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Measuring & Ranking Sustainability of Resource and Product Use at the Washington State Department of Ecology's Lacey Headquarters Facility

by
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This article describes three different methods for measuring the "ecological footprint" of operations during 2000 in and from the Washington State Department of Ecology's Lacey headquarters facility, and reports the quantitative results of using these three tools to actually measure and rank ecological impacts caused by, and associated with, Ecology's current footprint. The team that conducted this assessment was guided by the objective of applying a "sustainability lens" and straightforward, science-based analytical tools to quantify and rank ecological impacts.

Overview of Three Different Methodologies for Measuring and Ranking Ecological Impacts

The footprint assessment and impacts rankings detailed in this section are based on three different methodologies for measuring ecological impacts from using resources, products and services. Sustainability concepts inform the three different methodologies because all three look beyond just immediate environmental impacts, to take both upstream and ongoing future impacts into account. The three methodologies (to varying extents) not only examine the here and now impacts of, for example, driving Ecology's fleet vehicles or using natural gas to heat the headquarters facility. In addition, they examine the upstream impacts associated with extracting material and energy resources to provide fuel for the fleet vehicles and natural gas for heating, ventilation and cooling (HVAC) systems. All three also to varying extents account for ongoing future impacts of activities, such as the impact on ecosystems from building and maintaining roads that are used by Ecology's fleet vehicles.

Please note: Some aspects of sustainability are more difficult to quantify, and are not currently reflected in these or any other available quantitative tools. Users of these tools as well as readers of this report need to recognize these caveats:

- The more difficult to measure aspects of sustainability such as biodiversity and ecosystems productivity (i.e., the services of natural capital) are not factored into the assessment and rankings. This is one area where future work on these quantitative tools may yield improvement. Our working assumption is that the mainly human-health-based indicators of environmental impact used by the three methodologies may provide a reasonable basis for decision-making most of the time, since human health is one important indicator of ecosystem health. However, users of currently available tools for assessing ecological impacts will need to exercise good judgment if pollutant releases or other ecological disturbances ranked low in an assessment appear to have high impacts on biodiversity or ecosystem productivity (e.g. on habitat for and health of wild salmon).
- Social aspects of sustainability, such as accessibility for all beings to the means to lead productive and fulfilling lives, are virtually ignored in the available tools, and therefore do not weigh in the relative ranking of impacts. Available science-based analytical tools provide little guidance on how to measure and factor in social impacts, and offer no widely accepted methods for comparing

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more success on one social indicator against less success on another. Again, users will have to utilize good judgment if impacts ranked low by these tools appear to have high impacts on social aspects of sustainability.

The three methodologies are often referenced in this report as Method 1 or M1, Method 2 or M2, and Method 3 or M3. To account for ecological impacts and the economic costs of these impacts, each of these methods uses quantitative models that have come into mainstream use in economics over the past half-century. Some of these quantitative models – such as the input-output models used to sum up releases of pollutants into the environment as a result of the interindustry flow of material and energy resources through the economy in order to produce a particular good or service for final consumption – are based on widely accepted economic models. Others – such as models for estimating the economic cost of environmental releases – are not as widely accepted, or at least the results of their use are controversial, because these models at times yield widely divergent results. Each of the three methods makes use of one or more of the three steps involved in a complete Life Cycle Assessment (LCA) – life cycle inventory (LCI), environmental impacts assessment (EIA), and economic valuation (EV) of environmental impacts.

The LCI step of an LCA attempts to measures all releases of pollutants to air, water and land, as well as disturbances to ecological systems, which result from:

- o Resource extraction and production of goods and services.
- o Actual use of the product or service.
- o Management of wastes generated after the product or service is used up.

