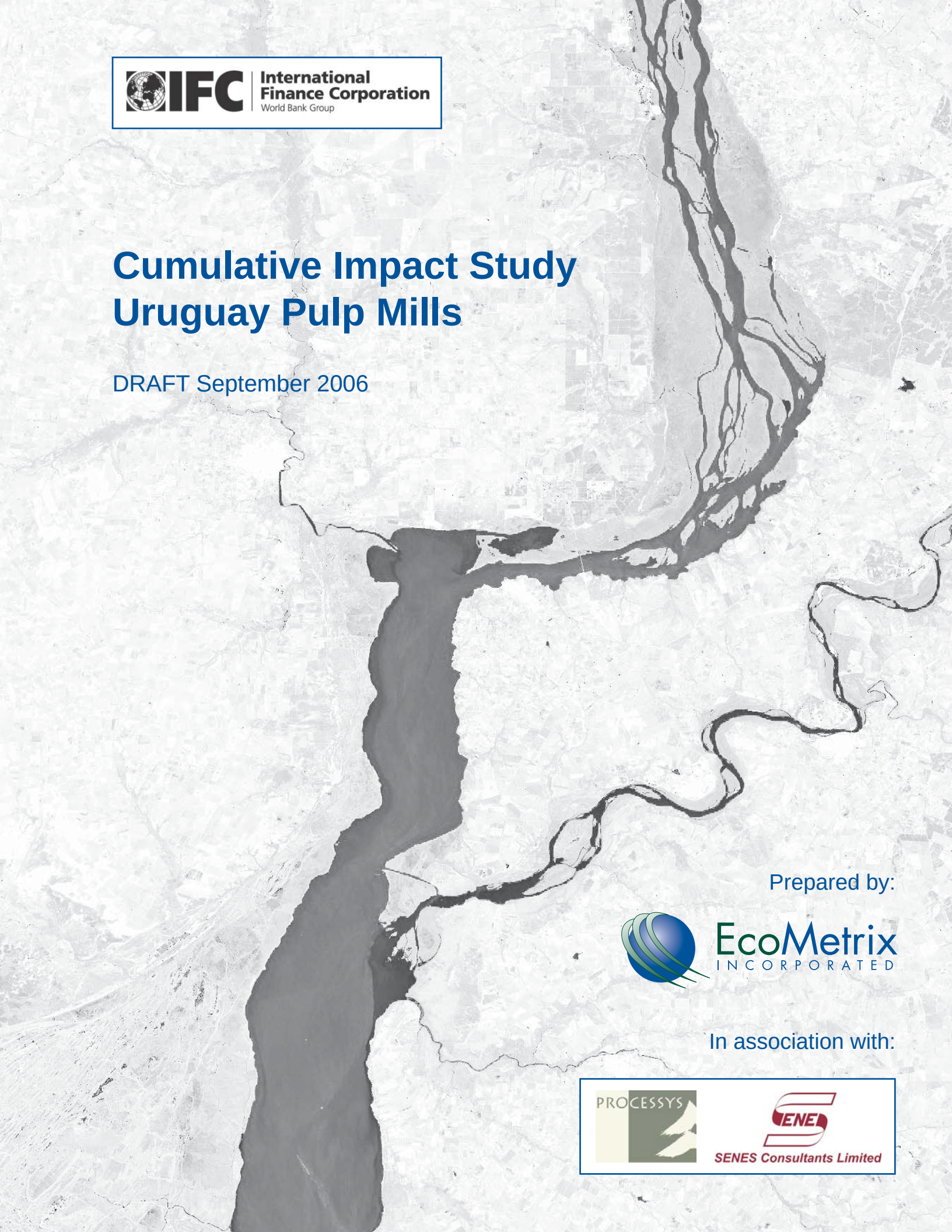

Cumulative Impact Study
Uruguay Pulp Mills

DRAFT September 2006

Prepared by:

EcoMetrix INCORPORATED

In association with:

PROCESSYS

SENES Consultants Limited

EXECUTIVE SUMMARY

[Explanatory Note: Given an announcement by ENCE's President on September 21, 2006 indicating the company's intention to relocate, it is now not clear when or where ENCE may initiate operation of a pulp mill in Uruguay. This CIS was initiated well before this announcement and is based on the presumption that ENCE would initiate production at the Fray Bentos site.]

