Comparing Prevention, Recycling, and Disposal

A supplement to DEQ's "Life Cycle Assessment of Drinking Water Delivery Systems: Bottled Water, Tap Water, and Home/Office Delivery Water"

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DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

Examining the waste management hierarchy

Oregon law (ORS 459.015) establishes a "hierarchy" of preferences for managing solid wastes. Reducing waste generation (sometimes called "waste prevention") is the top priority, followed by reuse. Only after prevention and reuse are maximized does the hierarchy turn to recycling. At the bottom of the hierarchy (after composting and energy recovery) is the least preferred option – disposal.

Oregon has made excellent progress at increasing recycling. In contrast, progress at prevention and reuse has been uneven. One reason may be that many Oregonians consider recycling and prevention to be comparable.

A study commissioned by DEQ sheds some light on the environmental impacts and benefits of prevention and recycling relative to disposal. The study is a Life Cycle Assessment (LCA) of different methods of delivering drinking water to Oregon households. Included in the study are several different scenarios for delivering water in bottles, as well as several different scenarios for delivering water via the tap. The full study can be downloaded at www.deq.state.or.us/lq/sw/wasteprevention/drinkingwater.htm.

Life Cycle Assessment

Life Cycle Assessment is an evaluation of the environmental burdens and impacts over the entire life cycle of a product or service. DEQ's LCA of Drinking Water Delivery Systems follows International Standards Organization (ISO) standards for LCA methodology. It evaluates energy and materials used, and solid wastes, atmospheric emissions and waterborne emissions over the entire life cycle of consuming water in single-serve bottles as well as from the tap.

The life cycle of **tap water** includes producing energy that is used in water pumping, treatment and distribution; producing materials such as aluminum and glass that are used to create drinking cups and reusable bottles; washing the cups and bottles periodically; and disposing of or recycling them at the end of their life.

The life cycle of **bottled water** includes producing energy that is used in manufacturing and transportation; producing materials such as PET (polyethylene terephthalate) plastic and corrugated cardboard that are used to package drinking water; water pumping, treatment and distribution; retail and consumer transport; and disposing or recycling the packaging at the end of its life.

DEQ's study reports energy use as well as nine different impact categories over the life cycle: acidification potential, carcinogenic potential, ecotoxicity potential, eutrophication potential, global warming potential, non-carcinogenic potential (chronic health impacts other than cancer), ozone depletion potential, respiratory effects potential and smog potential. Each provides a different measure of the potential impacts on human health and/or the natural environment.

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Definition of three systems

DEQ's study contains a large number of different subscenarios (forty-eight). For the purpose of this supplemental report, we define three scenarios as follows:

Purchase + Disposal involves the purchase of water in a half-liter plastic bottle that weighs 13.3 grams. The bottle is made from PET plastic and contains no recycled content. The water originates from a municipal (tap water) supply and undergoes additional treatment (reverse osmosis, ozone treatment and ultraviolet treatment) by the bottler. The bottled water is transported 50 miles to a retail location. The consumer travels 5 miles to purchase the bottled water along with 24 other items. After use, the bottle is disposed of via an Oregon-specific mix of landfilling and incineration. Some secondary packaging (such as corrugated paper) is recycled; the remainder is disposed of. The environmental burdens and benefits of recycling are shared between the packaging user and the subsequent user of recycled materials using a "shared allocation" approach. Results for this scenario are extrapolated from Scenarios 1 and 22 in the full report.

Purchase + Recycle is exactly the same as "Purchase + Disposal" except that the bottle is recycled at the end of its life. Consistent with secondary packaging, the environmental burdens and benefits of recycling are shared using a "shared allocation" approach. Results for this scenario are extrapolated from Scenarios 1 and 22 in the full report.

Waste Prevention involves drinking water from the tap. We assume that the water is consumed from a container that represents a simple average of a 20-ounce reusable aluminum bottle, a 32-ounce reusable PET bottle, and a 27-ounce reusable steel bottle. The composite/average bottle is filled and water is consumed once per day; the bottle is then washed in a home dishwasher (daily) that is run full but uses an unusually large quantity of hot water (14 gallons per load). After a year, the reusable container is disposed of (no recycling). Results for this scenario are a simple average of Scenarios 26, 27 and 28 in the full report.

