Paper Calculator™
presented by environmental paper network

Estimated environmental impacts were calculated using the Environmental Paper Network's Paper Calculator(tm). When used publicly, it is required that the information is properly cited as "Environmental impact estimates were calculated using the Environmental Paper Network Paper Calculator Version 4.0. For more information visit www.papercalculator.org".

	VIRGIN CARDBOARD	RECYCLED CARDBOARD
Paper Type:	Paperboard: Solid Bleached Sulfate	Paperboard: Uncoated Recycled
Quantity:	1 Metric Tons	1 Metric Tons
% Recycled:	0%	100%
	4.6 U.S. short tons	0 U.S. short tons *4.6 U.S. short tons less*
	33 million BTUs	17 million BTUs *16 million BTUs less*
	21,000 pounds CO_2 equiv.	3,290 pounds CO_2 equiv. *17,710 pounds CO_2 equiv. less*
	33,200 gallons	11,500 gallons *21,700 gallons less*
	565 pounds	234 pounds *331 pounds less*
NITROGEN OXIDES (NO_x)	646 O_3 equiv/m^3*	842 O_3 equiv/m^3* *196 more*
PURCHASED ENERGY	20 million BTUs	17 million BTUs *3 million BTUs less*
PARTICULATES	255 $PM_{2.5}$ equiv/m^3*	179 $PM_{2.5}$ equiv/m^3* *76 less*
SULFUR DIOXIDE (SO_2)	14.8 pounds	2.5 pounds *12.3 pounds less*
VOLATILE ORGANIC COMPOUNDS (VOCs)	0.7 pounds	0.1 pounds *0.6 pounds less*
TOTAL REDUCED SULFUR (TRS)	0.3 pounds	0.1 pounds *0.1 pounds less*
HAZARDOUS AIR POLLUTANTS (HAPs)	2.8 pounds	2.7 pounds *0.1 pounds less*
CHEMICAL OXYGEN DEMAND (COD)	48.5 pounds	4.2 pounds *44.3 pounds less*
BIOCHEMICAL OXYGEN DEMAND (BOD)	7.0 pounds	1.9 pounds *5.07 pounds less*
TOTAL SUSPENDED SOLIDS (TSS)	9.9 pounds	4.3 pounds *5.6 pounds less*
FOREST DISTURBANCE	0.5 acres	0 acres *0.5 acres less*

THREATENED SPECIES	11 species	0 species *11 less*
OCEAN ACIDIFICATION	3,670 pounds H_2CO_3	921 pounds H_2CO_3 *2,749 pounds less*
MERCURY EMISSIONS	43.7 milligrams	34.9 milligrams *8.8 milligrams less*
DIOXIN EMISSIONS	3,500 micrograms	4.9 micrograms *3495.1 micrograms less*
FRESHWATER DISTURBANCE	See below	See below
HERBICIDES	See below	See below
OCEAN WARMING	See below	See below
WETLAND DISTURBANCE	See below	See below

Explanation of Data Values

Wood use measures the amount of wood required to produce a given amount of paper. Results are reported in fresh/green U.S. short tons of wood. The methodology does not include the forest residues left behind during pulpwood harvest in the forests (i.e., slash, roots). If forest residues were included it could be twice the number, as roughly 50% of biomass is left after harvest.

- Virgin Cardboard uses 4.6 U.S. short tons, made from about 27.6 trees
- Recycled Cardboard uses 0 U.S. short tons, made from about 0 trees
  Recycled Cardboard uses 4.6 U.S. short tons less, a difference of 27.6 trees

Total energy measures all energy required over the paper's life cycle, including all renewable and nonrenewable resource use, including black liquor and all wood sources.

- Virgin Cardboard uses 33 million BTUs, equivalent to 39.3 residential refrigerators operated/year
- Recycled Cardboard uses 17 million BTUs, equivalent to 20.2 residential refrigerators operated/year
  Recycled Cardboard uses 16 million BTUs less, a difference of 19.1 residential refrigerators operated/year

Greenhouse gases/climate change impacts measures carbon dioxide or CO_2 from burning fossil fuels, methane from paper decomposing in landfills and short-lived climate pollutants (such as black carbon and organic carbon) which contribute to climate change by trapping energy from the sun in the earth's atmosphere. This impact category also includes forest carbon storage loss from logged forests.

