Washington State Department of Ecology
Industrial Footprint Project

Key Aspects of Economic, Environmental, and Social Sustainability Relevant to Pulp and Paper Sector Operations

Project Task 2.1

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1.0: Background

The pulp and paper industry processes purchased or recycled cellulose fibers from timber into primary products including commodity grades of wood pulp, printing and writing papers, sanitary tissue, industrial-type papers, containerboard and boxboard. The industry is a significant driver of the Pacific Northwest economy, providing family wage employment with salaries that exceed the overall average for manufacturing. In its latest Annual Survey of Manufacturers, the U.S. Census Bureau reports 2005 Washington State employment of 11,329, payroll of over $645 million, and value of product shipments to be nearly $5.2 billion. In addition, the industry offers employees outstanding health care and retirement benefits.

The industry also generates a high “multiplier” effect, where each pulp and paper job supports the creation of additional jobs in other sectors of the economy. In Washington, the multiplier for the sector ranks second amongst all sectors at 4.759, meaning that for every job created in the pulp and paper sector, approximately 3.8 jobs are created elsewhere in all other sectors of the State’s economy. Thus, the sustainability of the pulp and paper sector is critical to Washington State’s economic future.

As with all heavy industry, the pulp and paper sector faces significant challenges in meeting the demands of sustainable economic development in the 21st century. In this report, we identify significant aspects of economic, environmental, and social sustainability for the pulp and paper sector as well as common sustainability indicators. Sources of information include scientific papers, publications of government agencies and non-governmental organizations (NGOs), and pulp and paper sector sustainability reports. Our goal is to provide a comprehensive overview of important aspects relevant to the Washington State Department of Ecology (DOE) in the context of its Industrial Footprint Project (IFP). The IFP is an attempt to develop a holistic measure of performance useful for identifying beyond compliance opportunities for pulp and paper facilities, improving their environmental performance, and developing priorities for DOE staff.

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The remainder of this report is organized as follows. In Section 2, we review key aspects of economic sustainability. In Section 3, we do the same for environmental sustainability, but segment our discussion into aspects that arise in three separate stages of the sector’s product life cycle – logging and transportation of raw materials, manufacturing, and final consumption. In Section 4, we consider aspects of social sustainability. In Section 5, we identify the most common indicators industry leaders are using to measure progress towards economic, environmental and social sustainability.

2.0: Key Aspects of Economic Sustainability

A sustainable economic presence implies that the overall economic impact of both the pulp and paper sector as whole as well as individual facilities will be relatively constant over time. Thus, an important aspect of economic sustainability relevant to Washington State’s pulp and paper industry is the magnitude of that economic impact and how it can be maintained or improved. The economic impact of any particular sector is typically evaluated with use of an input output (IO) or regional economic model. Regional models calculate the direct, indirect, and induced employment, income, and taxes generated by a sector’s expenditures on labor, goods, services, equipment, fuel, and any other input to the production process in a given year in a given geographic region.

Direct economic effects of the pulp and paper sector are immediate changes in employment, income, and taxes generated by expenditures on inputs. Indirect effects are the secondary changes in employment, income, and taxes that occur when companies pulp and paper mills do business with alter their expenditures on inputs in response to changes in pulp and paper sector demands for their goods and services. Induced effects represent changes in employment, income, and taxes in all local industries caused by expenditures of new household income generated by the direct and indirect effects of pulp and paper sector operations. Taken together, direct, indirect, and induced effects provide a relatively complete assessment of a given sector’s total economic contribution, which is often several times greater than when direct effects are considered alone. For example, while the pulp and paper sector supported 11,329 direct Washington jobs in 2005, its total impact – taking direct, indirect, and induced employment effects into consideration – was 53,914 jobs based on the latest published employment multiplier.

Maintaining this economic presence is, of course, a function of staying competitive through technological innovations, efficiency improvements, enhancing labor and capital productivity, reducing costs, eliminating debt, and maintaining customer satisfaction including customer demands for environmentally friendly products. As such, all of these factors have been cited by pulp and paper industry leaders as important aspects of economic sustainability. However,

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7 However, there are many external factors – like international competition from mills that have lower environmental or labor standards – that may cause a sector that is efficient and otherwise sustainable to lose its market share over time.
there are other ways individual mills and the sector as a whole can sustain or increase their regional economic impact.

For example, paying living wages rather than minimum wages has been shown to have three significant local economic benefits (1) increased employment, sales, and tax collections associated with the increased expenditures of low wage families; (2) higher productivity in the workplace associated with lower turnover, improved moral, and a more qualified workforce, and (3) a reduction in poverty and associated reliance on public support. Procuring goods and services locally rather than from afar takes advantage of the local multiplier effect and builds good will in surrounding communities. Social investments are another avenue for stimulating local economic activity especially when they involve labor intensive activities such as environmental remediation or restoration.

Key aspects of economic sustainability reported in the pulp and paper sector literature can be summarized as follows:

- **Total economic impact**: The sum of direct, indirect, and induced effects of pulp and paper sector expenditures on labor, goods, capital equipment, services, and social investments.
- **Factor productivity**: The return on capital and labor.
- **Local procurement**: The degree to which pulp and paper mills purchase goods, services, equipment and other inputs from local (or Washington State) suppliers.
- **Net capital expenditures**: Expenditures in excess of those needed to maintain properties, plants, and equipment at current levels of productivity.
- **Customer satisfaction**: A key to sustaining product demand.
- **Government subsidies**: An indicator of whether or not a given facility needs public support in order to stay competitive.

### 3.0: Key Aspects of Environmental Sustainability

An important framework for understanding key environmental aspects associated with pulp and paper production is the Life Cycle Assessment Framework (LCA). LCA “tracks the environmental impacts of a product from its raw materials through disposal at the end of its useful life.”

Most pulp and paper sector sustainability leaders use LCA to identify all of the significant aspects and impacts arising from their operations. An example is International Paper:

> Our company is committed to responsible stewardship throughout the product life cycle, from product concept, design and manufacture to customer use, recycling and

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disposal. This life cycle begins with the sun, through photosynthesis, growing trees for wood fiber in well-managed forests.

Figure 1, below, and Appendix 2.1A identify significant aspects associated with each major stage of the life cycle – logging and transportation of raw materials, manufacturing, and final consumption. Appendix 2.1B provides citations from the literature by topic. These are summarized in Sections 3.1, 3.2, and 3.3 below.

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3.1 Key aspects related to logging and transportation of raw materials

The primary sustainability concern over raw materials for pulp and paper production is related to the environmental consequences of short rotation forestry, especially loss of biological diversity, long term forest productivity, and carbon storage. Tree plantations managed on rotations between 10 years (cottonwood) and 35 years (pine, fir, other softwoods) represent a simplification of both in-stand and landscape diversity inherent in native stands. The lack of large trees, snags of various sizes and various stages of decay, large down logs, and multilayered canopies is detrimental to species dependent upon late successional/old growth forests when native stands are converted to high yield plantations. Clearcutting and other intensive forest practices fragment intact forest canopies and thereby harm interior dwelling species. Biodiversity concerns extend to aquatic ecosystems as well. Increased adult and juvenile salmonid mortality, decreased aquatic amphibian and invertebrate abundance or diversity, and decreased habitat complexity all result from increased fine sediment deposition in streams as well as altered streamflows and channel morphology associated with intensively managed forest landscapes.

Long term forest productivity is another key concern. High yield, short rotation plantations drain soil nutrients and disrupt key nutrient cycling processes such as those associated with ectomycorrhizal fungi. Logging roads and repeated entries over relatively short time spans increase soil compaction and erosion. Forest productivity is also jeopardized by increased spread of exotic species, insects, and other pathogens that thrive in younger, less complex stands. Pest success increases with forest simplification as the diversity of habitats decreases, resulting in declines of important predators, such as spiders and birds. Fire risk is yet another concern indirectly related to forest productivity. Logging slash, roads (which increase access), and simplification of forest structure are associated with increased risk and severity of wildfire.

