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Plastic Lumber in Landscaping Applications

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Abstract

Plastic lumber, a product made from recycled plastic, is ideal for use in landscaping applications. By using plastic lumber, landscapers can create cost-effective, high quality, and environmentally beneficial projects.

- 13.1 million tons of plastic suitable for use in plastic lumber were generated in 2000.
- 1.0 million tons of plastic suitable for use in plastic lumber were recovered for beneficial use in 2000.
- Utilizing plastic lumber in landscaping projects would create a market for currently discarded plastic. Landscaping uses for plastic lumber include guardrail posts, barricades, sign supports, fences, posts, edges, borders, retaining walls, raised beds, decking, gazebo construction, picnic tables, park benches, boardwalks and walkways, and pedestrian bridges.
- Benefits from using plastic lumber in landscaping projects include decreased maintenance and replacement costs, reduced litter, increased landfill space, greenhouse gas benefits associated with avoided incineration and reduced pressure on forests, and avoided wood preservative use.

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1. Introduction and Summary of Results

The term plastic lumber refers to several different products with different compositions. Those with potential landscaping use generally fall into three categories:[1,2]

1. Single Polymer/High Density Polyethylene (HDPE) – Containing up to 95% HDPE, this product is typically used in decks and landscape applications, and is produced in a variety of colors. However, it lacks the stiffness of wood and requires material sorting to ensure purity of the plastic input, thus increasing its cost.
2. Composite/Wood-Filled – Plastic/wood composite lumber typically comprises 50% low-density polyethylene (LDPE) and 50% sawdust or other recycled wood. The combination yields a product that offers good traction, surface roughness, and which can be readily painted. However, it also lacks the stiffness and strength of wood, may be susceptible to insect and moisture damage, and can become discolored and otherwise degrade over time.
3. Fiberglass Reinforced – HDPE reinforced with fiberglass offers greater strength and stiffness that make it better suited for structural applications. EPA Comprehensive Procurement Guidelines recommend 75% post-consumer and 95% total recovered material content.[3]

A summary of results related to the use of plastic lumber in landscaping applications is presented below.

Plastic Lumber Supply, Demand, and Potential Use - In 2000, 13.1 million tons of plastic suitable for use in plastic lumber were generated in the municipal solid waste stream (MSW). Of those, 1.0 million tons were recovered for beneficial purposes, and 12.1 million tons were discarded.[4] Of the plastics recovered, 0.16 million tons were converted into plastic lumber. The 12.1 million tons of HDPE, LDPE and polyethylene terephthalate (PET) plastics that are incinerated or sent to landfills each year can be considered the potential supply of plastic lumber. Using plastic lumber in a variety of landscaping projects (such as park benches, signs, boardwalks, decking and fencing) would utilize available recycled plastic.

Benefits – An economic benefit from using plastic lumber is decreased maintenance and replacement costs, which reduces the lifetime costs of landscaping projects. By increasing demand for HDPE, LDPE, and PET recycled plastics, plastic lumber utilization would make plastics recycling more economical and therefore more prevalent.

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[1] California Integrated Waste Management Board (CIWMB). *Recycled Plastic Lumber*. Online: <www.ciwmb.ca.gov/Plastic/Recycled/Lumber> (Oct. 8, 2002).

[2] PLTA. 2000 State of the Recycled Plastic Lumber Industry, Annual Meeting of the Plastic Lumber Trade Association November 16, 2002, Orlando, Florida. Alan E. Robbins, Presenter. Online: <http://www.plasticlumber.org/srplpdfs/srp100.pdf> (Oct.8, 2002).

[3] EPA. *Comprehensive Procurement Guidelines – Landscaping Timbers and Posts (Plastic Lumber).* (EPA530-R-00-002). September 1999. Online: <www.epa.gov/cpg/products/timbers.htm> (Oct. 8, 2002).

[4] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (GPO No. EPA530-R-02-001). June 2002.

Benefits resulting from avoided plastics disposal include reduced litter, increased landfill space and avoided incineration. Using recycled material instead of virgin wood reduces pressure on forests and avoids the use of wood preservatives.

Project Size - Landscaping applications of plastic lumber range from small projects such as park benches and signposts to large projects such as boardwalks. When planning projects, landscapers can refer to the specifications for utilization, product costs, and maintenance costs of plastic lumber presented in section 5.

In the following sections, we explain the current plastic lumber supply and demand structure as well as the potential for using plastic lumber in landscaping projects. Next, we present the benefits of using plastic lumber instead of conventional landscaping materials. The final section, a description of application recommendations and unit equivalents, will aid landscapers in calculating costs and benefits associated with using plastic lumber for a particular project.

2. Current Plastic Generation, Recovery, Disposal, and Markets

Since plastic lumber is most often made from HDPE, LDPE and PET plastics[5] (with PET plastic the least commonly utilized), the analysis of recycled plastic markets presented below will focus on these types of plastics.

