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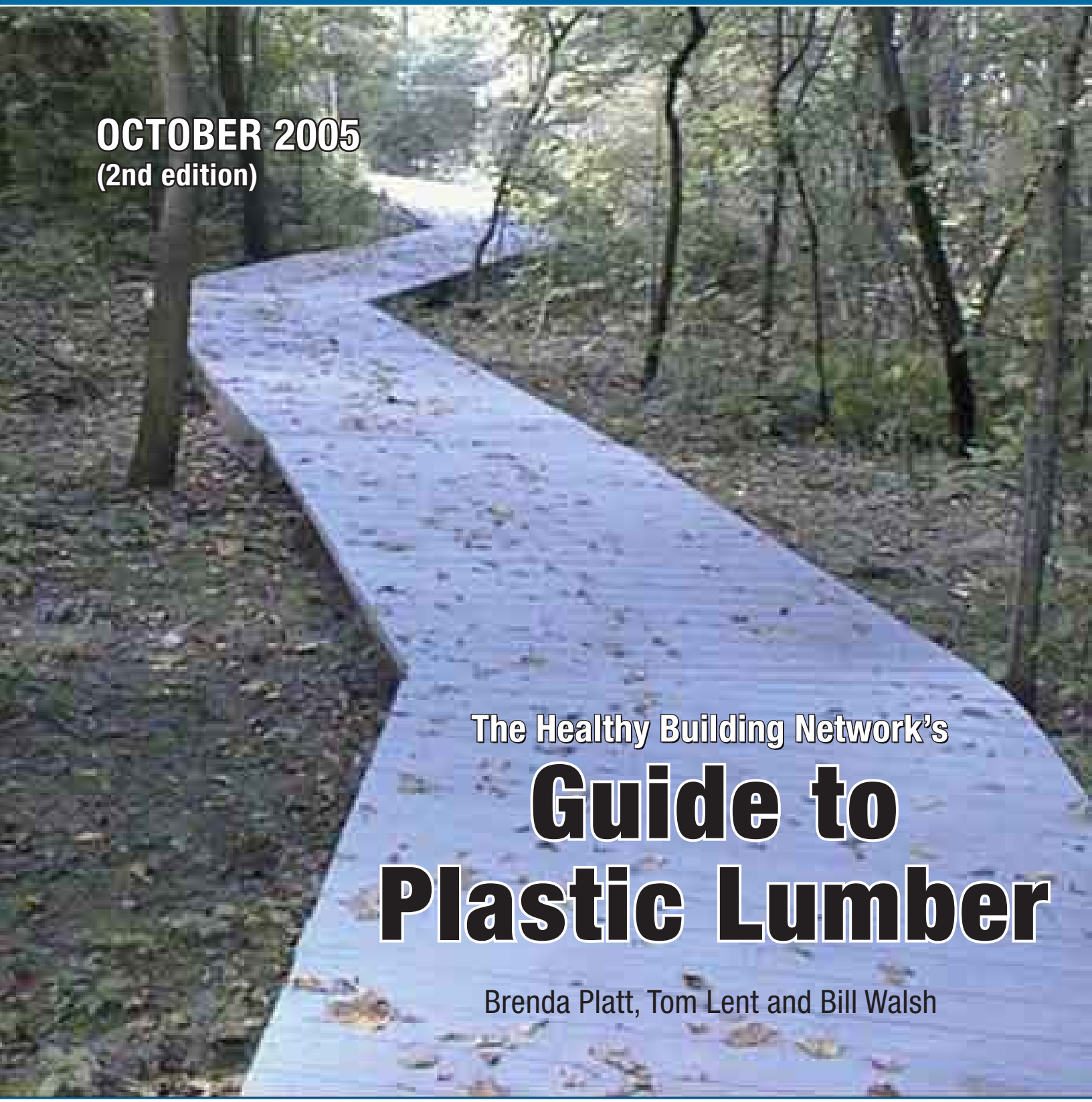

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The Healthy Building Network's

Guide to Plastic Lumber

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A report by **The Healthy Building Network**. A project of the Institute for Local Self-Reliance
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About the Institute for Local Self-Reliance

Since 1974, the Institute for Local Self-Reliance (ILSR) has advised citizens, activists, policymakers, and entrepreneurs on how to design and implement state-of-the-art recycling technologies, policies, and programs with a view to strengthening local economies. ILSR's mission is to provide the conceptual framework, strategies, and information to aid the creation of ecologically sound and economically equitable communities.

About the Healthy Building Network

A project of ILSR since 2000, the Healthy Building Network (HBN) is a network of national and grassroots organizations dedicated to achieving environmental health and justice goals by transforming the building materials market in order to decrease health impacts to occupants in the built environment – home, school and workplace – while achieving global environmental preservation. HBN's mission is to shift strategic markets in the building and construction industry away from what we call *worst in class* building materials, and towards healthier, commercially available alternatives that are competitively priced and equal or superior in performance.

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All responsibility for the views expressed in this report or for any errors in it rests with the authors.

(Cover photo courtesy of the U.S. Army Corps of Engineers.)

Preface

The Healthy Building Network (HBN) published this report for two reasons. First, we want to assist consumers interested in purchasing environmentally responsible plastic lumber products. Many who choose plastic lumber are motivated by a desire to save forests or recycle plastic waste. Manufacturers often market their products to appeal to these concerns. This study is the first to compare and evaluate plastic lumber products strictly from an environmental and public health perspective.

More than one-third of the plastic lumber products considered are rated "Most Environmentally Preferable."

We also want to positively influence the future direction of the plastic lumber industry. The market for plastic lumber is growing rapidly and the industry is very much in flux. Manufacturers continue to experiment with various materials and formulations in order to improve performance, reduce costs, and build new markets. As a result, plastic lumber's composition varies widely, from 100% post-consumer recycled content to 100% virgin plastic resin. Some products are made with a single plastic resin, others use combinations of resins, and still others combine other materials with plastic to make a composite. This report seeks to steer both manufacturers and purchasers towards product formulations that are ecologically superior, and to reverse sales trends for the most ecologically harmful products such as virgin polyvinyl chloride (PVC) plastic.

We know this can be done. In 2002 HBN initiated a consumer campaign that resulted in a negotiated agreement to eliminate the use of the chromated copper arsenate (CCA) wood treatment formula from approximately 80% of the annual $4 billion dollar pressure-treated wood market. This ended, as of January 2004, the nation's largest use of arsenic and the largest source of arsenic exposure to Americans. In another area, our close collaboration with leading healthcare institutions to develop green building and procurement guidelines has already resulted in the introduction of more than a dozen PVC-free alternative products.

Happily our research concludes that more than one quarter of the plastic lumber products for which we have information currently use material formulations that we rate "Most Environmentally Preferable" in this report. This finding holds with it the prospect that the plastic lumber industry on the whole can be an important part of a more sustainable economy.

Executive Summary

This Healthy Building Network report compares and evaluates different plastic lumber types from an environmental and public health perspective, and offers advice on how to choose a plastic lumber product based upon its health hazards and recycling impacts. We rate the environmental preferability of 55 plastic lumber products manufactured by 44 companies based on three criteria:

1) Materials used
2) Recycled content
3) Potential recyclability

No determination is made as to whether plastic lumber is on the whole either more or less preferable to other materials with which it competes such as naturally rot-resistant wood, pressure-treated wood, steel, aluminum, or concrete. Rather, this information is intended to inform those who are interested in understanding the range of environmental and public health impacts associated with different plastic lumber products.

Materials Used

Most plastic lumber products on the market are made from polyethylene (commonly available in high and low densities, HDPE and LDPE). Some manufacturers are also using polystyrene (PS) and polyvinyl chloride (PVC). Still others rely on a commingled mix of different types of plastics (largely collected from municipal recycling programs). All plastic types (also called plastic resins) currently used for lumber share a common origin in fossil fuels and thus a common set of initial environmental and public health impacts. Plastics differ, however, according to their manufacturing procedures and the additional materials used in formulating various products. These differences distinguish some plastics as possessing greater chemical hazards than others throughout their lifecycle of production, use, and disposal. While no plastic is environmentally benign, our analysis concludes that the polyethylenes possess lesser chemical hazards and associated environmental health impacts, making them environmentally preferable to those that have greater hazards and impacts such as PS and PVC.

To improve performance qualities such as rigidity or strength, some plastic lumber producers reinforce the primary plastic resin with other materials. Fiberglass is one material often used to increase the load-bearing capacity of plastic lumber. As fiberglass production and use raise significant health concerns, we rate fiberglass-reinforced lumber products lower than fiberglass-free products. At least one company combines polystyrene with HDPE for added strength. Because polystyrene's lifecycle of production, use and disposal is associated with greater chemical hazards, we give a lower rating to products containing this resin.

Recycled Content

Recycled content varies widely among plastic lumber products. One half of the products we review contain post-consumer plastic content. We give the most credit to products that have a minimum 50% post-consumer content. We give a lower rating to products that have less than 50% minimum post-consumer content.

Recyclability

In general, products that can be recycled after their intended use are environmentally preferable over those that cannot. Recycling contributes to an overall reduction in resource consumption and pollution over time. More than a dozen companies offer lumber made from a single resin, polyethylene, one of the most recyclable and recycled plastics, while other plastic lumber products also contain other plastics, fiberglass, and/or wood fiber or wood flour. Based upon the record of plastics recycling to date, these composite products will be more difficult to recycle effectively than single resins. Therefore, we favor single-polyethylene-resin products as more environmentally preferable over plastic composites or lumber made from commingled plastics.