Given the global importance of forests as carbon sinks, carbon sequestration and storage is another significant concern associated with forests managed for pulp and paper. Carbon sequestration peaks at stand ages that exceed average rotation age for plantations and the Intergovernmental Panel on Climate Change (2003) considers all carbon transferred out of managed forests as wood products to be an immediate emission. Intact forests in the Pacific Northwest are complex systems of carbon production and sequestration, but researchers have found that harvested areas are a net source of carbon to the atmosphere. Of the carbon removed from a logging site and distributed throughout the forest products sector, nearly 40% is returned rapidly to the atmosphere through losses in primary and secondary manufacture as well as incineration and decomposition of short-lived forest products. Cohen et al. (1996) state, generally, that decay of carbon pools from previous logged forests outweighs sequestration by early-successional conifer forests in the Pacific Northwest.  

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One important way pulp and paper sector leaders have addressed issues arising from forest management is to adopt policies requiring certification that raw materials they acquire have been obtained from sustainably managed forests or forests devastated by wildfires or pathogens that mitigate the impacts of biodiversity and forest productivity loss as well as adverse changes in carbon sequestration and storage. For example, The Nippon Paper Group has set a goal of “having all of its company-owned forests within and outside Japan certified by 2008.” As of June 2006, nearly 100% of the company owned forests in Australia were certified as being sustainable. Boise Cascade was one of the founders of the Sustainable Forestry Initiative (SFI), and now obtains over 97% of its raw materials from SFI certified forests. Forest certification is a system in which forestry operations or products can receive a stamp of approval ensuring that they are environmentally and socially responsible, giving consumers the confidence and power to “vote” with their dollars. There are several certification programs including American Tree Farm System, Forest Stewardship Council (FSC), Forest Stewardship Program (USFS), Green Tag (Nat. Forestry Association), and Sustainable Forestry Initiative (SFI). The most popular in the U.S. are the FSC and SFI standards. The systems vary in their scope of criteria, detail, type of professional reviewer, rigor of review/assessment, and costs and benefits and have received variable reception from environmental organizations. According the Natural Resources Defense Council, SFI lacks certain protections of the FSC such as preventing natural forests from conversion to plantations, protection of old growth in the U.S., protection of sensitive, rare, and state-listed threatened and endangered species, and control of clear cutting.

There have been numerous reviews of the two certification systems, including two that are considered independent. One measure of the difference in the systems is that FSC had certified 70 million acres in 54 countries in 9 years, whereas in two years SFI had certified nearly the entire U.S. industrial timber base. An independent study sponsored by both SFI and the AF&PA, found differences in 24 areas and 7 similarities. According to NRDC (2002), the overall difference is captured best in the program’s objectives: SFI establishes a baseline of performance to encourage improvement while FSC establishes a high standard for exemplary management.

3.2 Key aspects related to manufacturing and overall facility operations

Key environmental aspects arising from operation of pulp and paper facilities include materials, water, and energy use, emissions and effluents, and waste as succinctly illustrated by Figure 1, page 5. Over the past 10 years or so, the growing scarcity and cost of almost all inputs into the production of pulp and paper as well as almost every other manufacturing process has

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prompted companies to adopt initiatives designed to reduce the amount of inputs required per unit of output. Generally, these initiatives fall under the banner of “eco-efficiency.” Eco-efficiency is about reducing the amount of water, energy, chemicals, and raw materials used per unit output. It is a central tenet of the Biomimicry Sustainability Principles, which call on humans to emulate nature’s optimization of resources by using only the energy that is needed, recycling everything, and curbing “excesses from within.” Eco-efficiency is motivated not only by environmental concerns but by the prospects of significant financial savings in the form of reduced energy and water bills, less money spent on raw materials and fewer regulatory hurdles. For example, Dupont committed to a policy of keeping energy use flat no matter how much its production increased, a strategy that is reported to have saved over $2 billion in the past decade. Eco-efficiency is an important objective in almost every sustainability plan published by pulp and paper industry leaders.

For example, the pulp manufacturing process is the largest consumer of process water. A bleached kraft pulp mill requires 4,000-12,000 gallons of water per ton of pulp. Major variations occur depending on what product is manufactured. For example, a 1989 study found that “[i]n general, requirements for water is least in straw and paperboard mills (75-1,000 cm3 per tonne) and highest in specialty paper mills (370-1,220 cm3 per tonne).” Variation also is attributable to differences in installed capacity, types of fibrous raw material, and adoption of water saving technology.

Regardless, given the industry’s heavy water use, a nearly universal objective in industry sustainability programs is reducing water intensity by re-using water and by adopting water conservation technologies and measures. Boise reports a 6% reduction in water use per ton of paper produced between 2004 and 2005. Votorantim achieved a nearly 8% reduction in water use intensity at its four facilities between 2004 and 2006. Reducing energy intensity is another key industry objective. The pulp and paper industry is the 4th largest industrial consumer of energy in the world, consuming 5.9 exajoules of final energy in 2003 or 6% of total industrial energy use. But energy improvements have made a big difference. Between 1970 and 1994 the industry reduced its primary energy intensity in the U.S. by 27%. The industry’s energy to physical production index (PPI) (which would be at a level of 100 if the energy used to

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16 Process water is water used for nonpotable industrial uses, or water that is used for, or comes in contact with an end product or the materials used in an end product.
18 However, it should be noted that reduced water use intensity may conflict with sustainability goals related to water pollution since less effluent often means higher concentrations of pollutants or higher levels of thermal loading.
produce its commodities was at the same level as that associated with best available technologies) for 14 countries fell 10% from 137 in 1990 to 125 in 2003.\textsuperscript{21} This shows a significant real improvement in energy efficiency in the sector.

Reducing both the absolute magnitude and intensity of air emissions and water effluents is another key sustainability objective throughout the pulp and paper sector. Important air emissions include sulfur oxides (SO\textsubscript{x}), nitrogen oxides (NO\textsubscript{x}), volatile organic compounds (VOCs), carbon dioxide (CO\textsubscript{2}), chloroform and odor. Greenhouse gas emissions (GHG) are an important subcategory. Twelve percent of total manufacturing energy use in the United States can be attributed to the pulp and paper industry, not including materials procurement and product transportation, resulting in 9% of total carbon dioxide emissions from U.S. manufacturing.\textsuperscript{22} GHG reduction initiatives are ubiquitous elements of sector sustainability programs. GHG indicators appear in all 10 of the sustainability plans reviewed in Section 5. Key water effluents include pentachlorophenol and other absorbable organic halides (AOX), biological oxygen demand, chemical oxygen demand (COD), and suspended solids.

Achieving zero waste is another ambitious, but laudable goal increasingly adopted throughout the sector. For example, Nippon Paper Group “endeavors to control its waste generation and emissions (the ‘Zero Discharge’ program), while also slashing waste in terms of resource procurement cost so as to maintain sound business operations.”\textsuperscript{23} Most of the waste produced by the paper and pulp industry is bark, reject wood, sludge from water treatment facilities, and ash and slag from combustion plants, most of which can be reused or recycled. Key uses of reused materials include compost mixture, cement additives, potting soil, landscape bark, and roofing shingles. An important sub-category of waste is hazardous or toxic materials. Pulp and paper manufacturing results in discharges or emissions to land of heavy metals including mercury, cadmium, chromium, nickel and zinc. The top chemicals by weight released into the environment include methanol, ammonia, hydrochloric acid, manganese compounds and sulfuric acid.

2.3 Key aspects related to final consumption

The most important issue arising from final consumption is landfill waste. At about 35 percent, paper and paperboard products constitute the largest portion of the municipal solid waste (MSW) stream. Americans generated about 83 million tons of paper products in the MSW stream in 2003, nearly a three-fold increase from 1960. Recycling, however, can significantly reduce the flow of paper products to the landfill. Total U.S. paper and paperboard recovery reached a record level of 53.4% in 2006. The recycled content of pulp and paper products is steadily improving. In 2004 International Paper put approximately 1.1 million metric tonnes of recycled fiber in products made in the U.S. alone. This figure includes recycled fiber purchased


\textsuperscript{22} Martin, et al. (2000).

from the market, used paper deinked and recycled at its mills, and old corrugated containers repulp and recycled at its mills. In addition to reducing demands for landfill space, recycled paper production saves primary energy use and reduces carbon dioxide emissions at each stage of the pulp and paper life cycle.

