The Big Box Calculator

A Guide to Reducing the Ecological Footprint of Large Retail Stores

By

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REDEFINING PROGRESS

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I. Synopsis

The proliferation of new "big box" retail superstores throughout the nation challenges city and county planning departments to find ways to mitigate the economic, social, and environmental damage they cause. Displacement of small, locally owned business, downward pressure on wages, increased fiscal burden, lower tax revenues, increased traffic congestion, stormwater runoff, sprawl, waste, and stress on power and water supplies are among the well documented ills associated with big box construction in communities throughout the United States (CLBBS 2005). Many of these impacts can be reduced through careful site selection, limitations on size, and environmental design (Beaumont and Tucker 2002).

To demonstrate the effectiveness of such mitigation measures in the context of big box construction permit decisions planners need quantitative information linking these measures with a reduction in the overall impact of a new big box store. Moreover, big box retailers like Wal-Mart are now interested in ways they can offset their impacts and signal to their customer base that they are moving toward sustainable practices (NFWF 2005). Redefining Progress is developing its Big Box Calculator to meet these needs.

The Big Box Calculator is a corporate variant of the Ecological Footprint pioneered by Redefining Progress (RP) in the mid 1990s. The Ecological Footprint is one of the most ubiquitous measures of environmental sustainability now in use. The Ecological Footprint is a measure of the area of biologically productive land needed to meet the consumption demands of a given nation, state, city, business or individual and assimilate their wastes. As such, the Big Box Calculator will allow city and county planners to compare and contrast the ecological footprint of various big box configurations.

The remainder of this report is organized as follows. In Section II, we provide a brief overview of the environmental impacts commonly associated with big box stores. In Section III, we provide an explanation of RP's Big Box Calculator prototype and how it can be used to capture these impacts in a useful, quantitative fashion. In Section IV, we apply the Big Box Calculator prototype to a "generic" big box configuration to demonstrate how the Calculator works. In Section V, we use the Calculator's framework to recommend how big box footprints can be reduced. We conclude in Section VI by discussing future refinements needed to make the Calculator a more useful and effective tool for analysis purposes in the years ahead.

II. Environmental Impacts of Big Box Stores

While there is no universal definition of a "big box" store, most definitions tier to the square footage of retail outlets rather than the items sold inside the stores. For example, California defines big box retail stores as a "store of greater than 75,000 square feet of gross buildable area that will generate sales or use tax" (Clanton et al. 2004). The Maryland Department of Planning (MDP) defines big box retail facilities as "large, industrial style buildings or stores with footprints that generally range from 20,000 to 200,000 square feet" (MDP 2001). The size range reflects the economic aspect of the big box phenomenon – i.e. a store with a relatively small area footprint can nevertheless have a big box economic impact if it is significantly larger than the average square footage of existing stores in that sector. None the less, for environmental considerations, a definition based on square footage is the most appropriate.

Big box stores are proliferating rapidly. While overall commercial construction spending in the past few years has been relatively flat, construction for big box stores has been booming (Grant and Hagenbaugh 2004). For example, Wal-Mart recently announced plans to open 270 to 280 Supercenters in the next fiscal year alone adding more than 60 million square feet to its total retail space.[1] Much of the big box building spree is being fueled by a shift in the retail industry away from indoor malls and towards outdoor shopping centers.

The rapid rate of new big box construction coupled with the fact that big box stores are large, stand alone developments usually located in sprawling areas far from city centers has led to a number of well-documented environmental impacts. As summarized by Beaumont (1994) and the Maryland Department of Planning (2001) these include:

- Big box retailers generate more car and truck trips per hour and day due to higher sales volumes and merchandise scale. For example, a home improvement store can generate as many as 948 car trips hour, 9,710 per day and 35 tractor-trailer tips a day (Beaumont 1994). This can exacerbate traffic congestion and air pollution in surrounding areas.
- Big box stores place huge demands on already overstressed water and sewer systems.
- Big boxes are usually built as "stand-alone" structures – the most wasteful from an energy consumption standpoint.
- Long hours and steady truck traffic generate substantial amounts of noise pollution to nearby neighborhoods.
- The development of a big box store often results in the demand for special thoroughfares, which can decrease pedestrian safety and increase the need for road repairs and street lighting. Local governments often foot the bill for this infrastructure.
- An increase in impervious surfaces can substantially increase erosion and surface runoff of toxic substances such as oil from parking lots and fertilizers and pesticides sold in gardening centers. This runoff is a threat to local water supplies.
- Large surface areas occupied by buildings and parking lost cause a direct loss of wildlife habitat and fragment what remains. This can significantly lower local biological diversity.

[1] "Wal-Mart Looks to Get Even Bigger." www.money.cnn.com, October 25, 2005.

- Big box stores require enormous inputs of construction materials. The embodied energy in all these materials can generate a large off-site footprint.

While these impacts are reasonable foreseeable, they are often difficult to quantify, especially in cities and counties that do not have adequate resources to conduct detailed environmental impact analyses of big box applications in a timely manner. RP's Big Box Calculator is an inexpensive tool for estimating the overall ecological footprint generated by any particular big box store facility using information provided by the applicant. In Sections III through V, we present the Big Box Calculator prototype and discuss how it can be used as a tool for developing mitigation measures to minimize the ecological footprint of new big box stores.

III. The Big Box Calculator Prototype

RP's Big Box Calculator prototype provides a framework for calculating the ecological footprint of any big box store in the United States. In a nutshell, the ecological footprint measures humanity's use of nature. A population's footprint is the biologically productive area required to produce the resources and to absorb the waste of that population. Since people use resources from all over the world, footprints add up the extent of these areas wherever they may be located on the planet.

Footprints can be compared to the biological capacity of a region or the planet. If we are taking more from nature than nature can renew, we erode the very natural capital that current and future generations depend on. This liquidation of our ecological assets is called "overshoot."

The facility[2] footprint of a big box store is divided into four major components:

1) The building footprint, which reflects the environmental impacts associated with constructing the store and any associated buildings, parking lots and sidewalks as well as the energy required to produce all the materials used in construction.
2) The transportation footprint, which reflects the environmental impact of delivery vehicles as well as consumer and employee travel to and from the store.
3) The operation footprint, which reflects the environmental impacts of computers, cash registers, and other durable equipment required to run the store, cleaning products needed to maintain the store, and the store's ongoing use of energy and water.
4) The waste footprint, which reflects the environmental impacts of the store's stream of glass, metal, paper, packaging, wood, and plastic waste.

Each component footprint can, in turn, be further subdivided into footprint land area types. Footprint land areas are both real and hypothetical, and are normalized by equivalency factors based upon a ranking of these land areas in accordance with their potential agricultural productivity as classified by the Food and Agricultural Organization of the United Nations. In a comprehensive footprinting application, real land areas include cropland, forests, pasture, and built land, while hypothetical land areas include forest lands needed to sequester carbon dioxide

[2] In addition to the "facility" footprint, big box stores also have footprints associated with "umbrella" operations such as advertising and management at distant offices as well as footprints associated with all the goods and services which flow through the store. In this iteration of the Calculator, we are only concerned with the facility footprint.

emissions generated by our use of energy and wetland area needed to purify effluent and stormwater runoff. The reason why the latter categories are hypothetical is that our use of energy and water does not directly require land as an input but our use of these resources still places demands on the environment in the form of lands needed to assimilate wastes – in this case, excess carbon dioxide emissions and polluted water. In our prototype, we are only addressing the big box footprint with respect to carbon sequestration land, forests, built space, and wetlands. Later versions of the Big Box Calculator will be able to capture impacts to cropland and pasture as we factor in food sold by in-store restaurants and as merchandise.

