Cradle to Gate Life Cycle Assessment of U.S. Particleboard Production

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August 2013

1 Background

CORRIM, the Consortium for Research on Renewable Industrial Materials, has derived life cycle inventory (LCI) data for major wood products and wood production regions in the United States (U.S.) The life cycle inventory data cover from forest regeneration through to final product at the mill gate. Research has covered nine major forest products including both structural and nonstructural uses and four major regions: in this report we focus on the average U.S. production of particleboard. Wood residue inputs for the U.S. average particleboard production are sourced from the Pacific Northwest (PNW) and Southeast (SE) regions and various wood manufacturing processes. This document updates the current particle board LCI from a gate to gate to a cradle to gate LCI. Updates include the addition of forestry operations, and boiler, and electrical grid data that have been updated since the original mill surveys were conducted in 2004. The updated LCI data were used to conduct a life cycle impact assessment (LCIA) using the North American impact method, TRACI 2.0 (Simapro version 4.0) (Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts) (Bare et al. 2011). These updates are necessary for the development of environmental product declarations (EPD) which will be based on this document. This document originates from the CORRIM LCI reports by Wilson (2008) and Johnson et al. (2005). Updates to the original Wilson report include: wood combustion boiler updates, electricity grid updates (Goemans 2010), and a LCIA. Updates to the forestry operations report (Johnson et al. 2005) include electricity grid updates and a LCIA using the TRACI method. This report follows data and reporting requirements as outlined in the Product Category Rules (PCR) for North American Structural and Architectural Wood Products (PCR 2011) that will provide the guidance for preparation of North American wood product EPD's. This report does not include comparative assertions.

2 Introduction

The goal of this work is to determine energy and material inputs and outputs associated with the production of particleboard representing average manufacturing practices in the U.S. These data are needed for the inclusion of the production process in life-cycle analyses of wood. The data were obtained through a scientifically sound and consistent process established by the Consortium for Research on Renewable Industrial Materials (CORRIM), following ISO14040 standards (ISO 2006).

The scope of this study was to develop an LCI and LCIA for the production of particleboard from a variety of wood residue using practices and technology common to the U.S. forestry and manufacturing sectors. It covers the impacts in terms of input materials, fuels, and electricity through to the outputs of product, co-products, and emissions (Wilson 2008). Wood residues used in particleboard production are obtained from softwood plywood and lumber manufacturers in the PNW and SE regions. These manufacturers obtain logs from forest resources located in western Washington, western Oregon,

Georgia, Alabama, Mississippi, and Louisiana, as representative of the PNW and SE softwood regions. Data for the life cycle assessment (LCA) are based on manufacturing gate to gate LCI's from wood product manufacturing reports (Wilson and Sakimoto 2004, Milota et al. 2005, Wilson 2008) and forest resources cradle to gate LCI's (Johnson et al. 2005). The report does not consider how the wood was used which requires a comparison to the impact of substitute products.

3 Description of Product

Particleboard is a non-structural panel product developed in the 1950s to utilize industrial wood residue from the production of primary wood products such as softwood lumber and plywood. These wood residues were previously burned or sent to landfill to dispose of them as waste material. Over the years the product has evolved into a highly engineered product designed to meet specific end-use requirements. Particleboard generally falls into two product categories, underlayment used in housing floor construction and industrial used for making furniture, cabinets, tables, countertops, and millwork (Figure 1). The production of particleboard falls into the Standard Industrial Classification (SIC) Code 2493, reconstituted wood products, which includes other wood composite products such as hardboard, insulation board, medium density fiberboard, and oriented strand board (U.S. Census Bureau 2007).

Particleboard production in the U.S. uses industrial wood residues such as shavings, sawdust, panel trim, fines, and chips, though it can be produced from chips from logs or trees. The residues are refined to small particles that are dried, blended with adhesive and wax, and formed into a mat that is then consolidated and cured under pressure and heat. Particleboard is produced in densities ranging from 37 lb/ft^3 to 50 lb/ft^3 (593-801 kg/m^3))(Figure 2) consistent with the material properties listed in the American National Standard ANSI A208.1-2009(ANSI 2009. Production is measured on a thousand square foot (MSF) ¾-inch basis (19.05 mm). The panels are produced in thicknesses ranging from 3/8 inch (9.525 mm) to 1-1/4 inch (31.75 mm) and in widths from 4 to 5 feet (1.22 to 1.52 m) and lengths from 8 to 24 feet (2.44 to 7.32 m).

Figure 1 Particleboard

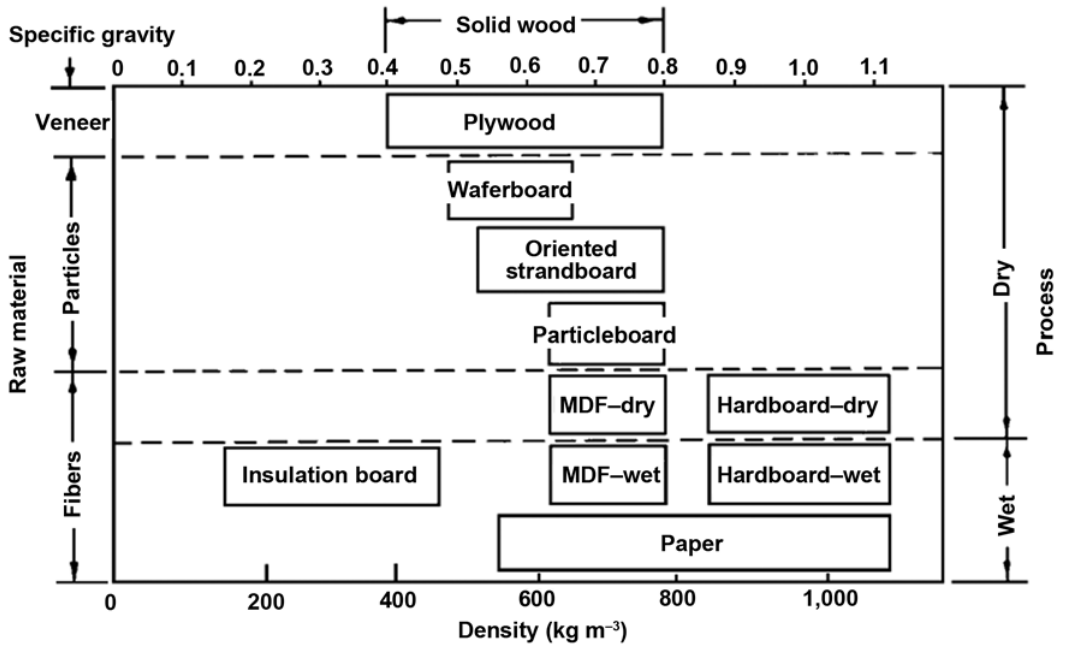

Figure 2 Classification of wood composite panels by particle size, density, and process (Suchsland and Woodson 1986).

3.1 Functional and declared unit

In accordance with the PCR (2011), the declared unit for particleboard is one cubic meter (1.0 m^3). A declared unit is used in instances where the function and the reference scenario for the whole life cycle of a wood building product cannot be stated (PCR 2011). For conversion of units from the US industry measure, 1.0 MSF (1000 square feet) is equal to 1.7698 m^3. All input and output data were allocated to the declared unit of product based on the mass of products and co-products in accordance with International Organization for Standardization (ISO) protocol (ISO 2006). As the analysis does not take the declared unit to the stage of being an installed building product no service life is assigned.

3.2 System Boundaries

The system boundary begins with regeneration in the forest for the PNW and SE softwood regions and ends with particleboard (Wilson 2008) (Figure 3). The forest resources system boundary includes: planting the seedlings, forest management which included fertilization and thinning on a subset of hectares, final harvest with the transportation of logs, wood residue from lumber and plywood manufacturing processes and particleboard production (Figure 3). Seedlings and the fertilizer and electricity it took to grow them were considered as inputs to the system boundary. The particleboard production complex was modeled as a single process representing all the steps necessary to make particleboard: sorting of wood residue, screening, refining, drying, blending, forming, hot pressing, cooling, sawing, and sanding (Figure 4). A single unit approach was used to model the particleboard process since the percentage of co-product was very small (0.7%) and the approach does not impact the accuracy of assigning the burdens.

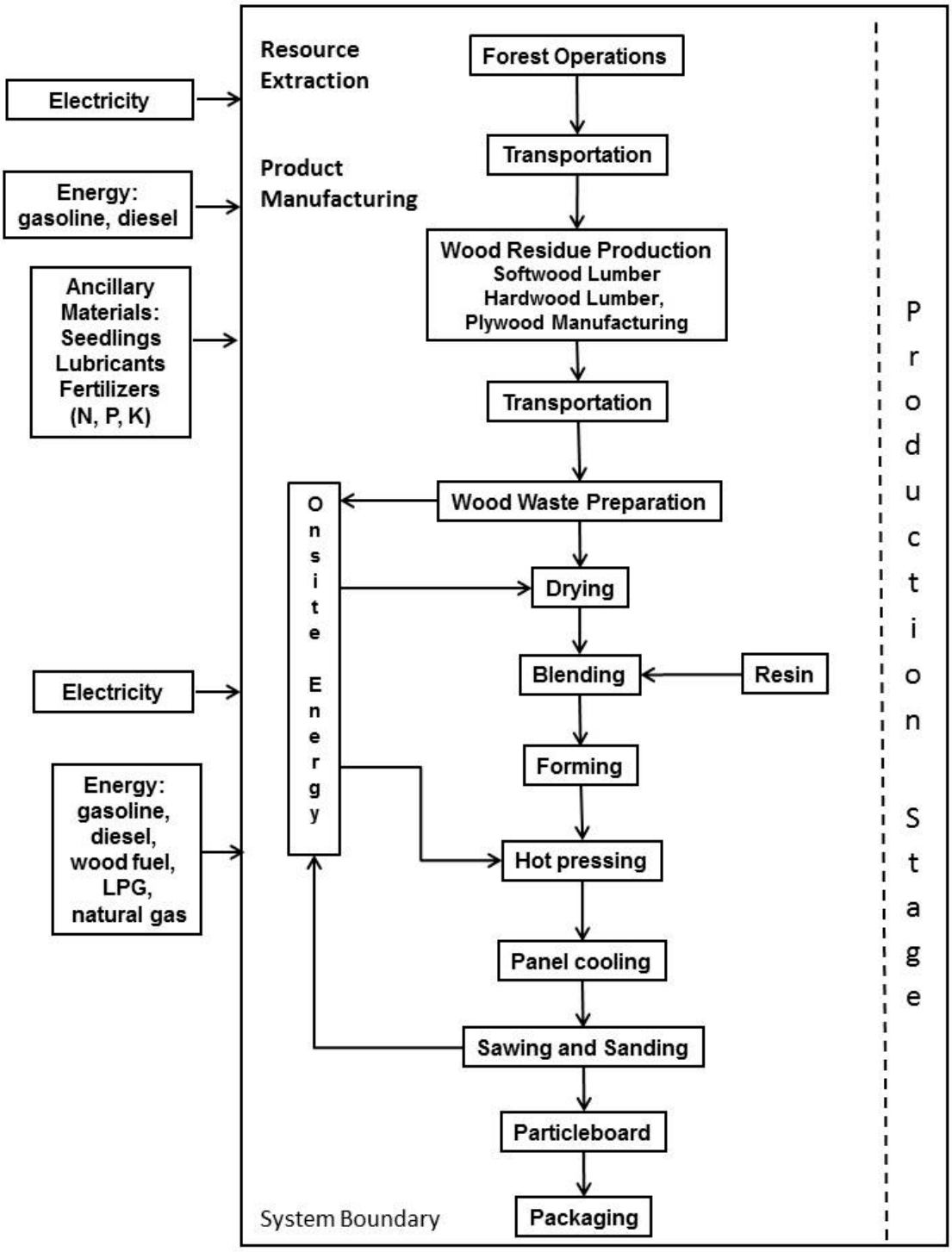

Figure 3 Cradle to gate life cycle stages for particleboard.

3.3 Description of data/Process Description

3.3.1 Forestry Operations

Forest operations modeled as inputs to particle board production were based on forest resource LCI data inputs from the PNW (40%) and SE (60%) softwood forests (Johnson et al 2005). Forestry operations vary regionally (Johnson et al. 2005) but typically include some combination of growing seedlings, site preparation, planting, thinning, fertilization (where applicable) and final harvest. The specific processes involved are reforestation: which includes seedling production, site preparation and planting, pre-commercial thinning, and fertilization, and harvesting: which includes felling, skidding, processing, and loading for both commercial thinning and final harvest operations. Weighted average allocation to different processes takes into account inherent differences in site productivity and energy usage by different kinds of logging equipment. Inputs to the forest resources management LCI include seed, electricity used during greenhouse operations, fertilizer used during seedling production and stand growth, and the fuel and lubricants needed to power and maintain equipment for thinning, and harvest operations. The primary output product for this analysis is a log destined for the lumber or plywood mill. The co-product, non-merchantable slash, is generally left at a landing. Slash disposal was not modeled as it was assumed to decay in-situ. Details of the processes are provided in Johnson et al 2005. A summary of the energy use and fuel consumption for the forest operations by region, along with the weighted average values used in particle board production are provided in Table 1.

Table 1 Fuel consumption for regional forest resource management processes (regeneration, thinning, and harvest).

	Unit	Fuel Consumption per m^3		
		PNW softwoods	SE softwoods	Weighted Average
Seedling, Site Prep, Plant, Pre-commercial Thinning				
Diesel and gasoline	L	0.088	0.515	0.344
Lubricants	L	0.002	0.009	0.006
Electricity	kWh	0.107	0.455	0.316
Commercial Thinning and Final Harvest				
Diesel	L	2.850	2.930	2.898
Lubricants	L	0.051	0.050	0.050
Total Forest Extraction Process				
Gasoline and Diesel	L	2.938	3.440	3.239
Lubricants	L	0.053	0.059	0.057
Electricity	kWh	0.107	0.455	0.316

3.3.2 Wood Product Manufacturing

The particleboard manufacturing process is highly automated, process-controlled and fairly linear. The complete process is shown in Figure 4.