Findings

- **Most Environmentally Preferable**: More than one-third of the products (15 of 55) we survey earn this designation. They use only high- or low-density polyethylene and contain high volumes (50% and greater) of post-consumer recycled content.

- **Environmentally Preferable**: Only three products we survey combine high percentages of post-consumer recycled content with other plastics or wood fibers. This designation acknowledges the high post-consumer content but downgrades the blending of different materials.

- **Less Environmentally Preferable**: One third of the products we survey (18 of 55) earn this designation**.** These include mixtures of plastics and wood having low (less than 50%) post-consumer recycled content, and the HDPE-only products with low, zero, or unknown post-consumer recycled content.

- **Not Environmentally Preferable Except for Structural Applications:** Four of the products we survey are unique for their use in demanding structural applications such as bridge supports or railroad ties. These products contain fiberglass or polystyrene, materials associated with greater health hazards during their lifecycle. Their use may be justified for these applications; otherwise avoid.

- **Not Environmentally Preferable:** More than one quarter of the products we survey (15 of 55) earn this designation. These include PVC and polystyrene products that contain no post-consumer recycled plastic content. None of the products in this category contain more than 30% post-consumer plastic content.

Plastic Lumber Product Ratings

Most Environmentally Preferable

Ameriwood (American Plastic Lumber)
Bear Board (Engineered Plastic Systems)
BreezeWood (Aeolian Enterprises)
Eco-Tech (Eco-Tech)
Eco-Tuff (Eco-Tech)
Enviro-Curb (Enviro-Curb Manufacturing)
Everlast (Everlast Plastic Lumber)
HDPE lumber (U.S. Plastic Lumber)
Leisure Deck (The Plastic Lumber Company)
MAXITUF (Resco Plastics)
Millennium Lumber (BJM Industries)
Orcaboard (Durable Plastic Design)
Perma-Deck Advantage+ (Cascades)
PlasTEAK (PlasTEAK)
Select (Bedford Technology)

Environmentally Preferable

Perma-Deck Elegance (Cascades)
Plasboard (Northern Plastic Lumber)
Rhino Deck (Master Mark Plastics)

Less Environmentally Preferable

Dream Composite Deck (Thermal Industries)
ChoiceDek (A.E.R.T., Inc.)
CorrectDeck (Correct Building Products)
CrossTimbers (Elk Composite Building Products)
Evergrain (Epoch Composite Products)
Evolve & Perma-Poly (Renew Plastics Division)
fiberon (Fiber Composites)
Four Seasons (Delmarva Industries)
Geodeck (Kadant Composites)
Latitudes Decking (Universal Forest Products)
Monarch (Green Tree Composites)
Oasis Composite (Alcoa Home Exteriors)
Polywood nonstructural (Polywood)
TimberTech (TimberTech)
Trex Origins (Trex)
Veranda (Universal Forest Products)
WeatherBest Select (Louisiana-Pacific)
WindRiver Fence (Aeolian Enterprises)

Not Environmentally Preferable Except for Structural Applications

Ameriwood-Plus (American Plastic Lumber)
FiberForce (Bedford Technology)
Polywood (Polywood)
Trimax (U.S. Plastic Lumber)

Not Environmentally Preferable – Avoid

Boardwalk (CertainTeed)
Country Estate (Nebraska Plastics)
Deck Lok (Royal Crown)
Deck/Dock (Wastech Fencing)
Dream Deck (Thermal Industries)
eon (CPI Plastic Group)
EverNew, Bufftech (CertainTeed)
Forever-Wood (Forever Wood)
Oasis PVC Deck (Alcoa Home Exteriors)
Procell (Procell Decking Systems)
Sheerline (L.B. Plastics)
Synboard (Synboard America)
VEKAdeck (VEKA)
vinyl decking (Poly Vinyl Creations)
Xpotential (XPotential Products)

Source: Healthy Building Network, 2005.
Note: Full chart is on page 8.

Recommendations

The Healthy Building Network endorses the following guidelines for plastic lumber purchases. These guidelines are based on environmental, public health, and recycling considerations.

- **Favor products:**
  - **with high recycled content,** specifically high post-consumer recycled content.
  - **made from high-density and low-density polyethylene (HDPE and LDPE)**, recyclable resins associated with fewer chemical hazards and impacts than other petroleum-based polymers.
  - **by producers sourcing resins from local municipal recycling programs**, therefore cutting transportation costs and supporting the local economy.
- **Limit use of:**
  - **wood-plastic composites** because of concerns about mixing biological and synthetic materials, including limited end-of-life recyclability.
  - **fiberglass-reinforced or polystyrene-blended "structural" plastic lumber to demanding structural applications** such as railroad ties and bridge supports, as a less toxic alternative to chemically treated wood.
  - **products with multiple commingled recycled consumer plastics** as they will have more contaminants and inconsistent properties. They also support token markets for plastics that otherwise are largely unrecyclable, and many of which are highly toxic. This perpetuates the use of plastics that should be phased out.
- **Avoid products made with:**
  - **PVC and polystyrene** because these are associated with more chemical hazards and impacts throughout their lifecycle than other plastics.
  - **fiberglass for nonstructural applications** that do not require reinforced plastic lumber (such as decking boards, benches, and tables).
  - **predominantly non-recycled plastics.** Alternatives with high recycled content are readily available.

Introduction

Plastic lumber is gaining market share in applications ranging from decking, retaining walls, and fencing to park benches, tables, playground equipment, and landscaping products.[1] Plastic lumber is generally perceived as an environmentally friendly substitute to hardwoods from endangered forests, and a "non-toxic" alternative to widely used pressure-treated wood, which contains copper and other chemicals.[2] Plastic lumber is also an important market for discarded consumer plastics, helping to divert valuable materials from landfill and incinerator disposal. Product advertising often emphasizes these advantages. Product names such as Enviro-Curb, Green Tree Composites, CorrectDeck, and Eco-Tech help brand the product as "green."

All plastic lumber is not equal, however. The term "plastic lumber" encompasses a wide range of materials and products. The type of plastics used, the amount of recycled content, recyclability of the end products, additives and intended applications differ from product to product. Several authorities currently offer consumers advice concerning the price and performance of plastic lumber products.[3] This *Healthy Building Network's Guide to Plastic Lumber* is the first to compare and evaluate plastic lumber types and brands from an environmental and public health perspective, and to offer buyers advice on how to choose a plastic lumber product based upon its environmental, public health and recycling impacts.

This *Guide* evaluates plastic lumber products based upon three criteria:

Materials Used: Most plastic lumber products on the market are made from a single resin, polyethylene, which is available in high and low densities (HDPE and LDPE). Some manufacturers are also using polystyrene (PS) and polyvinyl chloride (PVC). Still others rely on a commingled mix of different types of plastics (largely collected from municipal recycling programs). All plastic types (also called plastic resins) currently used for lumber share a common origin in fossil fuels and thus a common set of initial environmental and public health impacts. Plastics differ, however, according to their manufacturing procedures and the additional materials used in formulating various products. These differences distinguish some plastics as possessing greater chemical hazards than others throughout their lifecycle of production, use, and disposal. While no plastic is environmentally benign, our evaluation concludes that the polyethylenes possess lesser chemical hazards and associated environmental health impacts, making them environmentally preferable to those that have greater hazards and impacts such as PS and PVC.

Plastic Lumber and Its Applications

Plastic lumber is a manufactured product generally rectangular in cross-section and typically supplied in sizes corresponding to traditional lumber. It may be solid or hollow and composed of single or commingled resins or may be blended with wood or other plant fibers. It is typically at least 50 percent by weight resin.

Plastic lumber appeared in the marketplace in the late 1980s. Since then, plastic lumber products have undergone a series of developmental advancements that have improved performance, reduced the price, and increased availability. Early offerings had significant problems with sagging and heat-induced warping. Engineering has greatly increased the mechanical properties of current products.

A wide variety of products can be made with plastic lumber; most represent outdoor applications:

Dimensional lumber	Planters & landscaping timbers
Decking	Trash can receptacles
Boardwalks & walkways	Playground equipment
Marine docks	Compost bins
Fencing & posts	Animal stalls
Picnic tables	Sound barriers
Benches	Parking stops
Bridges	Sign posts and signs
Retaining walls	Bicycle racks
Railroad ties	Truck sideboards
Pallets	

Source: Healthy Building Network, 2005; and "ASTM Specifies Plastic Lumber for Exterior Decking," ASTM Standardization News, Sept. 2001, available online at http://www.astm.org/SNEWS/SEPTEMBER_2001/pllum_sept01.html.

HBN's Guide to Plastic Lumber is the first to compare and evaluate plastic lumber types and brands from an environmental and public health perspective.

To improve performance qualities such as rigidity or strength, some plastic lumber producers reinforce the primary plastic resin with other materials. Fiberglass is one material often used to increase the load-bearing capacity of plastic lumber. As fiberglass production and use have been linked to pulmonary lung disease, affecting the lungs in a manner similar to asbestos, we rate fiberglass-reinforced lumber products lower than fiberglass-free products. At least one company combines polystyrene with HDPE for added strength. Because polystyrene's lifecycle of production, use and disposal is associated with greater chemical hazards, we give a lower rating to products containing this resin.

Post-consumer Recycled Content: Recycled content varies widely among plastic lumber products. More than one half of the products we review contain post-consumer recycled plastic content. We give the most credit to products that have a minimum 50% post-consumer content and a composition with high potential for end-of-life recyclability.