The carbon sequestration (Co2) footprint is calculated first by estimating the energy embodied in the building, parking area, and sidewalks, the energy used in transporting goods, employees, and customers to the store, the energy needed to supply water, energy required for electricity and heat, and energy needed to recycle wastes. This total energy demand for the facility is transformed into Co2 emissions based on an assumed distribution of electric power production between fossil fuel and renewable sources. The emissions figure is then transformed into an equivalent area of forest needed to sequester these emissions after deducting what the earth can absorb naturally. Finally, the forest area figure is transformed into "global" acres based on the equivalency factor discussed above.

In this iteration of the Calculator, the only link to forest footprint is the board feet of pallet and lumber waste generated by a big box facility each year. Waste figures that are currently reported in metric tons need to be converted into board feet. Once the conversion is made, this board feet/year figure can be transformed into an equivalent forest footprint area which, again, can be transformed into global acres. Paper, packaging, and construction lumber also require forestland area, and these impacts will be incorporated in later Calculator versions.

Construction of any big box store directly converts land from one cover type to built up space. In the prototype, we assume that big box stores are constructed on land that is already developed in one way or another. Thus, all direct footprint impacts are to built up land. However, it may certainly be the case that a big box store is constructed on forestland, farmland, or even wetland fill.

Lastly, we are interested in the water footprint of big box facilities. Big box facilities use significant quantities of water for operations and cleaning and discharge polluted water in the form of effluent, grey water, and stormwater runoff. While there is no widely endorsed method for footprinting water consumption, one method is to calculate the energy required to supply clean water to the facility, and transform that into a Co2 footprint. As for wastewater, a method analogous to the Co2 footprinting method is to calculate the wetland area needed to purify effluent, stormwater runoff, and grey water generated by the facility. For example, federal guidance for the use of constructed wetlands to mitigate stormwater runoff suggest guideline for a size equivalent to 2% of the affected area (Schueler 1992). We adopt both water footprinting methods here as placeholders pending more formal peer review.

IV. <u>Facility Footprint of a Standard Big Box Store</u>

We used this Big Box Calculator prototype to calculate the facility footprint of a "generic" big box store. The Calculator itself and the results of this simulation are provided in Appendix A. The Calcuator's inputs and outputs are displayed on page 1, while pages 2-4 contain supporting data and various conversion factors. Columns 1, 2, 3, and 4 of page 1 describe the variables input into the Calculator, their units, and their values as well as their link to footprint land area. Inputs are either directly provided – i.e. square footage of the building and parking area – or generated by some intermediate calculations – i.e. the embodied energy in the building's concrete floor. Each variable's footprint by land area type is displayed in columns 5-8, with the total displayed in column 9. By rows, the Calculator groups variables into the building footprint, transportation footprint, operation footprint, and waste footprint, as discussed above. Subtotals for each group are displayed immediately below each group.

The data used in the prototype footprint calculations are the best available given the constraints requiring the use of publicly available data. In some cases, estimates have been made from local stores, while in others national-level research gave us an idea of the scale of the impact at hand. The calculations will benefit from improvements in the data, ideally provided by the businesses themselves. Currently, it gives an idea of what calculations can be done with existing data and where there is a need for more data or more refinement of underlying equations. As such, there are several missing cells. Cells with 0s indicate that we do not yet have generic information to fit into the Calculator, and would need either store specific or generic, nationwide information that is not yet available. Cells marked with a * indicate that there are elements in the underlying equations that have yet to be completed or that the input data has yet to be provided.

RP has assembled a complex, interactive spreadsheet form that businesses can fill out to provide most of the missing information. A set of instructions for filling out these data request forms is included in Appendix B and one of the forms – for building and grounds – is attached as Appendix C.