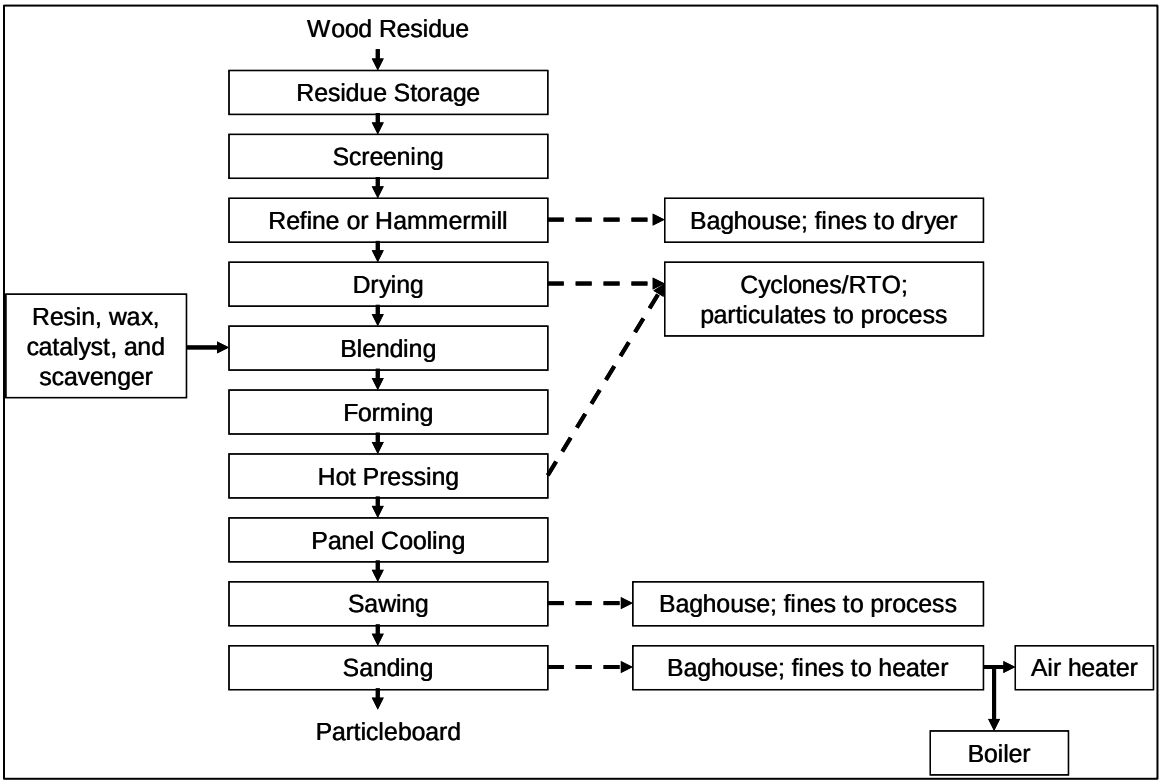

Figure 4 Process flow for the production of particleboard.

3.3.2.1 Transportation Process

Transportation is the first process of product manufacturing (Figure 3). Delivery of wood residues and materials to the mills is by truck. Some resin is delivered by pipeline from adjacent resin plants and is not considered in the transport in this study. Based on mill surveys the average haul distance for wood residues was 136 km, and resin, wax, ammonium-sulfate catalyst and scavenger[1] 124 km.

Table 2 Average delivery distance (one-way) for materials to particleboard mill.

Material delivered to mill	Delivery Distance (km)	
	km	miles
Wood residue	136	85
Urea-formaldehyde resin	124	77
Wax	124	77
Urea scavenger	124	77
Ammonium-sulfate catalyst	124	77

[1] Scavenger is used to "capture" excess formaldehyde to reduce its emission from the panel.

3.3.2.2 Energy use and generation

Energy for the production of particleboard comes from electricity, wood sources, natural gas, and oil, whereas other fuels such as diesel, liquid propane gas (LPG), and gasoline are used to operate transport equipment within the mill. The electricity is used to operate equipment within the plant, equipment such as conveyors, refiners, fan motors, hydraulic press motors, sanders, and emission control systems. Electricity is used throughout the process. The fuels for equipment are used for loaders and forklifts, and the natural gas and wood fuels are used to operate flash tube dryers and heat presses.

Emission control devices such as baghouses, cyclones, biofilters (BFs), regenerative thermal oxidizers (RTOs) and regenerative catalytic oxidizers (RCOs) are used throughout the mill. The emission control devices are used to reduce particulate and chemical emissions with a trade-off in that there is a large quantity of natural gas and electricity used to operate the RTO and RCO devices, and similarly large quantities of electricity to operate BF systems

Natural gas is the primary fuel used in the particleboard process; it is used for providing process heat for digesting, drying wood residue and heating steam or oil for hot pressing. Wood is used for drying wood furnish, heating steam or oil for hot presses, and for combusting VOC's and HAP emissions control systems which use natural gas and electricity for their operation. Wood is used for fuel in the form of sander dust that is generated in the process when the panel is sanded to thickness and smoothness. A small amount of additional wood fuel was generated during processing. In addition, a small amount of fuel oil was used for process heat and a small amount of fuel was used to operate fork lift trucks and handlers within the mill. Table 2 gives the boiler inputs heating fuel used on-site energy for manufacturing particleboard. The total fuel use for process heat is 1,706.7 MJ/m^3 of which 67% is generated by direct fired natural gas and the other 33% from self-generated wood fuel.

The wood boiler used self-generated wood waste (Table 3 and 4). One kg of wood material based on an oven dry basis for moisture content contained 20.9 MJ of energy. The wood-based fuel mix was 93 percent sander dust and 7 percent wood waste.

Table 3 Boiler inputs for drying per 1 m^3 particleboard (PB).

Fuel	Unit	Value (Unit/m^3)	HHV (MJ/kg)	MJ/m^3 of product
Wood waste- self generated	kg	27.00	20.9	564.30
Natural Gas	m^3	30.00	54.40	1,142.40
TOTAL Heat Energy – at PB	MJ	-	-	1,706.70

Table 4 Wood Boiler Process

Product	Value	Unit/m^3
Wood biomass, combusted in industrial boiler-oven dry	1.00	kg
Avoided products		
Electricity, at Grid	0.0048	kWh
Materials/fuels		
Wood fuel, sander dust, at particleboard mill, US, kg	0.93	kg
Wood fuel, at particleboard mill, US, kg	0.07	kg
Emissions to air		
Acetaldehyde	7.47E-06	kg
Acrolein	3.60E-05	kg
Antimony	7.11E-08	kg
Arsenic	1.98E-07	kg
Benzene	3.78E-05	kg
Beryllium	9.90E-09	kg
Cadmium	3.69E-08	kg
Carbon dioxide, biogenic	1.76E+00	kg
Carbon monoxide	5.40E-03	kg
Chlorine	7.11E-06	kg
Chromium	1.89E-07	kg
Cobalt	5.85E-08	kg
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	7.74E-14	kg
Formaldehyde	3.96E-05	kg
Hydrogen chloride	1.71E-04	kg
Lead	4.32E-07	kg
Manganese	1.44E-05	kg
Mercury	3.15E-08	kg
Metals, unspecified	3.85E-04	kg
Methane	1.89E-04	kg
Methane, dichloro-, HCC-30	2.61E-06	kg
Naphthalene	8.73E-07	kg
Nickel	2.97E-07	kg
Nitrogen oxides	1.17E-04	kg
Nitrogen oxides	1.98E-03	kg
Particulates, > 2.5 um, and < 10um	4.50E-03	kg
Phenols, unspecified	4.59E-07	kg
Selenium	2.52E-08	kg
Sulfur oxides	2.25E-04	kg
TOC, Total Organic Carbon	3.68E-05	kg

In terms of the total energy, which includes fuel for process heat and equipment, and includes electricity, the wood fuel energy represents 70%, natural gas energy 15%, and the electricity energy 14%. The non-wood energy component represents an opportunity for improving sustainability by substituting sustainable wood fuel.

3.3.2.3 Wood residue Sort and Store

Wood residue is delivered to the mill normally by truck; the residue, referred to in the industry as furnish, consists of shavings, sawdust, panel trim, fines, and chips of various moisture contents. The residue is sorted by geometry and moisture content and then stored under cover. Incoming residue has a moisture content that ranges from 10 to 100% on an oven-dry weight-basis.

3.3.2.4 Screening

During screening the wood residue is passed through a set of screens that sort them by size, with oversize particles going to refining. Particles are sorted according to the desired sized for use in face and core layers, and undersized particles referred to as fines can either be put into the board which is the most common practice, or sometimes used as fuel for dryers.

3.3.2.5 Refining

After screening the wood residue is refined by mechanically reducing the residue geometry into uniform sizes of desired dimensions. This process is usually accomplished with the use of refiners, hammermills[2] and occasionally flakers[3] and hogs[4]. Particulate emissions are addressed by baghouses and cyclones.

3.3.2.6 Drying

The fibers are sent through rotary dryers using either a single pass or triple pass configuration. The particles enter the dryers at moisture contents of 10-100% oven-dry wood basis, and are dried to a targeted moisture content of about 3-5% depending on whether the particles will be used for face or core layers. The dryers are normally fired directly with natural gas, although some dryers also use sander dust that is recycled from a later process step. As wood dries at elevated temperatures in the dryers, particulates and air emissions of volatile organic compounds (VOCs) are released. Emissions from dryers go to cyclones and control devices such as regenerative thermal oxidizers (RTOs), catalytic regenerative oxidizers (RCOs), and biofilters.

3.3.2.7 Blending

This process distributes the resin, wax, catalyst, and scavenger onto the particles in the form of discrete droplets. Urea-formaldehyde (UF) is the most commonly used resin except for those products where moisture resistance is desired which are made with either melamine-urea-formaldehyde or polymeric isocyanate resins.

3.3.2.8 Forming

The blended fibers are distributed into a flat mat in multiple layers of three or five consisting of face and core layers. The size of particles, their moisture and resin content are controlled for the face and core layers to obtain desire panel properties.

[2] A machine for producing fibers from solid wood pieces by hammering or flailing them.
[3] A machine that converts round wood and/or mill wastes into flakes for use as the raw material for particleboard or waferboard.
[4] A machine used to grind wood into chips for use as fuel or for other purposes.

3.3.2.9 Hot pressing

The physical properties of the panel are controlled during pressing. The formed mats are conveyed into large stack presses with multiple openings, Presses operate at sufficient temperature 340°F (170°C) and duration to cure the resin, and sufficient pressure of approximately 750 psi (5.17 MPa) to consolidate the mat to a desired density of 37 to 50 lb/ft^3 (593- 801 kg/m^3). As a result of the elevated temperature and resin curing, particulates and air emissions of VOCs, HAPs, and other resin related emissions are generated. Emissions, if treated, go to control devices such as RTOs, RCOs, and biofilters

3.3.2.10 Cooling

The hot panels are placed on a cooling wheel to enable the temperature of the panels to drop below a value where the UF resin will start to break down with time and emit formaldehyde gas. Limited amounts of air emissions occur at this point.

3.3.2.11 Sanding

The panels are sanded on both major surfaces to targeted thickness and smoothness. Sander dust coming off this process can either be put back into residue prior to the blending process or used as fuel for the dryers.

3.3.2.12 Sawing

Sanded, conditioned panels are sawn to their final dimensions during this step in the manufacturing. Typical dimensions are panel widths of 4 or 5 feet and lengths of 8 or 9 feet and sometimes longer lengths. Panel trim is hammermilled into particles and sent back into the process prior to the former. The panels are then stacked and prepared for shipping. Final particleboard product has an average dry density of 746 kg/m^3.

Table 5 Unit process inputs/outputs to produce 1 m^3 of particleboard.

Products	**Value**	**Unit/m^3**	**Allocation**
Particleboard	1.00	m^3	95.86%
Wood fuel, sander dust	25.00	kg	3.21%
Wood fuel	2.00	kg	0.26%
Wood waste, sold	5.18	kg	0.67%
Resources	**Value**	**Unit/m^3**	
Water, unspecified natural origin/m^3	304	L	
Materials/fuels	**Value**	**Unit/m^3**	
Wood residue, average US	703.60	kg	
Urea-formaldehyde (UF) resin, 100% solids	68.00	kg	
Urea	2.90	kg	
Slack wax	2.50	kg	
Ammonium sulphate, as N	0.72	kg	
Electricity, at Grid	158.00	kWh	
Diesel	0.32	L	
Gasoline	0.02	L	
LPG	0.33	L	

Natural gas	30.00	m^3	
Wood waste, combusted in boiler, self-generated fuel	27.00	kg	
Transportation Transport, combination truck, diesel power, wood residue	114.90	tkm	
Transport, combination truck, diesel powered, UF Resin	13.02	tkm	
Transport, combination truck, diesel powered, Wax, Urea, Ammonium sulfate	1.78	tkm	
Wrapping material - Packaging	0.46	kg	
Strap Protectors - Packaging	0.20	kg	
Strapping - Packaging	0.08	kg	
Spacers - Packaging	4.67	kg	
Emissions to air	**Value**	**Unit/m^3**	
VOC, volatile organic compounds	0.3570	kg	
Particulates	0.2150	kg	
Particulates, < 10 um	0.0326	kg	
Formaldehyde	0.0551	kg	
Methanol	0.0250	kg	
Acrolein	0.0000	kg	
Acetaldehyde	0.0006	kg	
Phenol	0.0047	kg	
HAPS, unspecified	0.0789	kg	
Emissions to water	**Value**	**Unit/m^3**	
Suspended solids, unspecified	0.0103	kg	
Waste to treatment			
Disposal, wood waste, to unspecified treatment	0.40	kg	
Disposal, solid waste, unspecified, to unspecified treatment	0.10	kg	

3.3.2.13 Wood residue

Wood residue attributes vary across the major production centers of the U.S. The wood residue comes from co-products that are generated in the SE and PNW softwood region during lumber, plywood, and oriented strandboard (OSB) production (Table 6)(Wilson and Sakimoto 2004, Milota et al. 2005). Dry planar shavings, a co-product from sawmill operations, represent the greatest wood residue input at 60 percent (405 kg, oven dry) followed by green sawdust, green chips, dry chips, green planer shaving, panel trim and oriented strandboard fines at 14, 9, 7, 5, 4, and <1 percent, respectively. All flow analyses of wood and bark in the process were determined on an oven-dry weight basis with a green specific gravity of 0.672.

Table 6 Wood residue type and source for input for particleboard production, average US.

Wood Residue Type	kg/m^3	Percent contribution
Pacific Northwest Region (PNW)		
Planer shavings, softwood, kiln dried, at planer, PNW	118.47	42%
Sawdust, softwood, green, at sawmill, PNW	44.35	16%
Planer shavings, softwood, green, at planer, PNW	33.55	12%
Panel trim, from trim and saw at plywood plant, PNW	31.45	11%
Pulp chips, softwood, dry, at planer, PNW	51.37	18%
Pulp chips, softwood, green, at sawmill, PNW	3.15	1%
TOTAL	282.34	100%
Southwest Region (SE)		
Planar shavings, at planer mill, SE	306.14	73%
Pulp chips, at sawmill, SE	59.76	14%
Sawdust, at sawmill, SE	52.11	12%
Fines, at oriented strand board production, SE	3.25	1%
TOTAL	421.26	100%
PNW –Region	**282.34**	**40%**
SE - Region	**421.26**	**60%**
TOTAL US Average	**703.60**	**100%**

3.3.2.14 Packaging

Table 7 Materials used in packaging and shipping per m^3 particleboard, average US.

Material	Value	Unit
Wrapping Material – HDPE and LDPE laminated paper	0.4601	kg
PET Strapping	0.0834	kg
Cardboard strap protectors	0.2002	kg
Wooden spacers	4.6721	kg

Packing materials represent only 0.73% of the cumulative mass of the model flow. The wooden spacers make up the bulk of this mass, representing 86 percent of the total packaging material. The wrapping material, strap protectors, and strapping made up, 8, 4, and 2 percent of the packaging by mass.

4 Cut-off rules

According to the PCR, if the mass/energy of a flow is less than 1% of the cumulative mass/energy of the model flow it may be excluded, provided its environmental relevance is minor. This analysis included all energy and mass flows from primary data.

In the primary surveys, manufacturers were asked to report total hazard air pollutants (HAPS) specific to their wood products manufacturing process: these include formaldehyde, methanol, acrolein, acetaldehyde, phenol, and propionaldehyde. If applicable to the wood product, HAPS are reported in Table 8 and would be included in the impact assessment. Table 9 shows all air emissions to 10^{-4} to simplify and report on the dominant releases by mass. There were no cut-offs used in the impact assessment. A complete list of all air emissions is located in Section 13 Appendix of this report.