Key aspects of environmental sustainability reported in the pulp and paper sector literature can be summarized as follows:

- **Sustainable management of forests where raw materials are procured.** A variety of certification systems are now in place to help companies achieve this goal.
- **Eco-efficiency.** Reducing the amount of water, energy, and materials used per ton of product output.
- **Emissions and effluents.** Reducing both the total output and intensity of air emissions and water effluents. Greenhouse gases are an increasingly important subcomponent of air emissions.
- **Waste reduction and re-use.** Minimizing the stream of both solid and liquid wastes by maximizing re-use.
- **Landfill waste and recycling.** Reducing paper and packaging’s presence in our landfills by promoting recycling and expanding production of recycled paper products.

### 4.0: Key Aspects of Social Sustainability

The various aspects of social sustainability relevant to pulp and paper sector operations can be grouped into two broad categories – workplace and community well-being. The World Health Organization identifies meaningful and satisfying work, open decision making, worker health and safety, and just compensation as key aspects of sustainable workplace environments. Workplace diversity is another common aspect.

Workplace satisfaction surveys are an increasingly important tool sustainability leaders are using to evaluate how their employees rate the quality of their jobs, supervision, and role in decision making as well as opportunities for training and advancement. For example, Catalyst’s annual Focus, Accountability, Involvement and Response (FAIR) Scorecard survey “provides feedback on employees’ understanding of the company, their personal and departmental goals, their responsibilities, how engaged they feel in the business and how both hourly and salaried employees feel about the feedback, coaching and development they receive.” The results are used to measure progress toward keeping employees informed and involved and to identify areas in which they need to improve. In addition to overall satisfaction, companies are also

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measuring turnover rates, accident rates, participation in management idea programs, wages and benefits in relation to legally mandated or industry-average levels, employee coverage by collective bargaining agreements, and employee training hours as various aspects of workplace well-being.

Institutions committed to sustainable development universally recognize that they must contribute to the vitality of the communities in which they operate. As noted in the Houston Principles of the Alliance for Sustainable Jobs and the Environment, “the original purpose behind the creation of corporations was to serve the public interest – namely, working people, communities, and the earth.” The Business Alliance for Local Living Economies (BALLE) principles call on businesses to “use their business practices to support an inclusive and healthy community.” 27 There a many ways institutions contribute to healthy communities, and many ways to measure progress. Procuring goods and services from the local community rather than importing these goods and services from afar is one way community vitality is promoted. This is considered an important goal from both an economic and social sustainability perspective. The value of both in-kind and cash donations is also routinely monitored in institutional level sustainability reports. Taken together, these are characterized as “social investments,” and may include a wide variety of grants, donations, and both educational and environmental projects and programs as well as encouraged volunteering for community organizations.

Another social sustainability aspect triggered by pulp and paper manufacturing involves the rights of indigenous communities who often have historic or current claims to resources on lands managed for raw materials. For example, Aracruz recently withdrew FSC certification for its Guaíba Unit due to a dispute over legal rights with indigenous communities in Espírito Santo. 28 To promote social sustainability then, the pulp and paper sector needs to resolve potential conflicts with indigenous communities on or adjacent to lands managed for their wood products. Environmental justice is another key social aspect. Some pulp and paper mills (but not necessarily those in Washington State) are located near low income communities or communities of color, who are disproportionately exposed to the various air, water, noise, and light pollution created by pulp and paper mills. Mitigating effects on these communities is an important sustainability objective in many pulp and paper sector plans.

Paying living wages is yet another way institutions can promote community vitality and obviate the need for employees to seek public assistance or move from job to job. Living wages take into account cost of living at the local level and seek to provide a wage that fulfills the basic needs of workers and their families. Monitoring wages paid in relation to living wages is a way to identify where adjustments need to be made.

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Key aspects of social sustainability reported in the pulp and paper sector literature can be summarized as follows:

- **Workplace satisfaction.** As summarized by the WHO, this includes meaningful and satisfying work, open decision making, worker health and safety, and just compensation. Paying living wages is one way to insure just compensation.
- **Turnover rates.** Maintaining low turnover is a sign of a healthy workplace environment. Low turnover also reduces recruiting and training costs.
- **Accident rates.** Reducing lost time work injuries for both salaried and outsourced workers.
- **Workforce diversity.** Sustainability leaders strive to have the composition of their management teams reflect the diversity of their employees and the communities in which they operate.
- **Social investments.** Social investments include cash and in-kind donations, educational and environmental programs, and encouraged volunteering for community organizations.
- **Collective bargaining.** Insuring employee representation by unions and other worker advocates.
- **Environmental justice.** Avoiding disproportional effects of operations on low income, indigenous, and disadvantaged communities.

### 5.0: Measuring Impacts

The Global Reporting Initiative (GRI) has become the “world’s leading benchmark for measuring, monitoring, and reporting corporate sustainability efforts.” Although their are other reporting systems such as the Pacific Sustainability Index (PSI), sponsored by the Roberts Environmental Center at Claremont College, the GRI is emerging as the global standard. Currently, GRI includes 146 indicators drawn from economic, social, and environmental domains and 33 “aspects” within these domains such as biodiversity, labor/management relations, and investment and procurement practices. Institutions can be certified as “in accordance” with GRI if they report on all relevant indicators and satisfactorily explain omissions. A list of GRI’s core indicators is attached as Appendix 2.1C. Most sustainability leaders in the pulp and paper link their reports to the GRI framework. The Facility Reporting Framework (FRP) is a recent adaptation of the GRI for industrial facilities, however, since it is new, there are no pulp and paper sector sustainability reports that use FRP of which we are aware.

Appendices 2.1D and 2.1E identify significant sustainability aspects by domain and a list of common GRI and GRI related indicators used in the context of pulp and paper sector sustainability reports. We reviewed 10 sustainability reports currently available through the GRI register. Appendix 2.1D identifies which aspects appear in which report. The first page of

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Appendix 2.1D classifies these aspects\(^{30}\) and reports the frequency each aspect appears overall. In the economic domain, sustainability reports identify 9 significant aspects. The most frequently reported aspects are employment, payroll, and benefits, capital expenditures and return, overall economic impact, and customer satisfaction. In the environmental domain, sustainability reports identify 20 significant aspects. Of these, greenhouse gas emissions, water use, energy use, waste, toxins, air and water pollutants, fines and environmental certifications appear most frequently. In the social domain, sustainability reports identify 10 significant aspects. Workplace satisfaction, social investments, safety, and diversity are the aspects most commonly addressed. Appendix 2.1E provides a sample of indicators responsive to each aspect and identifies the source document where applicable. The last two columns cross reference the indicators with those contained in the GRI and FRP sets.

In the context of Project Task 2.2, we will compare the aspects and indicators identified herein with those identified by DOE’s draft IFP indicator set and make recommendations for a final indicator set that responsive to all the significant aspects identified in this report.

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\(^{30}\) The aspect identifiers (i.e. EC9) are not the same as those reported by GRI.
Appendix 2.1A
Life Cycle of Pulp and Paper Production

Pulp and Paper Manufacturing Process

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Appendix 2.1B
Key Environmental Impacts of Pulp and Paper Production
Noted in the Literature

Short rotation forestry

Managed regeneration forests and tree plantations have three major effects: (1) detrimental effects on soils and forest productivity from harvesting or site preparation methods that can deplete nutrient levels over the long term; (2) damage to forest streams when activities such as harvesting, fertilizer and pesticide use, and road construction are performed without safeguards, such as adequate buffer strips along streams; and (3) loss of plant and animal habitat and species diversity—for example, resulting from the alteration of species composition and the physical structure of vegetation that, at a landscape scale, can reduce the available range of forest habitats (Blum et al. 1997)

Increased susceptibility to insects and disease

Logging and logging roads can promote the spread of damaging and lethal tree diseases that affect forest health overall. Smith (1989) reviewed multiple studies demonstrating that annosus root disease, often fatal or damaging for a number of conifer species, has increased in western forests as a result of logging. Hansen et al. (1988) summarized 10 years of research on black-stain root disease in Douglas-fir plantations in California, Oregon, and Washington where thinning and soil disturbance were found to increase the risk of infection and mortality. In addition to direct introduction of pathogens, reduced habitat for insect predators due to roads and other forest management activities can increase the severity of pest outbreaks. Pest success increases with forest simplification as the diversity of habitats decreases, resulting in declines of important predators, such as spiders and birds. Old-growth forests and roadless areas are less vulnerable to pest outbreaks (Schowalter and Means 1989).