Notwithstanding missing values that can only be provided on a case by case basis, the Calculator's results using generic, nationwide averages are as follows:

1) While the area occupied by buildings, sidewalks, and parking areas associated with a typical big box store is roughly 9 acres, the ecological footprint is likely to exceed that acreage by over three orders of magnitude. According to the Calculator prototype, a big box store with a direct footprint of 8.61 acres has a footprint of at least 9,900 acres.
2) This implies a ratio of building area to footprint of 1:1150.
3) This footprint is equivalent to .18 acres for every tax dollar generated by an average big box facility.
4) By far, the largest land area type included in the big box footprint is carbon sequestration land needed to absorb the Co2 emissions associated with construction of the building, transportation, operation, and waste. Over 99% of the footprint falls into this land type category.
5) In terms of footprint components, transportation accounted for the largest share at 48.6%, followed by operation (30%), waste (12.8%) and building (8.6%).

It is important to note this preliminary footprint calculation is an underestimate. A complete footprint would also account for the footprint of "umbrella" activities that support any particular big box store, such as advertising and management provided by distant offices. A complete footprint would also account for the footprint of all the goods and services offered by the store. With further information, the facility footprint could be put together with the umbrella and product footprints to generate a complete footprint of a big box company.

V. Recommendations for Minimizing the Facility Footprint

In our "generic" big box store, energy used for transportation accounted for nearly 50% of the footprint. Thus, measures to reduce energy consumed in travel to and from the store would have a substantial footprint reduction impact. In the Calculator prototype, the transportation component is divided into truck traffic, employee commuting, and customer travel. The latter has the greatest impact. In order to minimize the distance customers travel, stores should be centrally located, preferably as part of infill, urban redevelopment, or other location efficient development (LED) projects, and not located on urban fringes, as in the typical case.

For example, several studies have shown that per capita vehicle miles traveled (VMTs) can be reduced by 50% in an LED style development (CCAP 2003). Using the Calculator, it can be shown that reducing customers' VMT by this magnitude will reduce the transportation footprint from 4350 to 2350 acres or 53% and the overall footprint by just over 23%.

Another important way big box stores can reduce their footprint is through energy conservation. Installation of skylights, energy efficient fixtures, and improved controls can reduce lighting energy demand by 40 to 80% (Fedrizzi and Rogers 2002). Heating energy can be reduced as much as 50% by installing more efficient heating systems and controls, by installing heat recovery equipment, and by limiting the quantity of outside air entering the facility. Id. If we assume that these measures average out to a 50% reduction in overall energy demand, our Calculator shows that the overall footprint can be reduced by 15%.

Waste stream reduction is yet another way to reduce the footprint. For example, if the recycling rates for plastics, packaging, glass and metal were boosted to 80% from their current ranges of 5-42%, the waste footprint would decrease by 28% and the overall footprint by roughly 4%.

These are just a few options. Other options would include reducing water demand through low flow toilets and more efficient fixtures, using biodegradable cleaners, sprays, and pesticides to reduce the embodied energy impact of their toxic counterparts and reducing the embodied energy component of buildings by more efficient designs that reduce material demands.

Overall, such footprint reduction measures fall generally into three timeframes:

1. **Short-term** ─ Many low-cost measures exist to help reduce the footprint, such as better energy management and use of biodegradable cleaners. These measures have additional benefits of educating employees and customers about conservation, and have been shown to boost employee morale.

2. **Medium-term —** These are measures that require some capital expenditure, but result in significant improvements in the footprint. Bus service is an example. Measures such as these can also help a store build community connections.

3. **Long-term —** For dramatic changes to a store's ecological footprint, strategic changes, best done with new stores, are required. These truly engage the community and all stakeholders.

The following matrix shows examples of footprint reduction initiatives in each time frame.

