**EXECUTIVE SUMMARY**

# Recycling System Analysis for the Vermont Bottle Bill

## An Executive Summary Analysis of System Costs and Environmental Impacts of Three Scenarios

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# Executive Summary

The Vermont Agency of Natural Resources (ANR), Department of Environmental Conservation (DEC) commissioned the Signalfire Group, a subsidiary of Resource Recycling Systems (RRS), to conduct this study to analyze and compare the costs and benefits – financial and environmental – associated with three models for the management of beverage containers via the "bottle bill" deposit return system and the regular Vermont recycling system. The three models are:

1. Model 1, Existing Bottle Bill: The current Vermont bottle bill and recycling systems.
2. Model 2 (A and B), PRO Bottle Bill: All currently "covered" bottle bill beverage containers, except liquor, are managed by a beverage manufacturer/distributor producer responsibility organization (PRO); a convenience standard is established to increase redemption sites (similar to H.158), sorting by brand at redemption sites is eliminated, and all redemption sites must accept all redeemable containers, not just what they sell. Model 2A relies primarily on bag drop systems, while Model 2B relies on reverse vending machines (RVM).
3. Model 3, Expanded Bottle Bill (EBB) with PRO: Includes all the elements of Model 2 and expands the types of beverages included in the bottle bill deposit program as originally proposed in H.158.

To inform the development of the three models, the project team collected data from various industry subject matter experts and state documents, conducted stakeholder interviews, and gathered information from redemption centers and retailers. This report intends to facilitate discussion about the potential system impacts of various models. The results are based on the best data available, and the most reasonable assumptions; nonetheless they should be viewed as directional, not precise. Table 1 summarizes the key differences applied in the three models.

**NOTATION:** Given the complexity of the bottle bill system in practice, the following should be considered when interpreting the model results:

1. Model 1 quantifies costs for the VT Bottle Bill system as it currently functions, i.e., without full compliance since it is well established that not all retailers are serving as redemption sites as the law requires. If there were comparable convenience in Model 1 to those levels assumed in Models 2 and 3, the total annual cost of Model 1 would increase by an estimated 20%, surpassing the total cost of Model 2 but not that of Model 3.
2. Model 2 and Model 3 quantify costs associated with increased convenience standards, but they do not include any corresponding impact on **redemption rates** that may result from this change. While one would expect **redemption rates** to increase as a result of increased convenience, the level of increase could not be quantified due to insufficient data available. However, expanded bottle bill systems can increase the beverage container **diversion rate** by capturing more beverage containers from trash/litter in addition to pulling in more containers from the recycling system. RRS found redemption rates increase the most when the deposit increases, as shown with Oregon's experience moving to 10 cents.
3. Brand sorting is eliminated in Model 2 and Model 3. In practice, eliminating brand sorting would be expected to reduce sorting time and by extension, reduce labor costs. In the extensive interviews conducted with redemption centers, there were a wide range of responses with some redemption centers noting potential significant labor savings and some reporting little or none at all. The analysis reflects the average savings projected; it should be noted that when a sensitivity analysis was conducted, it was found that cost impact was highly sensitive to changes in assumptions around labor reduction from elimination of brand sorting.

*Table 1: Key differences in Beverage Container Deposit Systems between Models 1, 2 and 3*

| | MODEL 1 | MODEL 2 | MODEL 3 |
|---|---|---|---|
| Beverage Containers Included in Deposit / Redemption System | Beer, wine coolers, other malt beverages, pre-mixed spirits cocktails, carbonated non-alcoholic beverages including sodas, sparkling waters and juices, and carbonated sports and energy drinks (5 cent deposit). Liquor and spirits (15 cent deposit). | | All beverages included, except milk, dairy, plant-based beverages, infant formula, meal replacement drinks, and nonalcoholic cider. |
| Containers Requiring Brand Sorting at Point of Redemption | 18% of containers | None, brand sorting at point of redemption is eliminated. | |
| Containers in Commingling Agreement | 82%[1] | 100%[2] | |
| Handling fee | 3.5 cents for commingling; 4 cents for others | No set handling fee. PRO negotiates appropriate compensation for the redemption site which would likely be based on a per container fee[3]. | |
| Convenience Requirements | Retailers are required to take back covered containers of the kind, size, and brand they sell, unless they receive an exemption from the Secretary based on alternate redemption sites that can serve the public need. | • Universal redemption<br>• Minimum of 3 redemption sites per county.<br>• Retailers of 5,000 square feet or more must redeem<br>• Municipalities with populations of 7,000+ must have at least one point of redemption. | |
| Bottle Bill Management | Distributors/manufacturers "Pickup agent" + Dept. of Liquor & Lottery (DLL for liquor | PRO + DLL (for liquor) | |
| Number of Redemption Sites | 123 | 170 | |