Loss of native forest and associated biological diversity

Roads, soil disturbance, and reduced forest cover associated with logging can facilitate invasion by exotic (non-native) species. Parendes and Jones (2000) demonstrate that exotic plant species occurred on active and abandoned forest roads with frequency associated with disturbance level and canopy cover. Amaranthus et al. (1989) find that ectomycorrhizal fungi are critical for nutrient cycling and that logging and site preparation have an impact on soil organisms through soil compaction and erosion. The loss of soil mycorrhizae can result in a loss of site productivity. Biological diversity can be impacted by logging and road building as well. Corn and Bury (1989) found that abundance, density, and biomass of four aquatic amphibian species in the Oregon Coast Range were lower in streams flowing through logged forest than unlogged forest streams likely due to higher levels of fine sediment.
Fire risk

Logging can increase fire hazard without proper mitigation of activity fuels (SNEP 1996; Huff et al. 1995). While responsible thinning is an important tool for reducing fire risk, overzealous logging and thinning often reduce canopy cover and basal area too much resulting in warmer, drier conditions that result in uncharacteristic fire behavior.

Greenhouse gas emissions

Twelve percent of total manufacturing energy use in the United States can be attributed to the pulp and paper industry, not including materials procurement and product transportation, resulting in 9% of total carbon dioxide emissions from U.S. manufacturing. (Martin et al. 2000). Each step in the manufacturing process is responsible for a portion of overall energy consumption and resulting GHG emissions and these figures are found in detail in Tables 1 and 2 of Martin et al. (2000) and Table 1 in ICFPA (2005).

Carbon storage and sequestration

Cohen et al. (1996) demonstrate that forests in the Pacific Northwest are complex systems of carbon production and sequestration, but that harvested areas in a 20-year study period were a net source of carbon to the atmosphere. Of the carbon removed from a logging site and distributed throughout the forest products sector, nearly 40% is returned rapidly to the atmosphere through losses in primary and secondary manufacture as well as incineration and decomposition of short-lived forest products (Cohen et al. 1996).32 Cohen et al. (1996) state, generally, that decay of carbon pools from previous logged forests outweighs sequestration by early-successional conifer forests in the Pacific Northwest. The IPCC (2003) considers all carbon transferred out of managed forests as wood products to be an immediate emission.33 According to ForestEthics (2007), the most cost-effective way to preserve carbon is by conserving intact forests; managed forests in Ontario, Canada store 25 to 50 percent less carbon than intact forests. Ontario’s boreal forests store approximately 165 tonnes of carbon per hectare (CANFI 2001 as cited in ForestEthics 2007). 34

Pesticide use in plantations

Some plantations that supply the pulp and paper industry, in particular eucalyptus plantations require the application of pesticides to ensure rapid, economically beneficial growth cycles (Aracruz Celulose S.A. 2006). These pesticides can impact non-target species as well as eventually entering aquatic ecosystems where adverse impacts can result.

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32 However, see Law et al. (2004) who estimate the annual increase in C stored in long-lived forest products and land fills was 1.4 Tg C yr⁻¹ (1Tg = 10¹²g)
33 http://www.ipcc.ch/
34 CANFI 2001; http://nfi.cfs.nrcan.gc.ca/canfi/data/index_e.html
Soil compaction and erosion

Logging activities and associated roadbuilding can result in soil compaction, organic layer disturbance, and soil erosion, which may persist for decades. Jurgensen et al. (1997) review scientific literature in the inland Northwest and find that logging can result in soil compaction, displacement of surface mineral soil, loss of organic matter, and loss of nitrogen. Logging activity has caused significant soil compaction and erosion in the Pacific Northwest (Swanson et al. 1989). Amaranthus et al. (1985) found that soil erosion rates due to debris slides in southern Oregon were many times higher on forests with roads, landings, and logging activity than on undisturbed forests.

Aquatic ecosystems and salmonids

Logging activities can degrade stream habitat by affecting the amount, quality, and timing of water flow, increasing erosion rates, and reducing stream habitat diversity. Forest management may significantly alter water quality: temperature, suspended solids, and turbidity are all affected by forest management, but sedimentation is the most common direct effect on water quality (Brown and Binkley 1994). Chamberlin et al. (1991) found that logging can degrade stream habitat in steep, high-rainfall forests of the Pacific Northwest by changing the amount, quality, and timing of flowing water, increasing erosion rates, and reducing stream habitat diversity and in turn salmonid habitat. In southwestern Washington forest roads were a direct source of sediment delivery to streams during storm events (Bilby et al. 1989). Increased adult and juvenile salmonid mortality, decreased aquatic amphibian and invertebrate abundance or diversity, and decreased habitat complexity all result from increased fine sediment deposition in streams and altered streamflows and channel morphology. Hicks et al. (1991) found that salmonid survival rates decreased after logging and road construction as fine sediment levels in streams increased and as important habitat characteristics, including the number of pools and winter cover, decreased. In Oregon coastal basins, Reeves et al. (1993) found those with 25% or more area logged had lower stream habitat diversity and lower populations of juvenile salmonids that those with less than 25% area logged.

Water use

The pulp manufacturing process is the largest consumer of process water. For example, a bleached kraft pulp mill requires 4,000-12,000 gallons of water per ton of pulp (EPA 2002). Roughly half is used for non-contact cooling. There are measures that plants can take to increase water use efficiency. However, it should be noted that water use is non-consumptive and is eventually discharged back into the water bodies from where it was drawn.

Energy intensity

Pulp and paper manufacturing is an energy intensive process, however to the industry’s credit, it reduced primary energy intensity by 27% between 1970 and 1994 (Martin et al. 2000).
Twelve percent of total manufacturing energy use in the United States can be attributed to the pulp and paper industry, not including materials procurement and product transportation, resulting in 9% of total carbon dioxide emissions from U.S. manufacturing (Martin et al. 2000). Each step in the manufacturing process is responsible for a portion of overall energy consumption and resulting GHG emissions and these figures are demonstrated in detail in Tables 1 and 2 of Martin et al. (2000) and Table 1 of ICFPA (2005). Tables 3 and 4 in Martin et al. (2000) propose energy—efficient technologies and measures for the pulp and paper industry as well as energy savings, costs, and carbon dioxide emissions reductions available to the industry.

**Materials and chemical use**

The processing and manufacturing phase of pulp and paper is resource and chemical intensive. Wood, fiber, water, and chemicals are all significant inputs and generate significant emissions and effluents to air, land, and water (Pineda-Henson 2002).

**Landfill waste**

At about 35 percent, paper and paperboard products constitute the largest portion of the municipal solid waste stream. Americans generated about 83 million tons of paper products in the MSW stream in 2003, nearly a three-fold increase from 1960. About 48 percent of all paper and paperboard products in MSW were recovered in 2003, nearly two-and-a-half times the percentage recovered in 1960 (U.S. EPA 2007).

**Recycling**

Recycled paper production could result in a significant savings of primary energy use to the pulp and paper industry and a decrease in attendant carbon dioxide emissions (Martin et al. 2000). Total U.S. paper and paperboard recovery reached a record level of 53.4% in 2006 (Paper Industry Association Council 2007). The economic and environmental benefits of paper recycling are many. Recycled paper products reduce energy consumption, combustion and landfill emissions, and carbon dioxide.