	Short-term	Medium-Term	Long-term (New store)
Operations	Energy efficient appliances, turning off equipment daily, natural cleaners and sprays, recycling	Installing efficient toilets, climate control systems, warehouse doors with greater insulation	Energy managements systems, not designing for worst day use
Structures		Installing skylights, planting trees, creating stormwater absorption systems	Creating energy efficient, eco-friendly buildings, creating smallest parking lots, including stormwater systems, using rainwater
Transportation	Offering incentives to carpool and use mass transit	Offering bus service during busy days, using biodiesel in delivery trucks	Locating near public transport
Capital Eqiupment	Using less equipment, buying smallest equipment, buying used equipment	Reparing, entering take-back and reuse programs	
Waste	Reducing waste, recycling waste, resuing pallets	Creating packing return programs	Working on reduced packaging designs

VI. <u>Future Refinements and Concluding Thoughts</u>

In this report, we presented preliminary results of the Calculator as applied to a "generic" big box store using national averages and other publicly available data. Because of this, one important refinement would be to apply the Calculator to store specific data described by Appendices B and C. Of course, this would require the participation of managers from big box stores themselves. Another refinement would be to include the umbrella and goods and services aspect of the footprint, but, again, this would require data from big box store owners since there is no public information about a particular big box chain's ancillary operations or detailed flows of goods and services.

Refinements that could potentially be made with generic nationwide information are identified in the Calculator by 0s or *s. For example, it is likely that water consumption and effluent discharge figures are published in environmental impact reports or other similar application materials, as are figures regarding expected traffic flows, natural gas use, and cleaning products. Likewise, there are a number of studies addressing the energy requirements of our water supply systems throughout the nation. From these studies, we can assign a figure to the embodied energy in water supply in a given region and from there calculate the energy footprint associated with a big box's water consumption.

Despite limitations on existing data sources RP's Big Box Calculator prototype demonstrates the feasibility of ecological footprinting for corporate facilities. By quantifying a particular big box or other large retail facility's demands on the environment in one simple measure, the Calculator may have useful applications in the context of planning and land use decisions. In particular, the Calculator can be used to evaluate the environmental benefits of alternative design configurations that would reduce miles traveled to and from the store, energy use, waste, water use, and other environmental factors of concern to decision makers evaluating big box store applications.

References

Beaumont, Constance and Leslie Tucker. 2002. "Big Box Sprawl and How to Control It." Municipal Lawyer 43(2).

Beaumont, Constance E. 1994. "How Superstore Sprawl Can Harm Communities." Washington, D.C.: National Trust for Historic Preservation.

Center for Clean Air Policy (CCAP). 2003. "State and Local Leadership On Transportation And Climate Change." www.ccap.org.

Clanton, Adam and Kerry Duffy. 2004. "California Responses to Supercenter Development: A Survey of Ordinances, Cases, and Elections." Public Law Research Institute, Hastings College of the Law, University of California at San Francisco.

Coalition to Limit Big Box Stores (CLBBS). 2005. "The Coming of Wal-Mart: An Ominous Event." Santa Fe, New Mexico.

Grant, Lorrie and Barbara Hagenbaugh. 2004. "A Big Box Building Spree." USA Today. January 21st, 2004.

Maryland Department of Planning (MDP). 2001. "Managing Maryland's Growth: Models and Guidelines for "Big-Box" Retail Development." Annapolis, Maryland.

National Fish and Wildlife Foundation (NFWF). 2005. "Wal-Mart Pledges One Acre for Every Acre it Develops." www.nfwf.org/programs/walmart/.

Schueler, T.R. 1992. "Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetlands in the Mid-Atlantic Region. Washington, D.C.: Metropolitan Washington Council of Governments.