Potential Recyclability: Products that can be recycled after their intended use are environmentally preferable to those that cannot. More than a dozen companies offer lumber made from a single resin, polyethylene, one of the most recyclable and recycled plastics. However, many other plastic lumber products also contain other plastics, fiberglass, or plant fiber. Based upon the record of plastics recycling to date, these composite products will be more difficult to recycle than single resins. Therefore, we favor single-resin products as more environmentally preferable over plastic composites or lumber made from commingled plastics.

Guide to the Ratings

Most Environmentally Preferable	Favor products with high post-consumer recycled content and made from recyclable resins that avoid the environmental health concerns of the worst resins	• Post-consumer recycled plastic content 50% and greater • Made from high-density and low-density polyethylene, considered to have a less toxic lifecycle than other resins • More readily recyclable
Environmentally Preferable	Limit the use of composite products	• Mostly plastic resins mixed with biological materials, primarily wood fiber • Questionable end-of-life recyclability
Less Environmentally Preferable	Limit the use of products with low post-consumer recycled content	• Post-consumer recycled plastic content less than 50% or do not provide data on post-consumer content • Comparable products with higher post-consumer content are readily available
Not Environmentally Preferable Except for Structural Applications	Limit to demanding structural applications	• Contain materials with high health impacts: – fiberglass – recycled polystyrene (PS)
Not Environmentally Preferable	Avoid – Environmental and public health hazard concern	• Contain materials with highest health impact: – virgin PVC – virgin polystyrene (PS), or – shredded mixed automobile parts (auto-shredder fluff), which contains heavy metals and toxic fire retardants

Most Environmentally Preferable

More than one quarter of the products (15 of 55) we survey earn the designation Most Environmentally Preferable because they use only polyethylene and contain high volumes (50% and greater) of post-consumer content.

Environmentally Preferable

Only three products we survey combine high percentages of post-consumer recycled content with other plastics or wood fibers. This designation acknowledges the high post-consumer content but downgrades the blending of different materials.

Less Environmentally Preferable

Almost one third of the products we survey (18 of 55) earn this designation**.** These include mixtures of plastics and wood having low (less than 50%) post-consumer recycled content; the HDPE-only products with low, zero, or unknown post-consumer recycled content; and one product that combines post-consumer polyethylene with pre-consumer polystyrene.

Not Environmentally Preferable Except for Structural Applications

Four of the products we survey are unique for their use in demanding structural applications such as bridge supports or railroad ties. These products contain fiberglass or polystyrene, materials associated with greater health hazards during their lifecycle. Their use may be justified for these applications; otherwise avoid them.

Not Environmentally Preferable: Avoid

More than one quarter of the products we survey (15 of 55) earn this designation. These include products made from PVC, polystyrene, and plastics recovered from shredding automobiles. This auto-shredder fluff is often contaminated with toxic flame retardants and heavy metals. None of the products contain more than 30% post-consumer plastic content, and the PVC and polystyrene products contain no post-consumer recycled plastic content. Competitive products made from less harmful plastics and higher recycled content are readily available on the market. PVC-based and polystyrene-based products made of predominantly virgin resin are completely unsustainable products and can be easily avoided.

Ratings

Figure 1 lists 44 plastic lumber companies and 55 of their products. Also included are data on these products' recycled content and main material feedstocks (recycled or not). Appendix 1 lists those companies that did not provide information upon request. Avoid products from these companies until they inform consumers of product composition.

Methodology

We initially identified 67 plastic lumber manufacturers by searching the Internet, especially recycling market and recycled-content databases,[4] and by using our existing knowledge of some companies. In February 2005, all 67 companies were invited to participate in our online survey soliciting data on the companies and their products. Fifteen companies responded to our survey. We rate these and 29 other companies for which we were able to obtain data, including the more widely known brands such as Trex and ChoiceDek. [Additional or corrected information provided to us will be periodically added to the online version of this report. We invite submissions of company and product data for our database. Contact *plasticlumber@healthybuilding.net*.]

A Note on Additives

Plastic lumber contains various additives such as color pigments, UV stabilizers, and sometimes flame retardants. Analysis of these compounds was beyond the scope of this report.

Rating Disclaimer

Data on material feedstocks and recycled content were provided directly by companies through the survey, by follow-up calls and emails to manufacturers, and from their Web sites. Material assessments are made solely based on data provided by companies. Neither the Healthy Building Network nor the Institute for Local Self-Reliance has directly tested any of these products for material content, nor have we independently verified any manufacturers' claims. No recommendation on performance of these products is made or implied.

Figure 1: Plastic Lumber Product Ratings

Brand (Company)	Composition Plastics / Other	Recycled Content (%) Post-consumer	 Total	Notes
Most Environmentally Preferable				
Bear Board (Engineered Plastic Systems)	HDPE	100	100	A
Millennium Lumber (BJM Industries)	HDPE, LDPE	100	100	A
Orcaboard (Durable Plastic Design)	HDPE	100	100	A
PlasTEAK (PlasTEAK)	HDPE	100	100	A
Select (Bedford Technology)	HDPE, LDPE	100	100	A
HDPE lumber (U.S. Plastic Lumber)	HDPE	90	90	A
Leisure Deck (The Plastic Lumber Company)	HDPE	80 to 95	100	A
Everlast (Everlast Plastic Lumber)	HDPE	80	100	A
Eco-Tech (Eco-Tech)	HDPE	75 to 100	95 to 100	A
Ameriwood (American Plastic Lumber)	HDPE, LDPE	75 to 95	85 to 95	A
Enviro-Curb (Enviro-Curb Manufacturing)	HDPE	75	100	A
MAXITUF (Resco Plastics)	HDPE	60	100	A
Perma-Deck Advantage+ (Cascades)	HDPE	50	100	A
Eco-Tuff (Eco-Tech)	HDPE	50	90	A
BreezeWood (Aeolian Enterprises)	HDPE	50	50	A
Environmentally Preferable				
Perma-Deck Elegance (Cascades)	HDPE / wood	50	100	B
Rhino Deck (Master Mark Plastics)	HDPE / wood	50	100	B
Plasboard (Northern Plastic Lumber)	HDPE, LDPE, PP / R	75	100	C
Less Environmentally Preferable				
Evolve, Perma-Poly (Renew Plastics Division)	HDPE	NA	90	D
Four Seasons (Delmarva Industries)	HDPE	0	100	D
WindRiver Fence (Aeolian Enterprises)	HDPE	0	0 to 30	D
Dream Composite Deck (Thermal Industries)	HDPE, LDPE / rice hulls, paper pulp	33	100	E
ChoiceDek (A.E.R.T., Inc.)	HDPE, LDPE / wood	30	100	E
CorrectDeck (Correct Building Products)	PP / wood	1 to 20	70	E
Trex Origins (Trex)	HDPE, LDPE / wood	some	100	E
Geodeck (Kadant Composites)	HDPE / cellulosic fiber, minerals	0 to 35	40 to 85	E
fiberon (Fiber Composites)	HDPE, LDPE / wood	NA	50 to 100	F
Latitudes Decking (Universal Forest Products)	HDPE / wood	NA	75 to 88	F
Veranda (Universal Forest Products)	HDPE / wood	NA	75 to 88	F
Monarch (Green Tree Composites)	HDPE / wood	0	75 to 80	F
WeatherBest Select (Louisiana-Pacific)	HDPE / wood	0	60 to 95	F
CrossTimbers (Elk Composite Building Products)	PP / wood	0	66	F
Evergrain (Epoch Composite Products)	HDPE, LDPE / wood	NA	NA	F
Oasis Composite (Alcoa Home Exteriors)	HDPE / wood	NA	NA	F
TimberTech (TimberTech)	HDPE / wood	NA	NA	F
Polywood nonstructural (Polywood)	HDPE, PS	50	100	G
Not Environmentally Preferable Except for Structural Applications				
Ameriwood-Plus (American Plastic Lumber)	HDPE, LDPE / FG	75 to 95	85 to 95	H
Trimax (U.S. Plastic Lumber)	HDPE / FG	65	65	H
FiberForce (Bedford Technology)	HDPE, LDPE / FG	50	95	H
Polywood (Polywood)	HDPE, PS	30	100	H
Not Environmentally Preferable – Avoid				
Boardwalk (CertainTeed)	PVC / wood	0	45 to 50	I
Country Estate (Nebraska Plastics)	PVC	0	0	I
Deck Lok (Royal Crown)	PVC	0	0	I
Deck/Dock (Wastech Fencing)	PVC	0	0	I
Dream Deck (Thermal Industries)	PVC	0	0	I
EverNew, Bufftech (CertainTeed)	PVC	0	0	I
Forever-Wood (Forever Wood)	PVC	NA	94	I
Oasis PVC Deck (Alcoa Home Exteriors)	PVC	0	0	I
Procell (Procell Decking Systems)	PVC / flax	0	<20	I
Sheerline (L.B. Plastics)	PVC	0	0	I
Synboard (Synboard America)	PVC	NA	NA	I
VEKAdeck (VEKA)	PVC	0	0	I
vinyl decking (Poly Vinyl Creations)	PVC	0	0	I
eon (CPI Plastic Group)	PS	0	0	J
XPotential (Xpotential Products)	Many types	30	100	K

FG = fiberglass **HDPE** = high-density polyethylene **LDPE** = low-density polyethylene
PP = polypropylene **PS** = polystyrene **PVC** = polyvinyl chloride **R** = rubber

Notes to Figure 1

Total recycled content may include scrap generated from manufacturing. For wood-plastic composites, the total recycled content includes wood and plastic. These composites are typically 50 to 75 percent wood.

Avoid products from companies not listed on this chart until they provide product information. See Appendix of report for a list of companies who did not respond to our information requests.