The EIA step provides an analysis of the environmental/ecological impacts caused by pollutant releases. The EV step attempts to impute a dollar figure for the cost of each impact. All three steps – LCI, EIA and EV – are necessary if one wishes to, say, quantitatively compare the monetary value of reduced emissions against the cost of some up front investment that yields those reduced emissions, to site just one example of the usefulness of having estimates of the monetary cost for each environmental impact.

The project team investigated ecological impacts for eleven different groups of products and services used at Ecology's Lacey headquarters – (1) electricity, (2) gasoline, (3) natural gas, (4) paper, (5) office supplies other than paper, (6) commercial printing, (7) computers, (8) computer printers, (9) furniture, partitions and other furnishings, (10) water consumption and sewerage, and (11) building and grounds maintenance. The project team applied each of the three methods to as many of these eleven product/service groupings as was possible given the LCA data available under each method.

Method 1 (Limited LCA) – Method 1 involved the use of life cycle inventory (LCI) data in combination with environmental impact assessment (EIA) and economic valuation (EV) estimates for a limited number of pollutant releases. The LCI data are from US EPA's five-year project to develop a decision support tool (DST) for solid waste management. That study reports emissions for 27 pollutants[1] for both upstream and end-of-life recycling or disposal components in the life cycle of seventeen particular products.[2]

Under Method 1 LCI data are available to measure emissions of ten air pollutants, seventeen water pollutants, and generation of indus-

[1] This number counts the emission of the same chemical substance, e.g., lead, to both air and water as two pollutants.

[2] Research Triangle Institute, Franklin Associates, Roy F. Weston, North Carolina State University, and University of Wisconsin-Madison, *A Decision Support Tool for Assessing the Cost and Environmental Burdens of Integrated Municipal Solid Waste Management Strategies*, US EPA National Risk Management Research Laboratory, forthcoming 2002. Further information about this study is provided in *The Monthly UnEconomist* for April 2001.

trial solid wastes during resource extraction, refining and product manufacturing for four of the eleven product/service groupings -- (1) resource extraction and generation of electricity, (2) resource extraction and production of gasoline and its consumption in driving (although no LCI data were available for waterborne emissions generated during driving), (3) resource extraction and production of natural gas and its combustion[3], and (4) resource extraction and production of paper. LCI data are not available for the other seven groupings of products/services -- (5) office supplies other than paper; (6) commercial printing; production or use of (7) computers and (8) computer printers; production of (9) furniture, partitions and other furnishings; (10) water consumption and sewerage; and (11) building and grounds maintenance.

EIA/EV estimates for emissions impacts are available from the literature on life cycle analyses. The project team used low and high estimates found in that literature to provide lower and upper bounds for the economic cost of pollutant releases.[4] While the economic valuation for releases of industrial solid wastes did to some extent take into account impacts of those releases on land based ecosystems, for the most part economic costs cited in the life cycle analysis literature are derived from estimates of the impact of pollutants on human health or from estimates of the economic cost of technologies used to attain regulatory limits on pollutant emissions.[5]

Method 2 (UCS) – Method 2 involved the use of calculations published in the study for the Union of Concerned Scientists (UCS) by Michael Brower and Warren Leon, *The Consumer's Guide to Effective Environmental Choices*, in order to compute seven indicators of environmental impact:

- (1) Releases of greenhouses gases.
- Releases of (2) common and (3) toxic pollutants to air.
- Releases of (4) common and (5) toxic pollutants to water.
- (6) Habitat alteration from water use.
- (7) Habitat alteration from land use.

In addition to impacts from resource extraction and manufacturing of goods and services, the UCS method also attempts to evaluate impacts from product and service use, with appropriate adjustments in cases such as hot water use where the impacts from energy to heat water are counted only in the energy for utility services categories, and not the water category, to avoid double counting. Thus, the UCS method is in principle more comprehensive than Method 1. In addition, data are available from the UCS study to measure all but commercial printing among the eleven product and service groupings whose use at Ecology's Lacey headquarters facility characterize that facility's impacts from resource and product/service use.