**Air emissions and odors**

Pineda-Henson (2002) provide a theoretical framework representing the inputs, process, outputs, impacts, and improvement options for pulp and paper manufacture in Figure 1. Air emissions include SO$_x$, NO$_x$, VOCs, CO$_2$ and chloroform as well as odor and are considered contributors to human toxicity and climate change (Pineda-Henson 2002).

**Water effluents**

Pineda-Henson (2002) provide a theoretical framework representing the inputs, process, outputs, impacts, and improvement options for pulp and paper manufacture in Figure 1. In this
framework, manufacturing results in emissions to water of pentachlorophenol, biochemical oxygen demand and suspended solids.

Toxic contamination

Pineda-Henson (2002) provide a theoretical framework representing the inputs, process, outputs, impacts, and improvement options for pulp and paper manufacture in Figure 1. In this framework, manufacturing results in emissions to land of heavy metals including mercury, cadmium, chromium, nickel and zinc. Many of these heavy metals enter the production chain through the raw materials provided. The top chemicals by weight released into the environment include methanol, ammonia, hydrochloric acid, manganese compounds, sulfuric acid (EPA 2002).

Residuals re-use

Manufacturing byproducts are often used to make compost mixture, cement additives, potting soil, landscape bark, and roofing shingles. Useful manufacturing residuals are abundant, for example, in 2005, Boise Cascade generated 179 pounds of residuals per ton from paper manufacturing. (Boise Cascade 2006).

Environmental sustainability certifications

Forest certification is a system in which forestry operations or products can receive a stamp of approval ensuring that they are environmentally and socially responsible, giving consumers the confidence and power to “vote” with their dollars. There are several certification programs including American Tree Farm System, Forest Stewardship Council (FSC), Forest Stewardship Program (USFS), Green Tag (Nat. Forestry Association), and Sustainable Forestry Initiative (SFI) but two are most popular in the U.S., the non-profit FSC and the industry-standard SFI developed by the American Forest & Paper Association in 1995. The systems vary largely in their scope of criteria, plan - rigor or detail, type of professional reviewer, rigor of review/assessment, and costs and benefits and have received variable reception from environmental organizations. According the Natural Resources Defense Council, SFI lacks certain protections of the FSC such as: preventing natural forests from conversion to plantations, protection of old growth in the U.S., protection of sensitive, rare, and state-listed threatened and endangered species, and control of clear cutting. (NRDC 2002).

There have been numerous reviews of the two certification systems, including two that were “independent.” One measure of the difference in the systems is that FSC had certified 70 million acres in 54 countries in 9 years, whereas in two years SFI had nearly certified the entire U.S. industrial timber base. The most “independent” study, sponsored by both SFI and the AF&PA, found differences in 24 areas and 7 similarities. According to NRDC (2002), the overall difference is captured best in the program’s objectives: SFI establishes a baseline of performance to encourage improvement while FSC establishes a high standard for exemplary management.
Noise pollution results from manufacturing and transportation, both of input materials as well as product.

**Literature Cited**


Appendix 2.1C – Global Reporting Initiative
Complete Indicator Set by Domains and Sub-Domains

Economic Domain

Economic Performance
- EC1: Economic value generated and distributed, including revenues, operating costs, employee compensation, donations and other community investments, retained earnings, and payments to capital providers and governments. (Core)
- EC2: Financial implications and other risks and opportunities for the organization's activities due to climate change. (Core)
- EC3: Coverage of the organization's defined benefit plan obligations. (Core)
- EC4: Significant financial assistance received from government. (Core)

Market Presence
- EC5: Range of ratios of standard entry level wage compared to local minimum wage at significant locations of operation. (Additional)
- EC6: Policy, practices, and proportion of spending on locally-based suppliers at significant locations of operation. (Core)
- EC7: Procedures for local hiring and proportion of senior management hired from the local community at significant locations of operation. (Core)

Indirect Economic Impacts
- EC8: Development and impact of infrastructure investments and services provided primarily for public benefit through commercial, in-kind, or pro bono engagement. (Core)
- EC9: Understanding and describing significant indirect economic impacts, including the extent of impacts. (Additional)

Environmental Domain

Materials
- EN1: Materials used by weight or volume. (Core)
- EN2: Percentage of materials used that are recycled input materials. (Core)

Energy
- EN3: Direct energy consumption by primary energy source. (Core)
- EN4: Indirect energy consumption by primary source. (Core)
- EN5: Energy saved due to conservation and efficiency improvements. (Additional)
• EN6: Initiatives to provide energy-efficient or renewable energy based products and services, and reductions in energy requirements as a result of these initiatives.  
  (Additional)
• EN7: Initiatives to reduce indirect energy consumption and reductions achieved.  
  (Additional)

Water
• EN8: Total water withdrawal by source. (Core)
• EN9: Water sources significantly affected by withdrawal of water. (Additional)
• EN10: Percentage and total volume of water recycled and reused. (Additional)

Biodiversity
• EN11: Location and size of land owned, leased, managed in, or adjacent to, protected areas and areas of high biodiversity value outside protected areas. (Core)
• EN12: Description of significant impacts of activities, products, and services on biodiversity in protected areas and areas of high biodiversity value outside protected areas. (Core)
• EN13: Habitats protected or restored. (Additional)
• EN14: Strategies, current actions, and future plans for managing impacts on biodiversity.  
  (Additional)
• EN15: Number of IUCN Red List species and national conservation list species with habitats in areas affected by operations, by level of extinction risk. (Additional)

Emissions, Effluents, and Waste
• EN16: Total direct and indirect greenhouse gas emissions by weight. (Core)
• EN17: Other relevant indirect greenhouse gas emissions by weight. (Core)
• EN18: Initiatives to reduce greenhouse gas emissions and reductions achieved.  
  (Additional)
• EN19: Emissions of ozone-depleting substances by weight. (Core)
• EN20: NOx, SOx, and other significant air emissions by type and weight. (Core)
• EN21: Total water discharge by quality and destination. (Core)
• EN22: Total weight of waste by type and disposal method. (Core)
• EN23: Total number and volume of significant spills. (Core)
• EN24: Weight of transported, imported, exported, or treated waste deemed hazardous under the terms of the Basel Convention Annex I, II, III, and VIII, and percentage of transported waste shipped internationally. (Additional)
• EN25: Identity, size, protected status, and biodiversity value of water bodies and related habitats significantly affected by the reporting organization's discharges of water and runoff. (Additional)

Products and Services
• EN26: Initiatives to mitigate environmental impacts of products and services, and extent of impact mitigation. (Core)
• EN27: Percentage of products sold and their packaging materials that are reclaimed by category. (Core)

Compliance
• EN28: Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with environmental laws and regulations. (Core)

Transport
• EN29: Significant environmental impacts of transporting products and other goods and materials used for the organization's operations, and transporting members of the workforce. (Additional)

Overall
• EN30: Total environmental protection expenditures and investments by type. (Additional)

Social Domain

Employment
• LA1: Total workforce by employment type, employment contract, and region. (Core)
• LA2: Total number and rate of employee turnover by age group, gender, and region. (Core)
• LA3: Benefits provided to full-time employees that are not provided to temporary or part-time employees, by major operations. (Additional)

Labor/Management Relations
• LA4: Percentage of employees covered by collective bargaining agreements. (Core)
• LA5: Minimum notice period(s) regarding significant operational changes, including whether it is specified in collective agreements. (Core)

Occupational Health and Safety
• LA6: Percentage of total workforce represented in formal joint management-worker health and safety committees that help monitor and advise on occupational health and safety programs. (Additional)
• LA7: Rates of injury, occupational diseases, lost days, and absenteeism, and number of work-related fatalities by region. (Core)
• LA8: Education, training, counseling, prevention, and risk-control programs in place to assist workforce members, their families, or community members regarding serious diseases. (Core)
• LA9: Health and safety topics covered in formal agreements with trade unions. (Additional)