5 Data quality requirements

This study collected data from representative particleboard manufacturers in the U.S. The particleboard producers responding were of average technology for the U.S. The wood residue to produce particleboard comes from a variety of co-products produced in both sawmills, plywood mills and OSB mills located in the PNW and SE regions of the U.S. Wood residues come in the form of wet and dry shavings, green chips, green sawdust, fines, and panel trim. The wood residue is comprised of PNW and SE softwood species representing a mix of *Pseudotsuga menziesii*, *Tsuga heterophylla*, *Pinus palustris* Mill., *P. echinata*. Mill., *P. taeda* L., and *P. elliottii* Engelm.

In 2004 the particleboard production in the U.S. was approximately 7,618,167 m^3 and Canada produced an additional 3,134,914 m^3 (CPA 2005). Survey data for this study of particleboard production in the U.S. collected data from mills that produced 1,738,448 m^3 in 2004, representing 23% of total production in the U.S or 16% of the total North American production.

An internal critical review of the survey procedures, data, analysis, and report was completed to assess conformance with CORRIM and ISO 14040 standards (Puettmann 2009, Wilson 2009). The review provided assurances that the study methodology, data collection, and analyses were scientifically sound, and in conformance with ISO 14040 and CORRIM research protocol (ISO 2006). Complete details of this study for particle board production and the overall CORRIM project can be found in Wilson (2008, 2010b) and Lippke et al. (2004, 2010), respectively.

6 Life cycle inventory analysis

6.1 Data collection

Primary data for the LCI was collected through surveys in accordance with CORRIM and ISO 14040 protocols. This study relied almost exclusively on production and emissions data provided by particleboard producers in the U.S., with some secondary data on electrical grid inputs from the US LCI database (Goemans 2010). The survey data represents particleboard production in terms of input materials, electricity, and fuel use, and emissions for the 2004 production year. The four mills surveyed were selected to be representative of U.S. production practices.

6.2 Calculation rules

Particleboard is most commonly reported in a thousand square foot (MSF) ¾ inch basis, which in SI units is equivalent to 1.7698 m^3. The survey results were converted to a unit production basis, 1 MSF (3/4 inch basis) and a weighted average of input data was calculated based on production. This approach resulted in a particleboard complex that represents a composite of the mills surveyed, but may not represent any mill in particular. The USLCI database was used to assess off-site impacts associated with the materials and energy used. SimaPro, version 7+ (Pré Consultants 2012) was used as the accounting program to track all of the materials.

Missing data is defined as data not reported in surveys by the particleboard facilities. Whenever missing data occurred for survey items, they were checked with plant personnel to determine whether it was an unknown value or zero. Missing data were carefully noted so they were not averaged as zeros. Unaccounted wood mass between input and output material flows in the production of particleboard based on survey data were found to be 4.8%. Final particleboard product has an average dry density of 746 kg/m^3 representing 89.95 percent wood residue and 9.12, 0.39, 0.34, and 0.10 percent UF resin, urea scavenger, ammonium sulphate, and wax respectively.

6.3 Allocation rules

All allocation was based on the mass of the products and co-products.

6.4 LCI Results

Life cycle inventory results for particleboard are presented by three life stages, 1) forestry operations, 2) wood residue production, particleboard production (Tables 8-11). The majority of the raw material energy consumption occurs during particleboard production, followed by the production of the wood residue with only a very small portion arising from forestry operations. Raw material energy requirements are presented in Table 8 for 1 m^3 of particleboard. Air emissions are reported in Table 9, water emissions are reported in Table 10 and solid waste emissions are reported in Table 11.

Table 8 Raw material consumed for energy production per 1 m^3 of particleboard, average US.

Fuel	Total	Forestry Operations	Wood Residue Production	Particleboard Production
	kg/m^3			
Coal, in ground	64.9928	0.2525	17.3906	47.3496
Gas, natural, in ground	80.2305	0.6456	10.7633	68.8216
Oil, crude, in ground	18.6681	3.9976	5.5096	9.1609
Uranium oxide, in ore	0.0017	0.0000	0.0004	0.0012
Wood waste	123.5429	0.0000	95.7188	27.8240

Particleboard manufacturers reported particulate and particulate PM10 (less than 10 µm in size) that occur in refining, drying, sawing, and sanding. Other air emissions include the VOCs that occur in drying, pressing, and panel cooling. Recorded emissions of formaldehyde and methanol are used as a measure of the amount of Hazardous Air Polluntants (HAPs). All mills in the survey reported VOC, HAPS, formaldehyde, and methanol, while only two mills reported acetaldehyde and phenol, and only one mill reported acrolein. No mills reported propionaldehyde emissions.

Table 9 Air emissions released per 1 m^3 of particleboard, average US.

Fuel	Total	Forestry Operations	Wood Residue Production	Particleboard Production
	kg/m^3			
Carbon dioxide, fossil	3.32E+02	1.31E+01	7.95E+01	2.39E+02
Carbon dioxide, biogenic	2.36E+02	1.09E-02	1.86E+02	5.01E+01
Carbon dioxide	6.25E+00	3.54E-01	9.78E-02	5.80E+00
Sulfur dioxide	2.71E+00	2.11E-02	4.99E-01	2.19E+00
Nitrogen oxides	1.34E+00	2.36E-01	4.83E-01	6.24E-01
Methane	1.22E+00	2.32E-02	2.34E-01	9.63E-01
VOC, volatile organic compounds	8.03E-01	6.67E-03	3.73E-01	4.22E-01
Carbon monoxide	7.23E-01	2.59E-05	5.70E-01	1.53E-01
Particulates, > 2.5 um, and < 10um	6.51E-01	7.23E-03	4.89E-01	1.55E-01
Carbon monoxide, fossil	5.76E-01	1.18E-01	1.39E-01	3.20E-01
Particulates, < 2.5 um	5.41E-01	0.00E+00	4.04E-01	1.37E-01
Particulates, unspecified	5.25E-01	1.48E-03	4.48E-01	7.59E-02
Methane, fossil	2.30E-01	2.18E-03	2.27E-02	2.05E-01
Particulates	2.14E-01	0.00E+00	1.67E-06	2.14E-01
Ammonia	1.65E-01	3.52E-04	1.41E-04	1.64E-01
NMVOC, non-methane volatile organic compounds, unspecified origin	1.49E-01	7.88E-03	1.29E-02	1.28E-01
Sulfur oxides	1.04E-01	1.31E-02	4.29E-02	4.79E-02
HAPS, unspecified	7.84E-02	0.00E+00	0.00E+00	7.84E-02
Particulates, < 10 um	7.54E-02	0.00E+00	4.30E-02	3.24E-02
Formaldehyde	6.19E-02	8.38E-05	5.39E-03	5.65E-02
Hydrogen chloride	5.68E-02	1.40E-04	2.71E-02	2.96E-02
Metals, unspecified	5.14E-02	3.09E-14	4.06E-02	1.07E-02
Organic substances, unspecified	4.30E-02	6.86E-07	5.05E-05	4.30E-02
Isoprene	3.25E-02	2.73E-04	1.10E-02	2.12E-02
Methanol	3.17E-02	0.00E+00	6.45E-03	2.52E-02
Particulates, > 10 um	2.90E-02	0.00E+00	0.00E+00	2.90E-02
BTEX (Benzene, Toluene, Ethylbenzene, and Xylene), unspecified ratio	2.59E-02	2.27E-04	3.78E-03	2.19E-02
Acrolein	2.28E-02	6.54E-06	2.17E-02	1.05E-03

Fuel	Total	Forestry Operations	Wood Residue Production	Particleboard Production
	kg/m^3			
Hydrocarbons (other than methane)	5.97E-03	0.00E+00	5.97E-03	0.00E+00
Benzene	5.62E-03	6.61E-05	4.33E-03	1.22E-03
TOC, Total Organic Carbon	4.92E-03	0.00E+00	3.90E-03	1.03E-03
Phenol	4.88E-03	4.40E-11	2.13E-04	4.67E-03
Hydrogen fluoride	4.23E-03	1.65E-05	1.13E-03	3.09E-03
Particulates, SPM	4.17E-03	0.00E+00	4.17E-03	0.00E+00
Dinitrogen monoxide	4.17E-03	2.08E-03	5.45E-04	1.54E-03
alpha-Pinene	2.92E-03	0.00E+00	2.92E-03	0.00E+00
Acetaldehyde	2.56E-03	5.40E-05	1.74E-03	7.62E-04
Radionuclides (Including Radon)	2.34E-03	8.28E-06	6.22E-04	1.71E-03
Manganese	1.94E-03	9.12E-08	1.52E-03	4.13E-04
Ethane	1.58E-03	0.00E+00	0.00E+00	1.58E-03
Dimethyl ether	1.48E-03	0.00E+00	3.43E-06	1.47E-03
N-Nitrodimethylamine	1.23E-03	0.00E+00	2.36E-05	1.20E-03
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-	1.13E-03	0.00E+00	1.13E-03	0.00E+00
Chlorine	9.50E-04	0.00E+00	7.50E-04	2.00E-04
Aldehydes, unspecified	6.74E-04	1.62E-04	2.29E-04	2.83E-04
Propane	5.46E-04	0.00E+00	0.00E+00	5.46E-04
Hydrocarbons, unspecified	5.04E-04	1.79E-06	1.34E-04	3.68E-04
Cumene	4.72E-04	1.46E-11	4.72E-04	1.08E-07
Propene	4.06E-04	1.82E-04	2.08E-04	1.67E-05
Pentane	3.90E-04	0.00E+00	0.00E+00	3.90E-04
Methane, dichloro-, HCC-30	3.57E-04	9.26E-08	2.78E-04	7.95E-05
D-limonene	3.28E-04	0.00E+00	3.28E-04	0.00E+00
Butane	3.21E-04	0.00E+00	0.00E+00	3.21E-04
Magnesium	3.16E-04	1.22E-06	8.26E-05	2.32E-04
Hydrogen sulfide	2.36E-04	2.69E-13	1.08E-11	2.36E-04
Acetone	1.94E-04	0.00E+00	1.94E-04	6.47E-07
Naphthalene	1.18E-04	1.72E-08	9.23E-05	2.54E-05
Hydrocarbons, aliphatic, alkanes, unspecified	1.05E-04	0.00E+00	0.00E+00	1.05E-04
Toluene	1.04E-04	2.88E-05	7.65E-06	6.73E-05

[1/] Due to large amount of air emissions, total emissions less than 10^{-4} are not shown. A complete list of all air emissions can be found in Section 13.

Waterborne emissions reported by particleboard manufactures and produced all off-site are in shown in Table 10.

Table 10 Emissions to water released per 1 m^3 of particleboard, average US.

Water Emission	Total	Forestry Operations	Wood Residue Production	Particleboard Production
	kg/m^3			
Solved solids	1.74E+01	7.63E-01	3.03E+00	1.36E+01
Chloride	1.41E+01	6.19E-01	2.46E+00	1.10E+01
Sodium, ion	3.97E+00	1.74E-01	6.93E-01	3.11E+00
Calcium, ion	1.26E+00	5.50E-02	2.19E-01	9.86E-01
Heat, waste	5.87E-01	0.00E+00	0.00E+00	5.87E-01
Suspended solids, unspecified	4.20E-01	4.10E-02	8.62E-02	2.92E-01
Lithium, ion	3.57E-01	3.15E-03	5.22E-02	3.02E-01
Magnesium	2.49E-01	1.08E-02	4.27E-02	1.95E-01
Barium	1.64E-01	1.83E-02	3.76E-02	1.08E-01
COD, Chemical Oxygen Demand	1.41E-01	5.82E-03	2.81E-02	1.07E-01
BOD5, Biological Oxygen Demand	1.25E-01	3.11E-03	1.93E-02	1.03E-01
Sulfate	9.97E-02	1.38E-03	1.50E-02	8.32E-02
Bromide	8.34E-02	3.67E-03	1.46E-02	6.52E-02
Iron	3.09E-02	2.70E-03	6.68E-03	2.15E-02
Strontium	2.14E-02	9.34E-04	3.71E-03	1.67E-02
Solids, inorganic	1.55E-02	1.35E-11	5.44E-10	1.55E-02
Ammonium, ion	1.27E-02	6.61E-08	4.96E-06	1.27E-02
Oils, unspecified	1.09E-02	3.87E-04	1.42E-03	9.12E-03
Waste, solid	1.09E-02	0.00E+00	0.00E+00	1.09E-02
Fluoride	1.05E-02	1.02E-02	8.07E-05	2.75E-04
Phosphate	9.03E-03	7.64E-03	1.46E-07	1.39E-03
Ammonia, as N	8.17E-03	8.79E-11	3.53E-09	8.17E-03
Ammonia	7.78E-03	3.07E-04	9.78E-04	6.50E-03
Silicon	7.51E-03	0.00E+00	0.00E+00	7.51E-03
Aluminum	7.10E-03	1.33E-03	2.72E-03	3.05E-03
Aluminium	5.66E-03	0.00E+00	9.87E-05	5.56E-03
Formaldehyde	4.92E-03	0.00E+00	0.00E+00	4.92E-03
TOC, Total Organic Carbon	3.29E-03	0.00E+00	2.09E-03	1.20E-03
DOC, Dissolved Organic Carbon	3.29E-03	5.37E-13	2.09E-03	1.20E-03
Potassium, ion	2.55E-03	0.00E+00	0.00E+00	2.55E-03
Barite	1.50E-03	0.00E+00	0.00E+00	1.50E-03
Benzene	1.43E-03	2.87E-05	8.88E-04	5.11E-04
Boron	1.24E-03	5.38E-05	2.13E-04	9.76E-04
Manganese	1.24E-03	1.91E-05	2.10E-04	1.01E-03
Iron, ion	1.18E-03	0.00E+00	0.00E+00	1.18E-03

Water Emission	Total	Forestry Operations	Wood Residue Production	Particleboard Production
	kg/m^3			
Cumene	1.13E-03	0.00E+00	1.13E-03	2.58E-07
Sulfur	1.04E-03	4.54E-05	1.80E-04	8.10E-04
Silver	8.16E-04	3.60E-05	1.43E-04	6.37E-04
Waste water/m3	7.62E-04	0.00E+00	0.00E+00	7.62E-04
Dissolved solids	7.26E-04	0.00E+00	7.26E-04	0.00E+00
Toluene	6.18E-04	2.72E-05	1.08E-04	4.84E-04
Propene	4.18E-04	0.00E+00	4.18E-04	1.13E-07
Benzoic acid	3.95E-04	1.74E-05	6.90E-05	3.09E-04
Nitrate	3.90E-04	5.89E-14	2.37E-12	3.90E-04
Detergent, oil	3.79E-04	1.47E-05	6.46E-05	2.99E-04
Xylene	3.23E-04	1.45E-05	5.65E-05	2.52E-04
Zinc	3.10E-04	3.09E-05	7.18E-05	2.07E-04
Chromium, ion	1.77E-04	3.68E-06	2.76E-05	1.46E-04
Phenols, unspecified	1.52E-04	2.20E-06	2.30E-05	1.27E-04
Lead	1.45E-04	1.10E-05	2.75E-05	1.06E-04
Chromium	1.40E-04	3.91E-05	4.64E-05	5.48E-05
Titanium, ion	1.35E-04	1.27E-05	2.51E-05	9.74E-05
Zinc, ion	1.31E-04	0.00E+00	0.00E+00	1.31E-04

[1/] Due to large amount of water emissions, total emissions less than 10^{-4} are not shown. A complete list of all air emissions can be found in Section 13.