Method 3 (EIO-LCA) – Method 3 involved the use of calculations available online (www.eiolca.net) from Carnegie Mellon's Green Design Initiative "Economic Input-Output Life Cycle Assessment model" to compute six indicators of environmental impact:

- (1) Releases of greenhouse gases.
- Releases of (2) common and (3) toxic pollutants to air.
- Releases of (4) toxic pollutants to water.

[3] Emissions data were available for combustion of natural gas in the generation of electricity. Data for on-site combustion to generate heating and cooling were not available, so the emissions from using natural gas to generate electricity were used instead. As a result, these emissions data likely underestimate actual emissions from combusting natural gas on site at Lacey headquarters due to absence of acid gas scrubbers, baghouses, and other equipment often used at power plants to control pollution.

[4] See Table 3, Economic Valuation of Atmospheric and Waterborne Emissions ($ per pound), in "Evaluating Externalized Costs in the Management of Discards," in *The Monthly UnEconomist* for April 2001

[5] The reader should understand that the releases measured by LCI data are the pollutant releases that occur after the emitter has complied with regulations. Thus, these releases are "allowed" because the total release is below the emitter's regulatory limit for releases of a particular pollutant.

- (5) Untreated discharges of water used for resource extraction and production.
- (6) External costs of estimated damages resulting from air emissions of conventional pollutants and greenhouse gases.

The Carnegie Mellon EIO-LCA method only assesses resource extraction and manufacturing impacts for a product or service. It does not assess impacts from actual use of the product or service. Data are available under Method 3 to measure resource extraction and production impacts for all eleven product and service groupings.

Impacts Assessment and Ranking

Table 1, Lacey Facility & Operations Environmental Impacts Measured by LIMITED LCA (M1), UCS (M2), and EIO-LCA (M3) Methodologies, summarizes and compares measurements of ecological impact by these three methodologies. The table reports impacts that result from consumption of electricity, natural gas, paper, office supplies other than paper, commercial printing services, computer printers, computers, office furnishings, and water/sewerage at Lacey, as well as impacts from building and grounds maintenance and from driving passenger cars and light trucks in order to carry out Ecology's missions.

The table reports eight different categories for measuring environmental impacts for each product/service grouping –(a) external costs, (b) greenhouse gas emissions, (c) emissions of common air pollutants, (d) emissions of toxic air pollutants, (e) emissions of toxic water pollutants, (f) emissions of common water pollutants, (g) impacts of water use on habitat, and (h) impacts of land use on habitat.

The three methodologies do not all provide a measure under each category, as indicated by the absence of an M1, M2 or M3 in the rows under four of the eight categories. Nor do all three methodologies provide a measure for each of the eleven product and service groupings, as indicated by the "no data" entry in some cells of Table 1. Nevertheless it is instructive to note and compare rankings and magnitudes for those cells that contain data in Table 1.

Electricity consumption *is the highest impact product/service at Lacey in eleven of the twenty combinations of impact category and measurement methodology shown in Table 1. Electricity ranks second in another two of the twenty. Furthermore, for those categories in which electricity ranks number 1, electricity's impact is between 1.1 and 9.6 times greater than the impact of the second ranking product or service grouping.*

Computer purchases and fuel consumption from driving *come in as somewhat distant seconds. Computers rank first in four of the twenty impact category-measurement method combinations, while driving ranks first in three. Each garners six second place rankings.*

Paper consumption *gets two firsts, and in combination with commercial printing four seconds. Building and grounds maintenance gathers two seconds, due to its impacts on water and water-based habitat.*

Natural gas, office supplies other than paper, computer printers, office furnishings, and water & sewerage fall far below the above leaders in all categories, except for water use, which has substantial impacts on water-based habitat and from emissions of common water pollutants.