A	High post-consumer recycled content, high potential recyclability, AND made from resins associated with fewer environmental health hazards throughout their lifecycle.
B	Good recycled content but end-of-life recyclability hampered by wood-plastic mixture.
C	High recycled content but made with a mixture of recycled resins which could limit applications as well as end-of-life recyclability.
D	Low or unknown post-consumer recycled content; similar products with higher post-consumer recycled content available.
E	Some post-consumer recycled content but end-of-life recyclability still hampered by wood-plastic mixture.
F	Zero or unknown post-consumer recycled content AND combines wood or other cellulosic material with plastic hampering end-of-life recyclability.
G	Made with recycled pre-consumer polystyrene. Virgin polystyrene is a material associated with a hazardous production process.
H	Made with polystyrene or fiberglass, materials associated with greater health hazards during their lifecycle. These products have added strength for demanding structural applications and their use may be justified for these situations; otherwise avoid.
I	Made with virgin PVC, a material associated with greater environmental health hazards throughout its lifecycle and that has few recycling options.
J	Made with virgin polystyrene, a material made with known and suspected human carcinogenic materials.
K	Contains auto-shredder fluff, which can contain brominated flame retardants and heavy metals.

Disclaimer: Neither the Healthy Building Network nor the Institute for Local Self-Reliance has tested or assessed any of these products for material content or performance. In addition, we could not fully assess the nature of additives and did not rate these products based on toxicity of additives such as color pigments.

Source: Healthy Building Network (HBN), 2005. Data for 15 companies was collected via HBN's February 2005 Web-based survey. For the other 29 companies, data is based on visiting the manufacturer's Web site and/or by contacting the company.

Rating Criteria and Findings

I. Materials Used

Most plastic lumber products on the market are made from high- and low-density polyethylenes (HDPE and LDPE). Some manufacturers are also using polystyrene (PS) and polyvinyl chloride (PVC). Some combine polystyrene or fiberglass with HDPE. Still others rely on a commingled mix of different types of plastic resins (largely collected from municipal recycling programs).

Presently all the plastics used in plastic lumber are derived from petroleum and natural gas. As such they share the significant environmental health burdens associated with fossil fuel extraction, refining, and use. They vary significantly, however, in their environmental and public health implications because of differences in the chemicals and additives used to achieve the desired properties of the plastic.

The toxic hazards of the PVC lifecycle from its manufacture, use, and disposal lead many to consider it the worst plastic from an environmental health perspective.

In this report, the plastic resins used in plastic lumber are evaluated and compared for chemical hazards applying a methodology developed by the Healthy Building Network. This hazard assessment method emphasizes pollution prevention at the source "by avoiding materials and processes that use or generate priority hazardous chemicals …that have been targeted for reduction or elimination on a select set of U.S. and international governmental lists."[5] By using this methodology, we link the significance which we place on the environmental and public health impacts of these materials to established public policy goals. When applied against these criteria, some plastic resins are clearly better than others from an environmental and public health perspective. Polyethylene has fewer chemical hazards and associated impacts than PVC or PS. A similar conclusion has been reached by other independent authorities including Environmental Building News,[6] The GrassRoots Recycling Network,[7] and Greenpeace.[8]

Figure 2 lists the various plastic resins used to make plastic lumber, and identifies associated health issues and recyclability potential. In addition, fiberglass is a major component of some plastic lumber, and its human health impacts also deserve consideration.

Polyethylene (HDPE and LDPE)

High-density polyethylene plastic (HDPE), frequently used to make milk and water jugs and shampoo containers, is one of the most highly recycled plastics. In 2001, the recycling level for high-density polyethylene (HDPE) milk and water bottles was 28.4%.[9] An average 300-pound picnic table made from recycled HDPE utilizes between 1,890 and 2,700 milk jugs.[10] Low-density polyethylene (LDPE) is used to package cream cheese, butter, spreads, and other dairy products. In addition, many plastic bags are made from LDPE.

Like all fossil-fuel-based plastics, polyethylene manufacturing is an energy-intensive process that utilizes numerous toxic and hazardous materials. Emissions of polyethylene manufacturing facilities include a wide range of persistent, bioaccumulative, and toxic outputs. However, both HDPE and LDPE lack additional toxic inputs associated with the two other plastics used in plastic lumber, polystyrene, and PVC. This in turn results in fewer toxic hazards throughout the full production cycle, as well as during routine use and at the end of the product's service life.[11] Fewer additives and a more uniform composition also help account for the relatively high recycling rate of HDPE. These properties also suggest that recycled polyethylene products intrinsically have high recycling potential.

Figure 2: Plastics Used in Plastic Lumber

		Other Common Applications	Health Issues	Recyclability
PREFER	High-Density Polyethylene (HDPE)	milk and water jugs, detergent containers, trash bags	HDPE does not require toxic plasticizers such as phthalates. Some applications use flame retardant additives, which if brominated are toxic.	High potential for mechanical recycling. HDPE bottles are collected in most curbside recycling programs. In 2001, 28% of HDPE milk and water bottles were recycled.
▲	Low-Density Polyethylene (LDPE)	dry-cleaning, trash, produce, and bread bags; shrink wrap; containers for dairy products	LDPE does not require toxic plasticizers such as phthalates. Some applications use flame retardant additives, which if brominated are toxic.	Technically can be recycled; actual recycling levels are under 3%. Infrastructure for collection of LDPE wrap and bags is not well developed.
▲	Polystyrene (PS)	foam insulation, packaging peanuts, plastic utensils, meat trays, egg cartons, take-out containers, single-use disposable cups	PS production uses benzene (a known human carcinogen), and styrene and 1,3-butadiene (suspected human carcinogenic substances). Styrene is a neurotoxin and is known to be toxic to the reproductive system. PS releases toxic chemicals when burned.	Recycling level is negligible, less than 1%.
AVOID	Polyvinyl Chloride (PVC or vinyl)	Most PVC is used in building materials such as pipes, siding, membrane roofing, flooring, and window frames as well as in other consumer products such as shower curtains, beach balls, and credit cards	PVC is made from the vinyl chloride monomer, a known human carcinogen. PVC has a high chlorine and additive content. Toxic additives such as phthalate softeners are not bound to the plastic and leach out. PVC releases dioxin and other persistent organic pollutants during its manufacture and disposal.	Recycling level is negligible. At trace quantities, PVC can interfere with the recycling of other resins such as HDPE and polyethylene terephthalate (PET) used in soda and water bottles.

Source: Healthy Building Network, 2005.

Polyvinyl Chloride (PVC)

PVC plastic, commonly known as vinyl, is unique in that its composition is at least 50% chlorine content by weight. PVC uses about a third of the world's chlorine production. The toxic hazards of the PVC lifecycle from its manufacture, use, and disposal lead many to consider it the worst plastic from an environmental health perspective. Production and disposal of PVC releases – into the air, water and land – persistent pollutants that present both acute and chronic health hazards. They are known to cause cancer, disrupt the endocrine system, impair reproduction, cause birth defects, impair child development, damage the brain, disrupt the immune system, and cause endometriosis and neurological damage. Many of these pollutants, especially dioxins, are dispersed throughout the world and exist in the bodies of most Americans at detectable levels.[12] [13]

Finally, PVC is useless without the addition of a plethora of toxic chemical stabilizers – such as lead, cadmium and organotins – and phthalate plasticizers. These are required to keep PVC from breaking down and to make it flexible or rigid as needed. They are, however, not permanently bound to the PVC but rather slowly released from the PVC. The resulting pollution presents risks that include asthma, lead poisoning, birth defects, and cancer. The multitude of additives required to make PVC useful make large scale post-consumer recycling nearly impossible for most products and interfere with the recycling of other plastics. The Association of Post Consumer Plastics Recyclers declared PVC a contaminant in 1998.[14] PVC also poses a great risk in building fires. Long before it ignites, PVC releases deadly gases such as hydrogen chloride, which turns to hydrochloric acid in contact with moisture, such as in the lungs when inhaled. As PVC burns, whether intentionally in waste incinerators or burn barrels, or accidentally in building or landfill fires, it releases yet more toxic dioxins.[15]

The Chlorine Factor: The Problem with PVC

PVC is made from the monomer vinyl chloride, classified by the U.S. Environmental Protection Agency as a known human carcinogen. Vinyl chloride is made from substantial amounts of chlorine. It is the chlorine in PVC that contributes to the formation of dioxin, another human carcinogen, during production, and when it burns in fires or waste incinerators. Because of its high chlorine content and large production volumes, PVC is likely the largest material source of dioxin to the environment.

Dioxin is a persistent bioaccumulative toxic chemical (PBT). It does not degrade rapidly, accumulating in fatty tissue and concentrating as it goes up the food chain. For example, dioxins from Louisiana manufacturing plants migrate on the wind and concentrate in Great Lakes fish. Dioxins are even found in hazardous concentrations in the Arctic Circle in the tissues of whales and polar bears and in Inuit mothers' breast milk. The dioxin exposure of the average American already poses a calculated risk of cancer of greater than 1 in 1,000. Even worse, dioxins concentrate in breast milk to the point that human infants now receive high doses, orders of magnitude greater than those of the average adult.

Dioxins are among a class of synthetic chemicals known as endocrine disruptors, chemicals that mimic the role of hormones in human biology and that are believed to interfere with each stage of human development – damaging the male sperm, the female egg prior to fertilization, and the fetus in utero.

In the US, PVC is manufactured predominantly near low-income communities in Texas and Louisiana. The toxic impact of pollution from these factories on these communities has made them a focus in the environmental justice movement. Chlorine is also a highly toxic chemical and makes the PVC manufacturing plants and the trains that supply them highly vulnerable. A simple terrorist attack could release a toxic cloud or clouds that would spread for miles, potentially endangering millions of lives.