Solid emissions include ash generated at the boiler and in the upstream processes, primarily fuels and resins, used in particleboard production (Table 11). On-site production makes up about 1.34% of the total waste generated cradle to gate.

Table 11 Waste to treatment per 1 m^3 of particleboard, average US (kg/m^3).

Waste to treatment	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Solid waste	35.90	0.23	15.46	20.21

7 Life cycle impact assessment

The life cycle impact assessment (LCIA) phase establishes links between the life cycle inventory results and potential environmental impacts. The LCIA calculates impact indicators, such as global warming potential and smog. These impact indicators provide general, but quantifiable, indications of potential environmental impacts. The target impact indicator, the impact category, and means of characterizing the impacts are summarized in Table 12. Environmental impacts are determined using the TRACI method (Bare et al. 2011). These five impact categories are reported consistent with the requirement of the wood products PCR (PCR 2011).

Table 12 Selected impact indicators, characterization models, and impact categories.

Impact Indicator	Characterization Model	Impact Category
Greenhouse gas (GHG) emissions	Calculate total emissions in the reference unit of CO_2 equivalents for CO_2, methane, and nitrous oxide.	Global warming
Releases to air decreasing or thinning of ozone layer	Calculate the total ozone forming chemicals in the stratosphere including CFC's HCFC's, chlorine, and bromine. Ozone depletion values are measured in the reference units of CFC equivalents.	Ozone depletion
Releases to air potentially resulting in acid rain (acidification)	Calculate total hydrogen ion (H+) equivalent for released sulfur oxides, nitrogen oxides, hydrochloric acid, and ammonia. Acidification value of H^+ mole-eq. is used as a reference unit.	Acidification
Releases to air potentially resulting in smog	Calculate total substances that can be photo-chemically oxidized. Smog forming potential of O_3 is used as a reference unit.	Photochemical smog
Releases to air potentially resulting in eutrophication of water bodies	Calculate total substances that contain available nitrogen or phosphorus. Eutrophication potential of N-eq. is used as a reference unit.	Eutrophication

Each impact indicator is a measure of an aspect of a potential impact. This LCIA does not make value judgments about the impact indicators, meaning that no single indicator is given more or less value than any of the others. All are presented as equals. Additionally, each impact indicator value is stated in units that are not comparable to others. For the same reasons, indicators should not be combined or added. Table 13 provides the environmental impact by category for particleboard. In addition, energy and material resource consumption values and the waste generated are also provided.

Environmental performance results for global warming potential (GWP), acidification, eutrophication, ozone depletion and smog, energy consumption from non-renewables, renewables, wind, hydro, solar, and nuclear fuels, renewable and nonrenewable resources, and solid waste are shown in Table 13. For GWP, 73 percent of the CO_2 equivalent emissions come from producing particleboard, with 23 and 4 percent assigned to wood residue production and forestry operations, respectively. Similar results are presented for acidification. Forestry operations contributed 23 percent to eutrophication, ranking second to particleboard production at 59 percent. For the smog impact category, wood residue and particleboard production produce similar impacts at 37 and 48 percent of the total, respectively.

Non-renewable resources represented the greatest proportion of energy consumption (68%) with particleboard production life cycle dominating the use at 78 percent. Renewable biomass consumption for energy was 25 percent with 77 percent consumed during wood residue production and 23 percent used during particleboard production. Biomass energy is the primarily used in drying, conditioning, and pressing process for both wood residue and particleboard production.

Table 13 Environmental performance of 1 m^3 particleboard, average US.

Impact category	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Global warming potential (GWP)	kg CO_2 equiv	375.67	14.71	86.18	274.78
Acidification Potential	H+ moles equiv	215.47	11.21	48.19	156.07
Eutrophication Potential	kg N equiv	0.1299	0.0293	0.0246	0.0760
Ozone depletion Potential	kg CFC-11 equiv	0.0000	0.0000	0.0000	0.0000
Smog Potential	kg O_3 equiv	37.44	5.87	13.75	17.82
Total Primary Energy Consumption	**Unit**	**Total**	**Forestry Operations**	**Wood Residue Production**	**Particleboard Production**
Non-renewable fossil	MJ	6,924.11	223.84	1,287.72	5,376.16
Non-renewable nuclear	MJ	628.97	2.22	166.65	460.10
Renewable (solar, wind, hydroelectric, and geothermal)	MJ	97.01	0.29	43.98	52.74
Renewable, biomass	MJ	2,590.63	0.00	2,003.84	586.78
Material resources consumption (Non-fuel resources)	**Unit**	**Total**	**Forestry Operations**	**Wood Residue Production**	**Particleboard Production**
Non-renewable materials[5]	kg	0.97	0.03	0.12	0.82
Renewable materials[6]	kg	799.83	0.00	794.00	5.83
Fresh water	L	600.38	5.50	228.14	366.74
Waste generated	**Unit**	**Total**	**Forestry Operations**	**Wood Residue Production**	**Particleboard Production**
Solid waste	kg	35.90	0.23	15.46	20.21

[5] Limestone, in ground has been removed from a precombustion wood fuel extraction process (NREL 2012). This process was used for "purchased wood fuel" as reported by some wood product manufacturers. As noted in the process documentation the data was collected from pulp and paper mills using fluidized bed boilers. Fluidized bed boilers are not used in the solid wood products industry.

[6] Roundwood inputs: SE softwoods = 470 kg/m^3, and PNW softwoods = 330 kg/m^3.

8 Treatment of Biogenic Carbon

Treatment of biogenic carbon is consistent with the Intergovernmental Panel for Climate Change (IPCC 2006) inventory reporting framework in that there is no assumption that biomass combustion is carbon neutral, but that net carbon emissions from biomass combustion are accounted for under the Land-Use Change and Forestry (LUCF) Sector and are therefore ignored in energy emissions reporting for the product LCA to prevent double counting. Standards such as ASTM D7612, which are used in North America to define legal, responsible and/or certified sources of wood materials, are in place to provide assurances regarding forest regeneration and sustainable harvest rates that serve as proxies to ensure stable carbon balances in the forest sector. They are outside the accounting framework for this LCA.

This approach to the treatment of biogenic carbon was taken for the Norwegian Solid Wood Product PCR (Aasestad 2008), and the North American PCR has adopted an identical approach to ensure comparability and consistency. The North American PCR approach is followed here for GWP reporting therefore the default TRACI impact assessment method was used. This default method does not count the CO_2 emissions released during the combustion of woody biomass during production. Other emissions associated from wood combustion, e.g., methane or nitrogen oxides, do contribute to and are included in the GWP impact category. For a complete list of emissions factors for the GWP method used, see Bare et al. (2011). Using this method, 376 kg CO_2e were released in the production of 1 m^3 of particleboard from cradle to production gate. That same 1 m^3 of particleboard stores 352 kg of carbon[7] or 1,289 kg CO_2e resulting in more carbon storage in the product then released during manufacturing (cradle to gate) (Table 14).

Table 14 Carbon per 1 m^3 particleboard, average US.

	kg CO_2 equivalent
released forestry operations	14.71
released wood residue production	86.18
released particleboard manufacturing	274.78
CO_2 eq. stored in product	1,289.21

[7] Using 52.4% carbon content of particleboard (Wilson 2010). Weight of prticleboard 671 kg/m^3.

9 Conclusions

The cradle to gate LCA for particleboard includes: 1) the LCI of forest resources that relies on secondary and tertiary data; 2) the LCI of lumber, plywood, and oriented strandboard manufacturing that produce the wood residue as an input into particleboard that relies on primary survey data and secondary data for process inputs such as natural gas, diesel, and electricity, and 3) the particleboard LCI that relies on primary survey data and secondary data for process inputs such as natural gas, diesel, and electricity. The survey results for particleboard were representative of the U.S. average with wood inputs representing the PNW and the SE wood production regions of the U.S. The survey data are representative of the particleboard sizes and production volumes consistent with trade association production data.

Emissions from the forest resources LCI are small relative to manufacturing emissions (particleboard and wood residue). At the particleboard site emissions can originate at the boiler, drying, and pressing processes and are a function of the fuel burned and resin type.

Renewable biomass represented 25 percent of the total energy consumption with 23 percent consumed during particleboard production and 77% consumed during wood residue production. The use of non-renewable fossil fuels dominated the energy consumption representing 6,924 of the 10,241 MJ/m^3 cradle to gate total required energy for particleboard production. Forestry operations consumed exclusively (99%) fossil fuels. The production of the wood residue used in particleboard represented 19 percent of the fossil consumption leaving the production of particleboard with about 78 percent or 5,376 MJ/m^3 of the fossil fuel use. Energy consumed during urea formaldehyde (UF) resin production is included in the fossil fuel use for particle board as an upstream process. Wilson (2009) reported that UF resin total production energy was 29.35 MJ/kg or 2,175 MJ (based on 74.14 kg of UF resin + additives). Although not specifically assessed in this LCA, this would represent approximately 40 percent of the fossil consumption in the particleboard production process. In summary, to produce 1 cubic meter of particleboard consumed 25 percent of the total energy from biomass (wood fuel) and 68 percent from nonrenewable fossil fuels leaving a small portion of energy needs coming from nuclear (6%) and solar, wind, hydroelectric, and geothermal (1%).

The TRACI impact method does not count the contribution of wood-derived CO_2 emissions from burning wood fuel in the boiler towards the global warming impact estimate. This is consistent with the current US EPA ruling on wood emissions from stationary sources which considers the CO_2 taken up by the forest ecosystem when the tree grew as balancing any CO_2 emissions when it is burned. Under the TRACI method, combustion of fossil fuels generates CO_2 and other air emissions that contribute to the global warming impact. Using this method, 376 kg CO_2e were released in the production of 1 m^3 of particleboard. That same 1 m^3 of particleboard stores 1,289 kg CO_2e.

10 Acknowledgments

The original research project would not have been possible without the financial and technical assistance provided by the USDA Forest Service, Forest Products Laboratory (USFS (JV11111137-084& 094), by DOE's support for developing the research plan (DE-FC07-961D13437), CORRIM's University membership, and the contributions of many forest companies. The data updates provided in this document were made possible with the financial assistance of the American Wood Council. Our special thanks are extended to those companies and their employees that participated in the surveys to obtain production data. Any opinions, findings, conclusions, or recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the contributing entities.

11 Critical Review

11.1 Internal Review

An internal review of the LCA product was provided by:

Bruce Lippke, Professor Emeritus, University of Washington

The purpose of the LCA Report internal review is to check for errors and conformance with the PCR prior to submittal to for external review. The technical and editorial comments of the reviewers were carefully considered and in most instances incorporated into the final document. CORRIM addressed the internal review comments, as appropriate, and maintains a record of all comments and responses for future reference.

11.2 External Review

The external review process is intended to ensure consistency between the completed LCA and the principals and requirements of the International Standards on LCA (ISO 2006) and the Product Category Rules (PCR) for North American Structural and Architectural Wood Products (PCR 2011). Following CORRIM's internal review evaluation, documents were submitted to UL Environment (ULE) for independent external review. The independent external review performed by ULE was conducted by:

TBD – this will be modified when we know the verifier's name

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13 Appendix

13.1 Air Emissions

Table A.1 Air emissions released per 1 m^3 of particleboard, average US.

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
1,4-Butanediol	kg	1.50E-12	0.00E+00	0.00E+00	1.50E-12
1-Butanol	kg	9.08E-14	0.00E+00	0.00E+00	9.08E-14
1-Pentanol	kg	3.27E-14	0.00E+00	0.00E+00	3.27E-14
1-Pentene	kg	2.47E-14	0.00E+00	0.00E+00	2.47E-14
1-Propanol	kg	1.05E-11	0.00E+00	0.00E+00	1.05E-11
2,4-D	kg	1.36E-09	0.00E+00	0.00E+00	1.36E-09
2-Aminopropanol	kg	8.14E-15	0.00E+00	0.00E+00	8.14E-15
2-Butanone, 3,3-dimethyl-	kg	2.02E-05	0.00E+00	2.02E-05	0.00E+00
2-Butene, 2-methyl-	kg	5.49E-18	0.00E+00	0.00E+00	5.49E-18
2-Chloroacetophenone	kg	3.59E-10	1.93E-11	3.23E-11	3.08E-10
2-Methyl-1-propanol	kg	1.32E-13	0.00E+00	0.00E+00	1.32E-13
2-Nitrobenzoic acid	kg	1.45E-14	0.00E+00	0.00E+00	1.45E-14
2-Propanol	kg	1.72E-08	0.00E+00	0.00E+00	1.72E-08
5-methyl Chrysene	kg	6.20E-10	2.43E-12	1.65E-10	4.52E-10
Acenaphthene	kg	1.44E-08	5.64E-11	3.83E-09	1.05E-08
Acenaphthylene	kg	7.04E-09	2.76E-11	1.88E-09	5.14E-09
Acetaldehyde	kg	2.56E-03	5.40E-05	1.74E-03	7.62E-04
Acetic acid	kg	4.98E-05	0.00E+00	0.00E+00	4.98E-05
Acetochlor	kg	1.88E-08	0.00E+00	0.00E+00	1.88E-08
Acetone	kg	1.94E-04	0.00E+00	1.94E-04	6.47E-07
Acetonitrile	kg	3.04E-09	0.00E+00	0.00E+00	3.04E-09
Acetophenone	kg	7.70E-10	4.13E-11	6.92E-11	6.60E-10
Acrolein	kg	2.28E-02	6.54E-06	2.17E-02	1.05E-03
Acrylic acid	kg	4.46E-11	0.00E+00	0.00E+00	4.46E-11
Actinides, radioactive, unspecified	Bq	9.39E-05	0.00E+00	0.00E+00	9.39E-05
Aerosols, radioactive, unspecified	Bq	2.25E-03	0.00E+00	0.00E+00	2.25E-03
Alachlor	kg	1.85E-09	0.00E+00	0.00E+00	1.85E-09
Aldehydes, unspecified	kg	6.74E-04	1.62E-04	2.29E-04	2.83E-04
alpha-Pinene	kg	2.92E-03	0.00E+00	2.92E-03	0.00E+00
Aluminium	kg	4.79E-05	0.00E+00	0.00E+00	4.79E-05
Ammonia	kg	1.65E-01	3.52E-04	1.41E-04	1.64E-01
Ammonium carbonate	kg	8.05E-10	0.00E+00	0.00E+00	8.05E-10
Ammonium chloride	kg	8.73E-05	3.09E-07	2.32E-05	6.38E-05