These rankings exhibited in Table 1 indicate clearly that ***electricity use, consumption of fossil fuels and lubricants in driving, computers, and paper use are the high impacts activities, with building & grounds maintenance activities and water use/sewerage discharges also providing serious impacts on water quality and water habitat.*** These are the areas that need to be addressed first in Ecology's planning efforts and actions to reach sustainability within twenty-five years.

As a caveat it also should be noted with respect to building and grounds maintenance that

Ecology's reported emphasis on use of non-toxic and biodegradable cleaning agents and pest controls may already mean that actual impacts are substantially less than those portrayed by the estimates in Table 1 for year 2000 activities. All three measurement methodologies are based on emissions and impacts for the average user of cleaning agents and pest controls. To the extent that Ecology is below average in use of toxics and non-biodegradable agents, the impacts data listed in Table 1 significantly and substantially overestimate actual impacts at Lacey headquarters. Furthermore, the UCS and EIO-LCA methodologies are based on data that is at least six years old, and even the average as measured by the UCS and Carnegie Mellon models has probably decreased in terms of intensity of use of toxic and non-biodegradable agents.

Consistency & Differences in Impact Measurements

Table 1 reveals surprising consistency in ranking among the three models. The minor inconsistencies exhibited in Table 1 are in some cases due to differences in what portion of a product/service's life cycle is covered by the methodology. For example, in the UCS model (M2) impairment of land habitat from driving includes use of land space for roads, as well as impacts from extraction, refining and consumption of petroleum products, whereas the LIMITED LCA (M1) model does not capture habitat/biodiversity impacts of roadways and parking lots.

Some of the differences between numerical magnitudes reported for the same impact under the three methodologies are also due to which particular pollutants are included in each impact category. The particular pollutants and other impacts measured by each method in each category are, as follows:

1. External Costs – Used in M1 to summarize impacts of releases to the atmosphere of ten air pollutants (total particulates, NOx, non-CH4 hydrocarbons, SOx, CO, CO2, NH3, Pb, CH4, and HCL), releases to waterways of seventeen water pollutants (dissolved solids, suspended solids, BOD, COD, oil, H2SO4, Fe, NH3, Cu, Cd, As, Hg, phosphate, Se, Cr, Pb, and Zn), and releases to land of industrial solid wastes. Used in M3 to summarize impacts of releases to the atmosphere of greenhouse gases (CO2, CH4, N2O and CFCs) and conventional air pollutants (PM10, SO2, CO, NO2, VOCs, and Pb). M2 does not provide estimates of dollar costs to weight impacts across its seven categories.
2. Greenhouse Gases – M1 includes just CO2 and CH4, although M1 weights CH4 by 21 instead of the 11 multiplier used in M3. M3 includes N2O and CFCs in addition to CO2 and CH4.
3. Common Air Pollutants – M1 includes total particulates, NOx, SO2, and non-CH4 hydrocarbons. M2 includes PM2.5, NOx, SO2 and VOCs. M3 includes PM10, SO2, CO, NO2, VOCs, and Pb.
4. Toxic Air Pollutants – M1 includes non-CH4 hydrocarbons, lead and hydrochloric acid. M2 includes 188 toxics listed in the 1990 Clean Air Act Amendments. M3 includes air pollutants called out in EPA's Toxics Release Inventory.
5. Toxic Water Pollutants – M1 includes heavy metals, H2SO4 and NH3. M2 includes water pollutants called out in EPA's Toxics Release Inventory, as well as pesticides. M3 includes water pollutants in EPA's Toxics Release Inventory.
6. Common Water Pollutants – M1 includes dissolved solids, suspended solids, and BOD. M2 includes nutrients, suspended solids, sediments, and BOD. M3 does not have a common water pollutant category.
7. Water Habitat – M1 does not include a measure for water habitat impairment. M2 uses water consumption (as opposed to water withdrawals) as a rough measure of threat to aquatic habitat. For purposes of Table 1 we used the M3 model's estimates for discharges of untreated water as a measure of water habitat threat.