1 Redemption Centers that handle more than 250,000 containers per year are required to commingle according to an Agency-approved commingling agreement. Bottle Bill Fact Sheet: Retailers and Redemption Centers. Vermont DEC. (2024, September). https://dec.vermont.gov/sites/dec/files/wmp/SolidWaste/Documents/BottleBillFactSheet-Retailers.pdf. The percentage of containers that are part of the Commingling agreement were provided by Vermont container processors.

2 Given that distributors/manufacturers will need to join and pay the PRO, it is assumed that this would logically go together with electing to being part of the commingling-type agreement.

3 This report does not stipulate a handling fee, which provides the PRO and redemption sites the flexibility for negotiations, which would be useful, for example, in the event of changes in market conditions.

# Comparative Impacts of Bottle Bill Models

For each model, the following were considered:

## 1. MATERIAL DIVERSION RATES:[5]

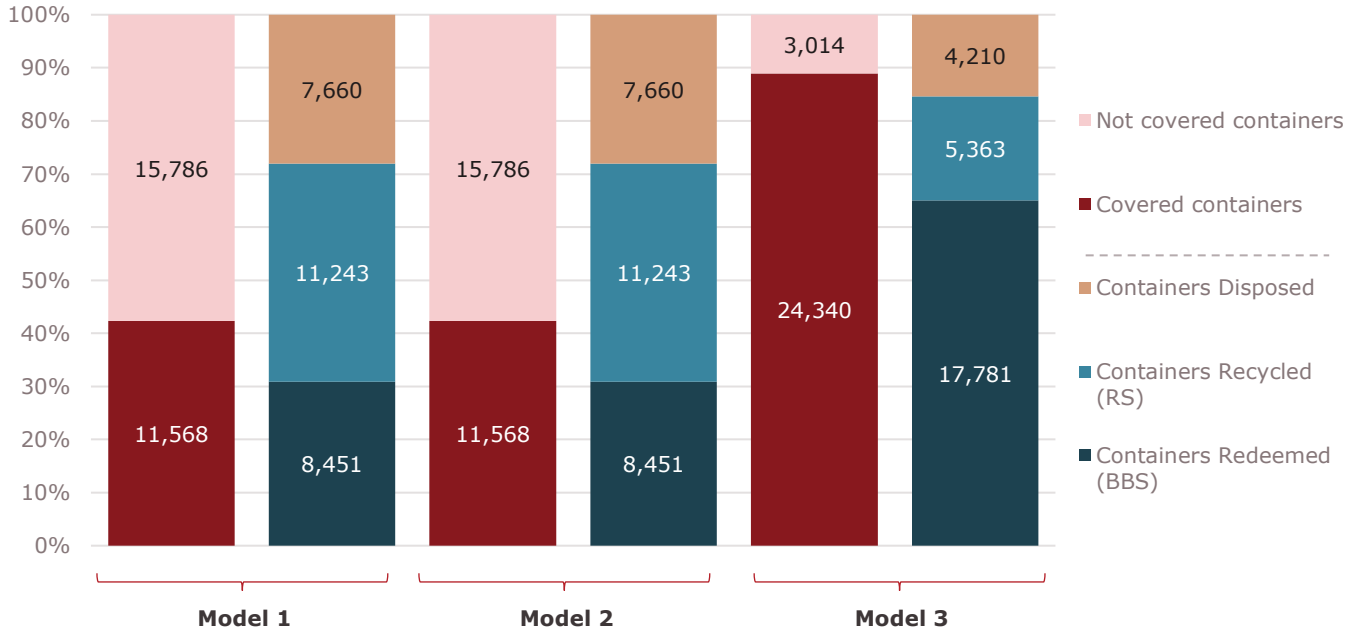
For Models 1, 2A (Bag Drop), and 2B (RVM), the diversion of beverage containers, through both the recycling system and bottle bill system, remain at current levels (see the blue Notation box above for disclaimers and details about why no redemption rate change is projected in Model 2A and B). For Model 3, overall diversion of beverage containers is estimated to grow from 72% to 85% due to the addition of new types of covered containers to the bottle bill program – primarily #1 PET plastic bottles, wine bottles, hard ciders, juice and tea. In Model 3, more containers are covered by the BB, and more are redeemed, but the redemption rate remains the same. This is summarized in Table 2 and illustrated in Figure 1.