The Environmental Protection Agency (EPA) reports that 13.1 million tons of PET, HDPE and LDPE plastics were generated in MSW in the United States in 2000. Of those plastics generated, 1.0 million tons (7.7%) were recovered, and 12.1 million tons were discarded.[6]

The American Plastics Council's *Recycled Plastics Products Source Book* lists over 1,300 products containing post-consumer recycled plastic. The primary market for recycled PET bottles is fiber for carpet and textiles. The primary market for recycled HDPE is bottles.[7] Information about the market for LDPE recycled plastic is not readily available, because it is smaller than the markets for HDPE and PET recycled plastics. Recycling of LDPE plastic (plastic film) can be a difficult process because of the complexity of diversion processes. Distinguishing between resin types and subsequently sorting those types correctly is difficult because most films do not have identification codes. However,

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[5] Graham, Christi. *Plastic Composite Lumber.* Online: < http://www.healthyhomedesigns.com/information13.php > (April 7, 2003).

[6] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (GPO No. EPA530-R-02-001). June 2002.

[7] American Plastics Council. *State of Plastics Recycling: November 2000.* Online: < http://www.plasticsresource.com/recycling/recycling_backgrounder/state_of_recycling.html > (Mar. 21, 2003)

both the market for recycled plastic films and efficient recovery processes are being developed.[8]

Although the entire market for LDPE recycled lumber is small, plastic lumber manufacturers are significant consumers of recycled LDPE. For example, in 1996, the plastic lumber manufacturer Trex bought about half of the plastic grocery bags collected nationwide.[9] Plastic lumber producers are also part of the market for recycled PET and HDPE plastics. A 2000 report describes the market shares for both domestic recycled PET bottle end use and domestic recycled HDPE bottle end use. For HDPE bottles, plastic lumber represents 8% of the end-use markets. For PET bottles, 4% of the end-use is classified as 'other', which includes plastic lumber.[10] PET plastic is not as common as PE plastic in plastic lumber.

Based on the composition of plastic lumber and the recycling rates of plastics, we can determine the amount of recycled plastic that is made into plastic lumber. Table 1 presents the results from this calculation.

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[8] American Plastics Council. *Plastic Film Recovery Guide*. Online: <http://www.plasticsresource.com/recycling/film_recovery_guide/Plastic_Film_Recovery_Guide/toc.html> (Nov. 8, 2002).

[9] North Carolina Department of Environment and Natural Resources. *Markets Assessment 1998, Plastic: L/LDPE (#4) Commodity Profile*. Online: <http://www.p2pays.org/ref/02/0162225.pdf> (Nov. 8, 2002).

[10] American Plastics Council. *2000 National Post-Consumer Plastics Recycling Report.* Online <http://www.globalgreen.org/BEAR/Links/link%20attachments/APC%20Plastics%20Recycling%20Report.pdf> (Oct. 29, 2002).

Table 1. Plastics Recycling Rates and Use in Plastic Lumber Applications[11,12]

Plastic	Common Uses of Material[13,14]	Generation (thousand tons)	Recovery (thousand tons)	Recovery (Percent of generation)	End-Use in Plastic Lumber (thousand tons)
HDPE	Containers for milk, juice, water, laundry detergent; margarine tubs; cereal box liners; trash and retail bags	4,830	420	8.7	33.6
LDPE	Grocery bags, breadbags, frozen food bags, sandwich bags, dry cleaning bags, produce bags, trash can liners	5,740	150	2.6	108.8 (approximate)
PET	Soft drink, juice, and cooking oil bottles; peanut butter and salad dressing jars; oven-safe food trays	2,490	430	17.3	17.2

Plastic lumber has use in a variety of sectors. The Plastic Lumber Trade Association (PLTA) estimated gross revenue from plastic lumber at $70 to $90 million in 2000 with the following market shares:

Commercial and Residential Decking	30% to 40%
Park and Recreation	20% to 30%
Industrial/OEM/Agriculture	20% to 25%
Marine Waterfront	5% to 15%
Railroad Tie	2% to 4%
Material Handling	1% to 2%
Fencing	1% to 2%

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[11] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (GPO No. EPA530-R-02-001). June 2002.

[12] American Plastics Council. *2000 National Post-Consumer Plastics Recycling Report*. Online: < http://www.globalgreen.org/BEAR/Links/link%20attachments/APC%20Plastics%20Recycling%20Report.pdf> (Oct. 29, 2002).

[13] American Plastics Council. *Plastics Packaging Resins*. Online: < http://americanplasticscouncil.org/benefits/about_plastics/resin_codes/resin.html > (Dec. 6, 2002).

[14] Sonoma County Waste Management Agency. *Recycling: A look at Plastics*. Online: < http://www.recyclenow.org/r_plastics.html > (Dec. 6, 2002).

Accordingly, a large segment of the current market for plastic lumber could be qualified as use in landscaping. By material, the PLTA provided the following information on current usage:

- Single Polymer/HDPE – In 2000, the PLTA considered these products to be the "clear leader in the decking board market of all the plastic material systems" (distinguishing purely-plastic products from the composites discussed below). However, the Association also noted that production capacity exceeded demand at that time, and noted the problem of seasonal demand from the building and construction markets.
- Composite/Wood-Filled – Sales of composite products in 2000 eclipsed those of the entire plastic lumber industry as defined by the ASTM standard. Trex of Winchester, Virginia appears to dominate, with a focus on residential decking that yielded sales of approximately $100 million that year.
- Fiberglass Reinforced – While the PLTA found that "The building and construction markets are continuing to look for products with enhanced physical properties" in 2000, the degree to which it has been used in landscaping applications is unclear.

