

## Appendix B: Response Rate, Data Analysis, and Confidence Intervals

Throughout this report, the response rate (or participation rate) is expressed as the *number of survey respondents responding “yes” (such as, participating in a specific behavior) divided by the total number of survey respondents*, unless noted otherwise. This is a reasonable assumption, if the 89% of households responding to the survey have similar behaviors to the 11% of households not responding to the survey. If the survey respondents engage in a behavior at a higher participation rate than the non-respondents, then this approach will slightly over-estimate the total participation. Figures B-1 and B-2 illustrate this point.

In Figure B-1, 223 (82%) of survey respondents claim to be using their compost bins, while the remaining 48 (18%) claim not to be using them. If the 271 survey respondents are representative of the entire population of 303 households, then 82% of all households are using their bin (and 18% are not).

**Figure B-1.**  
**Hypothetical Results, Equal Bin Use Between Respondents and Non-Respondents**

	Survey Respondents	Survey Non-Respondents	All
Number using their compost bin	223	26	249
Number not using their compost bin	48	6	54
Total	271	32	303
% using their bin	82%	82%	82%

But Figure B-2 illustrates an extreme example of where none of the non-responding households are using their bin. In this case, the true participation rate is 74%, which represents the extreme “worst case” scenario. The relatively small spread between results of Figures B-1 and B-2 is due to the exceptionally high response rate to the survey (89%, as described in the report). Because only 11% of households didn’t respond to the survey, even if none (or all) of them are participating in a specific behavior, this don’t have a large influence on the total results one way or the other.

**Figure B-2.**  
**Hypothetical Results, Non-Equal Bin Use Between Respondents and Non-Respondents**

	Survey Respondents	Survey Non-Respondents	All
Number using their compost bin	223	0	223
Number not using their compost bin	48	32	80
Total	271	32	303
% saying “yes”	82%	0%	74%

Throughout this report, confidence intervals are calculated using the normal approximation of the binomial distribution, unless noted otherwise. All confidence intervals are calculated at 95% confidence. With a population size of  $N$  ( $N = 303$ ), a sample size of  $n$  ( $n = 271$  or less, if not all survey respondents answered a specific question), and  $x$  representing the number of “yes” responses to each question, the estimated percentage of “yes” responses is calculated as  $x/n$  and the upper and lower bounds of the confidence interval equals  $x/n \pm 1.96 * \text{SQRT} ([x/n][1 - (x/n)][N - n]/N[n - 1])$ . For example, if 72% of respondents answered “yes” to a certain question, and the confidence interval is 70%-74%, then we are 95% confident that the true percentage of all households answering “yes” *had they responded* would be somewhere between 70% and 74%.

## Appendix C: Methodology for Estimating Total and New Diversion

This Appendix describes in detail the methodology used to estimate total and new diversion resulting from the compost bin distribution program.

There are many different methods that other communities have used to estimate landfill diversion from compost bin distribution programs. Summarizing these methods is beyond the scope of this report, but interested readers are invited to contact the author for additional information if desired (David Allaway, Oregon DEQ, (503) 229-5479, [allaway.david@deq.state.or.us](mailto:allaway.david@deq.state.or.us)).

### **Summary of Methodology.**

The methodology applied in this report is a hybrid approach that draws on the methods used by several other communities. It is far from perfect but should yield a reasonable range of results within which the “true” answer can be found.

First, two different estimates are developed of the total weight of material expected to be placed in City-distributed home compost bins in La Grande in the first year following bin distribution. On-site composting in loose piles or other (non-City provided) bins is not included in these estimates, nor is other on-site management such as grasscycling, mulching, chipping, etc. The first estimate involves using survey results to estimate the total volume (in cubic feet) of material composted, then multiplying this amount by a range of material densities in order to derive a range of estimated weights. The second estimate involves applying participation data from this survey against published national estimates of per-household diversion, again in order to derive a range of estimated weights. Averages from the two low estimates and the two high estimates are used as the low and high estimate of total diversion, respectively.

Next, survey data are analyzed to derive an estimate of the fraction of total materials composted on-site in City-provided bins which is truly “new” diversion. This analysis accounts for materials that were composted on-site prior to bin distribution, as well as materials put into compost bins that, prior to bin distribution, had been managed through some other diversion effort, such as off-site composting. This fraction is applied to the low and high estimate of total diversion (described above) to arrive at a low and high estimate of “new” diversion.

Finally, total diversion over a ten-year period is estimated by estimating attenuation (decay) in bin use over a ten-year time horizon and applying these estimates to the low and high estimates of both total and new diversion in year one, thereby deriving estimates of ten-year diversion totals.

### **Estimate of Total Diversion: Method One.**

This estimate of total diversion starts with responses to Question 7 of the survey. In Question 7, respondents were asked: “Thinking of the size of the City compost bin, please estimate the total amount of material you placed in your bin(s) over the last 12 months”. Respondents were given six options to choose from:

- Less than ½ of a bin.
- ½ to 1 full bin.