*Table 2: Diversion rates for Models 1, 2 and 3.*

| BEVERAGE CONTAINER DIVERSION RATES | | |
|---|---|---|
| MODEL 1: | MODEL 2: | MODEL 3: |
| 72%[4] | 72% | 85% |

Diversion rates for all beverage containers include estimated collection through the recycling system i.e. mandatory curbside and drop off recycling service and programs, as well as the bottle bill system. They include all beverage containers sold in Vermont made of aluminum, glass, PET plastic, or HDPE plastic and, therefore, include containers not currently covered.

*Figure 1: Breakdown of containers by coverage as well as by end destinations (Disposed, Recycled and Redeemed) for Models 1, 2 and 3.*




[4] Depending on the assumptions applied and the data used, calculated beverage container diversion rates for the current system, Model 1, could range widely, due to differences in data sources and methodological approaches. While multiple valid methods exist for estimating diversion, this analysis applies the most reasonable and well-supported assumptions to ensure consistency with Vermont's system. Stakeholders reviewed the methodology and resulting estimates to verify their reliability and alignment with real-world conditions. The findings presented represent the most rigorous and defensible assessment of system-wide impacts, based on the best available data.

[5] "Diversion" means the management of solid wastes through methods other than disposal. In this report, diversion of beverage containers includes redemption through the bottle bill and recycling through the recycling system i.e. curbside + drop-off.

## 2. COSTS

Costs are described across the three models for both the Bottle Bill System (BBS) and the Recycling System (RS) in three ways: 1) system-level cost, 2) cost allocated to beverage containers, and 3) per container cost. This allows for an analysis of the nuanced cost impact of each system. An Overall System (i.e. weighted BBS + RS) per container cost is also presented to quantify the overall efficiency of the container recycling in Vermont.

**Bottle Bill System System-Level Costs and Cost Allocated to Beverage Containers:** Model 1 represents the existing system and has a system-level cost similar to that of Model 2A and Model 2B. Costs of Model 2 are reduced with the elimination of brand sorting and redistributed away from redemption sites when managed by the PRO; however, Model 2 also has an increased number of redemption sites to meet convenience requirements. Model 3 has the highest system-level cost to support the increased container throughput due to expansion. For the BBS, which only collects containers, the system-level cost and cost allocated to beverage containers is the same.

**Bottle Bill System Per Container Cost:** Model 3 is the most cost-efficient on a per container basis, largely due to increased throughput and adoption of a strategic mix of technologies, including bulk RVMs for high-volume redemption centers and a combination of retail redemption RVMs and bag drop options to meet required convenience standards. Should Model 1 meet the same convenience standards required in Model 2 and Model 3, the per container cost is estimated to be $0.059. This is summarized in Table 3.