Appendix A
Big Box Calculator Prototype

Variables	Unit	Input Data	Footprint Link (s)	Global acres impacted				
				CO2	Forest	Built	Wetlands	Total
(I) Building footprint								
Area of building (square feet)	sq. ft.	125,000	Direct land loss	n/a	n/a	6.24	n/a	6.24
Area of parking lots and sidewalks	sq. ft.	250,000	Direct land loss	n/a	n/a	12.48	n/a	12.48
Embodied energy in building, excluding floor	gj/m2	11	CO2 sequestration land	411.15	n/a	n/a	n/a	*
Embodied energy in concrete floor of building	mj/m3	4,745	CO2 sequestration land	177.36	n/a	n/a	n/a	177.36
Embodied energy in parking lots and sidewalks	mj/m3	4,745	CO2 sequestration land	266.03	n/a	n/a	n/a	266.03
Stormwater runoff area	sq. ft.	375,000	Wetland filtration area	n/a	n/a	n/a	0.37	0.37
Building subtotal:				**854.54**	**0.00**	**18.71**	**0.37**	**873.63**
(II) Transportation footprint								
Truck traffic	miles	73,000	CO2 sequestration land	56.49	n/a	n/a	n/a	56.49
Employee commuting	miles	1,763,213	CO2 sequestration land	463.00	n/a	n/a	n/a	463.00
Customer travel to store	miles	16,567,200	CO2 sequestration land	4350.39	n/a	n/a	n/a	4350.39
Transportation subtotal:				**4813.40**	**0.00**	**0.00**	**0.00**	**4813.40**
(III) Operation footprint								
Embodied energy in water supply	mj/acre-foot	0	CO2 sequestration land	*	n/a	n/a	n/a	*
Effluent discharge	acre-foot	0	Wetland filtration area	n/a	n/a	n/a	*	*
Natural gas use	mcf	0	CO2 sequestration land	*	n/a	n/a	n/a	*
Electricity use	kwh/yr	2,000,000	CO2 sequestration land	2981.65	n/a	n/a	n/a	2981.65
Cleaning products	gallon/yr	0	Wetland filtration area	n/a	n/a	n/a	*	*
Computers and electronic equipment	units	50	CO2 sequestration land	5.69	n/a	n/a	n/a	*
Operation subtotal:				**2987.34**	**0.00**	**0.00**	**0.00**	**2987.34**
(IV) Waste footprint								
Glass	mtons/yr	21	CO2 sequestration land	12.49	n/a	n/a	n/a	*
Metal	mtons/yr	11	CO2 sequestration land	28.16	n/a	n/a	n/a	*
Paper and packaging	mtons/yr	422	CO2 sequestration land	514.74	n/a	n/a	n/a	*
Pallets and lumber	bf/yr	57	CO2 sequestration land	n/a	n/a	*	n/a	*
Plastic	mtons/yr	282	CO2 sequestration land	669.99	n/a	n/a	n/a	*
Waste subtotal:				**1225.38**	**0.00**	**0.00**	**0.00**	**1225.38**
Total footprint area:				**9880.66**	**0.00**	**18.71**	**0.37**	**9899.74**

Total size of building and lot:	**8.61**	**Key:**	**n/a**	**not applicable**
Ratio of developed space to footprint:	**0.00087**		**0**	**additional data required**
Footprint per employee:	**49.4987242**		*****	**additional calculations required**
Footprint acres per local tax dollar:	**0.18**			
Footprint acres per dollar revenue:	**0.0002**			

SUPPORTING DATA

		[global m2/m3 roundwood]
Forest		
Timber	6469.0000	6,469
Constants and Conversion Factors		
absorption rate [t C/ha/yr]:	0.95	
% absorbed by oceans:	31%	
Carbon intensity [t C/GJ]:		
coal	0.026	
oil (avg. fossil fuel)	0.020	
natural gas	0.015	
Carbon absorption factor [m^2/MJ]:		
coal	0.19	
oil (avg. fossil fuel)	0.15	
natural gas	0.11	
Structural consumption	1.1	
Total built area of goods and waste (m2/cap)	244	
Total built area of services (m2/cap)	244	
Weight conversion (kg/lb)	0.454	
Area conversion (acres/ha)	2.47	
Area conversion (m^2/ft^2)	0.093	
Equivalence and Yield Factors & Footprint [m2]	**Equivalence Factors**	**Yield Factors**
	[global area/area	[-]
Fossil Energy	1.35	
Cropland	2.17	
Pasture	0.47	1.3
Forest	1.35	
Wetland	2.17	
Built-up land	2.17	1.4
Fisheries	0.35	
TOTAL	-	-
Carbon and Electricity background		
Annual electricity generation for the US (2003) kwh	3.69067E+12	
Annual CO2 emissions for the US (2003) in mmt	2279.3	
Carbon dioxide emissions metric tons per kwh	0.000617584	
Calculation--metric tons of carbon per kwh	0.000168432	
Calculation--lbs of Carbon dioxide per kwh	1.361540319	
Calculation--lbs of carbon per kwh	0.371329178	