Several other publications have described the current use of plastic lumber. *WOOD Markets* newsletter reported on the use of substitutes for lumber. The report projected an increase in plastic lumber production (up to about 42 million ft^3 in 2005), and reported that plastic lumber production in 1998 was about 17 million ft^3.[15] A 2002 Industry Study from the Freedonia Group details an outlook for the Composite and Plastic Lumber industry.[16] Table 2 incorporates plastic lumber demand values (in pounds) from the Freedonia Group study with the density specifications noted earlier to display the amount of lumber used.

Table 2. Plastic and Composite Lumber Use (demand)

Composite and Plastic Lumber demand by Material	**1996 (million ft^3)**	**2001 (million ft^3)**	**2006 Projected Demand (million ft^3)**
Plastic Lumber*	13.46	21.77	32.02
Wood-Plastic Composite Lumber	7.25	16.58	35.67

*(excludes plastic lumber used in siding, windows and doors)

[15] International Woodmarkets Research, Inc. *News Release: Substitute Products to Lumber Growing Rapidly*. Online < http://www.woodmarkets.com/Press%20Releases/2000-10-17-WMM-10-2000-Sub.htm > (Oct. 24, 2002).

[16] The Freedonia Group. *The Freedonia Group Report: 1551. Composite and Plastic Lumber to 2006. Table of Contents.* Online: <http://freedonia.ecnext.com/free-scripts/freedonia_gen_toc.pl?0001&1551> (Oct. 24, 2002).

Table 3 presents the demand for plastic lumber and composite lumber in several landscaping applications, as well as total demand. Demand is presented in million dollar units.

Table 3. Plastic and Composite Lumber Use (demand)

Wood type or Application type	**1996 (million dollars)**	**2001 (million dollars)**	**2006 projected (million dollars)**
Plastic lumber	410	695	1,070
Wood-plastic composite lumber	148	375	880
Decking	195	410	900
Fencing	55	160	315
Other*	75	105	170

*(excludes plastic lumber used in siding, windows and doors, and moulding and trim)

Another example of a product made of plastic lumber is the railroad tie. Each plastic railroad tie is made of 200 pounds of plastic, or 1,200 plastic bottles.[17]

3. Current Potential Use

The strong potential for using plastic lumber in landscaping projects is illustrated by the 12.1 million tons of discarded HDPE, LDPE, and PET plastic in 2000. Tables 2 and 3 illustrate the projected demand for recycled lumber in 2006; plastic lumber demand is expected to reach 32.02 million ft^3, or $1.07 billion, while the wood-plastic composite lumber demand will be 35.67 million ft^3, or $880 million. By creating markets for recycled plastic, using plastic lumber in landscaping projects would make recycling programs more economical, and thus, more prevalent.

Plastic lumber made from recycled plastic can be used in many types of landscaping applications. Roadside construction using plastic lumber includes guardrail posts, barricades, and sign supports. Basic landscaping applications using plastic lumber include fences, posts, edges, borders, retaining walls, and raised beds. Additionally, plastic lumber can be used for decking, gazebo construction, picnic tables, park benches, boardwalks and walkways, and pedestrian bridges.

An example of a government policy that encourages use of plastic lumber is the King County Recycled Product Procurement Policy, instituted in 1989 in Washington State. County agencies are instructed to purchase recycled products "whenever practicable”; as a result, the Parks Division has purchased plastic lumber for various park furnishings, including benches, tables, and playground equipment. In the Fall of 2001, the Parks Division purchased eight recycled plastic picnic tables to replace older wood tables. The

[17] American Plastics Council. *Plastic Lumber*. Online: <http://www.plasticsresource.com/recycling/recycling_backgrounder/plastic_lumber.html> (Oct. 24, 2002).

County as a whole spent $3,337 on plastic lumber in 2002, with an estimated cost savings (not including maintenance and installation savings) of $10,000.[18] King County's success with plastic lumber in landscaping projects illustrates its potential use throughout the United States.

4. Benefits

The use of recycled plastic lumber products yields benefits that depend in part on the materials they comprise. There are also benefits that result from avoiding the use of alternatives, such as pressure-treated lumber.

Decreased maintenance and replacement costs

Plastic lumber is more durable than wood, which results in decreased maintenance and replacement costs. Treated and untreated wood used in landscaping applications requires the application of sealants to avoid having the wood crack, split, warp, mold, and/or mildew. Plastic lumber requires little to no maintenance, as it does not warp, splinter, or crack, and it resists absorption of moisture and bacteria. Painting and staining the wood is not necessary. Two examples discussing potential project maintenance costs (materials, labor, and disposal if available) are summarized in Table 4.

