commonly available educational tools for municipalities.
    - Few of the municipalities included in the desktop research have social media accounts dedicated to recycling and/or solid waste management.

- Few municipalities have data on recycling rates and recycled material quantities readily available on their website.
- Fifteen (15) of the areas researched offered some materials in other languages, primarily Spanish. These range from pre-translated printable materials to videos with Spanish narration. Several municipalities had websites that were translatable into multiple languages via Google Translate.
- Some municipalities have unique tools and tactics for recycling education. Some of the resources are toolkits that require residents to be "recycling ambassadors" and evaluate their own recycling practices, such as a Zero Waste Champion toolkit (Lakewood), Eco-Cycle's Eco-Leader Program (supported by and serves Boulder County and communities in Boulder, Broomfield, and Denver)), and home waste audit toolkit (Wheat Ridge). Other resources can be accessed by residents and require less individual effort, such as a recycling app (Thornton), cart tagging (Loveland), and a recycling sorting game (Denver).
- Most recycling education was targeted toward single-family rather than multifamily households.
- Some municipalities and counties partner with nonprofit recycling advocacy and education groups to educate residents and businesses about proper recycling and support recycling education in schools. These groups include Cloud City Conservation Center (Leadville), EcoAction Partners (San Miguel and Ouray Counties), Eco-Cycle (Boulder County), High Country Conservation Center (Summit County), Walking Mountains Science Center (Eagle County), Yampa Valley Sustainability Council (Routt County). These partnerships have led to higher recycling participation, higher diversion rates, and lower contamination than in areas without this type of support.

- Key findings from the Needs Assessment municipality survey include the following:
  - Approximately two-thirds of municipal survey respondents noted that they provide recycling education.
  - Websites or social media campaigns are most commonly used for recycling education, but municipalities also use print, radio, television, in-person events, and other methods to provide recycling education.
  - Colorado has a robust network of nonprofit organizations that are committed to increasing recycling and decreasing contamination in their communities. Municipalities reported that they collaborate with these organizations for recycling education materials.
  - Survey respondents asked where they obtain solid waste and recycling educational materials. Most of the respondents stated that they develop materials in-house or partner with local recycling organizations.
  - Several survey respondents commented that a third-party provider, contractor, or contracted hauler provided recycling education. The desktop research was

primarily focused on education provided by municipalities. However, when the project team found educational materials from haulers, nonprofits, and MRF operators, it was typically not specific to one area.

- Over half of the respondents who provide recycling education reported that they distribute educational materials in multiple languages, typically English and Spanish. The City of Arvada provides recycling education in Russian.
- 26% of the municipalities surveyed had recycling coordinators.
- The amount spent on recycling education was reported to be between $500 and $1 million per year. Calculated per-household costs ranged from less than $1 per household to up to $26 per household.

- Nonprofit recycling and zero waste advocacy organizations in Colorado are also providing educational support for recycling programs and can continue to play a role in the future to improve outcomes. This includes assistance with communication in multifamily buildings, resort/destination communities, and underserviced communities. There are opportunities to leverage developed materials, specific understandings of local communities, and different communication channels.

1.4 SCENARIO CONSIDERATIONS

- Increase funding for recycling education up to The Recycling Partnership's recommended investment of $10 per household per year for five (5) years. This investment aligns with the high performing diversion communities in both the Front Range and Mountain regions within Colorado.
- Implement recycling education programs that incorporate both strategic messaging and in-home tools in alignment with recycling education best practices.
- Create a repository of information and educational resources in multiple languages that are accessible, culturally relevant, and can be used by municipal governments, haulers, MRF operators, compost operators, and nonprofits. At a minimum, recycling education should be provided in English and Spanish. As discussed in the **Element 3 Technical Memorandum,** the third most spoken languages in Colorado are Chinese (including Cantonese and Mandarin) and German, and could potentially be used in recycling education. All signage and materials should be visual, simple, multilingual, and understood at a glance. The library of tools should be comprehensive and broad and include information on extended producer responsibility (EPR) in Colorado, why packaging is being targeted through EPR, and the benefits of packaging recycling.
- Tailor recycling education to the local geography, demographics, and most common recycling contaminants. Additional care should be taken to develop messaging and tactics to reach Environmental Justice (EJ) communities in coordination with community leaders and the Colorado Department of Public Health and Environment's (CDPHE) Environmental Justice Action Task Force.

- Build on existing education programs that have been developed and successfully implemented in the state, working with local jurisdictions, service providers, and nonprofit recycling advocates.
- Use consistent visuals in recycling education and on recycling containers used for single-family and multifamily households.
- Consider including requirements for contracted service providers to provide recycling education, such as mailers and cart tags.
- Consider encouraging and incentivizing municipalities, haulers, and advocacy groups to perform lid-lift campaigns or other high-impact activities.
- Education outreach should be done regularly, including with seasonal nuances, and not just on an annual basis or through one channel.

2 BACKGROUND DATA

Education is often cited as the most effective way to increase diversion and reduce contamination of recyclable materials (see the **Element 4 Technical Memorandum** for more information on contamination). The project team reviewed reports and studies centered on Colorado to assess what information is already available on recycling education.

2.1 ERASE THE WASTE CAMPAIGN

CDPHE provides a statewide recycling campaign called Erase the Waste.[1] CDPHE's website provides resources on waste reduction and recycling best practices. Educational materials are provided in both English and Spanish.[2,3] The website provides tips on reducing waste and recycling containers, locations of local recycling centers, resources for kids, and a "No Glass in the Trash" pledge. CDPHE provides campaign texts and graphics for community use, and some community and nonprofit organization websites reference Erase the Waste as a resource.[4,5]

2.2 FRONT RANGE WASTE DIVERSION BASELINE ASSESSMENT REPORT

The 2021 Front Range Waste Diversion Baseline Assessment was commissioned by the Front Range Waste Diversion (FRWD) Enterprise and prepared by Eco-Cycle.[6] The report was intended to identify current recycling, composting, and waste diversion programs and services along the Front Range and identify barriers to diversion. The report included results from phone interviews with seventy-five (75) municipalities. The municipalities interviewed noted a need for educational materials to remind residents to recycle and reduce contamination. The report findings indicated that education is primarily provided by recycling or waste hauling companies, nonprofits, or volunteer groups.

The survey asked respondents how FRWD funding and technical assistance could help, and providing educational materials was among the top five (5) most common responses. Respondents noted that ready-to-use educational materials targeting a variety of demographics (by age, language, and other factors) would be beneficial.

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[1] https://cdphe.colorado.gov/erase-the-waste

[2] https://www.erasethewasteco.com/

[3] https://www.erasethewasteco.com/espanol

[4] https://www.steamboatpilot.com/news/erase-the-waste-december-tip-making-smart-purchases/

[5] https://yvsc.org/2022/08/11/erase-the-waste-tips/

[6] Eco-Cycle, FRWD Enterprise (2021). *Front Range Waste Diversion Baseline Assessment*.

Municipalities also noted that sharing educational materials between municipalities would reduce the need for each community to develop its own resources.

The report also noted that there was limited quantitative data on education programs and recommended a survey with a list of program options to check off if provided by the municipality.

2.3 GREATER COLORADO WASTE DIVERSION ASSESSMENT REPORT

The 2022 Greater Colorado Waste Diversion Baseline Assessment was commissioned by CDPHE and the (Recycling Resources Economic Opportunity) RREO grant program and prepared by Eco-Cycle.[7] The goal of the project was to evaluate current waste diversion programs in Colorado to measure future progress. The report noted several challenges to recycling education. In some municipalities, seasonal tourism causes significant population fluctuations. This can result in challenges with recycling education, as visitors may not be aware of recycling infrastructure and may not be motivated to recycle. Materials accepted in recycling streams may vary by community, meaning that even in-state tourists may struggle to understand which materials can be recycled. Furthermore, it is difficult for haulers to right-size containers, as seasonal needs for waste and recycling handling varies widely.

The study also noted that some municipalities that have opt-in recycling programs have low participation rates.

2.4 STAKEHOLDER OUTREACH WITH NONPROFIT ORGANIZATIONS

Colorado has a robust network of local recycling nonprofit organizations that have worked for decades to improve education, increase recycling rates, and reduce recycling contamination. In November 2023, Eco-Cycle conducted two stakeholder workshops in coordination with the project team. The goals of the workshops were to gather information on local recycling programs, seek input on strategies to enhance existing services and record each organization’s perspective on producer responsibility legislation. Eco-Cycle prepared a report for the project team summarizing key findings.[8] The report indicated that stakeholders from recycling and environmental nonprofit organizations prioritize increasing recycling access, ensuring equity, eliminating financial barriers, reducing packaging waste, eliminating non-recyclable packaging, and prioritizing locally appropriate recycling education. They also agreed that recycling education should be ongoing, consistent, clear, and culturally appropriate. The stakeholder feedback collected during the two workshops

[7] Eco-Cycle, CDPHE, RREO (2022). Greater Colorado Waste Diversion Baseline Assessment.

[8] Eco-Cycle (2023). Stakeholder Outreach with Nonprofit Organizations dedicated to Recycling and Zero Waste Advocacy and Environmental and Environmental Justice Causes.

will inform the program plan, which will be developed after the Needs Assessment is approved.

3 DESKTOP RESEARCH

Understanding the state of recycling education starts with comprehensive research. To get an accurate portrait of this topic, desktop research was conducted on forty-nine (49) municipalities across the state. With a geography as varied as the state of Colorado, care was taken to ensure municipalities of all sizes and from each of the state's four main geographic regions were researched.

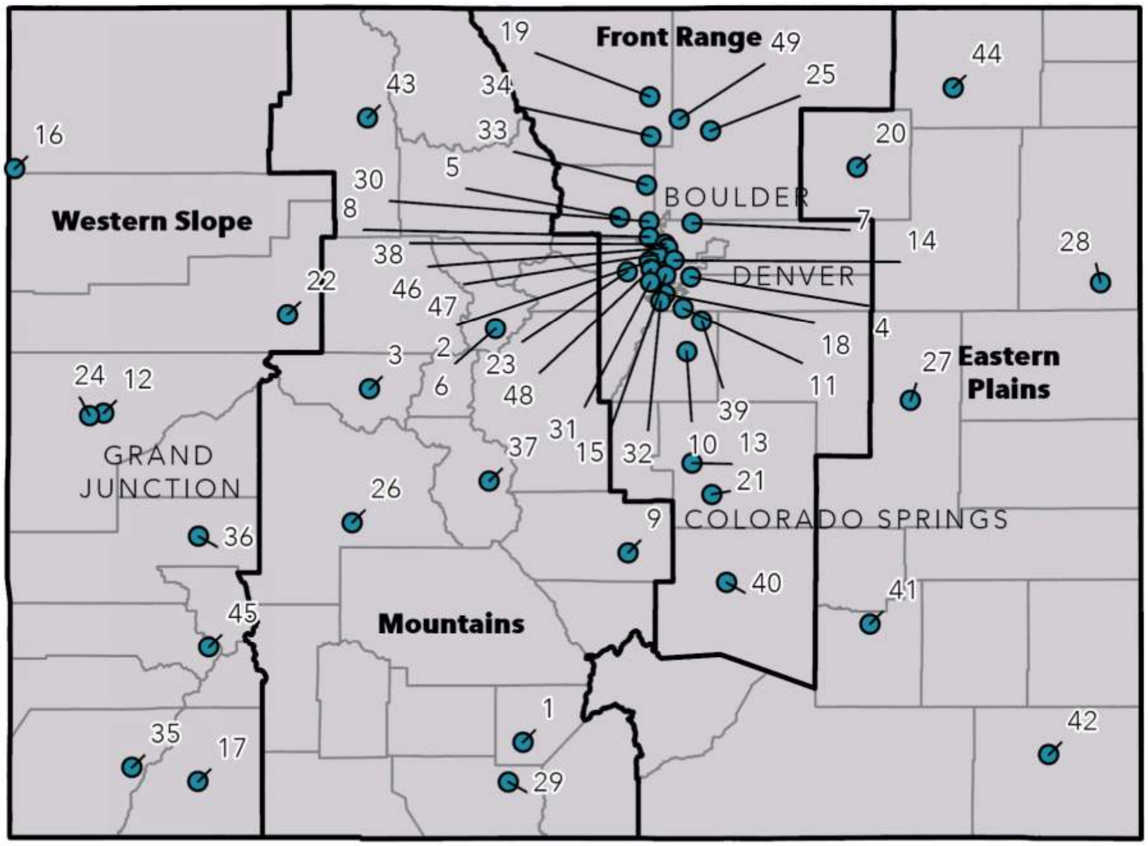
3.1 SELECTED MUNICIPALITIES

To successfully accomplish this, the project team researched each municipality that has more than 30,000 residents based on the 2020 U.S. Census, which was twenty-seven (27) municipalities. The project team understands that many Coloradans live in smaller or rural communities, and therefore, twenty-two (22) additional municipalities were selected for review. The selected municipalities were distributed across the four (4) regions, geographically diverse, and had a variety of population sizes. As most of the state's population inhabits the Front Range, a majority of the selected research occurred in that region, as shown in **Figure 1** below. A table of selected municipalities by population is shown in **Appendix A**, and a breakdown of the selected municipalities by geographic region is shown in **Table 1**.

Table 1: Geographic Breakdown

Region	Number of Municipalities Researched
Western Slope	8
Mountains	8
Front Range	27
Eastern Plains	6

Figure 1: Selected Cities



Label	Name
1	ALAMOSA
2	ARVADA
3	ASPEN
4	AURORA
5	BOULDER
6	BRECKENRIDGE
7	BRIGHTON
8	BROOMFIELD
9	CANON CITY
10	CASTLE ROCK
11	CENTENNIAL
12	CLIFTON
13	COLORADO SPRINGS
14	COMMERCE CITY
15	DENVER
16	DINOSAUR
17	DURANGO

Label	Name
18	ENGLEWOOD
19	FORT COLLINS
20	FORT MORGAN
21	FOUNTAIN
22	GLENWOOD SPRINGS
23	GOLDEN
24	GRAND JUNCTION
25	GREELEY
26	GUNNISON
27	HUGO
28	IDALIA
29	LA JARA
30	LAFAYETTE
31	LAKEWOOD
32	LITTLETON
33	LONGMONT
34	LOVELAND

Label	Name
35	MANCOS
36	MONTROSE
37	NATHROP
38	NORTHGLENN
39	PARKER
40	PUEBLO
41	ROCKY FORD
42	SPRINGFIELD
43	STEAMBOAT SPRINGS
44	STERLING
45	TELLURIDE
46	THORNTON
47	WESTMINSTER
48	WHEAT RIDGE
49	WINDSOR

3.2 DESKTOP RESEARCH METHODS

To gauge a base level of understanding of the selected municipality's educational outreach methods and as a supplement to the municipality survey outlined in **Section 4**, the project team performed a variety of desktop research. These included primarily online methods, including scanning municipality and other affiliated websites (municipality solid waste webpage, linked resources, nonprofit educators, etc.), identifying related social media, and searching for key terms. The project team performed deep dives into the educational materials, tools, and tactics highlighted (or omitted) by each municipality with special regard to their online presence.

3.3 OUTCOMES

A strong online presence is the first step in a multi-faceted community engagement strategy. A breakdown of the research results is summarized below. Digital engagement, including education, can serve as a conduit to in-person materials, further exploration, and connections to helpful resources.

3.3.1 Websites

The initial spot to look for online information is a dedicated website for solid waste and/or recycling information. These sites serve many functions, most importantly as a trusted repository of information. Of the municipalities that were researched, the availability of a webpage dedicated to recycling – and the content contained within – were varied. However, this largely reflected the varied nature of recycling services in the state. For example, many of the state's largest cities, such as Denver, Aurora, and Fort Collins, which have organized recycling services, have well-thought-out sites dedicated to recycling with many educational materials.

However, many municipalities without organized resident recycling and waste disposal services have large information gaps. For example, one of the state's larger municipalities has county-level solid waste and recycling services. City-sponsored webpages do not contain more than a cursory look at recycling. In many cases, the responsibility of sharing educational information on these topics is unclear, and it often falls to haulers, facilities, and nonprofits.

3.3.2 Frequently Used Educational Tools

The following educational tools are currently in use in Colorado, based on the project team's desktop research:

- **Material list:** Material lists of what can and cannot be recycled were one of the most commonly found education tools during the desktop research. These lists were sometimes incredibly detailed, as is the case for Boulder County, Pueblo County, and Denver, and other times rather basic. This type of education is a simple, resident-friendly resource to assist in the proper disposal of waste and recyclable materials. Many of the researched municipalities or related haulers had printable versions of these lists, increasing the ease of posting in a convenient place.

  - The City of Denver and Boulder County/City of Boulder also had an intuitive online search/waste directory tool, as well as interactive games (provided by Eco-Cycle) to test one's knowledge of what materials are acceptable in which waste streams.

- **Social media:** Very few of the surveyed municipalities have social media accounts dedicated to recycling and/or solid waste management. Those that do tend to be primarily on Facebook and post a variety of educational content that can be both evergreen and seasonally based. A handful of the municipalities post about trash, yard waste, and/or recycling occasionally on their main municipality social media pages. Similarly, some haulers, MRF operators, and nonprofits have their own individual pages for municipalities and regions without organized collections. Nonprofit recycling advocates in the state do use social media, including Facebook, Instagram, Twitter/X, LinkedIn, and YouTube, to promote recycling activities.
- **In-person events:** The project team's research showed that few of the selected municipalities hold in-person events. However, those that do host events vary greatly in size and location, from Aurora and Lakewood (Front Range Region) to Aspen and Breckenridge (Mountain Region). The vast majority of these events promote sustainability and collect hard-to-recycle items such as electronic waste. Nonprofit recycling providers/advocacy groups are frequently contracted to support recycling events in communities. Of note, Lafayette held/is holding informational meetings on the transition to a new waste collection system.
- **Annual data on recycling:** Few municipalities have readily available, public-friendly data on recycling. This could be impacted by the lack of municipalities that have organized collections or required data reporting. Some of the information found online was several years old.
- **Languages:** Fifteen of the areas researched offered some materials in other languages, primarily Spanish. These range from pre-translated printable materials to videos with Spanish narration. Several municipalities had websites that were translatable into multiple languages via Google Translate.
- **Calendars and reminders:** Few municipalities offer calendar tools online; even fewer offer the availability for residents to sign up for email, text, and/or phone call reminders. This could be due to the lack of organized collection services within the state.

3.3.3 Other Educational Tools and Tactics

Below are unique tools and tactics some municipalities used to increase recycling education and awareness.

- **Lakewood:** A Zero Waste Champion toolkit is available for public use. It includes printable decals for waste and recycling bins and advice on how to engage your neighbors.[9] There is also a dedicated toolkit for event organizers on how to reduce waste, increase recycling and composting, and measure successful waste diversion rates.[10]
- **Thornton:** There is a specific, dedicated app that includes recycling info and schedule information.
- **Eco-Cycle (Boulder County (and municipalities therein), Broomfield and Denver):** Eco-Cycle's Eco-Leader program empowers volunteers through training and by providing recycling education materials to educate neighbors, coworkers, and friends about recycling best practices, including at multifamily housing. The EcoVisits program, which is separate, is operated in partnership with the University of Colorado and is geared toward college students. [11,12]
- **Loveland:** Drivers of trucks have tags to place on bins to alert residents of contamination. They can use tablets to quickly note which pick-up locations have contamination issues.[13] Additionally, trucks have murals with educational marketing materials.
- **High Country Conservation Center (Summit County):** provides a map of all recycling drop-off centers in the area on their website.
- **Wheat Ridge:** Residents can use the home waste audit toolkit to measure their recycling actions and increase diversion.[14]
- **Denver:** The Denver Recycles Waste Sorting Game allows residents to learn about Denver's waste diversion programs in a fun way.[15] The game has five (5) levels and is available in both English and Spanish.
- **Republic Services:** has a variety of Kids' Corner activities for the communities they serve.[16] These include short videos, activities, and materials in Spanish.

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[9] https://www.lakewood.org/files/assets/public/v/1/planning/sustainability/zero-waste/zero-waste-champion-toolkit.pdf

[10] https://www.lakewood.org/files/assets/public/v/1/planning/sustainability/zero-waste/zero-waste-toolkit-1.pdf

[11] https://ecocycle.org/get-involved/eco-leaders/

[12] EcoVisits | Environmental Center | University of Colorado Boulder

[13] https://wasteadvantagemag.com/the-city-of-loveland-cos-solid-waste-division-creating-a-stronger-circular-economy-at-home/

[14] https://www.ci.wheatridge.co.us/DocumentCenter/View/33256/SWR-Residential-Waste-Audit-Fillable?bidId=

[15] https://denver.recycle.game/

[16] https://www.republicservices.com/municipality/arvada-co/kids-corner

- **Recycling Education in Schools (K-12):** Nonprofit recycling advocate groups in the state have extensive experience supporting recycling programs and education in local schools and could be valuable partners for the PRO in expanding school-based recycling programs statewide.

4 MUNICIPALITY SURVEY AND STAKEHOLDER DISCUSSION WITH ENVIRONMENTAL JUSTICE AND NONPROFIT ENVIRONMENTAL GROUPS

A comprehensive survey was distributed to municipalities around the state to gather data on a variety of topics, including recycling education. Additional information on the survey is included in the **Element 1 Technical Memorandum**.

The project team worked with Eco-Cycle to conduct two stakeholder workshops with diverse recycling advocates and environmental organizations from across Colorado. The goals of these workshops were to (1) gather information regarding local package recycling programs accessible to the organizations' constituents/members and/or that the organizations directly implement, (2) seek input on strategies to enhance the reach of existing or upcoming services within their communities and among underserved demographics, and (3) to record how these organizations' see the implementation of Producer Responsibility for Recycling Packaging leveraging the successes in their areas and improving recycling in their areas and other similar parts of the state.

4.1 SURVEY OUTREACH

When possible, the project team contacted municipalities directly. The survey was also distributed by a variety of nonprofit and industry organizations, including Recycle Colorado, Eco-Cycle, and the Colorado Municipal League. The project team distributed a Colorado Extended Producer Responsibility Needs Assessment Interest Form as an outreach method. Individuals who filled out the Interest Form also had access to the municipality survey. Members of the project team attended conferences to promote community participation in the Needs Assessment and survey. In some cases, members of the project team followed up directly with municipalities to encourage the completion of the survey.

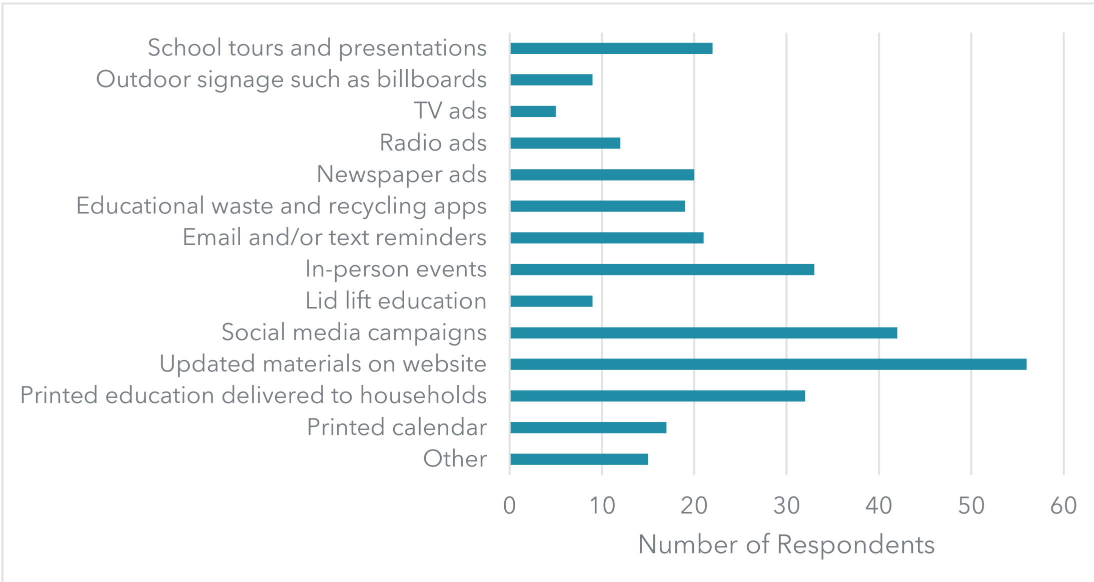
4.2 SURVEY RESULTS

The survey was distributed to approximately 270 municipalities and received 182 overall responses. Survey respondents did not answer every question in the survey. The number of responses per question on recycling education ranged from thirty-six (36) to 110 responses.

4.2.1 Types of Recycling Education

Respondents were asked what type of trash and recycling education survey respondents have provided to residents in the past two (2) years. Respondents were asked to select all that applied. Most municipalities use their websites and social media campaigns to provide recycling education, as shown in **Figure 2**. Educational efforts also rely on in-person events and printed materials.

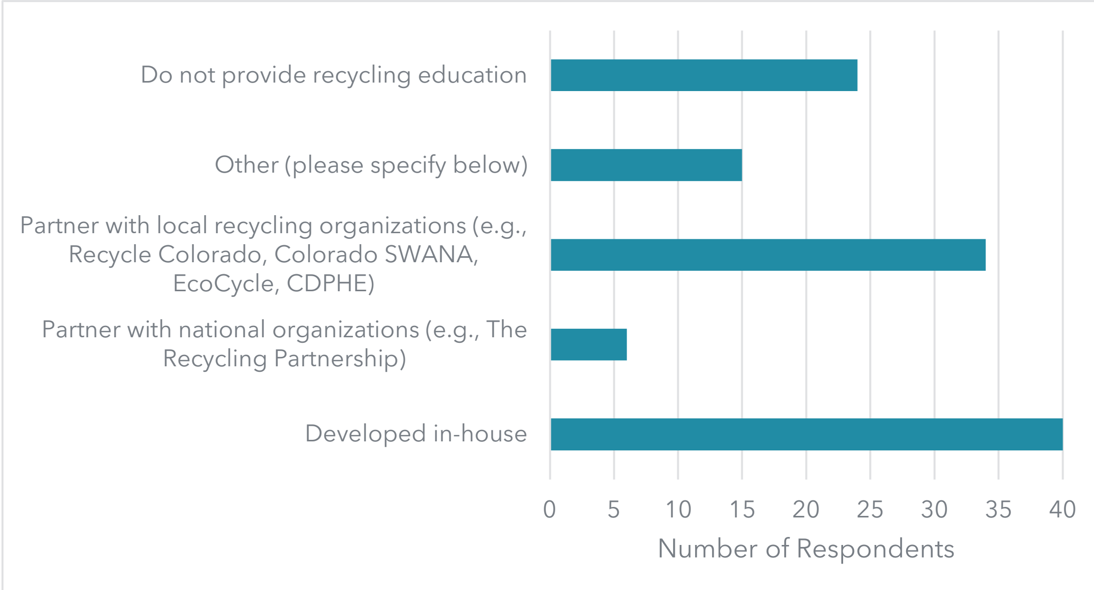
Figure 2: Types of Recycling Education



Respondents who answered "Other" were asked to list additional education efforts. Answers included sorting guideline signs, movie theater ads, virtual and in-person events, school tours, and newspaper stories. One (1) municipality noted that the local hauler provided education on their own website.

Survey respondents were also asked where they obtain solid waste and recycling educational materials. As shown in **Figure 3**, most of the respondents stated that they develop materials in-house or partner with local recycling organizations. Many respondents noted that they do not provide recycling education. Several survey respondents commented that a third-party provider, contractor, or contracted hauler provided recycling education.

Figure 3: Sources of Recycling Education



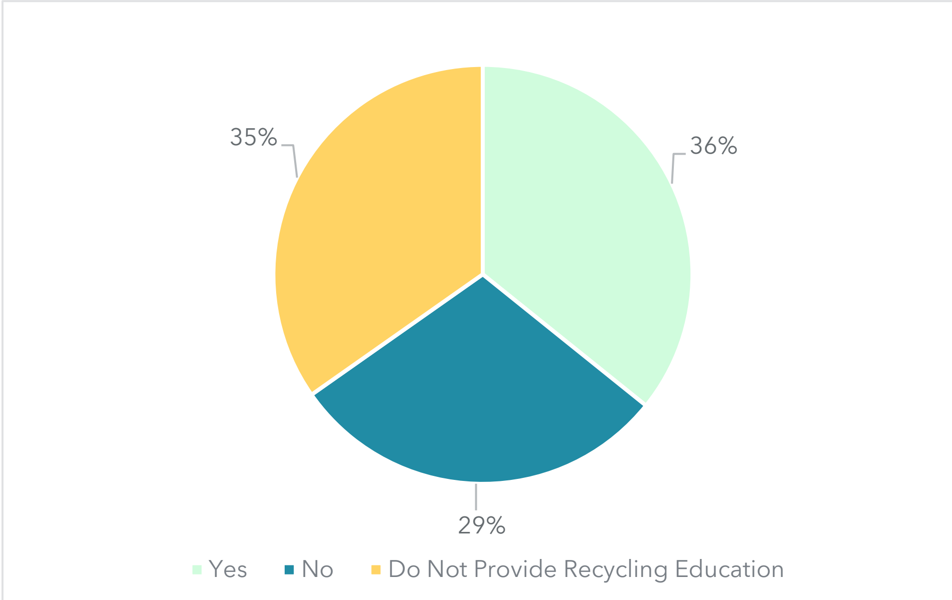
4.2.2 Language Accessibility

As discussed in the **Element 3 Technical Memorandum**, multiple languages are spoken in Colorado, with English and Spanish spoken most often. Over half of the respondents who provide recycling education distribute educational materials in multiple languages, as shown in **Figure 4**. Nearly all of the municipalities that reported which languages they use for recycling education listed English and Spanish. The City of Arvada also provides its recycling education in Russian. The City of Northglenn's website can be translated into multiple languages.[17] Both cities are located in the Front Range.

Partnering with existing nonprofit recycling advocates and environmental justice groups could help determine which messages resonate with different communities. These groups have decades of experience facilitating discussions with community leaders, focus groups, and surveys and will be able to help identify where further research and engagement is needed. Including financial incentives with surveys can help achieve a higher response rate. Qualitative data and selective interviews can also inform the effectiveness of the outreach program. Messaging should also acknowledge and celebrate the fact that a lot of underserved communities have already been recycling and reusing materials. This will help people "see themselves" and make recycling more accessible.

[17] https://www.northglenn.org/government/departments/public_works/trash/recycling.php

Figure 4: Recycling Education Provided in Multiple Languages



4.2.3 Staffing and Cost

Of the municipalities surveyed, approximately 26% had recycling coordinators. If the responding municipality had a staff member who spent part of their time as a recycling coordinator, respondents were asked to enter the number as a fraction. For example, a staff member who spent half their time on recycling efforts would be listed as 0.5. When asked how many full-time employees are dedicated to recycling, the answers ranged from 0.1 to 14.

Municipalities were also asked what they spent annually on solid waste management education. Responses varied widely. Nine (9) respondents spent $10,000 or less; seven (7) spent between $10,000 and $100,000; and three (3) respondents spent more than $100,000. Recycling education ranged from less than $1 per household to up to approximately $26 per household. The average cost per household was approximately $4. However, most municipalities surveyed did not answer the question on recycling education, and therefore, limited data was available to calculate average costs per household. Furthermore, different communities may measure recycling education costs differently, depending on which factors they include in their education costs. For example, communities with recycling coordinators may or may not include staff time in their recycling education costs. Therefore, this cost per household is not necessarily consistent statewide.

Note: Some municipalities and counties contract with Colorado nonprofit recycling advocacy and education organizations to create and distribute educational campaigns around proper recycling.

5 BEST PRACTICES

5.1 FINANCIAL INVESTMENT IN RECYCLING EDUCATION

The Recycling Partnership estimates that $1.2 billion invested annually in education and outreach strategies to improve recycling behavior could push recycling rates up to 70% when implemented alongside improvements in infrastructure and access.[18] The Recycling Partnership is a mission-driven non-governmental organization (NGO) that is committed to advancing a circular economy by building a better recycling system. They work with everyone, from municipalities to industry partners to government entities, to address challenges within each part of the waste system. The insights they gather along the way have made them a trusted source for data-driven solutions.[19] Colorado also has a robust network of nonprofits that are committed to recycling and recycling education and have tools and resources available to residents and businesses. As shown in **Figure 3**, many municipalities reported that they partner with local organizations (e.g., Recycle Colorado, Colorado SWANA, EcoCycle, and CDPHE) to obtain or develop recycling education.

5.1.1 Funding Breakdown

Using an EPA framework for calculating economic benefit, The Recycling Partnership estimates that an investment of $17 billion over five years will create an economic benefit of $30.8 billion over ten years (including wages, taxes, landfill savings, and the value of recyclables).[20] The proposed investment includes costs for both education and infrastructure.

The annual investment in education over five years is $6 billion, which is the largest investment in this model, compared to $4 billion for equitable recycling access improvements, $3 billion for upgrading Material Recovery Facilities (MRFs), and $4 billion for film and flexible plastic solutions (which includes funds for education specific to these solutions)5.[21]

5

This total was calculated using an average cost of $10 per household per year, which is based on The Recycling Partnership's prior experience and a data-backed best practice approach to resident education and engagement. This level of outreach and

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[18] Paying-It-Forward-5.18.21-final.pdf (recyclingpartnership.org)

[19] About Us | Solving for Circularity (recyclingpartnership.org)

[20] 2020 Recycling Economic Information Report (epa.gov)

[21] Paying-It-Forward-5.18.21-final.pdf (recyclingpartnership.org)

engagement, especially with residents who previously did not have recycling service, can increase material recovery by 40% or more.[22] This investment was consistent with high-performing communities both in the Front Range with heavy single-family and multifamily residential populations, as well as in the Mountains with heavy multifamily and tourism (transient) populations.

The project team also reviewed spending by households in some Canadian communities that have implemented EPR policies. In 2022, spending on promotion and education in British Columbia was $0.97 per household.[23] Circular Materials is currently offering municipalities in Ontario $1.50 per household for education. A 2007 KPMG report assessed eight high-performing Ontario municipalities showed that similar municipalities with similar diversion rates spend, on average, $1.00 per household.[24] Those prices may increase if enforcement activities, such as cart tagging, and other activities that could be considered both operational and education-related (such as the provision of recycling containers), are incorporated into an education program.

5.1.2 Application of Funds

The Recycling Partnership has identified some of the most effective ways to use funds allocated to recycling education. The level and type of education needed will vary by municipality and household, but these general best practices can help ensure the greatest outcome per dollar spent.

- **Restore public trust in the recycling system.** Stories revealing negative information about the end destination of recyclables have been common in the news and on social media in the past several years. Many people are skeptical and believe their recyclables are not being managed properly. This, along with conflicting information about what can and cannot be recycled, often leads people to feel that their efforts are futile. According to The Recycling Partnership, "There is convincing evidence that lifting back the curtain on recycling to demonstrate how and why the system works through local storytelling, tours, customer feedback, and more could help rebuild trust."[25] Increasing transparency in the recycling system will also restore public trust over time.
- **Tailor outreach to specific audiences.** Not all residents are the same, and their needs related to recycling education differ. Using culturally relevant images, creating materials in a language that is accessible to recipients, and developing messages that resonate with residents of a particular community can help increase

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[22] Paying-It-Forward-5.18.21-final.pdf (recyclingpartnership.org)
[23] https://recyclebc.ca/wp-content/uploads/2023/06/RecycleBC_AR2022_FINAL.pdf
[24] https://www.stewardshipontario.ca/wp-content/uploads/2013/03/KPMG_final_report_vol1.pdf
[25] Recycling-Partnership-Center-Sustainable-Behavior-Knowledge-report2.pdf (recyclingpartnership.org)

participation in recycling programs.[26] Additional information on Colorado's demographics, which could be used to inform recycling education strategies, is included in the **Element 3 Technical Memorandum**.

- **Conduct studies at the cart- or MRF level to understand needs.** Starting by identifying the most common issues (i.e., which items are most often placed in the wrong container) allows municipalities to focus their outreach on those specific items and can create a positive feedback loop.[27] Additional information on common contaminants and their impact on MRFs is included in the **Element 4** and **Element 6 Technical Memorandums**.
- **Engage drivers in identifying contamination.** Cart-tagging by drivers (i.e., "Oops, this material belongs in the garbage" or "These metal cans can be recycled!") is an effective strategy for reducing contamination and improving diversion rates and can inform cart-level analysis.[28] Some haulers also reject contaminated carts to incentivize greater attention to sorting. There are emerging technology solutions that can assist in this activity.

5.2 CASE STUDIES

The Recycling Partnership has conducted case studies to understand the impact of various strategies on recycling outcomes, including associated costs for the strategy. These strategies and their impacts are summarized in **Table 2**. Most of the case studies identified focused on single-family households.

- One (1) study compared recycling rates for residents who received a mailer with recycling education or a mailer *and* an in-home recycling bin in Elgin, IL, and Baldwin Park, CA, as well as a control group who received no education. There was no statistically significant difference in recycling rates at the route level, but **residents who received an intervention that included an in-home recycling bin were more likely to recall campaign materials** and agree with positive sentiments about recycling.[29]
- In a study in Chicago, in-home tools (like a recycling bin and a spatula to clean out containers with food residue) were provided alongside motivational messaging through mailers, cart tags, or info packets with the tools. There was a statistically significant increase in average recycling volume in the groups that received strategic messaging. This suggests **tactics that motivate residents with messaging could be more impactful than in-home tools.**[30]

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[26] Recycling-Partnership-Center-Sustainable-Behavior-Knowledge-report2.pdf (recyclingpartnership.org)

[27] Start at the Cart - The Recycling Partnership

[28] Start at the Cart - The Recycling Partnership

[29] BaldwinPark_Elgin__Pilot_Report_Final-1.pdf (recyclingpartnership.org)

[30] Chicago_Pilot_Report_Final.pdf (recyclingpartnership.org)

- Another study analyzed door-to-door intervention. Canvassers attempted interviews with residents and provided follow-up mailers and/or door hangers. Across groups, there was no increase in overall recycling tonnage, but the composition of the material changed, with a **20% increase in recyclable fiber in the single-family intervention group.**[31]
- One study conducted in Ottawa, Canada, focused on multifamily housing. The City of Ottawa conducted a pilot project to evaluate whether using colorful vinyl wrapping with images of recyclables on bins would help residents place items in the correct bins.[32] The project received funding from the Continuous Improvement Fund (CIF), an Ontario fund financed by municipalities and packaging producers. CIF reported that the project increased capture and reduced contamination in multifamily structures.[33] The City concluded that the cost of the program was too high to expand it City-wide but that it could be effective as a targeted strategy for areas with low recycling rates and high contamination rates.[32]

Table 2: Results from The Recycling Partnership Case Studies on Recycling Education Tactics

Tactic	Cost Per Tactic	Impact
Mailer	$0.31 (Elgin, IL) $0.44 (Baldwin Park, CA)	Less likely than those who also received an in-home recycling bin to recall campaign materials.
Mailer AND in-home recycling bin	$6.20 (Elgin, IL) $18.61 (Baldwin Park, CA)[34]	More likely than mailer-only to recall campaign materials and agree with positive sentiments about recycling.
Motivational messaging via cart tags, mailers, info packets	Varied depending on the type of messaging Mailer-only: $1.50	Statistically significant increase in average recycling volume.
In-home tools	Varied depending on the tool and type of messaging All materials: $18.25[35]	Strategic messaging may be more impactful than in-home tools.
Door-to-door education	$8.69 per single-family	20% increase in recyclable fiber in the single-family intervention group.

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31 CollierCounty_Pilot_Report_Final.pdf (recyclingpartnership.org)

32 https://resource-recycling.com/recycling/2019/01/22/how-visuals-can-boost-multi-family-recycling/

33 https://thecif.ca/tis-the-season-for-wrapping/

34 The cost per household was much lower for the bin and mailer group in Elgin, IL, because city staff delivered all the bins to households and internalized all costs. In Baldwin Park, CA, a consultant was hired to deliver the bins, and this price included compensation for staff time.

35 This was the highest cost and included cart tags, spatulas, AND in-home bins with info cards and labels.

Tactic	Cost Per Tactic	Impact
	$17.56 per multifamily unit[36]	
Wrapping Multifamily Bins	$75,000 total[37] $530 per wrap[37]	11% increase in capture and 6% decrease in contamination for fiber, and 7% increase in capture and 10% decrease in contamination for containers

[36] This included staff costs to execute the door-to-door motivational interviews and deliver bins and door hangers to multifamily locations.

[37] Cost in Canadian dollars.

6 EDUCATION CONSIDERATIONS

There exist several opportunities to increase diversion and positive sentiment through improved public education. The current state of recycling education is highly variable across Colorado. Any additional attention to the development and dissemination of educational materials would be an improvement; a targeted, coordinated effort could yield substantial results. Building a successful, comprehensive behavior change campaign requires a combination of proven methods and tailoring of tactics for individual audiences. Below is a list of key recommendations to achieve the stated education-focused goals.

6.1 REGION-SPECIFIC OPPORTUNITIES

As Colorado develops a state-specific Minimum Recyclables List, as discussed in the **Element 8 Technical Memorandum**, standardized educational materials that can be used across the state may be developed. Educational materials should be clear, accessible, non-technical, and use simple language and graphics for clarity. Different versions of those materials may be developed to optimize messaging for certain audiences, demographic, or geographic factors. See below for potential education considerations for each region:

- **Eastern Plains:** As discussed in the **Element 3 Technical Memorandum**, this region has the least amount of recycling infrastructure and also several areas defined as Disproportionate Impacted Communities. Using a multi-platform approach (mailers, social media, online materials, in-person events) will ensure that more residents are reached.
- **Front Range:** This densely populated corridor contains some of the most diverse communities in the state. While some of the municipalities researched have educational materials available in Spanish or websites with translation widgets, performing outreach in additional languages would be a strong tool to engage more residents, particularly immigrants. The City and County of Denver is a regional leader in efforts to engage residents with Limited English Proficiency (LEP). All municipal agencies must develop a language access plan.[38] To assist in these efforts, the municipality has developed a neighborhood language map with a breakdown of languages spoken in the city's distinct neighborhoods.[39] Other municipalities and organizations within the Front Range region should consider implementing similar data collection efforts to best target residents. Making clear, consistent messaging such as the Readily Recyclables List easily accessible in the Front Range in communities that currently lack robust recycling education should increase recycling behaviors.

  Also, a high concentration of colleges can be found in this region, including the University of Colorado Boulder, Colorado State University in Fort Collins, University of Denver, Colorado School of Mines, University of Colorado-Denver in Denver, and Metro State University in

[38] https://denvergov.org/Government/Agencies-Departments-Offices/Agencies-Departments-Offices-Directory/Human-Rights-Community-Partnerships/Divisions-Offices/Office-of-Immigrant-Refugee-Affairs/Language-Access

[39] https://experience.arcgis.com/experience/6c876a097e0c41808e9c5db8bbc1575b/

Denver. [40] There is an opportunity to develop or strengthen partnerships with these institutions to engage the typically youthful population that frequently changes residences. Efforts could include outreach efforts on platforms frequently used by college students, such as social media (Snapchat, Instagram, TikTok); encouraging reuse and donation of household materials during move-in and move-out periods; and engaging professors, students, and administration within sustainability, environmental science, and other related fields.

- **Mountains:** As discussed in the **Element 3 Technical Memorandum**, this region faces a high degree of population fluctuation due to seasonal tourism draws. Colorado Ski Country, a trade association that represents twenty-one (21) ski and snowboard resorts in the state (primarily in the Mountain region), reported 14.8 million skier visits within the state in the 2022-2023 season.[41] This provides an opportunity for municipalities to directly reach tourists who may not be familiar with the region's recycling opportunities through partnerships with ski resorts, hotels, and short-term rentals. Nonprofit recycling advocates, including Walking Mountains Science Center and High Country Conservation Center, have experience working with resorts and other venues, local media, and events to educate tourists and seasonal employees about local recycling systems.
- **Western Slope:** The majority of the population in this region is centered in a Tri-County Area. Focusing efforts within the area could have the largest return on investment.

6.2 FISCAL ENHANCEMENTS

As outlined in Section 5, delivering impactful recycling education has associated costs. Case studies have shown that the right investments in recycling education can have an impact on recycling outcomes, including reduced contamination rates and increased volume of recycling. People who received certain types of education in these studies were more easily able to recall information about recycling and were more likely to agree with positive sentiments about recycling. Key recommendations include:

- Increase funding for recycling education up to The Recycling Partnership's recommended investment of $10 per household per year. To engage all households across Colorado would require a total investment of approximately $22.3 million per year.[42]
- Provide municipalities information on available grant program funding to support recycling education (such as the CDPHE's Recycling Resources Economic Opportunity program and the Front Range Waste Diversion program).