INTRODUCTION

Two major European pulp producers are proposing pulp mill projects along the Río Uruguay near the city of Fray Bentos, Uruguay. Oy Metsä-Botnia Ab from Finland (Botnia), is developing the Orion project and Grupo Empresarial ENCE S.A. (ENCE), from Spain, is developing the Celulosas de M'Bopicuá (CMB) project. Both have prepared and publicly disclosed environmental and social assessments that describe the expected impacts of their projects and the mitigation and enhancement measures to manage those impacts.

The Botnia mill is located alongside the Río Uruguay approximately 5 km upstream (east) of the city of Fray Bentos near the end of the Libertador General San Martin International Bridge that connects Argentina and Uruguay. The site is currently under development with the port, stack and civil structures near completion. The ENCE mill is located approximately 11 km upstream (east) of the city of Fray Bentos on a site that currently contains a wood chipping plant and port facilities of the Terminal Logistica de M'Bopicuá.

Project Description

Botnia and ENCE are each proposing to develop a bleached Kraft pulp mill designed to produce approximately 1,000,000 tons of air dried pulp on an annual basis (ADt/a) and 500,000 ADt/a, respectively at full production. The wood will be sourced from established eucalyptus plantations within western and central-north Uruguay. The wood is processed by mechanical chipping, screening, cooking, bleaching and drying to separate it from water and lignin (natural glue that holds the fibre together in the wood) to produce pulp. The pulp will be exported to markets in Europe, Asia and other countries. The projects also include infrastructure for the supply of raw materials, water and energy, and for the storage, transport and disposal of waste and primary and final materials.

Regulatory Context

The Department of the Environment (Dirección Nacional de Medio Ambiente, DINAMA), as part of the Ministry of Housing, Territorial Planning, and Environment (i.e., Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente, MVOTMA), is the agency directly responsible for the administration and enforcement of the environmental laws and regulations of Uruguay.

Specific laws require project proponents to conduct Environmental Impact Statements (EIS) which describe the projects, evaluate the potential environmental effects, and develop monitoring plans and mitigation strategies. The mill proponents have submitted their respective EISs to DINAMA as required. Following approval of the EIS, and after all conditions were met, the proponents were granted a "Previous Environmental Authorization" (Authorización Ambiental Previa, AAP) for the project. The AAPs are an initial authorization for the mills. They identify certain restrictions such as compliance with all effluent limitations set forth in Uruguayan law (i.e., Decree 253/79); compliance with limits on other water quality parameters (e.g., AOX, nitrogen and nitrates); and compliance with the commitments made in their respective EISs. The AAPs also require the mills to comply with international surface water quality standards developed by the Administrative Commission of the Río Uruguay (Comision Administradora del Río Uruguay, CARU). These water quality standards are approved by the Governments of Argentina and Uruguay and are considered by these Governments as acceptable and adequately protective of the aquatic environment of the Río Uruguay.

For the construction and operation phases of the mills, the project proponents are required to submit detailed Environmental Management Plans (Plan de Gestión Ambiental, PGA) at which time additional requirements and safeguards may be stipulated by DINAMA. To date, ENCE has received authorization to commence earth movement to prepare the site for further construction of the mill and associated infrastructure, and Botnia has received authorization to construct the port, stack, concrete plant, foundations, bleached cellulose plant, wastewater treatment plant, and to operate the harbor terminal during the construction phase of the mill.

A separate authorization is required before operations can begin. The Environmental Authorization of Operation (Autorización Ambiental de Operación, AAO) will only be issued after construction is complete and a compliance monitoring plan has been submitted and approved. To ensure that operating standards and procedures continue to be state-of-the-art, the mills must request a renewal of their AAO every three years. At each renewal, Decree 349/005 empowers DINAMA to impose additional protective conditions on the project proponent, if additional requirements and safeguards are considered necessary.