- 1 to 1 ½ full bins.
- 1 ½ to 2 full bins.
- 2 to 3 full bins.
- More than 3 full bins.

This may be a very difficult question for respondents to answer accurately. Because materials may quickly begin settling and decomposing when they are first placed in a bin, a typical bin can hold more than its own capacity in loose materials, as long as those materials are placed into the bin over a period of time. For example, a household might begin by filling their bin with loose material. After a month, if this material has settled to a third of its original volume, the household could re-fill the bin with another two thirds of a bin worth of loose material. Repeating this process every month, the bin after six months would be 90% full yet would have had 2.75 “bins worth” of “loose material” put into it. Unless respondents carefully read and understand this question, and understand how much loose material settles, it is expected that they will underestimate the amount of material put into their bin.

Regardless, answers to this question from survey respondents who said that they are using their bin (a year after receipt) were tabulated, using mid-points of the ranges provided. (A household checking the ½ to 1 full bin option was assumed to have put 0.75 bins worth of material in their bin. Households checking “more than 3 full bins” were assumed to average 4 bins worth of material diverted.) Not including results from 5 households who didn’t answer Question 7, the total estimated volume of material placed in bins equals 309 cubic yards (388 bins worth of capacity multiplied by 21 cubic feet per bin).

This result represents a likely “low” end of the range. A higher estimate is derived by adding to the low estimate an estimate of diversion from the five households who claimed to be using the bin but didn’t answer Question 9, as well as a portion of the households who didn’t respond to the survey at all. This higher estimate results in a total estimated volume of 345 cubic yards (444 bins worth of capacity multiplied by 21 cubic feet per bin).

These low and high estimates of volume are then multiplied by low and high estimates of material density. The density of loose yard waste is estimated to be 100–250 pounds per cubic yard, according to estimates published by the National Recycling Coalition. The density of food waste is considerably higher and is estimated at 800 pounds per cubic yard. (This estimate is based on research by the City of Portland [650 pounds/cubic yard, including soiled paper] and primary research conducted by the author, who measured the volume and weight of his household’s compostable food scraps for a year [950 pounds/cubic yard]). According to Figure 13, 55% of households are composting some food scraps, which compares to 91% of households who are composting some yard debris. (Put differently, 60% of all households composting yard debris are composting food waste.)

The average density of mixed materials composted in bins is estimated as follows:

- Average volume of all materials placed in bins: 1.39 cubic yards per household (based on responses to Question 7).
- Average weight of food waste composted by those households composting food waste: 200 pounds/year (this is considerably lower than the 427 pounds/year measured by the author).

- Average weight of food waste composted among all households doing on-site composting (including those not composting food waste): 120 pounds/year (weighted average of 200 pounds/year among 60% of households composting food and 0 pounds/year among 40% of households not composting food).
- Average volume of food waste composted (among all households doing on-site composting): 0.15 cubic yards/year per household (120 pounds/year @ 800 pounds/cubic yard).
- Average volume of yard waste composted: 1.24 cubic yards per household (1.39 total, less 0.15 food).
- Weighted density (low end): 176 pounds/cubic yard (1.24 cubic yards of yard waste @ 100 pounds/cubic yard + 0.15 cubic yards of food waste @ 800 pounds/cubic yard).
- Weighted density (high end): 310 pounds/cubic yard (1.24 cubic yards of yard waste @ 250 pounds/cubic yard + 0.15 cubic yards of food waste @ 800 pounds/cubic yard).

Applying these density estimates to estimated total volumes results in an estimated diversion of 27 tons (309 cubic yards @ 176 pounds per cubic yard) to 54 tons (345 cubic yards @ 310 pounds per cubic yard) of total diversion in the City-provided bins in the first year.

#### **Estimate of Total Diversion: Method Two.**

Perhaps the greatest shortcoming of the first method is that it relies on a highly speculative method of estimating the volume of materials composted. Other communities in the U.S. have conducted more precise estimates using a variety of techniques including on-site scales and diaries and on-route weighing schemes involving control groups. Many of these programs were surveyed in 1995 by the consulting firm Applied Compost Consulting (ACC) on behalf of the U.S. Composting Council. ACC's report, titled "Economic Cost-Benefit Analysis of Home Composting Programs in the United States" notes that among 35 programs surveyed, the average program claims to be diverting 646 pounds/year per household, with a 95% confidence range of 467–825 pounds/year.

These low and high estimates (467–825 pounds/year) of per-household diversion are applied to low and high estimates of bin use in La Grande. The low estimate of bin use is limited to the 223 households who both responded to the survey and said they were still using their bin a year later. A higher estimate of bin use is derived by taking the 82% rate of bin use among survey respondents and multiplying it by the total number of households receiving bins (303), for an estimate of 249 households using the City-provided bins.