Source: Thornton, Joe. *Pandora's Poison: Chlorine, Health and a New Environmental Strategy* (March 2000, MIT Press); and Thornton, Joe. *Environmental Impacts of Polyvinyl Chloride Building Materials*. Washington: Healthy Building Network, 2002.

Polystyrene (PS)

The process of manufacturing polystyrene includes benzene, ethyl benzene, and the monomer styrene. Benzene is a known carcinogen. Ethyl benzene is a possible carcinogen. Styrene is a suspected human carcinogen and a known neurotoxin which can attack the central and peripheral nervous systems.[16] Styrene also adversely affects the digestive, respiratory, and endocrine systems.[17] Styrene is considered a hormone-disrupting chemical.[18] Burning polystyrene poses further health impacts. One study indicates that when burned at temperatures of 800-900 degrees Celsius (the typical range of a modern incinerator), the products of polystyrene combustion consisted of "a complex mixture of polycyclic aromatic hydrocarbons (PAHs) from alkyl benzenes to

benzo[ghi]perylene. Over 90 different compounds were identified in combustion effluents from polystyrene."[19] In addition, like PVC, polystyrene is recycled at negligible levels due in part to technical difficulty and in part to difficulty and impracticality of establishing an infrastructure for collecting polystyrene discards.

Fiberglass

Some companies add fiberglass to reinforce plastic lumber and enable it to bear loads comparable to wood lumber. Fiberglass is a "mechanical irritant" and any surface fiberglass should be removed for applications where human or animal skin will come into contact with the material.[20] More importantly fiberglass has been linked to pulmonary disease, affecting the lungs in a manner similar to asbestos, though not as virulent. In 1994, the U.S. National Toxicology Program in its Seventh Annual Report on Carcinogens noted that fiberglass is "reasonably anticipated to be a carcinogen." Although currently listed by the International Agency for Research on Cancer (IARC) as "unclassifiable" with regards to carcinogenicity, this status is controversial, and some researchers believe fiberglass (like the similar naturally occurring fiber asbestos) causes cancer in animals and humans. [21] Workers machining fiberglass-reinforced plastic lumber are advised to wear a properly fitting NIOSH[22] approved dust mask for respiratory protection and to wear protective gloves when handling it.[23]

Although manufacturers using fiberglass claim that respirable glass fibers are present at de minimus levels during manufacturing and use,[24] we know of no independent studies that support this claim with data gathered during the manufacturing process, or during the sawing and grinding typically associated with product usage and recycling operations respectively.

Aren't all plastics bad?

A 1996 *Report of the Berkeley Plastics Task Force* found that a link exists between the promotion of plastics recycling and an increase in production of virgin resin.[1] The most recycled plastics are HDPE, LDPE, and polyethylene terephthalate (PET, commonly used for soda bottles). Their combined recycling rate is 8%.[2] The recycling level for all other types of plastics combined is less than 3%. Plastics recycling can also be used to justify the production of disposable and single-use packaging and thus thwart any efforts to switch to biodegradable or reusable materials.[3] Plastic is the fastest growing part of the waste stream and by far the most expensive for cities to manage. Plastic waste also threatens the very life of the ocean. Recent research, for example, reveals that the ocean surface has six times more mass of plastic pieces than zooplankton, the source of life.[4]

The manufacture of virgin plastics from fossil fuels is causing serious damage to our environment. Refining petroleum and making virgin plastics consumes energy and releases pollution, some of which is highly toxic. (Plastics production accounts for 4 percent of all U.S. energy consumption.[5]) All fossil-fuel-based plastics contain or release some carcinogens at some point in their lifecycle. Some – like PVC and polystyrene – rely upon additional toxic chemicals, which make their environmental health impact even greater.

On the other hand, plastic lumber reduces demand for other materials having serious environmental impacts. Many people do not realize that "pressure-treated" wood widely used for decks and fences is infused with chemicals. Even though the worst of these (arsenic and chromium) have been drastically curtailed, they have not been totally eliminated. All pressure-treated wood still contains copper, which alone renders the wood unacceptable for chipping and mulching. The wood itself, as well as naturally rot-resistant species like redwood, usually comes from unsustainable timber operations. Plastic lumber also competes with other materials such as concrete, steel and aluminum, which have high environmental impacts.

Clearly some plastics, such as PVC and polystyrene, are not only bad, but also easily replaced by other materials, including other plastics. These plastics must be phased out of production and use. Phasing out the worst plastics, halting the indiscriminate use of plastics – especially in non-durable goods – increasing the societal commitment to mandatory plastics recycling, and increasing investment in bio-based plastics hold out the prospect that some plastics may have a role in a sustainable economy. In that context, recycled plastic could play a role in reducing the demand for virgin plastic resin and the volume of plastic waste.

1 Report of the Berkeley Plastics Task Force, April 8, 1996, available online at http://www.ecologycenter.org/ptf.

2 U.S. EPA Office of Solid Waste and Emergency Response, *Municipal Solid Waste in The United States: 2001 Facts and Figures*, EPA530-R-03-011 (Washington, DC: October 2003).

3 Woolley, Tom and Sam Kimmins. *Green Building Handbook: A Guide to Building Products and Their Impact on the Environment, Vol. II*. London: E & FN Spon, 2000.

4 "Plastic Debris: Rivers to Sea," Algalita Marine Research Foundation Web site at http://www.plasticdebris.org.

5 "Plastics," Municipal Solid Waste Web site of the U.S. Environmental Protection Agency, http://www.epa.gov/epaoswer/non-hw/muncpl/plastic.htm.

Findings

Polyethylene plastic lumber products are clearly preferable to those manufactured with PVC, polystyrene, or fiberglass. While still burdened with the significant environmental problems associated with all fossil-fuel-based plastics, polyethylene lacks many of the unique environmental and health impacts associated with PVC, polystyrene, and fiberglass. For these reasons, we rate polyethylene feedstocks as most environmentally preferable, downgrade any product whose composition combines other materials that "contaminate" the polyethylene, and recommend avoiding the use of PVC, polystyrene, and fiberglass – especially products made from virgin PVC or polystyrene such as Synboard, CertainTeed's Boardwalk and CPI's eon.

II. Recycled Content

Plastic lumber products range from 100% recycled content to those made entirely from newly manufactured or "virgin" PVC.

Our ratings value recycled content and recyclability of the product strongly not only because of the reduction in raw materials consumption and solid waste, but because of the reduction in the environmental and health impacts of production and disposal. Recycling can save energy, reduce air and water pollutants, and cut greenhouse gases that contribute to global warming.[25]

Furthermore, buying recycled products supports local recycling initiatives by increasing demand for material collected. This in turn creates jobs and can help strengthen local economies, especially if materials are made into finished products within local economies. This is often the case with many plastic lumber companies who obtain recycled feedstocks from local or regional sources.

Recycled plastic lumber can potentially utilize a high proportion of polyethylene plastics in the waste stream. In the late 1990s, total recycled plastic lumber production was about 16 million board feet (about 40 million pounds of discarded plastics). By 2001, total production had climbed to more than 120 million board feet (about 300 million pounds of discarded plastics). The current annual growth rate for this industry is about 40 percent. However, the consumption rate of plastic lumber is still a fraction of what it is for softwood lumber (about 34 *billion* board feet per year).[26]

Post-consumer vs. Post-industrial Recycled Plastic Content

Recycling experts generally value *post-consumer* recycled materials higher than *post-industrial*. Post-consumer[27] recycled materials come from products that have already been used and discarded by a business or consumer, as opposed to post-industrial (also called pre-consumer) recycled materials that are from manufacturing waste. It is important to distinguish the two.

Obviously recycling industrial plastic scraps is preferable to disposing them, but for most manufacturing operations this has long been a standard business practice. Therefore, the use of post-industrial, pre-consumer recycled materials in plastic lumber does not represent an improvement over current practice. Because the use of pre-consumer or post-industrial content does not meaningfully reduce the overall consumption of raw materials and disposal of products, we do not reward the use of post-industrial recycled content plastic.

Findings

Recycled content varies among plastic lumber products that claim post-consumer content. More than one half of the products we review contain post-consumer plastic content. We give the most credit to products that have a minimum of 50% post-consumer recycled content and a composition with a high potential for end-of-life recyclability. We give lower ratings to products that have less than 50% minimum post-consumer content, or whose mixtures limit the products' own potential recyclability. We also rank lower products that contain plastics recovered from shredded automobiles, known as auto-shredder fluff, because these are known to contain heavy metals and other toxic chemicals.

III. End-of-Life Recyclability: A Facet of Sustainable Design

In order to make a significant long-term impact on reducing resource use and disposal, it is not only important that plastic lumber include recycled content, but also that the lumber product itself be recyclable at the end of its life. Otherwise the material will still eventually end up in an incinerator or landfill. Plastics use overall is increasing, while plastics recycling fails to keep pace with that growth.[28] Plastic lumber could help close that gap – or it could just provide greenwash incentive for more plastic manufacturing and use.

Plastic lumber is currently largely made from first-use applications that are not environmentally sound, like packaging made from virgin plastic.[29] Unless plastic lumber is itself truly, efficiently recyclable and thus can become part of a closed-loop system of plastic products being indefinitely recycled, a growing plastic lumber market could actually increase plastics production and waste volumes.