*Table 3: Bottle Bill System-Level Costs and Per Container Costs for Models 1, 2 and 3.*

| | MODEL 1: | MODEL 2A, Bag Drop: | MODEL 2B, RVM: | MODEL 3, EBB: |
|---|---|---|---|---|
| **BBS SYSTEM-LEVEL COSTS** (excluding latent cost of separate trips taken by consumers to redeem) | **$9.4 million** | **$10.5 million** | **$9.2 million** | **$14.0 million** |
| **BS COST PER REDEEMED CONTAINER** (excluding latent costs of separate trips taken by consumers to redeem) | **$0.050**[6] | **$0.056** | **$0.049** | **$0.040** |

**Recycling System System-Level Costs and Cost Allocated to Beverage Containers:** Costs from curbside collection and drop-off programs change only slightly with the expansion of covered containers under Model 3 and the expected movement of some beverage containers from curbside and drop-off recycling to redemption sites. Most recycling system costs are fixed – such as trucks and recycling facilities – so they will not decrease when containers are recycled through the deposit program instead of the municipal system. They will incur a slight loss of revenue with this shift, resulting in an overall estimated system cost increase of 2%.

[6] Model 1 costs might be 20% higher if there were full compliance.

**Recycling System Per Container Cost:** Models 1 and 2 per container cost are the most cost efficient across both BBS and RS per container costs, while Model 3 is less cost-efficient in the recycling system on a per container basis, largely due to decreased throughput, i.e., more containers collected through the BBS and fewer through the RS.

The Recycling System costs are summarized in Table 4.

*Table 4: Recycling System-Level Costs, Container Costs and Per Container Costs for Models 1, 2 and 3.*

| | MODEL 1: | MODEL 2: | MODEL 3: |
|---|---|---|---|
| **RS SYSTEM-LEVEL COSTS** (all recyclables: paper, cardboard, steel and aluminum cans, glass bottles and jars, plastic bottles and jugs, but excluding latent cost of separate trips taken by consumers to redeem) | **$37.95 million** | **$37.95 million** | **$38.85 million** |
| **RS CONTAINER COSTS[7]** (excluding latent cost of separate trips taken by consumers to redeem) | **$4.25 million** | **$4.25 million** | **$2.20 million** |
| **RS COST PER CONTAINER** (excluding latent costs of separate trips taken by consumers to redeem) | **$0.033** | **$0.033** | **$0.045** |

**Overall System[8] (i.e., Weighted BBS + RS) per container cost:** Model 3 is the most cost-efficient on a per container basis, given the reduction in costs with the elimination of brand sorting, increased efficiencies through technology adoption and management by the PRO, as well as increased overall volume of containers collected. This is summarized in *Table 5*.

*Table 5: Overall Cost Per Container for Models 1, 2 and 3.*

| | MODEL 1: | MODEL 2A, Bag Drop: | MODEL 2B, RVM: | MODEL 3, EBB: |
|---|---|---|---|---|
| **OVERALL COST PER CONTAINER** (excluding latent costs of separate trips taken by consumers to redeem) | **$0.043[9]** | **$0.047** | **$0.043** | **$0.040** |

**Unclaimed Deposits:** Unclaimed deposits reflect a redistribution of funds from consumers who forfeit their deposits to the State. In consideration of financial impact across the system, unclaimed deposits appear as a financial "loss" to consumers and as a financial "gain" to the State, that then funds systems unconnected to the bottle bill. In Model 3, unclaimed deposits increase because the same redemption rates are applied to more beverage types. Since more deposits are received than redeemed for a greater volume of containers, there is a corresponding greater amount of deposits being forfeited and therefore an increase in unclaimed deposits. This is summarized in Table 6.

[7] Includes non-bottle bill covered containers. System-level Cost refers to the total cost, including blue bin recycling collection costs for those that use curbside haulers, as well as the costs for the haulers and facilities to collect, sort, store, transport, and process material for sale or shipment to end markets. Container Cost is the cost allocated to beverage containers, which is used to calculate the cost per container, i.e., System-level Cost multiplied by Beverage Container Tons, divided by Total Waste Tons.

[8] "Overall System" refers to the combined system of both the Bottle Bill System (BBS) and the Recycling System (RS).

[9] Model 1 costs would be 20% higher if there were full compliance. The per container rate would be $0.06 i.e. higher than that of Model 2 & 3.