Table 4. Maintenance Cost Savings of Plastic Lumber

Project	Materials and Installation	Maintenance (after __ years)	Disposal	Total Costs	Project Cost Compared to Plastic Lumber
Project 1: 800 ft^3 deck[19]					
Plastic Lumber	$4,400	$0 (after 5 years)		$4,400	
Pressure Treated Lumber	$2,890	$2,500 (after 5 years)		$5,390	$+990
Cedar	$3,990	$2,500 (after 5 years)		$6,490	$+2,090
Project 2: Picnic Bench (10.4 ft^3) [20]					
Plastic Lumber	$266.40	$0 (after 20 years)	$0	$266.40	
Pine	$75	$285 (after 20 years)	$30	$390	$+123.60

[18] King County Department of Executive Services. *King County Environmental Purchasing 2002 Annual Report*. Online: < http://www.metrokc.gov/procure/green/annrep02.pdf > (April 1, 2003).

[19] American Ecoboard. *"How does ECOBOARD® Compare to Wood?"* Online: <http://www.americanecoboard.com/alt.htm> (Oct. 24, 2002).

[20] Joint Service Pollution Prevention Technical Library. *Economic Analysis for Recycled Plastic Lumber*. Naval Facilities Engineering Service Center. Online: <http://p2library.nfesc.navy.mil/econs/7ia11.xls> (Nov. 7, 2002).

Plastic lumber has additional advantages over wood. It is completely waterproof and is graffiti resistant. Plastic lumber can hold nails approximately 90% better than wood, and can hold screws approximately 50% better than wood.[21]

Plastic lumber can be used in many applications, however it is not suitable for certain types of structures. All plastic lumber has a lower stiffness and strength than wood, and can only be used in low load structures (not in primary load-bearing applications). HDPE and PET lumber is flexible, and can be curved and shaped. This advantage is paired with the disadvantage that the lumber can be affected by temperature fluctuation (it can expand and contract).

Market Creation

EPA found that, in 2000, recycling rates of plastics in US MSW were 17% of PET plastic, 9% of HDPE plastic, and 3% of LDPE plastic. Increasing the demand for these resins through growth of the plastic lumber industry would not only capture more of the available material, but also make plastics recycling in general more economical and therefore more prevalent. Current commodity pricing data is a method to display material demands. The data in Table 5 represent the average prices recyclers pay for materials in Chicago (November 2001-October 2002 average prices, this price represents baled materials picked up). Combination HDPE prices are the average price from March 2001 through February 2002.

Table 5. Value per Ton Recycled Material[22]

Material	**$/ton**
HDPE – Natural	$266
HDPE – Colored	$135
HDPE – Combination (at least 60% Natural HDPE)	$144
PET (containers)	$144

The value of LDPE was not readily available. As described earlier, the national market for LDPE recycled plastic is currently not as large as the markets for HDPE and PET recycled plastics. However, plastic lumber manufacturers are significant consumers of recycled LDPE plastic. End-use market development such as plastic lumber, combined with efficient and effective recycling management will strengthen the recovered LDPE market.

[21] American Plastics Council. *Plastic Lumber*. Online: < http://www.plasticsresource.com/recycling/recycling_backgrounder/plastic_lumber.html> (Oct. 24, 2002).

[22] *Waste News*. "Historical Commodity Pricing". 10/18/2002. Online: <http://www.wastenews.com/commo.html> (Nov. 4, 2002).

Reduced Litter

Increasing the demand for items such as milk bottles and plastic bags should make it easier for people to recycle them rather than create litter. National litter rates are difficult to ascertain, due to the limited availability of studies on litter rates.

Several recent studies in Washington State have described the composition of public litter. Table 6 presents plastic litter composition rates from a statewide study of litter sampled from roads (interstates, state roads, and county roads), interchanges, state and county parks, public access areas (e.g. Fish & Wildlife areas), and rest areas.[23]

Table 6. Plastic Beverage Bottles, Bags and Film in Washington State Public Litter

Material	Amount Sampled (tons)	Total Litter Sampled (tons)	Material Percent of Total Litter
Plastic beverage bottles	173.7	11,985	1.4%
Plastic bags and film	376.9	11,985	3.1%

Another study sampled the composition of garbage placed in public trashcans throughout Seattle (streets, parks, commercial downtown, etc). Of the garbage in the public trashcans, 3.9% was PET and HDPE plastic containers.[24] Increased market demand for PET, HDPE, and LDPE could translate into an increased push for creating options for recycling these materials. A similar movement has been detailed in research on bottle bills – when markets are created for the recyclable material, and subsequently recycling is made more accessible and feasible, one public response is to reduce litter.

Along with market creation, reduced litter rates result in decreased costs for litter cleanup. While there are no national statistics available for costs associated with litter cleanup, individual reports from state and city cleanup activities indicate that the costs of litter cleanup are significant. Table 7 presents estimates of annual costs of plastic litter cleanup in two states and one city. The costs are based on the litter composition information from the Washington state study and cleanup cost data from the individual state or city.

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[23] Washington State Department of Ecology, Solid Waste and Financial Assistance Program. *Washington State Litter Composition Study, Volume 2 – Litter Generation and Composition Report*. May 2000. 00-07-023. Online: < http://www.ecy.wa.gov/pubs/0007023.pdf> (Nov. 6, 2002).