These estimates lead to an estimated range of diversion from 52 tons in City-provided bins in the first year (223 households @ 467 pounds per household) to 103 tons (249 households @ 825 pounds per household).

Perhaps the greatest shortcoming of this methodology is that it applies national averages to a community that may be atypical in yard waste generation. La Grande has a shorter growing season than many parts of the country, and its landscaping practices, mixture of grass vs. leaves vs. prunings, and lot sizes may also be different.

### **Combined Estimates of Total Diversion**

The simple average of the low end-points of Method One and Method Two is 40 tons composted in the first year in City-provided bins.

The simple average of the high end-points of Method One and Method Two is 78 tons composted in the first year in City-provided bins.

### **Estimate of New Diversion.**

Not all of this diversion is “new” diversion. A significant number of households using the bins are “free riders”; they were already composting on-site before they received the bins. And households that are new to home composting may simply be shifting materials into their compost bin from methods such as off-site composting or grasscycling that were already diverting the yard wastes from disposal. This report estimates the fraction of total diversion which is new diversion according to the following formula:

$$F_n = [(1/2)B_1 + (2/3)B_2 + (3/4)B_3 + (1/3)B_4 + (1/2)B_5 + (1/4)B_6 + C_1 + wC_3]/[T]$$

Where:

- $F_n$  = Fraction of total diversion that is new diversion
- $T$  = Grand sum of total diversion among all survey respondents using their bins, measured in units of “bins” and estimated in a method very similar to that described in Method One, above.
- $B_1$  = Diversion among free riders who increased the number of yard debris materials composted on-site from one to two (out of a possible maximum of four). This is measured in units of “bins” and estimated in a method very similar to that described in Method One, above. Thus, we make the simplifying assumption that  $\frac{1}{2}$  of the material composted on-site is “new”.
- $B_2$  = Similar to  $B_1$  except these free riders increased the number of yard debris materials composted on-site from one to three (out of a possible maximum of four). Thus, we make the simplifying assumption that  $\frac{2}{3}$  of the material composted on-site is “new”.
- $B_3$  = Similar to  $B_1$  except these free riders increased the number of yard debris materials composted on-site from one to four (out of a possible maximum of four).
- $B_4$  = Similar to  $B_1$  except these free riders increased the number of yard debris materials composted on-site from two to three (out of a possible maximum of four).
- $B_5$  = Similar to  $B_1$  except these free riders increased the number of yard debris materials composted on-site from two to four (out of a possible maximum of four).
- $B_6$  = Similar to  $B_1$  except these free riders increased the number of yard debris materials composted on-site from three to four (out of a possible maximum of four).
- $C_1$  = Diversion among households new to home composting who started home composting without discontinuing any on-site mulching, grasscycling, or chipping, and also without discontinuing any hauling (of any materials) to an off-site composter. As with  $B_1$ , this is measured in units of “bins” and estimated in a method very similar to that described in Method One, above.
- $C_3$  = Diversion among households new to home composting who started home composting and discontinued a combination of a) any on-site mulching, grasscycling, or chipping,

and/or off-site composting and also discontinued b) some combination of burning and/or disposal. Thus, a fraction of the material put into their compost bin, but not 100%, can be conjectured to be new diversion.

w = A weighting factor that gives more credit for new diversion to those individual materials (grass, leaves, etc.) that households stop disposal of without also stopping other diversion-based management, and gives less (but still partial) credit to those materials where households cease both disposal and other diversion-based management.

This very rough estimation method leads to estimate that only 35% of the material put into City-provided compost bins is “new” diversion. The remainder would be materials that were already (previously) composted on-site (by free riders) and materials that were shifted from other types of diversion, including off-site composting, grasscycling, mulching, and chipping.

This 35% estimate is multiplied against the estimate of total diversion (in year one) of 40–78 tons, resulting in an estimate of new diversion of 14–27 tons.

### **Ten-Year Estimate of Diversion.**

This report takes a 10-year horizon for the purpose of estimating total diversion. It is known that use of bins attenuates over time as people move, age, or otherwise stop using their bins. Very few communities have studied participation in bin use several years after bin distribution. One community that has, however, is the City of Seattle. Seattle began an active program to distribute compost bins in the 1980s and has conducted a series of longitudinal surveys since then. The City has concluded that the long-term rate of use of its compost bins is approximately 70%.

Lacking data from other communities, this report assumes that of the bins distributed in La Grande, 70% are still in use during their tenth year. It also assumes that 82% of bins are used during their first year (see Figure 2) and that use ramps down between years one and 10 (with decreases greater in earlier years and smaller in later years). This leads to a 10-year multiplier of 9.2. Expressed differently, the cumulative amount of material diverted in years one through ten averages 9.2 times the amount diverted in the first year (when participation is 82%).

Applying this multiplier to the year one estimates above leads to ten-year cumulative estimates of 127–250 tons of new diversion, and 363–716 tons of total diversion, through the City-provided compost bins.