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Aniline	kg	2.02E-12	0.00E+00	0.00E+00	2.02E-12
Anthracene	kg	5.91E-09	2.32E-11	1.58E-09	4.32E-09
Anthranilic acid	kg	1.06E-14	0.00E+00	0.00E+00	1.06E-14
Antimony	kg	1.00E-05	1.99E-09	7.63E-06	2.37E-06
Antimony-124	Bq	1.80E-08	0.00E+00	0.00E+00	1.80E-08
Antimony-125	Bq	1.88E-07	0.00E+00	0.00E+00	1.88E-07
Argon-41	Bq	1.19E+00	0.00E+00	0.00E+00	1.19E+00
Arsenic	kg	3.87E-05	6.18E-08	2.41E-05	1.45E-05
Arsine	kg	5.19E-16	0.00E+00	0.00E+00	5.19E-16
Ash	kg	2.34E-05	0.00E+00	4.51E-07	2.29E-05
Atrazine	kg	3.67E-08	0.00E+00	0.00E+00	3.67E-08
Barium	kg	7.54E-06	0.00E+00	7.07E-06	4.66E-07
Barium-140	Bq	1.22E-05	0.00E+00	0.00E+00	1.22E-05
Bentazone	kg	1.50E-10	0.00E+00	0.00E+00	1.50E-10
Benzal chloride	kg	8.16E-18	0.00E+00	0.00E+00	8.16E-18
Benzaldehyde	kg	5.60E-11	0.00E+00	0.00E+00	5.60E-11
Benzene	kg	5.62E-03	6.61E-05	4.33E-03	1.22E-03
Benzene, 1,2-dichloro-	kg	3.03E-13	0.00E+00	0.00E+00	3.03E-13
Benzene, 1-methyl-2-nitro-	kg	1.25E-14	0.00E+00	0.00E+00	1.25E-14
Benzene, chloro-	kg	1.13E-09	6.05E-11	1.02E-10	9.67E-10
Benzene, ethyl-	kg	2.49E-07	2.59E-10	6.05E-09	2.43E-07
Benzene, hexachloro-	kg	5.86E-10	0.00E+00	0.00E+00	5.86E-10
Benzene, pentachloro-	kg	4.20E-12	0.00E+00	0.00E+00	4.20E-12
Benzo(a)anthracene	kg	2.25E-09	8.84E-12	6.00E-10	1.64E-09
Benzo(a)pyrene	kg	1.24E-08	4.20E-12	2.85E-10	1.21E-08
Benzo(b,j,k)fluoranthene	kg	3.10E-09	1.22E-11	8.26E-10	2.26E-09
Benzo(ghi)perylene	kg	7.60E-10	2.98E-12	2.03E-10	5.55E-10
Benzyl chloride	kg	3.59E-08	1.93E-09	3.23E-09	3.08E-08
Beryllium	kg	1.98E-06	3.08E-09	1.23E-06	7.50E-07
Bicyclo[3.1.1]heptane, 6,6-dimethyl-2-methylene-	kg	1.13E-03	0.00E+00	1.13E-03	0.00E+00
Biphenyl	kg	4.79E-08	1.88E-10	1.28E-08	3.49E-08
Boron	kg	3.88E-06	0.00E+00	0.00E+00	3.88E-06
Boron trifluoride	kg	7.11E-18	0.00E+00	0.00E+00	7.11E-18
Bromine	kg	3.68E-07	0.00E+00	0.00E+00	3.68E-07
Bromoform	kg	2.00E-09	1.07E-10	1.80E-10	1.71E-09
Bromoxynil	kg	3.28E-10	0.00E+00	0.00E+00	3.28E-10
BTEX (Benzene, Toluene, Ethylbenzene, and Xylene), unspecified ratio	kg	2.59E-02	2.27E-04	3.78E-03	2.19E-02

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Butadiene	kg	3.50E-06	2.75E-06	5.14E-07	2.33E-07
Butane	kg	3.21E-04	0.00E+00	0.00E+00	3.21E-04
Butene	kg	2.35E-07	0.00E+00	0.00E+00	2.35E-07
Butyrolactone	kg	2.73E-13	0.00E+00	0.00E+00	2.73E-13
Cadmium	kg	7.87E-06	1.55E-08	4.57E-06	3.28E-06
Calcium	kg	4.18E-06	0.00E+00	0.00E+00	4.18E-06
Carbofuran	kg	2.81E-10	0.00E+00	0.00E+00	2.81E-10
Carbon dioxide	kg	6.25E+00	3.54E-01	9.78E-02	5.80E+00
Carbon dioxide, biogenic	kg	2.36E+02	1.09E-02	1.86E+02	5.01E+01
Carbon dioxide, fossil	kg	3.32E+02	1.31E+01	7.95E+01	2.39E+02
Carbon dioxide, land transformation	kg	7.11E-05	0.00E+00	0.00E+00	7.11E-05
Carbon disulfide	kg	1.70E-06	3.58E-10	6.00E-10	1.70E-06
Carbon monoxide	kg	7.23E-01	2.59E-05	5.70E-01	1.53E-01
Carbon monoxide, biogenic	kg	2.26E-06	0.00E+00	0.00E+00	2.26E-06
Carbon monoxide, fossil	kg	5.76E-01	1.18E-01	1.39E-01	3.20E-01
Carbon-14	Bq	9.39E+00	0.00E+00	0.00E+00	9.39E+00
Cerium-141	Bq	2.96E-06	0.00E+00	0.00E+00	2.96E-06
Cesium-134	Bq	1.42E-07	0.00E+00	0.00E+00	1.42E-07
Cesium-137	Bq	2.51E-06	0.00E+00	0.00E+00	2.51E-06
Chloramine	kg	1.32E-13	0.00E+00	0.00E+00	1.32E-13
Chloride	kg	9.90E-10	8.33E-12	3.35E-10	6.47E-10
Chlorinated fluorocarbons and hydrochlorinated fluorocarbons, unspecified	kg	3.69E-08	0.00E+00	6.74E-09	3.01E-08
Chlorine	kg	9.50E-04	0.00E+00	7.50E-04	2.00E-04
Chloroacetic acid	kg	9.82E-11	0.00E+00	0.00E+00	9.82E-11
Chloroform	kg	3.26E-09	1.62E-10	2.72E-10	2.83E-09
Chlorosilane, trimethyl-	kg	3.17E-11	0.00E+00	0.00E+00	3.17E-11
Chlorosulfonic acid	kg	9.72E-14	0.00E+00	0.00E+00	9.72E-14
Chlorpyrifos	kg	2.16E-09	0.00E+00	0.00E+00	2.16E-09
Chromium	kg	3.50E-05	4.48E-08	2.23E-05	1.27E-05
Chromium VI	kg	2.25E-06	8.73E-09	5.93E-07	1.65E-06
Chromium-51	Bq	1.90E-07	0.00E+00	0.00E+00	1.90E-07
Chrysene	kg	2.82E-09	1.11E-11	7.51E-10	2.05E-09
Cobalt	kg	1.16E-05	8.17E-08	7.09E-06	4.43E-06
Cobalt-58	Bq	2.64E-07	0.00E+00	0.00E+00	2.64E-07
Cobalt-60	Bq	2.33E-06	0.00E+00	0.00E+00	2.33E-06
Copper	kg	9.46E-07	7.96E-10	4.96E-08	8.96E-07
Cumene	kg	4.72E-04	1.46E-11	4.72E-04	1.08E-07

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Cyanazine	kg	3.24E-10	0.00E+00	0.00E+00	3.24E-10
Cyanide	kg	1.51E-07	6.88E-09	1.15E-08	1.33E-07
Cyanoacetic acid	kg	7.96E-14	0.00E+00	0.00E+00	7.96E-14
Dicamba	kg	1.91E-09	0.00E+00	0.00E+00	1.91E-09
Diethylamine	kg	9.00E-13	0.00E+00	0.00E+00	9.00E-13
Dimethenamid	kg	4.50E-09	0.00E+00	0.00E+00	4.50E-09
Dimethyl ether	kg	1.48E-03	0.00E+00	3.43E-06	1.47E-03
Dimethyl malonate	kg	9.99E-14	0.00E+00	0.00E+00	9.99E-14
Dinitrogen monoxide	kg	4.17E-03	2.08E-03	5.45E-04	1.54E-03
Dioxin, 2,3,7,8 Tetrachlorodibenzo-p-	kg	1.48E-07	1.25E-17	1.46E-07	1.45E-09
Dioxins, measured as 2,3,7,8-tetrachlorodibenzo-p-dioxin	kg	2.23E-11	2.65E-13	6.95E-12	1.51E-11
Dipropylamine	kg	5.70E-13	0.00E+00	0.00E+00	5.70E-13
Dipropylthiocarbamic acid S-ethyl ester	kg	3.08E-09	0.00E+00	0.00E+00	3.08E-09
D-limonene	kg	3.28E-04	0.00E+00	3.28E-04	0.00E+00
Ethane	kg	1.58E-03	0.00E+00	0.00E+00	1.58E-03
Ethane, 1,1,1,2-tetrafluoro-, HFC-134a	kg	1.03E-07	0.00E+00	7.67E-10	1.03E-07
Ethane, 1,1,1-trichloro-, HCFC-140	kg	2.52E-09	4.30E-10	6.04E-10	1.49E-09
Ethane, 1,1,2-trichloro-1,2,2-trifluoro-, CFC-113	kg	2.12E-12	0.00E+00	0.00E+00	2.12E-12
Ethane, 1,1-difluoro-, HFC-152a	kg	2.83E-10	0.00E+00	0.00E+00	2.83E-10
Ethane, 1,2-dibromo-	kg	6.16E-11	3.30E-12	5.54E-12	5.28E-11
Ethane, 1,2-dichloro-	kg	2.35E-08	1.10E-10	1.85E-10	2.32E-08
Ethane, 1,2-dichloro-1,1,2,2-tetrafluoro-, CFC-114	kg	3.99E-09	0.00E+00	0.00E+00	3.99E-09
Ethane, 1,2-dichloro-1,1,2-trifluoro-, HCFC-123	kg	7.67E-10	0.00E+00	7.67E-10	0.00E+00
Ethane, chloro-	kg	2.16E-09	1.16E-10	1.94E-10	1.85E-09
Ethane, hexafluoro-, HFC-116	kg	6.60E-09	0.00E+00	0.00E+00	6.60E-09
Ethanol	kg	1.17E-06	0.00E+00	0.00E+00	1.17E-06
Ethene	kg	5.89E-06	0.00E+00	0.00E+00	5.89E-06
Ethene, chloro-	kg	1.18E-08	0.00E+00	0.00E+00	1.18E-08
Ethene, tetrachloro-	kg	1.23E-06	5.65E-09	3.29E-07	8.95E-07
Ethene, trichloro-	kg	6.10E-14	0.00E+00	0.00E+00	6.10E-14
Ethyl acetate	kg	8.08E-08	0.00E+00	0.00E+00	8.08E-08
Ethyl cellulose	kg	1.62E-10	0.00E+00	0.00E+00	1.62E-10
Ethylamine	kg	6.25E-14	0.00E+00	0.00E+00	6.25E-14
Ethylene diamine	kg	8.75E-13	0.00E+00	0.00E+00	8.75E-13
Ethylene dibromide	kg	3.53E-11	0.00E+00	3.53E-11	0.00E+00
Ethylene oxide	kg	2.39E-09	0.00E+00	0.00E+00	2.39E-09

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Ethyne	kg	7.55E-07	0.00E+00	0.00E+00	7.55E-07
Fluoranthene	kg	2.00E-08	7.85E-11	5.33E-09	1.46E-08
Fluorene	kg	2.56E-08	1.01E-10	6.83E-09	1.87E-08
Fluoride	kg	8.23E-06	4.12E-06	7.31E-07	3.38E-06
Fluorine	kg	2.83E-07	0.00E+00	0.00E+00	2.83E-07
Fluosilicic acid	kg	7.53E-09	0.00E+00	0.00E+00	7.53E-09
Formaldehyde	kg	6.19E-02	8.38E-05	5.39E-03	5.65E-02
Formamide	kg	5.99E-14	0.00E+00	0.00E+00	5.99E-14
Formic acid	kg	2.05E-08	0.00E+00	0.00E+00	2.05E-08
Furan	kg	5.91E-09	4.92E-13	3.71E-11	5.88E-09
Glyphosate	kg	4.05E-09	0.00E+00	0.00E+00	4.05E-09
HAPS, unspecified	kg	7.84E-02	0.00E+00	0.00E+00	7.84E-02
Heat, waste	MJ	4.34E+02	0.00E+00	4.94E-01	4.34E+02
Helium	kg	6.92E-07	0.00E+00	0.00E+00	6.92E-07
Heptane	kg	2.35E-06	0.00E+00	0.00E+00	2.35E-06
Hexane	kg	6.19E-06	1.84E-10	3.09E-10	6.19E-06
Hydrazine, methyl-	kg	8.73E-09	4.68E-10	7.84E-10	7.47E-09
Hydrocarbons (other than methane)	kg	5.97E-03	0.00E+00	5.97E-03	0.00E+00
Hydrocarbons, aliphatic, alkanes, cyclic	kg	2.77E-09	0.00E+00	0.00E+00	2.77E-09
Hydrocarbons, aliphatic, alkanes, unspecified	kg	1.05E-04	0.00E+00	0.00E+00	1.05E-04
Hydrocarbons, aliphatic, unsaturated	kg	1.67E-06	0.00E+00	0.00E+00	1.67E-06
Hydrocarbons, aromatic	kg	5.18E-05	0.00E+00	0.00E+00	5.18E-05
Hydrocarbons, chlorinated	kg	4.93E-09	0.00E+00	0.00E+00	4.93E-09
Hydrocarbons, unspecified	kg	5.04E-04	1.79E-06	1.34E-04	3.68E-04
Hydrogen	kg	5.59E-06	0.00E+00	2.60E-07	5.33E-06
Hydrogen chloride	kg	5.68E-02	1.40E-04	2.71E-02	2.96E-02
Hydrogen fluoride	kg	4.23E-03	1.65E-05	1.13E-03	3.09E-03
Hydrogen peroxide	kg	1.20E-10	0.00E+00	0.00E+00	1.20E-10
Hydrogen sulfide	kg	2.36E-04	2.69E-13	1.08E-11	2.36E-04
Hydrogen-3, Tritium	Bq	5.35E+01	0.00E+00	0.00E+00	5.35E+01
Indeno(1,2,3-cd)pyrene	kg	1.72E-09	6.74E-12	4.58E-10	1.25E-09
Iodine	kg	2.03E-07	0.00E+00	0.00E+00	2.03E-07
Iodine-129	Bq	9.37E-03	0.00E+00	0.00E+00	9.37E-03
Iodine-131	Bq	4.71E-01	0.00E+00	0.00E+00	4.71E-01
Iodine-133	Bq	2.61E-05	0.00E+00	0.00E+00	2.61E-05
Iodine-135	Bq	2.49E-05	0.00E+00	0.00E+00	2.49E-05
Iron	kg	1.25E-05	0.00E+00	0.00E+00	1.25E-05
Isocyanic acid	kg	1.17E-08	0.00E+00	0.00E+00	1.17E-08