[24] Cascadia Consulting Group, Sky Valley Associates, and Tamre Cardoso. *Seattle Public Utilities 2000/01 Litter Composition Study*. November 2001. Online: <http://www.cityofseattle.net/util/solidwaste/docs/reports/LitterCompRpt.pdf> (Nov. 6, 2002).

Table 7. Estimated Annual Costs of Plastic Litter Cleanup

Year	State or City	Litter Cleanup Costs	Estimated Costs for Plastic Litter Cleanup
2000	California (highway only)	$16 million	$720,000 ($.72 million)
2000	California		$750 million (estimate reported by state; cost includes disposal)[25]
2001	Kentucky	$4.8 million[26]	$216,000 ($.22 million)
2001	Jacksonville, FL	$4 million[27]	$180,000 ($.18 million)

The reduction of litter through programs such as increased recycling would decrease the costs associated with litter cleanup.

Landfill space

Table 8 presents the landfill space benefit from using plastic lumber and the common uses of the recycled materials found in plastic lumber.

Table 8. Benefits from Use of Plastic Lumber

Material Used	Common Uses of Material[28,29]	Landfill Space Saved* (Ft^2/Ton)
HDPE	Containers for milk, juice, water, laundry detergent; margarine tubs; cereal box liners; trash and retail bags	190
LDPE	Grocery bags, breadbags, frozen food bags, sandwich bags, dry cleaning bags, produce bags, trash can liners	190
PET	Soft drink, juice, and cooking oil bottles; peanut butter and salad dressing jars; oven-safe food trays	190
Wood		84

*Including fill

[25] Butte Environmental Council. *Reducing Plastic Waste Tops 2001 Legislative Agenda.* Online: < http://www.becnet.org/ENews/01sp_plastic.html > (Dec. 27, 2002).

[26] Kentucky Resources Council. *What we need to cleanup Kentucky*. Online: < http://www.kyrc.org/webnewspro/100324991961549.shtml > (Dec. 27, 2002).

[27] Jacksonville Community Council, Inc. *Making Jacksonville a Clean City.* Online: < http://www.jcci.org/ccpressconference.pdf > (Dec. 27, 2002).

[28] American Plastics Council. *Plastics Packaging Resins*. Online: < http://americanplasticscouncil.org/benefits/about_plastics/resin_codes/resin.html > (Dec. 6, 2002).

[29] Sonoma County Waste Management Agency. *Recycling: A look at Plastics*. Online: < http://www.recyclenow.org/r_plastics.html > (Dec. 6, 2002).

Landfill space is saved when these materials are recycled rather than landfilled.

Avoided incineration

Similar to the landfill space benefit, recycling plastic and wood scraps for use in plastic lumber removes them from potential incineration, thus reducing pressure on capacity constraints as well as materials that could form dioxin, furan and/or CO_2 emissions when burned.

Overall CO_2 emissions from waste combustion in 2000 were 22.5 million metric tons of carbon equivalents (MMTCE), as shown in Table 9.[30] These emissions were from 33,730 thousand tons of combusted MSW. The multipliers related to avoided incineration, presented in Table 9, include three emissions: direct CO_2 emissions from combustion, N_2O emissions from combustion, and CO_2 emissions from transportation of waste to the WTE plant.

Table 9. Avoided Gross GHG Emissions per Ton Recycled Input[31,32]

Waste type	% of Total Discards	Tons Combusted (estimate based on percent of MSW discard)	Avoided Gross GHG Emissions Per Ton Combusted	Avoided Emissions (MTCE)
All	100%	33,730,000		22.5 MMTCE
HDPE	1.3%	438,500	.77	337,645
LDPE	2.7%	910,700	.77	701,239
PET	3.5%	1,180,600	.56	661,136
Wood (Dimensional Lumber)	7.5%	2,529,750	.02	50,595

Diversion of plastics from incineration could reduce the amount of electricity generated as by-product of incineration. However, this will only occur if there is a reduction in the tonnage incinerated. If, instead, incinerators simply take waste to “replace” the plastic, what will drop is landfilling, the management disposal option in most of the United States.

Reduced pressure on forests

Using alternatives reduces the demand for harvesting wood. The 2000 Forest Service Renewable Resources Planning Act notes that in the future, more wood outputs “must be

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[30] EPA. *The U.S. Inventory of Greenhouse Gas Emissions and Sinks*. (EPA430-F-02-008). April 2002.

[31] EPA. *Municipal Solid Waste in the United States: 2000 Facts and Figures.* (EPA530-R-02-001). June 2002.

[32] EPA. *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. (EPA530-R-02-006). June 2002. p.85.

produced from a slowly declining land base".[33] Alternatives to wood products are timely and important when there are challenges to natural resources availability and sustainability.