*Table 6: Unclaimed deposits for Models 1, 2 and 3.*

| UNCLAIMED DEPOSITS | MODEL 1: | MODEL 2: | MODEL 3: |
|---|---|---|---|
| | $3.94 million | $3.94 million | $7.54 million |

**Distribution of Costs:** In Model 1, redemption sites and distributors/manufacturers bear the system cost. In Models 2A/B and 3, the PRO redistributes the cost, ultimately entirely to distributors/manufacturers. Compared to Model 1, the distributors/manufacturers' costs are two times higher in Model 2 and three times higher in Model 3. Given expansion, there is also an increase in unclaimed deposits between Model 1 and 2 compared to Model 3, thereby increasing the cost to consumers who do not redeem. Similarly, expansion causes a cost increase for Municipal Solid Waste (MSW) System Haulers and Processors that collect mandated recyclables including beverage containers. This cost redistribution is illustrated in *Table 7*.

***Although represented as a net zero transaction, the decision not to reinvest the unclaimed deposits within the bottle bill systems is a loss of benefits to distributors.***

*Table 7: Overall Financial Impact by Stakeholder*

| STAKEHOLDER | MODEL 1 | MODEL 2 | MODEL 3 |
|---|---|---|---|
| Consumers | COST | COST | COST MORE |
| State (Unclaimed deposits) | GAIN | GAIN | GAIN MORE |
| Retail redemption | COST | GAIN MORE | GAIN MORE |
| Redemption centers | COST | GAIN MORE | GAIN MORE |
| Distributors/Manufacturers | COST | COST MORE | COST MORE |
| MSW System Haulers and Processors | COST | COST | COST MORE |

## 3. GREENHOUSE GAS EMISSIONS:

Greenhouse gas emissions estimates for beverage containers managed through the bottle bill system and the existing recycling system were developed using EPA's Waste Reduction Model (WARM) and supplemented with additional consumer trip information. Model 2 yields slightly higher environmental benefits than Model 1, primarily due to reduced transportation emissions associated with a higher number of redemption locations. Model 3 provides the most significant environmental benefit (i.e., a greater emission reduction than Models 1 and 2). This 13% greater reduction in emissions is due to increased recovery of materials and reduced contamination in the curbside and drop-off recycling system.

## 4. LITTER:

Litter tonnage estimates are expected to be the same for Models 1 and 2, with a slight decrease in Model 3 because of expansion in covered beverages.

The key metrics and impacts, as elaborated above, are summarized in Table 8.

*Table 8: Key Metrics and Impacts of Models 1, 2, and 3*

| METRIC | | MODEL 1 | | MODEL 2A/B[10] | | MODEL 3 | |
|---|---|---|---|---|---|---|---|
| **1. Resources and Diversion** | **BEVERAGE CONTAINERS REDEEMED BY BBS BY MATERIAL TYPE** | | | | | | |
| Tons % by tons | **Cans** | 2,064 | 24% | 2,064 | 24% | 2,691 | 15% |
| | **Glass** | 5,638 | 67% | 5,638 | 67% | 11,722 | 66% |
| | **PET** | 749 | 9% | 749 | 9% | 2,875 | 16% |
| | **HDPE** | 0 | 0% | 0 | 0% | 493 | 3% |
| | **TOTAL** | 8,451 | 100% | 8,451 | 100% | 17,781 | 100% |
| | **BEVERAGE CONTAINERS COLLECTED BY RS BY MATERIAL TYPE** | | | | | | |
| Tons % by tons | **Cans** | 591 | 5% | 591 | 5% | 148 | 3% |
| | **Glass** | 9,360 | 83% | 9,360 | 83% | 4,680 | 87% |
| | **PET** | 1,110 | 10% | 1,110 | 10% | 444 | 8% |
| | **HDPE** | 182 | 2% | 182 | 2% | 91 | 2% |
| | **TOTAL** | 11,243 | 100% | 11,243 | 100% | 5,363 | 100% |
| | **BEVERAGE CONTAINER DIVERSION RATE** | | | | | | |
| | **Overall diversion rate** | | 72% | | 72% | | 85% |
| | % of containers by BBS | | 43% | | 43% | | 76% |
| | % of containers by RS | | 57% | | 57% | | 24% |
| **2. Costs** | **BOTTLE BILL SYSTEM COSTS** | | | | | | |
| | **BBS system-level cost** (exc) | $ 9,366,280 | | a. $ 10,496,224 | | $ 14,002,337 | |
| | | | | b. $ 9,221,988 | | | |
| | *# Containers Redeemed* | 188,324,041 | | 188,324,041 | | 351,011,408 | |
| | Per-container cost (exc) | $ 0.050 | | a. $ 0.056 | | $ 0.040 | |
| | | | | b. $ 0.049 | | | |
| | Annual Separate Trip cost | $ 2,573,108 | | $ 2,250,684 | | $ 2,250,684 | |
| | **BBS system-level cost** (inc) | $ 11,939,388 | | a. $ 12,746,908 | | $ 16,253,020 | |
| | | | | b. $ 11,472,672 | | | |
| | Per-container cost (inc) | $ 0.063 | | a. $ $0.068 | | $ 0.046 | |
| | | | | b. $ $0.061 | | | |
| | Unclaimed Bottle Bill Deposits[11] | $ 3,939,820 | | $ 3,939,820 | | $ 7,537,845[12] | |