6.3 MATERIALS DEVELOPMENT

Since many municipalities within the state do not have existing recycling educational materials available, there is a major opportunity to provide an impactful groundswell of baseline information. Key recommendations include:

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[40] https://highered.colorado.gov/Data/InstSelect.aspx

[41] https://media.coloradoski.com/colorado-ski-country-usa-announces-record-skier-visitation-during-snowy-2022-2023-season

[42] https://www.census.gov/quickfacts/fact/table/CO/HSD410221

- Implement recycling education programs that incorporate both strategic messaging and in-home tools in alignment with recycling education best practices.
- Tailor recycling education to the local geography and most common recycling contaminants.
- Consider demographic information when developing materials. As outlined in the **Element 3 Technical Memorandum,** there is a high degree of limited English proficiency within the state. In addition to Spanish, areas of concentrated non-English speakers exist and would be well served by materials in additional languages and adapted to be culturally relevant.
- Take additional care to develop specific strategies in conjunction with community leaders for EJ communities. EJ and historically disadvantaged areas are not one-size-fits-all, and tactics should be selected that reflect the most common challenges faced within those areas, as well as their demographics and other unique factors. This work could be conducted in coordination with CDPHE's Environmental Justice Action Task Force and other environmental justice organizations and recycling advocate organizations.
- Building on successful materials already developed for different demographics within the Colorado community, create a free repository of information and resources in multiple languages that municipalities can customize and use to fit their sustainability goals.
    - This online library would also have public-facing information on topics including why packaging should be managed, why recycling and solid waste management are important, and how materials are recycled.
    - Materials should include graphics, handouts including materials lists, articles, drafted social media posts, and press releases.
    - Specific campaigns can be developed for distinct audiences, including the various geographic regions, businesses, and recycling types (compost, residential curbside, residential drop-off, etc.).
    - To complement the online repository and to be mindful that not all Coloradans have access to broadband, consider implementing a statewide phone number where residents can call to receive information about recycling in their area, how to recycle unusual items, etc.
- Building on successful materials already created for Colorado audiences, develop specific, strategic messaging tailored to special groups such as college students, large multi-unit apartment buildings, and K-12 educational facilities.
- Building on tools such as Waste Wizard used by multiple haulers, municipalities, and nonprofit educators, consider using artificial intelligence (AI) to support educational efforts. Technologies such as TrashBot[43] and OscarSort[44] can sort recyclable material at the user-bin interface. Furthermore, AI-based tools such as KnowWaste could be trained to answer questions on which materials are recyclable.[45]

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[43] https://cleanrobotics.com/trashbot/

[44] https://intuitiveai.ca/oscar-sort

[45] https://knowaste.app/

6.4 IMPLEMENTATION

After investments have been made and materials developed, the next step is successfully delivering educational messaging to key audiences. Key recommendations include:

- Encouraging and incentivizing municipalities, haulers, and advocacy groups to perform lid lift campaigns or other high-impact activities.
- Providing multiple formats of message delivery in tandem, such as online information and mailed materials, will help reach residents where they are. (e.g., not all Coloradans have access to broadband; renters may not receive mailed notices)
- Partnering with (and training more) ambassadors within key communities. These range from collections workers to advocacy group members.
- Working with stakeholders within municipalities (such as elected officials and community leaders) to develop strategies that best fit the needs of their areas. Including those affected by a project in its genesis is a best practice for creating and delivering impactful and successful educational and behavior change campaigns. In particular, it is important to engage historically marginalized communities and those who are disproportionately impacted by environmental issues in designing effective outreach strategies.

Appendix A.
Selected Municipalities

Municipality	Region	2022 Population [46]
Denver	Front Range	713,252
Colorado Springs	Front Range	486,248
Aurora	Front Range	393,537
Fort Collins	Front Range	169,249
Lakewood	Front Range	156,120
Thornton	Front Range	143,282
Arvada	Front Range	121,581
Westminster	Front Range	114,533
Pueblo	Front Range	111,456
Greeley	Front Range	109,209
Centennial	Front Range	105,865
Boulder	Front Range	105,485
Longmont	Front Range	98,687
Castle Rock	Front Range	80,191
Loveland	Front Range	77,884
Broomfield	Front Range	76,121
Grand Junction	Western Slope	68,034
Commerce City	Front Range	66,115
Parker	Front Range	61,222
Littleton	Front Range	44,755
Brighton	Front Range	41,881
Windsor	Front Range	38,510
Northglenn	Front Range	38,106
Englewood	Front Range	33,642
Wheat Ridge	Front Range	31,879
Lafayette	Front Range	30,699
Fountain	Front Range	28,907
Clifton	Western Slope	21,003
Montrose	Western Slope	21,003

[46] https://www.census.gov/

Municipality	Region	2022 Population [46]
Golden	Front Range	20,460
Durango	Western Slope	19,531
Cañon City	Mountains	17,258
Steamboat Springs	Mountains	13,302
Sterling	Eastern Plains	13,102
Fort Morgan	Eastern Plains	11,453
Glenwood Springs	Western Slope	10,264
Alamosa	Mountains	9,845
Gunnison	Mountains	6,794
Aspen	Mountains	6,741
Breckenridge	Mountains	5,373
Rocky Ford	Eastern Plains	3,822
Telluride	Western Slope	2,429
Springfield	Eastern Plains	1,386
Mancos	Western Slope	1,196
Hugo	Eastern Plains	776
La Jara	Mountains	730
Nathrop	Mountains	288
Dinosaur	Western Slope	243
Idalia	Eastern Plains	97

COLORADO NEEDS ASSESSMENT

ELEMENT 14: COMPOST

JANUARY 25, 2024

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1 EXECUTIVE SUMMARY

1.1 PURPOSE

Composting diverts organic material from landfilling and produces a useable end product. The composting process is a way to potentially manage compostable single-use packaging, including compostable service ware. This memo outlines the capacity and feedstocks of composting facilities in Colorado. The purpose of the analysis for the Colorado Needs Assessment is to evaluate whether facilities accept compostable packaging and service ware, the capacity of composting facilities, and the potential for expanded capacity.

1.2 APPROACH

To accomplish this task of assessing existing capacity, organic trends, and associated costs, the project team took a two-fold approach. First, the project team conducted a literature review of existing studies and regulations impacting Colorado's organic waste stream. The team then developed and executed site visits and surveys of composting facilities operating in Colorado.

1.2.1 Permitting and Regulatory Impact Assessment

Several recent studies have been prepared assessing the State's organics industry, including the 2022 Statewide Organics Management Plan (2022 SOMP). The 2022 SOMP and several other studies were reviewed for this study. The commercial compost facilities evaluated are regulated under Section 14 of 6 CCR 1007-2. This study outlines the permitting requirements by facility type and assesses potential opportunities and hurdles to increasing in-state organics processing capacity.

1.2.2 2023 Compost Processor Needs Assessment Survey

The HDR team developed the 2023 Compost Processor Needs Assessment Survey (2023 Compost Survey) to gather relevant data on a select but diverse list of composting operations across the four (4) distinct Colorado regions (Western Slope, Mountains, Front Range, and Eastern Plains). The surveys covered a range of factors related to the composting facility's operations, including, but not limited to, acceptance or ability to accept compostable packaging, processing capacity, and expansion opportunities, capital and operational costs, and feedstock sources. The survey also included questions on contamination, which are included in the **Element 4 Technical Memorandum**.

1.3 FINDINGS

- The primary feedstock of the compost facilities visited and surveyed is organic materials (food processing waste, brewery spent grains, yard waste, and biosolids). There are limited facilities that currently accept and process compostable packaging products.
- Based on a review of municipal codes from the most populated counties in the four (4) Colorado regions, composting is not a clearly defined use and is most often grouped with solid waste facilities. This, in turn, may limit the composting operations access to properly zoned land. Separating out the processing of organic materials into a nutrient-rich product from the disposal or transfer of materials is a critical step in supporting the development of organics processing infrastructure in the state.
- Nearly all composting facilities surveyed take a mixture of green and food waste. While only two (2) operators surveyed reported composition data for compostable packaging. Six (6) surveyed facilities reported currently accepting compostable packaging, and several more suggested that they are willing to accept compostable packaging. Note: Based on the types of organics and compostables being accepted, the generators serviced, and the associated weights of materials will have an impact on contamination rates.
- Nine (9) of the facilities surveyed reported accepting paper products, and fourteen (14) facilities surveyed reported accepting other compostable materials. Other compostable materials could include molded pulp, tissue/toweling, soiled paper, soiled cardboard, and shredded paper.
- The two (2) largest concerns for compostable products were labeling and field test data (certification standards). Another significant concern for compostable products was the presence of PFAS in the materials. It was reported that an absence of standards results in elevated contamination within the feedstock and reduced compost quality.
- The State of Colorado has a current organics processing capacity of approximately 400,000 tons per year and a potential capacity of roughly 1,100,000 tons per year. These values include weights of materials from residential and commercial generators, including feedstocks comprising green waste, food waste, wood waste, biosolids, and compostable packaging materials.
- Approximately one-quarter of the current processing capacity and potential capacity are associated with facilities currently accepting or willing to accept compostable packaging at the time of the survey. Additionally, approximately 20% by weight of that capacity is dedicated to feedstocks or generators that include compostable packaging products.
- Consistent end markets impact processing capacity, as it is necessary to move material to end markets to allow room for processing additional feedstock.

- The most common processing approach was windrow composting, although aerated static pile systems are currently being piloted or used in conjunction with windrow composting at a few facilities.
- The leading recommendation from feedstock generators and other participants along the value chain was to focus on education to reduce contamination.

  Facility operators surveyed suggested that receiving pads, de-packagers, sortation lines, shredders, and associated operation building would be the primary need for facilities to effectively process compostable packaging.

1.4 RECOMMENDATIONS

- Increase statewide education to ensure proper sorting of organic waste and reduce contamination of non-compostable materials in the organic waste stream.
- Implement waste auditing process by the hauler and/or the jurisdiction managing the collection of the organic waste stream.
- Encourage implementation of uniform labeling to more easily and effectively differentiate compostable vs. non-compostable packaging in the waste stream.
- Encourage implementation of practical and transparent certification standards.
- Invest in infrastructure (buildings, sorting equipment, de-packagers, and shredders) to promote more effective processing of compostable packaging products.
- Develop enforcement mechanisms to control contamination.
- Improve and streamline permitting process composting operation to reduce time and costs associated with the process.

Please refer to the **Element 7 Technical Memorandum** for a detailed description of the opportunities and costs associated with considerations for improvement of facilities to promote increased management of compostable packaging in Colorado.

2 STATE GOALS AND ORGANICS ASSESSMENTS

The project team reviewed reports that address composting from readily available resources. The reports obtained information from a variety of sources, such as stakeholder interviews and facility data collection. A summary of key information relevant to the Needs Assessment is included below.

2.1 2022 STATEWIDE ORGANICS MANAGEMENT PLAN

The 2022 SOMP was commissioned by the Colorado Department of Public Health & Environment (CDPHE) to serve as "a framework to identify key elements, options, and recommendations to increase organic waste diversion opportunities throughout the State," which could be used by policy makers, counties, and municipalities to develop organics programs.[1] Research and recommendations are presented on a state-wide level and in more detail by region (Western Slope, Mountains, Front Range, and Eastern Plains). The report makes the case for tailoring organics management solutions to each region due to the many differences found between urban and rural regions.

Much of the information found in the 2022 SOMP is relevant to the Colorado Needs Assessment. A selection of key findings and corresponding methodologies are presented below. The 2022 SOMP considered organic waste sorted into five categories. This summary focuses primarily on the findings related to yard waste and food waste, as waste in those categories is most likely to be processed at facilities that currently accept or may eventually accept compostable plastic materials. Agricultural materials, forest materials, and biosolids were also discussed in the 2022 SOMP.

2.1.1 Municipal and Regional Organics Waste Survey

A municipal and regional Organics Waste Survey was prepared as part of the 2022 SOMP. It was used to collect data from processing facilities as well as cities and counties.

Compost Processors

The 2022 SOMP chose twenty-six (26) compost facility operators in Colorado to survey facility gate fees and processing capacity, as well as plans for future processing capacity and perceived barriers to processing organic materials. Responses were received from seventeen (17) of the facility operators chosen. Using both the survey

[1] Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. August 29, 2022. (2022 SOMP)

results and supplemental state-published data, the 2022 SOMP found that there is existing, unused processing capacity at some of the composting facilities across the state. These facilities would be able to process an additional 127,000 to 157,000 total tons annually without making any significant investments in expansion; this equates to only 5-6% of the state's total tons of organic waste sent to landfills in 2020. The biggest opportunities for capturing organic waste are in the metro areas of the Front Range Region. With expanding processing capacity and end market development, the 2022 SOMP estimates that the demand for finished compost could be as much as five (5) times the amount of compost currently being produced.

Some of the most common barriers to composting in Colorado that were cited in the survey responses included the time and costs required by the permitting process, a lack of end-markets for the compost, a lack of public awareness of how to participate and how to participate correctly, issues with contamination that have forced compost facilities to limit accepting feedstocks from anywhere but trusted sources, staffing shortages, and high hauling costs due to the distances between feedstock sources and composting facilities.

Cities and Counties

The 2022 SOMP contains results from an organics survey conducted to identify existing information on organics in city/county databases, as well as gaps in information and barriers to organics management. The survey included a web questionnaire and phone interviews with communities, counties, and landfill operators. Complementary research was also conducted through reviewing reports and online searches of city and county websites. One of the primary sources of supplemental data used for the 2022 SOMP is the 2021 Annual Report, which was submitted to the Colorado General Assembly on February 1, 2022, and was largely based on generation, organics management, and disposal data from 2020. The results from these combined efforts covered 85% of counties and 31% of communities in the state. Though not statistically representative, the results can be used to identify trends and get an overall picture of the current system and planned expansions.

One key finding of this survey and research effort is the level of access to organics services for each region and across the state. Access is defined as a program being available; programs may have fees and may not be fully utilized by everyone with access. The results are reproduced below as reported in the 2022 SOMP. Please note this data is based on data acquired prior to August 2022. Non-recycled paper refers to food-soiled/compostable paper. Per Colorado regulations, (6 CCR 1007-2 Part 1) the 2022 SOMP considers food residuals to include compostable food service ware and packaging that may be commingled with discarded food.

Table 1: Access to Organics by Collection Method and Material by Region

Percent of	Access by Collection Method	State-Wide	Eastern Plains	Western Slope	Mountains	Front Range
Communities	Curbside: Percent of communities	18%	0%	17%	8%	40%
	Drop-off: Percent of Communities	53%	25%	55%	32%	89%
	No program: percent of communities	47%	75%	43%	68%	11%
Population	Curbside: Percent of population	59%	0%	28%	8%	67%
	Drop-off: Percent of population	79%	33%	79%	44%	83%
	No program: Percent of population	21%	64%	20%	56%	17%
Communities	Yard Waste: Percent of communities	59%	7%	55%	68%	91%
	Food Scraps: Percent of communities	23%	0%	19%	25%	41%
	Non-Recycled Paper: Percent of Communities	9%	0%	0%	8%	21%
Population	Yard Waste: Percent of Population	80%	12%	78%	65%	83%
	Food Scraps: Percent of population	59%	0%	20%	39%	65%
	Non-Recycled Paper: Percent of population	39%	0%	0%	12%	45%

Source: Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. Table 5.1-4. August 29, 2022.

Other key findings of the 2022 SOMP to highlight for this Colorado Needs Assessment are the barriers to additional organics diversion that were identified in the previous survey responses and interviews with communities statewide. A summary of the results are reproduced below as reported in the 2022 SOMP. The most cited barrier identified by communities statewide was the presence of a facility. This was also the most commonly cited barrier in the Eastern Plains and the Front Range. Transportation/end market was the most cited barrier by communities in the Mountain region. Not enough material was the most cited barrier by communities in the Western Slope, followed closely by transportation/end market and financial/equipment/staff.

Table 2: Key Barriers to Additional Organics Diversion or Access by Region (Weighted by Communities)

Key Barriers	State-Wide	Eastern Plains	Western Slope	Mountains	Front Range
Presence of facility	54%	64%	33%	44%	65%
Facility capacity	28%	8%	28%	25%	45%
Ability to accept food	26%	8%	23%	19%	45%
Permitting	8%	4%	24%	6%	5%
Transportation/end market	38%	5%	43%	63%	40%
Not enough material	28%	9%	48%	31%	30%
Knowledge and interest in organics, change	27%	39%	37%	13%	25%
Financial/equipment/staff	28%	32%	43%	31%	15%

Source: Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. Table 5.1-6. August 29, 2022.

2.1.2 Regional Stakeholder Engagement Meetings

The results from the 2022 SOMP's Organics Waste Survey were shared at a series of five (5) regional stakeholder engagement meetings: one in each of the regions and an extra one in the Front Range region (one in the south and one in the north). Stakeholders were considered to be anyone from any aspect of the organics management value chain, including members of the public, processors and haulers, and local government officials. Stakeholders were invited to give input on potential strategies for organics management, including policy recommendations, and discuss regional needs.

Based on written comments from the stakeholders, the most significant barriers to organics diversion in the state were the costs of diversion relative to disposal, resulting in a lack of economic incentives. The need for more awareness and the need for more infrastructure were also highly ranked on the list of common barriers. Issues with contamination and challenges with siting new facilities were cited as additional significant barriers. Results related to contamination are discussed in more detail in the **Element 4 Technical Memorandum**.

The meetings also resulted in a consensus amongst stakeholders to create a regional approach to organics management planning. Support was also found for new programs focusing on residential and commercial food and yard waste recovery, state-level policies, and funding for expanding collection and processing capacity. The role of CDPHE was seen as providing grant funding, but otherwise stakeholders felt its role should be limited.

2.1.3 Estimated Costs for Expanding Processing Capacity

As part of the 2022 SOMP, TetraTech prepared a series of engineer's estimates to create a range of capital and operating costs for five (5) different organics processing technologies at five (5) different levels of design capacity. This illustrates the relative cost difference between processing technologies and the effect of economies of scale for each technology. The estimates are based on construction and material costs in the State of Colorado. Some of the key assumptions used for these cost estimates are listed below. Additional detailed unit costs and contingency assumptions are contained in Appendix F of the 2022 SOMP. It should be noted that for the most common anaerobic digestion operations (in-vessel systems), compostable packaging would be screened out of the feedstock due to the processing time of the systems.

- The organic waste feedstock being processed is 50% green waste, 25% food waste and compostable paper, and 25% biosolids with a required bulking agent (not specified).
- Facilities have receiving areas large enough to store a week's worth of feedstock, assuming peak rates.
- In order to provide protection from the weather and to manage odors, receiving areas are covered by a dome-shaped fabric building on top of concrete blocks.
- Digestate from anaerobic digestion facilities is stabilized through aerated static pile (ASP) composting.
- Composting sites are operated on a geomembrane-lined pad with a 2% grade for drainage (including the final product storage area).
- Half of the compost produced is sold for $13.75 per ton.
- Electricity generated from biogas (for anaerobic digestion facilities) is sold at $0.05 per kilowatt-hour.
- No land acquisition cost is included.

Table 3: Capital Costs Estimated for New Processing Facilities (2022 Dollars)

Design Capacity (Tons)	Turned Windrow	Aerated Static Pile	Membrane Covered Aerated Static Pile	In-Vessel Composting	Anaerobic Digestion
50	$2,884,686	$5,151,400	$5,582,543	$8,126,546	$15,627,039
100	$4,556,788	$8,824,960	$9,879,305	$14,974,778	$30,008,759
200	$8,165,090	$16,634,177	$19,091,191	$28,969,294	$58,866,310
300	$11,809,560	$24,515,571	$28,318,671	$42,956,602	$87,945,519
450	$18,048,097	$37,056,664	$42,370,114	$64,628,838	$132,207,027

Source: Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. Table 6.3-1. August 29, 2022.

Table 4: Annual Operating Costs for New Processing Facilities (2022 Dollars)

Design Capacity (Tons)	Turned Windrow	Aerated Static Pile	Membrane Covered Aerated Static Pile	In-Vessel Composting	Anaerobic Digestion
50	$804,054	$625,809	$1,024,507	$1,082,236	$1,415,215
100	$949,156	$797,161	$1,329,689	$1,433,124	$2,089,150
200	$1,489,105	$1,594,937	$1,342,977	$1,714,687	$3,732,057
300	$2,251,920	$1,769,628	$1,898,914	$2,448,538	$5,618,868
450	$3,250,188	$2,513,486	$2,708,302	$3,533,757	$8,270,608

Source: Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. Table 6.4-1. August 29, 2022.

2.1.4 Additional Key Findings and Recommendations

Though not summarized here, the 2022 SOMP includes a thorough discussion on the amount of organics generated, with diversion versus disposal estimates, and potential additional diversion based on potential capture rates. It also includes cost estimates for various collection and transportation scenarios, and a market analysis for finished compost. A discussion is included on how organics management relates to Colorado's climate change mitigation strategies by reducing greenhouse gas emissions.

Statewide and Regional recommendations are included in the 2022 SOMP. These cover a wide range of categories, including policy, diversion goals, funding, partnerships, and interagency cooperation. In line with the State's 2016 Integrated Solid Waste and Materials Management Plan (2016 ISWMMP).

2.1.5 Letter from Colorado Chapter of US Composting Council

In March 2022, the Colorado State Chapter of the United States Composting Council (Colorado Composting Council) sent a letter to CDPHE with their recommendations for the 2022 SOMP. These recommendations and requests for consideration are summarized below. The letter itself can be found in Appendix C of the 2022 SOMP.

- Support startups to build a distributed network of compost processors by:
  - Making the financial assurance requirements more flexible and easier to update, and exploring new funding sources (e.g., polluters, landfill taxes) to assist community composters in meeting requirements.
  - Lowering permit review costs for small operations.
  - Creating one or more tiers between conditionally exempt and Class III, allowing for new entry-level food waste composting facilities.
  - Permitting in-vessel composting as an emerging technology, separate from Class III systems.
  - Providing guidance on county-level permitting for conditionally exempt small-quantity commercial composting facilities.
- Build end markets for finished compost by:
  - Adopting Colorado Department of Transportation (CDOT) procurement standards that encourage the use of Seal of Testing Assurance (STA) certified compost.
  - Continuing to collaborate with the Colorado Department of Agriculture (CDA), its STAR program, and the State's new Soil Health Program in order to incentivize compost use in agriculture.
  - Exploring opportunities to incentivize municipalities to require repurchasing the compost created by the organics they divert.

2.2 2022 STATE OF RECYCLING & COMPOSTING IN COLORADO

The 2022 State of Recycling & Compost in Colorado (2022 SR&C) stated that the access to curbside organics collection will not be addressed through the Producer Responsibility system created in HB22-1355, however, CDPHE has made recommendations for improvements to compost collection within the 2022 SOMP.[2] At the time of the 2022 SR&C, less than 5% of solely Front Range residents throughout the state have guaranteed access to curbside organics collection services. The 2022 SR&C identified that the most influential factor contributing to the state not accomplishing its 2021 recycling and composting goals was due a lack of accessibility. With the adoption of House Bill 22-1159 and the 2022 SOMP, there is a push for municipalities and entrepreneurial businesses to increase drop-off centers and expand access for residents with the help of the Circular Economy Development Center. Eco-Cycle stated that within the 2022 SOMP, Colorado intends to create a circular composting system to improve residential and commercial participation rates, improve composting conditions at facilities, and help return the final product back to local residents.

2.3 ECO-CYCLE 2021-2022 ANNUAL REPORT

Eco-Cycle explained in their annual report how they are working with local residents to make their vision of a circular compost system a reality.[3] This includes improving the collection system by introducing electric-powered compost collection trucks. The new frontline vehicle will help reduce greenhouse gas emissions (GHG) by reducing the number of diesel trucks on the road. Eco-Cycle has partnered with entrepreneurs, local regenerative farmers, and the City of Boulder to promote composting and carbon farming through the agricultural and urban landscape to engage more members of the community. Programs such as the "Cool Boulder Campaign" outreached to local residents to become involved in nature-based climate solutions to regenerate soils by using local compost distributed by farmers.

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[2] Eco-Cycle (2022). *The State of Recycling and Composting in Colorado*.

[3] Eco-Cycle (2022). *Eco-Cycle 2021-2022 Annual Report*.

2.4 FRONT RANGE WASTE DIVERSION BASELINE ASSESSMENT

Eco-Cycle performed a baseline assessment for the compost collection services in the Front Range, the most populous region in Colorado, in 2022.[4] The Front Range Waste Diversion Baseline Assessment is important to consider as it provides an in-depth explanation of the region's composting services and regulations. As a state, Colorado statute CRS 30-15-401 prohibits municipalities from contracting for commercial waste and recycling services. Multifamily residences of eight (8) or more residences are classified as commercial properties by state law. In some municipalities where there are universal recycling ordinances that mandate recycling at commercial facilities and multifamily complexes, jurisdictions offer compost collection. At the time this assessment was conducted, The City of Boulder, Fort Collins, and Golden (2022) were involved with composting for commercial operations dependent on the regulations within the City's Zero Waste Ordinance. At the time of this assessment in 2022, universal composting was even more limited to residents in the Front Range with programs serving less than 5% of the Region's population. Municipalities and private providers provided opt-in curbside compost collection available to 25% of residents, however, the majority of the Front Range does not have any such programs available resulting in the low composting rates shown in **Table 5**. Drop-off locations are provided in over one-third of the communities throughout the Front Range, making composting a possible option for the majority of residents. However, communities with collection services see higher participation rates due to the nature of transporting food scraps. Most drop-off locations are run by municipalities in the Front Range, as some private providers host drop-off locations at their own recycling/compost centers to be more accessible to residents.

Table 5: Summary of Collection Programs

Available Collection Program	Number of Programs	Percentage of cities/towns with programs	Percentage of municipal residents with access	Percentage of municipal residents participating
Universal curbside composting	4	4%	4.7%	4.7%
Opt-in, municipally-coordinated	6	7%	24%	4.6%
Opt-in, private provider	20	22%	49%	0.1%
No curbside compost is available	59	64%	22%	N/A

Source: Eco-Cycle. Front Range Waste Diversion Baseline Assessment. Page 21. December 2021.

[4] Eco-Cycle (2022). *Front Range Waste Diversion Baseline Assessment.*

2.5 2022 ONTARIO PATH FORWARD REPORT

A Compostable Products and Packaging Pilot Testing Project was undertaken in 2022 by the Ministry of the Environment, Conservation, and Parks (MECP) in Ontario, Canada, and co-undertaken by Environment and Climate Change Canada.[5] It included a literature review and the testing of processing certified compostable products at existing aerobic composting and wet anaerobic digestion (AD) facilities. Although this pilot project was carried out in Ontario, the results are relevant to the evaluations of the same or similar products currently accepted by or under consideration for acceptance by Colorado's organics processing facilities. HDR reviewed the Path Forward Report, which was prepared by GHD as a summary report for the pilot program.

2.5.1 Ontario's Blue Box Regulation

Certified compostable products and packaging were designated for management under extended producer responsibility (EPR) through Ontario's Blue Box Regulation (Ontario Regulation 391/21).[6] Although the regulation went into effect in 2021, certified compostable products and packaging are currently exempt from collection and management requirements and are not yet required to register and report annually to the Resource Productivity and Recovery Authority (RPRA). The exemption is to allow more time to determine how these products can best be managed and diverted from disposal. The Path Forward Report recommends that policymakers, producers, and the organics processing industry come to an agreement on the accepted standards for the definition of "certified compostable products." This term is defined in the Blue Box Regulation as "material that is only capable of being processed by composting, AD or other processes that result in decomposition by bacteria or other living organisms" and that is certified compostable by a third party under one of the following international, national, or industry standards: CAN/BNQ 0017-088, ISO 17088, ASTM D6400, ASTM D6868, and EN 13432.[7] In the United States, the Biodegradable Products Institute (BPI) certifies standards specifications for industrial aerobic composting and performs third-party verification of the testing performed.

[5] GHD, Ministry of the Environment, Conservation and Parks, Ontario, Canada (2022). *Path Forward Report: Compostable Products and Packaging Pilot Testing Project*.

[6] https://www.ontario.ca/laws/regulation/r21391

[7] GHD, Ministry of the Environment, Conservation and Parks, Ontario, Canada (2022). *Path Forward Report: Compostable Products and Packaging Pilot Testing Project*.

2.5.2 Recommended System Improvements

Modifications to material recycling facilities (MRF) or compost facilities may be necessary to sort and shred compostable products for proper processing at compost facilities. Certified compostable products that generate sharp or foreign matter in the final compost can have a negative impact on the end product. However, it is difficult to screen out non-compostable plastics without removing compostable plastics due to their similar appearances, and shredding can introduce contamination issues if non-compostables are not removed. Some compost facilities recycle the oversized material ("overs") that is screened from the compost material after active composting to recover greater organic fractions and inoculate the incoming feedstock. Some other facilities send this fraction to the landfill. It is important to note that different certified compostable products may react differently in different facilities due to their composition. For example, a product made of PHA, as opposed to a cellulose product, may show completely different amounts of disintegration in the same facility.

Other important considerations generated from studies in Ontario include considering longer active composting processing times, reducing operating temperatures, processing for longer durations, and enhanced screening and sorting of certified compostable material. Longer processing times at lower temperatures may reduce large pieces of compostable products in the final product. Enhanced screening will reduce contamination in the final product. Changes to existing facilities to accept certified compostable products may be required depending on the volume of compostable products to be managed, which is expected to increase significantly in the coming years.

The Path Forward Report recommends that on the federal level, the government should require field testing as part of the process of becoming a certified compostable product and promote further field pilot testing at existing facilities by supplying the funding. The report recommends that the Government of Ontario create national standards for compostable products and packaging and make certified compostable products part of EPR. The recommendations for producers are to support the government recommendations previously mentioned, to work on product design improvements, and to collaborate with processors and governments to field test their products. Because of the proposed federal ban on single-use plastics in Canada, the Path Forward Report recommends that all producers collaborate to share data and estimate how this will affect the amount of compostable products that will be entering the waste streams.

2.6 STANDARDS FOR PRODUCTS REPRESENTED AS COMPOSTABLE (SENATE BILL 23-253)

One common complaint by various composting operations throughout the state is how difficult it is to distinguish between compostable and non-compostable products. This often causes contamination issues within compost feedstocks. To address this issue, Senate Bill 23-253 was recently signed into law, which creates clear standards for products represented as compostable.[8] This act establishes guidelines for any products that are marketed as being capable of decomposing in a composting system in accordance with ASTM standards. Some of these changes will go into effect at the start of 2024, and some will be enforced starting in July 2024.

Starting on January 1, 2024, producers of products that are not certified compostable will not be allowed to use any tinting, color schemes, labeling, or words that are required for certified compostable products. In this case, the distinction "certified compostable" refers not to a specific verification but to any certification by a recognized, independent, third-party verification body. Furthermore, producers of non-certified compostables will be prohibited from using any kind of labeling, images, or wording that could mislead consumers into believing that a product is compostable or may eventually break down in a landfill or otherwise. Effective July 1, 2024, producers will not be able to represent a product as compostable in any way until they have been officially certified as compostable by a recognized verification body. Once this certification is in place, producers of compostables will be required to comply with labeling standards that make the product easily distinguishable as certified compostable. In addition to these rules, any person will be entitled to request information and documentation demonstrating compliance with the act, and a forum will be established that will allow for violations to be reported. Education efforts will also be made by the Department and local governments to inform the public about the standards put into place by this new act.

2.6.1 Eco-Cycle Survey

Eco-Cycle prepared a survey of compost facilities in response to SB23-253: Standards for Products Represented as Compostable. The survey was distributed before SB23-253 was passed and requested data on contamination potentially associated with plastics.

Twenty-one (21) businesses associated with composting, including composters, haulers, third-party certifiers, producers of compostable plastics, and other interested parties, responded to the survey during February and March of 2023. When asked what materials each business accepted from the source-separated food and yard waste stream either currently or historically, sixteen (16) of the twenty-one (21) facilities said they accepted compostable paper products such as paper towels, napkins, coffee filters, waxed paper, and food-soiled cardboard. Similarly, thirteen (13) of the twenty-one (21) facilities said they accepted compostable serving wear and compostable bags. Despite many of the surveyed businesses accepting these products in the past, at least seven (7) of them noted that they had recently transitioned away from accepting compostables for a variety of reasons. Examples of these reasons include compostables not breaking down at the same rate as the other feedstocks, degrading the quality of the finished compost, and being easily confused with non-compostable products that have similar appearances.

[8] https://leg.colorado.gov/bills/sb23-253

Fourteen (14) of the twenty-one (21) facilities noted that they see misleadingly labeled or lookalike "compostable" materials that are not actually compostable. Several facilities reported spending anywhere from $1,000 to $100,000 per year inspecting incoming loads for contamination and removing materials. Facilities also reported costs associated with transferring rejected loads and excess contamination to the landfill and lost value of contaminated finished compost.

Eco-Cycle also collected data on whether businesses would support a bill that bans the sale of products in Colorado that are falsely labeled in a way to make them look compostable, even though they are not certified compostable. Nineteen (19) of the twenty-one (21) facilities were in support of this ban. The survey also asked if the businesses would support a bill that requires clear labeling of certified compostable products sold in Colorado to make them easily identifiable as certified compostable. Seventeen (17) of the twenty-one (21) facilities were in support of this bill. Some noted that it would help their facilities be able to accept more compostables and reduce contamination.

3 COMPOST FACILITY PERMITTING REQUIREMENTS

3.1 CDPHE 6 CCR 1007-2, PART 1, SECTION 14

Composting facilities are subject to CDPHE Regulations Pertaining to Solid Waste Sites and Facilities, 6 CCR 1007-2, Part 1, Section 14 (Compost Regulations). This section defines three (3) types of feedstocks, which are then used to classify the types of composting facilities.

There are several types of composting operations that are exempt from Section 14. These include backyard composting, composting facilities that only use agricultural wastes, and composting of biosolids at wastewater treatment facilities.

3.1.1 2023 Pending Updates to Composting Regulations

During the Section 14 Revision Stakeholder Meeting, it was established that CDPHE is proposing changes to Section 14 of the Solid Waste Regulations with a focus on increasing opportunities for food waste composting. The reasoning for these proposed changes is related to previously conducted shareholder surveys that identified the permitting process as a major barrier to the development of organics waste diversion infrastructure. The solution was to create a "middle tier" composting facility to accommodate those who are outgrowing the CESQ exemption or cannot accommodate a significantly larger facility.

The first proposed change would increase Type 2 volume for CESQs from five (5) cubic yards to twenty (20) cubic yards. Changes to Class I permitting requirements include the addition of a new mid-size food waste facility type, new on-farm food waste facility type, and clarification of stormwater and contact water requirements on site. There is also a proposed change to training protocol, which will require operators of all facility classes to complete a nationally recognized operator training. Finally, changes will be made regarding finished compost. These changes include requiring finished compost to be tested with passing results for both Salmonella and fecal coliform and be stored in a location specified in the facility's operations plan. Soil amendment use and storage are also clarified in the proposed changes. These changes could potentially go into effect as soon as April 2024 if they are approved during the February 2024 Solid and Hazardous Waste Commission meeting.

3.2 CERTIFICATE OF DESIGNATION

Facilities subject to the Compost Regulations must obtain a Certificate of Designation (CD) unless otherwise exempt. Exemptions are considered for Class I and II facilities because they start with only green materials and do not accept any food material (see section below for descriptions of Class I-III facilities).

There is no statewide application form to obtain a CD. CDPHE has the role of conducting a comprehensive technical review for a CD to determine if the location, design, and operating criteria are protective of human health and the environment. Composting facilities are also required to comply with all health laws, standards, rules, and regulations of the CDPHE Water and Air Quality Control Commission, as well as all applicable local laws, ordinances, and regulations.

3.3 TYPE 1-3 FEEDSTOCKS

Compost feedstock can be broadly broken into three (3) types; however, CDPHE recognizes that case-by-case determinations may be necessary concerning the selection of an appropriate category for a particular feedstock. See **Table 6** for definitions of Type 1-3 Feedstocks. Compostable packaging fits into Type 3 of the defined feedstocks.

Table 6: Composting Feedstock Types

Type	Feedstock Definition
1	• Vegetative waste • Other materials that pose a low risk to human health and the environment
2	• Animal waste • Manure • Source-separated organics • Food residuals • Food processing vegetative waste
3	• Biosolids • Mixed solid waste • Processed solid waste, sludges, and food processing residuals not covered in Type 2 • Fats, oils, and greases • Dairy manufacturing wastes • Dissolved air flotation (DAF) skimmings • Paunch and any other compostable material not covered in Type 1 or Type 2

CDPHE also defines a list of prohibited wastes that are not accepted by composting facilities, which includes asbestos or asbestos-containing materials, infectious waste, hazardous waste, Polychlorinated biphenyl waste, and lead-acid batteries.

3.4 CLASS I-III FACILITIES

Based on feedstock type and size, compost facilities are defined as Class I, Class II, and Class III. See **Table 4** below for definitions of Class I-III facilities. Class III facilities can accept compostable packaging.

Table 7: Composting Facility Classes

Class	Facility Description
I	• Composts only Type 1 feedstocks with less than 50,000 CY of processing capacity: or • Composts only source-separated organics and/or food residuals generated onsite with a total volume of no greater than 5,000 CY of source-separated organics onsite and a composting area of 2 acres or less: or • Composts at the site of generation or on agriculturally zoned property owned by the generator using only agricultural waste generated onsite.
II	• Composts Type 1 feedstock and manure with less than 50,000 CY of processing capacity.
III	• Composts Type 1, Type 2, and/or Type 3 feedstocks or other materials approved by the department.

3.5 CONDITIONALLY EXEMPT SMALL QUANTITY

Conditionally Exempt Small Quantity (CESQ) composting operations have specific regulatory thresholds and conditions. A CESQ composting operation is any composting facility that has up to (a) 100 cubic yards of Type 1 feedstock onsite or in process; (b) 100 cubic yards of Type 1 feedstock, and up to 5 cubic yards of Type 2 feedstock onsite or in process; or (c) 100 cubic yards of Type 1 and up to 10 cubic yards of Type 2 feedstock on site or in process when composted in vessel, and meets the following criteria:

- Maintain records of feedstock types and quantities for CDPHE inspection.
- Register as a CESQ Composting Facility.
- Submit an annual report to CDPHE including the following items:
  - Types of materials recovered for composting.
  - Amount in tons or cubic yards of material recovered for composting.
- Submit a final closure report to CDPHE after terminating composting operations.
- Sample and test finished compost in accordance with the minimum requirements of CDPHE 6 CCR 1007-2, Part 1, Section 14.6.

The CESQG facilities are relevant to this assessment as the facilities can be re-permitted and subsequently reclassified to a Class III facilities if feedstock volumes and types of feedstocks processed change (i.e., acceptance of compostable packaging).

3.6 ENGINEERING, DESIGN, AND OPERATIONS PLAN (EDOP)

The EDOP requirements are dependent on the class of the facility. Class I facilities are not required to have an approved EDOP. Class II and III facilities must be designed, constructed, operated, closed, and maintained in post-closure in accordance with its approved EDOP which must include, at a minimum:

- Owner/operator information, including names, addresses, and phone numbers.
- Name of the composting facility, the physical address and legal description, location with respect to the nearest town, and mailing address.
- Site maps and plans drawn to a commonly recognized engineering scale illustrating the facility's surveyed property boundaries, location of processing and storage areas, adjoining properties, roads, fencing, existing and proposed structures, contact water containment, and control structures.
- A description of the feedstocks to be processed and composted.
- An evaluation of potential impacts to existing surface water and groundwater quality, including but not limited to:
    - A description of site geological and hydrogeological conditions based on an onsite geotechnical investigation.
    - Floodplain information, including evidence that the proposed site is not located within a 100-year floodplain.
    - Public water supply information, including the location of all water supply wells, springs, and surface water intakes within one-half mile of the proposed facility boundary.
    - Identification of all lakes, rivers, streams, springs, or bogs, on-site or within one-half mile of the proposed facility boundary.
    - Depth to the uppermost aquifer.
    - The hydrologic properties of the uppermost aquifer.
    - The existing quality of groundwater beneath the proposed facility groundwater monitoring is required for the facility.
    - The types and regional thickness of unconsolidated soil materials.
    - The types and regional thickness of consolidated bedrock materials.
    - Geologic hazards such as slope stability, faulting, folding, rockfall, landslides, subsidence, or erosion potential.

- How the facility will be designed in a way that prevents negative impacts on surface water and groundwater; clearly defines the feedstock receiving, processing, and storage areas; and specifies the maximum throughput capacity.
- How the areas where all mixing, tipping, and composting occur will be designed to meet all necessary criteria, including:
    - Groundwater protection.
    - Slopes.
    - Withstand varying temperatures.
    - Heavy equipment operation.
    - Low permeability workpad.
- How the surface water control system features will be designed, constructed, and maintained to control stormwater run-on and run-off from a twenty-five (25) year, twenty-four (24) hour storm event.
- Quality Assurance and Quality Control Plan
- Operation standards include:
    - General information.
    - Financial assurance estimates.
    - Material acceptance.
    - Surface water control.
    - Access control.
    - Signage.
    - Nuisance conditions such as noise, dust, mud, odors, vectors, and windblown debris.
    - Contingency plan.
    - Fire protection plan.
    - Odor management plan.
    - Personnel training.
    - Compost processing time and temperature.
    - Groundwater monitoring plan.
    - Compost sampling and testing.
    - Feedstock processing areas.
    - Recordkeeping.
    - Closure and post-closure care and maintenance.

3.7 FINANCIAL ASSURANCE

Financial assurance coverage must be provided by all Class I, II, and III facilities before the compost facility commences operation and must be maintained throughout operation. CESQ operations are not required to provide financial assurance. No CD shall be effective unless and until the required financial assurance mechanism has been fully implemented. The coverage must include cost estimates for closure and post-closure of the facility.

3.8 LOCAL PERMITTING OVERVIEW

The local land use permitting and zoning requirements for the state of Colorado were analyzed in each of the state's four regions – Western Slope, Mountains, Front Range, and Eastern Plains. Within each region, the largest county (by population) was selected to be representative of the entire region. Two (2) counties were selected for the Front Range region due to the high population density. This analysis was conducted to provide an understanding of the permitting requirements that may be in place to site a new compost facility that manages compostable packaging.

3.8.1 Western Slope: Mesa County (Rural/Mountain)

Composting facilities are not explicitly called out in the municipal code for Mesa County. Instead, composting would fall under the classification of "Waste-Related Uses." In this context, Waste-Related Uses are defined as "uses that receive solid or liquid wastes from others for disposal on the site or for transfer to another location; uses that collect sanitary wastes; or uses that manufacture or produce goods or energy from the composting of organic material" (12.06.D). Because composting is not explicitly defined in this code, the land use regulations for Waste-Related Uses in Mesa County are summarized as follows.

- **Conditional Use** – allowed within the respective zoning district only after review and approval of a Conditional Use Permit, in accordance with the review procedures of Section 4.03
    - Rural – Agricultural and Forestry District (AF-35) or Agricultural, Forestry, Transitional District (AFT)
    - Non-residential – General Industrial District (I-2)
    - Mack Overlay Districts (Tier #2) - Property owners shall have the option of developing allowed uses in accordance with the underlying zoning or with the Mack Overlay District zone as shown on the Overlay District Map. If a new development uses the Mack Overlay District, it shall comply with the standards in the Mack Overlay District zone. The property will be designated as Tier 1 or Tier 2 of the Mack Overlay District on the Official Zoning Map (5.05 E)
- **Prohibited Use** – not allowed within the respective zoning district.

- All other districts – Urban residential, nonresidential, mixed-use districts, gateway overlay districts.

3.8.2 Mountains: Eagle County (Mountain)

Composting facilities are not explicitly permitted and are called out in the municipal code for Eagle County. Instead, composting falls under the description of "Reduction or Disposal by Sanitary Landfill Method of waste materials, garbage, offal or dead animals; or refuse disposal area conducted under a landfill or sanitary landfill method" (Table 3-320). Because composting is not explicitly defined in this code, the land use regulations for this type of activity in commercial and industrial zone districts in Eagle County are summarized as follows.

- Allowed by specific review.
    - Industrial (I)
- Not allowed.
    - Commercial Limited (CL)
    - Commercial General (CG)
    - Rural Center (RC)

3.8.3 Front Range: Denver County (Urban)

Composting facilities are not explicitly called out in the municipal code for Denver County. Instead, composting falls under the classification of "Waste Related Services" and, more specifically, "Solid Waste Facility". Because composting is not explicitly defined in this code, the land use regulations for solid waste facilities in Denver County are summarized as follows.