Some manufacturers claim that their plastic lumber products (including wood-plastic composite lumber) are recyclable.[30] These claims cannot be easily tested at this time. Although most manufacturers claim that there are few technical barriers to recycling their product, the same could be said for most plastics in use today, or bottles or cans or paper, most of which goes unrecycled in the United States for the lack of infrastructure and the public policy to support it. Even if original manufacturers are able to recycle their products once they come out of service, experience shows that in the absence of legislation or a well-developed infrastructure, this is unlikely to happen.

While plastic lumber has been in use for the last 15 years, it is a durable product and little of it has yet to come out of service. [31] Therefore, there is not enough experience with plastic lumber to determine whether or not it will be feasible to recycle after its service life. A number of plastic lumber manufacturers take back scraps from construction or installation and recycle this material back into their product lines. Some companies producing all-HDPE plastic lumber are even selling scraps to third-party recyclers.[32] However, this is far different than recycling the product once it has reached the end of its service life.

Municipal recycling programs generally do not accept and recycle plastic lumber. However, private sector recycling at construction demolition and building sites is a growing trend. Successful construction material recovery efforts involve segregating materials by type such as wood, metal, bricks, and gypsum board. Few if any building products are sent back to original manufacturers. Thus it is likely that if plastic lumber is to be recycled efficiently after its service life, it will have to be marketable to multiple end users. Because of this, product

Will recycled-content products perform as well as their virgin-materials-based counterparts?

The U.S. Environmental Protection Agency (EPA) issues recommended guidelines for buying a variety of recycled-content products, including plastic lumber products such as landscaping timber, park benches and tables, and fencing. These Comprehensive Procurement Guidelines, which are updated every two years, recommend post-consumer recycled content – as well as total recovered content – for specific products. U.S. EPA research indicates that items designated in its guidelines can perform as well as products made with virgin materials. Many federal, state, and local agencies have purchased recycled-content plastic lumber for a wide range of end uses and have been pleased with product performance and cost effectiveness.

The American Society for Testing and Materials (ASTM) has coordinated the development of performance-based industry standards for plastic lumber products. It has developed nine standard specifications for plastic lumber and more are on the way. These standards include test methods, specifications, recommended practices, and definitions for dimensional profiles made from recycled plastics. ASTM's latest standard on polyolefin-based plastic lumber decking boards, for instance, addresses the proper use of recycled plastic lumber and resolves issues such as dimensional tolerances, creep, allowable material properties for structural design, outdoor weathering, and UV exposure.

For more information on EPA's Comprehensive Procurement Guidelines, visit http://www.epa.gov/cpg

For more information on ASTM's plastic lumber standards, visit http://www.astm.org

composition assumes greater importance. One major factor that will likely impact the recovery of plastic lumber is its composition.

Single Resins

More than two dozen companies offer lumber made from a single resin, polyethylene, most commonly HDPE, one of the most recyclable and recycled plastics. (Some products also use LDPE, a low-density version of the same resin.) Plastic lumber made from a single recyclable resin has more recycling possibilities than lumber made from mixtures.

To be economically feasible, plastics recycling must have sufficient volumes to support the necessary infrastructure to handle the materials separately from solid waste, and provide a reliable resource stream to end users. Although setting up dedicated recovery systems for each plastic lumber blend is theoretically possible, there is no evidence to suggest that such a system would be economically feasible.

A growing plastic lumber market could actually increase plastics production and waste volumes.

The most successful plastics recycling ventures – municipal beverage container recycling programs – teach that avoiding contamination of desirable commodities such as polyethylene increases their value.[33] Indeed, because HDPE has one of the highest plastics recycling levels, there is ample reason to believe that HDPE lumber is the most likely plastic lumber product to be routinely recycled by far. Some companies making all-HDPE lumber currently sell returned cut-offs to third party recyclers, providing further confirmation that "pure" resin lumber will have more recycling options than composites.[34]

Synthetic Composites

Some plastic lumber manufacturers combine different plastics or add fiberglass to their product. With the exception of high load-bearing or demanding structural applications (see below), there appears to be no clear environmental advantage and numerous environmental disadvantages to these mixtures, because of the chemical hazards and associated impacts of the additional materials such as PVC, polystyrene, fiberglass, and the mixed plastics in automobile fluff. Another disadvantage is the lack of a viable recycling option after the service life of the product.

Composite products are usually more difficult to recycle than single-resin products, have fewer end markets, and are therefore inherently less valuable to secondary markets than a "pure" product. There is no evidence to suggest that there will be an end market for synthetic composite lumber products, other than the original manufacturer. It is not likely to be economically feasible to systematically return all plastic lumber to the manufacturer at the end of its service life.

Wood-Plastic Composites

Many lumber manufacturers blend wood fiber with plastics. While this may reduce the use of non-renewable plastics, there are several environmental disadvantages to this formula. As with other composites, the record of plastics recycling to date shows that "contaminating" the polyethylene with another material is likely to limit long-term recycling options.[35] The decision to inextricably combine a biodegradable material with a synthetic material also appears to violate a fundamental principle of sustainable design, which is to segregate synthetic from biological materials.[36]

Furthermore, it is unknown whether or not a plastic lumber product containing biodegradable materials can be technically recycled after 10 or more years of exposure to the elements.

Findings

Plastic lumber has not been on the market long enough to evaluate recycling rates for products at the end of their service life. The record of plastics recycling to date suggests that polyethylene is one of only two plastic resins to be recycled systematically. (The other is polyethylene terephthalate – PET, commonly used for soda bottles – which is not a main feedstock material for plastic lumber.) For all low load-bearing plastic lumber applications, there are all-polyethylene lumber products with high recycled content. Therefore we give a lower rating to products that combine other materials with HDPE or LDPE.

IV. Structural Lumber: The Exception to the Rule

In general we downgrade plastic lumber products that combine fiberglass or polystyrene feedstocks with polyethylene. At the present time, however, all plastic lumber products suitable for demanding structural or high load-bearing applications rely upon one of these combinations for added strength. These applications include bridge supports and railroad ties. Because structural plastic lumber products compete directly with wood that is treated with toxins such as arsenic, copper, chromium and creosote, which also present environmental and health hazards throughout their lifecycle, composite plastic lumber has advantages in these applications that may outweigh the disadvantages of these composites, such as leaching while in service.

Recommendations

The Healthy Building Network endorses the following guidelines for plastic lumber purchases. These guidelines are based on environmental, public health, and recycling considerations.

- **Favor products:**
  - **with high recycled content,** specifically high post-consumer recycled content.
  - **made from high-density and low-density polyethylene (HDPE and LDPE)**, recyclable resins associated with fewer chemical hazards and impacts than other petroleum-based polymers.
  - **by producers sourcing resins from local municipal recycling programs**, therefore cutting transportation costs and supporting the local economy.
- **Limit use of:**
  - **wood-plastic composites** because of concerns about mixing biological and synthetic materials, including limited end-of-life recyclability.
  - **fiberglass-reinforced or polystyrene-blended "structural" plastic lumber to demanding structural applications** such as railroad ties and bridge supports, as a less toxic alternative to chemically treated wood.
  - **products with multiple commingled recycled consumer plastics** as they will have more contaminants and inconsistent properties. They also support token markets for plastics that otherwise are largely unrecyclable, and many of which are highly toxic. This perpetuates the use of plastics that should be phased out.
- **Avoid products made with:**
  - **PVC and polystyrene** because these are associated with more chemical hazards and impacts throughout their lifecycle than other plastics.
  - **fiberglass for nonstructural applications** that do not require reinforced plastic lumber (such as decking boards, benches, and tables).
  - **predominantly nonrecycled plastics.** Alternatives with high recycled content are readily available.

How to Choose

Check Healthy Building Network's ratings: HBN's ratings will help identify which brands to avoid and which ones are more environmentally preferable.

Know your application: Different products have different performance qualities. Take the time to understand the properties of the particular plastic lumber you buy, particularly whether it will be used in demanding structural or high-load-bearing applications. The most environmentally preferable HDPE-only plastic lumber can be used for many plastic lumber applications: benches, tables, decking, playground equipment, and more. HDPE-only plastic lumber does not have the same load-bearing capacity as wood, so it won't work for bridge supports and other higher-load-bearing applications. No high-load-bearing plastic lumber products – such as fiberglass-reinforced plastic or polystyrene-polyethylene blends – earn our most environmentally preferable rating. For certain applications, however, they may actually be preferable to the products they replace. A good example may be railroad ties, which have traditionally been made from creosote-soaked wood, or chemically treated wooden bridge supports. When choosing a more engineered plastic for demanding structural situations, at minimum look for high post-consumer content.

Beware of nontoxic claims and greenwashing: Despite claims of being "green," not all plastic lumber products are created equal. If the product is made from PVC or polystyrene, be assured it is not environmentally preferable. Lumber made from high-density and low-density polyethylene (HDPE and LDPE) and 100% post-consumer recycled content is the most environmentally preferable currently available on the market. Most manufacturers add additives such as color pigments and UV stabilizers to prevent polymer breakdown in the sun. Some companies acknowledge the "possible risk of exposure to hazardous ingredients" but tend to emphasize that the risk "is reduced to encapsulation in plastic."[37] These claims have not been verified.

Talk to suppliers: Insist that suppliers offer the most environmentally preferable products. (Most lumber yards offer a limited selection and this tends to feature the wood-plastic composites. Lowe's offers ChoiceDek, Home Depot offers Veranda, and many offer Trex, all of which fall in our "Less Environmentally Preferable" category.) Also request that suppliers recycle installation scraps and cut-offs and let them know that recycling is important to you.