Appendix A
Big Box Calculator Prototype

Unit Conversion Factors			
Square meter	1	Hectares	0.0001
Square meters	1	Square miles	3.86E-07
Square mile	1	Acres	640
Mile	1	Feet	5280
Acre	1	Square feet	43560
Kilometer	1	Mile	0.621371192
mile	1	kilometer	1.609344001
Pound	1	kilogram	0.45359237
watt-hour	1	Joules	3,600
hectare	1	square meter	10000
megawatt	1	kilowatts	1000
metric ton	1	pounds	2204.62262
square foot	1	square meters	0.09290304
metric ton	1	short ton (200lbs)	1.102311311

Embodied Energy in Highways	MJ/kg	MJ/m3
asphalt (paving)	3.4	7140
ready mix concrete, 17.5 MPa	1.0	2350
average	**2.2**	**4745**

Transportation Factors	
MPG	22.10
Lbs C per Gallon Gasoline	5.30
Person trip length (miles) To/From work	12.11
Person trip length (miles) Shopping	7.50
Truck MPG	7.50
Truck trip length one way (miles)	10.00
Truick trips per day	10.00

Store Factors	
Number of customers per year	1,104,480
# of employees	200
Local tax revenue	$55,625
Sales revenue	$43,883,350
Lifespan of building (years)	15
Water consumption	
Effluent discharge	
Average weight of one computer (kilograms)	11.79340163
Embodied energy in one computer (Mj/kg)	200

Appendix A
Big Box Calculator Prototype

Waste Factors	% Red fr. Recy.	E-Intensity (GJ/ton)	
Glass	0.3100	15	
Metal	0.6100	60	
Paper	0.3300	35	
Pallets and lumber			
Plastic	0.6867	50	
Trees per ton of paper	10.0000		
Plastic bag mJ/bag	480.0000		
Pounds of waste per 100 square feet per day	6.0000	lbs/100 sq. ft.	
Glass	0.017	0.102	0.02642487
Metal	0.009	0.054	0.013989637
Paper and packaging	0.343	2.058	0.533160622
Pallets and lumber	0.046	0.276	0.071502591
Plastic	0.229	1.374	0.355958549
		3.8640	

Recycling Factors

Waste type	% recycled
Glass	26%
Metal	32%
Paper and packaging	42%
Pallets and lumber	
Plastics	5%

Introduction

Thank you for submitting information for the ecological footprint model. This information will be used to calculate fuel consumption and embodied energy in structures, chemicals and manufactured equipment. Furthermore, information about run off and waste will be used to calculate a total by-product amount. The sum of consumption and by-products minus the results of recycling and mass transit programs yields a net impact figure. Greater detail to the requests below will result in not only a more accurate footprint result but also better opportunities for a reduced footprint. While it may not be possible to respond to all of the requested detail, there will be High-Level data options for each main request. There are six major categories of information requests below:

		Detail	High-Level
I)	Structures		X
II)	Operations	X	X
IV)	Capital Equipment		
V)	Transportation		
VI)	Waste	X	

If the detailed information is not available or incomplete, please use the high-level alternatives listed below. By left clicking on the underlined blue categories, the survey user can navigate between the detailed and high-level forms. This introduction page will also track which sections have been completed above.

