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Plastic Lumber in Landscaping Applications

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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]

Benefits resulting from avoided plastics disposal include reduced litter, increased landfill

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.

[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)

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"

Table 3 presents the demand for plastic lumber and composite lumber in several

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

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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

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; [25] cost includes disposal)
2001	Kentucky	$4.8 million	

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

[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

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[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

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*

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	gallonsf6r885.9631ed wood

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 13. Plastic Lumber Unit Prices[67]