Consider where you live: Many of the companies making recycled-content lumber products are small-scale enterprises that obtain their recycled feedstocks from local and regional municipal recycling programs and largely market their lumber within the same region. If you live near one of these enterprises, your purchase can help divert plastic waste from disposal and contribute to local economic development and job creation. More than 1,800 U.S. businesses handle or reclaim post-consumer plastics.[38] In contrast, only a handful of corporations make virgin resins.

If you live in an area where sustainably harvested lumber products are locally grown, produced, and sold, these may be your greenest choice. Look for lumber certified by the Forest Stewardship Council (FSC), which ensures that the wood was grown and harvested in a manner that balances economic, environmental, and social justice concerns. See http://www.fscus.org for more information.

Dollars & Sense: Plastic lumber is generally more expensive than wood, but it may be more durable and does not need sealants, preservatives or paint, so the savings in maintenance expenses can outweigh the initial costs. When materials and installation, maintenance, replacement, and disposal costs are included in a cost analysis, recycled plastic lumber can cost less than wood.[39]

High-volume purchasers: Government agencies and other high-volume purchasers can specify environmentally preferable products in their purchasing policies. In addition, procurement contracts with plastic lumber vendors can encourage collection and recycling of plastic lumber products once they have served their intended use. (The Commonwealth of Massachusetts, Operational Services Division, specifies in its procurement language for recycled plastic equipment that "it is desirable that bidders offer recycling options" for such products.[40])

Conclusions

More than one quarter of the products reviewed in this report are identified as "Most Environmentally Preferable." These products are made from polyethylene, a highly recyclable plastic, and thus have a realistic chance of being recycled after their service life. All have at least 50% post-consumer content, and a number of these are made from 100% post-consumer recycled content. This suggests that the most environmentally preferable products can also become the industry standard in plastic lumber products.

Manufacturers of composite products (those containing mixtures of plastics, fiberglass, or wood-plastic mixtures) sometimes claim performance advantages, such as greater strength and less heat retention and slipperiness. Manufacturers of HDPE-only products counter that they are able to engineer comparable features and performance into noncomposite products for most applications. According to the *Consumer Reports Magazine* review of plastic lumber (which did not distinguish among the plastics used), "In most instances, one type will serve as well as another."[41] We identified only one exception to the general preference for 100% post-consumer HDPE products – demanding structural applications. Presently it appears that the only plastic lumber products suitable for demanding structural applications obtain their additional strength from polystyrene or fiberglass that is added to make a composite product. Consequently, we conclude that is the only exception to the general rule to buy all-polyethylene products.

In summary, the plastic lumber market manifests high potential to create a closed-loop system for using large volumes of post-consumer HDPE plastic over the long term. This is an excellent opportunity for retailers and consumers to steer this emerging market toward its greatest sustainability potential by selecting these products. Manufacturers should concentrate research and development programs towards optimizing these products, and especially developing the infrastructure necessary to ensure recycling of their products after their service life.

Resources

RecyclingMarkets.Net
Recycling Markets
P.O. Box 577
Ogdensburg, NY 13669

info@recyclingmarkets.net
http://www.recyclingmarkets.net

A searchable database of more than 17,000 U.S. and Canadian companies involved in the recycling process. It includes manufacturers and distributors of plastic lumber and decking and of products constructed from these materials. Companies in the database must meet the Recycled Products Guide (RPG) certification of recycled content in their products.

Recycled-Content Product Directory
California Integrated Waste Management Board
1001 I Street, Sacramento, CA 95812

http://www.ciwmb.ca.gov/RCP

A searchable database of vendors who sell or distribute products with recycled content. Its database lists post-consumer as well as total recycled content and has links to company Web sites.

Comprehensive Procurement Guidelines (CPG)
1200 Pennsylvania Avenue
Washington, DC 20460

cpg@erg.com
http://www2.ergweb.com/cpg

A searchable database of vendors who sell or distribute CPG-designated products with recycled content. This powerful tool allows users to search for vendors of a specific CPG product, product category, or type of material.

Building Green, Inc.
122 Birge Street, Suite 30
Brattleboro, VT 05301

info@buildinggreen.com
http://www.buildinggreen.com

An independent company that provides information for building-industry professionals and policy makers who want to reduce the environmental impacts and natural-resource demands of buildings. Publisher of *Environmental Building News*, *The GreenSpec Directory*, and *Green Building Advisor*.

Green Resource Center (GRC)
PO Box 11944
Berkeley, CA 94712

info@greenresourcecenter.org
http://www.greenresourcecenter.org

The GRC's Web site provides an extensive source of information about green building and includes links to many other organizations and sources. It also has a fact sheet on "Recycled Plastic Lumber."

Appendix 1:
Plastic Lumber Companies That Did Not Respond to Our Inquiries or Survey

The following companies did not respond to our survey or requests for data on their products. Avoid their products until they inform consumers about product composition. We will periodically add products and update content information on our Web listing and the Web version of this report. Please submit company/product updates to plasticlumber@healthybuilding.net.

Company	Brand Name
Amazing Recycled Products	Aztec Plastic Lumber
Black Rhino Recycling	
Center Industries Ltd.	
Cooley Forest Products	Geodeck, cactus pine, Pyro-Guard
Duraplex Inc.	
Earth Technology Corporation	
Envirosafe Products Corp.	Permawood, Duraplast, Permapost, Permafloor
Fibrex Group Inc.	The FiberX Group envirodesign
Inteq Corporation	
J L Sims Company, Inc.	
J-Mac Lumber Inc.	MacLumber II
Outwater Plastics Industries Inc.	
P&M Plastics Inc.	Altree
Phoenix Recycled Plastics	Foreverdeck, Foreverdock
Plastic Lumber Depot	
Plastic Recycling of Iowa Falls	
Play Mart, Inc.	RSP

Appendix 2:
Contacts for Plastic Lumber Companies

A.E.R.T., Inc. (ChoiceDek)	http://www.aertinc.com
Aeolian Enterprises (BreezeWood)	http://www.aeo1.com
Alcoa Home Exteriors (Oasis Composite, Oasis PVC Deck)	http://www.alcoa.com/alcoahomes/Content/OasisDecking.aspx
American Plastic Lumber (Ameriwood3)	http://www.american-plasticlumber.com
Bedford Technology (Select)	http://www.plasticboards.com
BJM Industries	http://www.bjmindustries.com
Cascades (Perma-Deck Advantage +)	http://www.cascadesreplast.com/english/fs_replast.html
CertainTeed (Boardwalk)	http://www.certainteed.com/certainteed/index.htm
Correct Building Products (CorrectDeck)	http://www.correctdeck.com
CPI Plastic Group (eon)	http://www.cpiplastics.com
Delmarva Industries (Four Seasons)	http://www.delmarvaindustries.com/index.html
Durable Plastic Design (Orcaboard)	http://www.orcaboard.com
Eco-Tech (Eco-Tech)	EcTch@aol.com
Elk Composite Building Products (CrossTimbers)	http://www.elkcorp.com
Engineered Plastic Systems (Bear Board)	http://www.epsplasticlumber.com
Enviro-Curb Manufacturing (Enviro-Curb)	http://www.envirocurb.com
Epoch Composite Products (Evergrain)	http://www.evergrain.com
Everlast Plastic Lumber (Everlast)	http://www.everlastlumber.com
Fiber Composites (fiberon)	http://www.fiberondecking.com/sitemap.asp
Forever Wood (Forever-Wood)	http://www.forever-wood.com
Green Tree Composites (Monarch)	http://www.biewerlumber.com/greentree.htm
Kadant Composites (Geodeck)	http://www.geodeck.com
L.B. Plastics (Sheerline)	http://www.lbplastics.com/products/sheerline.asp
Louisiana-Pacific (WeatherBest Select)	http://www.lpcorp.com
Master Mark Plastics (Rhino Deck)	http://www.rhinodeck.com
Nebraska Plastics (Country Estate)	http://www.countryestate.com
Northern Plastic Lumber	http://www.northernplasticlumber.com
PlasTEAK (PlasTEAK)	http://www.plasteak.com
Polyvinyl Creations (vinyl decking)	http://www.polyvinylc.com/decking.htm
Polywood (Polywood nonstructural)	http://www.polywood.com
Procell Decking Systems (Procell)	http://www.procelldeck.com
Renew Plastics Division (Evolve, Perma-Poly)	http://www.RENEWPlastics.com
Resco Plastics (MAXITUF)	http://www.rescoplastics.com
Royal Crown (Deck Lok)	http://www.royalcrownltd.com
Synboard America (Synboard)	http://www.synboard.com
The Plastic Lumber Company (Leisure Deck)	http://www.leisuredeck.com
Thermal Industries (Dream Composite Deck, Dream Deck)	http://www.thermalindustries.com
TimberTech (TimberTech)	http://www.timbertech.com
Trex (Trex Origins)	http://www.trex.com
U.S. Plastic Lumber (HDPE)	http://www.usplasticlumber.com
Universal Forest Products (Latitudes Decking)	http://www.latitudesdeck.com
VEKA (VEKAdeck)	http://www.vekadeck.com
Wastech Fencing (Deck/Dock)	http://www.westechfence.com
XPotential Products (XPotential)	http://www.xpotentialproducts.com

End Notes

[1] Alan E. Robbins, "The Plastic Lumber Industry in Competitive Markets, 2001-2002 State of the Recycled Plastic Lumber Industry," presented at The Annual Meeting of the Plastic Lumber Trade Association, March 11, 2002, Pittsburgh, Pennsylvania. Available online at http://www.plasticlumber.org.