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Isophorone	kg	2.98E-08	1.60E-09	2.68E-09	2.55E-08
Isoprene	kg	3.25E-02	2.73E-04	1.10E-02	2.12E-02
Isopropylamine	kg	1.57E-14	0.00E+00	0.00E+00	1.57E-14
Kerosene	kg	4.18E-05	1.48E-07	1.11E-05	3.06E-05
Krypton-85	Bq	3.73E+00	0.00E+00	0.00E+00	3.73E+00
Krypton-85m	Bq	2.35E-01	0.00E+00	0.00E+00	2.35E-01
Krypton-87	Bq	8.43E-02	0.00E+00	0.00E+00	8.43E-02
Krypton-88	Bq	8.71E-02	0.00E+00	0.00E+00	8.71E-02
Krypton-89	Bq	2.49E-02	0.00E+00	0.00E+00	2.49E-02
Lactic acid	kg	4.47E-13	0.00E+00	0.00E+00	4.47E-13
Lanthanum-140	Bq	1.04E-06	0.00E+00	0.00E+00	1.04E-06
Lead	kg	7.18E-05	7.65E-08	4.90E-05	2.27E-05
Lead-210	Bq	1.14E-01	0.00E+00	0.00E+00	1.14E-01
Magnesium	kg	3.16E-04	1.22E-06	8.26E-05	2.32E-04
Manganese	kg	1.94E-03	9.12E-08	1.52E-03	4.13E-04
Manganese-54	Bq	9.71E-08	0.00E+00	0.00E+00	9.71E-08
MCPA	kg	2.54E-11	0.00E+00	0.00E+00	2.54E-11
Mercaptans, unspecified	kg	1.10E-05	5.96E-07	9.97E-07	9.43E-06
Mercury	kg	7.11E-06	1.54E-08	4.05E-06	3.04E-06
Metals, unspecified	kg	5.14E-02	3.09E-14	4.06E-02	1.07E-02
Methacrylic acid	kg	3.22E-12	0.00E+00	3.22E-12	0.00E+00
Methacrylic acid, methyl ester	kg	9.96E-10	5.50E-11	8.90E-11	8.52E-10
Methane	kg	1.22E+00	2.32E-02	2.34E-01	9.63E-01
Methane, biogenic	kg	2.43E-05	0.00E+00	0.00E+00	2.43E-05
Methane, bromo-, Halon 1001	kg	8.21E-09	4.40E-10	7.38E-10	7.04E-09
Methane, bromochlorodifluoro-, Halon 1211	kg	4.91E-07	0.00E+00	0.00E+00	4.91E-07
Methane, bromotrifluoro-, Halon 1301	kg	6.53E-09	0.00E+00	0.00E+00	6.53E-09
Methane, chlorodifluoro-, HCFC-22	kg	1.70E-06	0.00E+00	9.90E-09	1.69E-06
Methane, chlorotrifluoro-, CFC-13	kg	1.81E-10	0.00E+00	1.81E-10	0.00E+00
Methane, dichloro-, HCC-30	kg	3.57E-04	9.26E-08	2.78E-04	7.95E-05
Methane, dichlorodifluoro-, CFC-12	kg	3.53E-09	4.64E-10	6.33E-10	2.43E-09
Methane, dichlorofluoro-, HCFC-21	kg	1.77E-14	0.00E+00	0.00E+00	1.77E-14
Methane, fossil	kg	2.30E-01	2.18E-03	2.27E-02	2.05E-01
Methane, monochloro-, R-40	kg	2.72E-08	1.46E-09	2.45E-09	2.33E-08
Methane, tetrachloro-, CFC-10	kg	1.56E-08	4.64E-11	8.94E-09	6.57E-09
Methane, tetrafluoro-, CFC-14	kg	5.80E-08	0.00E+00	0.00E+00	5.80E-08
Methane, trichlorofluoro-, CFC-11	kg	2.87E-14	0.00E+00	0.00E+00	2.87E-14
Methane, trifluoro-, HFC-23	kg	5.63E-12	0.00E+00	0.00E+00	5.63E-12

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Methanesulfonic acid	kg	8.05E-14	0.00E+00	0.00E+00	8.05E-14
Methanol	kg	3.17E-02	0.00E+00	6.45E-03	2.52E-02
Methyl acetate	kg	3.35E-15	0.00E+00	0.00E+00	3.35E-15
Methyl acrylate	kg	5.06E-11	0.00E+00	0.00E+00	5.06E-11
Methyl amine	kg	4.29E-13	0.00E+00	0.00E+00	4.29E-13
Methyl borate	kg	1.27E-14	0.00E+00	0.00E+00	1.27E-14
Methyl ethyl ketone	kg	4.72E-05	1.07E-09	4.71E-05	9.79E-08
Methyl formate	kg	5.83E-05	0.00E+00	0.00E+00	5.83E-05
Methyl lactate	kg	4.90E-13	0.00E+00	0.00E+00	4.90E-13
Methyl methacrylate	kg	2.71E-11	0.00E+00	7.06E-14	2.70E-11
Methylene diisocyanate	kg	4.04E-07	0.00E+00	4.04E-07	0.00E+00
Metolachlor	kg	1.49E-08	0.00E+00	0.00E+00	1.49E-08
Metribuzin	kg	6.90E-11	0.00E+00	0.00E+00	6.90E-11
Molybdenum	kg	7.68E-08	0.00E+00	0.00E+00	7.68E-08
Monoethanolamine	kg	3.64E-09	0.00E+00	0.00E+00	3.64E-09
m-Xylene	kg	1.25E-08	0.00E+00	0.00E+00	1.25E-08
Naphthalene	kg	1.18E-04	1.72E-08	9.23E-05	2.54E-05
Nickel	kg	6.28E-05	1.03E-06	3.60E-05	2.58E-05
Nickel compounds	kg	9.90E-09	0.00E+00	9.90E-09	0.00E+00
Niobium-95	Bq	1.15E-08	0.00E+00	0.00E+00	1.15E-08
Nitrate	kg	5.16E-08	0.00E+00	0.00E+00	5.16E-08
Nitrobenzene	kg	2.71E-12	0.00E+00	0.00E+00	2.71E-12
Nitrogen oxides	kg	1.34E+00	2.36E-01	4.83E-01	6.24E-01
Nitrogen, total	kg	7.99E-05	7.99E-05	0.00E+00	1.82E-09
Nitrous oxide	kg	9.76E-09	0.00E+00	9.76E-09	0.00E+00
NMVOC, non-methane volatile organic compounds, unspecified origin	kg	1.49E-01	7.88E-03	1.29E-02	1.28E-01
N-Nitrodimethylamine	kg	1.23E-03	0.00E+00	2.36E-05	1.20E-03
Noble gases, radioactive, unspecified	Bq	9.00E+04	0.00E+00	0.00E+00	9.00E+04
Organic acids	kg	3.21E-07	1.14E-09	8.53E-08	2.35E-07
Organic substances, unspecified	kg	4.30E-02	6.86E-07	5.05E-05	4.30E-02
Ozone	kg	3.77E-06	0.00E+00	0.00E+00	3.77E-06
PAH, polycyclic aromatic hydrocarbons	kg	1.82E-05	1.18E-05	2.21E-06	4.13E-06
Paraquat	kg	3.01E-10	0.00E+00	0.00E+00	3.01E-10
Parathion, methyl	kg	2.28E-10	0.00E+00	0.00E+00	2.28E-10
Particulates	kg	2.14E-01	0.00E+00	1.67E-06	2.14E-01
Particulates, < 10 um	kg	7.54E-02	0.00E+00	4.30E-02	3.24E-02
Particulates, < 2.5 um	kg	5.41E-01	0.00E+00	4.04E-01	1.37E-01

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Particulates, > 10 um	kg	2.90E-02	0.00E+00	0.00E+00	2.90E-02
Particulates, > 2.5 um, and < 10um	kg	6.51E-01	7.23E-03	4.89E-01	1.55E-01
Particulates, SPM	kg	4.17E-03	0.00E+00	4.17E-03	0.00E+00
Particulates, unspecified	kg	5.25E-01	1.48E-03	4.48E-01	7.59E-02
Pendimethalin	kg	1.55E-09	0.00E+00	0.00E+00	1.55E-09
Pentane	kg	3.90E-04	0.00E+00	0.00E+00	3.90E-04
Permethrin	kg	1.39E-10	0.00E+00	0.00E+00	1.39E-10
PFC (perfluorocarbons)	kg	9.90E-08	0.00E+00	9.90E-08	0.00E+00
Phenanthrene	kg	7.60E-08	2.98E-10	2.03E-08	5.55E-08
Phenol	kg	4.88E-03	4.40E-11	2.13E-04	4.67E-03
Phenol, 2,4-dichloro-	kg	3.07E-13	0.00E+00	0.00E+00	3.07E-13
Phenol, pentachloro-	kg	2.52E-09	0.00E+00	0.00E+00	2.52E-09
Phenols, unspecified	kg	6.25E-05	4.74E-08	4.88E-05	1.37E-05
Phorate	kg	7.13E-11	0.00E+00	0.00E+00	7.13E-11
Phosphate	kg	1.82E-06	1.82E-06	0.00E+00	0.00E+00
Phosphine	kg	3.85E-14	0.00E+00	0.00E+00	3.85E-14
Phosphorus	kg	1.34E-07	0.00E+00	0.00E+00	1.34E-07
Phthalate, diisooctyl-	kg	1.17E-11	0.00E+00	1.17E-11	0.00E+00
Phthalate, dioctyl-	kg	3.74E-09	2.01E-10	3.25E-10	3.21E-09
Platinum	kg	1.39E-13	0.00E+00	0.00E+00	1.39E-13
Plutonium-238	Bq	1.28E-09	0.00E+00	0.00E+00	1.28E-09
Plutonium-alpha	Bq	2.93E-09	0.00E+00	0.00E+00	2.93E-09
Polonium-210	Bq	2.06E-01	0.00E+00	0.00E+00	2.06E-01
Polychlorinated biphenyls	kg	9.89E-10	0.00E+00	0.00E+00	9.89E-10
Polycyclic organic matter, unspecified	kg	4.60E-10	0.00E+00	4.60E-10	0.00E+00
Potassium	kg	4.26E-05	0.00E+00	0.00E+00	4.26E-05
Potassium-40	Bq	3.00E-02	0.00E+00	0.00E+00	3.00E-02
Propanal	kg	1.96E-08	1.05E-09	1.75E-09	1.68E-08
Propane	kg	5.46E-04	0.00E+00	0.00E+00	5.46E-04
Propene	kg	4.06E-04	1.82E-04	2.08E-04	1.67E-05
Propionic acid	kg	6.27E-06	0.00E+00	0.00E+00	6.27E-06
Propylamine	kg	1.90E-14	0.00E+00	0.00E+00	1.90E-14
Propylene oxide	kg	1.28E-08	0.00E+00	4.76E-09	8.02E-09
Protactinium-234	Bq	1.29E-03	0.00E+00	0.00E+00	1.29E-03
Pyrene	kg	9.29E-09	3.65E-11	2.48E-09	6.78E-09
Radioactive species, other beta emitters	Bq	7.22E-02	0.00E+00	0.00E+00	7.22E-02
Radioactive species, unspecified	Bq	1.59E+06	6.11E+03	4.25E+05	1.16E+06
Radionuclides (Including Radon)	kg	2.34E-03	8.28E-06	6.22E-04	1.71E-03

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Radium-226	Bq	7.13E-02	0.00E+00	0.00E+00	7.13E-02
Radium-228	Bq	9.70E-02	0.00E+00	0.00E+00	9.70E-02
Radon-220	Bq	5.09E-01	0.00E+00	0.00E+00	5.09E-01
Radon-222	Bq	1.71E+05	0.00E+00	0.00E+00	1.71E+05
Ruthenium-103	Bq	2.53E-09	0.00E+00	0.00E+00	2.53E-09
Scandium	kg	1.76E-08	0.00E+00	0.00E+00	1.76E-08
Selenium	kg	4.04E-05	1.54E-07	1.26E-05	2.77E-05
Silicon	kg	2.42E-05	0.00E+00	0.00E+00	2.42E-05
Silicon tetrafluoride	kg	1.92E-10	0.00E+00	0.00E+00	1.92E-10
Silver	kg	7.00E-10	0.00E+00	0.00E+00	7.00E-10
Silver-110	Bq	2.51E-08	0.00E+00	0.00E+00	2.51E-08
Simazine	kg	9.77E-10	0.00E+00	0.00E+00	9.77E-10
Sodium	kg	4.94E-06	0.00E+00	0.00E+00	4.94E-06
Sodium chlorate	kg	2.15E-09	0.00E+00	0.00E+00	2.15E-09
Sodium dichromate	kg	3.90E-09	0.00E+00	0.00E+00	3.90E-09
Sodium formate	kg	1.21E-11	0.00E+00	0.00E+00	1.21E-11
Sodium hydroxide	kg	4.48E-10	0.00E+00	0.00E+00	4.48E-10
Strontium	kg	3.35E-07	0.00E+00	0.00E+00	3.35E-07
Styrene	kg	2.08E-09	6.88E-11	1.15E-10	1.90E-09
Sulfate	kg	1.12E-05	0.00E+00	0.00E+00	1.12E-05
Sulfur	kg	4.57E-06	0.00E+00	0.00E+00	4.57E-06
Sulfur dioxide	kg	2.71E+00	2.11E-02	4.99E-01	2.19E+00
Sulfur hexafluoride	kg	5.26E-08	0.00E+00	0.00E+00	5.26E-08
Sulfur oxides	kg	1.04E-01	1.31E-02	4.29E-02	4.79E-02
Sulfur trioxide	kg	2.18E-11	0.00E+00	0.00E+00	2.18E-11
Sulfur, total reduced	kg	2.68E-06	0.00E+00	0.00E+00	2.68E-06
Sulfuric acid	kg	1.93E-10	0.00E+00	9.90E-11	9.44E-11
Sulfuric acid, dimethyl ester	kg	2.46E-09	1.32E-10	2.22E-10	2.11E-09
Tar	kg	1.11E-09	9.37E-12	3.77E-10	7.27E-10
t-Butyl methyl ether	kg	2.04E-09	9.63E-11	1.62E-10	1.79E-09
t-Butylamine	kg	6.74E-14	0.00E+00	0.00E+00	6.74E-14
Terbufos	kg	2.43E-09	0.00E+00	0.00E+00	2.43E-09
Terpenes	kg	2.54E-09	0.00E+00	0.00E+00	2.54E-09
Thallium	kg	2.47E-09	0.00E+00	0.00E+00	2.47E-09
Thorium	kg	2.80E-09	0.00E+00	0.00E+00	2.80E-09
Thorium-228	Bq	1.00E-02	0.00E+00	0.00E+00	1.00E-02
Thorium-230	Bq	5.13E-03	0.00E+00	0.00E+00	5.13E-03
Thorium-232	Bq	8.40E-03	0.00E+00	0.00E+00	8.40E-03

Air Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Thorium-234	Bq	1.30E-03	0.00E+00	0.00E+00	1.30E-03
Tin	kg	1.98E-08	0.00E+00	0.00E+00	1.98E-08
Titanium	kg	8.43E-07	0.00E+00	0.00E+00	8.43E-07
TOC, Total Organic Carbon	kg	4.92E-03	0.00E+00	3.90E-03	1.03E-03
Toluene	kg	1.04E-04	2.88E-05	7.65E-06	6.73E-05
Toluene, 2,4-dinitro-	kg	1.44E-11	7.70E-13	1.29E-12	1.23E-11
Toluene, 2-chloro-	kg	8.15E-13	0.00E+00	0.00E+00	8.15E-13
Trimethylamine	kg	5.97E-15	0.00E+00	0.00E+00	5.97E-15
Tungsten	kg	1.77E-09	0.00E+00	0.00E+00	1.77E-09
Uranium	kg	3.66E-09	0.00E+00	0.00E+00	3.66E-09
Uranium alpha	Bq	7.04E-02	0.00E+00	0.00E+00	7.04E-02
Uranium-234	Bq	1.54E-02	0.00E+00	0.00E+00	1.54E-02
Uranium-235	Bq	7.30E-04	0.00E+00	0.00E+00	7.30E-04
Uranium-238	Bq	3.80E-02	0.00E+00	0.00E+00	3.80E-02
Vanadium	kg	9.40E-06	0.00E+00	0.00E+00	9.40E-06
Vinyl acetate	kg	3.90E-10	2.09E-11	3.51E-11	3.34E-10
VOC, volatile organic compounds	kg	8.03E-01	6.67E-03	3.73E-01	4.22E-01
Water	kg	4.29E-05	0.00E+00	0.00E+00	4.29E-05
Xenon-131m	Bq	3.96E-01	0.00E+00	0.00E+00	3.96E-01
Xenon-133	Bq	1.29E+01	0.00E+00	0.00E+00	1.29E+01
Xenon-133m	Bq	4.72E-02	0.00E+00	0.00E+00	4.72E-02
Xenon-135	Bq	5.27E+00	0.00E+00	0.00E+00	5.27E+00
Xenon-135m	Bq	3.15E+00	0.00E+00	0.00E+00	3.15E+00
Xenon-137	Bq	6.83E-02	0.00E+00	0.00E+00	6.83E-02
Xenon-138	Bq	5.77E-01	0.00E+00	0.00E+00	5.77E-01
Xylene	kg	3.02E-05	2.01E-05	5.06E-06	5.13E-06
Zinc	kg	3.42E-06	1.47E-06	3.60E-08	1.91E-06
Zinc-65	Bq	4.85E-07	0.00E+00	0.00E+00	4.85E-07
Zirconium	kg	1.05E-09	0.00E+00	0.00E+00	1.05E-09
Zirconium-95	Bq	4.74E-07	0.00E+00	0.00E+00	4.74E-07

13.2 Water Emissions

Table 15 Emissions to water released per 1 m^3 of particleboard, average U.S.