Training and Education
• LA10: Average hours of training per year per employee by employee category. (Core)
• LA11: Programs for skills management and lifelong learning that support the continued employability of employees and assist them in managing career endings. (Additional)
• LA12: Percentage of employees receiving regular performance and career development reviews. (Additional)

Diversity and Equal Opportunity
• LA13: Composition of governance bodies and breakdown of employees per category according to gender, age group, minority group membership, and other indicators of diversity. (Core)
• LA14: Ratio of basic salary of men to women by employee category. (Core)

Investment and Procurement Practices
• HR1: Percentage and total number of significant investment agreements that include human rights clauses or that have undergone human rights screening. (Core)
• HR2: Percentage of significant suppliers and contractors that have undergone screening on human rights and actions taken. (Core)
• HR3: Total hours of employee training on policies and procedures concerning aspects of human rights that are relevant to operations, including the percentage of employees trained. (Additional)

Non-Discrimination
• HR4: Total number of incidents of discrimination and actions taken. (Core)
• HR5: Operations identified in which the right to exercise freedom of association and collective bargaining may be at significant risk, and actions taken to support these rights. (Core)

Child Labor
• HR6: Operations identified as having significant risk for incidents of child labor, and measures taken to contribute to the elimination of child labor. (Core)

Forced and Compulsory Labor
• HR7: Operations identified as having significant risk for incidents of forced or compulsory labor, and measures to contribute to the elimination of forced or compulsory labor. (Core)

Security Practices
• HR8: Percentage of security personnel trained in the organization's policies or procedures concerning aspects of human rights that are relevant to operations. (Additional)

Indigenous Rights
• HR9: Total number of incidents of violations involving rights of indigenous people and actions taken. (Additional)

Community
• SO1: Nature, scope, and effectiveness of any programs and practices that assess and manage the impacts of operations on communities, including entering, operating, and exiting. (Core)

Corruption
• SO2: Percentage and total number of business units analyzed for risks related to corruption. (Core)
• SO3: Percentage of employees trained in organization's anti-corruption policies and procedures. (Core)
• SO4: Actions taken in response to incidents of corruption. (Core)

Public Policy
• SO5: Public policy positions and participation in public policy development and lobbying. (Core)
• SO6: Total value of financial and in-kind contributions to political parties, politicians, and related institutions by country. (Additional)

Anti-Competitive Behavior
• SO7: Total number of legal actions for anti-competitive behavior, anti-trust, and monopoly practices and their outcomes. (Additional)

Compliance
• SO8: Monetary value of significant fines and total number of non-monetary sanctions for non-compliance with laws and regulations. (Core)

Customer Health and Safety
• PR1: Life cycle stages in which health and safety impacts of products and services are assessed for improvement, and percentage of significant products and services categories subject to such procedures. (Core)
• PR2: Total number of incidents of non-compliance with regulations and voluntary codes concerning health and safety impacts of products and services during their life cycle, by type of outcomes. (Additional)

Products and Service Labeling
• PR3: Type of product and service information required by procedures, and percentage of significant products and services subject to such information requirements. (Core)
• PR4: Total number of incidents of non-compliance with regulations and voluntary codes concerning product and service information and labeling, by type of outcomes. (Additional)
• PR5: Practices related to customer satisfaction, including results of surveys measuring customer satisfaction. (Additional)

Marketing Communications
• PR6: Programs for adherence to laws, standards, and voluntary codes related to marketing communications, including advertising, promotion, and sponsorship. (Core)
• PR7: Total number of incidents of non-compliance with regulations and voluntary codes concerning marketing communications, including advertising, promotion, and sponsorship by type of outcomes. (Additional)

Customer Privacy
• PR8: Total number of substantiated complaints regarding breaches of customer privacy and losses of customer data. (Additional)

Compliance
• PR9: Monetary value of significant fines for non-compliance with laws and regulations concerning the provision and use of products and services. (Core).
Appendix 2.1D – Aspects Reported in Pulp and Paper Industry Sustainability Plans

I: Aspect Index by Domain (number of occurrences in parentheses, max = 10).

**Economic:**
EC1: Local procurement (1)
EC2: Worker productivity (2)
EC3: Economic impact (4)
EC4: Employment, payroll and benefits (7)
EC5: Capital expenditures and return (5)
EC6: Customer satisfaction (3)
EC7: Debt (2)
EC8: Investments (1)
EC9: Government subsidies (1)

**Environmental:**
EN1: Overall forest and plantation management (7)
EN2: Biological diversity (4)
EN3: Greenhouse gas emissions (10)
EN4: Carbon storage and sequestration (3)
EN5: Pesticide use in plantations (1)
EN6: Soil compaction and erosion (1)
EN7: Surface water quality and quantity (4)
EN8: Water use (8)
EN9: Energy use and profile (10)
EN10: Materials and chemical use (6)
EN11: Landfill waste (8)
EN12: Recycling (8)
EN13: Air emissions and odors (10)
EN14: Water effluents (10)
EN15: Toxic contamination (8)
EN16: Residuals re-use (6)
EN17: Fines and notifications (8)
EN18: Environmental improvement expenditures (6)
EN19: Environmental sustainability certifications (9)
EN20: Noise pollution (3)

**Social:**
SL1: Indigenous lands and communities (3)
SL2: Workplace satisfaction (8)
SL3: Social investments (6)
SL4: Media exposure (1)
SL5: Institutional image (1)
SL6: Workplace safety (10)
SL7: Collective bargaining (1)
SL8: Overall sustainability certifications (3)
SL9: Political involvement (1)
SL10: Workforce diversity (4)

II: Aspects Reported in Individual Sustainability Plans

Document #: 1
Author: Aracruz Celulose S.A.
Location: São Paulo, Brazil
Document Title: 2006 Annual and Sustainability Report
Access: Accessible via Global Reporting Initiative web portal at:
http://www.corporateregister.com/gri/
Sustainability Issues by Domain:

Economic:
EC1: Local procurement
EC2: Worker productivity
EC3: Economic impact
EC4: Employment, payroll and benefits
EC5: Capital expenditures and return
EC6: Customer satisfaction

Environmental:
EN1: Overall forest and plantation management
EN2: Biological diversity
EN3: Greenhouse gas emissions
EN4: Carbon storage and sequestration
EN5: Pesticide use in plantations
EN6: Soil compaction and erosion
EN7: Surface water quality and quantity
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN17: Fines and notifications
EN18: Environmental improvement expenditures
EN19: Environmental sustainability certifications

Social:
SL1: Indigenous lands and communities
SL2: Workplace satisfaction
SL3: Social investments
SL4: Media exposure
SL5: Institutional image
SL6: Workplace safety
SL7: Collective bargaining
SL8: Overall sustainability certifications
SL10: Workforce diversity

Document #: 2
Author: Boise Cascade
Location: Boise, Idaho
Document Title: 2005 - 2006 Sustainability Report
Access: Accessible at http://www.bc.com/environment/index.jsp

Sustainability Issues by Domain:

Economic:
EC5: Capital expenditures and return
EC7: Debt

Environmental:
EN1: Overall forest and plantation management
EN3: Greenhouse gas emissions
EN8: Water use
EN9: Energy use and profile
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN16: Residuals re-use
EN17: Fines and notifications
EN18: Environmental improvement expenditures

Social:
SL2: Workplace satisfaction
SL6: Workplace safety

Document #: 3
Author: Catalyst Paper Corporation
Location: Vancouver, British Columbia
Document Title: 2006 Sustainability Report, Fresh Thinking on Paper
Access: Accessible via Global Reporting Initiative web portal at:
http://www.corporateregister.com/gri/
Sustainability Issues by Domain:

**Economic:**
EC3: Economic impact
EC4: Employment, payroll and benefits
EC6: Customer satisfaction

**Environmental:**
EN3: Greenhouse gas emissions
EN7: Surface water quality and quantity
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN17: Fines and notifications
EN19: Environmental certifications

**Social:**
SL1: Indigenous lands and communities
SL2: Workplace satisfaction
SL3: Social investments
SL6: Workplace safety
SL10: Workforce diversity