- **Conditional Use**
    - Light Industrial District - an employment area containing offices, business, and light industrial uses that are generally compatible with adjacent Residential or Mixed-Use Commercial Zone Districts (9.1.2.B)
        - Subject to zoning permit review with informational notice
        - General Industrial District - employment area containing industrial uses that are generally more intensive than uses permitted in the I-A zone district (9.1.2.C)
        - Zoning permit review
        - OS-A - Open space public parks district
            - Determined by Parks and Recreation Manager
        - DIA – Denver International Airport
        - Determined by Denver Manager of Aviation
- **Not permitted use**

- Industrial Mixed-Use Districts - accommodate a variety of industrial, commercial, civic, and residential uses and encourage affordable housing (9.1.2.A)
- Campus - midsize to large medical, institutional, educational, or entertainment sites (9.2.1)
  - OS-B - Open space recreation district
  - OS-C - Open space conservation district
  - O-1 Zone district.
  - M-RH-3 – Row House 3
  - M-RX-3,5,5A (residential, mixed-use)
  - M-CC-5 (commercial corridor)
  - M-MX-5 (commercial mixed-use)
  - M-IMX-5,8,12; M-GMX (industrial mixed use)

3.8.4 Front Range: El Paso County (Urban)[9]

Composting facilities are not explained in depth in the land development code for El Paso County. They are defined as "A site where compost is produced, except at a residential location." Compost storage, preparation, and transfer facilities must have proper coverage to reduce potential pollution/contamination concerns. Under specific development standards, manure-based compost facilities must setback a minimum distance of 100 feet from any lot line. Manure-based compost facilities cannot accumulate an excessive amount, and there must be proper drainage onsite to protect adjacent sites from runoff.

3.8.5 Eastern Plains: Morgan County (Rural)

Morgan County specifically refers to composting in its municipal code. In most cases, it is listed as a subcategory of solid waste management. The land use regulations for solid waste management in Morgan County are as follows.

- 3-180 Agriculture Zone Special Review Uses
  - Solid waste management, such as but not limited to sanitary landfills, waste treatment, and storage facilities, including manure storage and composting facilities.
- 3-345 Light Industrial Zone Special Review Uses
  - Solid waste management, including waste treatment and storage facilities and recycling and composting facilities, but excluding manure storage and processing and landfills, on a lot that contains at least 20,000 square feet.
- 3-365 Heavy Industrial Zone Uses by Special Review

[9] https://library.municode.com/co/el_paso_county/codes/land_development_code

    - Solid waste management, including waste treatment and storage facilities and recycling facilities but excluding manure storage and processing, on a lot that contains at least 20,000 square feet.

- Solid waste management is not permitted on any other land-use type.

4 Compost Facilities in Colorado

The following are lists of conditionally exempt small quantity and permitted composting facilities in Colorado.

4.1 CESQ COMPOST FACILITIES

- Colorado Manure Hauling (Richer Lands Compost
- Colorado State University Campus Composter
- Compost Colorado
- Compost Queen - N College Ave
- Compost Queen - Shields St
- Compost Queen - W Mulberry
- Compost Queen - Victoria Ct
- Cowgirl Compost Co
- Dirty Sturdy's Mountain Compost - Ridgway
- Eco Action Partners (Town of Ophir)
- Elements Mountain Compost
- Elements Mountain Compost - Cr 140
- Food To Power - Bijou St
- Food To Power - Boulder St
- Food To Power - Institute St
- Princess Gardens LLC
- Pueblo Green Center
- Purple Bucket Compost, LLC
- Reincarnated
- Sol Gardens LLC
- T+D's Mulch and Grind, Inc.
- TNT Forest Products

4.2 CLASS I-III FACILITIES

- BV Correctional Facility
- City Of Fort Collins - Hoffman Mill
- CHT Resources
- Climax Mine-Lake County
- Colorado State University Compost Facility
- Delta Correctional Doc
- Denver Arapahoe Disposal Site (Dads)
- Dons Garden Shop
- East Regional Landfill
- Eaton Composting-A1
- Mesa County Landfill
- Midway Landfill and Midway Organic
- Milner Landfill
- Montezuma County Lf
- Mountain View Farm

- Organix Supply (Richlawn Turf Food)
- Pioneer Wholesale Supply (Aka Southwest Soils)
- Pitkin County Solid Waste Center
- Rattler Ridge Composting-A1
- South Canyon Solid Waste Disposal Site
- Sterling Correctional Facility
- Stromo, LLC (Renewable Fiber)
- Summit County Resource Allocation Park
- Table To Farm Compost LLC
- Thunder Mountain Composting (3xm)
- Tv Dairy
- Vail Honeywagon

4.3 HIGH-LEVEL SUMMARY OF FACILITIES

For a high-level summary of the CESQ and Class I, II, and III Composting Facilities, please see **Table 5** in Appendix A.

5 COMPOST OPERATOR INTERVIEWS

5.1 SITE SELECTION

Site selection was narrowed down with criteria found using CDPHE resources and other publicly available information. At least one (1) conditionally exempt small quantity (CESQ) site was included for both an in-person site visit and a phone interview.

- First, compost facilities were split by region (Western Slope, Mountains, Front Range, and Eastern Plains) and their permitting type (CESQ, Class I, Class II, and Class III). Through this breakdown, it was noted there is limited infrastructure on the Eastern Plains and limited Class II facilities.
- Second, facilities were assessed on their willingness to accept certain feedstocks, placing a priority on those accepting food waste, source-separated organics, and the ability to accept from residential and commercial entities. These criteria would be useful for the contamination assessment of plastics and compostable plastics, discussed in further detail in the **Element 4 Technical Memorandum**. A priority was placed on facilities that publicly stated they accept compostable plastics.
- Next, the Google Earth aerial of each facility was investigated to determine if the site was, in fact, actively composting.
- While the majority of composting facilities were listed as private, sites were selected to represent both publicly and privately owned facilities.
- Lastly, those with the interest and ability to expand were also ranked with higher priority.

The list of facilities targeted for in-person site visits and phone interviews was presented to CAA for review and concurrence. Back-up facilities were identified as needed by the HDR team using the same criteria as above.

5.2 INTERVIEW FORMAT

5.2.1 Facility Outreach

The HDR team used both email and phone to contact the target facilities. Due to the short timeline, facility availability was critical for scheduling the interviews. Sites that required additional approval to access the site in person were moved to phone interviews, and thus, some virtual interviews were elevated to in-person site visits. The team had great success utilizing the following approach:

1. Send an email to the listed facility contact.
2. Send a follow-up email to the listed facility contact.
3. Place a phone call to the facility to schedule an interview.
4. Conduct interviews (in-person or virtual).
5. Follow-up via email with facility contact as needed.

In the end, the team was able to conduct eight (8) in-person site visits and nine (9) phone interviews.

5.2.2 2023 Compost Survey Approach

Prior to sharing the 2023 Compost Survey with the target facilities, the HDR team consulted with CAA on survey content. Revisions to the survey were made, as needed, based on CAA guidance.

Every 2023 Compost Survey participant was provided a high-level summary of the project and the purpose of the survey. Participants were provided the survey prior to the interview to review via the body of an email. Surveys were not attached as separate documents to comply with ADA requirements. When available, at least two (2) HDR team members were present for each interview.

5.2.3 2023 Compost Survey Questions

A copy of the 2023 Compost Survey is included in **Appendix B.** Slight modifications to the survey have been made to more accurately reflect the results of the interviews.

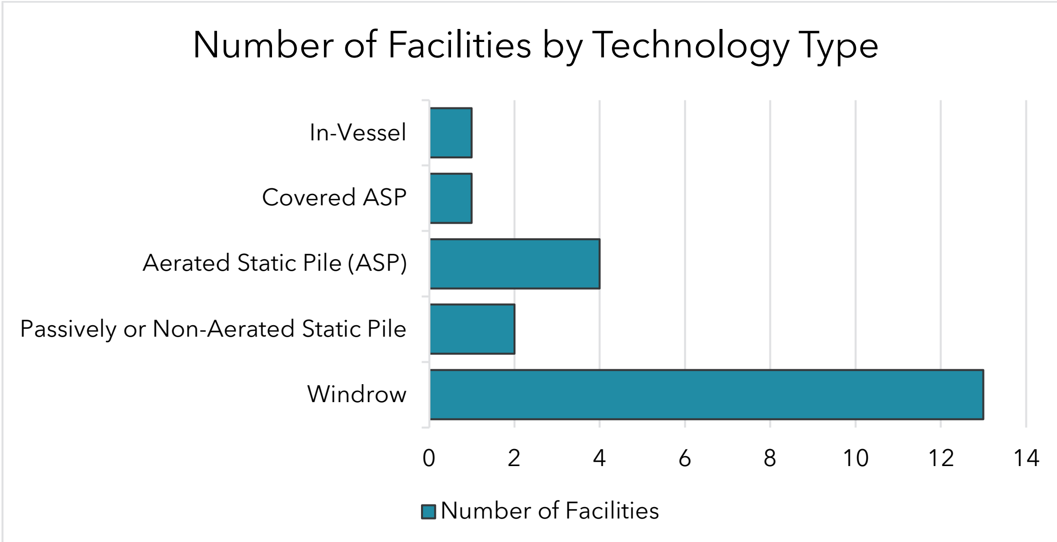
5.3 2023 COMPOST SURVEY RESULTS

5.3.1 General

The 2023 Compost Survey began by collecting basic information about each site, including the type of organics processing technology utilized at the site, the current (within the last five years) annual throughput, and the potential facility capacity. Permitted capacity, design capacity, and similar reasonable determinations of site capacity were all acceptable types of potential capacity included in the survey results.

Figure 1 shows the distribution of processing technology types for the surveyed facilities. Windrow was by far the most common type encountered.

Figure 1. Number of Facilities by Technology Type



Each of the facilities surveyed had the potential to expand processing capacity at their current sites. As shown in

Figure 2, the surveyed facilities are currently processing nearly 400,000 tons per year combined but have the ability to expand to process roughly three times that much material. Note: These values include both residential and commercial generators and all feedstock streams. **Table 8** shows this potential for expansion further broken down into different levels. Most sites are able to at least double their processing capacity. Based on the survey responses, approximately one-quarter of the current processing capacity and potential capacity are associated with facilities currently accepting or willing to accept compostable packaging at the time of the survey.

Figure 2. Actual vs. Max. Potential Annual Capacity (Tons)

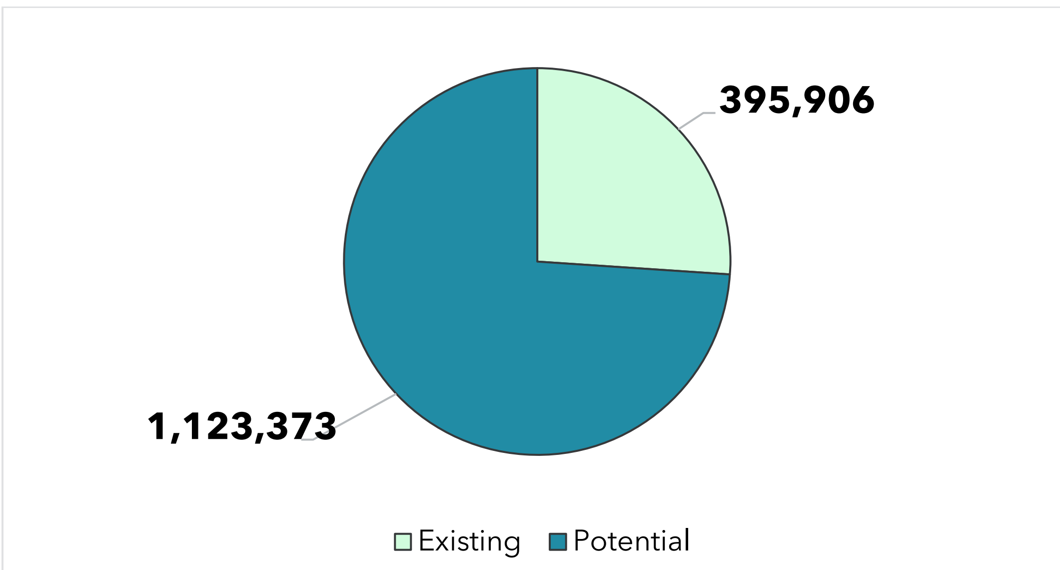


Table 8: Ability of Surveyed Facilities to Expand Processing Capacity

Percent Increase	Number of Facilities
No Ability to Expand	0
1-100%	4
100-250%	6
250-500%	4
Over 500%	2

The survey asked facilities to share their gate tip fees by material type. The range of fees by material type is provided in **Table 9**. The presence of compostable packaging generally increased the gate tip fee, particularly at the high range of costs.

Table 9: Range of Gate Tip Fees at Surveyed Compost Facilities (per ton)

Feedstock	Low Price	Average Price	High Price
Green waste	$12	$23	$44
Food waste	$12	$30	$55
Food waste with compostable packaging	$12	$34	$85
Mixed green and food waste	$12	$29	$55
Brush	$0	$27	$45

5.3.2 Feedstock

Information on the type of feedstock accepted at each surveyed facility was collected and included data on the type, quantity, and source of materials. In addition, the survey gathered information on the acceptance of compostable materials at each facility. This section only includes the facilities that provided enough data to be included in the analysis. **Figure 3** shows the breakdown of feedstock type at each surveyed facility. The majority of the facilities accept green and food waste, with only two facilities providing composition data on compostable products. **Figure 4** shows the breakdown of materials from residential, commercial, or other sources.

Figure 3: Breakdown by Feedstock Type

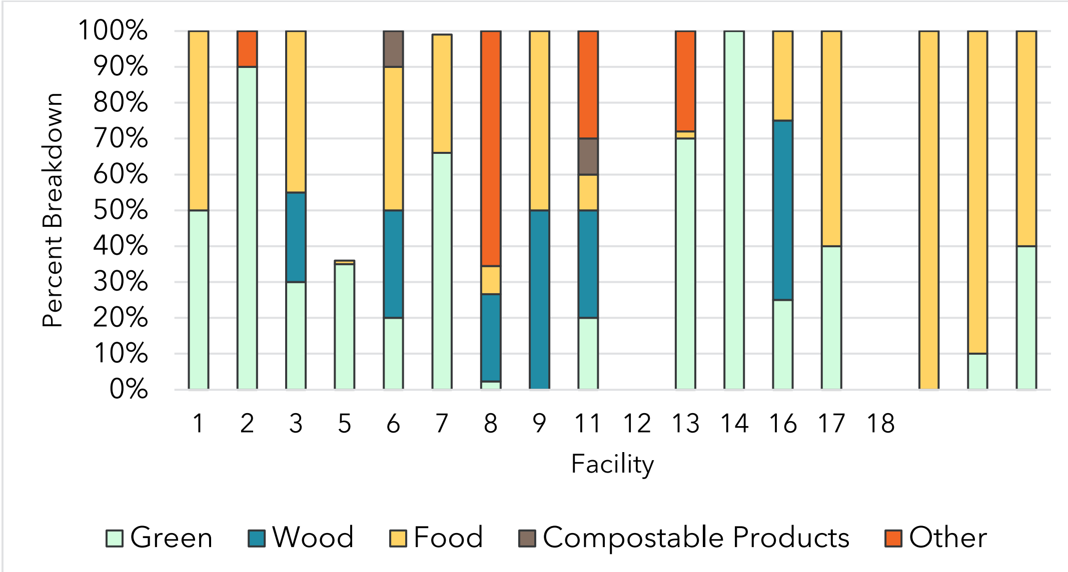


Figure 4: Breakdown by Feedstock Source

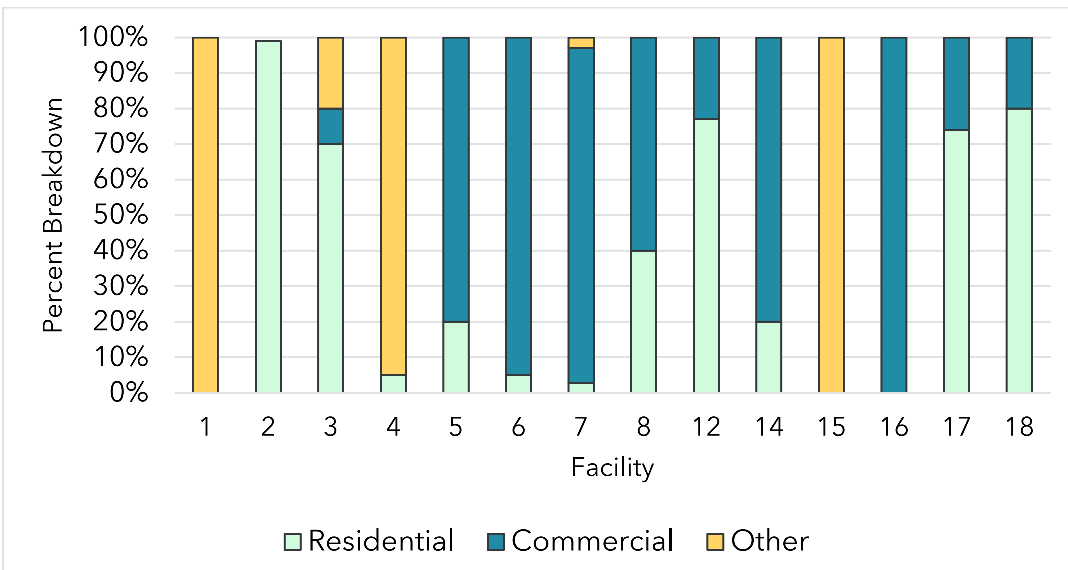
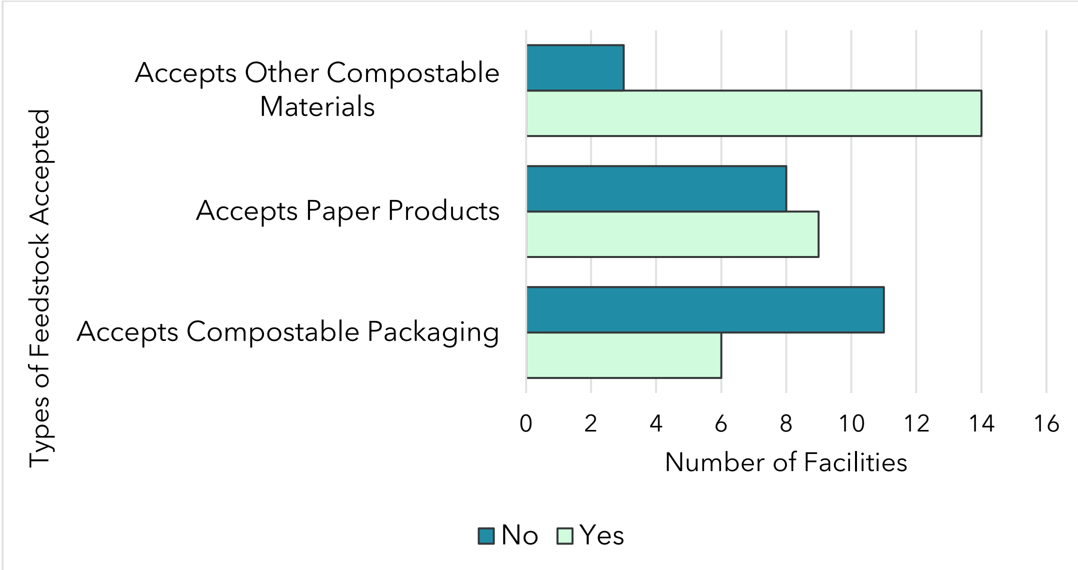


Figure 5 shows the number of facilities that accept compostable materials, paper products, or other compostable materials. While only a limited number of facilities accept compostable packaging, several more facilities accept paper products or other compostable materials. As listed in the survey in Appendix B, other compostable materials could include molded pulp, tissue/toweling, soiled paper, soiled cardboard, and shredded paper.

Figure 5: Acceptance of Compostable Packaging



The biggest hurdle to accepting compostable packaging appears to be related to labeling and certification standards. Specifically, operators are looking for clear and distinctive labels and colors to differentiate certified compostable materials from non-certified materials, such as single-use plastic. Several operators mentioned SB23-253 and are hopeful the standards created from this act will help alleviate the issue. Secondly, operators want the product manufacturers to perform field testing of their products and have full transparency in the results of this data. Two compostable product certifications were mentioned as part of the interviews: the BPI Certification Mark[10] and the Compost Manufacturing Alliance (CMA).[11] While the CMA certification process is newer, it reportedly requires field test data from the product manufacturers.

5.3.3 Contamination

Contamination data was also collected as part of the 2023 Compost Survey. Information regarding contamination rates, common contaminants, charges associated with high contamination, and challenges handling contamination was acquired. Please refer to the **Element 4 Technical Memorandum** for a detailed description of the contamination portion of the compost facility survey.

[10] https://bpiworld.org/certification

[11] https://compostmanufacturingalliance.com/

5.3.4 Service Area

The following maps show the counties that have access to composting infrastructure that accept compostable packaging or may accept compostable packaging in the future. The available capacity map was derived from actual processing tonnages by the facilities but applied to each individual county, so it may be double counted but is meant to be representative of the maximum capacity available to each county to process compostable packaging.

Figure 6: Counties with Access to Composting for Compostable Packaging

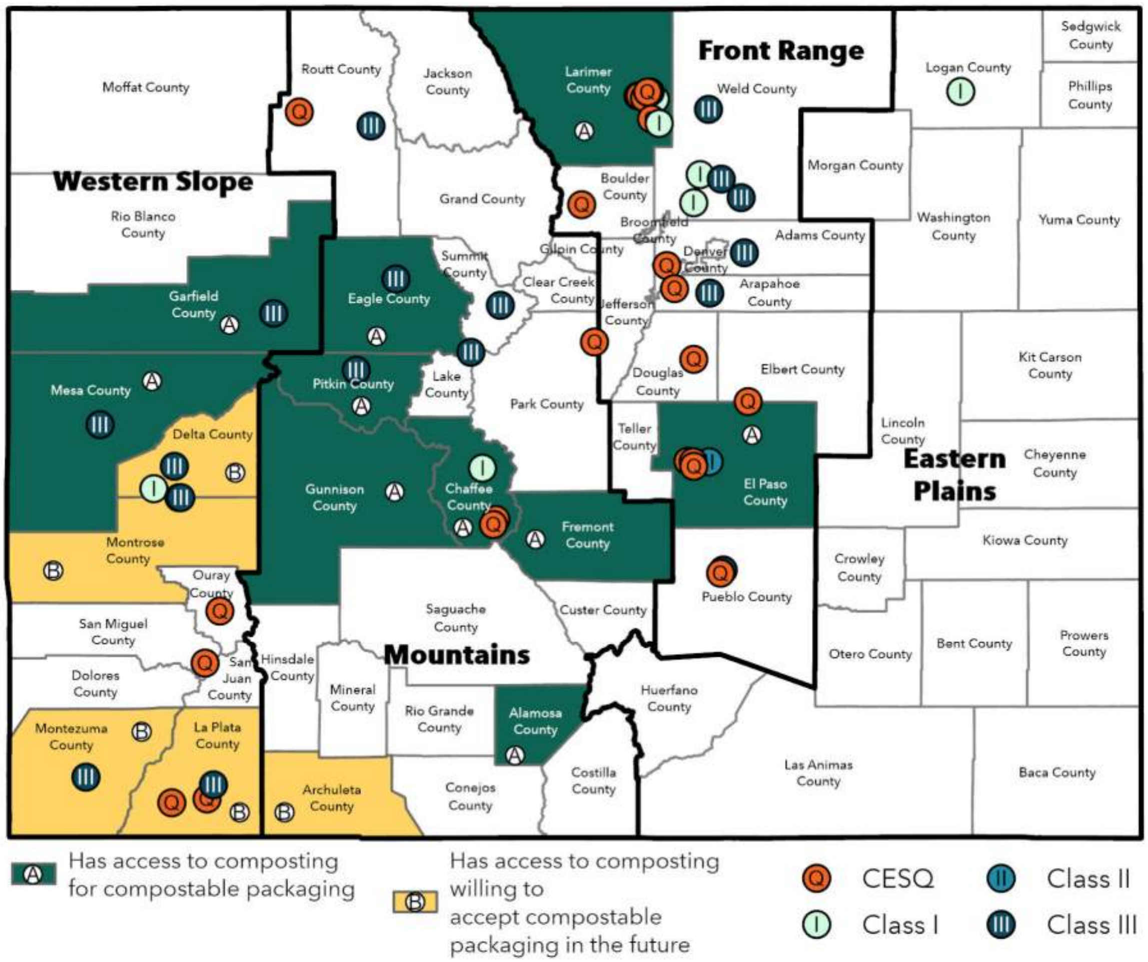
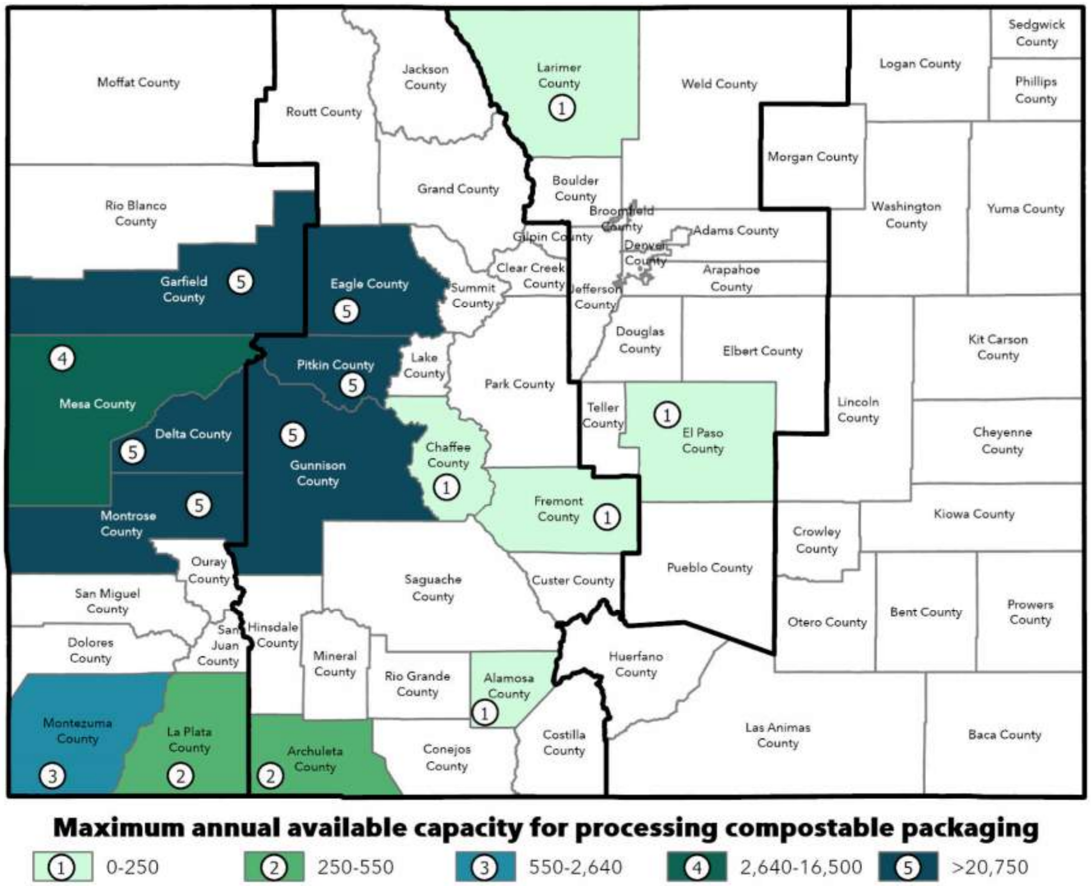


Figure 7: Maximum Annual Available Capacity for Processing Compostable Packaging (Tons)



5.3.5 Product

From the facilities surveyed, the state of Colorado produces roughly 314,750 cubic yards of compost product per year. As part of the producer responsibility requirements in Colorado, the producer is responsible for ensuring responsible end markets for finished material that incorporates compostable packaging. Currently, there are three (3) main types of compost products:

- **Compost**

  This is compost that meets the state standards of finished compost, having completed the required Process to Further Reduce Pathogens (PFRP), which varies from maintaining temperatures to at least 131 degrees Fahrenheit for three (3) to fifteen (15) days, depending on the composting technology.

- **Seal of Testing Assurance (STA) Compost**

  The United States Composting Council (USCC) manages the STA program, which requires the submittal of regular analytical testing results and disclosure of those results to potential customers.

- **Organic Materials Research Institute (OMRI) Compost**

  OMRI was developed as an international reviewer of input materials for certified organic production. While registration with OMRI is voluntary, their program is well-known and respected within the agricultural growing community.

Other products produced include topsoil, compost tea, and mulch. Some composters sold compost as bagged products, while most sold it in bulk. Often, compost overs, or a large fraction of composted materials, were recycled into the compost process. In nearly all cases, the customer paid for transportation of the product and hauled the product off-site for end use.

Table 10 shows the sales price per product as reported by the surveyed facilities.

Table 10. Sales Price per Product

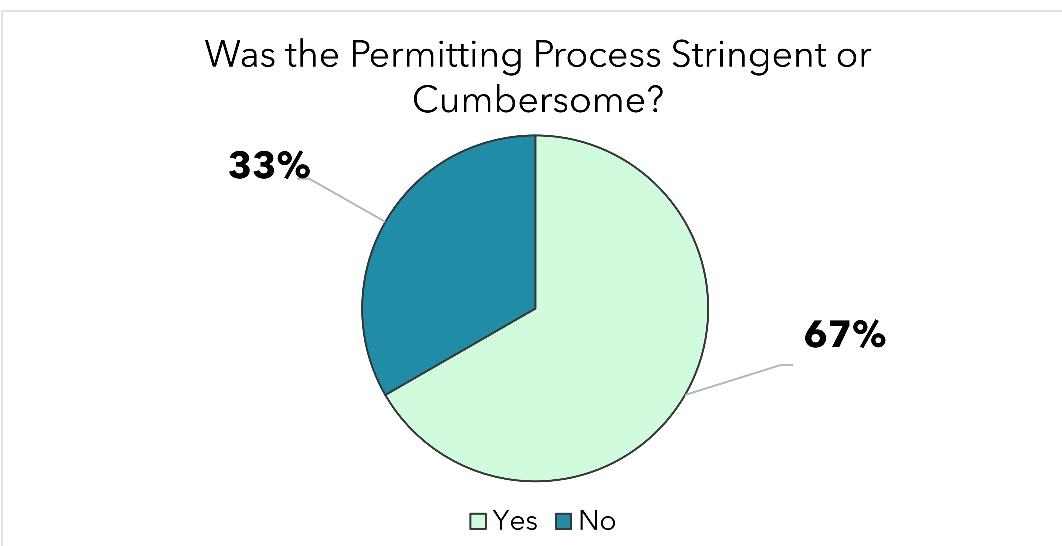
Product Type	Low Price ($/CY)	Average Price ($/CY)	High Price ($/CY)
Compost	$8.25	$62.02	$150
STA Compost	$19	$34.17	$52
OMRI Compost	$45	$48.50	$52
Mulch	$5.25	$11.17	$100

5.3.6 Permitting

Permitting Process and Timeline

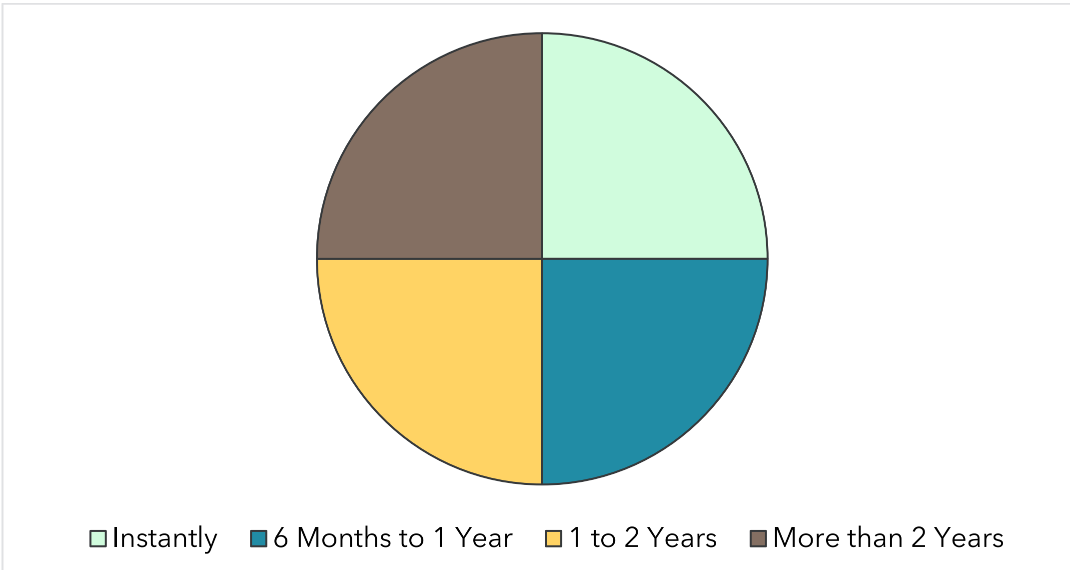
When asked about the facility permitting process, approximately two-thirds of surveyed facilities reported finding the permitting process stringent or cumbersome. Secondary comments reported that the permitting process was also expensive, specifically when upgrading the facility from a CESQ to a larger facility. This could impact those facilities where the PRO may be attempting to upgrade the designated class of the facility.

Figure 8: Was the Permitting Process Stringent or Cumbersome?



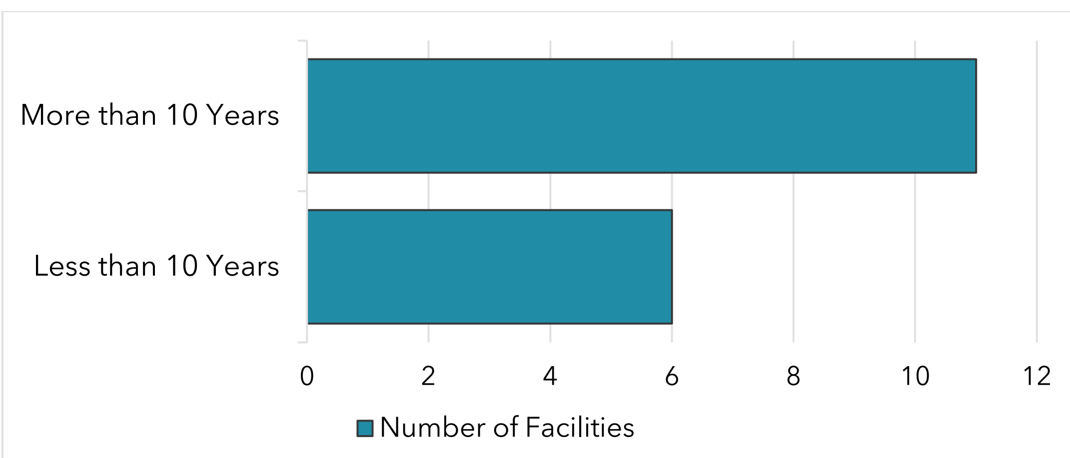
The time to obtain their facility permit varied among composters. All CESQ facilities reported receiving the approval was almost immediate, where the larger facilities, such as Class III facilities, reported the permitting process took one to two years or more than three years. Class III facilities are those facilities that can process compostable packaging. Class I facilities typically fell in the six-month to one-year timeline.

Figure 9: Percent of Facilities vs. Permitting Timeline



It is important to note that a majority of the facilities surveyed have been in operation for more than ten years, commenting that while their initial permitting process was stringent or cumbersome, it was over a decade ago. Some commented they are interested in learning more about the 2023 updates to the Compost Regulations as this may help reduce the burden on future or expanded facilities entering the market.

Figure 10: Years Facility Has Been in Operation



Reporting Procedures and Material Tracking

Every surveyed composting facility reported annual reporting as part of the permit with CDPHE. In addition, one or more internal recordkeeping procedures or material testing occurred at most facilities. The following is an example of some of these activities:

- STA Product Testing
- Pile Temps
- Feedstock Logs
- Contamination Audits
- Other Regulatory Requirements
  - Stormwater
  - Groundwater
  - Odor and Vectors
  - Litter

As part of this EPR study, composters were asked if there was a method to track material destruction. An example was provided that explicitly described if a truck came in with a load of compostable packaging and wanted to verify that the compostable packaging was 100% composted and whether there was a way to track its breakdown. Several stated they did not currently have a method but could develop something on a pilot or test basis on a portion of their managed material. They suggested that to track material destruction on every inbound load would be economically and operationally prohibitive.

5.3.7 Costs

As part of this EPR study, composters were asked about capital costs associated with their operations. Several of the composters stated that in order to manage high volumes of compostable packaging, costs for operation would need to include a facility with a sortation line, de-packager, shredder, and additional personnel.

Current Capital

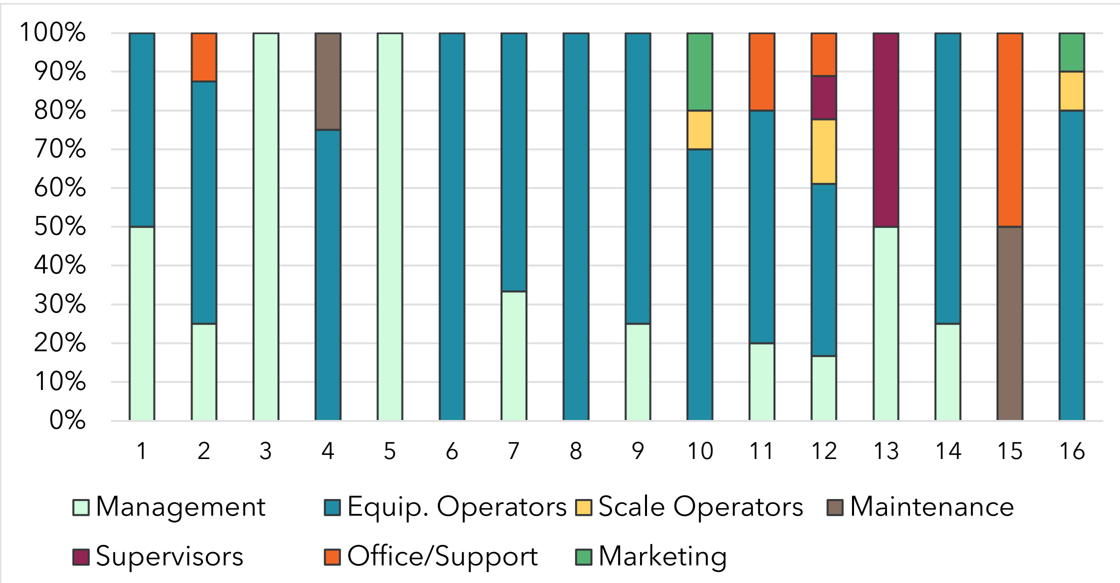
- Many of the facilities surveyed have been operating for more than ten (10) years and did not have accurate records of the capital cost at the time of development. Cost data obtained was primarily for windrow composting facilities and ranged from roughly $10 to $200 per ton received.
- The majority of the facilities surveyed own their property and did not have a building used for composting activities (e.g., receiving or pre-processing).

Current Operational

Labor

- Facilities ranged from less than one (1) Full Time Employee (FTE) to up to eighteen (18) FTEs depending on the size of the site and auxiliary activities (collection). Some of the FTEs shown below place collection drivers under equipment operators. By default, if the facility was unsure of where to place a particular FTE, they were typically seen as equipment operators. As shown in the chart below, most operations are comprised of management staff and equipment operators.
- Shifts were typically five (5) to eight (8) hours a day, five (5) to six (6) days a week for fifty-two (52) weeks of the year.

Figure 11: Facility Staffing Breakdown by Title



Equipment

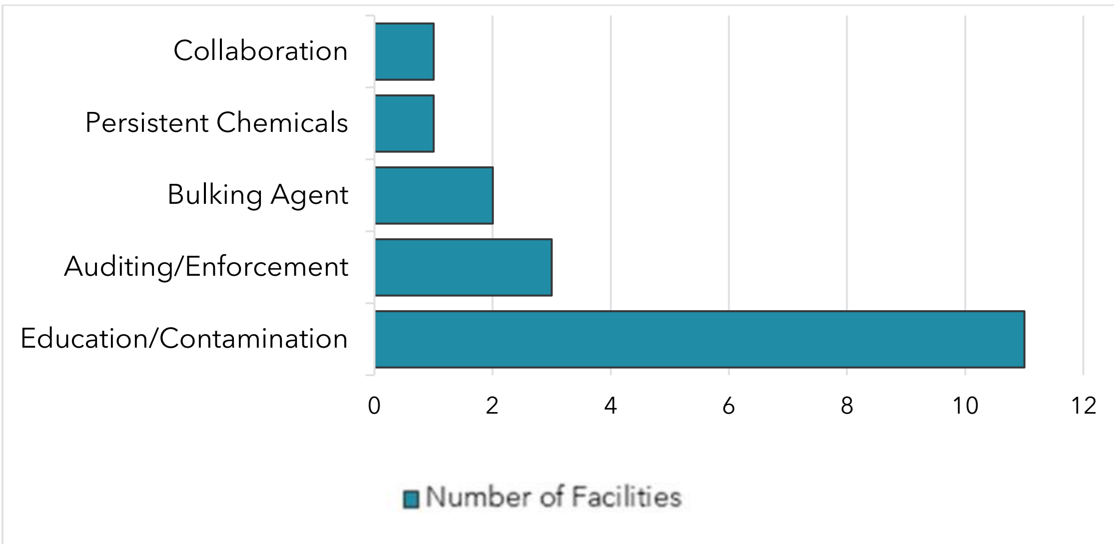
- Most facilities operated with one screen and one grinder, although a few facilities did not have any processing equipment. For mobile equipment, most sites had at least one (1) loader. Depending on the size of the site and other activities (e.g., collection), the site would have one (1) to four (4) front-end loaders, one (1) forklift, and one (1) skid steer, and anywhere from one (1) to five (5) trucks used for collection or other auxiliary activities.
- Equipment life varied; most reported that equipment should operate for fifteen (15) to twenty (20) years, but at a minimum, six (6) to seven (7) years.
- Most facilities did not have an equipment replacement fund.

5.3.8 Needs Assessment Input

The 2023 Compost Survey requested information regarding how feedstock generators, product manufacturers, and the state of Colorado could help each facility succeed in their operations. **Figure 12**, **Figure 13**, and **Figure 14** below provide an overview of the results.

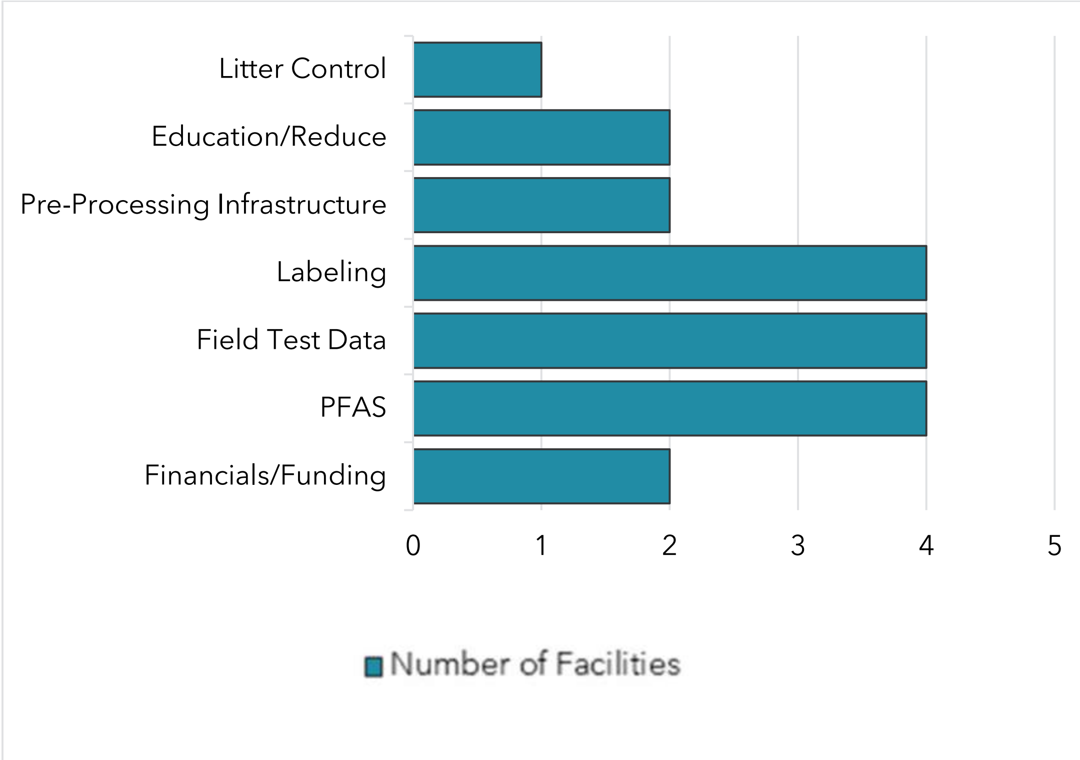
The majority of the surveyed facilities suggested that feedstock generators should be provided more education on acceptable materials in the organic waste stream to reduce contamination received at the composting facility. This could be implemented by either community groups, haulers, or jurisdictions. Other recommendations include auditing bins and enforcing a contamination standard, issues with obtaining bulking agents such as mulch and cow manure, and abolishing the use of persistent chemicals such as herbicide by feedstock generators. While collaboration was only singled out by a few, most of these recommendations relate to creating partnerships between haulers and the city to better support compost collection.