[2] See for example the Minnesota Office of Environmental Assistance plastic lumber Web page at http://www.moea.state.mn.us/lc/purchasing/plasticlumber.cfm; "Why Use Recycled Plastic Lumber?" Publication #431-97-009, California Integrated Waste Management Board, Sacramento, California, March 1997, available online at http://www.ciwmb.ca.gov/plastic/recycled/Lumber; and the Markets Initiatives Alternative Suppliers Database at http://www.oldgrowthfree.com/suppliers.php3, which lists companies offering alternatives to old growth wood-derived products.

[3] See for instance "Decking: Serious Alternatives," *Consumer Reports* (July 2004), pp. 22-25; Jennifer Lucich, "Party on the Patio, Alternative Materials Help Make the Most of Outdoor Spaces," *E Magazine* (May 2005); and *Environmental Building News* articles such as "Recycled Plastic Lumber," (July/August 1993) and its GreenSpec Directory featuring dozens of plastic lumber products, available at http://www.buildinggreen.com.

[4] See www.recyclingmarkets.net (a searchable database of more than 17,000 U.S. and Canadian companies involved in the recycling process) and the California Integrated Waste Management Board's Recycled-Content Product Directory available at http://www.ciwmb.ca.gov/RCP.

[5] For more information on HBN's hazard assessment methodology, refer to http://www.healthybuilding.net/target_materials.html

[6] Williams and Yost, "Plastics in Construction: Performance and Affordability at What Cost?" *Environmental Building News* (July/August 2001).

[7] Peter Anderson, RecycleWorlds Consulting, *Message In A Bottle* (GrassRoots Recycling Network, 2004), available online at http://www.healthybuilding.net/pvc/PVCBottleRecyclingReport.pdf

[8] "PVC Alternatives Database," Greenpeace Web site at http://archive.greenpeace.org/toxics/pvcdatabase/bad.html.

[9] U.S. EPA Office of Solid Waste and Emergency Response, *Municipal Solid Waste in The United States: 2001 Facts and Figures*, EPA530-R-03-011 (Washington, DC: October 2003).

[10] *Background Document for the Final Comprehensive Procurement Guideline (CPG) III and Final Recovered Materials Advisory Notice (RMAN) III*, EPA530-R-00-002, U.S. Environmental Protection Agency (Washington, DC: Sept. 1999), p. 80, available online at http://www.epa.gov/cpg/pdf/backgr1.pdf.

[11] For applicable comparative analyses of polyethylene, PVC and styrene bearing plastics see Williams and Yost, "Plastics in Construction: Performance and Affordability at What Cost?" *Environmental Building News* (July/August 2001); see also Rossi, Harvie and Lent. *Plastic Pipe Alternatives Assessment*. San Francisco Department of Environment. February 2005. http://www.healthybuilding.net/pvc/SFE_Plastic_Pipe_Alts_Assess.pdf, p. 2.

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[13] Woolley, Tom and Sam Kimmins. *Green Building Handbook: A Guide to Building Products and Their Impact on the Environment, Vol. II*. London: E & FN Spon, 2000.

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[16] National Institute of Health, U.S. National Library of Medicine, Specialized Information Services Web site at http://hazmap.nlm.nih.gov/cgi-bin/hazmap_generic?tbl=TblDiseases&id=326

[17] Environmental Defense Scorecard: Chemical Profiles. http://www.scorecard.org/chemical-profiles.

[18] See for instance, "Fact Sheet on Hormone-Disrupting Chemicals," available on the Web page of *Rachel's Environment & Health News* at http://www.rachel.org/library/getfile.cfm?ID=6.

[19] R.A. Hawley-Fedder, M.L. Parsons, and F.W. Karasek, "Products Obtained During Combustion of Polymers Under Simulated Incinerator Conditions, II Polystyrene," *Journal of Chromatography,* #315, 1984, Elevier Science Publishers B.V., Amsterdam, The Netherlands. Summary of results available online at http://www.ejnet.org/plastics/polystyrene/disposal.html.

[20] U.S. Plastic Lumber Group's material safety data sheet for its semi-reinforced plastic lumber, undated. Available online at http://www.usplasticlumber.com.

[21] Fiberglass Information Network Web page at http://www.sustainableenterprises.com/fin/index.htm; "A Carcinogen That's Everywhere," *Rachel's Environment & Health News*, #444 (May 31, 1995), available online at http://www.rachel.org/bulletin/bulletin.cfm?Issue_ID=681&bulletin_ID=48; Peter Montague, *Rachel's Environment & Health News*, personal communication, May 2005; and Washington Toxics Coalition Web page at http://www.watoxics.org/redirect/PCTE_BUILD.aspx?fromMenu=0&pos=&name=PCTE_BUILD#6.

[22] The National Institute for Occupational Safety & Health

[23] U.S. Plastic Lumber Group's material safety data sheet for its semi-reinforced plastic lumber, undated. Available online at http://www.usplasticlumber.com.

[24] Ibid.

[25] U.S. EPA, *Greenhouse Gas Emissions from Management of Selected Materials in Municipal Solid Waste*, EPA530-R-98-013 (Washington, DC: U.S. EPA, September 1998), pp. ES-1, ES-2; and *Recycling for the future… Consider the benefits*, prepared by the White House Task Force on Recycling (Washington, DC: Office of the Environmental Executive, 1998).

[26] Prabhat Krishnaswamy and Richard Lampo, "Recycled-Plastic Lumber Standards: From Waste Plastics to Markets for Plastic-Lumber Bridges," *Standardization News* (December 2001), available online at http://www.astm.org/SNEWS/DECEMBER_2001/wsd_dec01.html.

[27] "Products generated by a business or consumer which have served their intended end uses, and which have been separated or diverted from solid wastes for the purposes of collection, recycling, and disposition" "RPG Certification," The Official Recycled Product Guide (RPG) Web site at http://www.recyclingmarkets.net/products/rpginfo.html.

[28]The recycling level for high-density polyethylene milk and water jugs, among the most recycled plastic products in the nation, hovers at less than 25%. The recycling level for PVC bottles is less than 1%. Other plastic packaging and product recycling is statistically insignificant. See Peter Anderson, RecycleWorlds Consulting, *Message In A Bottle* (GrassRoots Recycling Network, 2004), p. 13, available online at http://www.healthybuilding.net/pvc/PVCBottleRecyclingReport.pdf

[29] LDPE plastic shopping bags, for instance, can easily be substituted with alternatives such as biodegradable paper bags or even better, reusable bags. Beverage containers can be offered in refillable plastic bottles, which are the norm in Germany and other European countries. A 2005 report by the Center for Health, Environment and Justice, Arlington, Virginia, *PVC, Bad News Comes In Threes: The Poison Plastic, Health Hazards & The Looming Waste Crisis* highlights the problems with and alternatives to PVC packaging. This report is available online at http://www.besafenet.com/pvc.htm.

[30] Survey of plastic lumber companies and products conducted by the Healthy Building Network, February 2005. Advanced Environmental Recycling Technologies (AERT) of Springdale, Arkansas, maker of ChoiceDek wood-plastic composite decking, reports recycling all scrap left from building with their products. Correct Building Products, LLC, maker of CorrectDeck wood-plastic composite decking, reports collecting and recycling scraps from installation.

[31] The Commonwealth of Massachusetts, Operational Services Division, is one agency that specifies in its procurement language for recycled plastic equipment that "it is desirable that bidders offer recycling options" for such products. Because the equipment is still in place, the Division does not know as yet if manufacturers will actually take back their plastic lumber for recycling. Personal communication, Marcia Deegler, Procurement Team Leader of Environmental Affairs, Operational Services Division, State of Massachusetts, April 25, 2005.

[32] Survey of plastic lumber companies and products conducted by the Healthy Building Network, February 2005. Everlast Plastic Lumber, Inc., of Auburn, Pennsylvania, maker of Everlast all-plastic lumber, reports selling scrap to a recycled-materials broker who then sells it to other end processors. RENEW Plastics of Luxemburg, Wisconsin, a division of NEW Plastics Corporation and maker of Evolve recycled all-plastic lumber, reports it recycles scrap from its dealers. Some of its larger distributors have secured contracts with manufacturing centers that will accept plastic-lumber scraps.

[33] *Message in a Bottle: The Impacts of PVC on Plastics Recycling*, a report to the GrassRoots Recycling Network by Peter Anderson, Recycle Worlds Consulting, Madison, Wisconsin (2004), available online at http://www.healthybuilding.net/pvc/PVCBottleRecyclingReport.pdf

[34] Tiffany Cougar, COO, Everlast Plastic Lumber Co., Auburn, Pennsylvania, personal communication, May 6, 2005.

[35] See discussion of synthetic composites.

[36] See William McDonough and Michael Braungart, *Cradle to Cradle: Remaking the Way We Make Things* (North Point Press, 2003), information available at http://www.mcdonough.com/cradle_to_cradle.htm.

[37] U.S. Plastic Lumber Group's material safety data sheet for its Composite Plastic Lumber, undated. Available online at http://www.usplasticlumber.com.

[38] "Plastics," Municipal Solid Waste Web site of the U.S. Environmental Protection Agency, http://www.epa.gov/epaoswer/non-hw/muncpl/plastic.htm.

[39] "Why Use Recycled Plastic Lumber?" Publication #431-97-009, California Integrated Waste Management Board, Sacramento, California, March 1997, available online at http://www.ciwmb.ca.gov/plastic/recycled/Lumber.

[40] "Product Information, Plastic Lumber, Recycled," The Commonwealth of Massachusetts Environmentally Preferable Products Procurement Program Web page at http://www.mass.gov/epp/products/lumber.htm.

[41] "Decking Serious Alternatives," *Consumer Reports* (July 2004), p. 22.