8. Land Habitat – M1 uses an economic cost estimate for the impacts of industrial solid wastes generated during resource extraction, refining and product manufacturing that are released to the land. This economic cost estimate is based 95% on threats to biodiversity and ecological productivity, and 5% on mineral resource productivity loss. M2 calculates threats to land habitat based on US Forest Service data that associates number of endangered plant and animal species with various land use activities, combined with data on number of acres of land devoted to each use. M3 does not have an output series that is easily associated with threats to land habitat, although one might consider that model's estimates of fuels, ores and fertilizer use as an approximate indicator of threats to land habitat.

Discussion of Weighting Schemes

The UCS study (M2) measured environmental impacts in seven different categories using input-output tables to measure resource extraction and production impacts, and life cycle studies to account for impacts from actual use of various products and services by households. In order to deal with the fact that different products and services ranked differently in these seven different categories, the UCS study reviewed two comprehensive risk assessments – one reported in a 1990 EPA document *Reducing Risk: Setting Priorities and Strategies for Environmental Protection*, Report of the Science Advisory Board to William K. Reilly, Administrator; and the other in a California Comparative Risk Project document *Toward the 21st Century: Planning for the Protection of California's Environment*, Summary report, Submitted to the California Environmental Protection Agency. Based on these two documents, the UCS study ranked the leading consumption-related environmental problems in descending order of import as air pollution, global warming, habitat alteration and water pollution.

However, the UCS study did not take the final step of providing a quantitative index for adding up or comparing impacts across the seven different categories. Instead, The UCS study provides a table that highlights for each product or service grouping of household expenditures whether a particular product or service grouping has more than twice the average impact in a category or more than five times the average impact. Thus, readers of the UCS study are left with the task of deciding whether a product ranking high in, say, toxic air pollution is more or less of a problem than a product ranking high in, say, common air pollution.

By contrast the LIMITED LCA model (M1) does provide a summary index of total impact for the pollutants included in the LCI, as shown in Table 1 under the external costs category. The Carnegie Mellon model (M3) also provides a summary impact index, but just for releases of greenhouse gases and conventional air pollutants. Both M1 and M3 calculate their summary indices by using estimates of the economic cost from impacts caused by releases of each pollutant to weight the quantity of each pollutant released. The results are reported in the external cost category shown in Table 1.

In the case of model M1 these estimates of impact cost for each of the ten atmospheric pollutants, seventeen waterborne pollutants, and industrial solid waste are added together to yield the estimates of external cost shown in the first row of Table 1 for each of the eleven Lacey activities. If one is confident that estimates of economic cost are accurate indicators of relative impact for each pollutant, then these estimates of total cost for impacts provide a very convenient index, both for comparing impacts among the eleven activities and for deciding how much should be spent to reduce impacts from any one or all eleven activities.

The LCI measurements for M1 reported in Table 1 in five of the physical release categories (Greenhouse Gases, Common Air Pollutants, Toxic Air Pollutants, Toxic Water Pollutants, and Common Water Pollutants) listed below the External Costs category are based on LCI data supplied to Ecology by Research Triangle Institute and US EPA for use in Ecology's study of internal and external costs of solid waste management systems and methods. That study was conducted early in 2001 as part of the process of producing a series of issue papers to help scope the currently ongoing process to update the Washington State Solid Waste Plan. This inventory of pollutant release data is combined with estimates of external economic costs for pollutant releases to yield the summary external costs reported for M1 in the External Costs impacts category in Table 1.[6]

That summary measure includes an estimated cost for releases of industrial solid wastes in addition to costs for the ten air and seventeen waterborne pollutants. The estimated cost for industrial solid wastes is also reported separately in the Land Use Impacts on Habitat category shown in Table 1.