Structures

For the building and parking lot, different materials contain different amounts of embodied energy. The dimensions will help us estimate the mass of each material. If there is insufficient information about materials and dimensions, please enter square footage information in the Summary Structures section. Finally, the parking lot was engineered with water volume run off and vehicle contaminant assumptions. Please list the available data in either the Detailed Structures or High-Level Structures sections.

Detailed Structures   High-Level Structures

Operations

Operations includes energy consumption, water consumption, supplies and other consumable goods. Water use is conveniently monitored by utilities. For energy consumption, most companies have the option of choosing a green alternative for a portion of their energy needs. The green energy statements will have the information requested in the Detailed Operations tab, Energy section. Conventional energy providers have statewide energy source profiles available from the Energy Information Administration. By entering your state code in the top line, these figures will be pulled into the matrix. Alternatively, total annual electricity, gas and propane figures can be submitted in the High-Level Operations section. All of this information can be entered with monthly or annual figures.

For store and office supplies that are consumed on a regular basis, the ecological impact calculation focuses on specific chemicals and chemical by-product supplies. The Detailed Operations tab is looking for specific chemicals and compounds and annual use by volume. If some of this information is incomplete, the calculator can estimate embodied energy on the highest volume chemicals listed in the High-Level Operations section.

Detailed Operations High-Level Operations

Capital Equipment

For Capital Equipment, the footprint model calculates embodied energy in computers, machinery, industrial equipment and other electronics. If detailed equipment information is not available, please use the High-Level Capital Equipment section.

Detailed Capital Equipment High-Level Capital Equipment

Transportation and Fuel Consumption

For merchandise delivered to the store, please distinguish between inventory shipped directly by the vendors and inventory shipped from the distribution center. Miles traveled, payload and mode of transportation will determine fuel consumption. If the number of vendors or distribution centers exceeds the numbered lists in the detailed form, please continue attach a complete list as needed. Furthermore, this survey also requests separate listings of employee commute miles and customer transactions by billing zip code. If employee commute days and/or customer billing zip code is not available, please use the High-Level Transportation section.

Detailed Transportation High-Level Transportation

Waste

For waste, the footprint model calculates both total waste and embodied energy in shipping materials minus recyclables. Total recyclables and garbage is calculated by dumpster size times number of weekly trash removals. If this information is not available, please use the High-Level Waste section.

Detailed Waste High-Level Waste

Appendix C
Sample Data Request form for Building and Grounds

Back to Introduction — Introduction
Move to Summary Structures — High-Level Structures

	Y/N	Units	Amt.	Metal	Fiber Glass	Wood	Concrete	Plastic	Tile	Asphalt	Carpet	Linoleum	Other	Total Comp.	Notes:
				% Content											
I) STRUCTURES															
Total Square Footage															
Enclosed		sq ft													
Open		sq ft	10												
Exterior Walls If not pushed up concrete construction, please describe right															
Insulation, if yes Type		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Thickness		inches													
Height		ft													
Surface Area		sq ft													
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Interior Walls															
Load bearing		number													
Thickness		inches													
Height		feet													
Surface Area		sq ft													
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Shear Walls		number													
Thickness		inches													
Height		feet													
Surface Area		sq ft													
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Roof															
Surface Area		sq ft													
Thickness		inches													
Insulation, if yes Type		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Flooring If not concrete slab, please describe right															
Thickness		inches													
Surface Area		sq ft													
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Foundation															
Volume		cubic yards													
Composition		desc. Rt.		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Parking Area															
Surface Area		Sq ft.													
Composition		Desc. Rt		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Multi level?															
Side Walk Area															
Surface Area		Sq ft.													
Composition		Desc Rt		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	
Green Area															
Surface Area		Sq ft.													
Absorbsion Factor		saturation?													
Water run-off															
Volume		cubic ft/yr													
Toxicity Elements															
Element 1		ppm													
Element 2		ppm													
Element 3		ppm													