- Virgin Cardboard produces 21,000 pounds of CO_2 equiv., equivalent to 1.9 cars/year
- Recycled Cardboard produces 3,290 pounds of CO_2 equiv., equivalent to 0.3 cars/year
  Recycled Cardboard produces 17,710 pounds CO_2 equiv. less, a difference of 1.6 cars/year

Water consumption measures the amount of process and cooling water that is consumed or degraded throughout the life cycle of the paper product.

- Virgin Cardboard uses 33,200 gallons, equivalent to 24 clothes washers operated/year
- Recycled Cardboard uses 11,500 gallons, equivalent to 8.3 clothes washers operated/year
  Recycled Cardboard uses 21,700 gallons less, a difference of 15.7 clothes washers operated/year

Solid waste measures sludge and other wastes generated during pulp and paper manufacturing, and used paper disposed of in landfills and incinerators.

- Virgin Cardboard produces 565 pounds of solid waste, equivalent to 129 people generating solid waste/day
- Recycled Cardboard produces 234 pounds of solid waste, equivalent to 53.4 people generating solid waste/day
  Recycled Cardboard produces 331 pounds less, a difference of 75.6 people generating solid waste/day

Nitrogen oxides/ground level ozone (NO_x, which includes NO and NO_2) measures products of the combustion of fuels that

contain nitrogen. NO_x can react with volatile organic compounds and sunlight in the lower atmosphere to form ozone, a key component of urban smog. NO_x forms ozone and can also, in parallel, lead to acid rain. *The measurement of NO_x in this calculator is a complex equation that takes into account human exposure across a sample of locations of pulp and paper mills. For more information please see the *Methodology* document under the Resources tab of this website (https://c.environmentalpaper.org/pdf/SCS-EPN-PC-Methods.pdf).

- Virgin Cardboard produces 646 persons x hrs. x pounds O_3 equiv/m^3, equivalent to 0.8 gasoline powered passenger cars/year
- Recycled Cardboard produces 842 persons x hrs. x pounds O_3 equiv/m^3, equivalent to 1.07 gasoline powered passenger cars/year
  Recycled Cardboard produces 196 persons x hrs. x pounds O_3 equiv/m^3 more, a difference of 0.3 gasoline powered passenger cars/year

Purchased energy is a subset of total energy, and measures how much energy comes from purchased electricity and other fuels.

- Virgin Cardboard uses 20 million BTUs, equivalent to 23.8 residential refrigerators operated/year
- Recycled Cardboard uses 17 million BTUs, equivalent to 20.2 residential refrigerators operated/year
  Recycled Cardboard uses 3 million BTUs less, a difference of 3.6 residential refrigerators operated/year

Particulates/$PM_{2.5}$ impacts measures the effect of particulate matter (PM) emissions from pulp/paper production, contributing to smog. Particulates are small airborne particles generated during combustion, and pose a range of health risks, including asthma and other respiratory problems, when inhaled. *The measurement of particulates in this calculator is a complex equation that takes into account human exposure across a sample of locations of pulp and paper mills. For more information please see the *Methodology* document under the Resources tab of this website (https://c.environmentalpaper.org/pdf/SCS-EPN-PC-Methods.pdf).

- Virgin Cardboard produces 255 persons x hrs. x pounds $PM_{2.5}$ equiv/m^3, equivalent to 9.7 gasoline powered passenger cars/year
- Recycled Cardboard produces 179 persons x hrs. x pounds $PM_{2.5}$ equiv/m^3, equivalent to 6.8 gasoline powered passenger cars/year
  Recycled Cardboard produces 76 persons x hrs. x pounds $PM_{2.5}$ equiv/m^3 less, a difference of 2.9 gasoline powered passenger cars/year

Sulfur Dioxide (SO_2) and other acidifying emissions/regional acidification measures chemical compounds such as sulfur dioxide, nitrogen oxides, and other acids (e.g. ammonia) that are produced when boilers burn fuel containing sulfur and other acid-producing substances. Of the fuels used in the paper industry, oil and coal generally contain the highest quantities of sulfur. These acidifying emissions contribute to air pollution problems like acid rain and smog. This category includes SO2 emissions, but also other acids and emissions like NO_x.