Those who are not so confident that estimates of economic cost for pollutants are reliable indicators of relative impact have to resort to some other ranking methodology, whether explicit or implicit, in order to judge which of Lacey's eleven activities should be addressed first. Categorization of pollutant releases into categories of physical releases such as those shown in Table 1 is one way to add up different pollutants. In the case of greenhouse gases the pollutants are weighted according to their relative impact on global warming. The resultant global warming index is often expressed as tons or metric tons of carbon dioxide or carbon equivalents. Similar indices have been developed for acidification of the air and eutrophication of water bodies to summarize these two impacts from releases of certain pollutants to the air or water, respectively. However, the project team did not use these two indices in our assessment of Ecology's ecological footprint.

Data reported in other categories of releases shown in Table 1 - in particular, Common and Toxic Air Pollutants, and Common and Toxic Water Pollutants – are simply the result of adding up quantities released for the pollutants included in each category. This is somewhat unsatisfactory in that, for example, releases of lead and mercury to air are added together under the Toxic Air Pollutants category without regard for whether one has more damaging impacts than the other. At the same time, toxics are separated from common pollutants in order to reduce the inaccuracies from adding up physical quantities of dissimilar chemicals.

Finally, the Carnegie Mellon model (M3) also provides a summary estimate of total impact cost, but only for conventional air pollutants and greenhouse gases. The decision to limit the monetary cost estimates to just these two impact categories is likely due to the difficulty of obtaining widely accepted estimates of economic cost for impacts caused by releases of the large number of air and water pollutants included in EPA's Toxics Release Inventory. By contrast the LCI literature provides numerous studies that estimate economic costs for the small number of pollutants in the conventional air and greenhouse gas categories.[7]

The discussion in this section also motivates a final comment on the data underlying all three methodologies. Estimates for emissions of each

[6] Sources for estimates of economic cost for pollutant releases to the atmosphere and waterways that were used to calculate external costs reported in the external costs and land use impacts on habitat categories listed in Table 1 for Method 1 are detailed in Table 3, Economic Valuation of Atmospheric and Waterborne Emissions ($ per pound), in "Evaluating Externalized Costs in the Management of Discards," *The Monthly UnEconomist*, Vol. 3, No. 4, April 2001, available online at www.zerowaste.com.

[7] The user of the Carnegie Mellon model is asked to contact Carnegie Mellon for further details on the actual dollar costs assigned to each greenhouse gas and common air pollutant included in that external cost estimate. External cost rankings of Lacey activities using M3 agree exactly with ranks for M1 for the four Lacey activities that were measured under both methodologies, as shown in Table 1, so the unknown economic cost weights used in the Carnegie Mellon model may be similar to the cost weights used in Method 1. At the same time, Method 1 includes waterborne emissions and industrial solid wastes in its calculation of external costs, while the Carnegie Mellon model does not, so the similarity in rankings may just be coincidental.

pollutant for each product or service produced, as well as estimates of the economic costs imposed by those emissions, are not easily developed. Different researchers often come up with quite divergent results. Developments in technology, environmental regulations, and a host of other factors constantly change estimates of emissions rates and economic burdens imposed by those emissions both over time and among different geographic locations. Thus, it is important to regard the data shown in Table 1 as indicators rather than precise estimates.