Figure 12: Recommendations for Feedstock Generators



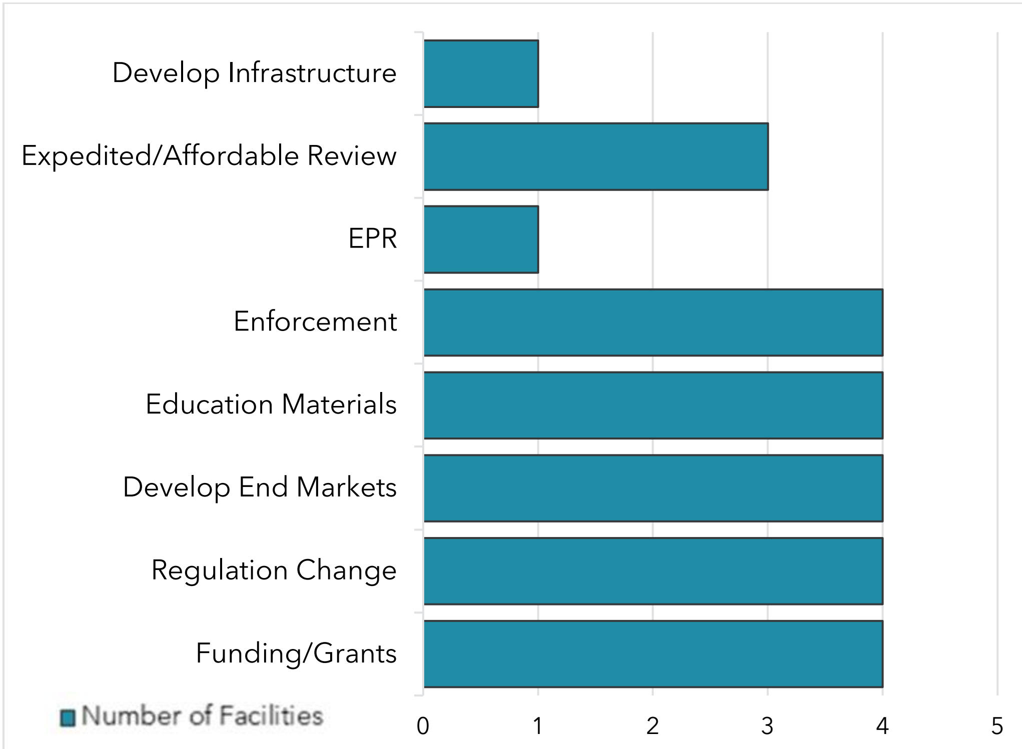
Surveyed facilities had several suggestions for product manufacturers to support their operations. Surveyed facilities suggested that product manufacturers should provide clear labeling on packaging to make it easy for consumers to know what is and is not compostable while avoiding the combination of compostable and non-compostable packaging on the same product. In addition, surveyed facilities suggested that field tests should be completed, executed, and shared to confirm the composability of the product, as laboratory tests are not accurate representations of field conditions. Product manufacturers must also remove per- and polyfluoroalkyl substances (PFAS) chemicals in their products as it degrades the value of the compost and final product. Other recommendations include controlling litter, providing more education on recycling and composting, adding more pre-processing infrastructure (sorting line and shredder), and additional funding to process materials. Please refer to the **Element 7 Technical Memorandum** for a detailed description of the opportunities and costs associated with considerations for improvement of facilities to promote increased management of compostable packaging in Colorado.

Figure 13: Recommendations for Product Manufacturers



Surveyed facilities had similar ideas on what the State could do to help them with their composting operations. As shown in **Figure 14**, these include consistency of rules enforcement throughout the state, educating the public on acceptable materials for compost and the proper use of compost, developing additional end markets for compost products, providing more funding opportunities such as grants, developing infrastructure, and supporting the completion of EPR. Surveyed facilities also suggested that the state should change regulations to make composting more feasible for mid-size and small composters and available to everyone regardless of zoning. In addition, regulations in the form of bans for food and yard waste and the use of pesticides should also be implemented to support composting and improve the composition of organic materials received.

Figure 14: Recommendations for the State



6 SUMMARY

The Colorado Needs Assessment took a comprehensive approach to assessing the current status of the organics industry in the State of Colorado. The HDR team first took a look at existing studies and reports and an overview of local permitting regulations throughout the most populated areas of the state per region (e.g., Western Slope, Mountains, Front Range, Eastern Plains). Then, we prepared an in-depth 2023 Compost Survey to cover a plethora of regulatory, economic, and operational components of seventeen (17) compost facilities operating in the state. The following is a summary of our findings.

6.1 ORGANICS TRENDS

6.1.1 Previous Studies and Reports

The various studies and reports that have been conducted in recent years have found that while progress is being made in increasing the amount of organics diverted from disposal, it has not been enough to keep pace with the State's diversion goals. Limits in the segregation, collection, and processing systems are preventing the full connection between organic waste generation and compost use. Recurring themes found across the studies, surveys, and annual reports include a need to increase access to organics collection programs, reduce the barriers to entry facing new composting facilities (including the cost of permitting), and develop more end markets to drive the demand for the finished compost. The Front Range is considered particularly important to these efforts, as it is the most populous region in Colorado and generates the most organic waste from residential, commercial, and industrial sources.

6.1.2 Permitting Regulations

As evident from the high-level review of municipal codes from the most populated counties in each of the four (4) regions of the state, it is clear that composting is not a clearly defined use and is most often grouped with solid waste facilities. This, in turn, may limit the composting operations access to properly zoned land as commercial and industrial properties are not only more expensive than agricultural properties but may be closer to sensitive receptors such as residential homes, schools, and hospitals. Separating out the processing of organic materials into a nutrient-rich product from the disposal or transfer of materials is a critical step in supporting the development of organics processing infrastructure in the state.

6.1.3 Feedstock

As described in **Section 5.3.2**, nearly all composting facilities surveyed take a mixture of green and food waste. While only two (2) surveyed reported composition data for compostable packaging, six (6) facilities currently accept compostable packaging, and several are willing to accept compostable packaging, as shown on the maps in **Section 5.3.4**.

The biggest hurdle to accepting compostable packaging appears to be related to labeling and certification standards.

6.1.4 Infrastructure

From the surveyed compost facilities, the State of Colorado has a current organics processing capacity of roughly 400,000 tons per year and a potential capacity of roughly 1,100,000 tons per year. The most common technology was windrow composting, although aerated static pile systems are currently being piloted or used in conjunction with windrow composting at a few facilities.

6.1.5 Product

From the surveyed compost facilities, the State of Colorado generates roughly 300,000 cubic yards of compost product per year. This is consistent with the actual processing capacity listed above. Compost product is sold at a sales price of $8.25 to $150 per cubic yard, and mulch is sold at a sales price of $5.25 to $100 per cubic yard. Most products are sold in bulk and hauled off-site by the customer.

6.2 STAKEHOLDER INPUT

6.2.1 Feedstock Generators

The leading recommendation from feedstock generators was to focus on education to reduce contamination. The next most common recommendation was to adopt some form of waste audit and enforcement, designed to be paired with a robust education campaign again focused on reducing contamination in the organic waste stream.

6.2.2 Product Manufacturers

As evident throughout the compost surveys and reiterated here, the two (2) largest concerns for compostable products were labeling and field test data (certification standards). Another large concern for compostable products was the presence of PFAS in the materials and their inability to break down via the composting process.

6.2.3 State

There was no one leading recommendation for the state, but a variety of suggestions varied by operator. The most consistent recommendations throughout the survey were enforcement, creation of education materials, the development of product end markets, changing regulations, and providing additional funding or grants.

6.3 NEXT STEPS/RECOMMENDATIONS

The project team recommends the following to improve the regulatory climate and operational components to increase the ability of composting facilities to accept and process compostable packaging materials.

6.3.1 Policy Recommendations

Related to state and local policy and regulations, the recommendations can be broken down and applied into three (3) sectors: 1) Feedstock Generators, 2) Product Manufacturers, and 3) State or CDPHE.

How Feedstock Generators Can Improve

- Increase Education: A major concern is the contamination of non-compostable materials in the organic waste stream. This is one of the main reasons why facilities do not accept compostable packaging.
- Implement Waste Auditing: Also aimed to reduce contamination in the waste stream, introducing a waste auditing process either by the hauler and/or jurisdiction managing the collection of the organic waste stream was identified as another helpful tool. Initial audits are useful to establish baselines and identify specific areas for improvement. Performing audits at regular intervals assists with evaluations of new programs and policies.

How Product Manufacturers Can Adjust

- Uniform Labeling: While the passing of SB23-253 may help alleviate concerns with labeling and colors for compostable packaging, more work may need to be done to easily and effectively differentiate compostable vs non-compostable packaging in the waste stream.
- Practical and Transparent Certification Standards: Another main reason composting facilities do not accept and process compostable packaging is due to the limited certification data. Some data has only been verified in a laboratory setting, which is an inaccurate representation of the composting system. As discussed, CMA recently adopted a certification that requires the submission of field data, but this is a new endeavor whose impacts have yet to be fully understood.

How the State or CDPHE Can Assist

- **Develop Enforcement Mechanisms**: Potentially paired with the waste audits, the composting industry is seeking enforcement on contamination in the organic waste stream and unpermitted composting facilities.
- **Improve Permitting Process**: Several composting facilities mentioned the permitting process was stringent or cumbersome and often times expensive. The recent 2023 proposed modifications to the Compost Regulations may help address these concerns, but similar to the recent bill and certification related to compostable packaging, the impacts of these changes have yet to be fully understood.
- **Develop Product End Markets**: While compost sales are mostly seasonal in relation to the growing season (Spring and Fall), the potential of product use from the growing industry and the municipal sector is not being fully utilized. The State has the ability to require entities (either product manufacturers, haulers, or municipalities) to procure a specific amount of compost product produced from the organic waste they generate.
- **Increase Funding Opportunities**: Most compost facilities surveyed were happy with the current funding opportunities offered by CDPHE (i.e., grants) but are hoping to see more funding opportunities and the ability to utilize the funding for additional resources and activities.

6.3.2 Operational Recommendations

From an operational post-collection perspective, there are three (3) main components to apply to composting facilities:

How to Increase Pre-Processing Activities

- **Increase Pre-Processing Equipment**: Promote the purchase and use of additional pre-processing equipment to sort out contamination and prepare a homogenized feedstock for the composting system.

How to Enhance Composting Systems

- **Improve Material Tracking**: While a few composters did confirm they are able to track material through their compost systems to verify if compostable packaging is fully broken down in the composting process, most had not yet developed or piloted this level of detail in their material tracking.

How to Expand Product Markets

- **Produce Specified Product**: While the Colorado Department of Transportation does not offer a third-party certification, it is important to note they have defined specifications for compost products to meet for them to utilize this product. Educating composters on these specifications could help improve this product market.
- **Obtain Third-Party Certifications**: Only two (2) surveyed composting facilities used a third-party certification on their compost product. Certifying the product quality has been shown to increase revenue and attract customers. This is evident in the certified organic products throughout the growing industry.
- **Recruit Dedicated Marketing Staff**: The composting facilities with dedicated marking staff were more likely to have third-party certifications on their product or offer a variety of different products. Both of these activities typically indicate the ability to sell more products.

Appendix A.
Permitted Compost Facilities

Table A-1: Class I, II, and III Facilities

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstocks	Product Certifications[B]	Permitting Type
Eastern Plains	Sterling Correctional Facility	12101 CO-61 Sterling, CO 80751	Public	<500 TPY	Food waste, paper waste, yard waste, and brush. Feedstock is primarily from the correctional facility		
Front Range	A1 Organics	12002 Co Rd 59 Keenesburg, CO 80643	Private	>10,000 TPY	Food waste, green waste, bioplastics, fats, sod, and manure	USCC	Composting-Class III
Front Range	Eaton Composting-A1	16350 Co Rd 76 Eaton, CO 80615	Private	>10,000 TPY	Food waste, green waste, bioplastics, fats, sod, and manure	USCC	Composting Class III
Front Range	Organix Supply (Richlawn Turf Food)	15121 Co Rd 32 Platteville, CO 80651	Private	>10,000 TPY	Untreated natural wood only, including pallets and wood from construction and demolition		Composting-Class I
Front Range	Renewable Fiber Inc	County Rd 18 ½ Fort Lupton, CO 80621	Private	>10,000 TPY	Biosolids, animal waste, blood mix, and compost bulking materials		Composting-Class III
Front Range	B.O.S.S. Compost	16700 Co Rd 12 Fort Lupton, CO 80621	Private	>10,000 TPY	Agricultural materials, such as cornstalks, straw, wood shavings, animal bedding, and manure	USCC	Ag Exempt - Class II
Front Range	The Dairy (Mountain View Farm)	1335, 6875 County Rd 9 Loveland, CO 80538	Private	>10,000 TPY	Yard waste, brush, manure, straw, and wood waste. The facility is primarily a cattle operation that processes cattle manure and wood.		Composting-Class I

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstocks	Product Certifications[B]	Permitting Type
Front Range	Denver Arapahoe Disposal Site (DADS)	3500 S Gun Club Rd Aurora, CO 80018	Private	<5,000 TPY	Commercial sector food waste, yard waste, and wood waste	USCC	Composting Class III
Front Range	Dons Garden Shop	6001 E Platte Ave Colorado Springs, CO 80915	Private	<5,000 TPY	Yard waste, brush, manure, and wood waste		Composting Class II
Front Range	East Regional Landfill	8201 Schumaker Rd Bennett, CO 80102	Private	<5,000 TPY	Yard waste, brush, food waste, and bioplastics from the commercial and agricultural sectors		Composting Class III
Front Range	Midway Landfill and Midway Organic	8925 Rancho Colorado Blvd Fountain, CO 80817	Private	<5,000 TPY	Biosolids, sludge, and food waste from the government and commercial sectors	USCC	Composting-Class III
Front Range	TV dairy	7262 Wheatland Blvd Fort Lupton, CO 80621	Private	<5,000 TPY	Manure and wood waste.		Composting-Class I
Front Range	City Of Fort Collins - Hoffman Mill	1380 Hoffman Mill Rd Fort Collins, CO 80524	Public	<500 TPY	Yard waste, leaves, brush, and tree limbs from city operations		Composting Class I
Front Range	Colorado State University Compost Facility	4318 Laporte Ave Ft. Collins, CO 80526	Public	<500 TPY	Food waste, paper waste, and straw from campus operations		Composting Class I
Front Range	Dyecrest Dairy	1137 N County Rd 1 Fort Collins, CO 80524	Private				Composting Class I

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstocks	Product Certifications[B]	Permitting Type
Front Range	Revolution Soil and Seed	19500 CO-14 Ault, CO 80610	Private			OMRI Composting-Class II	Composting-Class I
Mountains	Pitkin City Solid Waste Center	32046 Jack Gredig Ln Aspen, CO 81611	Public	>10,000 TPY	Yard waste, brush, food waste and processing residuals, biosolids, and wood waste from the commercial and residential sectors	USCC	Composting-Class III
Mountains	BV Correctional Facility	15125 US-24 Buena Vista, CO 81211	Public	<5,000 TPY	Wood waste and food waste		Composting Class I
Mountains	Climax Mine-Lake County	11230 CO-91 Leadville, CO 80461	Public	<5,000 TPY	Biosolids and sludge from the industrial and commercial sectors		Composting Class III
Mountains	Milner Mall	20650 Co Rd 205, Steamboat Springs, CO 80487	Private	<5,000 TPY	Biosolids, manure, and food waste from the residential and industrial sectors		Composting-Class III
Mountains	Summit County Resource Allocation Park	639 Landfill Rd Dillon, CO 80435	Public	<5,000 TPY	Biosolids, food waste, liquid waste, septage, manure, brush, and wood waste		Composting-Class III

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstocks	Product Certifications[B]	Permitting Type
Mountains	Vail Honeywagon	955 Ute Creek Rd Wolcott, CO 81655	Private	<5,000 TPY	Biosolids, sludge, yard waste, brush, food waste and processing residuals, wood waste, and compostable plastics from agricultural, commercial, and residential sectors		Composting- Class III
Western Slope	Mesa County Organic Materials Composting Facility	3071 US-50 Grand Junction, CO 81503	Public	<5,000 TPY	Yard waste, brush, and other material from residential drop-offs and commercial self-haul, primarily from professional landscapers	USCC	Composting- Class III
Western Slope	South Canyon Solid Waste Disposal Site	1205 Co Hwy 134, Glenwood Springs, CO 81601	Public	<5,000 TPY	Biosolids, sludge, yard waste, brush, food scraps, manure, wood waste, and grease from agricultural, commercial, and residential sectors	USCC	Composting- Class III
Western Slope	CHT Resources/ CB Industries	11289 Doughspoon Rd, Delta, CO 81416	Private	<500 TPY	Liquid waste, brush, and food waste from the commercial and residential sectors		Composting Class III
Western Slope	Delta Correctional Doc	11363 E10 Rd Delta, CO 81416	Public	<500 TPY	Food waste and manure generated internally, and the manure comes from nearby farms		Composting Class I

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstocks	Product Certifications[B]	Permitting Type
Western Slope	Montezuma County Landfill	26100 Road F Cortez, CO 81321	Public	<500 TPY	Biosolids and yard waste and is planning to accept food waste soon from the residential and government sectors		Composting- Class III
Western Slope	Table To Farm Compost LLC	556 Main Ave, Durango, CO 81301	Private	<500 TPY	Biosolids, food waste and processing residuals, wood waste, and brush from the commercial and residential sectors	USCC	Composting- Class III
Western Slope	Pioneer Wholesale Supply (Aka Southwest Soils)	58521 Amber Rd Olathe CO, 81425	Private	<500 TPY	Unknown		Composting- Class II
Western Slope	Thunder Mountain Composting (3xm)	59039 Amber Rd Olathe, CO 81425	Private				Composting- Class III

[A] Source: Tetra Tech, Skumatz Economic Research Associates, and Resource Recycling System. Colorado Statewide Organics Management Plan. Table 4.2-1. August 29, 2022.

[B] Certifications:
USCC STA = United States Composting Council Seal of Testing Assurance. *https://www.compostingcouncil.org/page/participants*. Date Accessed: August 24, 2023
OMRI = Organic Materials Review Institute

Table A-2: CESQ Facilities

Region	Name of Facility	Address	Public/ Private	Throughput (TPD or TPY)[A]	Feedstock	Operating Commercially?	Product Certifications
Front Range	Colorado Manure Hauling	10245 CR 74-82 Peyton, CO 80831	Private		Agricultural waste	Commercial services available	
Front Range	Colorado State University Campus Composter	3785 Laporte Ave Ft. Collins, CO 80521	Public	150 TPY	Pre-consumer food waste from our dining centers	No	
Front Range	Compost Colorado	4800 Washington St Denver, CO 80216	Private	140 TPY	Food waste, paper products, plants, compostable-ware	Commercial services available	
Front Range	Compost Queen	1505 N College Ave Fort Collins, CO 80524	Private	58 TPY	Food waste	No	
		1601 N Shields St Fort Collins, CO 80524					
		2035 W Mulberry St Fort Collins, CO 80521					
		7422 Victoria Ct Fort Collins, CO 80525					
Mountains	Cowgirl Compost Co	41090 CR 80 Hayden, CO 81639	Private		Food waste	Commercial services available	
Western Slope	Dirty Sturdy's Mountain Compost - Ridgway	8 Lynx Rd Ridgway, CO 81432	Private		Kitchen scraps, veggie ends, expired foods, egg shells, torn-up paper, coffee grounds, peels, rinds, seeds, pits,	Commercial services available	

					Leaves, untreated Hair, plants (not diseased ones), "Industrially compostable" plastics, grains, floor sweepings (if organic), rock, dust, ashes, grass, weeds, torn-up cardboard, garden residue, shells, wood chips, twigs		
Western Slope	Eco Action Partners	26 Porphyry St Ophir, CO 81426	Private		Food scraps under 6", shredded paper		
Mountains	Elements Mountain Compost	8875 County Road 150 Salida, CO 81201	Private		Food scraps are mixed with woodchips, sawdust, and other yard waste	Commercial services available	
		9245 County Rd 140 Unit B Salida, CO 81201	Private				
Front Range	Food To Power	1628 W Bijou St Colorado Springs, CO 80904	Private		Food waste, cardboard, leaves, trimmings	Commercial services available	
		702 E Boulder St Colorado Springs, CO 80903	Private				
		1090 S Institute St Colorado Springs, CO 80903	Private				
Front Range	Princess Gardens LLC	4925 E Donald Ave, Unit C Denver, CO 80222	Private				
Front Range	Pueblo Green Center	2833 Lowell Ave Pueblo, CO 81003	Public				

Mountains	Purple Bucket Compost, LLC	397 Chickadee Ln Bailey, CO 80421	Private	76.3 tons composted since 2021	Food scraps, not meat and dairy	Commercial services available	
Western Slope	Reincarnated	1603 CR 301 Durango, CO 81303	Private				
Western Slope	Sol Gardens LLC	901 Mira Mesa Hesperus, CO 81326	Private				
Front Range	T+D's Mulch and Grind, Inc.	1880 S Ridge Rd Castle Rock, CO 80104	Private		Trees and cannabis		
Front Range	TNT Forest Products	44106 Highway 72 Ward, CO 80481	Private				

Appendix B. Compost Survey

Date/Time: ______________________________
HDR Evaluator: ______________________________

Site Name: ______________________________
Address: ______________________________

Site Contact Name: ______________________________
Email: ______________________________
Phone #: ______________________________

1 GENERAL

- What is the facility technology? (check, as applicable)
  - Anaerobic
  - In-Vessel
  - Windrow
  - Aerated Static Pile
  - Other
- What is the facility throughput? (circle applicable units)
  - Permitted:
    - _______ (tons/cubic yards) per day
    - _______ (tons/cubic yards) per month (summer April-September)
    - _______ (tons/cubic yards) per month (winter October-March)
    - _______ (tons/cubic yards) per year
  - Designed, if different than permitted:
    - _______ (tons/cubic yards) per day
    - _______ (tons/cubic yards) per month (summer April-September)
    - _______ (tons/cubic yards) per month (winter October-March)
    - _______ (tons/cubic yards) per year
  - Actual (last five years):
    - _______ (tons/cubic yards) per day
    - _______ (tons/cubic yards) per month (summer April-September)
    - _______ (tons/cubic yards) per month (winter October-March)
    - _______ (tons/cubic yards) per year
  - Capable
    - _______ (tons/cubic yards) per day
    - _______ (tons/cubic yards) per month (summer April-September)
    - _______ (tons/cubic yards) per month (winter October-March)

  – _______ (tons/cubic yards) per year

- What is the gate tip fee?
  - Clean Green _____ per ton
  - Green and Food _____ per ton
  - Source-separate Food _____ per ton
  - Self-haul _____ per load
  - Other
    - Compostable Plastics _____ per ton
    - Compostable Paper _____ per ton
    - Soiled Paper _____ per ton
    - Other _____ per ton
    - Other _____ per ton
    - Other _____ per ton
- What is the size of composting area in acres?
  - <0.5 acre
  - <1 acre
  - 1 – 2 acres
  - 2 – 5 acres
  - 5 – 10 acres
  - 10 – 20 acres
  - >20 acres
- What is the total size of site in acres?
  - < 2 acres
  - 2 – 5 acres
  - 5 – 10 acres
  - 10 – 20 acres
  - >20 acres
- Is the compost area paved? (Y/N)
- What is the total paved acreage of site (including parking)?
  - Asphalt __________
  - Concrete __________
  - Site *Allocation (in acres)*
    - Receiving Area _______

- Pre-Processing _______
- Active Phase _______
- Curing Phase _______
- Screening _______
- Product Storage _______
- Admin _______
- Other _______

- What *temperatures are your piles maintained at?*
  - Active ______ *˚F* ______ *Days*
  - PFRP (Active) ______ *˚F* ______ *Days*
  - Curing ______ *˚F* ______ *Days*

2 FEEDSTOCK

- What is the mix of materials received (approx. percentage by weight)?
  - % Green Waste ___
  - % Wood Waste ___
  - % Food Waste ___
  - % Compostable Plastics ___
  - % Residue ___
  - % Other ___ _______________
- Are there any trends in feedstocks you've observed?
  ____
- Please indicate the percentage by weight for feedstock received from residential, commercial, and other feedstock.
  - Percent Residential ____
  - Percent Commercial ____
  - Percent Other ____
- Please *check if you accept any of these materials. (Check as applicable)*
  - Molded pulp (e.g. egg cartons, drink trays)
  - Tissue/Toweling (e.g., tissues, napkins, paper towels)
  - Soiled paper (e.g., newspaper, tea *bags, coffee filters)*
  - Soiled cardboard (e.g., pizza boxes)
  - Cardboard (e.g., occ)
  - Shredded paper (e.g., loose and/or bagged)
  - Take-out Containers (paper based)
  - Paper bags
  - Microwave popcorn bags
  - Compostable bags and liners (e.g., certified compostable)
  - Compo*stable coffee pods*
  - Compostable plates, cups, containers
  - Wood packaging (e.g., organic boxes)
- Textile packaging (e.g., burlap)

3 SERVICE AREA

- Please describe the facility service area noting areas and communities served. Indicate which service is provided for which city(ies), county(ies), and other or unincorporated area(s).
    - ____
      ____
- What is the population of the combined areas served?
    - <25,000 citizens
    - 25,001 – 50,000 citizens
    - 50,00 – 100,000 citizens
    - 100,001 - 250,000 citizens
    - 250,001 – 500,000 citizens
    - 500,001 – 1,000,000 citizens
    - >1,000,000 citizens
- What are the existing services provided? (Circle all applicable)
    - Collection
        - MSW (single family/multi-family/commercial)
        - Single Stream Recycling (single family/multi-family/commercial)
        - Dual Stream Recycling (single family/multi-family/commercial)
        - Green Waste (single family/multi-family/commercial)
        - Food Waste (single family/multi-family/commercial)
        - Other__________________
    - Transfer ____
    - Landfill ____
    - MRF ____
    - Composting Facility ____
    - Other___________________

- Indicate number and type of dropoff stations and quantity of feedstock collected
  - Green Waste #______________, Quantity______________
  - Food Waste #______________, Quantity______________
  - Green and Food Waste #______________, Quantity______________
  - Other #_________________, Quantity______________
- Describe other arrangements
  - ____
    ____

4 PRODUCT

- Outgoing commodities by type with weights/volumes (circle applicable units)
  - *Compost* __________ (tons/cubic yards) per (day/month/year)
  - *Organic Compost*__________ (tons/cubic yards) per (day/month/year**)**
  - *Mulch* __________ (tons/cubic yards) per (day/month/year)
  - *Organic Mulch*__________ (tons/cubic yards) per (day/month/year)
  - *Colored Mulch*__________ (tons/cubic yards) per (day/month/year)
  - *Overs* __________ (tons/cubic yards) per (day/month/year)
  - *Other* __________ (tons/cubic yards) per (day/month/year)
  - *Other* __________ (tons/cubic yards) per (day/month/year)
- By commodity, are the commodity markets in-state or out-of-state? (Circle if applicable)
  - Compost (in-state / out-of-state)
  - Organic Compost (in-state / out-of-state)
  - Mulch (in-state / out-of-state)
  - Organic Mulch (in-state / out-of-state)
  - Colored Mulch (in-state / out-of-state)
  - Overs (in-state / out-of-state)
  - Other
    - _________(in-state / out-of-state)
    - _________(in-state / out-of-state)
    - _________(in-state / out-of-state)
- Which commodities do you pay to ship to markets, or do the buyers pay for transportation/shipping? (Circle answer)

  - o Compost (You pay / Buyer pays)
  - o Organic Compost (You pay / Buyer pays)
  - o Mulch (You pay / Buyer pays)
  - o Organic Mulch (You pay / Buyer pays)
  - o Colored Mulch (You pay / Buyer pays)
  - o Overs (You pay / Buyer pays)
  - o Other______ (You pay / Buyer pays)
- How are products moved off-site?
  - o Customer Haul
  - o Dump Truck
  - o Tractor Trailer
  - o Railcar
  - o Other
- Sales price per product type/material
  - o Compost _______________
  - o Organic Compost _______________
  - o Mulch _______________
  - o Organic Mulch _______________
  - o Colored Mulch _______________
  - o Overs _______________
  - o Other_______________

5 RESIDUALS

- What is the average number of rejected loads per month?
  - o 0 per month
  - o < 1 per month
  - o 2 – 5 per month
  - o > 5 per month
  - o > 10 per month
- What is the average residue quantities per year?
  - o 0 TPY
  - o <5 TPY
  - o 6 - 25 TPY

- 26 - 100 TPY
- 101 – 250 TPY
- 251 – 500 TPY
- 501 – 2,500 TPY
- 2,501 – 5,000 TPY
- >5,000 TPY

- What is the cost and hauling distance for disposal of residue?
  - Disposal Costs _______________ $/t
  - Haul distance or disposal facility ______________miles

6 CONTAMINATION

- What is the estimated contamination rates of incoming material (residential)?
  - <1%
  - <2%
  - 2% - 5%
  - 6% - 10%
  - 10% - 20%
  - >20%
- What is the estimated contamination rates of incoming material (commercial)?
  - <1%
  - <2%
  - 2% - 5%
  - 6% - 10%
  - 10% - 20%
  - >20%
- What is the estimated contamination rates of incoming material (other)?
  - <1%
  - <2%
  - 2% - 5%
  - 6% - 10%
  - 10% - 20%

- >20%

- Common source of rejected loads? (check as applicable)
  - Certain municipalities
  - Certain routes
  - Specific industry
  - Depots
  - Multi-Family Residential
  - Other

- Do you charge extra if contamination is over a certain threshold? (Yes / No)
  If so, what is the rate? ____
- Provide any sort data for types of contaminants *(percentage by weight)*
  - *Dirty/wet paper products ___%*
  - *Non-recyclable plastics ___%*
  - *Compostable plastics___%*
  - *Glass ___%*
  - *Rocks and dirt ___%*
  - *Other ___%*
- Are there common contaminants that you observe? (check as applicable)
  - *___compostable plastic*
  - *___types of plastic that aren't accepted at your facility*
  - *___ceramics*
  - *___glass*
  - *___wet paper*
  - *___fabric/clothing*
  - *___Needles/other medical waste*
  - *___ Other ______________________*
- Are there any materials that are challenging to handle or cause issues with the equipment? (Yes/No)
  - Screen(s) _____
  - Grinder(s) _____
  - Windrow Turner _____
  - Other _____
- What *are the impacts of this?* (check, as applicable)
  - ___Downtime
  - ___Contaminated commodities
  - ___Lost revenue
  - ___Worker injuries

- ___Increased residue disposal costs
- ___Other

- What are the estimated costs associated with dealing with contamination?
  - $0 per month
  - <$1,000 per month
  - $1,001 - $5,000 per month
  - $5,001 to$10,000 per month
  - $10,001 – $50,000 per month
  - >$50,000 per month
- Have you noticed any patterns in which loads *you're rejecting?*
  - ___certain municipalities,
  - ___routes,
  - ___industry types
  - ___Other ____________________
- Do you have a protocol or SOP for when you reject loads? If so, request copy or brief description.

  ____

- Do you have to keep contamination below a certain level to send it to end *markets? If so, what is it?*
  - Compost ______________
  - Organic Compost ______________
  - Mulch ______________
  - Organic Mulch ______________
  - Colored Mulch ______________
  - Overs ______________
  - *Other*______________
- Do end markets charge a fee or reduce the *price if contamination levels are above a certain point?* Yes / No
- Has your facility ever been penalized for contamination? Yes / No

7 OPERATIONS

- Please provide a simple layout diagram or list of major equipment.
- Please indicate the age and condition of major stationary equipment.
  - Equipment No. Length of Life (yrs)
    - Screen(s) _____ _____
    - Grinder(s) _____ _____
    - Scale(s) _____ _____
    - Other _____ _____
- Please discuss any facility limitations impacting operations and maintenance.

  ____

- How many FTEs are onsite, _____FTE and is staffing a limitation? Yes / No
- Please list number by job title and estimated annual hours by category.
  - Management _____ #____ annual hours
  - Equipment operators _____ #____ annual hours
  - Sorters _____ #____ annual hours
  - Scale operators _____ #____ annual hours
  - Maintenance _____ #____ annual hours
  - Supervisors _____ #____ annual hours
  - Office/Support staff _____ #____ annual hours
  - Marketing Staff _____ #____ annual hours
- Please provide the total number of shifts, staff on-site, and annual labor cost.
  - # of shifts_____# days/week _____
  - # of staff on-site during normal operations ______
  - Total annual labor cost $______________________
  - Please provide storage/staging capacity for incoming and outgoing materials indicating approx. square footage, tons, or days processing.

    ____

- Please list rolling stock and age of equipment used at the site.
  Equipment *No.* *Length of Life (yrs)*
  - Frontend loader(s) _____ _____
  - Forklift(s) _____ _____
  - Skidsteer(s) _____ _____

- Roll-off Truck(s) _____ _____
- Compost turner _____ _____
- Trucks _____ _____
- Other _____ _____

- Please list the manufacturer of processing equipment:
  - Screen(s) _____
  - Grinder(s) _____
  - Scale(s) _____
  - Frontend loader(s)_____
  - Forklift(s) _____
  - Skidsteer(s) _____
  - Roll-off Truck(s) _____
  - Compost turner _____
  - Trucks _____
  - Other _____
- What is your Building Replacement/Repair Cost Fund?
  - ____% of total capital cost per year
  - Other ______________________
- What is your Stationary Equipment Replacement Cost?
  - ____% of total capital cost per year
  - Other ______________________
- What is your Mobile Equipment Replacement Cost?
  - ____% of total capital cost per year
  - Other ______________________
- What is your facility's estimated utility costs per year?
  - Internet/Phones/Radios/IT __________
  - Electricity _____________ kWh/yr _________________
  - Demand kWh _____________
  - Diesel _______________ gal/yr
  - HVAC (for buildings) $/yr______________

8 PERMITTING

- Was the permitting process stringent or cumbersome? Yes / No
- How long did it take to get the facility permitted?
    - < 1 week
    - < 3 months
    - 3 months to 6 months
    - 6 months to 1 year
    - > 1 year
    - > 2 years
- What was the construction timeline for constructing the facility?
    - < 6 months
    - 6 months to 1 year
    - 1 year to 2 years
    - >2 years
- What are your ongoing compliance and reporting requirements? (check as applicable)
    - Quarterly reporting ____
    - Semi-annual reporting ____
    - Annual reporting ____
    - Other ________________________
- Please describe any internal recordkeeping procedures or material testing?
    - ____ ____
- Is there an ability to track material destruction? (Y/N)
- How many years has the facility been operating? (check as applicable)
    - < 1 year ____
    - 1 - 5 years ____
    - 5 – 10 years ____
    - > 10 years ____

9 CAPITAL COSTS

- What were the overall Capital Cost at the time of development? ______________________
  - Year of development ________
  - Major improvements since original development
    - Amendment #1
      - Year ________
      - $ __________
      - Description ____
    - Amendment #2
      - Year ________
      - $ __________
      - Description ____
- What were the estimated building costs?
  - Type of building (admin, pre-processing, etc.), Total square footage, Tipping floor square footage
    - Type: _____________, ____________ total SF, _____________tipping floor SF
    - Type: _____________, ____________ total SF, _____________tipping floor SF
- What is the cost for the land lease, if applicable?
  - _____$/ Month
  - _____$/ Year
- Can you share any of the following annual costs?
  - Building insurance
  - Property insurance
  - Fire alarm & Sprinkler maintenance
  - Site Security
  - New Gate/Fencing
  - Leasehold Improvements
  - Taxes

10 DESCRIBE CURRENT PLANS TO MODIFY OR EXPAND OPERATIONS.

- Upgrade/replace equipment (Yes / No)
  - If Yes, please describe: ____________________________________
- Add more active phase composting piles (Yes / No)
  - If Yes, please describe: ____________________________________
- Add additional feedstock types (Yes / No)
  - If Yes, please describe: ____________________________________
- Increase/overhaul site space (capacity) (Yes / No)
  - If Yes, please describe: ____________________________________
- Expand service area or sources of feedstock. (Yes / No)
  - If Yes, please describe: ____________________________________
- Describe plans to add collection routes or dropoff sites:
  - ____
- Describe any planned changes to collection infrastructures such as ___new containers, ___trucks, ___signage, ___staffing, ___sites, ___contamination management,, ___Other
  - Briefly describe those checked__________________________________
- How can the feedstock generators best help you succeed?
  ____
  ____
- How can the product manufacturers best help you succeed?
  ____
  ____
- How can the State best help you succeed?
  ____
  ____
- Describe any other possible expansion opportunities you might consider, such as new processing sites.
  ____
  ____

COLORADO NEEDS ASSESSMENT

ELEMENT 13: SCENARIO RESULTS

JANUARY 25, 2024

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TABLES

FIGURES

Many of the tables and figures in this report include estimates that are presented as ranges or rounded figures. As estimates have been rounded, they may not sum to the total and/or may differ from percentage estimates.

1 INTRODUCTION

1.1 PURPOSE

The objective of this element is to estimate the impact of three projected scenarios for increasing the recycling rate and collection rate of covered materials in the state. This includes current collection and recycling rates, as well as the collection and recycling rates that the state could achieve by January 1, 2030, and January 1, 2035. The estimated operating and capital costs needed to reach each projected scenario is also provided. The modeling conducted in this element is the culmination of the findings from the other thirteen (13) elements.

2 APPROACH

In accordance with House Bill 22-1355, this element estimates the current material flows of packaging in Colorado and the costs of the system. Furthermore, three future scenarios were developed to show potential collection and recycling rates for covered materials in 2030 and 2035 and the necessary capital and operating costs to achieve those rates. This analysis was conducted in two primary components: waste flow analysis and cost assessment. This is detailed in the following sections.

2.1 WASTE FLOW ANALYSIS

The model is developed according to a bottom-up approach, systematically considering variables across the waste and recycling value chain. The model flow can be understood as a comprehensive tracking of packaging and paper product materials, from generation through consumption to disposal. More detail on the performance and cost methodology is found in the **Appendix**.

2.1.1 Baseline (2022)

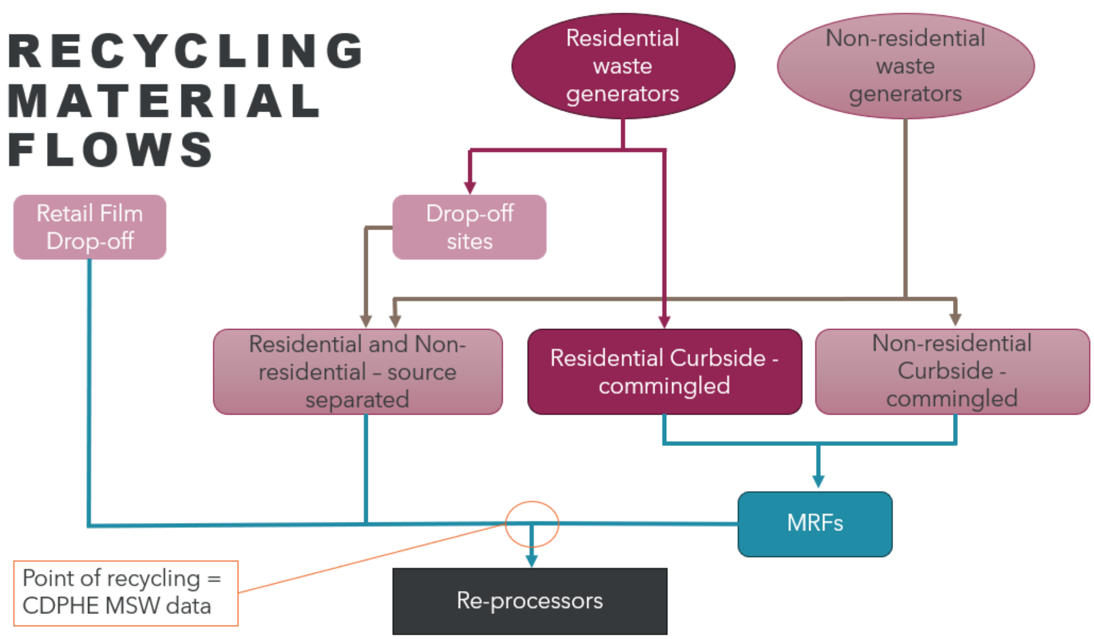
The first step in developing this comprehensive, tailored model for Colorado was to evaluate the existing state of the value chain. This analysis used more than 100,000 Colorado-specific data points gathered through interviews, surveys, site visit observations, and desktop research to develop a 2022 baseline model. Nearly every input used in this analysis is from Colorado. This provides a robust foundation for the modeling process and is informed by the insights from the preceding elements in the following way:

- Residential Collection (Element 1): The data from the research and analysis from this element, such as the current access to waste and recycling services, collection methods, and collection frequencies, were used in the development of the residential access, collection, and material-specific capture in the modeling. This analysis is based on survey responses from over 100 municipalities representing 81% of the municipality population in Colorado.

- Contamination (Element 4): Insights from contamination research in Colorado guided the system efficiencies used in the modeling, addressing material sorting and anticipated losses due to contamination.
- Nonresidential (Element 5): Data collected through stakeholder engagement, webinars, interviews, and surveys with Colorado's non-residential entities were used to estimate the volume of recyclables collected by the system currently across the state and the consequent impact on recycling performance.
- Processing Capacity (Element 6): Research in this section determined current processing capacities in Colorado and the potential to expand processing capacities in the model.
- End Markets (Element 9): Research from this element informed understanding of which materials have viable local end markets and how strong these domestic markets are.
- Reuse & Refill (Element 11): Research determined the current state of reuse and refill systems in the state of Colorado, informing waste prevention and material substitutions.

A simplified flow diagram of the key baseline elements is presented below in **Figure 1**. This diagram illustrates the sequential path of the main modeled flows.

Figure 1: Model Flow Diagram



The results of this analysis are an estimated recycling rate[1] and quantity of recycled packaging and paper product material volumes in Colorado. Additionally, detailed volume estimates along the value chain can be investigated to provide insights into system performance. To ensure the accuracy of these results, they were checked against the CDPHE-reported landfill and MRF output data. This process ensures that our findings align with official state government estimations of Colorado's current system performance.

2.1.2 Future Scenarios

The material flows for the scenarios were based on the current waste flows in Colorado, gathering further insights from the following elements:

- Minimum Recyclables List (Element 8): The minimum recyclables list developed under this element determined the list of materials in the scope of the modeled scenarios and which materials would be collected for different years. This impacted the quantity of materials estimated to be managed by the system.
- End Markets (Element 9): As for the baseline, research from this element informed the development of the end-market portion of this modeling. For instance, developing stronger glass collection and processing systems due to the current local glass market.
- New Technologies (Element 10): Current technology gaps were determined through surveys and site visits in Colorado to inform recommended new technologies, commercial availability, and cost estimations. Findings informed potential advancements in the collection, sorting, and processing of recyclable packaging and paper products. This helped inform the impact of access, collection, and materials controls in the model.
- Education (Element 12): This element informed estimated improvements to recycling participation and collection of materials resulting from educational/informational campaigns. The impact of educational programs on recycling performance is informed by investment rates equivalent to Colorado's highest-performing communities.

2.2 COST ASSESSMENT

As with the waste flow analysis, the cost assessment methodically follows packaging and paper products through the recycling value chain, focusing on accumulated costs at each stage. The first step in the cost modeling process involved establishing a baseline cost of the current system. This estimation was derived from insights obtained from the following elements:

[1] The point of recycling used to define the recycling rate in this study is the same point of recycling that CDPHE reports on, when material is sorted at a MRF and becomes a commodity output.