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
1,4-Butanediol	kg	6.01E-13	0.00E+00	0.00E+00	6.01E-13
1-Butanol	kg	6.18E-06	0.00E+00	0.00E+00	6.18E-06
1-Pentanol	kg	7.85E-14	0.00E+00	0.00E+00	7.85E-14
1-Pentene	kg	5.94E-14	0.00E+00	0.00E+00	5.94E-14
1-Propanol	kg	2.01E-13	0.00E+00	0.00E+00	2.01E-13
2,4-D	kg	5.82E-11	0.00E+00	0.00E+00	5.82E-11
2-Aminopropanol	kg	2.04E-14	0.00E+00	0.00E+00	2.04E-14
2-Hexanone	kg	2.54E-06	1.12E-07	4.44E-07	1.99E-06
2-Methyl-1-propanol	kg	3.18E-13	0.00E+00	0.00E+00	3.18E-13
2-Methyl-2-butene	kg	1.32E-17	0.00E+00	0.00E+00	1.32E-17
2-Propanol	kg	2.52E-09	0.00E+00	0.00E+00	2.52E-09
4-Methyl-2-pentanone	kg	1.64E-06	7.20E-08	2.86E-07	1.28E-06
Acenaphthene	kg	7.16E-11	0.00E+00	0.00E+00	7.16E-11
Acenaphthylene	kg	4.48E-12	0.00E+00	0.00E+00	4.48E-12
Acetaldehyde	kg	9.89E-06	0.00E+00	0.00E+00	9.89E-06
Acetic acid	kg	2.62E-08	0.00E+00	0.00E+00	2.62E-08
Acetochlor	kg	8.07E-10	0.00E+00	0.00E+00	8.07E-10
Acetone	kg	3.89E-06	1.71E-07	6.80E-07	3.04E-06
Acetonitrile	kg	6.67E-14	0.00E+00	0.00E+00	6.67E-14
Acetyl chloride	kg	6.17E-14	0.00E+00	0.00E+00	6.17E-14
Acid as H+	kg	6.33E-05	0.00E+00	1.22E-06	6.21E-05
Acidity, unspecified	kg	5.59E-08	0.00E+00	0.00E+00	5.59E-08
Acids, unspecified	kg	3.60E-06	1.75E-10	7.04E-09	3.59E-06
Acrylate, ion	kg	1.05E-10	0.00E+00	0.00E+00	1.05E-10
Actinides, radioactive, unspecified	Bq	1.52E-02	0.00E+00	0.00E+00	1.52E-02
Alachlor	kg	7.95E-11	0.00E+00	0.00E+00	7.95E-11
Aluminium	kg	5.66E-03	0.00E+00	9.87E-05	5.56E-03
Aluminum	kg	7.10E-03	1.33E-03	2.72E-03	3.05E-03
Ammonia	kg	7.78E-03	3.07E-04	9.78E-04	6.50E-03
Ammonia, as N	kg	8.17E-03	8.79E-11	3.53E-09	8.17E-03
Ammonium, ion	kg	1.27E-02	6.61E-08	4.96E-06	1.27E-02
Aniline	kg	4.85E-12	0.00E+00	0.00E+00	4.85E-12
Antimony	kg	7.42E-06	8.29E-07	1.63E-06	4.95E-06
Antimony-122	Bq	7.25E-06	0.00E+00	0.00E+00	7.25E-06

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Antimony-124	Bq	2.59E-03	0.00E+00	0.00E+00	2.59E-03
Antimony-125	Bq	2.41E-03	0.00E+00	0.00E+00	2.41E-03
AOX, Adsorbable Organic Halogen as Cl	kg	1.80E-08	0.00E+00	0.00E+00	1.80E-08
Arsenic, ion	kg	9.59E-05	8.00E-06	1.63E-05	7.17E-05
Atrazine	kg	1.57E-09	0.00E+00	0.00E+00	1.57E-09
Barite	kg	1.50E-03	0.00E+00	0.00E+00	1.50E-03
Barium	kg	1.64E-01	1.83E-02	3.76E-02	1.08E-01
Barium-140	Bq	3.18E-05	0.00E+00	0.00E+00	3.18E-05
Bentazone	kg	6.42E-12	0.00E+00	0.00E+00	6.42E-12
Benzene	kg	1.43E-03	2.87E-05	8.88E-04	5.11E-04
Benzene, 1,2-dichloro-	kg	1.28E-10	0.00E+00	0.00E+00	1.28E-10
Benzene, 1-methyl-4-(1-methylethyl)-	kg	3.89E-08	1.71E-09	6.80E-09	3.04E-08
Benzene, chloro-	kg	2.64E-09	0.00E+00	0.00E+00	2.64E-09
Benzene, ethyl-	kg	3.70E-05	1.62E-06	6.42E-06	2.90E-05
Benzene, pentamethyl-	kg	2.92E-08	1.28E-09	5.10E-09	2.28E-08
Benzenes, alkylated, unspecified	kg	6.05E-06	7.27E-07	1.43E-06	3.89E-06
Benzoic acid	kg	3.95E-04	1.74E-05	6.90E-05	3.09E-04
Beryllium	kg	4.83E-06	2.50E-07	7.88E-07	3.79E-06
Biphenyl	kg	3.92E-07	4.71E-08	9.27E-08	2.52E-07
BOD5, Biological Oxygen Demand	kg	1.25E-01	3.11E-03	1.93E-02	1.03E-01
Borate	kg	6.78E-12	0.00E+00	0.00E+00	6.78E-12
Boron	kg	1.24E-03	5.38E-05	2.13E-04	9.76E-04
Bromate	kg	1.37E-07	0.00E+00	0.00E+00	1.37E-07
Bromide	kg	8.34E-02	3.67E-03	1.46E-02	6.52E-02
Bromine	kg	8.66E-06	0.00E+00	0.00E+00	8.66E-06
Bromoxynil	kg	8.49E-12	0.00E+00	0.00E+00	8.49E-12
Butene	kg	1.32E-10	0.00E+00	0.00E+00	1.32E-10
Butyl acetate	kg	8.04E-06	0.00E+00	0.00E+00	8.04E-06
Butyrolactone	kg	6.55E-13	0.00E+00	0.00E+00	6.55E-13
Cadmium, ion	kg	1.51E-05	1.82E-06	2.43E-06	1.08E-05
Calcium, ion	kg	1.26E+00	5.50E-02	2.19E-01	9.86E-01
Carbofuran	kg	1.20E-11	0.00E+00	0.00E+00	1.20E-11
Carbon disulfide	kg	3.32E-12	0.00E+00	0.00E+00	3.32E-12
Carbonate	kg	3.78E-07	0.00E+00	0.00E+00	3.78E-07
Carboxylic acids, unspecified	kg	6.68E-05	0.00E+00	0.00E+00	6.68E-05
Cerium-141	Bq	1.27E-05	0.00E+00	0.00E+00	1.27E-05
Cerium-144	Bq	3.87E-06	0.00E+00	0.00E+00	3.87E-06

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Cesium	kg	1.15E-08	0.00E+00	0.00E+00	1.15E-08
Cesium-134	Bq	2.14E-03	0.00E+00	0.00E+00	2.14E-03
Cesium-136	Bq	2.25E-06	0.00E+00	0.00E+00	2.25E-06
Cesium-137	Bq	1.75E+00	0.00E+00	0.00E+00	1.75E+00
CFCs, unspecified	kg	2.52E-09	0.00E+00	0.00E+00	2.52E-09
Chloramine	kg	1.18E-12	0.00E+00	0.00E+00	1.18E-12
Chlorate	kg	1.16E-06	0.00E+00	0.00E+00	1.16E-06
Chloride	kg	1.41E+01	6.19E-01	2.46E+00	1.10E+01
Chlorinated solvents, unspecified	kg	1.15E-09	0.00E+00	0.00E+00	1.15E-09
Chlorine	kg	1.39E-08	0.00E+00	0.00E+00	1.39E-08
Chloroacetic acid	kg	1.58E-09	0.00E+00	0.00E+00	1.58E-09
Chloroacetyl chloride	kg	2.72E-14	0.00E+00	0.00E+00	2.72E-14
Chloroform	kg	2.66E-11	0.00E+00	2.06E-11	5.94E-12
Chlorosulfonic acid	kg	2.43E-13	0.00E+00	0.00E+00	2.43E-13
Chlorpyrifos	kg	9.25E-11	0.00E+00	0.00E+00	9.25E-11
Chromate	kg	3.36E-13	0.00E+00	0.00E+00	3.36E-13
Chromium	kg	1.40E-04	3.91E-05	4.64E-05	5.48E-05
Chromium VI	kg	1.48E-05	1.43E-07	1.95E-07	1.45E-05
Chromium, ion	kg	1.77E-04	3.68E-06	2.76E-05	1.46E-04
Chromium-51	Bq	3.48E-03	0.00E+00	0.00E+00	3.48E-03
Cobalt	kg	1.83E-05	3.80E-07	1.51E-06	1.64E-05
Cobalt-57	Bq	7.16E-05	0.00E+00	0.00E+00	7.16E-05
Cobalt-58	Bq	2.32E-02	0.00E+00	0.00E+00	2.32E-02
Cobalt-60	Bq	1.86E-02	0.00E+00	0.00E+00	1.86E-02
COD, Chemical Oxygen Demand	kg	1.41E-01	5.82E-03	2.81E-02	1.07E-01
Copper	kg	1.04E-09	0.00E+00	1.04E-09	0.00E+00
Copper, ion	kg	9.21E-05	6.96E-06	1.70E-05	6.81E-05
Cumene	kg	1.13E-03	0.00E+00	1.13E-03	2.58E-07
Cyanazine	kg	1.39E-11	0.00E+00	0.00E+00	1.39E-11
Cyanide	kg	2.42E-07	1.24E-09	4.95E-09	2.35E-07
Decane	kg	1.13E-05	4.99E-07	1.98E-06	8.87E-06
Detergent, oil	kg	3.79E-04	1.47E-05	6.46E-05	2.99E-04
Dibenzofuran	kg	7.40E-08	3.26E-09	1.29E-08	5.78E-08
Dibenzothiophene	kg	6.12E-08	2.78E-09	1.08E-08	4.76E-08
Dicamba	kg	8.17E-11	0.00E+00	0.00E+00	8.17E-11
Dichromate	kg	1.45E-08	0.00E+00	0.00E+00	1.45E-08
Diethylamine	kg	2.16E-12	0.00E+00	0.00E+00	2.16E-12
Dimethenamid	kg	1.93E-10	0.00E+00	0.00E+00	1.93E-10

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Dimethylamine	kg	1.51E-12	0.00E+00	0.00E+00	1.51E-12
Dipropylamine	kg	1.37E-12	0.00E+00	0.00E+00	1.37E-12
Dipropylthiocarbamic acid S-ethyl ester	kg	7.98E-11	0.00E+00	0.00E+00	7.98E-11
Dissolved organics	kg	4.05E-05	0.00E+00	7.81E-07	3.97E-05
Dissolved solids	kg	7.26E-04	0.00E+00	7.26E-04	0.00E+00
Disulfoton	kg	4.76E-12	0.00E+00	0.00E+00	4.76E-12
Diuron	kg	1.34E-12	0.00E+00	0.00E+00	1.34E-12
DOC, Dissolved Organic Carbon	kg	3.29E-03	5.37E-13	2.09E-03	1.20E-03
Docosane	kg	4.17E-07	1.83E-08	7.28E-08	3.25E-07
Dodecane	kg	2.15E-05	9.48E-07	3.76E-06	1.68E-05
Eicosane	kg	5.93E-06	2.61E-07	1.04E-06	4.63E-06
Ethane, 1,2-dichloro-	kg	1.70E-09	0.00E+00	0.00E+00	1.70E-09
Ethanol	kg	1.42E-05	0.00E+00	0.00E+00	1.42E-05
Ethene	kg	1.04E-07	0.00E+00	0.00E+00	1.04E-07
Ethene, chloro-	kg	1.50E-10	0.00E+00	0.00E+00	1.50E-10
Ethyl acetate	kg	2.40E-12	0.00E+00	0.00E+00	2.40E-12
Ethylamine	kg	1.50E-13	0.00E+00	0.00E+00	1.50E-13
Ethylene diamine	kg	2.11E-12	0.00E+00	0.00E+00	2.11E-12
Ethylene oxide	kg	5.60E-11	0.00E+00	0.00E+00	5.60E-11
Fluorene	kg	2.91E-11	0.00E+00	2.91E-11	0.00E+00
Fluorene, 1-methyl-	kg	4.43E-08	1.95E-09	7.74E-09	3.46E-08
Fluorenes, alkylated, unspecified	kg	3.51E-07	4.21E-08	8.30E-08	2.26E-07
Fluoride	kg	1.05E-02	1.02E-02	8.07E-05	2.75E-04
Fluorine	kg	1.95E-07	2.09E-08	4.42E-08	1.30E-07
Fluosilicic acid	kg	1.36E-08	0.00E+00	0.00E+00	1.36E-08
Formaldehyde	kg	4.92E-03	0.00E+00	0.00E+00	4.92E-03
Formamide	kg	1.44E-13	0.00E+00	0.00E+00	1.44E-13
Formate	kg	2.08E-11	0.00E+00	0.00E+00	2.08E-11
Formic acid	kg	4.17E-14	0.00E+00	0.00E+00	4.17E-14
Furan	kg	9.25E-11	0.00E+00	0.00E+00	9.25E-11
Glutaraldehyde	kg	1.85E-07	0.00E+00	0.00E+00	1.85E-07
Glyphosate	kg	1.74E-10	0.00E+00	0.00E+00	1.74E-10
Heat, waste	MJ	5.87E-01	0.00E+00	0.00E+00	5.87E-01
Hexadecane	kg	2.35E-05	1.03E-06	4.11E-06	1.84E-05
Hexanoic acid	kg	8.18E-05	3.60E-06	1.43E-05	6.39E-05
Hydrocarbons, aliphatic, alkanes, unspecified	kg	1.50E-06	0.00E+00	0.00E+00	1.50E-06
Hydrocarbons, aliphatic, unsaturated	kg	1.38E-07	0.00E+00	0.00E+00	1.38E-07