Table 1

Lacey Facility & Operations Environmental Impacts

Measured by Limited LCA (M1), UCS (M2), and EIO-LCA (M3) Methodologies

	Electricity	Driving	Natural Gas	Paper	Non-Paper Office Supplies	Print Shop Printing	Computer Printers	Computers	Furniture	Water & Sewerage	Building & Grounds Maintenance
External Costs (thousand $)											
M1	**$404**	*$137*	$18	$37	no data	no data	no data	no data	no data	no data	no data
M3	**$166**	$36	$3	$13	$3	$27	$2	*$133*	$0	$1	$4.2
Greenhouse Gases (thousand lbs CO2)											
M1	**9,433**	*2,602*	324	685	no data	no data	no data	no data	no data	no data	no data
M2	**13,161**	*2,369*	257	538	41	no data	18	782	4	7	30
M3	**8,907**	1,540	193	369	132	1,151	119	*6,760*	2	30	227
Common Air Pollutants (thousand lbs)											
M1	*119.8*	102.5	7.4	**685.5**	no data	no data	no data	no data	no data	no data	no data
M2	**121.9**	18.2	0.5	4.4	1.6	no data	0.7	*29.6*	0.2	0.2	4.9
M3	74.5	33.6	1.2	**537.9**	2.0	16.9	1.3	*76.6*	0.0	0.4	3.2
Toxic Air Pollutants (thousand lbs)											
M1	*5.4*	**16.6**	1.2	1.7	no data	no data	no data	no data	no data	no data	no data
M2	0.3	**2.7**	0.0	0.2	0.1	no data	0.0	*1.3*	0.0	0.0	0.6
M3	0.03	0.07	0.00	0.30	0.05	*0.83*	0.05	**2.59**	0.00	0.00	0.04
Toxic Water Pollutants (thousand lbs)											
M1	**0.09**	*0.06*	0.00	0.00	no data	no data	no data	no data	no data	no data	no data
M2	4.4	2.2	0.1	*21.0*	6.6	no data	2.2	**95.4**	0.3	0.4	13.8
M3	0.0021	0.0052	0.0002	0.0253	0.0029	*0.0441*	0.0018	**0.0881**	0.0003	0.0002	0.0062
Common Water Pollutants (thousand lbs)											
M1	**27.2**	*10.8*	7.0	0.4	no data	no data	no data	no data	no data	no data	no data
M2	**55.0**	4.4	0.4	3.2	0.7	no data	0.4	18.0	0.2	9.9	*48.9*
Water Use Impacts on Habitat (gallons)											
M2 - Habitat	**11,748**	120	58	864	270	no data	107	4,594	117	2,670	*8,539*
M3 - Untreated Discharges	112	294	15	920	153	*1,712*	104	**6,671**	2	11	264
Land Use Impacts on Habitat											
M1 - External Costs (thousand $)	**$69.2**	*$7.2*	$0.9	$3.4	no data	no data	no data	no data	no data	no data	no data
M2 - Habitat (acres)	3.3	**592.2**	0.1	8.7	1.0	no data	0.5	*21.2*	0.4	0.2	0.9

About The Monthly UnEconomist

This monthly online newsletter available at www.ZeroWaste.com (or www.SoundResource.com) intends to provide insight and analysis on the everyday economics of recycling and the unpriced or underpriced environmental benefits of reducing waste disposal and replacing virgin-content products with products manufactured from recycled materials. In addition to *The Monthly UnEconomist*, Sound Resource Management's website ZeroWaste.com also offers recycling markets price history graphs, reports on a variety of topics including the economic and environmental benefits of recycling, and GarboMetrics - elegant, yet not mysterious tools and spreadsheet models for solid waste and recycling.

These materials are all available for no charge at www.ZeroWaste.com. User feedback is encouraged via info@ZeroWaste.com, and substantive comments will be published in our newsletter whenever they add to our understanding of recycling.

As an example of newsletter content, some issues of the *UnEconomist* analyze northwestern and northeastern U.S recycling market prices for nine recycled materials (mixed paper, ONP, OCC, glass containers, tin cans, UBC, PET bottles, HDPE natural bottles, and HDPE colored bottles). These prices are tracked by online graphs updated quarterly.

In addition, some issues of the *UnEconomist* are devoted to GarboMetrics, economic models for managing and analyzing solid waste and recycling. These newsletter issues explain the structure and use of GarboMetric models provided at ZeroWaste.com for such purposes as designing garbage customer rate structures and correctly comparing garbage rates in different communities. GarboMetric models and corresponding issues of *The Monthly UnEconomist* can be downloaded at no charge from www.ZeroWaste.com