- Residential Collection (Element 1): Findings from this element informed the cost modeling of the residential access, collection, and material-specific capture.
- Service Costs (Element 2): Stakeholder engagement with the Colorado hauling industry through webinars, surveys, and interviews were used to inform the costs surrounding collection services. Furthermore, this informed the factors that affect costs of maintaining services such as subscriptions, geography, staffing, and fuel – as well as other unique factors in mountain regions such as wildlife (i.e., bear) proof containment.
- Demographics (Element 3): Demographic research directly influenced the cost model benchmarking, exploring correlations between regional demographics and curbside collection costs for recycling and trash.
- Non-residential (Element 5): Research in this element informed the development of the non-residential covered entity collection and recycling costs.
- Processing Capacity (Element 6): This element identified upgrade needs during site visits and interviews to MRFs in Colorado to handle the increase in throughput of feedstocks and increase end-market product quality. The scenario modeling used this information to estimate additional costs from upgrades to existing equipment at varying levels.
- Opportunities and Costs (Element 7): Extending research from Element 6, provided high-level costs for expanding or improving MRFs, composting facilities, and transfer station infrastructure based on survey data collected by the project team from Colorado.
- Education (Element 12): This research informed the estimated cost of educational/information campaigns on the recycling system based on the rate of investments found in best-performing Colorado jurisdictions.
- Composting (Element 14): This research informed the estimated cost for compost facility upgrades to manage compostable covered materials.

2.2.1 Curbside Collection Costs

Curbside collection costs contribute the largest proportion of overall system costs. The approach used multiple research and analysis methods to 1) increase the accuracy of the overall results and 2) address data gaps in the research. A top-down regression model based upon actual service fees was used in combination with a bottom-up collection cost model.

Firstly, considering residential curbside services[2], the primary and secondary research conducted under Element 1 collected Colorado-specific household fees for curbside recycling and trash collection services. Regression analysis was employed, using these

[2] Residential services are those collection from single family or smaller multifamily properties.

fees and further information provided by municipalities and haulers, to develop benchmark costs by jurisdiction. The following curbside collection fee function was employed:

$$\boldsymbol{Household\ Fee}_i = \propto\ + \beta_1 I(Region_{hi}) + \beta_2 I\left(Fee\ Type_{ji}\right) + \beta_3(Drive\ Time_i) + \beta_4(Poverty\ Level_i) + \beta_5(Average\ Rent_i) + \beta_6(Senior\ Population_i) + \beta_7(Unmployment_i) + \beta_8 I(Service\ Provider\ Type_{ki}) + \varepsilon_i$$

Where α is the constant, β are coefficients for each variable that quantifies the per unit impact to cost, I represent discrete categorical variables that take on the value of 0 or 1, ε_i is the error term, and

h = {Front Range, Western Slope, Eastern Plains, Mountains}

j= {Trash Fee, Recycling Fee, Bundled Fee}

k = {open market, municipal single hauler}

for i municipality.

Secondly, the bottom-up flow cost evaluation delved into estimating the cost of the curbside collection system, considering factors such as capital investment, operational expenses, system performance, and related impacts. In addition, transfer costs and the cost to the supplier for processing commingled material at MRFs (based upon gate/tipping fees) were calculated. This bottom-up approach produced service cost estimates per jurisdiction to benchmark, or cross-check, with the service costs estimated from the above regression analysis. Overall, the benchmarking demonstrated good alignment between these sets of estimates across jurisdictions.

2.2.2 Non-residential Costs

Finally, the same bottom-up collection cost model was used to estimate commercial collection costs (e.g., other covered residential and non-residential entities). The resultant service costs were benchmarked against Colorado-specific service costs provided by some haulers and municipalities operating commercial services.

2.3 SCENARIO DEVELOPMENT

House Bill 22-1355 requires that three scenarios be developed to show potential collection and recycling rates for covered materials in 2030 and 2035 and the necessary capital and operating costs.

As the model was developed through a bottom-up approach, different factors that impact collection performance and cost can be adjusted to develop various scenarios. These factors, also called model controls, were first presented to the Colorado Producer Responsibility Advisory Board on November 8th, 2023. Each of these controls can be adjusted in the scenario to understand how different program implementation factors could influence the potential for recycling and the cost associated with that collection and processing.

The model scenario controls are explained in **Table 1** and included five broad categories:

- **Access:** Percent of covered entities that have access to recycling services.
- **Collection:** Collection method for materials collected.
- **Materials:** The covered materials that will be collected based on the minimum recyclables list and additional materials list.
- **Education:** The impact of recycling education on participation rates, material capture, and quality.
- **Infrastructure:** Infrastructure improvements.
- **Waste generation:** The overall quantity of waste generated in future scenarios compared to today.

Table 1: Scenario Controls

Control	Controls Implemented	Relevance and Impact
Access		
Residential recycling access equivalency to trash	Achieved by 2030*	The EPR legislation requires that recycling access should be equivalent to trash based on the convenience standard, meaning that if a household has curbside trash collection, it should also have curbside recycling. This control relates to how quickly this equivalency is met. When more households have access to recycling, the overall number of households participating is likely to increase, which impacts the total volume of material collected and the cost of collection. Access is achieved according to the timeline of the Act; however, participation increases incrementally from service introduction through 2030 to 2035.
Recycling for non-residential covered entities	Offered to all by 2030*	Access to recycling to covered non-residential entities is expected to start by 2028. This control relates to how quickly those covered entities will receive service. When more non-residential entities have access to recycling, the overall number of entities participating is likely to increase, which impacts the total volume of material collected and the cost of collection.
Collection		
Collection method for newly provided service	Single stream	The scenario modeling does not change the collection method where recycling is

Control	Controls Implemented	Relevance and Impact
(current service remains the same)		currently being provided. This means that if a jurisdiction is providing service through dual-stream collection, the future system modeled is dual-stream no matter what is chosen in this control. This control only relates to newly provided service to areas that do not have recycling service. The collection method impacts the volume of material collected, the quality of that material, and the cost of collection. *[Dual stream systems were considered, but the project team were directed to focus on single stream as currently it is the predominant collection method.]*
Frequency of collection	Weekly or bi-weekly	The frequency of collection impacts the quantities of covered materials collected and the cost of collection. Colorado-specific research carried out for this analysis found that when collection is provided more frequently, more covered material is collected overall. The cost of collection is also impacted by the frequency of collection.
Collection route efficiencies	Minor, Medium, Major	Future scenarios consider the impact of more efficient collection routes on the total cost of the system. These efficiencies relate to the distance between households on a route, the time between collections, and the distance to tip. These efficiencies could lead to less trucks being required and less fuel use. Minor refers to a 25% increase in overall efficiency, medium refers to a 50% increase in overall efficiency, and major refers to a 75% increase in overall efficiency.
Materials		
Collection of hard-to-recycle packaging	Retail or event-based	There are some hard-to-recycle packaging covered under EPR (e.g., used oil containers and pressurized cylinders). This control determines the collection method for these materials, whether it is retail or event-based returns. This impacts the volumes of covered material collected and the cost of collection.
Minimum recyclables list collection	2030	The EPR legislation requires that the minimum recyclables list will inform the uniform collection of covered materials starting in 2026. The minimum recyclables list are materials that must be collected in a

Control	Controls Implemented	Relevance and Impact
		manner that is as convenient as the collection of solid waste. When this control is enabled, all materials on the minimum recyclables list are collected from curbside and drop-off recycling systems where households have access.
Additional materials list collection	2030 or 2035	The additional materials list are materials that may be collected through curbside services, drop-off centers, or other means. How and if the material is collected may vary by geography, which is unlike the minimum recyclables list, which must be provided equally to all households. When this control is enabled, the materials on this list will be collected from the specified regions. This impacts the volume of material collected as more covered materials will be accepted in the recycling system.
Flexible plastics collection	Curbside or drop-off	This control impacts where flexible plastics will be collected (Front Range or all regions), when collection will start (2030 or 2035), and the method of collection (curbside or drop off). Additional collection of flexible plastics impacts the volume of material collected and the cost of the system.
Glass collection and glass clean-up systems installed at MRFs	Current, all new curbside include glass	Colorado has some well-performing glass recycling programs that operate through the drop-off-only collection. This control relates to whether new curbside programs will include glass or not. Existing drop-off sites will remain at existing capture rates. In addition, this control also includes the installation of glass clean-up systems at MRFs to increase material quality and yields.
Education		
Educational/informational campaigns	Best practice investment	Education programs for recycling impact the likelihood that a household with access to recycling will participate in the program, how much material will be recycled from each household, and the quality of the material collected. This impact is related to the investment in the education program, which also impacts the cost.
Infrastructure		

Control	Controls Implemented	Relevance and Impact
Drop off sites	Expand, new	In addition to the rollout of trash equivalency, improvements can be made to the drop-off collection system, including the addition of new sites. This impacts the collection method for the materials and then impacts the cost (capital and operating) and performance of the system.
MRF upgrades	None, Advanced	It is likely all scenarios will require additional MRF capacity to process the increase in materials collected. This control is related to the technology available in all MRFs (new and existing) to properly sort the materials on the minimum recyclables list and further out materials on the additional materials list (e.g., glass cleaning systems, optical sorting and robotics, artificial intelligence, fire detection systems). This control impacts the expected yield of the inbound collected material, which impacts the recycling rate. This control also impacts the cost of the system.
Composting facility upgrades	2030, 2035	This control impacts the investment in composting facilities to manage covered compostable packaging and reduce contamination.
Waste Generation		
Generation increases due to population growth	Any percent	As the scenarios provide performance and costs for 2030 and 2035, increases in waste generated from population growth are included. More people living in Colorado will potentially lead to more waste being generated and impact the cost and performance of the system.
Waste prevention	5%, 10%, 15%	There is likely a reduction in the generation of covered products due to lightweight from producers, transition to reuse systems, and general waste prevention strategies. This will influence performance and cost.
*** Note, access is achieved prior to 2030 according to the requirements of the Act, however, the model only included years for 2022, 2030, and 2035, so this relates to the year of the model, not the actual year of implementation of this requirement.**		

Based on the scenario controls that were presented to the Advisory Board on November 8, 2023, three scenarios were developed in line with the requirements of the Needs Assessment. The project team proposed that three scenarios be named Low, Medium, and High scenarios, with each of the scenarios meeting the legislative requirements of the program. The draft proposed scenarios, without results, were presented to the Advisory Board on November 29, 2023. The project team met with the Advisory Board further at a technical work session on December 6, 2023, to discuss this in greater detail. Some adjustments were made to the scenarios based on the feedback received. The scenarios were first presented with performance results to the Advisory Board on December 13, 2023. Updated performance results were presented to the Advisory Board again on December 27, 2023. The scenarios with both performance and cost results were presented to the Advisory Board on January 10, 2024. After each presentation to the Advisory Board, adjustments were made based on the feedback provided. The three scenarios modeled are presented in **Table 2**.

Table 2: Descriptions of Three Scenarios Modeled

Control	Control Options	Low	Medium	High
Access				
Residential recycling access equivalency to trash	Achieved by 2030	2030	2030	2030
Recycling for non-residential covered entities	Offered to all by 2030	Offered to all covered entities by 2030 [participation rate = 40-50% by 2030 and 70-80% by 2035]	Offered to all covered entities by 2030 [participation rate = 40-50% by 2030 and 70-80% by 2035]	Offered to all covered entities by 2030 [participation rate = 40-50% by 2030 and 70-80% by 2035]
Collection				
Collection method for newly provided service (no changes to existing service)	Single stream	Single stream	Single stream	Single stream
Frequency of collection	Weekly or bi-weekly	No change to existing service, biweekly for new service	No change to existing service, biweekly for new service	All weekly (existing and new)

Control	Control Options	Low	Medium	High
Efficiencies in collection routes	Minor, Medium, Major	Minor	Medium	Major
Materials				
Collection of hard-to-recycle packaging	Retail or event-based	None	Periodic events	Periodic events
Minimum recyclables list collection	2030 or 2035	2030	2030	2030
Additional materials list collection	2030 or 2035	2035	2035	2030
Flexible plastics collection	Curbside or drop-off	None	Drop off by 2030, curbside by 2035	Drop off and Curbside by 2030
Glass collection and glass clean-up systems installed at MRFs	Current, all new curbside include glass	Current	All curbside includes glass – drop-off maintains captures near existing levels + glass clean-up systems installed in MRFs	All curbside includes glass – drop-off maintains captures near existing levels + glass clean-up systems installed in MRFs
Education				
Educational/informational campaigns	Best practice investment	Best practice	Best practice	Best practice
Infrastructure				
Drop off sites	Expand, new	Expansion and new in Mountains, Eastern, and Western	Expansion and new in Mountains, Eastern, and Western	Expansion and new in all regions
MRF upgrades	None, Advanced	None	Advanced	Advanced
Composting facility upgrades	2030, 2035	2030	2030	2030
Waste Generation				

Control	Control Options		Low	Medium	High
Generation increases due to population growth	Any percent		2022-2025 = 0.75% 2025-2030 = 1.25% 2030-2035 = 1.5%	2022-2025 = 0.75% 2025-2030 = 1.25% 2030-2035 = 1.5%	2022-2025 = 0.75% 2025-2030 = 1.25% 2030-2035 = 1.5%
Waste prevention	5%, 10%, 15%		5% by 2030, 10% by 2035	5% by 2030, 10% by 2035	5% by 2030, 10% by 2035

3 FINDINGS

This section reviews the estimated results for the baseline performance of covered packaging and paper products and the expected performance under the three scenarios. The EPR program in Colorado is for packaging and paper products for residential and some nonresidential entities. Additionally, some materials are exempt from the program. Therefore, recycling rates may not be directly comparable to other studies and reports that may analyze a different set of materials. A full explanation of what is included in covered packaging and paper products is given below, in addition to a more detailed description of the methodology that can be found in the appendix.

Consequently, all recycling rates, tonnage information, and costs are related to the materials and entities covered in the EPR program. Statements such as "Colorado recycled 25% of packaging in 2022" means that the with the data gathered, the project team estimated that Colorado recycled 25% of covered packaging and paper products by covered entities.

3.1 COVERED PACKAGING AND PAPER PRODUCTS

Not all MSW is covered under Colorado's EPR legislation; therefore, the MSW stream was analyzed in greater detail to understand the volume of covered material generated in Colorado.

Firstly, the current CDPHE-reported MSW recycling rate is calculated as follows:

$$MSW\ Recycling\ rate\ (16\%) = \frac{MSW\ Recycled\ (1.1\ million\ tons)}{MSW\ Generated\ (7.1\ million\ tons)}$$

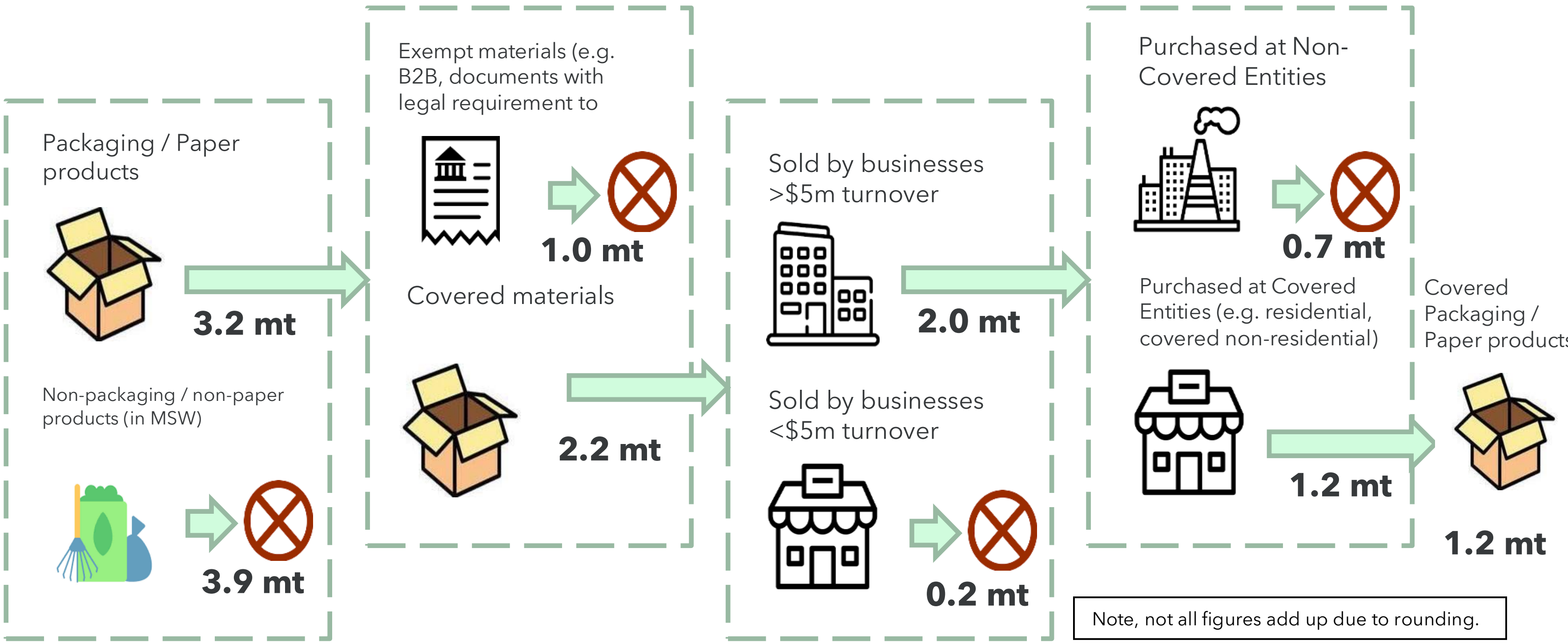
Secondly, Figure 2 shows how the total volume of covered packaging and paper products was calculated. Of the 7.1 million tons of MSW, 3.2 million tons is packaging and paper products while 3.9 million tons is non packaging or paper products. Of the 3.2 million tons, 1.0 million tons are considered exempt based on the exemptions within the legislation, such as business-to-business packaging and packaging for items with a legal requirement to be printed. Of the 2.2 million tons remaining, 0.2 million tons are exempt as they are produced by small businesses with less than $5 million in revenue. Finally, of that 2.0 million tons, 0.7 million tons are for products purchased at non-covered entities; therefore, approximately **1.2 million tons** is what is considered covered packaging and paper products within Colorado's EPR program.

Thirdly, covered recycled materials are those collected from covered entities. While exempt materials should not be included, some will be set out by households and businesses. Exempt materials that are collected through source-separated services are likely to be identifiable, so these are excluded from the calculation. In total, the current amount of recycling covered materials in Colorado is estimated to be **0.3 million tons**.

Finally, the following calculation describes the recycling rate of covered packaging and paper products. This shows that the rate is higher than seen when considering just MSW alone, primarily because the denominator (the amount of waste generated or the bottom of the formula) is relatively smaller because it is more narrowly defined than the whole of the municipal waste stream.

$$PRO\ Recycling\ rate\ (\sim 25\%) = \frac{Covered\ materials\ Recycled\ (0.3\ million\ tons)}{Covered\ materials\ Generated\ (1.2\ million\ tons)}$$

Figure 2: Generation (Supply) of Covered Packaging and Paper Products



3.2 PERFORMANCE

3.2.1 Statewide Performance

Table 3 shows the estimated performance of recycling in Colorado for the baseline year (2022) and for 2030 and 2035 for the low, medium, and high scenarios.

At the baseline year (2022), it is estimated that Colorado had a recycling rate between 22-28% or ~310,000 tons of packaging.

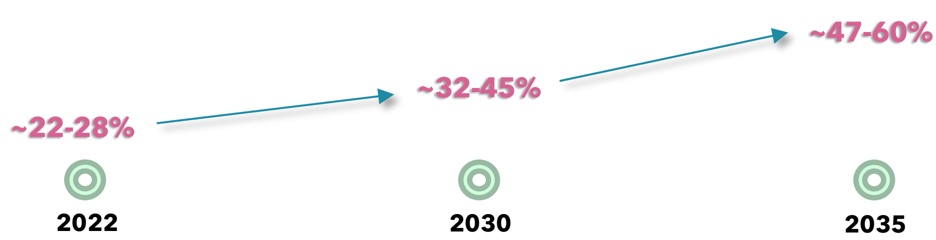
In the low scenario, Colorado could achieve a recycling rate between 32% and 38% in 2030 and 47% to 53% in 2035.

In the medium scenario Colorado could achieve a recycling rate between 34% - 40% in 2030 and 51% - 57% in 2035.

In the high scenario, Colorado could achieve a recycling rate between 39% - 45% in 2030 and 54% - 60% in 2035.

The likely trajectory of recycling rate increases across the state can be summarized in **Figure 3** as follows:

Figure 3: Likely Trajectory of Recycling Rates in Colorado



The biggest impacts on future recycling rates are:

- The provision of recycling access equivalent to trash – the convenience standard - which is expected before 2030 in all scenarios and
- Increased education which is expected to be at best practice levels in all scenarios.

The program is expected to start in 2026, and there are many legislative requirements between 2026 and 2030 (the first phase of modeling results). Advisory board members raised potential challenges of meeting these requirements, such as the convenience standard considering the necessary RFP and procurement processes (e.g., time to procure and implement infrastructure and services). This modeling assumes the program will be implemented as required in the legislation. Additional performance increases for the medium and high scenarios are based on further collections of materials on the additional materials list greater processing yields at MRFs due to investment upgrades, among other factors.

Table 3: Estimated Statewide Recycling Performance

		2022 (Baseline)	2030	2035
Low	Recycling Rate (%)	22% - 28%	32% - 38%	47% - 53%
	Recycling Tonnage (k tons)	~310	~450	~660
Medium	Recycling Rate (%)	22% - 28%	34% - 40%	51% - 57%
	Recycling Tonnage (k tons)	~310	~480	~710
High	Recycling Rate (%)	22% - 28%	39% - 45%	54% - 60%
	Recycling Tonnage (k tons)	~310	~550	~750

3.2.2 Performance By Material

The composition of covered materials is shown in **Figure 4**. Mixed paper and cardboard make up more than half of the covered waste stream. The next largest segments of the waste stream are rigid plastics, glass, flexible plastics, and finally, metals.

Figure 4: Baseline Statewide Recycling Generation, by material

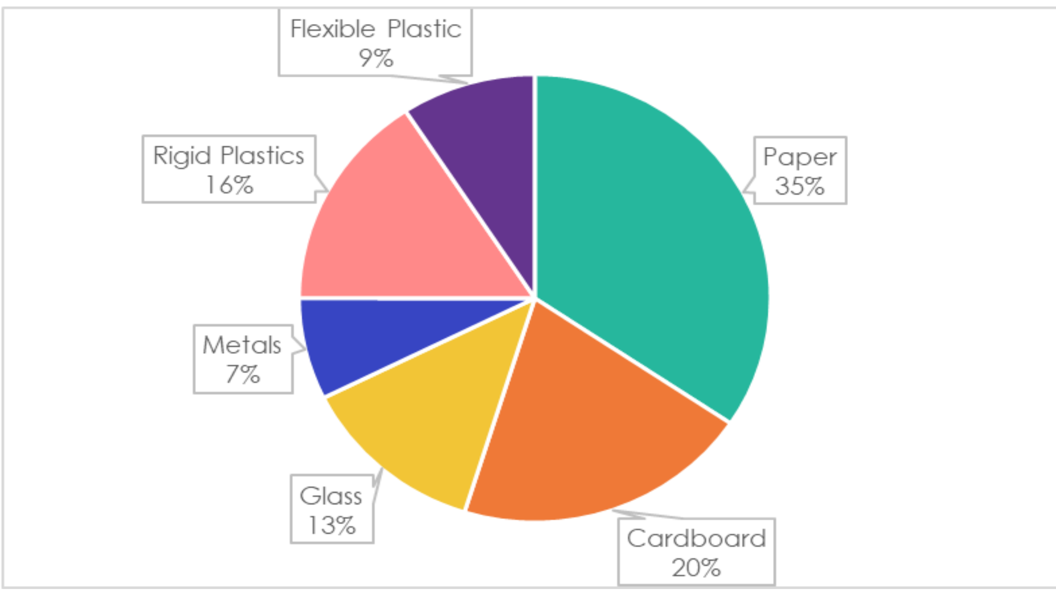


Table 4 and **Table 5** show the estimated collected rate and recycling performance at baseline and for the three scenarios for different packaging materials. Note the recycling rate is lower than the collected rate as there is sorting losses at the MRF. These material categories are aligned with how CDPHE and other organizations report waste compositions across the state.

At baseline, the highest recycling rate is for cardboard (42% - 48%), followed by metal (34% - 40%), glass (27% - 33%), mixed paper (19% - 25%), rigid plastics (11% - 17%), and finally flexible plastics (<1%).

By 2035, the recycling rates for all materials are expected to increase by 10 – 40 percentage points.

As previously indicated, much of the increase in performance for different materials is due to the trash equivalency standard. As more households have access to curbside recycling services, more material will be recycled. Increased investment in educational programming also improves recycling rates as more households are expected to participate in the program and can recycle more material. These education benefits are expected to be higher in 2035 compared to 2030.

For glass, in the low scenario in 2035, the difference between the collected rate and recycled rate is approximately 15 percentage points. In the medium and high scenarios, this difference is reduced to approximately seven percentage points. The increase in capture at the MRF for glass is due to the investment in MRF upgrades, including glass capture infrastructure, which supports the processing of glass material.

In the low and medium scenarios in 2030, there is little improvement in the flexible plastic recycling rate from the baseline as drop-off captures are low. By 2035, and under the high scenario, there is a greater collection of MRF sortable flexible plastics from curbside services, which increases the recycling rate for this material.

Table 4: 2030 Statewide Recycling Performance Compared to Baseline by Material

Material	Baseline (2022)		Low (2030)		Medium (2030)		High (2030)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Paper	21% - 27%	19% - 25%	33% - 39%	30% - 36%	33% - 39%	31% - 37%	40% - 46%	38% - 44%
Cardboard	46% - 52%	42% - 48%	60% - 66%	55% - 61%	60% - 66%	56% - 62%	64% - 70%	61% - 67%
Glass	37% - 43%	27% - 33%	47% - 53%	34% - 40%	50% - 56%	44% - 50%	54% - 60%	48% - 54%
Metals	37% - 43%	34% - 40%	53% - 59%	48% - 54%	53% - 59%	50% - 56%	56% - 62%	53% - 59%
Rigid Plastics	13% - 19%	11% - 17%	22% - 28%	18% - 24%	22% - 28%	20% - 26%	23% - 29%	21% - 27%
Flexible Plastics	<1%	<1%	<1%	<1%	<1% - 2%	<1% - 2%	8% - 14%	5% - 11%
Total	26% - 32%	22% - 28%	37% - 43%	32% - 38%	37% - 43%	34% - 40%	43% - 49%	39% - 45%

Table 5: 2035 Statewide Recycling Performance Compared to Baseline by Material

Material	Baseline (2022)		Low (2035)		Medium (2035)		High (2035)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Paper	21% - 27%	19% - 25%	55% - 61%	51% - 57%	55% - 61%	52% - 58%	58% - 64%	55% - 61%
Cardboard	46% - 52%	42% - 48%	71% - 77%	66% - 72%	71% - 77%	68% - 74%	76% - 82%	73% - 79%
Glass	37% - 43%	27% - 33%	57% - 63%	42% - 48%	61% - 67%	54% - 60%	66% - 72%	59% - 65%
Metals	37% - 43%	34% - 40%	70% - 76%	64% - 70%	70% - 76%	67% - 73%	74% - 80%	71% - 77%
Rigid Plastics	13% - 19%	11% - 17%	39% - 45%	34% - 40%	39% - 45%	37% - 43%	42% - 48%	39% - 45%
Flexible Plastics	<1%	<1%	15% - 21%	8% - 14%	17% - 23%	12% - 18%	19% - 25%	13% - 19%
Total	26% - 32%	22% - 28%	54% - 60%	47% - 53%	54% - 60%	51% - 57%	58% - 64%	54% - 60%

3.2.3 Performance By Covered Entity

Figure 5 shows waste generation in the state by covered entity. Residential single-family households generate the largest share of material, followed by small multi-family, large multifamily, small business, and hospitality. Schools, government buildings, and public spaces make up one percent or less of covered material generated.

Figure 5: Baseline Statewide Recycling Generation, by Covered Entity

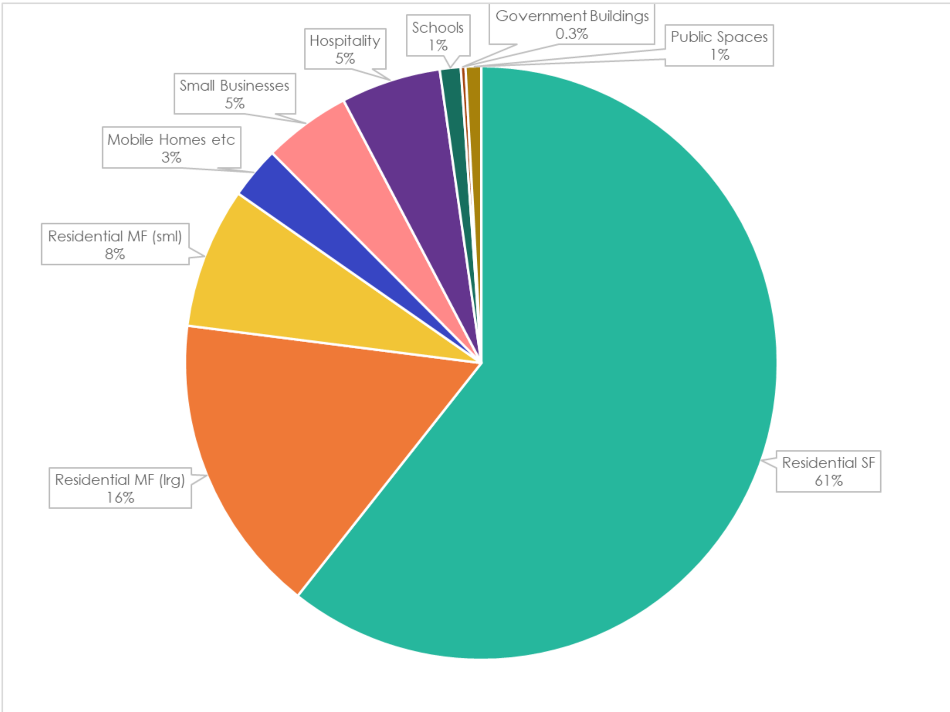


Table 6 and **Table 7** show the estimated performance of covered entities at baseline, and the estimated performance covered entities could achieve under the three scenarios for 2030 and 2035.

Residential single-family (SF) homes are the largest generators of waste of the covered entities and have the highest recycling rates between 32%-47% in 2030 and 45%-60% in 2035, depending on the scenario. One of the main factors increasing recycling rates is the need to implement recycling access equivalent to trash.

The recycling rate in nonresidential entities varies. By 2035, schools are expected to have some of the highest recycling rates of non-residential entities at approximately 36% -43%. Public spaces have some of the lowest recycling rates, only estimated to achieve recycling rates between 15% - 23% in 2035, depending on the scenario.

Table 6: 2030 Statewide Recycling Performance Compared to Baseline by Covered Entity

Covered Entity	Baseline (2022)		Low (2030)		Medium (2030)		High (2030)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Residential SF[3]	28% - 34%	24% - 30%	37% - 43%	32% - 38%	37% - 43%	34% - 40%	44% - 50%	41% - 47%
Residential MF (sml)[4]	28% - 34%	24% - 30%	37% - 43%	32% - 38%	37% - 43%	34% - 40%	44% - 50%	41% - 47%
Residential MF (lrg)[5]	14% - 20%	12% - 18%	27% - 33%	24% - 30%	27% - 33%	25% - 31%	27% - 33%	25% - 31%
Mobile Homes etc[6]	13% - 19%	11% - 17%	25% - 31%	22% - 28%	25% - 31%	23% - 29%	25% - 31%	23% - 29%
Small Businesses	8% - 14%	7% - 13%	21% - 27%	18% - 24%	21% - 27%	19% - 25%	21% - 27%	19% - 25%
Hospitality	10% - 16%	9% - 15%	20% - 26%	18% - 24%	20% - 26%	19% - 25%	20% - 26%	19% - 25%
Schools	10% - 16%	8% - 14%	25% - 31%	22% - 28%	25% - 31%	23% - 29%	25% - 31%	23% - 29%
Government Buildings	11% - 13%	10% - 12%	24% - 30%	21% - 27%	24% - 30%	22% - 28%	24% - 30%	22% - 28%
Public Spaces	13% - 19%	10% - 16%	11% - 17%	9% - 15%	11% - 17%	10% - 16%	11% - 17%	10% - 16%
Total	26% - 32%	22% - 28%	37% - 43%	32% - 38%	37% - 43%	34% - 40%	43% - 49%	39% - 45%

Table 7: 2035 Statewide Recycling Performance Compared to Baseline by Covered Entity

Covered Entity	Baseline (2022)		Low (2035)		Medium (2035)		High (2035)	
	Collected Rate	**Recycled Rate**	**Collected Rate**	**Recycled Rate**	**Collected Rate**	**Recycled Rate**	**Collected Rate**	**Recycled Rate**
Residential SF	28% - 34%	24% - 30%	52% - 58%	45% - 51%	53% - 59%	49% - 55%	58% - 64%	54% - 60%
Residential MF (sml)	28% - 34%	24% - 30%	53% - 59%	46% - 52%	54% - 60%	50% - 56%	58% - 64%	55% - 61%
Residential MF (lrg)	14% - 20%	12% - 18%	44% - 50%	39% - 45%	44% - 50%	40% - 46%	44% - 50%	40% - 46%
Mobile Homes etc	13% - 19%	11% - 17%	41% - 47%	35% - 41%	41% - 47%	37% - 43%	41% - 47%	37% - 43%
Small Businesses	8% - 14%	7% - 13%	33% - 39%	30% - 36%	33% - 39%	31% - 37%	33% - 39%	31% - 37%
Hospitality	10% - 16%	9% - 15%	33% - 39%	29% - 35%	33% - 39%	30% - 36%	33% - 39%	30% - 36%
Schools	10% - 16%	8% - 14%	40% - 46%	36% - 42%	40% - 46%	37% - 43%	40% - 46%	37% - 43%
Government Buildings	11% - 13%	10% - 12%	39% - 45%	34% - 40%	39% - 45%	36% - 42%	39% - 45%	36% - 42%
Public Spaces	13% - 19%	10% - 16%	19% - 25%	15% - 21%	19% - 25%	17% - 23%	19% - 25%	17% - 23%

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[3] SF = Single Family

[4] MF (sml) = Multifamily Small meaning multifamily units with less than 10 units. Likely collected on a residential route.

[5] MF (lrg) = Multifamily Large meaning multifamily units with more than 10 units. Likely collected on a commercial route

[6] Etc refers to other possible housing types such as boats, vans, and RVs

Total	26% - 32%	22% - 28%	54% - 60%	47% - 53%	54% - 60%	51% - 57%	58% - 64%	54% - 60%

3.2.4 Performance By Region

The recycling performance is not uniform across the state, and **Table 8** shows the baseline and expected recycling performance in the four regions of Colorado.

At baseline, the Front Range has the highest recycling rate (24%-30%), and by 2035 the recycling rate ranges from 49%-62% depending on the scenario. The Mountains has the second highest recycling rate (17%-23%) at baseline, and by 2035 the recycling rate ranges from 39%-52% depending on the scenario. The Western Slope has the next highest recycling rate (15%-21%) at baseline, and by 2035, the recycling rate ranges from 38%-52%, depending on the scenario. The Eastern Plains has the lowest recycling rate (8%-14%) at baseline, and by 2035 the recycling rate ranges from 31%-42% depending on the scenario.

Table 8: Recycling Performance by Region (% Recycled)

	Baseline (2022)	**Low**		**Medium**		**High**	
	2022	2030	2035	2030	2035	2030	2035
Front Range	24% - 30%	33% - 39%	49% - 55%	36% - 42%	52% - 58%	41% - 47%	56% - 62%
Mountains	17% - 23%	27% - 33%	39% - 45%	30% - 36%	44% - 50%	33% - 39%	46% - 52%
Western Slope	15% - 21%	25% - 31%	38% - 44%	29% - 35%	44% - 50%	32% - 38%	46% - 52%
Eastern Plains	8% - 14%	19% - 25%	31% - 37%	21% - 27%	34% - 40%	23% - 29%	36% - 42%

3.2.5 Performance Factors

The factors that contribute to recycling rate performance are summarized in **Table 9**.

One of the main contributors to the increase in recycling rates in the trash equivalency standard. Single-family and small multifamily access to curbside recycling will reach 90% by 2030, and a large share of those households will participate in the service. Recycling access does not reach 100%, as only 90% of residents in Colorado are estimated to have access to curbside trash collection. The remaining 10% are expected to have access to drop-off recycling equivalent to the drop-off trash service they use. Approximately 85% of single-family households with access to service will participate in 2030 (76% of total single-family households), later rising to 95% in 2035 (85% of total single-family households). Multifamily households tend to have lower participation overall compared to single families, but the overall increase in participating households is high, growing from only 22% of multifamily households at baseline to 60% of multifamily households in 2035.

At baseline, it is estimated that there are ~340,000 tons of commingled material covered under the EPR program processed at MRFs in the state. This is expected to grow to ~770,000 tons in the high scenario in 2035. Due to the investment in MRF upgrades, the expected yield rate[7] could increase from 88% at baseline to 94% by 2035 in the medium and high scenarios.

Table 9: Statewide Recycling Performance Factors

	Baseline	Low		Medium		High	
	2022	2030	2035	2030	2035	2030	2035
Residential and Non-Residential Entity Factors							
SF households with active curbside recycling service (% of all SF households)	64%	90%	90%	90%	90%	90%	90%
SF households who participate in curbside recycling (% of all SF households)	61%	76%	85%	76%	85%	76%	85%
MF households who participate in curbside recycling (% of all MF households)	22%	47%	60%	47%	60%	47%	60%
Non-residential covered entities who participate in curbside recycling (% of non-residential covered entities)	29%	50%	75%	50%	75%	50%	75%
Total household capture rate (pounds per annum per household)	~330	~440	~630	~470	~680	~540	~720
Infrastructure Factors							
Commingled waste processed at MRFs (k tons)[8]	~340	~490	~720	~490	~730	~560	~770
Additional commingled waste processed at MRFs (k tons)	~0	~150	~390	~160	~390	~220	~430
MRF yield rate (average %)	88%	89%	90%	93%	94%	93%	94%
Total number of drop of sites (including flexible plastics)	60	83	83	83	83	100	100
Number of additional new collection sites for flexible plastics (e.g., retail)	0	0	0	27	317	10	300

[7] MRF yield rate is defined as the percent of target material sorted into the correct commodity output and does not include contamination.

[8] This is commingled material collected through the EPR program

3.3 COSTS

The following sections provide additional information on the estimated current and future costs of EPR under the three scenarios. For each year, a lower and upper range of costs is provided.

3.3.1 Statewide Costs

At baseline, the total annualized cost of the recycling system for covered packaging and paper products and covered entities is between $80 and $140 million. The total annualized costs include both operating and annualized capital costs. The cost of the system at baseline is between $60 and $90 per household and between $260 and $430 per ton recycled.

In 2030, the future potential costs to the EPR system are as follows for the different scenarios:

- In the low scenario:
    - Total annualized cost between $130 and $200 million
    - Cost per household[9] between $60 and $90
    - Cost per ton recycled between $280 and $450
- In the medium scenario:
    - Total annualized cost between $130 and $ 210 million
    - Cost per household between $60 and $90
    - Cost per ton recycled between $260 and $430
- In the high scenario:
    - Total annualized cost between $150 and $240 million
    - Cost per household between $70 and $110
    - Cost per ton recycled between $270 and $430

In 2035 (or from 2030 to 2035 for capital investment), the future potential costs to the EPR system are as follows for the different scenarios:

- In the low scenario:
    - Total annualized cost between $160 and $250 million
    - Cost per household between $70 and $110
    - Cost per ton recycled between $240 and $380
- In the medium scenario:

[9] The cost per household is the estimated cost of the system per participating household, but is not the cost paid by households.

- Total annualized cost between $160 and $260 million
- Cost per household between $70 and $120
- Cost per ton recycled between $230 and $370

- In the high scenario:
    - Total annualized cost between $180 and $290
    - Cost per household between $80 and $130
    - Cost per ton recycled between $240 and $390

Table 10: Estimated Statewide Recycling Costs for Producer Implementation ($ millions)

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Total Annualized Cost ($ millions)	80	140	130	200	160	250
	Cost Per Household ($)	60	90	60	90	70	110
	Cost Per Ton Recycled ($)	260	430	280	450	240	380
Medium	Total Annualized Cost ($ millions)	80	140	130	210	160	260
	Cost Per Household ($)	60	90	60	90	70	120
	Cost Per Ton Recycled ($)	260	430	260	430	230	370
High	Total Annualized Cost ($ millions)	80	140	150	240	180	290
	Cost Per Household ($)	60	90	70	110	80	130
	Cost Per Ton Recycled ($)	260	430	270	430	240	390

To show the total potential of capital investment, the expected capital cost figures are also included in **Table 11**. The capital costs are already incorporated in the annualized costs, therefore, these are a subset of the annualized costs and not in addition to the annualized costs. These are also not for a single year but investments needed by that year for the expected service improvements. These figures also represent an estimated maximum as not all collection and processing infrastructure might be funded directly by the PRO but rather through fee payments with operators purchasing equipment, carts, vehicles, etc., through their own financing arrangements.

By 2030, capital cost investment is estimated to be between $250 million and $490 million, depending on the scenario, and by 2035, additional investment is estimated to be between $140 million and $240 million. Much of the capital expenses are expected in the earlier years of the program as there are significant service improvements in those years. As previously stated, these costs would be annualized over several years as it is likely they will be financed.

Table 11: Estimated Statewide Capital Costs ($ millions)*

		2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Total Capital Cost ($ millions)	250	340	140	230
Medium	Total Capital Cost ($ millions)	320	470	130	210
High	Total Capital Cost ($ millions)	340	490	140	240

* Capital costs are incorporated in annualized costs*

Using the mid-point of the medium scenario as an example, **Figure 6** and **Figure 7** show the breakdown of the total annualized costs by scenario control. This provides an indication of what is contributing to the overall costs. The primary components contributing to the increases in costs are increased access to recycling for residential households based on the convenience standard, followed by education, investment in advanced technology at MRFs, collection from non-residential entities, and collection materials on the additional materials list. Waste prevention and efficiencies in collection lead to cost savings.