Cumulative Impact Assessment

The International Finance Corporation of the World Bank Group (IFC) is currently assessing the two pulp mill projects in Uruguay for financing. In addition, the Multilateral Investment Guarantee Agency (MIGA) is evaluating whether to provide political risk insurance to the Botnia mill. To complete the assessment of the combined environmental and social effects of the two proposed mills, the IFC commissioned a Cumulative Impact Study (CIS) of the two pulp mills and their respective raw material sourcing. The draft CIS was released in December 2005 at which time it underwent a period of public review. The IFC also commissioned a panel of independent experts to review existing project documentation and all comments provided by stakeholders.

EcoMetrix Incorporated (EcoMetrix) and its consultants, SENES Consultants Limited (SENES) and Processys Incorporated (Processys), revised the draft CIS in response to the recommendations of the independent experts, the published Terms of Reference, original research, stakeholder commentary and other project related documentation. This report and its accompanying Annexes represent the final version of the CIS document as prepared by the EcoMetrix project team.

PROJECT DESCRIPTIONS

Wood Supply

An estimated 175,000 ha of eucalyptus plantations will be required to supply the two mills during their first eight years from start-up. Subsequently, a total of 208,000 ha of eucalyptus plantations will be needed to support the two pulp mills on a sustained basis. (At full production, Botnia's plant will require 3.5 million m^3 of eucalyptus per year and ENCE's plant approximately 1.7 million m^3 for a total of 5.2 million m^3 per year). In the western and center-north areas of Uruguay within convenient transportation distance of the pulp mills, are approximately 260,000 net ha of plantation. Both companies anticipate that supplies from their own lands, along with those from third party contractors will be sufficient to ensure adequate supply within an economically viable range for transport.

Both ENCE and Botnia are committed to ensuring that their own and associated supplier plantations are sustainably managed and do not have detrimental environmental and social impacts. The companies are requiring their suppliers to obtain independent certification of their forest management practices, through Forest Stewardship Council (FSC) certification.

Site Selection Process

Both Botnia and ENCE undertook detailed site selection evaluations based on macro- and micro-scales. Macro-scale factors included: location on the Río Uruguay (transportation, water supply and wastewater assimilation), proximity to eucalyptus plantations (wood transport costs and transportation impacts), and existing infrastructure (roads, electrical grid, educated workforce and services). Both companies decided to locate their pulp mills in Fray Bentos. Logistical factors played a key role in the companies' decision making, however environmental and infrastructural aspects were also important.

Distance from sensitive natural and cultural areas was an important consideration in the micro-scale evaluation. Both companies decided not to locate their pulp mills near the old Anglo meat processing plant because of its proximity to Las Cañas and Ñandubaysal. ENCE decided to minimize visual impacts by locating its site at a distance from urban areas. Enabling people to live within the city instead of in the rural areas was an important consideration for Botnia in their micro-scale site selection process.

Ports at M'Bopicuá, the Botnia mill, Nueva Palmira, and Montevideo will be used for the export/import of pulp and other supplies for the mills. Ports along the Río Uruguay have already experienced increased traffic because of increased log and woodchip exports.

Bleached Eucalyptus Kraft Pulp (BEKP) Mill Processes

The kraft or sulphate process is the dominant pulping process worldwide, due to superior pulp strength properties, its applicability for most wood species, the ability to recover and reuse the main process chemicals, and its energy efficiency. The main environmental concerns with kraft pulping include wastewater effluent, emissions to air including malodorous gases, the management of solid waste residuals, and energy consumption.

The kraft process is used in the production of paper pulp and involves the use of caustic sodium hydroxide and sodium sulfide (called white liquor) to extract the lignin from the wood fibre in large pressure vessels called digesters. The unbleached pulp is washed and the separated spent pulping liquor, called black liquor, is concentrated by evaporation and burned in the recovery boiler to generate high pressure steam for the mill processes. The inorganic portion of the black liquor is then treated to regenerate the sodium hydroxide and sodium sulphide needed for pulping.

Comparison of Expected Mill Emissions with BAT

The most widely accepted definition of Best Available Techniques (BAT) and the basic standard that has been used in this CIS for the environmental evaluation of the Botnia and ENCE pulp mills is the so-called IPPC-BAT (2001). The definition of Best Available Techniques (BAT) considered in IPPC-BAT (2001) is "the most effective and advanced stage in the development of activities and their methods of operation which indicates the practicable suitability of particular techniques for providing the basis for emission limit values designed to prevent, and where that is not practicable, generally to reduce the emissions and the impact on the environment as a whole".