- Virgin Cardboard produces 14.8 pounds SO_2 equiv., equivalent to 4.8 eighteen-wheelers/year
- Recycled Cardboard produces 2.5 pounds SO_2 equiv., equivalent to 0.8 eighteen-wheelers/year
  Recycled Cardboard produces 12.3 pounds SO_2 equiv. less, a difference of 4.0 eighteen-wheelers/year

Volatile organic compounds (VOCs) measure a broad class of organic gases, such as vapors from solvent and gasoline. VOCs react with nitrogen oxides (NO_x) in the atmosphere to form ground-level ozone, the major component of smog and a severe lung irritant.

- Virgin Cardboard produces 0.7 pounds, equivalent to 3,100 miles driven in a car/year
- Recycled Cardboard produces 0.1 pounds, equivalent to 621 miles driven in a car/year
  Recycled Cardboard produces 0.6 pounds less, a difference of 2,479 miles driven in a car/year

Total reduced sulfur (TRS) measures emissions of the compounds that cause the odor associated with kraft pulp mills. Exposure to TRS emissions has been linked to symptoms including headaches, watery eyes, nasal problems, and breathing difficulties.

- Virgin Cardboard produces 0.3 pounds
- Recycled Cardboard produces 0.1 pounds
  Recycled Cardboard produces 0.1 pounds less

Hazardous air pollutants (HAPs) measures any of a group of 188 substances identified in the 1990 U.S. Clean Air Act amendments because of their toxicity. Two of the most common occurring in air are formaldehyde and acrolein.

- Virgin Cardboard produces 2.8 pounds, equivalent to 0.6 passenger cars/year
- Recycled Cardboard produces 2.7 pounds, equivalent to 0.5 passenger cars/year
  Recycled Cardboard produces 0.1 pounds less, a difference of 0.02 passenger cars/year

Chemical oxygen demand (COD) measures the amount of oxidizable organic matter in the mill's effluent. Since wastewater treatment removes most of the organic material that would be degraded naturally in the receiving waters, the COD of the final effluent provides information about the quantity of more persistent substances discharged into the receiving water.

- Virgin Cardboard produces 48.5 pounds COD, equivalent to 0.3 homes/year
- Recycled Cardboard produces 4.2 pounds COD, equivalent to 0.03 homes/year
  Recycled Cardboard produces 44.3 pounds less, a difference of 0.3 homes/year

Biochemical oxygen demand (BOD) measures the amount of oxygen that microorganisms consume to degrade the organic material in the wastewater. Discharging wastewater with high levels of BOD can result in oxygen depletion in the receiving waters, which can adversely affect fish and other organisms.

- Virgin Cardboard produces 7.0 pounds BOD, equivalent to 0.04 homes/year
- Recycled Cardboard produces 1.9 pounds BOD, equivalent to 0.01 homes/year
  Recycled Cardboard produces 5.07 pounds less, a difference of 0.03 homes/year

Total Suspended Solids (TSS)/Freshwater eutrophication measures solid materials suspended in mill effluent, which can adversely affect bottom-living organisms upon settling in receiving waters and can carry toxic heavy metals and organic compounds into the environment.

- Virgin Cardboard produces 9.9 pounds TSS, equivalent to 0.05 homes/year
- Recycled Cardboard produces 4.3 pounds TSS, equivalent to 0.02 homes/year
  Recycled Cardboard produces 5.6 pounds less, a difference of 0.03 homes/year

Forest disturbance measures the impact of paper production on forest ecosystems and biodiversity. The indicator compares the ecosystem integrity of a harvested site to intact forests over 80 years old in the region, using on-the-ground measurements. It also considers the recovery potential which would be possible on the site if harvesting were halted, reflecting the long-term implication of forest management at suppressing ecosystem integrity.