Figure 6: Breakdown of Total Annualized Recycling Costs in 2030 (medium scenario)

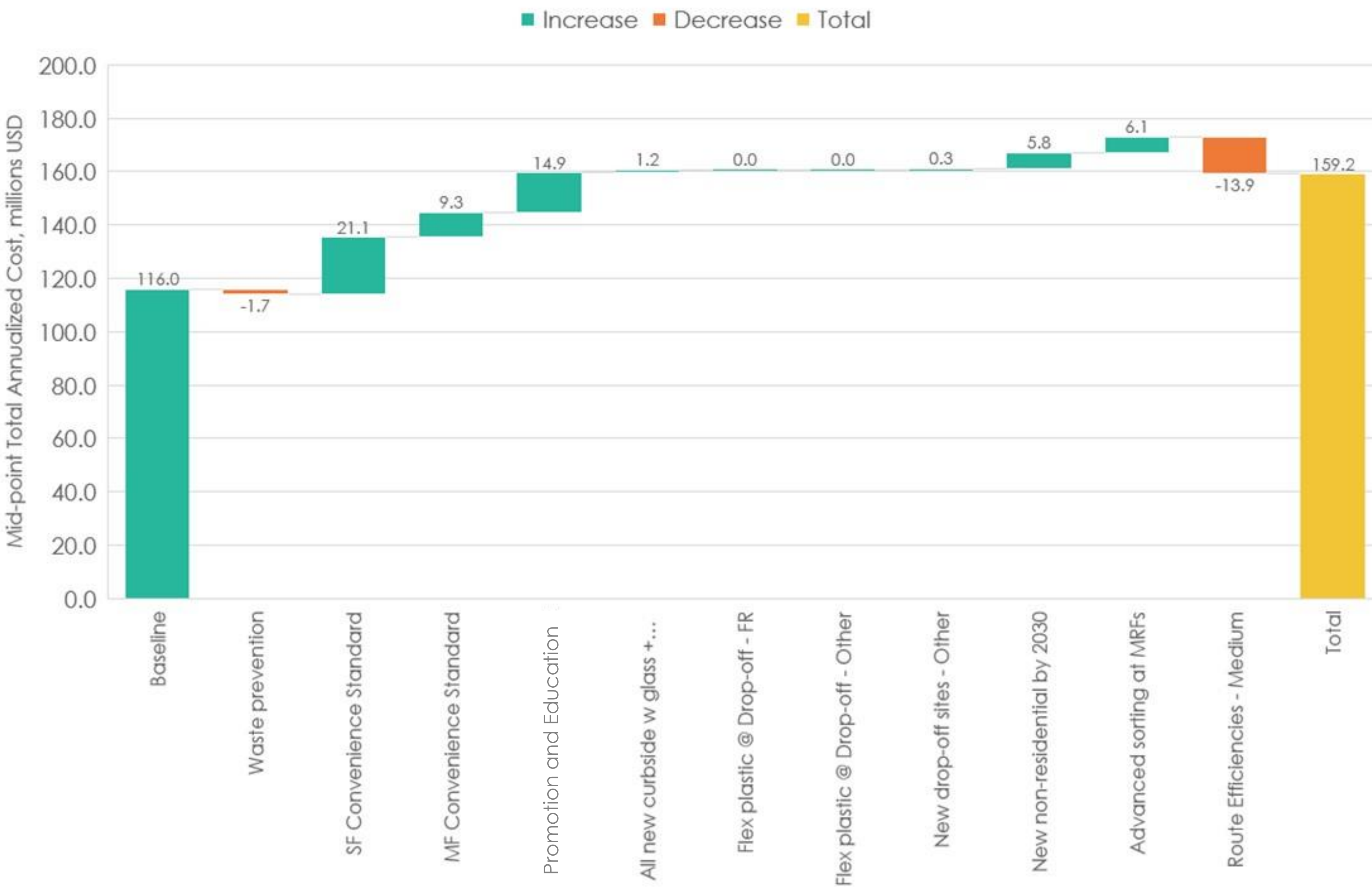
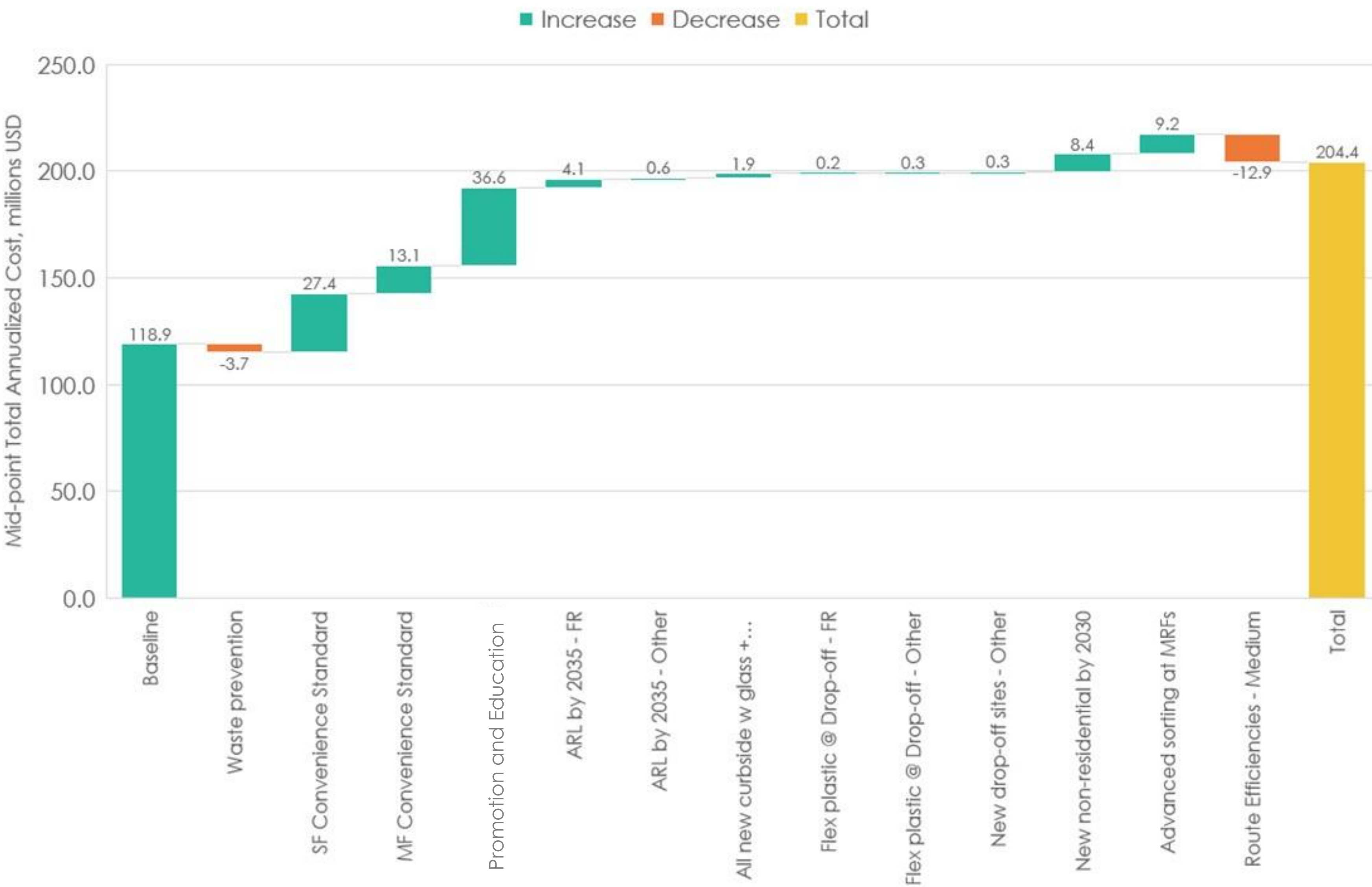


Figure 7: Breakdown of Total Annualized Recycling Costs in 2035 (medium scenario)



3.3.2 Costs By Region

Table 12 shows the estimated total annualized costs by region. More than 80% of the cost is estimated to be from services in the Front Range. This is expected as more than 80% of the population lives in this region.

Table 12: Estimated Total Annualized Recycling Costs by Region ($ million)

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Front Range	70	110	100	170	130	200
	Mountains	8	15	10	20	15	25
	Western Slope	4	7	9	15	10	15
	Eastern Plains	1	2	3	5	3	5
Medium	Front Range	70	110	100	170	130	210
	Mountains	8	15	10	20	15	25
	Western Slope	4	7	10	15	10	20
	Eastern Plains	1	2	3	5	4	6
High	Front Range	70	110	120	190	150	240
	Mountains	8	15	15	20	15	25
	Western Slope	4	7	10	15	15	20
	Eastern Plains	1	2	3	5	4	6

Table 13 and **Table 14** show the estimated costs on a per ton recycled and a household basis in the four regions. Costs in the Mountains are expected to be higher as the region has an overall higher cost of living, leading to higher costs in many sectors. Additionally, it is challenging to achieve economies of scale as haulers operating in rural areas are required to travel longer distances, often in severe weather, to pick up minimal amounts of material, and materials are transported longer distances for sorting, often to the Front Range. This increased cost aligns with the research findings on the current cost of services, details of which are provided in the appendix. Costs per ton decrease over time as collecting and processing greater volumes can be achieved at a higher level of cost efficiency.

Table 13: Estimated Cost Per Ton Recycled By Region ($)

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Front Range	250	410	260	420	220	360
	Mountains	480	790	480	780	400	640
	Western Slope	290	480	350	560	290	460
	Eastern Plains	310	520	390	630	310	480
Medium	Front Range	250	410	250	400	220	340
	Mountains	480	790	440	710	370	590
	Western Slope	290	480	320	520	270	430
	Eastern Plains	310	520	370	590	290	460

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
High	Front Range	250	410	250	410	230	370
	Mountains	480	790	430	710	380	610
	Western Slope	290	480	320	520	290	460
	Eastern Plains	310	520	340	550	280	440

Table 14: Estimated Recycling Costs Per Household by Region ($)

		Baseline (2022) Lower	Baseline (2022) Upper	2030 Lower	2030 Upper	2035 Lower	2035 Upper
Low	Front Range	50	90	50	90	70	110
	Mountains	120	190	120	190	140	220
	Western Slope	60	100	60	100	80	120
	Eastern Plains	80	130	80	120	90	140
Medium	Front Range	50	90	50	90	70	110
	Mountains	120	190	120	190	140	220
	Western Slope	60	100	70	110	80	130
	Eastern Plains	80	130	80	130	100	150
High	Front Range	50	90	60	100	80	120
	Mountains	120	190	130	210	150	240
	Western Slope	60	100	70	120	90	150
	Eastern Plains	80	130	80	120	100	150

In summary, EPR in Colorado is estimated to increase the recycling rate to between 32% and 45% in 2030, depending on the scenario. This is a roughly 40% to 68% performance increase from baseline and is estimated to cost 41% to 63% more than baseline cost in 2022, depending on the scenario. In 2035, the recycling rate is estimated to be between 47% and 60%, depending on the scenario. This is a performance increase of between 100% and 127% from baseline and is estimated to cost 69% to 97% more than baseline cost, depending on the scenario.

Table 15: Estimated Statewide Performance and Cost Increases

		Baseline (2022)	2030	2035
Low	Recycling rate (%)	22% - 28%	32% - 38%	47% - 53%
	Recycling rate (k tons)	~310	~450	~660
	Performance increase over baseline (% increase)		~40%	~100%
	Cost increase over baseline (% increase)		~41%	~69%
Medium	Recycling rate (%)	22% - 28%	34% - 40%	51% - 57%
	Recycling rate (k tons)	~310	~480	~710
	Performance increase over baseline (% increase)		~49%	~114%
	Cost increase over baseline (% increase)		~41%	~74%
High	Recycling rate (%)	22% - 28%	39% - 45%	54% - 60%
	Recycling rate (k tons)	~310	~550	~750

		Baseline (2022)	2030	2035
	Performance increase over baseline (% increase)		~68%	~127%
	Cost increase over baseline (% increase)		~63%	~97%

3.4 IMPACT OF EXEMPTIONS

Sections 25-17-703 (13)(b), 25-17-703 (25)(b), and 25-17-713 in the Producer Responsibility Program for Statewide Recycling Act provide exemptions for certain packaging and producers from the program. The project team evaluated the impact of these exemptions in Colorado, the impact of similar exemptions in other EPR programs, and if any industry sector would be disproportionately impacted by the results of the exemptions.

For reference[10] Section 25-17-703(b) and 25-17-703 (25)(b) exempt certain packaging and paper products including:

- Packaging intended to be used for "long-term storage or protection of a durable product and that are intended to transport, protect, or store the product for at least five years."
- Packaging materials used solely in transportation or distribution to non-consumers, used in B2B transactions, or that are not sold to covered entities.
- Beverage containers are subject to deposit return systems (DRS)
- Packaging material exclusively used in industrial or manufacturing processes
- Packaging for FDA-regulated drugs, medical devices, and dietary supplements
- Packaging for products regulated as animal biologics (vaccines, bacterins, antisera, diagnostic kits, others) under the federal Virus-Serums Toxin Act
- Packaging for federally regulated insecticide, fungicide, and rodenticide
- Packaging for architectural paint covered by a stewardship program
- Packaging material required to be sold in material that meets the poison prevention packaging act (anything that needs to have a child lock mechanism: prescription, OTC drugs, household chemicals)
- Packaging for electronic devices that have been repaired and reconditioned and that are sold as refurbished products

[10] Some descriptions of exemptions are summarized for clarity and the legislation should be reviewed for detailed descriptions.

- Infant formula, fortified nutritional supplements, medical food
- Paper products that can become "unsafe or unsanitary to handle"
- Paper products used for a print publication that mainly includes "current events from primary sources."
- Documents that are required by law to be printed (financial statements, billing statements, medical bills, etc.)
- Bound books
- Any other material, as determined by the Commission by rule, after an analysis of operational and financial impacts and consultation with the Advisory Board
- Packaging materials that are not sold or distributed to covered entities
- Packaging materials that are used for products sold or distributed outside the state

Section 25-17-713 describes producer exemptions, including:

- A business with less than $5 million in total revenue
- A business with less than one ton of covered materials produced in the state
- State and local government
- Nonprofit organization
- An agricultural employer
- An individual business operating a retail food establishment that is located at a physical business location and that is licensed under Section 25-4 16-7 (1)(a) or Section 32-106.5(1) to Section 320106.5(5) of the Denver Code of Ordinances.
- A builder or construction company

Table 16 provides a list of the material exemptions and an overview of the amount of material they represent of the total waste stream and their potential impact on the EPR system. **Table 17** provides a list of producer exemptions on their potential impact.

Table 16: Material Exemptions for Colorado EPR Program

Material	Magnitude of Materials	Exemptions in Other Jurisdictions	Overall Assessment
Long-term storage or protection	Minimal (<1% of total packaging and paper products)	Excluded in Canadian packaging and paper product EPR policies.	Minimal impact and aligned with reuse exemption; are exempted in other EPR jurisdictions.
Business-to-business packaging materials or not sold to covered entities	Significant (~25% of total packaging and paper products)	Excluded in Canadian packaging and paper product EPR policies except Quebec, which will require all businesses to be services not later than five years of the regulation comes into force.	Moderate impact on the overall system as materials may be collected but not included in the denominator. Note some of these materials have strong recycling markets (e.g., cardboard).
Packaging material exclusively used in industrial and manufacturing processes	Minimal	Typical across most jurisdictions with packaging and paper product EPR policies	Minimal as exempted as not included under covered entities.
Packaging for FDA-regulated drugs, medical devices, and dietary supplements	Minimal (<1% of total packaging and paper products) *could be higher but depends on what materials are included	Typically excluded but sometimes only the packaging in contact with the drugs	Minimal impact as materials typically flow through other channels, pose risks and are exempted in other EPR jurisdictions.
Packaging material required to be sold in material that meets the poison prevention packaging act	Minimal (<1% of total packaging and paper products)	Typical across most jurisdictions with packaging and paper product EPR policies	Minimal impact as materials typically flow through other channels, pose risks and are exempted in other EPR jurisdictions.
Packaging for products regulated as animal biologics under the federal Virus-Serums Toxins Act	Minimal (<1% of total packaging and paper products)	Typical across most jurisdictions with packaging and paper product EPR policies	Minimal impact as materials typically flow through other channels, pose risks and are exempted in other EPR jurisdictions.
Packaging for architectural paint covered by a stewardship program	Minimal (<1% of total packaging and paper products)	Typical in other jurisdictions to exempt materials designated under another EPR policy	Minimal impact and aligned with reuse exemption; are exempted in other EPR jurisdictions.
Packaging for electronic devices that have been repaired and reconditioned and sold as refurbished products	Minimal (<1% of total packaging and paper products)	Not found	Minimal impact as estimated to represent small amount of covered materials.

Material	Magnitude of Materials	Exemptions in Other Jurisdictions	Overall Assessment
Infant formula, fortified supplements, medical food	Minimal (<1% of total packaging and paper products)	Not found	Minimal impact as estimated to represent small amount of covered materials.
Paper products that become unsafe or unsanitary to handle	Significant, but most of these materials are managed through other waste streams (e.g., wastewater treatment)	Typical across most jurisdictions with packaging and paper product EPR policies	Minimal impact as materials do not typically flow through the recycling system, pose risks, and are exempted in other EPR jurisdictions.
Print publications mainly including current events from primary sources	Minimal (~1% of total packaging and paper products)	Typical for newspapers to be exempt in other jurisdictions.	Impact will depend on agreement with publishers.
Documents required to be printed by law	Moderate	Not found	Given the amount of different types of materials that this category could represent (e.g., sales receipts, invoices, financial statements, annual reports, warranties, tickets), this could reflect a moderate impact as these materials will still be recycled by residential and non-residential covered entities costs for materials will need to be accommodated by other producers.
Bound books	Minimal (<1% of total packaging and paper products)	Typical across most jurisdictions with packaging and paper product EPR policies	Minimal impact and aligned with reuse exemption; are exempted in other EPR jurisdictions.
Beverage containers subject to DRS	n/a	Typical across most jurisdictions with packaging and paper product EPR policies	Colorado does not yet have a DRS; therefore, this analysis was not included at this time, and the impact would depend on what beverage containers were included.

Table 17: Producer Exemptions for Colorado EPR Program

Producer	Magnitude of Materials	Overall Assessment
A business with less than $5 million in total revenue	Moderate. Estimated to be ~10% of covered products	Approximately half of all private sector employees work for small businesses in the state, but many of these businesses are not producers of packaging. This will be influenced by the definition of producer in the regulation. It is estimated that of covered non-exempt materials, about 10% are produced by small businesses.
A business with less than one ton of covered materials produced in the state	Assessed with the above row	Assessed with the above row
State and local government	Minimal	State and local governments are not large producers of packaging and paper products. Some jurisdictions do designate them as producers as they are generating materials (e.g., recreation guides, property bills, newsletters) that would end up in residential recycling bins.
Nonprofit organization	Minimal	Nonprofit organizations are not large producers of packaging and paper products.
An agricultural employer with less than five million dollars in revenue	Minimal	Estimated to be minimal or already estimated as part of the small business exemption.
An individual business operating a retail food establishment that is located at a physical business location and that is licensed under Section 25-4 16-7 (1)(a) or Section 32-106.5(1) to Section 320106.5(5) of the Denver Code of Ordinances	n/a	Given the uncertainty of the application of this provision, it was not included in this analysis.
A builder or construction company	Minimal	Construction companies are not large producers of packaging and paper products that are not already exempt.
Packaging materials that are not sold or distributed to covered entities	Moderate (~30% of non-exempt packaging sold by non-exempt producers)	Many covered products may be sold to exempt businesses such as large offices or other large businesses. The generated tonnage of these exempt entities was calculated as part of this analysis, and therefore, the packaging waste they generated is likely to be exempt as its purchased at these entities.

As shown in **Table 16**, many of the product exemptions would have a minimal impact as they represent small quantities and/or they are managed through channels that may not be compatible with more traditional types of packaging or paper products. They also reflect exemptions that are common in other jurisdictions. Their impact would not create a significant impact on the system.

There are three exemptions that make up a relatively higher share of the waste stream. These include:

- documents required to be printed by law,
- products that become unsafe or unsanitary to handle and
- business-to-business packaging materials.

While products that become unsafe or unsanitary to handle may make up a higher of the waste stream, most of these materials are managed through other waste streams (e.g., wastewater treatment) and other jurisdictions exempt them as well.

The total impact of all material exemptions was previously described in Figure 2. In Colorado, approximately 3.2 million tons of packaging and paper products were produced in 2022, and the material exemptions likely exempt 1 million tons of packaging and paper products. Therefore, there are 2.2 million tons of covered packaging and paper products sold in Colorado.

Many of the producer exemptions in **Table 17** have minimal impact on the total volume of material. The main exemption is the small business exemption, which is likely to exempt an estimated 10% of covered packaging. Colorado's threshold is higher than other jurisdictions, so the percentage impact may be reassessed when further data is captured. Of the 2.2 million tons of covered packaging and paper products, approximately 200,000 tons are supplied by exempt small businesses. As a result, approximately 2 million tons of covered packaging and paper products are sold by covered entities.

Finally, as only the covered packaging supplied to covered entities are included, another deduction is included in the legislation. An estimated 30% of covered materials are supplied to non-covered entities, reducing the quantity of covered materials from 2 million tons to 1.2 million tons.

The total estimated quantity of non-exempt covered packaging sold by non-exempt businesses to covered entities is 1.2 million tons.

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4 APPENDIX (DETAILED METHODOLOGY AND RESULTS)

A.1.0 BASELINE (2022) PERFORMANCE

The specifications of the Act require the PRO to manage covered materials (packaging and paper products) from covered entities (residential and some non-residential). The information required to fully and as accurately as possible assess baseline performance, including collection and recycling rates, is significant. Published data is generally at the statewide level and does not have the level of granularity required. Therefore, a full bottom-up analysis of multiple data sources was required to create the necessary datasets and analyses to construct a model of baseline performance, both across the state and at a regional level.

The baseline required, at a minimum, the following types of data:

- Waste generation
- By waste generator:
    - Residential SF
    - Residential MF (sml 1 – 10 units)
    - Residential MF (lrg 11plus units)
    - Mobile Homes etc
    - Small Businesses
    - Hospitality
    - Schools
    - Government Buildings
    - Public Spaces
    - Non-covered entities
- Waste growth
- Waste composition:
    - By detailed material categories to enable full modelling of material exemptions and align with published benchmarks

Waste recycled

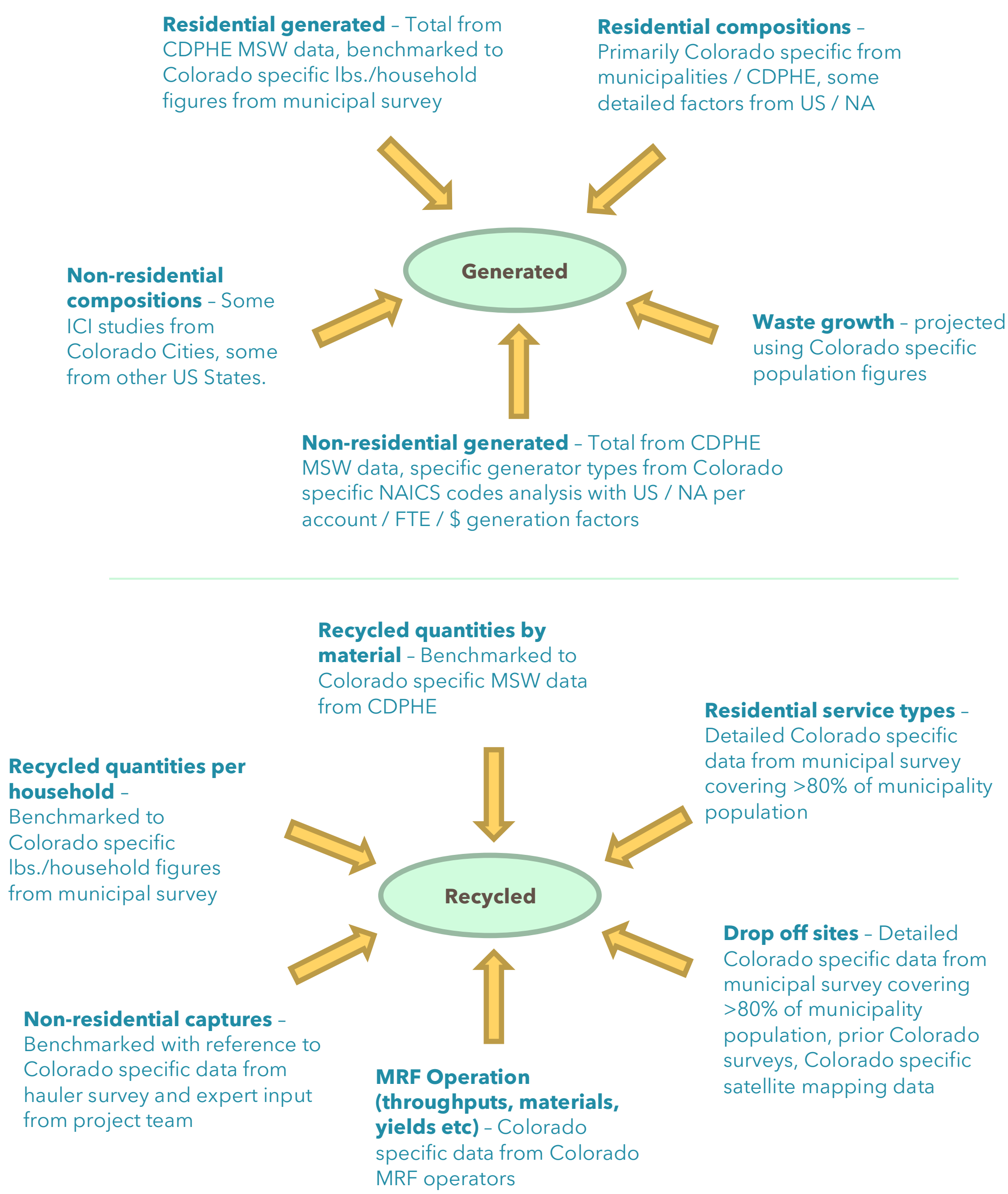
- By service type:
    - Residential curbside
    - Residential drop-off

- Non-residential curbside

- Sorting processes (MRFs)

The approach to constructing this detailed flow of Colorado's waste management baseline is outlined in the sections below. Firstly, the main sources of data for the modeling are shown in **Figure 8** below. This indicates that nearly all of the data for the modeling, including all figures used for benchmarking key baseline elements, were taken from Colorado-specific sources.

Figure 8: Key Data Sources



A.1.1 WASTE GENERATION

A.1.1.1 Overall Approach

The overall approach to developing the baseline waste generation figures was as follows:

- Set the baseline year as 2022.
- Reference published data from CDPHE on municipal solid waste generation in Colorado.[11]
- The CDPHE data includes MSW and Industrial – therefore, the project team confirmed that MSW figures include residential and non-industrial non-residential waste streams.
- Total MSW generation in 2021 (latest year of CDPHE data) = 7,073,814 tons.

Population growth

- Average population growth over the last few years was ~0.5%, and it was previously ~1.5-2%. The lower increase in recent years is assumed to be related to the Covid-19 pandemic. Increase from 2021 to 2022 is estimated at 0.6%. Further population increases are set out below in section A.1.1.4.

MSW Generation

- Estimating that waste growth is proportional to population growth, the total estimated MSW generation in 2022 = 7,116,257 tons.

Residential vs non-residential

- Data from MRFs interviewed and surveyed in Colorado indicates approximately 68% of input recycling comes from residential routes and 32% from commercial. However, commercial routes cover larger multifamily residential properties as well.
- Data from the EPA, albeit an older data source, indicates a split between residential and commercial of between 55-65%. Consequently, to align with this data, the growth of waste over time, changes in the waste stream, etc., were estimated using this similar split.[12]
- The overall proportion of waste generation from residential sources (small family households, large family households, and mobile homes) was set at 55%, and waste generation from non-residential sources was, therefore, 45%. This is on the lower end of the range as anecdotal evidence suggests

[11] https://cdphe.colorado.gov/hm/colorado-recycling-totals

[12] https://archive.epa.gov/epawaste/nonhaz/municipal/web/pdf/98charac.pdf

non-residential waste is becoming a larger proportion of MSW than residential waste across the US.

- This equates to 46% from 'residential routes,' which is aligned with the more anecdotal evidence that was provided.
- Moreover, the total residential waste quantities generated per household were benchmarked in the range of 2,500 to 3,500 lbs. per household per year, which related to some of the Colorado-specific data received through the municipal survey. Hence, it provides confidence in the proportional split between the residential and non-residential streams noted above.

A.1.1.2 Residential

Residential collection was broken down into four categories, relating to type and whether the household was likely to be served by a residential collection route or a commercial collection route:

- Residential collection routes:
- Single-family households (1 detached or attached housing unit)
- Multifamily (MF) households – small properties (2 to 10 housing units per property – note, often households over eight units are defined as commercial in Colorado, but the census data only had specific size bands, so ten was chosen as the upper limit to align with the available data)
- Commercial collection routes:
- Multifamily households – large properties (>10 housing units per property)
- Mobile homes[13]

Note that while larger multi-family households are typically included in commercial collection routes, this modeling analysis includes small properties in the residential route modeling. Hence, the covered entities are characterized according to residential or non-residential.

Residential Waste Generation

The approach taken to develop waste generation estimates for each waste generator type was as follows:

- Set generation figures for each type relative to single-family households in the Front Range, in lbs./household.
- Vary per household waste generation figures are based on estimated differences between other generator types against single-family Front

[13] Note, mobile homes can also be serviced with individual carts collected on residential routes, but for simplification of the modelling waste was chosen to be serviced by commercial routes – the proportion of households in mobile homes in Colorado is low so this simplification does not have a noticeable impact on the overall results.

Range households. For example, single-family households in different regions will generate different quantities related to household income. Households in multifamily properties will generate less MSW than single family as they have smaller or no yards, amongst other differences. [see below for further details]

- Sum the total and benchmark against total residential waste generation.
- Once the total is calculated, the project team adjusted the model inputs until the calculated total aligns with the published figures from CDPHE.

Differences in residential waste generation by region were first applied based upon Median Household Income, specific to Colorado, from the census reporting, as waste generation is correlated to household income. Therefore, the estimates of waste generation relative to the single-family households in the Front Range are:

- Single-family households in the Mountains region of Colorado = 95% (these homes produce 95% of the waste that a single-family household in the Front Range produces)
- Single-family households in the Western Slopes region of Colorado = 90%
- Single-family households in the Eastern Plains region of Colorado = 85%

The following estimates of waste generation are relative to waste generation of the related region for Single-family households. Multifamily households typically have less overall MSW compared to single family as they produce less yard waste, which is includes in CDPHE MSW totals.

- Multifamily households – small properties = 95%
- Mobile Homes = 90%
- Multifamily households – large properties = 80%

Specific data and references for these estimates were not readily available; however, they were based upon some Colorado-specific municipal waste compositional analyses and the input of experts to introduce some more realistic aspects into the modeling.

Finally, one further aspect around waste generation was required for the modeling:

- For single-family households and multifamily households – small on residential routes, the waste container is based on data collected from the survey conducted in Element 1. This showed carts of various sizes up to around 96 gallons are used, with each household having their own cart.
- For multifamily households – the survey from Element 1 informed that large multifamily and mobile homes on non-residential collection routes typically have larger shared dumpsters that multiple households will use. These are then picked up, in general, by front-loading non-residential waste collection vehicles.

Therefore, the number of households per collection site, or 'account,' is required as an input to the model. This is because the average volumes collected per account are required, not per household.

For multifamily households above ten units, averages building sizes were used to streamline the modeling process. For example, rather than create a typology for each unique building size (11 unit building, 12 unit building, etc.), data from the census was used to create an average, based upon assuming the following number of housing units represent the band the data was reported under:

- Multifamily housing between10 to 19 units = 15 units
- Multifamily housing between 20 to 49 units = 35 units
- Multifamily housing with more than 50 units = 75 units

Taking these estimates and using the number of households in each banding based on census data, the average number of households per account is 43.

For mobile homes, one data source estimated the number of mobile home parks in Colorado at 900.[14]

Using the total number of mobile home parks in Colorado was pulled from the State's census data, an average figure of 104 per park was calculated to represent the number of mobile homes per account.[15]

A.1.1.3 Non-Residential Covered Entities

The non-residential sector was broken down into six elements relating to the type of entity.

The approach taken to develop waste generation estimates for each waste generator type varied. Limited Colorado-specific data regarding non-residential waste is available, and only a few datapoints were obtained through the hauler survey. This provided a challenge to producing estimates for non-residential covered entities. Some national waste generation factors were used, and also benchmarking with figures from other North American reports was done in order to triangulate the estimates that were produced. This triangulation all provided similar estimates, providing confidence in a reasonable level of accuracy in the figures used.

Data regarding the number of businesses was obtained through a North American Industry Classification System (NAICS) search for Colorado businesses using the following NAICS codes:

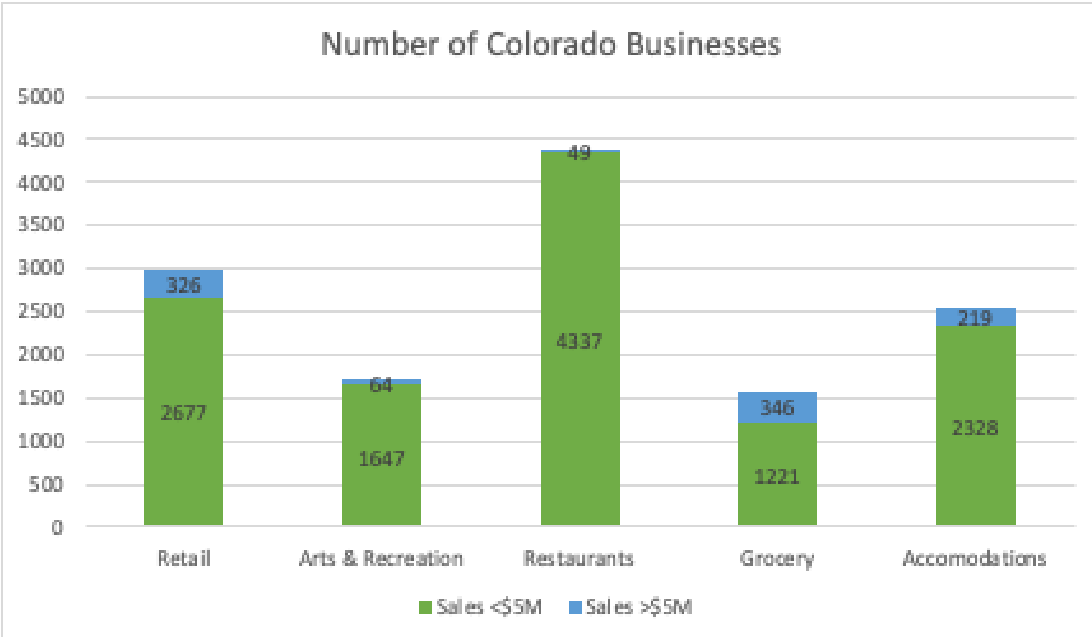
- 722: Restaurants

[14] https://www.ksut.org/news/2023-09-05/why-colorado-only-has-a-handful-of-resident-owned-mobile-home-parks

[15] Colorado - Profile data - Census Reporter

- 44 and 45: Retail
- 721: Accommodations
- 71: Arts and recreation
- 4451: Groceries

Figure 9: Number of Colorado Businesses Reported by NAICS Code



Small Businesses

Small businesses are defined as businesses that generate under $5M in gross revenues. Hospitality is a separate non-residential covered entity; therefore small business excludes hospitality.

If each business is related to one 'account,' the total number of accounts with waste collection services was 5,545, made up by the following.

- Arts and Rec: 1,647
- Retail: 2,677
- Grocers: 1,221

Additional data provided from engagement with Colorado-specific stakeholders also listed annual waste generated per business.

To estimate the average waste generated per account, the total waste generated across all small business accounts was divided by the number of accounts.

$$\frac{\sim 211\ k\ tons\ of\ waste}{5{,}545\ small\ business\ accounts} = 64{,}803\ lbs\ of\ waste\ per\ account$$

Hospitality

Hospitality, for the purpose of the needs assessment, is focused on accommodations, events, stadiums, and food and drink establishments.

Accounts

Utilizing the same NAICS dataset, the number of hospitality businesses generating under $5M and over $5M was downloaded. The following NAICS codes were used.

- 722: Restaurants
- 721: Accommodations

Based on the stakeholder engagement, surveys, and interviews conducted, each business was estimated to represent one account with a waste collection service. This resulted in 6,911 accounts in the hospitality sector of Colorado.

Waste generation

Accommodation waste generation was estimated by multiplying the total estimated guest nights with generated waste per guest per night.[16]

Food and beverage waste generation was estimated based on the number of employees. Waste produced per restaurant employee annually was multiplied by the total number of employees in restaurants. [17]

Average waste generated per account was a simple division of waste generated across accommodation and food and beverage by the total number of accounts.

Waste generation from both food and beverage and hospitality sectors were benchmarked against figures in other North American reports where possible.[18]

$$\frac{\sim 219\ k\ tons\ of\ waste}{6{,}911\ hospitality\ business\ accounts} = 63{,}466\ lbs\ of\ waste\ per\ account$$

Schools

Based on the definition of a school in the Colorado EPR law, this analysis did not look at preschools or universities.

Accounts

The number of public and private schools in Colorado was pulled from the Colorado Department of Education database. The number of schools and students by region is shown in **Table 18** below.

[16] https://solusgrp.com/blog/post/hotel-waste-management-solutions-bin-tippers-to-the-rescue.html

[17] https://www.fourth.com/article/how-much-food-restaurants-waste

[18] https://plasticspact.ca/wp-content/uploads/2023/04/CPP_BC-ICI-Baseline-Report.pdf

Table 18: Number of Schools and Students by Region

Region	Number of Schools	Number of Students
Eastern Plains	170	26,065
Front Range	1,899	794,371
Mountains	236	43,775
Western Slope	270	63,498

Based on a survey sent to municipalities, with questions regarding schools and interviews with school districts, the number of accounts was estimated. Schools located in municipalities that mandate recycling for schools were presumed to all have an account with waste collection services.

Schools that did not respond but were located in municipalities where curbside recycling is offered to residential areas were estimated to have a similar participation rate in recycling collection to households. For instance, if 20% of households in the municipality have curbside recycling, then 20% of schools in that municipality were estimated to have an account for waste collection, as guided by the data collected from schools in Colorado.

These numbers were summed together to determine the approximate number of school accounts in Colorado.

Waste generation

Schools that responded to the survey reported their annual quantity of recycled waste. This value was divided by the reported number of students at the school to estimate average lbs./student recycled.[19]

Multiplying the average lbs./student recycled by the average number of students at a school in Colorado to estimate the average quantity of recycled waste per school.

The average quantity of waste generated per school was estimated by dividing the recycled value by the average diversion rates reported by schools.

Government Buildings

Government buildings are covered by nonresidential entities, but the definition of what is considered a government building is not included in the Producer Responsibility Program for Statewide Recycling Act. The following information was used to estimate the characteristics of government buildings.

Waste generation

The waste generation of government buildings relied on a proxy for employees per government building.

[19] https://www.publicschoolreview.com/school-size-stats/colorado

The State of Colorado Workforce Report 2020/2021 reported the total government employees in the state.[20]

The number of employees was multiplied by the estimated waste generation per office worker per day to estimate daily waste generation in government buildings. [21]

Multiplying this by 365, it estimated the annual waste generated by state and local government buildings.

Generation from each type was approximately:

- State Government = 6.8 million lbs.
- Local Government = 20 million lbs.

The local government waste generation figure was split out by jurisdiction depending on whether they were classified as a City or a Town. According to other factors such as building size and employees, a City level government building (i.e., City Hall) was estimated to generate approximately 3x as much waste as a Town level government building (i.e., Town Hall). These are based on expert judgment as usable data to estimate this was not available.

Accounts

According to this analysis, one Town Hall was set to be equivalent to one account or one pick-up location, and a City Hall would have three accounts or pick-up locations.

For State level buildings in Denver, an equivalent number of accounts was estimated based upon the total generation figures. The estimated number of accounts pickups for State Government buildings from this approach was 155.

Public Spaces

National parks, airports, and train stations were assessed to estimate the approximate waste generation from public spaces in Colorado.

Waste generation

National Park data was used to estimate the national park waste generation average for Colorado. [22]

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[20] https://dhr.colorado.gov/sites/dhr/files/documents/DPA%20DHR%20Workforce%20Report%202020-2021_Final.pdf

[21] https://www.unsustainablemagazine.com/guide-to-office-waste-facts-figures/#:~:text=A%20typical%20office%20worker%20will,%2C%20plastic%2C%20and%20food%20waste

[22] https://www.leavenotraceireland.org/wp-content/uploads/2020/01/2019_Zachary-et-al.-Identifying-strategies-to-reduce-visitor-generated-waste-in-national-parks-of-the-United-States.pdf

The total lbs. of waste reported was divided by the total number of parks in the US. This came to 239,808 lbs./park.

To tailor this to Colorado parks, the average number of visitors to a national park was divided by the number of visitors to Colorado parks. This resulted in a 16% factor.

Consequently, the national lbs./park estimate was multiplied by 16% to get an average Colorado park waste estimate.

Accounts

The number of accounts was a summation of the parks and airports found from these sources. [23]

Other Non-residential Non-Covered Entities

Large businesses with a turnover greater than $5 million per annum (other than hospitality businesses, which are all covered by the regulation) and other non-covered entities were also included in the analysis. While they are not part of the scheme, they were included in the baseline modeling to create an overall mass balance of municipal solid waste in Colorado. Utilizing the NAICS dataset, it was found that there are around 12.5 thousand businesses that would not be covered under the regulations in Colorado. These businesses accounted for the remaining waste generation after the specific non-residential estimates set out above were deducted from the overall non-residential waste estimate (see above).

A.1.1.4 Waste Growth

There are various influences on the amount of MSW generated. Variations around economic conditions, trends in material usage, etc, are difficult to predict. Therefore, waste growth is estimated to vary by population growth only.

Annual population growth in Colorado has changed over time. Trends over the last ten years are shown in **Table 19** below.[24]

23

https://www.flydenver.com/sites/default/files/environmental/enviro_2021_Annual_Performance_Report.pdf

https://www.leavenotraceireland.org/wp-content/uploads/2020/01/2019_Zachary-et-al.-Identifying-strategies-to-reduce-visitor-generated-waste-in-national-parks-of-the-United-States.pdf

24

https://www.macrotrends.net/states/colorado/population#:~:text=The%20population%20of%20Colorado%20in,a%200.46%25%20increase%20from%202019.

Table 19: Population Growth Rate (2012-2022)

Year	Population	Growth Rate
2022	5,839,926	0.49%
2021	5,811,297	0.46%
2020	5,784,865	0.46%
2019	5,758,486	1.08%
2018	5,697,155	1.42%
2017	5,617,421	1.33%
2016	5,543,844	1.64%
2015	5,454,328	1.90%
2014	5,352,637	1.55%
2013	5,270,774	1.48%
2012	5,193,660	1.40%

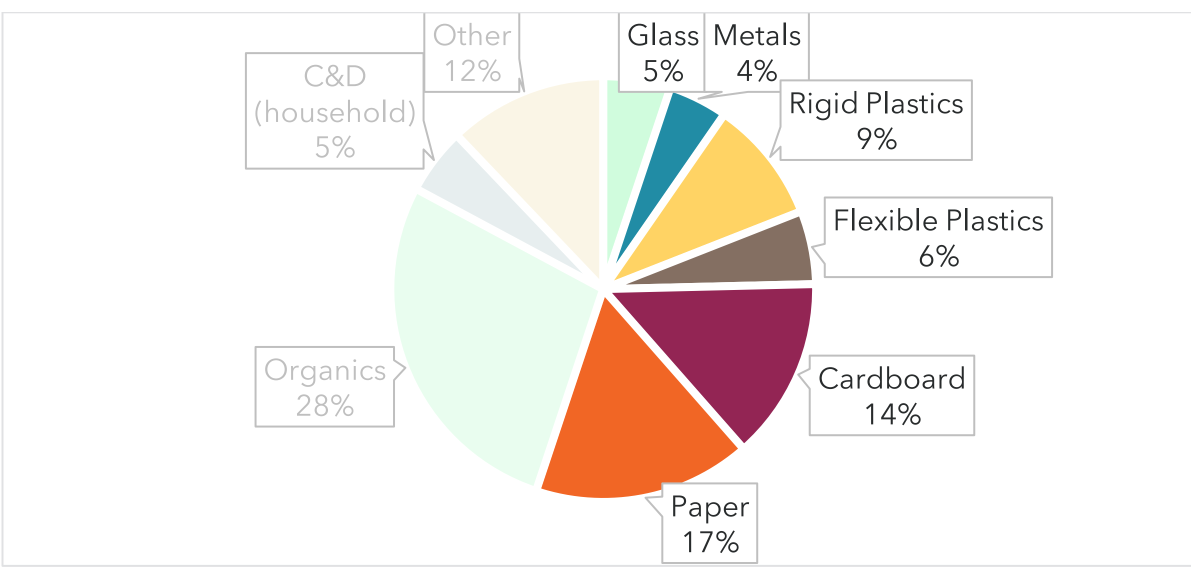
As mentioned above, the lower growth from 2020 to 2022 is estimated to be related to the Covid-19 pandemic. The average longer-term growth rate appears to be around 1.5% per annum on average. Based on historical population data, it is expected that this population growth will revert to the long-term average after 2030. Consequently, the growth level per year in the model are assigned the following average growth rates as population growth recovers to the longer-term level.

- 2022-2026 = 0.75%
- 2027-2030 = 1.25%
- 2031-2035 = 1.5%

A.1.2 WASTE COMPOSITIONS

A summary of any waste compositions that were found for Colorado is given in the Element 1 Memo – see that memo for further details. For reference, the overall MSW composition is given in **Figure 10** below.

Figure 10: Overall MSW Composition



Residential Waste Composition

For the modeling, the following approach was taken:

- An assessment of the various compositions was undertaken.
- Regional compositions were reviewed, but there were not enough in some regions to be sure they were representative, and some material-specific compositions had relatively significant variations, which affected modeled results.
- Therefore, an overall statewide 'residential' composition was created, taking the average of the 15 available published compositions. See **Table 20** below for waste compositions used:

Table 20: Waste Composition References Used

Front Range	Mountains	Western Slope	Eastern Plains
• Boulder County[25] • Larimer County[26]	• Eagle County[27] • Routt County[28] • Gunnison County[29] • Grand County[30] • Summit County[31] • Pitkin County[32]	• Garfield County[33] • Mesa County[34] • Delta County[35] • Montrose County[36]	• Huerfano County[37] • Las Animas County[38] • Baca County[39]

- CDPHE has a guidance document on waste sampling, so the compositions mostly had the same waste composition structure.
- The CDPHE categories were further split out into a more detailed structure to accommodate the needs of the modeling – i.e., taking into account material exemption categories, etc.

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25 Boulder County 2017 Waste Composition
26 LarimerCounty.pdf - Google Drive
27 NorthwestColorado.pdf - Google Drive
28 NorthwestColorado.pdf - Google Drive
29 DEHS_RREO_WesternStudy.pdf - Google Drive
30 GrandCounty.pdf - Google Drive
31 Summit County_Waste Diversion Study_2019.pdf
32 PitkinCounty.pdf - Google Drive
33 NorthwestColorado.pdf - Google Drive
34 DEHS_RREO_WesternStudy.pdf - Google Drive
35 DEHS_RREO_WesternStudy.pdf - Google Drive
36 DEHS_RREO_WesternStudy.pdf - Google Drive
37 Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).
38 Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).
39 Souder, Miller & Associates, "Southeast Colorado Waste Diversion Study", (2017).