One environmental concern related to wood harvesting is the difference between natural/virgin forests and plantation forests. Some of the benefits associated with natural/virgin forests include habitat preservation (about 1,550-2,100 species are dependent on forests), species diversity, ecosystem stability (e.g. water quality, decreased erosion), and the financial benefits associated with tourism.[34] Pressure on virgin forests is increasing; for example, the average diameter of old growth trees harvested from National Forests decreased from 24" twenty years ago to 13" today.[35]

Forest plantations differ from virgin forests in that they are comprised of fast growing trees that can renew themselves in our lifetime. Although plantations reduce pressure on virgin forest, environmental concerns include reliance on chemical fertilizers and herbicides to grow trees quickly in a concentrated area. Furthermore, wood that is harvested from plantations can be of lesser quality than wood from natural forests. For example, wood from the faster growing species could have less natural decay resistance, and/or a decreased likelihood of producing straight boards.[36] In 1997, approximately 7 percent of the total forest acreage was established through tree planting (were plantations).[37]

Plastic lumber is often an appropriate direct substitute for the dimensional lumber used in landscaping applications. When plastic lumber is used in these applications, one result is a decrease in tree harvesting rates. Reduced wood harvesting rates are summarized in this statement: "For every ton of solid wood product that is source reduced, the reduction in timber harvest is 1.1 tons."[38] Further, for every 4 tons of trees that are saved from harvesting, one acre of forest is saved.[39]

While dimensional lumber encompasses many wood species, pine and balsam were indicated as two of the predominant wood species being replaced by plastic lumber in landscaping applications.[40] In 1997, almost half of the pine forest acreage was in

[33] U.S. Department of Agriculture, Forest Service. *2000 RPA Assessment of Forest and Range Lands.* Online: < http://www.fs.fed.us/pl/rpa/rpaasses.pdf> (Nov. 6, 2002). p.2.

[34] U.S. Department of Agriculture, Forest Service. *2000 RPA Assessment of Forest and Range Lands.* Online: < http://www.fs.fed.us/pl/rpa/rpaasses.pdf> (Nov. 6, 2002). p.28.

[35] The City of Los Angeles Environmental Affairs Department. *Residential Rehabilitation Guidebook.* Online: < http://www.lacity.org/ead/EADWeb-MWR/Sust/guidebook.pdf > (April 1, 2003).

[36] Freedonia Group. *Composite and Plastic Lumber to 2006*. June 2002.

[37] Smith, W. et al. *Forest Resources of the United States, 1997.* U.S. Department of Agriculture, Forest Service, North Central Research Station. 2001. p.156.

[38] EPA. *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. (EPA530-R-02-006). June 2002. p.48.

[39] RCB Model Template, source is per Al Gertsel, American Forests and Paper Association, personal communication Nov. 7, 1996.

[40] Personal Communication. Energy and Environmental Concepts, Inc. Nov. 8, 2002.

plantation forests.[41] As a result, the use of plastic lumber reduces the pressure on both plantation and natural/virgin forests.

As noted in Table 8, the use of plastic lumber decreases the amount of plastic and wood that is sent to landfills. Once in the landfill, wood contributes to methane gas emissions. The methane yield for branches (representative of wood) is .17 MTCE per wet ton.[42] The global warming potential of methane gas is 21 times that of carbon dioxide gas.[43] Furthermore, a greenhouse gas benefit results from reducing pressure on forests; living trees serves as a carbon sink. Source reducing lumber instead of landfilling it accounts for a net reduction of 0.44 MTCE per ton.[44]

Avoided wood preservative use

In 1997, 727.8 million ft^3 of wood products were pressure treated with wood preservatives in the United States.[45] Residential and landscaping uses of these wood products include play-structures, decks, picnic tables, landscaping timbers, residential fencing, patios, walkways/boardwalks, and railroad ties.

The three "heavy-duty" chemicals used as wood preservatives are pentachlorophenol, arsenicals (notably chromated copper arsenate, or CCA), and creosote (creosote is the common term used for several products that are mixtures of many chemicals created by burning of wood or coal.) Table 10 shows the amounts of these chemicals used in 1995, and the landscaping-related wood products that use these types of treated wood. The EPA has banned (beginning January 1, 2004) the treatment of certain wood products with CCA. These products include all products with intended use in residential locations, such as play-structures, decks, picnic tables, landscaping timbers, patios, and walkways/boardwalks.[46] Due to this regulation, other types of wood preservatives are being investigated and developed. The wood preservative alkaline copper quaternary (ACQ) does not contain arsenic (though it does contain high levels of copper metal), and can be used as a preservative for most types of wood.[47] However, using plastic lumber would avoid the need for any type of wood preservatives. Like pressure treated lumber, plastic lumber is resistant to insects and rotting. Plastic lumber could serve as a replacement for all three of the wood products listed in Table 10.

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[41] Smith, W. et al. *Forest Resources of the United States, 1997.* U.S. Department of Agriculture, Forest Service, North Central Research Station. 2001. p.79.

[42] EPA. *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. (EPA530-R-02-006). June 2002. p.106.

[43] EPA. *Emissions*. Online: <http://yosemite.epa.gov/oar/globalwarming.nsf/content/emissions.html> (Nov. 5, 2002).

[44] [44] EPA. *Solid Waste Management and Greenhouse Gases: A Life-Cycle Assessment of Emissions and Sinks*. (EPA530-R-02-006). June 2002. p.135.