The Tasmanian-AMT (2004) and the USEPA Cluster Rule standards were also used in this CIS for reviewing the mills to further evaluate whether the high design standards have been applied. In order to assess BAT for the Botnia and ENCE mills, the following methodology was systematically executed for the purposes of this CIS:

1. *Assessment of the mill's compliance with the emission levels achievable with the use of BAT:* Based on emission levels from the IPPC-BAT (2001) and Tasmanian-AMT (2004) standards, it was found that the mills are implementing BAT. Furthermore, a comparison was made between the proposed mill emission rates and other mills including state-of-the-art BEKP mills in Brazil, as well as other well-operated Botnia and ENCE mills. It was found that the proposed emission rates for the new pulp mills were generally in the same order or better than these mills.

2. *Assessment of whether DINAMA has a comprehensive plan to ensure the BAT standard will be met through their permitting process and requirements:* DINAMA is employing a staged process to issue management plans for each of the two pulp mills as engineering and construction activities progress, which should eventually lead to the AAO or operating permit for the mills. Both concentration-based and loading-based discharge requirements are expected for the effluent and well-defined atmospheric emission limits. The companies and DINAMA are currently discussing monitoring and reporting requirements, which will be used as the basis for the operating permit renewal required every three years.
3. *Assessment of whether BAT has been included in the mill equipment design:* IPPC-BAT (2001), Tasmanian-AMT (2004) and certain USEPA Cluster Rule (2000) requirements were considered, and targeted issues have been discussed in greater detail in sections of Annex A. In summary, both mills will employ state-of-the-art process technology.
4. *Assessment of BAT operating requirements:* The Botnia and ENCE mills were evaluated regarding their plans for solid waste management practices, monitoring plans including those implemented in other operating mills, training and motivation of mill personnel, process control, equipment maintenance, environmental management systems (EMS), and plans for communication with the community. Expectations for state-of-the-art practices in regards to these issues are in place for both mills.

ENCE and Botnia have combined their operating experience and process knowledge with vendor offers to develop mill configurations that would be accepted in Canada, the USA or Europe. The companies in almost all respects have put together the best process technologies that they can, and are likely to perform better than any of their existing mills with respect to environmental performance. The selection of two-stage oxygen delignification, ECF-Light bleaching and the cautious approach to alkaline filtrate recycling taken by both mills is consistent with BAT for BEKP mills, and the mills will implement state-of-the-art Hexenuronic acid removal stages in their bleaching sequences. The expected performance with respect to bleaching effluent flow, COD content and color will be among the best in the world.

ENCE and Botnia will meet and exceed IPPC-BAT (2001) and Tasmanian-AMT (2004) measures to control odorous gases from the recovery boiler and kiln, including efficient combustion control and CO measurements in the recovery boiler and control of excess oxygen and residual sodium sulphide in the lime kiln. Both mills have an extensive and comprehensive dilute gas collection system, and use the recovery boiler as the primary point of incineration. ENCE uses a biomass boiler as back-up, while Botnia uses a dedicated lean gas fire-tube boiler as back-up. The provision of a back-up for the dilute gas system and also the inclusion of white liquor preparation sources goes significantly beyond the IPPC-BAT (2001), Tasmanian-AMT (2004) and USEPA (MACT) requirements. The

strong gas system in both mills collects strong odorous gases, and incinerates them in the recovery boiler.

The IPPC-BAT (2001) standard establishes achievable emission levels for a certain number of key parameters for bleached kraft pulp mills. The range of discharges rates is compared with the estimates provided by the companies in Table ES-1. The summary of mill emissions in the table is for the total emissions to each of the air and water receiving environments. As for fugitive emissions, in particular those from the wastewater treatment plant, these are expected to be very low for both mills because of the low sulphidity level of the eucalyptus pulping process and because of the extensive spills collection system to be implemented.

In summary, based on the above analysis, the BEKP mills proposed by Botnia-Orion and ENCE-CMB are considered by the CIS project team to be IPPC-BAT (2001) or better.