Comparison of disposal, recycling and prevention

Figure 1 compares the environmental impacts of these three systems. Results are normalized for each impact category so that "purchase + disposal" is assigned a score of 100%. Scores lower than 100% indicate lower impacts (compared to purchasing and disposing). When comparing the three systems, it is important to understand that small differences are not meaningful.

Figure 1 illustrates that recycling, rather than disposing, water bottles offers modest reductions in energy consumption (~26% savings) and greenhouse gas emissions (~16% savings). However, other impact categories are not changed enough to illustrate meaningful benefits (or impacts) from recycling.

In contrast, drinking water from the tap, even with frequent washing of a reusable bottle in an unusually water-intensive home dishwasher, reduces life cycle energy consumption by ~85% and greenhouse gas emissions by ~79%. Further, reductions on the order of 72% to 96% are observed in all other impact categories.

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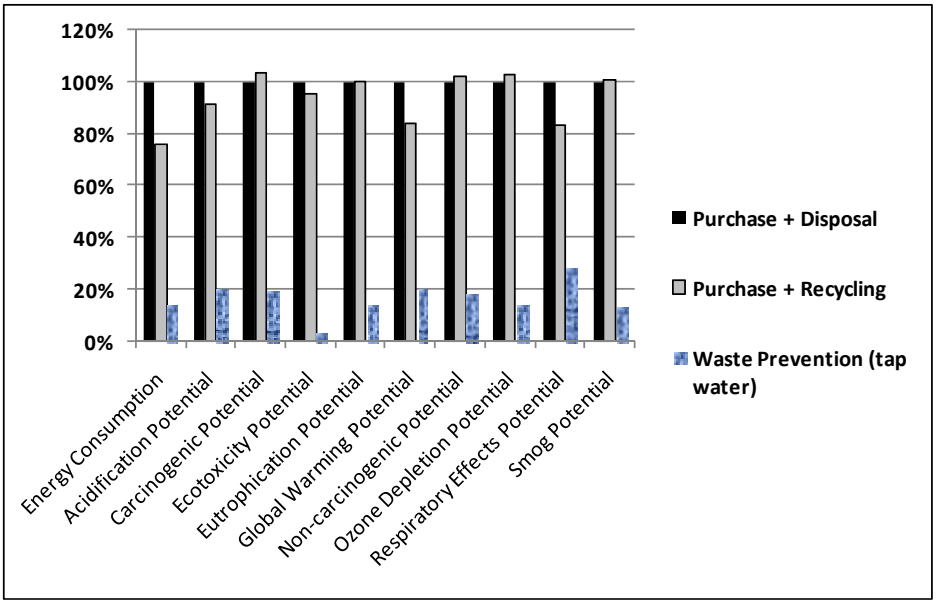
Figure 1.
Comparison of Disposal, Recycling and Prevention



It should be noted that the "purchase + disposal" and "purchase + recycle" scenarios involve water that is transported over relatively short distances. When water is shipped longer distances (for example, spring water from Maine, France, or Fiji), environmental impacts are substantially higher. Recycling does nothing to reduce these added impacts. So for bottled water shipped long distances, the life cycle benefits of recycling (relative to disposal) are even smaller than shown in Figure 1, and the life cycle benefits of prevention (relative to disposal and recycling) are even larger than shown in Figure 1.

"Best Case" Comparisons

Figure 1 illustrates what might be considered to be "reasonable midpoints." Bottled water may be more or less impactful than shown in Figure 1, as could tap water. It is illustrative to compare a reasonable "best" case for recycling vs. prevention. This is particularly important as some water bottlers have been promoting the environmental benefits of package lightweighting (using less plastic) and use of recycled content. A super lightweight bottle with recycled content could be considered a "best case" relative to current bottles.

Figure 2 compares a "best case" scenario for recycling against a "best case" scenario for prevention.

Best Case Purchase + Recycling corresponds to Scenario 23 in the LCA report. It involves an ultra-thin PET bottle (9.8 grams; not currently available in Oregon) made from PET containing 25% recycled content. The bottle is molded with low molding energy. Its cap is also lightweighted and the bottles are packaged without the use of corrugated paper. The water originates from a natural source (a spring) and undergoes only ultraviolet treatment. The bottled water is transported a mere 20 miles to a retail location. No impacts are associated with consumer travel to buy the water. After use, the bottle is recycled at a rate of 100%. The environmental burdens and benefits of recycling are allocated using a "producer credit allocation," in which the bottle user gets all of the credit for avoiding the need to produce more virgin material (and the subsequent user of the recycled PET gets no credit). This allocation approach maximizes the apparent benefit of recycling at a high rate.