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**Document #**: 4  
**Author**: Crown Van Gelder, N.V.  
**Location**: Velsen, The Netherlands  
**Document Title**: 2006 Sustainability Report  

Sustainability Issues by Domain:

**Economic:**
EC3: Economic impact
EC5: Capital expenditures and return
EC6: Customer satisfaction
EC8: Investments
EC9: Government subsidies

**Environmental:**
EN3: Greenhouse gas emissions
EN7: Surface water quality and quantity
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN17: Fines and notifications
EN19: Environmental sustainability certifications
EN20: Noise pollution

Social:
SL1: Indigenous lands and communities
SL2: Workplace satisfaction
SL6: Workplace safety
SL8: Overall sustainability certifications

Document #: 5 and 6
Author: International Paper
Location: Memphis, TN
Document Title: 2002 – 2003 Corporate Sustainability Report
2004 – 2006 Sustainability Update
Access: Accessible via Global Reporting Initiative web portal at:
http://www.corporateregister.com/gri/
Sustainability Issues by Domain:

Environmental:
EN1: Overall forest and plantation management
EN2: Biological diversity
EN3: Greenhouse gas emissions
EN9: Energy use and profile
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN16: Residuals re-use
EN17: Fines and notifications
EN18: Environmental improvement expenditures
EN19: Environmental sustainability certifications

Social:
SL2: Workplace satisfaction
SL3: Social investments
SL6: Workplace safety

Document #: 7
Author: Mondi Business Paper
Location: Austria

Sustainability Issues by Domain:

Economic:
EC4: Employment, payroll and benefits
EC5: Capital expenditures and return

Environmental:
EN1: Overall forest and plantation management
EN3: Greenhouse gas emissions
EN8: Water use
EN9: Energy use and profile
EN11: Landfill waste
EN13: Air emissions and odors
EN14: Water effluents
EN16: Residuals re-use
EN17: Fines and notifications
EN19: Environmental sustainability certifications
EN20: Noise pollution

Social:
SL2: Workplace satisfaction
SL3: Social investments
SL6: Workplace safety

Document #: 8
Author: Nippon Paper Group
Location: Toyko, Japan
Document Title: Sustainability Report 2006
Access: Accessible via Global Reporting Initiative web portal at:
Sustainability Issues by Domain:

Economic:
EC4: Employment, payroll and benefits

Environmental:
EN3: Greenhouse gas emissions
EN4: Carbon storage and sequestration
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN16: Residuals re-use
EN19: Environmental sustainability certifications
EN20: Noise pollution

Social:
SL6: Workplace safety
SL10: Workforce diversity

Document #: 9
Author: Oji Paper Group
Location: Toyko, Japan
Document Title: Environment and Sustainability Report 2006

Sustainability Issues by Domain:

Environmental:
EN1: Overall forest and plantation management
EN3: Greenhouse gas emissions
EN4: Carbon storage and sequestration
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN11: Landfill waste
EN12: Recycling
EN13: Air emissions and odors
EN14: Water effluents
EN15: Toxic contamination
EN16: Residuals re-use
EN18: Environmental improvement expenditures
EN19: Environmental sustainability certifications

Social:
SL3: Social investments
SL6: Workplace safety

Document #: 10
Author: Votorantim
Location: Sao Paulo, Brazil
Document Title: Sustainability Annual Report 2006

Sustainability Issues by Domain:

Economic:
EC2: Worker productivity
EC3: Economic impact
EC4: Employment, payroll and benefits
EC5: Capital expenditures and return
EC7: Debt

Environmental:
EN1: Overall forest and plantation management
EN2: Biological diversity
EN3: Greenhouse gas emissions
EN7: Surface water quality and quantity
EN8: Water use
EN9: Energy use and profile
EN10: Materials and chemical use
EN13: Air emissions and odors
EN14: Water effluents
EN17: Fines and notifications
EN18: Environmental improvement expenditures
EN19: Environmental sustainability certifications

Social:
SL2: Workplace satisfaction
SL3: Social investments
SL6: Workplace safety
SL8: Overall sustainability certifications
SL9: Political involvement
SL10: Workforce diversity
# Appendix 2.1E – List of Aspects and Sample Indicators in Pulp and Paper Industry Sustainability Reports

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Indicator(s) or Indicator Descriptions</th>
<th>Examples35</th>
<th>GRI Reference (s)</th>
<th>FRP Reference (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Economic Domain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC1: Local procurement</td>
<td>Percent of goods and services procured from local suppliers</td>
<td>N/A</td>
<td>EC6, E79, EC9</td>
<td>FEC1</td>
</tr>
<tr>
<td>EC3: Economic impact</td>
<td>Direct, indirect, and induced employment, income, and taxes generated by regional expenditures.</td>
<td>N/A</td>
<td>EC1, EC6, EC9</td>
<td>FEC2, FEC3, FEC6, FLA1</td>
</tr>
<tr>
<td>EC4: Employment, payroll and benefits</td>
<td>Number of employees by division</td>
<td>Nippon (2006)</td>
<td>LA1</td>
<td>FLA1</td>
</tr>
<tr>
<td></td>
<td>Value of payroll and benefits</td>
<td>Aracruz (2006)</td>
<td>LA1</td>
<td>FEC2, FLA2</td>
</tr>
<tr>
<td>EC5: Capital expenditures and return</td>
<td>Value of capital expenditures</td>
<td>Boise (2006)</td>
<td>EC1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Return on capital employed (ROCE)</td>
<td>Crown (2006)</td>
<td>EC1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additions to property, plant and equipment</td>
<td>Aracruz (2006)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EC6: Customer satisfaction</td>
<td>Number of customer complaints</td>
<td>Catalyst (2006)</td>
<td>PR5</td>
<td>FSO1</td>
</tr>
<tr>
<td></td>
<td>Customer satisfaction index score (1-10)</td>
<td>Crown (2006)</td>
<td>PR5</td>
<td>FSO1</td>
</tr>
<tr>
<td>EC7: Debt</td>
<td>Net debt by quarter</td>
<td>Boise (2006)</td>
<td></td>
<td>EC1</td>
</tr>
<tr>
<td>EC8: Investments</td>
<td>Value and percentage of investments that meet labor and environmental standards</td>
<td>N/A</td>
<td></td>
<td>HR1</td>
</tr>
</tbody>
</table>

| Environmental Domain | | | | |
|----------------------|-----------------|------------|------------------|