Table ES-1: Comparison of Emission Rates (annual average)

	IPPC-BAT (2001) Guidelines	World Bank Group Emission Guidelines	Botnia-Orion Long term average	ENCE-CMB Long term average
Effluent				
Flow (m^3/ADt)	30 – 50	-	25	29
BOD_5 (kg/ADt)	0,3 – 1,5	-	0,3	0,6
COD (kg/ADt)	8 – 23	15	8,0	8,7
AOX (kg/ADt)	< 0,25	0,20	0,08	0,10
Suspended solids (TSS, kg/ADt)	0,6 – 1,5	-	0,7	0,9
Total nitrogen (kg/ADt)	0,1 – 0,25	0,4	0,15	0,17
Total phosphorus (kg/ADt)	0,01 – 0,03	0,05	0,012	0,017
Air emissions				
Particulate matter (kg/ADt)	0,2 – 0,5	-	0,30	0,34
Total S (kg/ADt)	0,3 – 0,6	1,0	0,35	0,26
SO_2 (as S) (kg/ADt)	0,2 – 0,4	-	0,30	0,23
NO_x (as NO_2) (kg/ADt)	1,0 – 1,5	2,0	1,35	1,30
TRS (as S) (kg/ADt)	0,1 – 0,2	-	0,05	0,03
CO (kg/ADt)	-	-	1,7	1,7

ECF vs. TCF Bleaching Processes

Oxygen delignification reduces the lignin content of pulp prior to bleaching, through the use of oxygen gas and sodium hydroxide. Modern two-stage delignification is proposed by both the Botnia and ENCE mills. The use of two-stage oxygen delignification has replaced the single stage system originally proposed by ENCE in the Draft CIS. For hardwood pulp and specifically for eucalyptus, two stage systems may not significantly increase the amount of delignification due to the presence of Hexenuronic Acid, which is not removed in oxygen delignification. However, two stage systems give more operating flexibility and better control.

The principal BAT for minimizing or eliminating the formation of dioxin and furan (specifically the congeners 2,3,7,8- Tetrachlorodibenzo-p-dioxin and 2,3,7,8-Tetrachlorodibenzofuran) in wood and non-wood bleaching processes include:

- reduction of the application of elemental chlorine by decreasing the multiple or increasing the substitution of ClO_2 for molecular chlorine;
- elimination of elemental chlorine by replacing it with ClO_2 (elemental chlorine-free or "ECF" bleaching) or with chlorine-free chemicals;
- utilization of DBD- and DBF-free defoamers;
- effective brownstock washing to enable the reduction of chlorine multiple;
- maximization of knot and dirt removal to enable the reduction of chlorine multiple; and
- elimination of the pulping of furnish contaminated with polychlorinated phenols.

All of these BAT factors have been incorporated in the design of the beach plants at both the Botnia and ENCE mills.

Two approaches have been taken by pulp manufacturers in response to concerns on dioxin emissions from mills using chlorine bleaching in the 1980s. One approach was to eliminate molecular or elemental chlorine-based chemicals (i.e. bleaching sequences in which molecular chlorine (Cl) and hypochlorite are not used), referred to as ECF bleaching. The second approach was to bleach with no chlorine-based chemicals, which is called TCF bleaching (i.e. bleaching with oxygen, ozone, alkaline or acidic peroxide). Botnia and ENCE were leaders in the adoption of TCF technologies and today 21% of Botnia's and 38% on ENCE's production is manufactured using the TCF process. In selecting a bleaching technology for Uruguay, both companies investigated a range of ECF, TCF and ECF-Light technologies (an "ECF-Light" technology essentially has attributes of both ECF and TCF production). The ECF-Light technologies were selected as pulp from the TCF sequences has lower yields and poorer final quality than the ECF and ECF-Light pulps.

ENCE found that pulp using the TCF bleaching method could not reach the necessary market brightness and Botnia has found that TCF bleaching produces inferior fibre quality, namely fibre strength. The inferior strength properties translate to less recyclability of the fibre, which is environmentally undesirable.

The ECF versus TCF question was recently examined by the Government Agency (RPDC) responsible for permitting new pulp mills in Tasmanian, Australia. The RPDC review concluded that TCF pulp and ECF pulp have similar environmental impacts from air and water emissions, and neither emitted dioxins at environmentally significant levels. Neither technology offers significant advantages in terms of operating risk, safety and occupational health considerations. Both technologies are acceptable under the Stockholm Convention of POPs, IPPC-BAT, USEPA and all significant permitting authorities.