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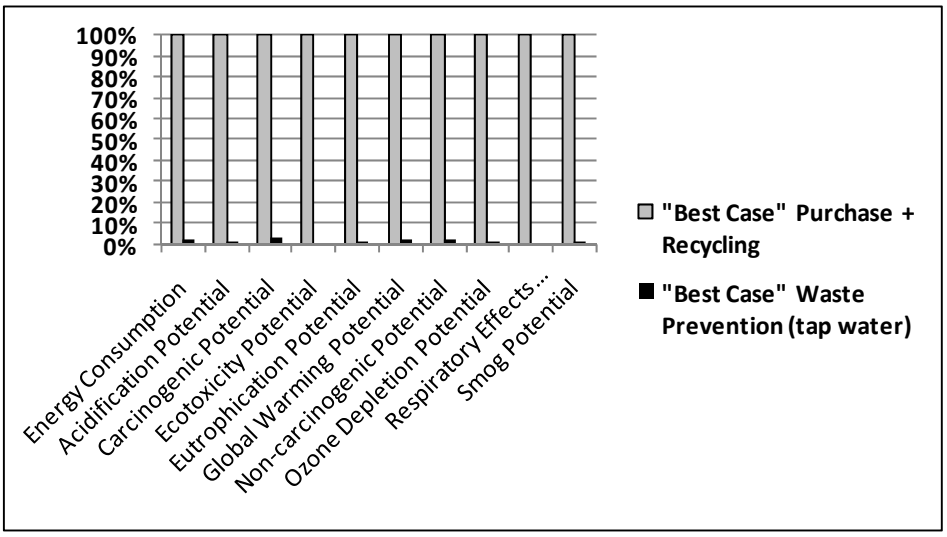
Best Case Waste Prevention corresponds to Scenario 37 in the LCA report. It involves drinking tap water in a refillable 32-ounce bottle made from virgin PET. The bottle is filled and water is consumed twice a day for a week before the bottle is washed in a home dishwasher that is run full and uses lower quantities of hot water (4 gallons per load; there are home dishwashers on the market that use considerably less). The bottle is used for five years, and then disposed of. Note that this "best case" for waste prevention involves no recycled material and no recycling, but does minimize the quantity of material used via long-term reuse of a single bottle.

When comparing these "best case" scenarios against each other, the waste prevention option has environmental impacts that are 97.0% to 99.7% lower than the impacts of purchasing and recycling water bottles. It should be noted that the "best case" waste prevention option is currently achievable, but the "best case" purchase and recycling option is not (such bottled water is not currently sold in Oregon).

Figure 2.
Comparison of "Best Case" Recycling and "Best Case" Prevention



Findings are Consistent with Other Studies

The benefits of recycling, and the superior benefits of prevention, have been documented in other studies as well. For example, DEQ's life cycle analysis of e-commerce order fulfillment packaging (www.deq.state.or.us/lq/pubs/docs/sw/packaging/lifecycleinventoryshort.pdf) compares the environmental burdens of shipping non-breakable items in recyclable corrugated cartons against a wide variety of shipping bags. All of the shipping bags weigh considerably less (waste prevention), but many are difficult to recycle. That study concludes that all of the shipping bags have considerably lower environmental burdens than the boxes in almost all categories studied. In other words, when viewed from the perspective of the catalog or e-commerce retailer, waste prevention (lighter packaging) correlates better with reduced environmental impact than recyclable or recycled content packaging.

Similar results have been found in other evaluations. Section 5.2 of this report (www.deq.state.or.us/lq/pubs/docs/sw/WPSBkgd02.pdf) provides several additional examples.

Conclusions

The basic conclusion of this supplemental analysis of drinking water is that the waste management hierarchy of "prevent first, *then* recycle" accurately reflects preferred approaches for

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reducing environmental impacts. Recycling offers moderate reductions in greenhouse gas emissions and energy consumption over the life cycle of the systems evaluated. Prevention offers much larger reductions in energy consumption and greenhouse gas emissions, as well as a host of other environmental and human health impacts. Consumers wanting to protect the environment should be encouraged to "prevent first, *then* recycle."

Alternative formats

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DEQ-DC1