35 Examples are identified only when specific indicators of relevance are included in sustainability reports. “N/A” is used when the issue area and indicators are discussed only in concept or in narrative terms.
<table>
<thead>
<tr>
<th>Topic</th>
<th>Description</th>
<th>Source</th>
<th>En</th>
<th>FEN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EN3: Greenhouse gas emissions</strong></td>
<td>Tonnes of greenhouse gas emissions per year in carbon dioxide equivalent units</td>
<td>Catalyst (2006)</td>
<td>EN16</td>
<td>FEN10</td>
</tr>
<tr>
<td></td>
<td>Direct and indirect GHG emissions in thousand metric tons of carbon dioxide equivalent units</td>
<td>Int. Paper (2006)</td>
<td>EN16, EN17</td>
<td>FEN10</td>
</tr>
<tr>
<td></td>
<td>Scope 1, 2, and 3 GHG emissions in tonnes carbon dioxide equivalent units</td>
<td>Aracruz (2006)</td>
<td>EN16, EN17</td>
<td>FEN10</td>
</tr>
<tr>
<td><strong>EN4: Carbon storage and sequestration</strong></td>
<td>Amount of carbon dioxide absorption on company owned forests per year</td>
<td>Nippon (2006)</td>
<td>EN18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Changes in carbon stock on company managed forests each year</td>
<td>Aracruz (2006)</td>
<td>EN18</td>
<td></td>
</tr>
<tr>
<td><strong>EN5: Pesticide use in plantations</strong></td>
<td>Pesticide use by toxicology class</td>
<td>N/A</td>
<td>EN1, EN24</td>
<td>FEN1</td>
</tr>
<tr>
<td><strong>EN6: Soil compaction and erosion</strong></td>
<td>Sediment yield in tonnes per hectare per year in managed plantations versus control areas</td>
<td>N/A</td>
<td>EN12</td>
<td></td>
</tr>
<tr>
<td><strong>EN7: Surface water quality and quantity</strong></td>
<td>Surface water quality and quantity data in managed plantations versus control areas</td>
<td>Aracruz (2006)</td>
<td>EN12, EN21, EN25</td>
<td>FEN5, FEN6</td>
</tr>
<tr>
<td><strong>EN8: Water use, profile, and intensity</strong></td>
<td>Thousand gallons used per ton of production</td>
<td>Boise (2006)</td>
<td>EN1, EN8</td>
<td>FEN4</td>
</tr>
<tr>
<td></td>
<td>Cubic meters per air dried ton of production</td>
<td>Votorantim (2006)</td>
<td>FEN4</td>
<td></td>
</tr>
<tr>
<td><strong>EN9: Energy use profile, and intensity</strong></td>
<td>Electricity (kwh), biomass (t), fuel oil (kg), and natural gas (m3) consumption per air dried ton of production</td>
<td>Votorantim (2006)</td>
<td>EN3, EN5, EN6</td>
<td>FEN3</td>
</tr>
<tr>
<td></td>
<td>Total (mj) energy use per tonne of output by paper type</td>
<td>Oji (2006)</td>
<td>EN5</td>
<td>FEN3</td>
</tr>
<tr>
<td></td>
<td>Percent of energy used from renewable sources</td>
<td>Int. Paper (2006)</td>
<td>EN6</td>
<td>FEN3</td>
</tr>
<tr>
<td><strong>EN10: Materials and chemical use, profile, and intensity</strong></td>
<td>Total consumption of wood (m3), pulp (t), minerals and additives (t), chemicals (t)</td>
<td>Votorantim (2006)</td>
<td>EN1</td>
<td>FEN1</td>
</tr>
<tr>
<td></td>
<td>Total key materials and chemicals used and percent sourced from wastes</td>
<td>Catalyst (2006)</td>
<td>EN1, EN2</td>
<td>FEN1, FEN2</td>
</tr>
<tr>
<td></td>
<td>Chlorine, wood, water, soda, and chlorate consumption (kg or m3) per adt production</td>
<td>Aracruz (2006)</td>
<td>EN1</td>
<td>FEN1</td>
</tr>
<tr>
<td></td>
<td>Solid waste (1000m3) to landfill each year</td>
<td>Catalyst (2006)</td>
<td>EN22</td>
<td>FEN13</td>
</tr>
<tr>
<td><strong>EN12: Recycling</strong></td>
<td>Percent recycled content by product type</td>
<td>Catalyst (2006)</td>
<td>EN2</td>
<td>FEN2</td>
</tr>
<tr>
<td></td>
<td>Mixture ratio of DIP in newsprint</td>
<td>Nippon (2006)</td>
<td>EN2</td>
<td>FEN2</td>
</tr>
<tr>
<td><strong>EN13: Air emissions and</strong></td>
<td>Total reduced sulfur (TRS), nitrogen oxide, and sulfur</td>
<td>Boise (2006)</td>
<td>EN20</td>
<td>FEN12</td>
</tr>
<tr>
<td>odors</td>
<td>dioxides emissions per ton of output</td>
<td>Aracruz (2006)</td>
<td>EN20</td>
<td></td>
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<tr>
<td>EN14: Water effluents</td>
<td>Effluent BOD, AUX, flow (m3/adt), color, COD, and TSS in kg/adt</td>
<td>Aracruz (2006)</td>
<td>EN21</td>
<td></td>
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<td></td>
<td>Number of reports from odor perception network</td>
<td></td>
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<td></td>
<td>Storage of PCB wastes, including PCB equipment in use (kg)</td>
<td>Oji (2006)</td>
<td>EN22, EN24</td>
<td></td>
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<tr>
<td></td>
<td>Amount handled (kg) and release or transfer destination of chemical substances</td>
<td>Oji (2006)</td>
<td>EN22, EN24</td>
<td></td>
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<td></td>
<td>Power boiler dioxins and furans (grams/yr)</td>
<td>Catalyst (2006)</td>
<td>EN22, EN24</td>
<td></td>
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<tr>
<td>EN16: Residuals re-use</td>
<td>Rate of water reutilization</td>
<td>Votorantim (2006)</td>
<td>EN10</td>
<td></td>
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<tr>
<td></td>
<td>Amount (t/adt) and disposal of solid residues to co-processing, composting, landfill, recycling, and reuse</td>
<td>Votoranim (2006)</td>
<td>EN22</td>
<td></td>
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<td>Effective utilization rate for industrial wastes</td>
<td>Oji (2006)</td>
<td>EN22</td>
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<td>Percent of wastes recycled</td>
<td>Aracruz (2006)</td>
<td>EN22</td>
<td></td>
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<td>Percent of residuals used for energy, land applications, production, other uses, and landfill</td>
<td>Boise (2006)</td>
<td>EN22</td>
<td></td>
</tr>
<tr>
<td>EN17: Fines and notifications</td>
<td>Number of non-compliance citations for air emissions and water effluents</td>
<td>Catalyst (2006)</td>
<td>EN28</td>
<td></td>
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<td></td>
<td>Number of environmental incidents and complaints</td>
<td>Crown (2006)</td>
<td>EN28</td>
<td></td>
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<tr>
<td>EN18: Environmental expenditures</td>
<td>Capital expenditures for environmental programs</td>
<td>Boise (2006)</td>
<td>EN30</td>
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<td></td>
<td>Environmental conservation costs by initiative</td>
<td>Oji (2006)</td>
<td>EN26, EN30</td>
<td></td>
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<tr>
<td>EN19: Environmental certifications</td>
<td>Fiber purchased by certification method</td>
<td>Boise (2006)</td>
<td>EN26, HR2</td>
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<td></td>
<td>Proportion of pulp from certified sources</td>
<td>Mondi (2004)</td>
<td>EN26, HR2</td>
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<td>Chain of custody certification (CERFLO)</td>
<td>N/A</td>
<td>EN26, HR2</td>
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<td></td>
<td>Certification rate (FSC, SGEC, AFS, Certforchile) on company managed forests</td>
<td>Nippon (2006)</td>
<td>EN26, HR2</td>
<td></td>
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<tr>
<td>EN20: Noise pollution</td>
<td>Number of noise complaints per year</td>
<td>Nippon (2006)</td>
<td>EN29</td>
<td></td>
</tr>
</tbody>
</table>

### Social Domain

| SL1: Indigenous lands and communities                                | FSC or other certifications that protect indigenous lands uses                                         | N/A             | HR2, HR9, FHR8 |
| SL2: Workplace satisfaction                                         | Own employee turnover index                                                                          | Aracruz (2006) | LA2, FLA6 |
|                                                                      | Focus, accountability, involvement and response (FAIR) scorecard survey results                      | Catalyst (2006) | |
|                                                                      | Average training hours per person                                                                     | Int. Paper (2006) | LA10 |
|-------------------------|---------------------------------------|--------------|-----------------|-----|------------|
| SL5: Institutional image| Percent excellent/ good replies to stakeholder surveys | Aracruz (2006) |                 | PR5 | FSO1       |
| SL6: Workplace safety   | Accidents with lost time frequency rate for employees and permanent outsourced workers | Aracruz (2006) | LA7             | FEC5, FEC6 |
|                         | Incidents per 100 employees            | Boise (2006)  | LA7             | FLA10 |
|                         | OSHA violations and fines per year     | Int. Paper (2006) | LA7, SO8 | FLA10 |
| SL8: Overall sustainability certifications | Degree of compliance with GRI reporting system, listing on DOW, PSI or other sustainability indices | N/A |                 | FHR1, FSO2 |
| SL9: Political involvement | Value of donations or in-kind support for political campaigns | N/A | SO6             | FSO3 |
| SL10: Workforce diversity | Breakdown of employees and management by gender, age group, minority group membership and other indicators of diversity. | Aracruz (2006) | LA13            | FLA16 |