[45] American Wood-Preservers' Association. *FAQ's: Treated Wood Uses.* Online: <http://awpa.com/faq/faq2.htm> (Oct. 28, 2002).

[46] EPA. *Manufacturers to use new wood preservatives, replacing most residential uses of CCA.* Online: < http://www.epa.gov/pesticides/citizens/cca_transition.htm> (Oct. 28, 2002).

[47] Chemical Specialties, Inc. *United States EPA Honors CSI/Rockwood Specialties as Presidential Green Chemistry Challenge Award Recipient.* Online: <http://www.treatedwood.com/news/> (Nov. 7, 2002).

Table 10. Wood Products Treated with Wood Preservatives, 1996[48]

Product	Amount Treated (thousand ft^3)	Percent of Total Wood Preservative Industry Production Volume
Lumber	294,479,500,000	52.4
Fence Posts	26,413,237,595	4.7
Landscape Timbers	16,859,513,359	3.0

Table 11 describes wood preservative use by preservative type and wood product. Additionally, notes on regulatory status are included where applicable.

[48] American Wood Preservers' Institute. *The 1996 Wood Preserving Industry Production Statistical* Report. September, 1997.

Table 11. Avoided Wood Preservative Use[49]

Chemical	Landscaping-Related Wood Products[50]	Preservative Use (1,000 ft^3)	Preservatives Used to Treat Lumber (1,000 ft^3)	Preservatives Used to Treat Fence Posts (1,000 ft^3)	Preservatives Used to Treat Landscape Timbers (1,000 ft^3)	Preservatives Consumed	Regulatory Status/Proposed Future Use
Oil-borne preservatives (includes Pentachloro-phenol)	utility poles, support beams, fresh water pilings, bridge timbers, fence posts, and guard rails	33,494.5	432	171	77	35,275,436 gallons	
Water-borne preservatives (includes CCA, ACQ)	decking, fencing, sills, railings, joists, posts, foundations, poles and piles, retaining walls, water pilings and bulkheads[51]	467,855.3	292,001	21,145	32,841	CCA: 144,506,900 lbs Other water-borne (includes ACQ): 4,363,600 lbs	CCA: use in wood products banned by EPA beginning 2004 ACQ: 1 billion board feet production (2002 projection)[52], could serve 99% of treated wood market[53]
Creosote Solutions	railroad ties, utility poles, pilings, bridge timbers, docks and seawalls	86,511.9	688	2,117	9.4	77,200,100 gallons	

[49] American Wood Preservers' Institute. *The 1996 Wood Preserving Industry Production Statistical* Report. September, 1997.

[50] American Wood Preservers' Institute. *Frequently Asked Questions*. Online: < http://www.preservedwood.com/faqs/faqs.html> (Nov. 5, 2002).

[51] Osmose Worldwide Wood Preservation Products. *CCA Pressure Treated Wood.* Online: < http://www.osmose.com/wood/worldwide/america/english/products/cca/> (Nov. 6, 2002).

[52] Chemical Specialties, Inc. *United States EPA Honors CSI/Rockwood Specialties as Presidential Green Chemistry Challenge Award Recipient*. Online: <http://www.treatedwood.com/news/> (Nov. 7, 2002).

[53] Solid Waste Management Coordinating Board. *Treated Wood*. Online: < http://www.swmcb.org/EPPG/8_2.HTM> (Nov. 7, 2002).

The chemicals used in wood preservatives are associated with detrimental human health effects. Table 12 presents potential exposures to the human system and certain health effects associated with the chemicals.

Table 12. Exposures and Health Effects of Chemicals Used in Wood Preservation

Chemical	Exposure	Health Effects
Pentachlorophenol	Contact during treatment of wood (inhale or touch), contact with treated wood, contaminated soil ingestion or absorption, chronic poisoning[54]	Dangerous increase in body temperature, liver and immune damage, probable human carcinogen[55]
Arsenic (in arsenicals)	Inhale during treatment of wood, sawing and sanding wood, burning wood, contaminated soil ingestion or absorption[56]	Carcinogenic, sore throat, irritated lungs[57]
Creosote	Contact during treatment of wood (inhale or touch), contaminated soil ingestion or absorption[58]	Skin rash, respiratory tract irritation, skin damage, probable human carcinogen[59]
Copper	Contact during treatment of wood (inhale), inhalation or ingestion of air, water or food, swimming in water with high levels of copper	Nose, mouth, and/or eye irritation; vomiting and nausea[60]

Wood treated with pesticides also has detrimental environmental effects, associated with both use (leaching into the environment) and disposal. Studies of the mobility of

[54] ATSDR. *ToxFAQs for Pentachlorophenol.* September 2001. CAS# 87-86-5. U.S. Department of Health and Human Services, Public Health Services. Online: < http://www.atsdr.cdc.gov/tfacts51.html> (Nov. 6, 2002).

[55] Ibid.

[56] ATSDR. *Toxicological profile for arsenic (Update).* 2000. U.S. Department of Health and Human Services, Public Health Services. Online: <http://www.atsdr.cdc.gov/ToxProfiles/phs8802.html> (Nov. 6, 2002).