- The average waste composition was applied to waste collected through residential-type collections.

The key sources of the figures used to split out the categories are as follows:

- Eunomia's 50 States of Recycling report [which referenced Colorado-specific data provided by CDPHE]. [40]
- Data on MRF yields provided by Colorado MRF operators.
- King County's 2020 MRF composition data.[41]
- Composition breakdown in 2022 Stewardship Ontario's Four-Step Methodology calculations.
- Estimates from the details of Ontario's Producer Responsibility Organization on hazardous household waste packaging – e.g., paint, gas canisters, anti-freeze, etc.
- Assumptions based upon expert experience.

Non-Residential Adjustments

The average residential composition described above was adjusted to create compositions for the other waste generator categories. Where available, other relevant compositions were used to benchmark the compositions for key material categories (e.g., metals, paper, plastics, glass, etc). The adjustments and final compositions are shown below. The main principles of the adjustments were:

- Multifamily and mobile homes will have less yard waste and household construction waste.
- Businesses will typically not have yard waste arisings or other arisings such as municipal construction waste or paint, etc.
- Businesses will have more corrugated cardboard from shipping supplies and office-related wastes, e.g., paper, etc.
- Hospitality businesses will have more food and glass waste.
- Large businesses will have even more corrugated cardboard and also more flexible plastics (e.g., pallet wrap) due to these being the main types of waste arising from transportation activities.

In addition, it was estimated that:

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[40] https://www.eunomia.co.uk/reports-tools/the-50-states-of-recycling-a-state-by-state-assessment-of-containers-and-packaging-recycling-rates/ and https://www.ball.com/sustainability/real-circularity/50-states-of-recycling#/

[41] https://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/documents/MRF_assessment-2020.ashx?la=en

- Government buildings have the same composition as small businesses.

A.1.3 QUANTITIES RECYCLED

The overall approach to estimating the amount of waste recycled per material and per waste generator type was as follows:

- Create 'bottom-up' modeled estimates for the capture of recyclables from different waste generators.
- Compare modeled estimates with material-specific recycling data from CDPHE.[42]
- Adjust key parameters until modeled results are aligned with the following.
    - CDPHE figures
    - The modeled MRF input is equivalent to the actual MRF input reported from operators
    - The modeled MRF input proportion = 68% from residential sources (average from all surveyed Colorado MRF operators)
    - Lbs./household captures are within ranges seen in Colorado and other North American states and provinces

The main service types and system elements included in the modeling are:

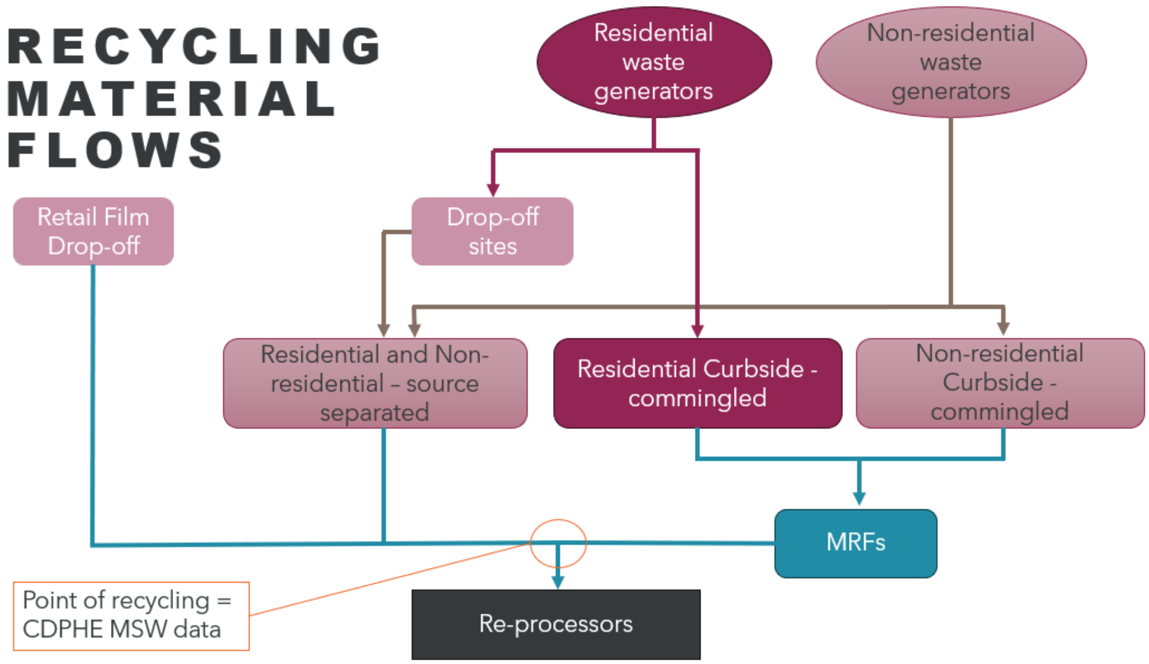
- Residential curbside recycling
- Residential drop-off recycling
- Non-residential curbside recycling
- Retail drop-off recycling
- Material recovery facilities (MRFs)

It is noted that some multifamily and non-residential recycling occurs through drop-off sites, but there was very limited data to determine the source of recycling brought to drop-off sites, so for the purpose of the modeling, the flows were accounted for through the residential single-family stream only.

A simplified flow diagram of the key baseline elements is shown in **Figure 11** below:

[42] https://cdphe.colorado.gov/hm/colorado-recycling-totals

Figure 11 Model Flow Diagram



The following sections outline the key assumptions for each of these main model elements.

A.1.4 RESIDENTIAL CURBSIDE RECYCLING

A.1.4.1 Service Type and Coverage

Information on the type and coverage of curbside recycling services is given in Element 1 and Element 5 Memos – refer to those for details.

Service type

For the modeling, the following approach was taken:

Existing service types taken from the surveys and coded based on:

- Stream (single/dual)
- Frequency
- Glass in / out
- Operator type
- Average cart size

For municipalities and CDPs with no survey responses, the following assumptions were made:

- Stream = Single Stream

- Frequency = Bi-weekly
- Glass = In
- Operator type = Open market subscription based

Coverage

In the context of the modeling, coverage means the households that have access to or are offered a recycling service. The average coverage for single-family (SF) households by region was calculated from those municipalities submitting survey responses. These figures are given below:

- Statewide – 64%
- Eastern Plains – 16%
- Front Range – 69%
- Mountains – 46%
- Western Slope – 41%

Coverage of curbside recycling services for households in rural unincorporated areas is not known as these areas were not, and could not, be included in the municipality survey. No other sources of data are available. The following estimates of service coverage were made for the modeling:

- Eastern Plains – 10%
- Front Range – 25%
- Mountains – 10%
- Western Slope – 10%

4.1.2 Participation

The total number of households covered by a recycling service is a key assumption. Of those households that are covered by a recycling service, a certain proportion will actively participate in the scheme.

Open market subscription-based service – in this case, households are actively signing up to a paid service, which suggests the majority will actively participate. Therefore, in this case, the average participation rate for subscribed households is set as 98%.

Mandatory municipality-wide service – in this case, residents are provided a cart and are charged in one of a variety of ways, but active participation is less likely. In this case, the average participation rate is set at 90%.

4.1.3 Recycling Captures

The model runs on a collection per account basis, that is, the average amount of recyclables collected per year from each household. The approach taken was:

- Calculate the total generation of each category of the waste composition (see above) by region and collection service type.
- Set capture rates, in %, by main categories of recyclables.
- The resultant curbside capture rates for single-family residential properties (for covered materials only, not the entire material category) from the modeling were:[43]
    - Paper = 47%
    - Cardboard = 82%
    - Glass = 79%
    - Metals = 66%
    - Rigid plastics = 25%
    - Flexible plastics = 0%
- Calculate the capture of recycling in lbs per household.
- The resultant captures, in lbs per household, by region and service type were calculated.
- Multiply by the total number of households covered and participating in a recycling service to calculate the total recycled by material.
- Benchmark against total recycled quantities by material from CDPHE MSW data.
- Cross-check calculated lbs per household outputs with Colorado-specific capture data gathered through the municipal survey carried out under Element 1. In general, figures ranged from 350 to 600 lbs per household. The modeled averages by region are provided in the results section A.6.0. At a statewide level, the average figure was around 450 lbs per household, well within the range noted above.

A.1.5 RESIDENTIAL DROP-OFF RECYCLING

A.1.5.1 Service Type and Capture

The drop-off site modeling was based upon detailed research from municipality websites, the municipality survey, and other online research. The following summarizes the approach:

- Identify individual drop-off site locations and types through research – including whether the site accepts packaging or not.

[43] These figures are a result of goal seeking the material capture rate inputs in the model by ensuring the recycled quantities from the model are consistent with the figures reported by CDPHE.

- Where possible, use satellite imagery to identify the type and number of collection containers at each site, e.g.
- Small dumpsters
- Larger dumpsters
- Roll-on, roll-off hook grab containers
- Estimate amounts collected at each site based upon:
- Estimate the average size of each containment type:
    - Small dumpsters = 4 cubic yards
    - Larger dumpsters = 8 cubic yards
    - Roll-on roll-off = 24 cubic yards
- Estimate average fill rate of container before collection = 90%
- Estimate total weight per pickup based upon average material bulk densities:
- Commingled:[44] [45]
    - Commingled (includes glass) = 333 lbs/cubic yard
    - Commingled (excludes glass) = 315 lbs/cubic yard
- Source separated:[46]
    - Cardboard = 371 lbs/cubic yard
    - Glass = 590 lbs/cubic yard
    - Metals & Plastics = 190 lbs/cubic yard
    - Flexible plastics[47] = 169 lbs/cubic yard
- Estimate average frequency of container pickup:
- Small dumpsters = Weekly
- Larger dumpsters = Weekly
- Roll-on roll-off = Biweekly

[44] Cross checked with data from Colorado specific figures provided by Colorado haulers, approximately 5 tons of commingled with glass collected in a 28 cubic yard truck = ~ 350 lbs/cubic yard.

[45] Bulk densities converted from kgs/m3 from Ontario's Stewardship program Four-Step Methodology calculations.

[46] Bulk densities converted from kgs/m3 from Ontario's Stewardship program Four-Step Methodology calculations.

[47] Not collected in the baseline, but presented in reference to the modelling of the scenarios where flexible plastics are collected at the curbside.

- Calculate tons of recyclables collected per container per year.
- Estimate the type of materials collected at drop-off sites based upon input from Colorado waste experts. The following logic was used:
- If one container was evident at the site, it was estimated to be commingled.
- If >3 containers were evident at the site, the total number of containers in each 10 provided was estimated to be the following for each material:
    - Cardboard – 5
    - Glass – 3
    - Metals & Rigid Plastics – 2
- Apply a small uplift factor to increase the amount of material captured from drop-off sites, assuming that the research did not manage to capture the location of all operating drop-off sites in Colorado.
- Calculate the total estimated capture of recyclables by material category for municipalities that did not report actual tonnages of recyclables collected from drop-off sites – where these actual data were available, and precedence was provided over modeled quantities in the overall modeling.

A.1.5.2 Coverage

Households that responded using a drop-off site in the surveys were assigned as having coverage for drop-off. Furthermore, any households in jurisdictions that have a drop-off site were also assigned as having coverage.

A.1.6 NON-RESIDENTIAL CURBSIDE RECYCLING

A.1.6.1 Service Type and Capture

Information on the type and coverage of curbside recycling services is given in the Element 1 and Element 5 Memos – refer to those for details. The team supplemented the information received from haulers (which was limited due to the business sensitivity of such day) with team experience of waste management in and out of Colorado to understand the current state of non-residential curbside recycling.

For the modeling, the following approach was taken:

- The service types listed below, broken down by commingled or source-separated, were estimated for the different non-residential entities.
- The stream types for commingled collection include (1) single stream with glass, (2) single stream without glass, and (3) dual stream – fiber and containers.
- The stream types for source separated include (4) cardboard only, (5) glass only, (6) metals and plastics only, and (7) flexible plastics only.

- For each of the seven stream types, three different frequencies of the collection were modeled: bi-weekly, weekly, and twice weekly. As is noted in the list below, twice weekly pickup was not modeled for hospitality locations with source-separated cardboard only, nor for public spaces.
- The proportion of each commercial type that are participating in a commingled or source-separated service is listed in parentheses next to the respective stream types. These proportions were estimated using three main benchmarks. The amount of material modeled as recycled in the baseline was benchmarked against the statewide amount of recycled material reported by CDPHE. These data were not available from Colorado haulers surveyed during the study.
- Additionally, the MRF survey data was used to benchmark the amount of commingled recycling material, as well as the proportion of residential single-family versus commercial multifamily versus commercial businesses.
- The list below includes the non-residential entities evaluated, the service types considered for each entity, and the estimated participation for each stream type by entity.
- Residential multifamily (large) / Mobile homes
- Commingled (~20% participation)
    - Single stream with glass – bi-weekly, weekly, or twice weekly
    - Single stream without glass – bi-weekly, weekly, or twice weekly
- Small Businesses
- Commingled (~25% participation)
    - Single stream without glass – bi-weekly, weekly, or twice weekly
- Source separated (~15% participation)
    - Cardboard only – bi-weekly, weekly, or twice weekly
- Hospitality
- Commingled (~25% participation)
    - Single stream without glass – bi-weekly, weekly, or twice weekly
- Source separated
    - Cardboard only (~15% participation) – bi-weekly or weekly
    - Glass only (~15% participation) – bi-weekly, weekly, or twice weekly
    - Metals & plastics only (~1% participation) – bi-weekly, weekly, or twice weekly
- Schools
- Commingled (~15% participation)

    - Single stream without glass – bi-weekly, weekly, or twice weekly
    - Dual stream (fibers and containers) – bi-weekly, weekly, or twice weekly
- Government Buildings
- Commingled (~15% participation)
    - Single stream with glass – bi-weekly, weekly, or twice weekly
- Public Spaces
- Commingled (~15% participation)
    - Single stream with glass – bi-weekly or weekly
- Non-residential non-covered entities
- Commingled (~5% participation)
    - Single stream without glass – bi-weekly, weekly, or twice weekly
- Source separated
    - Cardboard only (~24% participation) – bi-weekly, weekly, or twice weekly
    - Glass only (~<5% participation) – bi-weekly, weekly, or twice weekly
    - Metals & plastics only (~<5% participation) – bi-weekly, weekly, or twice weekly
    - Flexible plastics only (~<5% participation) – bi-weekly, weekly, or twice weekly

A.1.7 MRF CAPTURES

A.1.7.1 MRF Types and Capture Rates

The MRF Survey provides data for about 2/3 of the MRFs in Colorado. For the remaining 1/3 of the data, estimates were made to fill in the data gaps by stream and by region. Most of the gaps were in the Front Range.

To fill these data gaps, the tonnages of recycling that were unaccounted for were apportioned out to the other MRFs. The MRF capture rates statewide were then benchmarked.

For the benchmarking process, three types of MRFs were modeled: Single Stream, Single Stream excluding glass, and Dual Stream. Data received from Colorado MRF operators was used to benchmark the capture rates estimated by material type.

To complement the data provided, where more detailed and specific figures were required, studies from other US states were used.[48]

Overall loss rates were reported to be around 15% on average for single-stream MRFs (including glass) and 5-7% for dual-stream MRFs.

Target materials are those which are intended to form part of marketable outputs, e.g.:

- Paper
- Cardboard
- Metals
- Glass
- Plastics

For single-stream MRFs, non-target contaminants (e.g., fines, food, etc) were reported to comprise around 6% of the overall contamination.

The remaining 9% was unrecyclable target material that did not end up in marketable outputs but was disposed of in the residue stream.

The following material-specific capture rates, which result in around 85% of the overall waste stream being sent to an end market, were used in the model. The remaining unrecycled target materials summing to 9% of the total input. The capture estimates are listed below by material category:

- Glass (75%)[49] [50]
- Metals (96%)
- Plastic - PET Bottles (93%)
- Plastic – Other PET [e.g., clamshells, etc.] (85%)
- Plastic – HDPE (95%)
- Plastic - Rigid PP (93%)
- Plastic - Rigid PS (85%)
- Plastic – Rigid PVC, LDPE, and Other (85%)

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[48] https://kingcounty.gov/~/media/depts/dnrp/solid-waste/about/documents/MRF_assessment-2020.ashx?la=en

[49] Note, of the glass captured 10-20% is estimated to be directed to alternate daily cover (ADC) or other end markets that are not captured in the CDPHE glass 'recycling' figures and so an adjustment was made on this basis for the modelled recycling quantities to be consistent with the scope of the data reported by CDPHE.

[50] Glass captures set to zero for MRFs processing a commingled 'excluding glass' waste stream in the model.

- Plastic – Flexible plastics (60%)[51]
- Cardboard (97%)
- Paper – Newspaper etc (97%)
- Paper – Aseptics (85%)
- Paper – Other papers (90%)

Capture rates were adjusted for dual-stream MRFs to benchmark overall yields to overall rates received from the research (as indicated above).

[51] Colorado MRF operators are not currently sorting MRFs, this figure was taken from studies from a global MRF technology supplier.

A.2.0 SCENARIO CONTROLS

A.2.1 DESCRIPTION OF SCENARIO CONTROLS

See **Table 1** in the main report for reference.

A.2.2 DESCRIPTIONS OF SCENARIO CONTROL INPUTS

A.2.2.1 Curbside Access

As mandated in the legislation, residential recycling access reaches equivalency to trash by 2030.

Curbside recycling services coverage increases from 64% to 90%.

Recycling for non-residential covered entities

- For existing commercial collections, these are all covered over the period from 2026 to 2030.
- For new commercial collections, these are covered at a slower or faster pace. The slower pace is covered between 2031 and 2035. The faster pace is covered by 2030.
- Participation increases over time, from around 30% currently to 45% by 2030 and 70% by 2035.

A.2.2.2 Curbside Collection

Collection method for the newly provided service was single-stream. Dual stream systems were considered by the project team was directed to focus on single stream as it is currently the predominant collection method.

The frequency of collection can switch between weekly or bi-weekly.

- All single-family and small multifamily collections can be set to a weekly minimum for collection frequency. This is modeled in the High scenario.
- Taking the results of recent service changes in Colorado into account, the switch to weekly collections leads to an increase of around 10% capture in the model.

A.2.2.3 Materials

The Rollout of the Minimum Recyclables List

- The minimum recyclables list for residential curbside collection is collected at the start of the program.

The following materials were included in the minimum recyclables list.

Table 21: Proposed Minimum Recyclables List

	Packaging Type	Collection Method
1.1	Paper for General Use (uncoated)	Curbside
1.2	"Low grade" Printing and Writing Paper (e.g., bulk mail, envelopes, notebooks, cards)	Curbside
1.3	Other Printed Paper (e.g., flyers, calendars, brochures)	Curbside
1.4	Newspaper, Newsprint	Curbside
1.5	Magazines and Other Coated Paper (e.g., catalogs)	Curbside
1.6	Bound Directories (e.g., telephone)	Curbside
1.7	Tissue Paper (for packaging purposes)	Curbside
1.8	Shredded Paper (bagged)	Curbside
1.9	Corrugated Cardboard (except wax-coated)	Curbside
1.11	Kraft Packaging (e.g., paper-padded mailers, grocery bags)	Curbside
1.12	Paperboard Boxes and Packaging	Curbside
1.13	Molded Pulp Packaging excluding Food Serviceware (e.g., egg cartons, other protective packaging)	Curbside
1.18	Gable-Top	Curbside
1.19	Aseptic Cartons	Curbside
1.20	Non-Metalized Gift Wrap	Curbside
2.1	Clear PET Bottles, Jars, and Jugs (including Transparent Green or Blue)	Curbside
2.3	Clear PET Thermoform Containers (including Transparent Green or Blue)	Curbside
2.5	Natural HDPE Bottles, Jars, and Jugs	Curbside
2.6	Colored HDPE Bottles, Jars and Jugs	Curbside
2.7	Other Polyethylene (PE) Packaging (e.g., ice cream/butter containers) Except Pails and Lids and Squeezable	Curbside
2.8	Polypropylene (PP) Packaging Except for Pails and Lids (e.g., deli containers, cleaning products)	Curbside
2.16	Large HDPE & PP Pails & Lids (e.g., cat litter)	Curbside
4.1	Steel Aerosol Containers	Curbside
4.2	Steel Containers	Curbside

4.3	Aluminum Aerosol Containers	Curbside
4.4	Aluminum Non-Beverage Containers	Curbside
4.6	Aluminum - Beverage Containers	Curbside
5.1	Clear or Colored Glass	Curbside or Drop off

Glass Collection

- While glass must be collected, the method of collection varies depending on the scenario:
    - Low scenario: glass collection methods remain in line with current systems.
- Medium and high scenario: All curbside collection services include glass. Drop-off maintains capture rates for glass near existing levels with additional glass cleanup systems installed at MRFs.
    - Based upon interviews undertaken in the research, best practice glass cleanup systems were estimated to provide yield rates of up to 90%. As noted above, a fraction of this material is still estimated to be too small for some end markets like re-melt, and so sent to ADC.

Flexible Plastics Collection

- The scenarios looked at adding flexible plastics collection to the regions and also to curbside in the medium and high scenarios. The Front Range was modeled to perform differently under the Low and Medium scenarios to the other three regions. The same number of sites was selected, but as the population in the Front Range is much higher, this implies a much greater density of sites in the three other regions, where curbside recycling is less prevalent and more widely used. Therefore, the number of estimated collection sites were set according to this distinction:
    - Front Range – total number of required drop-off sites collecting flexible plastic in 2030 at 50
    - Front Range – total number of required drop-off sites collecting flexible plastic in 2035 at 200
    - Other 3 regions – total number of required drop-off sites collecting flexible plastic in 2030 at 50
    - Other 3 regions – total number of required drop-off sites collecting flexible plastic in 2035 at 200

Rollout of Additional Materials List

- The rollout of additional materials can be done at a slower or faster pace. The slower pace is by 2035, meaning that all of the additional materials are collected across the state either curbside or through drop-off by this date, and the faster pace is by 2030. The control for this has the Front Range as one option and groups the three other regions together. The proposed list is found in **Table 22** below.

Table 22: Proposed Additional Materials List

	Packaging Type	Collection Method
1.10	Wax Coated Corrugated Cardboard	Curbside or Drop off
1.14	Molded Pulp Food Serviceware (e.g., take-out "clamshells")	Curbside or Drop off
1.15	Paper Cups, Coated and Uncoated	Curbside or Drop off
1.16	Other Polycoated Packaging (e.g., some freezer and butter boxes)	Curbside or Drop off
1.17	Paper Laminate (e.g., paper/aluminum wrappers, poly-lined deli wrap, and other plastic-coated paper wrappers, including burger wraps)	Curbside or Drop off
1.21	Paper "cans" (spiral-wound containers) with steel ends	Curbside or Drop off
2.2	Colored Opaque PET Bottles, Jars and Jugs	Curbside or Drop off
2.4	Colored opaque PET Thermoform Containers	Curbside or Drop off
2.12	PE Squeezable Tubes (e.g., toothpaste, lotions/sunscreens)	Curbside or Drop off
2.13	LDPE Colored Nursery Containers (e.g., pots, trays, etc.)	Curbside or Drop off
2.15	PP Nursery Containers (e.g., pots, trays, etc.)	Curbside or Drop off
3.1	LDPE/HDPE Film (e.g., monoPE recycle compatible pouches)	Curbside or Drop off
4.5	Other Aluminum Packaging (Foil and Foil Trays)	Curbside or Drop off
4.7	Other Metal Packaging	Curbside or Drop off

A.2.2.4 Promotion and Education

Promotion and Educational Campaigns

- Promotion and Educational campaigns were implemented across all scenarios.
- This increased the level of educational investment made so align with investments made by best-performing jurisdictions in Colorado currently, at approximately $10 per household.
- This further aligned with the recommended investments as suggested by The Recycling Partnership.
- The impact of promotion and education is considered to relate to the following areas:

- Of those householders already participating in a recycling scheme, capture of recyclables increases are they become more aware of what can be placed in the recycling cart.
- Of those householders that have access to a recycling service but do not currently participate, they are encouraged to start actively using the service, so participation rates increase.
- For all householders using a recycling service, increased awareness leads to improved sorting behavior and reduced contamination levels.

- It is estimated that the impact of education will rise gradually and be greater in 2035 compared to 2030 according to the following effects:
    - Capture of recyclables (the amount of material householders put in their recycling carts per collection):[52]
        - 2030 – increases by around 5-10%
        - 2035 – increases by around 30-35%
    - Increased participation of households with access to a recycling service:[53]
        - 2030 – increases by around 10-15%
        - 2035 – increases by around 60-70%
    - Reduced contamination levels:[54]
        - 2030 – reduces by around -5%
        - 2030 – reduces by around -25%

A.2.2.5 Infrastructure

Drop off Sites

- New and expanded drop-off sites. The changes listed below are currently modeled the same across the state. This control increases the number of available drop-off sites for collecting recyclables. This is linked to the trash service equivalency standard in the legislation. Householders with access

[52] For clarity, this control relates to an increase in the amount of uncaptured material in the baseline. For example, if capture is 80% in the baseline, if this control was set at 50%, then 50% of the remaining uncaptured recyclables ((100% - 80% = 20%, x 50% = 10%) would be added to the baseline of 80%, meaning that the overall capture of material would be = 90%. Baseline captures by material are given in the previous section of this report, which describes the development of the baseline model.

[53] Ibid.

[54] Again, for clarity, this control input directly reduces the contamination level. So if contamination were 10%, then a -25% reduction would result in 7.5% contamination level remaining.

to drop-off sites for trash should also have access to recycling. In the drop-off site baseline research (see section A.1.5), the analysis indicated they are currently around 100 sites, of which 60 are potentially accepting recyclables. Therefore, to meet the service equivalency standard, it was estimated that the number of recycling drop-off sites would increase to 100. This is a ~67% increase from 60. Therefore, the model control was set at this proportion. Capture rates were also modeled to increase due to promotion and education.

- Increased proportion of / capture from drop-off sites in 2030 at 67%
- Increased proportion of / capture from drop-off sites in 2035 at 67%
- Increased captures by 2030 = 10%[55]

MRF Sorting Equipment

- All MRFs have advanced sorting equipment installed to increase the capture of all materials processed.
- Increased MRF captures (other than glass) (% of remaining capture) at 50%[56]

A.2.2.6 Waste Prevention and Material Changes

Generation Increases due to Population Growth

- See section A.1.1.4.

Waste Prevention is Driven by Lightweighting, Reuse, etc.

- Total generation for all waste streams is reduced based upon eco-modulation and other factors by 10% across all material categories equally implemented by 2035. By 2030, it is estimated that half of the reduction would have occurred, so a 5% factor was applied in this year of the model.

[55] Note, the same methodological approach to applying this control as for curbside capture increases is apply, see prior footnote.

[56] Also as above, 50% increase of remaining capture means that if the material yield is currently 96%, then the advanced sorting equipment will increase yields to 98%.

A.3.0 RESIDENTIAL CURBSIDE COSTS

A.3.1 OVERVIEW OF METHODOLOGY

A comprehensive analysis of residential curbside costs was carried out by employing a methodology that utilized two key approaches:

- regression analysis based on current service fees and
- a bottom-up flow cost assessment.

The regression analysis drew insights from the collection fees database developed in Element 1 to estimate baseline collection costs across all jurisdictions. The bottom-up flow cost evaluation sought to estimate the cost of the curbside collection system, considering factors such as capital investment, operational expenses, system performance, and related impacts. Subsequently, this bottom-up cost evaluation was benchmarked against the regression cost estimates to arrive at a per-household cost. This methodology is explained in the following sections.

A.3.2 RESIDENTIAL SERVICE FEES ANALYSIS

Primary and secondary research was conducted to collect the cost per household associated with waste and recycling collection services by municipality. This process was explained in detail in the memo for Element 1.

Due to limited information received from municipalities and the need for haulers to keep prices hidden in competitive markets, the team relied on the utilization of regression analysis techniques to develop benchmark costs across all jurisdictions.

The first step in conducting regression analysis was testing the potential for causal relationships among all potentially related data variables that were collected under the other elements of this work:

- Jurisdictional region
- Fee type
    - Recycling
    - Trash
    - Bundled
- Container sizes
    - ~35 Gallons
    - ~65 Gallons

  - ~95 Gallons
- Recycling Collection Frequency
  - Weekly
  - Biweekly
  - Monthly
  - Twice a week or more
- Recycling stream type
  - Single Stream
  - Dual Stream
- Trash Collection Frequency
  - Weekly
  - Biweekly
  - Monthly
  - Twice a week or more
- The number of materials collected
- Drive times to geographically central points
- Tourism activity
  - Spending
  - Employment
  - Earnings
  - Tax receipts
- Population density
- Housing compositions
  - Single-family vs multi-family
- Household demographics
  - Age
  - Race
  - Internet access
  - Unemployment rate
  - Poverty level
  - Median home value
  - Median contract rent

- Housing affordability index
- Owner-occupied vs renter occupied

Using RegressIT[57] in Excel, the relationship across all variables were assessed. Variables were gradually removed until only statistically significant variables remained (p-value<0.05.

The following function was used to estimate household fees:

$$\boldsymbol{Household\ Fee_i} = \propto\ + \beta_1 I(Region_{hi}) + \ \beta_2 I\left(Fee\ Type_{ji}\right) + \beta_3 (Drive\ Time_i) + \beta_4 (Poverty\ Level_i) + \beta_5 (Average\ Rent_i) + \beta_6 (Senior\ Population_i) + \beta_7 (Unmployment_i) + \beta_8 I(Service\ Provider\ Type_{ki})\ +\ \varepsilon_i$$

Where α is the constant, β are coefficients for each variable that quantifies the per unit impact to cost, I represent discrete categorical variables that take on the value of 0 or 1, ε_i is the error term, and

h = {Front Range, Western Slope, Eastern Plains, Mountains}

j= {Trash Fee, Recycling Fee, Bundled Fee}

k = {open market, municipal single market}

for i municipality.

These values were sense-checked against the real data points as well as against estimates from stakeholder engagement. Notably, we found that the estimate for the mountain region was lower than anticipated, likely stemming from insufficient data from this region. In response, this coefficient was adjusted to harmonize the results.

Furthermore, each variable was evaluated to discern factors influencing the magnitude of their impact on household fees. It was observed that open market services incurred higher costs compared to municipally provided alternatives. This finding aligns with qualitative insights obtained from stakeholder engagement. However, the competitive nature of open market systems poses a challenge, as limited available data impedes our ability to substantiate this correlation. Potential explanations for the elevated prices in open market systems include:

- Decreased efficiency due to extended distance between pickup locations,
- Private companies require higher profit margins than municipalities,
- Potential for monopolization in open market systems.

Additionally, the proportion of the bundled fee attributed to curbside recycling services was determined by examining the average recycling fee and average trash fee. Considering that recycling services often encompass composting as well, the average composting fee was subtracted from the recycling average. This derived proportion roughly accounts for 25-27% of the total bundled cost. This proportion was sense-checked against municipality-provided values, which fell within the range of 20-35%, aligning well with our estimates.

[57] https://regressit.com/index.html

A.3.3 RESIDENTIAL COLLECTION MODELING

A.3.3.1 Overview of modeling

A detailed bottom-up waste collections model was taken and adapted to the context of the state and populated with Colorado-specific data. The model was applied at the jurisdictional level for all jurisdictions with more than one thousand households. For jurisdictions with less than one thousand households and for households in unincorporated rural areas, typologies were used. These reflected the region and, for incorporated areas, how contiguous – or otherwise – they are with other population centers. This approach allowed for detailed modeling for a maximum number of jurisdictions.

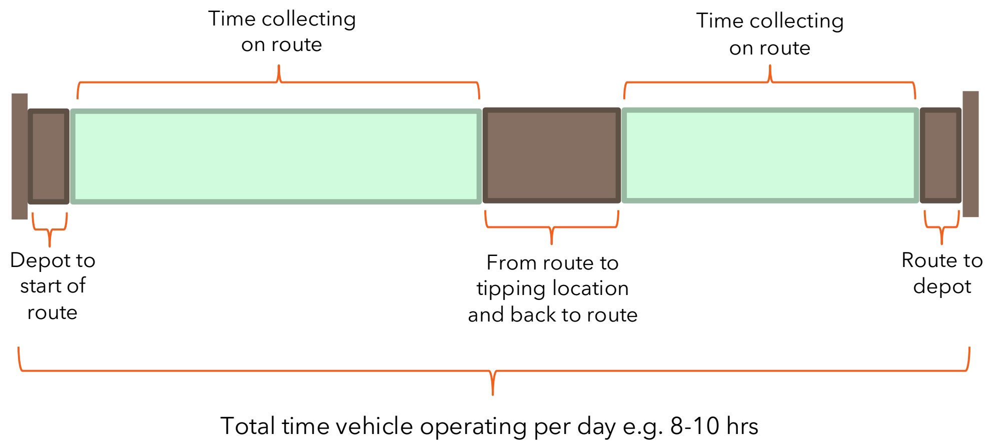
A detailed approach utilizing GIS mapping and drivetime techniques was developed to code each jurisdiction under one thousand households as contiguous, remote, or very remote. For each typology, relevant model input parameters were set to reflect, e.g., the differing densities of households requiring collection in the different areas.

The entire model is highly complex and has many inputs and calculations. Therefore, this report focuses on the key principles of the model and the main parameters of most relevance to the modeling outcomes.

Firstly, the key principles of the model are discussed. Essentially, the model describes the performance of an individual recycling collection truck throughout a day of operation. It then models the total amount of waste that could be collected based upon certain time, volume, and distance constraints. The total waste that could be collected by a vehicle over a year is then calculated. And based upon the total waste requiring collection in that jurisdiction, the total number of trucks required is calculated. Finally, the cost of that vehicle, associated staffing, depot costs, overheads, transfer costs, and cost to the hauler or jurisdiction for that collected material to be processed at MRFs (the gate/tipping fee they pay) are also added to derive an overall estimated cost for the jurisdiction. This is then divided by the number of households with access to the service to calculate the per-household costs that are presented below in this report. These costs were benchmarked against the per jurisdiction costs estimated from the regression modeling described above.

1. The model initially predicts whether a vehicle will need to tip at least once per day based upon the average volume collected per household, the distance and time between each household that is being picked up from, and the total volume capacity of the vehicle (for commingled recycling vehicles are constrained by volume rather than weight). In the following example, one tip in the middle of the route is required.
2. The total time available for actual collection on the route is then calculated (see **Figure 12** below).

Figure 12: Collection Model Principles – Total Time Collecting per Day



3. Based upon the time available for actual collection on the route, the total number of households that can be collected from is calculated. This is based upon the time for each pick-up and the time between households – the latter being calculated based on the average distance between households and the average speed of the truck on the round.

4. The average distance between households was estimated based on an in-depth analysis using Colorado-specific GIS satellite data on building footprints and GIS data on road lengths across the state. An example of the map used to derive the data is given in **Figure 13** below. This shows the building footprint of all identified buildings. The total number per jurisdiction and the total road length were extracted from the GIS model.

Figure 13: GIS Methodology Example to Estimate Distance between Pick-ups

5. The total pick rate (number of households picked up / collected from per day) was then calculated and benchmarked against Colorado-specific pick rates provided by haulers through the survey and one-to-one interviews, typically in the range of 800 to 1,200 per day.
6. Based upon average capture rates in lbs per household (see section 4.1.3) and the average number of vehicle operating days per year, the total weight of material collected per vehicle per year was then calculated.
7. Finally, the total number of vehicles required was calculated based upon the above figure per vehicle and the total weight of recycling being collected across the jurisdiction.

After the number of vehicles had been calculated, the costs of the service could be calculated. These are related to vehicle costs, including fuel, maintenance, depot, staffing, transfer costs, and costs for processing commingled materials at MRFs. Note the cost for MRF processing is not the processing cost to the MRF, but the cost after the sale of output materials have been deducted. Represented by the MRF input gate/tipping fee.

Some of the main input parameters varied by jurisdiction or were adjusted in relation to proxies. For example, the distance between properties was estimated for each jurisdiction using the GIS methodology summarized above, staffing costs were adjusted by property value to reflect relative pricing across the state, and some performance factors, such as time to tip and average speeds, were correlated to building densities.

The main input parameters used in the model are summarized in the following sections.

A.3.3.2 Jurisdictional Characteristics

The following jurisdictional characteristics were considered, with data ranges as follows:

- Building density: 13 - 595 number of accounts/total road mile with the majority being in the range 20 - 120
- Median home value: ~$200,000 to $1,800,000 in 2023 with the majority being in the range ~$250,000 to $750,000
- Distance between properties: 12 – 70 yards, with the majority being in the range 23 – 45 yards
- Location and time to tip: 1 – 2 hours [note, this is the time from the route to the tipping location, the time to tip – approximately 15-30 minutes depending on the site, vehicle wait times, etc – and the time back from the tipping location to the route].

A.3.3.3 Service Characteristics

Service characteristics were also considered:

- Coverage of recycling services
- Participation
- Service type
- Frequency

This information was researched and outlined in the **Element 1 Technical Memorandum**, where additional details can be found.

The **Element 1 Technical Memorandum** also provided data for each jurisdiction on whether the recycling services were primarily open-market subscription-based or mandatory single supplier operated. As noted above in the description of the recycling service fees regression analysis, jurisdictions that operate an open market approach tend to see higher average fees than those where there is a single operator.

Where there is a single operator, collection vehicles pick up from each household. Where there are multiple operators in an open market, each operator will not generally be picking up from each household. Although there are likely to be areas of greater density in a jurisdiction where householders choose the same operator, there will be other areas where they are less prevalent. This increases the distance between properties on average and so affects the modeled cost calculations.

Data from the municipal survey regarding the number of recycling operators operating in each jurisdiction was taken to estimate the average number in place across all open market jurisdictions. This typically ranged from 2 to 7 operators, but some report 10+.

The time factor between pickups is not linearly correlated with distance because of how collection trucks are driven, acceleration, and average speeds between pick ups. An analysis was undertaken to create a relationship between operator numbers and time between pick-ups. This factor was also adjusted in the scenario controls related to route efficiencies.

The following graphs in **Figure 14**, **Figure 15**, and **Figure 16** indicate the estimated performance of the vehicles in different scenarios of the number of households picked upon from in a given street. It can be seen that there is a non-linear relationship between the number of properties served and the time taken to travel between properties. This is an important parameter relating to route performance and efficiency. The relevance is that the analysis was used to create specific factors for the model to estimate changes in efficiency as the density of operators changes between different service models across different jurisdictions.

Figure 14: Estimated Speed Profile of Collection Trucks between Properties

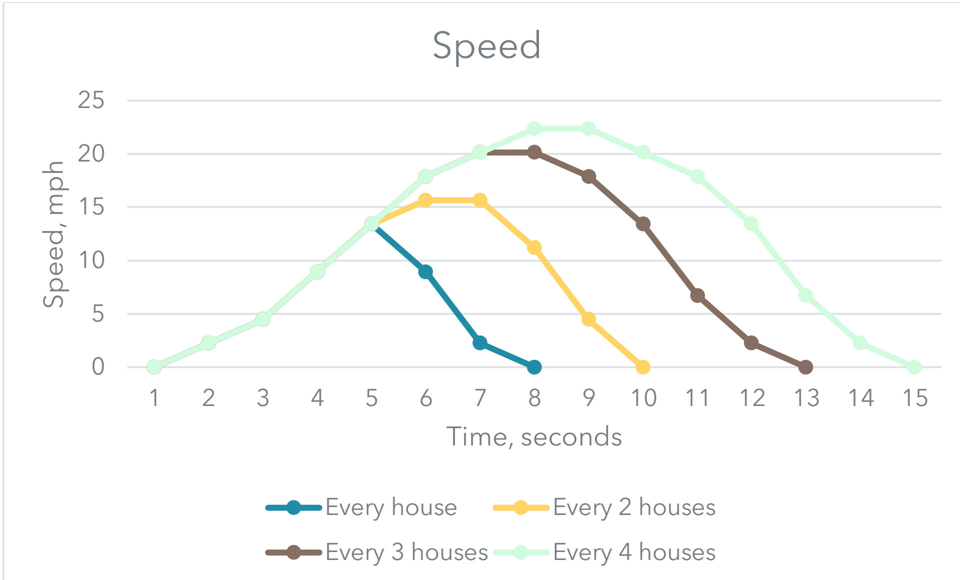


Figure 15: Estimated Distance Profile of Collection Trucks between Properties

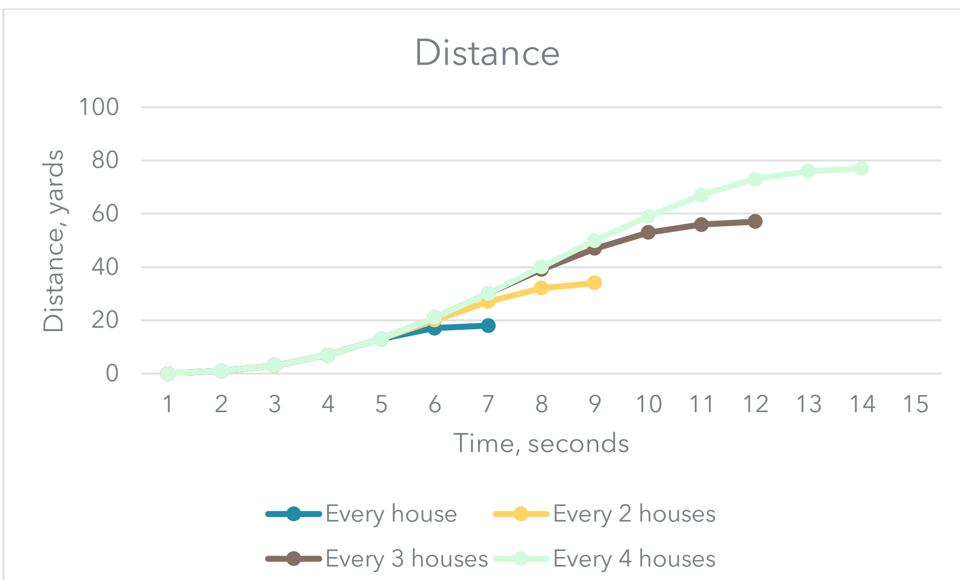
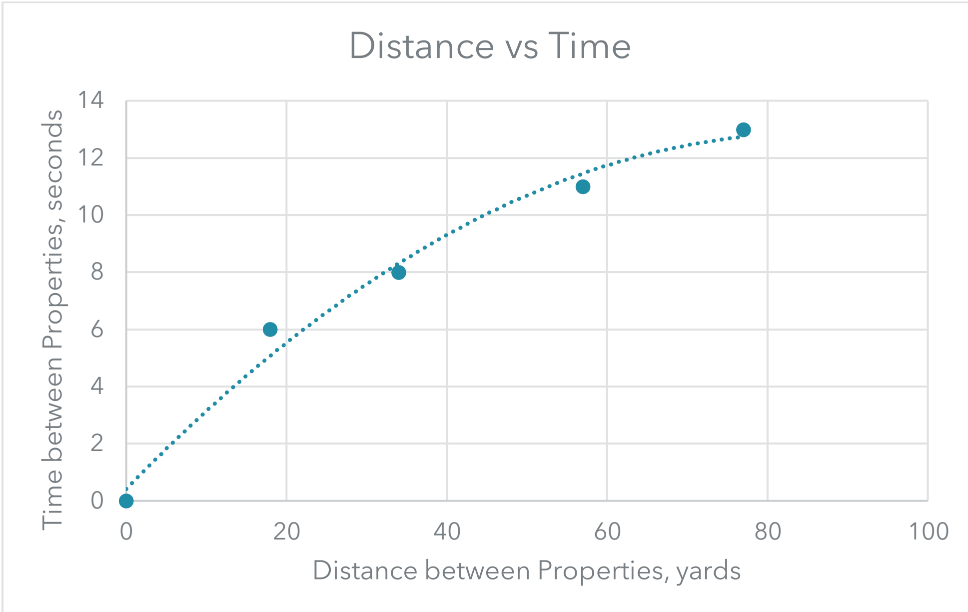


Figure 16: Estimated Non-linear Relationship - Time and Distance Between Properties



A.3.3.4 Service Operational Performance

Service operational performance was developed through consultation interviews with Colorado stakeholders and the experience of the project team. This section looked at vehicle and container performance:

- Vehicle performance averages:
  - Vehicle lifetime: 7 years
  - Vehicle capacity: 15 tons
  - Vehicle capacity volume: 28 cubic yards
  - Vehicle miles per gallon: 3-6
  - Average vehicle speed on round: 4-8 miles per hour
  - Average vehicle speed return to base: 15-25 miles per hour
  - Number of drivers per vehicle: 1
  - Number of supervisors per vehicle: 0.1
  - Number of admin staff per vehicle: 0.05
  - Number of executive staff per vehicle: 0.05
  - Collection time per household setting out: 13 seconds
  - Set out rate (proportion of actively participating households setting out a cart on each scheduled collection day): 95%

  - Operational hours per day: 8
  - Vehicle operating days per week: 5
  - Time tipping: 0.35 hours
- Container performance averages:
  - Container lifetime: 7 years
  - Annual container replacement: 2%

A.3.3.5 Service Cost Parameters

The same service operational parameters were assessed for costs. While there is a wide-ranging cost for new vehicles, upwards of $500,000, this cost analysis considered current vehicles in use. Assuming they have been in use for some time, the average capital cost used historical costs for new vehicles.