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Hydrocarbons, aromatic	kg	8.28E-06	0.00E+00	0.00E+00	8.28E-06
Hydrocarbons, unspecified	kg	2.82E-05	6.72E-13	2.70E-11	2.82E-05
Hydrogen peroxide	kg	1.26E-09	0.00E+00	0.00E+00	1.26E-09
Hydrogen sulfide	kg	1.12E-06	0.00E+00	0.00E+00	1.12E-06
Hydrogen-3, Tritium	Bq	4.01E+03	0.00E+00	0.00E+00	4.01E+03
Hydroxide	kg	3.58E-09	0.00E+00	0.00E+00	3.58E-09
Hypochlorite	kg	2.11E-07	0.00E+00	0.00E+00	2.11E-07
Iodide	kg	1.19E-06	0.00E+00	0.00E+00	1.19E-06
Iodine-131	Bq	4.85E-04	0.00E+00	0.00E+00	4.85E-04
Iodine-133	Bq	1.99E-05	0.00E+00	0.00E+00	1.99E-05
Iron	kg	3.09E-02	2.70E-03	6.68E-03	2.15E-02
Iron, ion	kg	1.18E-03	0.00E+00	0.00E+00	1.18E-03
Iron-59	Bq	5.48E-06	0.00E+00	0.00E+00	5.48E-06
Isopropylamine	kg	3.76E-14	0.00E+00	0.00E+00	3.76E-14
Lactic acid	kg	1.07E-12	0.00E+00	0.00E+00	1.07E-12
Lanthanum-140	Bq	3.38E-05	0.00E+00	0.00E+00	3.38E-05
Lead	kg	1.45E-04	1.10E-05	2.75E-05	1.06E-04
Lead-210	Bq	9.55E-02	0.00E+00	0.00E+00	9.55E-02
Lead-210/kg	kg	4.04E-14	1.78E-15	7.07E-15	3.16E-14
Lithium, ion	kg	3.57E-01	3.15E-03	5.22E-02	3.02E-01
Magnesium	kg	2.49E-01	1.08E-02	4.27E-02	1.95E-01
Manganese	kg	1.24E-03	1.91E-05	2.10E-04	1.01E-03
Manganese-54	Bq	1.43E-03	0.00E+00	0.00E+00	1.43E-03
MCPA	kg	1.09E-12	0.00E+00	0.00E+00	1.09E-12
Mercury	kg	3.26E-07	6.59E-08	3.51E-08	2.25E-07
Metallic ions, unspecified	kg	3.01E-09	8.21E-12	3.30E-10	2.67E-09
Methane, dichloro-, HCC-30	kg	1.24E-06	0.00E+00	0.00E+00	1.24E-06
Methane, monochloro-, R-40	kg	1.57E-08	6.90E-10	2.74E-09	1.22E-08
Methanol	kg	1.65E-05	0.00E+00	0.00E+00	1.65E-05
Methyl acetate	kg	8.04E-15	0.00E+00	0.00E+00	8.04E-15
Methyl acrylate	kg	9.88E-10	0.00E+00	0.00E+00	9.88E-10
Methyl amine	kg	1.03E-12	0.00E+00	0.00E+00	1.03E-12
Methyl ethyl ketone	kg	3.13E-08	1.38E-09	5.47E-09	2.45E-08
Methyl formate	kg	2.33E-05	0.00E+00	0.00E+00	2.33E-05
Metolachlor	kg	6.38E-10	0.00E+00	0.00E+00	6.38E-10
Metribuzin	kg	2.96E-12	0.00E+00	0.00E+00	2.96E-12
Molybdenum	kg	1.13E-05	3.94E-07	1.56E-06	9.31E-06
Molybdenum-99	Bq	1.17E-05	0.00E+00	0.00E+00	1.17E-05

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
m-Xylene	kg	1.18E-05	5.19E-07	2.06E-06	9.22E-06
Naphthalene	kg	7.07E-06	3.12E-07	1.24E-06	5.53E-06
Naphthalene, 2-methyl-	kg	6.17E-06	2.71E-07	1.08E-06	4.82E-06
Naphthalenes, alkylated, unspecified	kg	9.91E-08	1.19E-08	2.35E-08	6.38E-08
n-Hexacosane	kg	2.60E-07	1.14E-08	4.54E-08	2.03E-07
Nickel	kg	7.55E-05	6.13E-06	1.38E-05	5.55E-05
Nickel, ion	kg	4.44E-05	0.00E+00	0.00E+00	4.44E-05
Niobium-95	Bq	2.15E-04	0.00E+00	0.00E+00	2.15E-04
Nitrate	kg	3.90E-04	5.89E-14	2.37E-12	3.90E-04
Nitrate compounds	kg	2.82E-10	2.37E-12	9.56E-11	1.84E-10
Nitric acid	kg	6.32E-07	5.32E-09	2.14E-07	4.13E-07
Nitrite	kg	8.31E-08	0.00E+00	0.00E+00	8.31E-08
Nitrobenzene	kg	1.09E-11	0.00E+00	0.00E+00	1.09E-11
Nitrogen	kg	3.26E-06	0.00E+00	0.00E+00	3.26E-06
Nitrogen, organic bound	kg	3.54E-06	0.00E+00	0.00E+00	3.54E-06
Nitrogen, total	kg	5.69E-05	1.65E-07	1.24E-05	4.44E-05
o-Cresol	kg	1.12E-05	4.93E-07	1.96E-06	8.75E-06
Octadecane	kg	5.81E-06	2.56E-07	1.01E-06	4.54E-06
Oils, unspecified	kg	1.09E-02	3.87E-04	1.42E-03	9.12E-03
Organic substances, unspecified	kg	1.84E-09	0.00E+00	0.00E+00	1.84E-09
o-Xylene	kg	6.15E-11	0.00E+00	6.13E-11	2.55E-13
PAH, polycyclic aromatic hydrocarbons	kg	7.26E-08	0.00E+00	0.00E+00	7.26E-08
Paraquat	kg	1.29E-11	0.00E+00	0.00E+00	1.29E-11
Parathion, methyl	kg	9.75E-12	0.00E+00	0.00E+00	9.75E-12
p-Cresol	kg	1.21E-05	5.32E-07	2.11E-06	9.44E-06
Pendimethalin	kg	6.63E-11	0.00E+00	0.00E+00	6.63E-11
Permethrin	kg	5.96E-12	0.00E+00	0.00E+00	5.96E-12
Phenanthrene	kg	5.88E-08	4.43E-09	1.18E-08	4.26E-08
Phenanthrenes, alkylated, unspecified	kg	4.11E-08	4.94E-09	9.73E-09	2.64E-08
Phenol	kg	2.67E-05	6.33E-06	8.64E-06	1.17E-05
Phenol, 2,4-dimethyl-	kg	1.09E-05	4.80E-07	1.91E-06	8.52E-06
Phenols, unspecified	kg	1.52E-04	2.20E-06	2.30E-05	1.27E-04
Phorate	kg	1.84E-12	0.00E+00	0.00E+00	1.84E-12
Phosphate	kg	9.03E-03	7.64E-03	1.46E-07	1.39E-03
Phosphorus	kg	5.38E-06	0.00E+00	0.00E+00	5.38E-06
Phosphorus compounds, unspecified	kg	3.42E-08	0.00E+00	0.00E+00	3.42E-08
Phosphorus, total	kg	3.05E-06	0.00E+00	0.00E+00	3.05E-06

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Polonium-210	Bq	1.34E-01	0.00E+00	0.00E+00	1.34E-01
Potassium, ion	kg	2.55E-03	0.00E+00	0.00E+00	2.55E-03
Potassium-40	Bq	3.73E-02	0.00E+00	0.00E+00	3.73E-02
Process solvents, unspecified	kg	9.25E-09	0.00E+00	0.00E+00	9.25E-09
Propanal	kg	1.14E-13	0.00E+00	0.00E+00	1.14E-13
Propene	kg	4.18E-04	0.00E+00	4.18E-04	1.13E-07
Propionic acid	kg	7.80E-13	0.00E+00	0.00E+00	7.80E-13
Propylamine	kg	4.55E-14	0.00E+00	0.00E+00	4.55E-14
Propylene oxide	kg	1.93E-08	0.00E+00	0.00E+00	1.93E-08
Protactinium-234	Bq	2.39E-02	0.00E+00	0.00E+00	2.39E-02
p-Xylene	kg	6.13E-11	0.00E+00	6.13E-11	0.00E+00
Radioactive species, alpha emitters	Bq	2.18E-04	0.00E+00	0.00E+00	2.18E-04
Radioactive species, Nuclides, unspecified	Bq	2.72E+03	9.61E+00	7.21E+02	1.99E+03
Radium-224	Bq	5.76E-01	0.00E+00	0.00E+00	5.76E-01
Radium-226	Bq	1.59E+01	0.00E+00	0.00E+00	1.59E+01
Radium-226/kg	kg	1.41E-11	6.19E-13	2.46E-12	1.10E-11
Radium-228	Bq	1.15E+00	0.00E+00	0.00E+00	1.15E+00
Radium-228/kg	kg	7.20E-14	3.17E-15	1.26E-14	5.62E-14
Rubidium	kg	1.15E-07	0.00E+00	0.00E+00	1.15E-07
Ruthenium-103	Bq	2.46E-06	0.00E+00	0.00E+00	2.46E-06
Scandium	kg	1.05E-06	0.00E+00	0.00E+00	1.05E-06
Selenium	kg	9.35E-06	1.84E-07	2.06E-06	7.11E-06
Silicon	kg	7.51E-03	0.00E+00	0.00E+00	7.51E-03
Silver	kg	8.16E-04	3.60E-05	1.43E-04	6.37E-04
Silver, ion	kg	4.05E-08	0.00E+00	0.00E+00	4.05E-08
Silver-110	Bq	1.73E-02	0.00E+00	0.00E+00	1.73E-02
Simazine	kg	4.19E-11	0.00E+00	0.00E+00	4.19E-11
Sodium formate	kg	2.90E-11	0.00E+00	0.00E+00	2.90E-11
Sodium, ion	kg	3.97E+00	1.74E-01	6.93E-01	3.11E+00
Sodium-24	Bq	8.83E-05	0.00E+00	0.00E+00	8.83E-05
Solids, inorganic	kg	1.55E-02	1.35E-11	5.44E-10	1.55E-02
Solved solids	kg	1.74E+01	7.63E-01	3.03E+00	1.36E+01
Strontium	kg	2.14E-02	9.34E-04	3.71E-03	1.67E-02
Strontium-89	Bq	3.35E-04	0.00E+00	0.00E+00	3.35E-04
Strontium-90	Bq	1.30E+01	0.00E+00	0.00E+00	1.30E+01
Styrene	kg	2.86E-11	0.00E+00	1.69E-11	1.17E-11
Sulfate	kg	9.97E-02	1.38E-03	1.50E-02	8.32E-02

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Sulfide	kg	3.21E-05	7.35E-07	1.18E-06	3.02E-05
Sulfite	kg	5.76E-07	0.00E+00	0.00E+00	5.76E-07
Sulfur	kg	1.04E-03	4.54E-05	1.80E-04	8.10E-04
Sulfuric acid	kg	8.10E-11	0.00E+00	0.00E+00	8.10E-11
Surfactants	kg	2.88E-09	0.00E+00	2.88E-09	0.00E+00
Suspended solids, unspecified	kg	4.20E-01	4.10E-02	8.62E-02	2.92E-01
Tar	kg	1.59E-11	1.34E-13	5.39E-12	1.04E-11
t-Butyl methyl ether	kg	2.25E-08	0.00E+00	0.00E+00	2.25E-08
t-Butylamine	kg	1.62E-13	0.00E+00	0.00E+00	1.62E-13
Technetium-99m	Bq	2.70E-04	0.00E+00	0.00E+00	2.70E-04
Tellurium-123m	Bq	2.75E-04	0.00E+00	0.00E+00	2.75E-04
Tellurium-132	Bq	6.75E-07	0.00E+00	0.00E+00	6.75E-07
Terbufos	kg	6.29E-11	0.00E+00	0.00E+00	6.29E-11
Tetradecane	kg	9.44E-06	4.15E-07	1.65E-06	7.37E-06
Thallium	kg	1.53E-06	1.75E-07	3.44E-07	1.01E-06
Thorium-228	Bq	2.30E+00	0.00E+00	0.00E+00	2.30E+00
Thorium-230	Bq	3.26E+00	0.00E+00	0.00E+00	3.26E+00
Thorium-232	Bq	5.32E-03	0.00E+00	0.00E+00	5.32E-03
Thorium-234	Bq	2.39E-02	0.00E+00	0.00E+00	2.39E-02
Tin	kg	4.93E-05	3.52E-06	9.71E-06	3.61E-05
Tin, ion	kg	5.41E-07	0.00E+00	0.00E+00	5.41E-07
Titanium, ion	kg	1.35E-04	1.27E-05	2.51E-05	9.74E-05
TOC, Total Organic Carbon	kg	3.29E-03	0.00E+00	2.09E-03	1.20E-03
Toluene	kg	6.18E-04	2.72E-05	1.08E-04	4.84E-04
Toluene, 2-chloro-	kg	1.69E-12	0.00E+00	0.00E+00	1.69E-12
Tributyltin compounds	kg	1.88E-08	0.00E+00	0.00E+00	1.88E-08
Triethylene glycol	kg	5.48E-06	0.00E+00	0.00E+00	5.48E-06
Trimethylamine	kg	1.43E-14	0.00E+00	0.00E+00	1.43E-14
Tungsten	kg	5.96E-07	0.00E+00	0.00E+00	5.96E-07
Uranium alpha	Bq	1.38E+00	0.00E+00	0.00E+00	1.38E+00
Uranium-234	Bq	2.86E-02	0.00E+00	0.00E+00	2.86E-02
Uranium-235	Bq	4.73E-02	0.00E+00	0.00E+00	4.73E-02
Uranium-238	Bq	1.21E-01	0.00E+00	0.00E+00	1.21E-01
Urea	kg	1.38E-13	0.00E+00	0.00E+00	1.38E-13
Vanadium	kg	1.06E-05	4.65E-07	1.85E-06	8.26E-06
Vanadium, ion	kg	5.70E-06	0.00E+00	0.00E+00	5.70E-06
VOC, volatile organic compounds, unspecified origin	kg	4.09E-06	0.00E+00	0.00E+00	4.09E-06

Water Emission	Unit	Total	Forestry Operations	Wood Residue Production	Particleboard Production
Waste water/m3	m3	7.62E-04	0.00E+00	0.00E+00	7.62E-04
Waste, solid	kg	1.09E-02	0.00E+00	0.00E+00	1.09E-02
Xylene	kg	3.23E-04	1.45E-05	5.65E-05	2.52E-04
Yttrium	kg	2.62E-06	1.15E-07	4.58E-07	2.05E-06
Zinc	kg	3.10E-04	3.09E-05	7.18E-05	2.07E-04
Zinc, ion	kg	1.31E-04	0.00E+00	0.00E+00	1.31E-04
Zinc-65	Bq	1.20E-03	0.00E+00	0.00E+00	1.20E-03
Zirconium-95	Bq	1.39E-05	0.00E+00	0.00E+00	1.39E-05