[57] Ibid.

[58] Beyond Pesticides. *Poison Poles – A Report about their Toxic Trail and Safer Alternatives, Appendix A: Chemicals at a Glance*. Online: <http://www.beyondpesticides.org/main.html> (Oct. 28, 2002). {Original Source – American Wood Preservers' Institute. *1995 Wood Preserving Industry Production Statistical Report.* September 1996, p.12.}

[59] ATSDR. *ToxFAQs for Creosote.* September 2002. CAS# 8001-58-9. U.S. Department of Health and Human Services, Public Health Services. Online: <http://www.atsdr.cdc.gov/tfacts85.html> (Nov. 6, 2002).

[60] ATSDR. *ToxFAQs for Copper*. September 2002. CAS# 6440-50-8. U.S. Department of Health and Human Services, Public Health Services. Online: <http://www.atsdr.cdc.gov/tfacts132.html> (Nov. 7, 2002)

chemicals from pressure treated wood into the environment have had varied conclusions. Some of the environmental concerns that have been raised in such studies include elevated levels of chemicals in soil and water adjacent to the wood product, mobility of these chemicals, and the rate at which the chemicals leach into the environment.[61] The disposal or reuse potential of treated wood is dependent on the type of chemical treatment used.[62] Air emissions created during the treated wood recycling process have similar hazards as the emissions during production and use of the wood (e.g. air contaminants released during sawing). Disposal of treated wood by combustion often creates ash that is classified as hazardous waste.[63] The high levels of metals in some types of treated wood (e.g. in ACQ treated wood) create other disposal problems.[64]

5. Project Size

Projects using plastic lumber vary greatly in size and in construction details. The following paragraphs present plastic lumber cost information. Landscapers can use the information in this section to estimate the amount of plastic lumber necessary for a specific project and to calculate costs and benefits of using plastic lumber.

Expenditures on a particular type of plastic lumber can be used to calculate the amount used. Per unit pricing for plastic lumber is available for two categories of plastic lumber: Wood-Plastic Composite and Plastic. Table 13 shows the price per pound and the price per ft^3 (using the Plastic Lumber Company's plastic lumber density specifications of 35.6 pounds per ft^3[65] and Trex's composite lumber density specifications of 60 pounds per ft^3[66]).

[61] U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. *Frequently Asked Questions for Wood Preservation and Related Topics, Environmental impacts of wood and methods to reduce the impacts.* Online: <http://www.fpl.fs.fed.us/pres_fire/publist.htm#environ> (Nov. 5, 2002).

[62] De Groot, R.C. *Current and future options for managing used preservative-treated wood.* U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. IRG 95-50042. June 1995.

[63] Felton, C. and R. De Groot. *The Recycling Potential of Preservative-Treated Wood.* Forest Products Journal 26(7/8), 1996. Online: <http://www.fpl.fs.fed.us/documnts/pdf1996/felto96a.pdf> (Nov. 6, 2002).

[64] Blum, G. *New process may help clean treated wood.* U.S. Department of Agriculture, Forest Service, Forest Products Laboratory. News Release. Online: <http://www.fpl.fs.fed.us/notices/treated.htm> (Nov. 7, 2002).

[65] The Plastic Lumber Company, Inc. *Physical Properties of Plastic Lumber*. Online: <http://www.plasticlumber.com/> (Nov. 11, 2002).

[66] ICBO Evaluation Service, Inc. *ER-5747 Trex Wood-Polymer Composite Lumber*. Online: <http://www.icbo.org/ICBO_ES/Evaluation_Reports/pdf/5747.pdf> (Nov. 11, 2002).

Table 13. Plastic Lumber Unit Prices[67]

Plastic Lumber Type	1996 $/lb	1996 $/ft^3	2001 $/lb	2001 $/ft^3	2006 (projected) $/lb	2006 (projected) $/ft^3
Plastic lumber	.86	30.62	.90	32.04	.94	33.46
Wood-plastic composite	.34	20.40	.38	22.8	.41	24.60

Per unit pricing for plastic lumber was summarized in Table 13.

While prices for plastic lumber products vary from company to company, average values are summarized in Table 14, which also includes prices for traditional wood products. These amounts do not consider maintenance or replacement costs, which tend to lower lifecycle costs of plastic lumber as compared to wood projects.

Table 14. Average Retail Prices for Wood Products (price per linear foot)[68]

Material	Price (per linear foot)
Composite decking material (45% wood, 55% HDPE)	$3
Purely plastic	$4
Redwood	$2
Pressure-treated southern yellow pine	< $1

[67] The Freedonia Group. *The Freedonia Group Report: 1551. Composite and Plastic Lumber to 2006.* Online: <http://freedonia.ecnext.com/free-scripts/freedonia_gen_toc.pl?0001&1551> (Oct. 24, 2002).

[68] This Old House Ventures. *Landscaping a Sloped Lot*. Online: <http://www.thisoldhouse.com/toh/exteriors/article/0,13422,236162-5,00.html> (Oct. 29, 2002).