- Vehicle averages:
  - Vehicle capital cost: $350,000
  - Driver salary: $60,000-70,000
  - Crew salary: $30,000-60,000
  - Supervisor salary: $60,000-90,000
  - Admin salary: $20,000-50,000
  - Executive salary: $70,000-100,000
  - Salary adjustment (sick pay, annual holiday, taxes, etc): +35%
  - Vehicle maintenance and repair proportion of capital cost: 2.5%
  - Vehicle insurance proportion of capital costs: 10%
  - Depot maintenance and repair proportion of capital costs: 2.5%
  - Fuel cost: $4/gallon
  - Depot lifetime: 10 years
  - Depot and infrastructure costs per vehicle: $0.2 million
  - Per vehicle operating costs benchmarked to Colorado-specific data received from some operators.
- Container averages:
  - Container capital cost: $40-80 depending on size, shipping cost, etc.
- Transfer costs:
  - Limited data were available, but some cost factors were included in the model based upon input received during the study. There are a wide range of costs relating to transfer depending on the source of supply, the destination, road type, waste type, vehicle type, whether any

bulking/densifying has been carried out, etc. So, the costs used were considered to be representative only. However, they reflect a likely differential in costs where over-net costs from transfer through transfer stations were slightly lower than where direct delivery was utilized. Colorado-specific data was used from the surveys carried out on which municipalities were reported to be utilizing transfer stations and which were not. The following costs were applied in the model:

  - Cost for direct delivery = $10 per ton
  - Cost through bulk transfer = $5 per ton

- MRF costs:
  - Colorado-specific data were received from the various surveys and interviews carried out for the study. Many of the figures were received confidentially. The range used in the study to represent MRF costs to haulers (and by proxy, the PRO) was:
  - Lower MRF gate / tipping fee = $40 per ton
  - Upper MRF gate / tipping fee = $90 per ton

A.3.4 OVERALL BENCHMARKED COSTS PER HOUSEHOLD

The overall cost per household was estimated by summing the system hauling cost, transfer costs, and MRF costs per household.

The following tables show the upper and lower estimated average annual cost per household for hauling, transfer, MRFs, and the overall total cost.

Table 23: Annual Hauling Cost per Household, USD

	Lower Cost Estimate	Upper-Cost Estimate
Statewide	46	77
Eastern Plains	64	106
Front Range	43	71
Mountains	107	178
Western Slope	49	82

Table 24: Annual Transfer Costs per Household, USD

	With transfer station		Direct delivered	
	Lower Cost Estimate	Upper-Cost Estimate	Lower Cost Estimate	Upper-Cost Estimate
Statewide	0.4	0.7	1.1	1.8

	With transfer station		Direct delivered	
Eastern Plains	0.2	0.3	1.1	1.8
Front Range	0.4	0.7	1.1	1.9
Mountains	0.5	0.8	0.7	1.1
Western Slope	0.4	0.7	0.7	1.1

Table 25: Annual Processing Cost per Household, USD

	Lower Cost Estimate	Upper-Cost Estimate
Statewide	13	22
Eastern Plains	11	18
Front Range	14	23
Mountains	12	20
Western Slope	11	19

The overall annual household cost for curbside collection rolls up these costs and are as follows:

Table 26: Predicted Annual Household Cost, USD

	Lower Cost Estimate	Upper-Cost Estimate
Statewide	61	101
Eastern Plains	76	126
Front Range	58	96
Mountains	120	200
Western Slope	62	103

Each jurisdictional estimate was benchmarked to align with the regression cost estimates by adjusting a range of key performance and cost parameters in the model. These key parameters are as follows:

- Distance between properties
- Total time to tip
- Open market collection operator density
- Vehicles miles per gallon
- Average vehicle speed on round

- Collection time per household setting out
- Time tipping
- Salaries

The goal of this step was to close the difference between the modeled cost estimate and the regression estimate as much as possible. Overall, the benchmarking demonstrated good alignment between these two estimates across jurisdictions.

A.4.0 COMMERCIAL COLLECTION COSTS

A.4.1 COMMERCIAL COLLECTIONS MODEL

Commercial collections are related to households in multihousehold properties, mobile home parks, and covered non-residential entities.

The same collections model as described above for residential collections was used, but parameters were updated to reflect operations on commercial routes. Key performance parameters were benchmarked against Colorado-specific data received through the hauler survey and one-to-one interviews with municipalities and operators. The model was benchmarked with pick rates of around 35 to 55 accounts per vehicle per day, depending on the service type.

In addition to commingled stream services, commercial source-separated services are also in operation. In addition to hauling costs, material processing net of revenues were taken into account to derive the estimates for overall service costs. There will be a large range in the figures depending on various factors, including secondary materials markets; however, the following are considered to fall within likely ranges. Values were reviewed with Colorado operators, and in addition, overall cost estimates were benchmarked against Colorado-specific data to check overall efficacy:

- The tipping fee for commingled materials at MRFs:
  - Lower = $40 / ton
  - Upper = $90 / ton
- Sale/processing of mixed fibers:
  - Lower = -$20 / ton
  - Upper = $20 / ton
- Sale/processing of glass:
  - Lower = -$20 / ton
  - Upper = $20 / ton
- Sale/processing of mixed metals & plastics:
  - Lower = -$40 / ton
  - Upper = $0 / ton
- Sale/processing of flexible plastics:
  - Lower = $10 / ton

- Upper = $50 / ton

A.4.2 COMMERCIAL CAPTURES BY CONTAINER TYPE

The commercial model is structured by waste generator type and service type. For each service type, different container sizes were modeled with estimated captures relating to size and material bulk densities. The total number of containers per account type was then adjusted to produce an overall capture rate of 85% per participating account for the covered materials only (see table below). Captures per service type were benchmarked with Colorado-specific data provided confidentially by haulers operating across the state.

The total captures from the different waste generator types on commercial routes was then calculated based upon the participation of each type (see **Section A.1.6.1**) and the estimated captures per service type, found in **Table 27** .

Table 27: Estimated Commercial Collection Captures per Service Type

Stream Type	Frequency	Waste Generators	Container Code	Container Capacity (cubic yards)	Fill rate when collected	Number of containers per account	Total weight collected per year, thousand lbs
Single Stream with Glass	Bi-weekly	Residential MF (lrg)	300-GAL	1.5	75%	2	20
Single Stream with Glass	Bi-weekly	Mobile Homes etc	300-GAL	1.5	75%	4	38
Single Stream with Glass	Bi-weekly	Small Businesses	300-GAL	1.5	75%	2	18
Single Stream with Glass	Bi-weekly	Government Buildings	300-GAL	1.5	75%	1	10
Single Stream with Glass	Bi-weekly	Public Spaces	300-GAL	1.5	75%	1	12
Single Stream with Glass	Weekly	Residential MF (lrg)	2 CY DMPSTR	2.0	75%	2	40
Single Stream with Glass	Weekly	Mobile Homes etc	2 CY DMPSTR	2.0	75%	3	77
Single Stream with Glass	Weekly	Small Businesses	2 CY DMPSTR	2.0	75%	2	37
Single Stream with Glass	Weekly	Public Spaces	2 CY DMPSTR	2.0	75%	1	24
Single Stream with Glass	Twice Weekly	Mobile Homes etc	4 CY DMPSTR	4.0	75%	2	153
Single Stream without Glass	Bi-weekly	Residential MF (lrg)	2 CY DMPSTR	2.0	75%	2	20
Single Stream without Glass	Bi-weekly	Mobile Homes etc	2 CY DMPSTR	2.0	75%	3	38
Single Stream without Glass	Bi-weekly	Small Businesses	2 CY DMPSTR	2.0	75%	2	18
Single Stream without Glass	Bi-weekly	Hospitality	2 CY DMPSTR	2.0	75%	1	14

Stream Type	Frequency	Waste Generators	Container Code	Container Capacity (cubic yards)	Fill rate when collected	Number of containers per account	Total weight collected per year, thousand lbs
Single Stream without Glass	Bi-weekly	Schools	2 CY DMPSTR	2.0	75%	1	11
Single Stream without Glass	Weekly	Residential MF (lrg)	2 CY DMPSTR	2.0	75%	2	40
Single Stream without Glass	Weekly	Mobile Homes etc	2 CY DMPSTR	2.0	75%	3	77
Single Stream without Glass	Weekly	Small Businesses	2 CY DMPSTR	2.0	75%	2	37
Single Stream without Glass	Weekly	Hospitality	2 CY DMPSTR	2.0	75%	1	28
Single Stream without Glass	Weekly	Schools	2 CY DMPSTR	2.0	75%	1	23
Single Stream without Glass	Twice Weekly	Mobile Homes etc	4 CY DMPSTR	4.0	75%	2	153
Dual Stream - fiber and containers	Bi-weekly	Schools	95-GAL	0.5	75%	4	11
Dual Stream - fiber and containers	Weekly	Schools	2 CY DMPSTR	2.0	75%	1	23
Dual Stream - fiber and containers	Twice Weekly	Schools	2 CY DMPSTR	2.0	75%	1	46
Cardboard Only	Bi-weekly	Small Businesses	95-GAL	0.5	75%	3	9
Cardboard Only	Bi-weekly	Hospitality	95-GAL	0.5	75%	2	5
Glass Only	Bi-weekly	Hospitality	65-GAL	0.3	75%	1	4
Glass Only	Weekly	Hospitality	65-GAL	0.3	75%	1	7
Metals & Plastics Only	Bi-weekly	Hospitality	65-GAL	0.3	75%	1	1

A.4.3 KEY COMMERCIAL COST OUTPUTS

The collections model was used to create overall service costs per pick-up, as this is the most common cost metric for commercial waste services. The hauling cost was calculated as per the methodology described above in **Section A.3.3**, and processing costs and/or material revenues were applied to derive the overall service cost estimate. These costs were benchmarked using some Colorado-specific cost data provided by service providers. There is clearly a large range depending on location, operator type, operator size, market position, marketing, etc. A +/- 25% range was applied to the figures presented below to provide the lower to upper range in the overall cost estimates.

Table 28: Estimated Commercial Route Service Costs per Pick-up, USD

Region	Service Type	Frequency	Container Type Code	Total Cost per Pickup - Lower	Total Cost per Pickup - Upper
Eastern/Southeastern	Single Stream with Glass	Bi-weekly	300-GAL	22	37
Eastern/Southeastern	Single Stream with Glass	Weekly	2 CY DMPSTR	29	49
Eastern/Southeastern	Single Stream with Glass	Weekly	4 CY DMPSTR	51	84
Eastern/Southeastern	Single Stream with Glass	Twice Weekly	4 CY DMPSTR	49	81
Eastern/Southeastern	Single Stream without Glass	Bi-weekly	2 CY DMPSTR	30	50
Eastern/Southeastern	Single Stream without Glass	Weekly	2 CY DMPSTR	28	47
Eastern/Southeastern	Single Stream without Glass	Twice Weekly	4 CY DMPSTR	47	78
Eastern/Southeastern	Dual Stream - fiber and containers	Bi-weekly	95-GAL	11	19
Eastern/Southeastern	Dual Stream - fiber and containers	Weekly	2 CY DMPSTR	28	47
Eastern/Southeastern	Dual Stream - fiber and containers	Twice Weekly	2 CY DMPSTR	27	46
Eastern/Southeastern	Cardboard Only	Bi-weekly	95-GAL	8	13
Eastern/Southeastern	Cardboard Only	Weekly	2 CY DMPSTR	15	25
Eastern/Southeastern	Cardboard Only	Weekly	4 CY DMPSTR	22	37
Eastern/Southeastern	Cardboard Only	Twice Weekly	4 CY DMPSTR	21	34
Eastern/Southeastern	Glass Only	Bi-weekly	65-GAL	8	13
Eastern/Southeastern	Glass Only	Bi-weekly	300-GAL	12	20
Eastern/Southeastern	Glass Only	Bi-weekly	2 CY DMPSTR	17	29
Eastern/Southeastern	Glass Only	Weekly	65-GAL	8	13
Eastern/Southeastern	Glass Only	Twice Weekly	95-GAL	8	13
Eastern/Southeastern	Glass Only	Twice Weekly	300-GAL	11	19
Eastern/Southeastern	Glass Only	Twice Weekly	2 CY DMPSTR	15	25
Eastern/Southeastern	Metals & Plastics Only	Bi-weekly	65-GAL	8	13
Eastern/Southeastern	Metals & Plastics Only	Weekly	95-GAL	7	12
Eastern/Southeastern	Metals & Plastics Only	Weekly	2 CY DMPSTR	12	21
Eastern/Southeastern	Metals & Plastics Only	Weekly	4 CY DMPSTR	17	28
Eastern/Southeastern	Metals & Plastics Only	Twice Weekly	95-GAL	7	12
Eastern/Southeastern	Flexible Plastics Only	Bi-weekly	95-GAL	10	17
Eastern/Southeastern	Flexible Plastics Only	Weekly	95-GAL	10	17
Eastern/Southeastern	Flexible Plastics Only	Weekly	2 CY DMPSTR	23	39
Eastern/Southeastern	Flexible Plastics Only	Twice Weekly	95-GAL	10	17
Front Range	Single Stream with Glass	Bi-weekly	300-GAL	18	30
Front Range	Single Stream with Glass	Weekly	2 CY DMPSTR	23	38
Front Range	Single Stream with Glass	Weekly	4 CY DMPSTR	46	76
Front Range	Single Stream with Glass	Twice Weekly	4 CY DMPSTR	44	73

Region	Service Type	Frequency	Container Type Code	Total Cost per Pickup - Lower	Total Cost per Pickup - Upper
Front Range	Single Stream without Glass	Bi-weekly	2 CY DMPSTR	24	40
Front Range	Single Stream without Glass	Weekly	2 CY DMPSTR	22	37
Front Range	Single Stream without Glass	Twice Weekly	4 CY DMPSTR	42	70
Front Range	Dual Stream - fiber and containers	Bi-weekly	95-GAL	8	14
Front Range	Dual Stream - fiber and containers	Weekly	2 CY DMPSTR	22	37
Front Range	Dual Stream - fiber and containers	Twice Weekly	2 CY DMPSTR	21	35
Front Range	Cardboard Only	Bi-weekly	95-GAL	5	8
Front Range	Cardboard Only	Weekly	2 CY DMPSTR	9	14
Front Range	Cardboard Only	Weekly	4 CY DMPSTR	17	29
Front Range	Cardboard Only	Twice Weekly	4 CY DMPSTR	15	25
Front Range	Glass Only	Bi-weekly	65-GAL	5	8
Front Range	Glass Only	Bi-weekly	300-GAL	7	12
Front Range	Glass Only	Bi-weekly	2 CY DMPSTR	11	18
Front Range	Glass Only	Weekly	65-GAL	4	7
Front Range	Glass Only	Twice Weekly	95-GAL	5	8
Front Range	Glass Only	Twice Weekly	300-GAL	7	11
Front Range	Glass Only	Twice Weekly	2 CY DMPSTR	8	13
Front Range	Metals & Plastics Only	Bi-weekly	65-GAL	4	7
Front Range	Metals & Plastics Only	Weekly	95-GAL	4	7
Front Range	Metals & Plastics Only	Weekly	2 CY DMPSTR	7	11
Front Range	Metals & Plastics Only	Weekly	4 CY DMPSTR	13	21
Front Range	Metals & Plastics Only	Twice Weekly	95-GAL	4	7
Front Range	Flexible Plastics Only	Bi-weekly	95-GAL	7	11
Front Range	Flexible Plastics Only	Weekly	95-GAL	7	11
Front Range	Flexible Plastics Only	Weekly	2 CY DMPSTR	16	27
Front Range	Flexible Plastics Only	Twice Weekly	95-GAL	7	11
Mountains	Single Stream with Glass	Bi-weekly	300-GAL	30	50
Mountains	Single Stream with Glass	Weekly	2 CY DMPSTR	35	58
Mountains	Single Stream with Glass	Weekly	4 CY DMPSTR	63	106
Mountains	Single Stream with Glass	Twice Weekly	4 CY DMPSTR	61	102
Mountains	Single Stream without Glass	Bi-weekly	2 CY DMPSTR	36	59
Mountains	Single Stream without Glass	Weekly	2 CY DMPSTR	34	56
Mountains	Single Stream without Glass	Twice Weekly	4 CY DMPSTR	59	99
Mountains	Dual Stream - fiber and containers	Bi-weekly	95-GAL	16	26

Region	Service Type	Frequency	Container Type Code	Total Cost per Pickup - Lower	Total Cost per Pickup - Upper
Mountains	Dual Stream - fiber and containers	Weekly	2 CY DMPSTR	34	56
Mountains	Dual Stream - fiber and containers	Twice Weekly	2 CY DMPSTR	33	55
Mountains	Cardboard Only	Bi-weekly	95-GAL	12	21
Mountains	Cardboard Only	Weekly	2 CY DMPSTR	21	34
Mountains	Cardboard Only	Weekly	4 CY DMPSTR	35	59
Mountains	Cardboard Only	Twice Weekly	4 CY DMPSTR	33	55
Mountains	Glass Only	Bi-weekly	65-GAL	13	21
Mountains	Glass Only	Bi-weekly	300-GAL	20	34
Mountains	Glass Only	Bi-weekly	2 CY DMPSTR	24	40
Mountains	Glass Only	Weekly	65-GAL	12	21
Mountains	Glass Only	Twice Weekly	95-GAL	13	21
Mountains	Glass Only	Twice Weekly	300-GAL	19	32
Mountains	Glass Only	Twice Weekly	2 CY DMPSTR	21	35
Mountains	Metals & Plastics Only	Bi-weekly	65-GAL	12	20
Mountains	Metals & Plastics Only	Weekly	95-GAL	12	19
Mountains	Metals & Plastics Only	Weekly	2 CY DMPSTR	17	29
Mountains	Metals & Plastics Only	Weekly	4 CY DMPSTR	29	48
Mountains	Metals & Plastics Only	Twice Weekly	95-GAL	12	19
Mountains	Flexible Plastics Only	Bi-weekly	95-GAL	15	24
Mountains	Flexible Plastics Only	Weekly	95-GAL	15	24
Mountains	Flexible Plastics Only	Weekly	2 CY DMPSTR	30	50
Mountains	Flexible Plastics Only	Twice Weekly	95-GAL	15	24
Western Slope	Single Stream with Glass	Bi-weekly	300-GAL	20	34
Western Slope	Single Stream with Glass	Weekly	2 CY DMPSTR	26	43
Western Slope	Single Stream with Glass	Weekly	4 CY DMPSTR	47	78
Western Slope	Single Stream with Glass	Twice Weekly	4 CY DMPSTR	45	75
Western Slope	Single Stream without Glass	Bi-weekly	2 CY DMPSTR	27	44
Western Slope	Single Stream without Glass	Weekly	2 CY DMPSTR	25	41
Western Slope	Single Stream without Glass	Twice Weekly	4 CY DMPSTR	43	72
Western Slope	Dual Stream - fiber and containers	Bi-weekly	95-GAL	10	16
Western Slope	Dual Stream - fiber and containers	Weekly	2 CY DMPSTR	25	41
Western Slope	Dual Stream - fiber and containers	Twice Weekly	2 CY DMPSTR	24	40
Western Slope	Cardboard Only	Bi-weekly	95-GAL	6	11
Western Slope	Cardboard Only	Weekly	2 CY DMPSTR	11	19
Western Slope	Cardboard Only	Weekly	4 CY DMPSTR	19	31

Region	Service Type	Frequency	Container Type Code	Total Cost per Pickup - Lower	Total Cost per Pickup - Upper
Western Slope	Cardboard Only	Twice Weekly	4 CY DMPSTR	17	28
Western Slope	Glass Only	Bi-weekly	65-GAL	6	10
Western Slope	Glass Only	Bi-weekly	300-GAL	10	17
Western Slope	Glass Only	Bi-weekly	2 CY DMPSTR	14	23
Western Slope	Glass Only	Weekly	65-GAL	6	10
Western Slope	Glass Only	Twice Weekly	95-GAL	6	11
Western Slope	Glass Only	Twice Weekly	300-GAL	9	16
Western Slope	Glass Only	Twice Weekly	2 CY DMPSTR	11	19
Western Slope	Metals & Plastics Only	Bi-weekly	65-GAL	6	9
Western Slope	Metals & Plastics Only	Weekly	95-GAL	6	10
Western Slope	Metals & Plastics Only	Weekly	2 CY DMPSTR	9	15
Western Slope	Metals & Plastics Only	Weekly	4 CY DMPSTR	13	22
Western Slope	Metals & Plastics Only	Twice Weekly	95-GAL	6	9
Western Slope	Flexible Plastics Only	Bi-weekly	95-GAL	8	14
Western Slope	Flexible Plastics Only	Weekly	95-GAL	8	14
Western Slope	Flexible Plastics Only	Weekly	2 CY DMPSTR	20	33
Western Slope	Flexible Plastics Only	Twice Weekly	95-GAL	8	14
Eastern/Southeastern	Cardboard / Glass / Metals & Plastics	Monthly	RoRo Recyc	169	281
Front Range	Cardboard / Glass / Metals & Plastics	Monthly	RoRo Recyc	162	270
Mountains	Cardboard / Glass / Metals & Plastics	Monthly	RoRo Recyc	260	433
Western Slope	Cardboard / Glass / Metals & Plastics	Monthly	RoRo Recyc	171	285

A.5.0 OTHER COSTS

A.5.1 EDUCATIONAL AND INFORMATIONAL CAMPAIGNS

The Element 12 memo on education details the assessment of educational and informational campaigns, also described as promotion and education. That memo can be referred to for further details.

In summary, a cost of $10 per household for promotion and education was applied in the model by 2035. As these campaigns will ramp up over time, a cost of $5 per household was applied in 2030.

A.5.2 MRF INVESTMENTS

Elements 6 and 10 detail MRF processing capacities and new technologies. These can be referred to for further details.

In summary, a total investment cost of around $800 thousand for glass clean-up at MRFs was used for the modeling. This equates to around $15 million of capital investment by 2030.

For the full advanced MRF upgrading, the total investment cost of around $90 million was estimated through a detailed analysis of the potential infrastructure in place in 2030.

A.5.3 COMPOSTING INVESTMENTS

Element 14 sets out the details of potential upgrades to composting plants to manage packaging and paper product waste through the organics waste stream. This memo can be referred to for further details.

In summary, the overall investment cost was estimated to be around $100 million by 2030.

A.6.0 DETAILED RESULTS

A.6.1 BASELINE (2022)

A.6.1.1 Baseline (2022) Performance

Table 29: Statewide Baseline (2022) Performance

	Tons (k tons)	Percent
Generated	~1250	
Collected	~360	26% - 32%
Recycled	~310	22% - 28%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 30: Regional Baseline (2022) Performance

Region		Tons (k tons)	Percent
Front Range	Generated	~1050	
	Collected	~320	28% - 34%
	Recycled	~280	24% - 30%
Mountains	Generated	~80	
	Collected	~20	19% - 25%
	Recycled	~20	17% - 23%
Western Slope	Generated	~90	
	Collected	~20	18% - 24%
	Recycled	~20	15% - 21%
Eastern Plains	Generated	~30	
	Collected	~4	9% - 15%
	Recycled	~4	8% - 14%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 31: Performance by Material

Material	Baseline (2022) Percent		Baseline (2022) Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Tons	Recycled Tons
Paper	21% - 27%	19% - 25%	~100	~90
Cardboard	46% - 52%	42% - 48%	~130	~110
Glass	37% - 43%	24% - 30%	~60	~40
Metals	37% - 43%	33% - 39%	~40	~30
Rigid Plastics	13% - 19%	11% - 17%	~30	~30
Flexible Plastics	<1%	<1%	~0	~0
Total	26% - 32%	22% - 28%	~360	~310

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 32: Performance by Covered Entity

Covered Entity	Baseline (2022) Percent		Baseline (2022) Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Tons	Recycled Tons
Residential SF	28% - 34%	24% - 30%	~260	~230
Residential MF (sml)	28% - 34%	24% - 30%	~30	~30
Residential MF (lrg)	14% - 20%	12% - 18%	~40	~30
Mobile Homes etc	13% - 19%	11% - 17%	~6	~6
Small Businesses	8% - 14%	7% - 13%	~7	~6
Hospitality	10% - 16%	9% - 15%	~10	~9
Schools	10% - 16%	8% - 14%	~2	~2
Government Buildings	11% - 13%	10% - 12%	~0	~0
Public Spaces	13% - 19%	10% - 16%	~2	~2
Total	26% - 32%	22% - 28%	~360	~310

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 33: Baseline (2022) Access Factors

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	69%	46%	41%	16%	64%
SF households who participate in curbside recycling (% of all SF households)	66%	45%	38%	16%	61%
MF households who participate in curbside recycling (% of all MF households)	22%	22%	22%	22%	22%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	29%	29%	29%	29%	29%

Table 34: Baseline (2022) Collection and Material Factors

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~510	~440	~400	~390	~500
MF curbside capture rate (pounds per household)	~310	~310	~310	~310	~310
Total curbside household capture rate (pounds per annum per participating household)	~470	~400	~380	~350	~460

Percent of collected material collected through curbside	95%	86%	83%	82%	94%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 35: Baseline (2022) Infrastructure Factors

	Baseline (2022)
Commingled waste processed at MRFs (k tons)	340
Additional MRF capacity (k tons)	0
MRF yield rate (average %)	88%
Total number of drop-off sites	60

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.1.2 Baseline (2022) Costs

Table 36: Statewide Baseline (2022) Cost Breakdown ($)

	Baseline (2022) Lower Range	Baseline (2022) Upper Range
Cost per household	60	90
Cost per ton collected	220	370
Cost per ton recycled	260	430

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 37: Regional Baseline (2022) Cost Breakdown ($)

Region		Baseline (2022) Lower Range	Baseline (2022) Upper Range
Front Range	Cost per household	50	90
	Cost per ton collected	210	350
	Cost per ton recycled	250	410
Mountains	Cost per household	120	190
	Cost per ton collected	420	710
	Cost per ton recycled	480	790
Western Slope	Cost per household	60	100
	Cost per ton collected	240	400
	Cost per ton recycled	290	480
Eastern Plains	Cost per household	80	130
	Cost per ton collected	280	470
	Cost per ton recycled	310	520

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.2 SCENARIO 1 – LOW

A.6.2.1 Low Scenario Performance Results

Table 38: Low Scenario Performance

	2030		2035	
	Tons (k tons)	Percent	Tons (k tons)	Percent
Generated	~1290		~1320	
Collected	~520	37% - 43%	~750	54% - 60%
Recycled	~450	32% - 38%	~660	47% - 53%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 39: Low Scenario Performance by Material

Material	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Paper	34% - 40%	30% - 36%	56% - 62%	51% - 57%	~160	~150	~270	~240
Cardboard	60% - 66%	55% - 61%	71% - 77%	66% - 72%	~170	~150	~200	~190
Glass	48% - 54%	34% - 40%	58% - 64%	43% - 49%	~80	~60	~100	~80
Metals	53% - 59%	48% - 54%	71% - 77%	65% - 71%	~50	~50	~70	~70
Rigid Plastics	22% - 28%	19% - 25%	40% - 46%	35% - 41%	~50	~40	~90	~80
Flexible Plastics	<1%	<1%	15% - 21%	8% - 14%	~0	~0	~20	~10
Total	37% - 43%	32% - 38%	54% - 60%	47% - 53%	~520	~450	~750	~660

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 40: Low Scenario Performance by Covered Entity

Covered Entity	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Residential SF	37% - 43%	32% - 38%	52% - 58%	45% - 51%	~350	~300	~490	~430
Residential MF (sml)	37% - 43%	32% - 38%	53% - 59%	46% - 52%	~40	~40	~60	~60
Residential MF (lrg)	27% - 33%	24% - 30%	44% - 50%	39% - 45%	~70	~60	~110	~100
Mobile Homes etc	25% - 31%	22% - 28%	41% - 47%	35% - 41%	~10	~10	~20	~20
Small Businesses	21% - 27%	18% - 24%	33% - 39%	30% - 36%	~20	~10	~30	~20
Hospitality	20% - 26%	18% - 24%	33% - 39%	29% - 35%	~20	~20	~30	~30
Schools	25% - 31%	22% - 28%	40% - 46%	36% - 42%	~5	~4	~7	~7
Government Buildings	24% - 30%	21% - 27%	39% - 45%	34% - 40%	~1	~1	~2	~1
Public Spaces	11% - 17%	9% - 15%	19% - 25%	15% - 21%	~2	~1	~3	~2
Total	37% - 43%	32% - 38%	54% - 60%	47% - 53%	~510	~450	~750	~660

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 41: Low Scenario Performance by Region

		2030		2035	
		Tons (k tons)	Percent	Tons (k tons)	Percent
Front Range	Generated	~1080		~1110	
	Collected	~450	38% - 44%	~650	56% - 62%
	Recycled	~390	33% - 39%	~570	49% - 55%
Mountains	Generated	~90		~90	
	Collected	~30	30% - 36%	~40	43% - 49%
	Recycled	~30	27% - 33%	~40	39% - 45%
Western Slope	Generated	~90		~90	
	Collected	~30	30% - 36%	~40	44% - 50%
	Recycled	~30	25% - 31%	~40	38% - 44%
Eastern Plains	Generated	~30		~30	
	Collected	~8	21% - 27%	~10	34% - 40%
	Recycled	~7	19% - 25%	~10	31% - 37%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 42: Low Scenario Access Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside recycling (% of all SF households)	81%	52%	58%	28%	76%
MF households who participate in curbside recycling (% of all MF households)	47%	47%	47%	47%	47%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	50%	50%	50%	50%	50%

Table 43: Low Scenario Access Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside recycling (% of all SF households)	89%	62%	67%	40%	85%
MF households who participate in curbside recycling (% of all MF households)	60%	60%	60%	60%	60%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	75%	75%	75%	75%	75%

Table 44: Low Scenario Collection and Material Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~480	~340	~330	~220	~460
MF curbside capture rate (pounds per household)	~360	~360	~360	~360	~360
Total curbside household capture rate (pounds per annum per household with access)	~450	~350	~340	~260	~440
Percent of collected material collected through curbside	98%	82%	88%	81%	96%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 45: Low Scenario Collection and Material Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~670	~530	~500	~410	~650
MF curbside capture rate (pounds per household)	~550	~550	~550	~550	~550

Total curbside household capture rate (pounds per annum per household with access)	~640	~530	~510	~450	~630
Percent of collected material collected through curbside	99%	88%	92%	87%	98%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 46: Low Scenario Infrastructure Factors

	2030	**2035**
Commingled waste processed at MRFs (k tons)	~490	~720
Additional commingled waste processed at MRFs (k tons)	~150	~390
MRF yield rate (average %)	89%	90%
Total number of drop-off sites (including flexible plastics)	83	83
Number of additional new collection sites for flexible plastics (e.g., retail)	0	0

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.2.2 Low Scenario Costs

Table 47: Low Scenario Statewide Cost Breakdown ($)

	2030 Lower Range	**2030 Upper Range**	**2035 Lower Range**	**2035 Upper Range**
Cost per household	60	90	70	110
Cost per ton collected	250	400	270	210
Cost per ton recycled	280	450	270	430

Table 48: Low Scenario Regional Cost Breakdown ($)

		2030 Lower Range	**2030 Upper Range**	**2035 Lower Range**	**2035 Upper Range**
Front Range	Cost per household	50	90	70	110
	Cost per ton collected	230	370	290	450
	Cost per ton recycled	260	420	220	360
Mountains	Cost per household	120	190	140	220

	Cost per ton collected	430	710	520	840
	Cost per ton recycled	480	780	400	640
Western Slope	Cost per household	60	100	80	120
	Cost per ton collected	300	490	370	590
	Cost per ton recycled	350	560	290	460
Eastern Plains	Cost per household	80	120	90	140
	Cost per ton collected	360	580	440	690
	Cost per ton recycled	390	630	310	480

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.3 SCENARIO 2 – MEDIUM

A.6.3.1 Medium Scenario Performance Results

Table 49: Medium Scenario Performance

	2030		2035	
	Tons (k tons)	Percent	Tons (k tons)	Percent
Generated	~1290		~1320	
Collected	~520	37% - 43%	~760	54% - 60%
Recycled	~480	34% - 40%	~710	51% - 57%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 50: Medium Scenario Performance by Material

Material	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Paper	33% - 39%	31% - 37%	55% - 61%	52% - 58%	~160	~150	~270	~250
Cardboard	60% - 66%	56% - 62%	71% - 77%	68% - 74%	~170	~160	~200	~190
Glass	50% - 56%	44% - 50%	61% - 67%	54% - 60%	~90	~80	~110	~100
Metals	53% - 59%	50% - 56%	70% - 76%	67% - 73%	~50	~50	~70	~70
Rigid Plastics	22% - 28%	20% - 26%	39% - 45%	37% - 43%	~50	~50	~90	~80
Flexible Plastics	<1% - 2%	<1% - 2%	17% - 23%	12% - 18%	~1	~1	~20	~20
Total	37% - 43%	34% - 40%	54% - 60%	51% - 57%	~520	~480	~760	~710

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 51: Medium Scenario by Covered Entity

Covered Entity	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collecte d Rate	Recycled Rate	Collect ed Rate	Recycled Rate
Residential SF	37% - 43%	34% - 40%	53% - 59%	49% - 55%	~350	~330	~500	~460
Residential MF (sml)	37% - 43%	34% - 40%	54% - 60%	50% - 56%	~40	~40	~60	~60
Residential MF (lrg)	27% - 33%	25% - 31%	44% - 50%	40% - 46%	~70	~70	~110	~100
Mobile Homes etc	25% - 31%	23% - 29%	41% - 47%	37% - 43%	~10	~10	~20	~20
Small Businesses	21% - 27%	19% - 25%	33% - 39%	31% - 37%	~20	~20	~30	~20
Hospitality	20% - 26%	19% - 25%	33% - 39%	30% - 36%	~20	~20	~30	~30
Schools	25% - 31%	23% - 29%	40% - 46%	37% - 43%	~5	~4	~7	~7
Governmen t Buildings	24% - 30%	22% - 28%	39% - 45%	36% - 42%	~1	~1	~2	~1
Public Spaces	11% - 17%	10% - 16%	19% - 25%	17% - 23%	~2	~2	~3	~3
Total	**37% - 43%**	**34% - 40%**	**54% - 60%**	**51% - 57%**	**~520**	**~480**	**~760**	**~710**

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 52: Medium Scenario Performance by Region

		2030		2035	
		Tons (k tons)	Percent	Tons (k tons)	Percent
Front Range	Generated	~1080		~1110	
	Collected	~450	39% - 45%	~650	56% - 62%
	Recycled	~420	36% - 42%	~610	52% - 58%
Mountains	Generated	~90		~90	
	Collected	~30	32% - 38%	~40	46% - 52%
	Recycled	~30	30% - 36%	~40	44% - 50%
Western Slope	Generated	~90		~90	
	Collected	~30	32% - 38%	~50	48% - 54%
	Recycled	~30	29% - 35%	~40	44% - 50%
Eastern Plains	Generated	~30		~30	
	Collected	~0	23% - 29%	~10	37% - 43%
	Recycled	~0	21% - 27%	~10	34% - 40%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 53: Medium Scenario Access Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside recycling (% of all SF households)	81%	52%	58%	28%	76%

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
MF households who participate in curbside recycling (% of all MF households)	47%	47%	47%	47%	47%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	50%	50%	50%	50%	50%

Table 54: Medium Scenario Access Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside recycling (% of all SF households)	89%	62%	67%	40%	85%
MF households who participate in curbside recycling (% of all MF households)	60%	60%	60%	60%	60%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	75%	75%	75%	75%	75%

Table 55: Medium Scenario Collection and Material Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~480	~380	~380	~250	~470
MF curbside capture rate (pounds per household)	~360	~360	~360	~360	~360
Total curbside household capture rate (pounds per annum per household with access)	~450	~380	~370	~280	~440
Percent of collected material collected through curbside	98%	82%	88%	79%	96%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 56: Medium Scenario Collection and Material Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~670	~580	~560	~460	~660
MF curbside capture rate (pounds per household)	~550	~550	~550	~550	~550
Total curbside household capture rate (pounds per annum per household with access)	~640	~570	~550	~480	~630
Percent of collected material collected through curbside	99%	88%	92%	86%	97%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 57: Medium Scenario Infrastructure Factors

	2030	2035
Commingled waste processed at MRFs (k tons)	~490	~770
Additional commingled waste processed at MRFs (k tons)	~160	~430
MRF yield rate (average %)	93%	94%
Total number of drop-off sites (including flexible plastics)	83	100
Number of additional new collection sites for flexible plastics (e.g., retail)	27	300

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.3.2 Medium Scenario Costs

Table 58: Medium Scenario Statewide Cost Breakdown ($)

	2030 Lower Range	2030 Upper Range	2035 Lower Range	2035 Upper Range
Cost per household	130	210	160	260
Cost per ton collected	240	400	210	340
Cost per ton recycled	220	350	200	320

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 59: Medium Scenario Regional Cost Breakdown ($)

		2030 Lower Range	2030 Upper Range	2035 Lower Range	2035 Upper Range
Front Range	Cost per household	50	90	70	110
	Cost per ton collected	230	370	200	320

		2030 Lower Range	2030 Upper Range	2035 Lower Range	2035 Upper Range
	Cost per ton recycled	250	400	220	340
Mountains	Cost per household	120	190	140	220
	Cost per ton collected	410	670	350	560
	Cost per ton recycled	440	710	370	590
Western Slope	Cost per household	70	110	80	130
	Cost per ton collected	290	470	250	400
	Cost per ton recycled	320	520	270	430
Eastern Plains	Cost per household	80	130	100	150
	Cost per ton collected	350	560	280	440
	Cost per ton recycled	370	590	290	460

A.6.4 SCENARIO 3 - HIGH

A.6.4.1 High Scenario Performance Results

Table 60: High Scenario Performance

	2030		2035	
	Tons (k tons)	Percent	Tons (k tons)	Percent
Generated	~1290		~1320	
Collected	~590	43% - 49%	~800	58% - 64%
Recycled	~550	39% - 45%	~750	54% - 60%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 61: High Scenario Performance by Material

Material	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate
Paper	40% - 46%	38% - 44%	58% - 64%	55% - 61%	~190	~180	~280	~260
Cardboard	64% - 70%	61% - 67%	76% - 82%	73% - 79%	~180	~170	~210	~200
Glass	54% - 60%	48% - 54%	66% - 72%	59% - 65%	~100	~80	~120	~110
Metals	56% - 62%	53% - 59%	74% - 80%	71% - 77%	~60	~50	~70	~70
Rigid Plastics	23% - 29%	21% - 27%	42% - 48%	39% - 45%	~50	~50	~90	~90
Flexible Plastics	8% - 14%	7% - 9%	19% - 25%	13% - 19%	~10	~10	~30	~20
Total	43% - 49%	39% - 45%	58% - 64%	54% - 60%	~590	~550	~800	~750

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 62: High Scenario Performance by Covered Entity

Covered Entity	2030 Percent		2035 Percent		2030 Volume (k tons)		2035 Volume (k tons)	
	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collected Rate	Recycled Rate	Collecte d Rate	Recycled Rate
Residential SF	44% - 50%	41% - 47%	58% - 64%	54% - 60%	~410	~380	~540	~500
Residential MF (sml)	44% - 50%	41% - 47%	58% - 64%	55% - 61%	~50	~50	~70	~60
Residential MF (lrg)	27% - 33%	25% - 31%	44% - 50%	40% - 46%	~70	~70	~110	~100
Mobile Homes etc	25% - 31%	23% - 29%	41% - 47%	37% - 43%	~10	~10	~20	~20
Small Businesses	21% - 27%	19% - 25%	33% - 39%	31% - 37%	~20	~20	~30	~20
Hospitality	20% - 26%	19% - 25%	33% - 39%	30% - 36%	~20	~20	~30	~30
Schools	25% - 31%	23% - 29%	40% - 46%	37% - 43%	~5	~4	~7	~7
Government Buildings	24% - 30%	22% - 28%	39% - 45%	36% - 42%	~1	~1	~2	~1
Public Spaces	11% - 17%	10% - 16%	19% - 25%	17% - 23%	~2	~2	~3	~3
Total	43% - 49%	39% - 45%	58% - 64%	54% - 60%	~590	~550	~800	~750

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 63: High Scenario Performance by Region

		2030		2035	
		Tons (k tons)	Percent	Tons (k tons)	Percent
Front Range	Generated	~1080		~1110	
	Collected	~510	44% - 50%	~690	60% - 66%
	Recycled	~480	41% - 47%	~650	56% - 62%
Mountains	Generated	~90		~90	
	Collected	~30	35% - 41%	~50	49% - 55%
	Recycled	~30	33% - 39%	~40	46% - 52%
Western Slope	Generated	~90		~90	
	Collected	~30	36% - 42%	~50	51% - 57%
	Recycled	~30	32% - 38%	~40	46% - 52%
Eastern Plains	Generated	~30		~30	
	Collected	~9	24% - 30%	~10	38% - 44%
	Recycled	~8	23% - 29%	~10	36% - 42%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 64: High Scenario Access Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside	81%	52%	58%	28%	76%

recycling (% of all SF households)					
MF households who participate in curbside recycling (% of all MF households)	47%	47%	47%	47%	47%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	50%	50%	50%	50%	50%

Table 65: High Scenario Access Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF households with active curbside recycling service (% of all SF households)	94%	70%	76%	52%	90%
SF households who participate in curbside recycling (% of all SF households)	89%	62%	67%	40%	85%
MF households who participate in curbside recycling (% of all MF households)	60%	60%	60%	60%	60%
Nonresidential covered entities who participate in curbside recycling (% of non-residential covered entities)	75%	75%	75%	75%	75%

Table 66: High Scenario Collection and Material Factors 2030

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~560	~450	~440	~290	~540
MF curbside capture rate (pounds per household)	~360	~360	~360	~360	~360
Total curbside household capture rate (pounds per annum per household with access)	~510	~430	~420	~310	~500
Percent of collected material collected through curbside	97%	83%	89%	81%	95%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 67: High Scenario Collection and Material Factors 2035

	Front Range	Mountains	Western Slope	Eastern Plains	Statewide
SF curbside capture rate (pounds per household)	~720	~640	~600	~500	~710
MF curbside capture rate (pounds per household)	~550	~550	~550	~550	~550
Total curbside household capture rate (pounds per annum per household with access)	~680	~610	~590	~510	~670
Percent of collected material collected through curbside	98%	89%	92%	87%	97%

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 68: High Scenario Infrastructure Factors

	2030	2035
Commingled waste processed at MRFs (k tons)	560	770
Additional commingled waste processed at MRFs (k tons)	220	430
MRF yield rate (average %)	93%	94%
Total number of drop off sites (including flexible plastics)	100	100
Number of additional new collection sites for flexible plastics (e.g. retail)	10	300

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

A.6.4.2 High Scenario Costs

Table 69: High Scenario Statewide Cost Breakdown ($)

	2030 Lower Range	2030 Upper Range	2035 Lower Range	2035 Upper Range
Cost per household	70	110	80	130
Cost per ton collected	250	400	230	360
Cost per ton recycled	270	430	280	440

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.

Table 70: High Scenario Regional Cost Breakdown ($)

		2030 Lower Range	2030 Upper Range	2035 Lower Range	2035 Upper Range
Front Range	Cost per household	60	100	80	120
	Cost per ton collected	270	430	230	370
	Cost per ton recycled	250	410	230	370
Mountains	Cost per household	130	210	150	240
	Cost per ton collected	410	670	360	580
	Cost per ton recycled	430	710	380	610
Western Slope	Cost per household	70	120	90	150
	Cost per ton collected	290	470	260	420
	Cost per ton recycled	320	520	290	460
Eastern Plains	Cost per household	80	120	100	150
	Cost per ton collected	320	520	260	420
	Cost per ton recycled	340	550	280	440

*Note: estimates have been rounded and, therefore, may not sum to the total and/or may differ to percentage estimates.