- Virgin Cardboard disturbs 0.5 acres, equivalent to the size of 0.4 football fields
- Recycled Cardboard disturbs 0 acres, equivalent to the size of 0 football fields
  Recycled Cardboard uses 0.5 acres less, a difference of 0.4 football fields

Threatened species measures the possible number of species affected by logging for paper production in the North American region that are listed as Critically Endangered, Endangered, or Vulnerable in the IUCN Red List of Threatened Species (http://www.iucnredlist.org), though the exact impact will vary by forest of origin. The number of species is based on correlation with logging threats assessed by IUCN and the fiber basket of pulp and paper mills in the region. For more information see the Methodology Document (https://c.environmentalpaper.org/pdf/SCS-EPN-PC-Methods.pdf).

- Virgin Cardboard impacts 11 species
- Recycled Cardboard impacts 0 species
  Recycled Cardboard impacts 11 less

Ocean acidification measures increased ocean acidity caused by CO_2, which has detrimental consequences for many marine organisms. This indicator considers CO_2 emitted during the production of pulp and paper, but also evaluates the amount of CO_2 that could be sequestered in trees if forest harvests used for papermaking were halted.

- Virgin Cardboard produces 3,670 pounds H_2CO_3, equivalent to 0.9 cars/year
- Recycled Cardboard produces 921 pounds H_2CO_3, equivalent to 0.2 cars/year
  Recycled Cardboard produces 2,749 pounds H_2CO_3 less, a difference of 0.7 cars/year

Mercury emissions measure the amount of emissions during the production of pulp and paper. Mercury is a very toxic substance that persists in the environment for long periods of time. Emissions can therefore lead to contamination in the environment, including freshwater bodies and oceanic systems, subsequently exposing flora and fauna to elevated concentrations.

- Virgin Cardboard produces 43.7 milligrams, equivalent to 10.9 compact fluorescent lights
- Recycled Cardboard produces 34.9 milligrams, equivalent to 8.7 compact fluorescent lights
  Recycled Cardboard produces 8.8 milligrams less, a difference of 2.2 compact fluorescent lights

Dioxin emissions measure the amount of dioxin emissions that are released to air and water from pulp and paper mills.

Dioxins are persistent and bioaccumulative, and even small amounts of emission can contaminate local waterways and bioaccumulate in fish.

- Virgin Cardboard produces 3,500 micrograms
- Recycled Cardboard produces 4.9 micrograms
  Recycled Cardboard produces 3495.1 micrograms less

Freshwater disturbance measures the number of freshwater systems possibly affected by logging. Logging can impact streams, rivers and creeks by increasing erosion, removing riverside vegetation and removing large woody debris that many fish species require for habitat. Although this impact is important and relevant, no data is currently available to calculate results. Reflecting the critical nature of this impact category, it is reported here as relevant to pulp/paper production, although results cannot be evaluated at this time.

Herbicides measures the amount of toxic herbicides used in growing trees for paper production. Herbicides are applied to control the spread of non-desirable species. Although this impact is important and relevant, no data is currently available to calculate results. Reflecting the critical nature of this impact category, it is reported as relevant to pulp/paper production, although results cannot be evaluated at this time.

Ocean warming measures increased ocean temperatures linked to emissions of greenhouse gases. Although this impact is important and relevant to emissions and foregone growth from logging, no algorithm is currently available to calculate results. Reflecting the critical nature of this impact category, it is reported as relevant to pulp/paper production, although results cannot be evaluated at this time.

Wetland disturbance measures the acreage of wetlands possibly affected by logging. Logging can increase erosion, which will cause changes in the sediment, temperature and other characteristics of wetlands. Although this impact is important and relevant, no data is currently available to calculate results. Reflecting the critical nature of this impact category, it is reported as relevant to pulp/paper production, although results cannot be evaluated at this time.

If you have questions or would like more information about Paper Calculator V4.0, please see the Life Cycle Assessment Methodology document under the "Resources" tab of this website (https://c.environmentalpaper.org/resources.html) or contact us at info@environmentalpaper.org.