[10] 2A applies Bag Drop technology costs. 2B applies RVM technology costs.

[11] Includes unclaimed deposits retained by DLL.

[12] While redemption rates remain the same (since the deposit amount is unchanged), the expanded coverage results in an absolute higher volume of container deposits being collected, along with a corresponding higher amount of deposits being forfeited when those containers are not redeemed.

| METRIC | | MODEL 1 | MODEL 2A/B[10] | MODEL 3 |
|---|---|---|---|---|
| | **RECYCLING SYSTEM COSTS (CURBSIDE AND DROP-OFF)** | | | |
| | **RS system-level cost; RS container cost** (exc) | $ 37,949,369 | $ 37,949,369 | $ 38,852,556 |
| | | $ 4,247,725 | $ 4,247,725 | $ 2,203,278 |
| | *# Containers Collected* | 127,340,107 | 127,340,107 | 49,477,787 |
| | Per-container cost (exc) | $ 0.033 | $ 0.033 | $ 0.045 |
| | **System-level Recycling (& Refuse) Drop off Separate Trip Cost; Drop off Separate Trip Container Cost[13]** | $ 4,636,935 | $ 4,636,935 | $ 4,636,935 |
| | | $ 109,025 | $ 109,025 | $ 52,003 |
| | *# Containers Collected* | 6,298,687 | 6,298,687 | 2,447,344 |
| | Per-container cost (inc) | $ 0.051 | $ 0.051 | $ 0.066 |
| | **OVERALL SYSTEM COST (BBS + RS)** | | | |
| | Per-container cost (exc) | $ 0.043 | a. $ 0.047 | $ 0.040 |
| | | | b. $ 0.043 | |
| | Per-container cost (inc) | $ 0.058 | a. $ 0.061 | $ 0.049 |
| | | | b. $ 0.057 | |
| **3. Greenhouse Gas Emissions** | **TONS OF CARBON EQUIVALENT AVOIDED BY LANDFILL ALTERNATIVES** | | | |
| | Bottle Bill Metric Ton Carbon Equivalent[14] | (21,134) | (21,134) | (31,108) |
| | Recycling System Metric Ton Carbon Equivalent[15] | (9,244) | (9,244) | (3,158) |
| | Net Total Metric Ton Carbon Equivalent (exc) | (30,074) | (30,074) | (34,108) |
| | Net Total Metric Ton Carbon Equivalent (inc) | (27,631) | (27,924) | (32,011) |
| **4. Litter** | **LITTER** | | | |
| | All Beverage Container Litter (t) | 411 | 411 | 322 |
| **Key** | (t) = tons<br>(all) = all beverage containers | | (exc) = excluding separate trip cost<br>(inc) = including separate trip cost | |

[13] System-level Cost refers to the total cost for separate trip to drop-off refuse and recyclables. Drop Off Separate Trip Container Cost is the cost allocated to beverage containers dropped off for recycling. This is used to calculate the cost per container, i.e., System-level Cost multiplied by Recycled Beverage Container Tons via Drop Off, divided by Total Refuse and Recycled Tons Dropped Off.

[14] Excludes impacts from recycling system, refuse, and separate consumer trips,

[15] Excludes impacts from the bottle bill, refuse, and separate consumer trips.