Mill Processes: Effluent Treatment

The effluent treatment plants for both the Botnia and ENCE mills will employ the activated sludge treatment (AST) process, treating average discharge flows of approximately 73,000 m^3/d (25 m^3/ADt) and 46,000 m^3/d (29 m^3/ADt) respectively.

The IPPC-BAT (2001) standard considers an effluent discharge flow range of 30 to 50 m^3/ADt to be achievable by BAT mills. Both proposed mills will do better than the IPPC-BAT guideline. Effluent flows from the Botnia and ENCE mills also compare favorably with pulp mills around the world.

An efficient biological effluent treatment system is a critical element of BAT. Secondary or biological wastewater treatment by the activated sludge treatment (AST) process is widely implemented in the pulp and paper industry for the removal of organic matter. Both Botnia and ENCE will employ a form of the AST process, commonly referred to as “extended aeration”. A design-based review and analysis of the major equipment to be used in the mills for wastewater treatment was made as part of this CIS evaluation. It was found that Botnia and ENCE will implement the IPPC-BAT (2001) recommendations for biological treatment. Since both companies will implement state-of-the-art effluent treatment plants, and discharge into the Río Uruguay where the impact from marginal additional reduction in color and nutrients is likely to be insignificant, tertiary treatment was not considered necessary in either case.

ENVIRONMENTAL AND SOCIAL SETTING

Land Use

The western Uruguay region is characterized by gently rolling terrain primarily in agricultural use. Farms tend to be very large and agricultural production is a mix of cattle grazing, corn and soy production, and forest plantations (in descending order of importance). Nearly 38% of the total land area of Paysandú, Río Negro and Soriano is dedicated to agriculture and 70% of all agricultural operations in the three departments involve dairy, beef cattle and sheep ranching. Approximately half of all agricultural operations in each of the departments constitute 100 ha or less.

There are areas of natural tree growth in the landscape, usually in floodplains or low-lying areas (gallery forest), but such natural areas are mostly open-canopy, low-growing, deciduous forests that have been modified by grazing activity over the centuries since initial colonization. There are no designated protected natural areas in the immediate vicinity of the pulp mills.

The primary road network in the Fray Bentos and Paysandú area is paved with improvements still occurring in some areas. Many of the secondary roads are paved, and tertiary roads have gravel surfaces. The closest established recreational area to the project sites is Playa Ubici, on the east side of Fray Bentos, about 5 km from and within view from the Botnia project site. There are other recreational sites within and south of Fray Bentos; all are out of view of the proposed Botnia mill.

Water and Aquatic Resources

The Río Uruguay is, after the Río Paraná, the most important river draining to the Río de la Plata. The watershed for the Río Uruguay covers a surface area of approximately 365,000 km^2, of which 51% is in Brazil, 33.5% is in Argentina and 15.5 % is in Uruguay. The upper and middle reaches of the river above the Salto Grande Dam, are characterized as riverine environments with relatively narrow channel width (less than 0.5 km), steep channel slope and various rapids. The lower reaches, within which the mills will be located, are characterized as estuarine environments with a relatively wide (1.8 km) and flat channel with numerous islands.

The average flow in the Río Uruguay at the Salto Grande dam is approximately 6,230 m^3/s, however, flows can vary substantially based on season, precipitation and operation of the dam. The monthly average flow varies from a minimum of 500 m^3/s to a maximum of 22,500 m^3/s over a 20-year period of record.

In general, the quality of water in the Río Uruguay is considered good but there are localized issues and exceedances of water quality criteria such as near Bella Union, Salto, Concordia, Paysandú and the mouth of the Río Gualeguaychú. This localized deterioration of water quality was primarily attributed to runoff from areas of intense agricultural use and

discharges from urban centers and industries with inadequate effluent treatment. Contaminants which have been found to exceed guidelines include fecal coliforms, dissolved oxygen, ammonia, phosphorus, chromium, iron, zinc and phenols.

In general, sediment quality is also considered good but some nutrients and metals have been found to be elevated. Nitrogen and phosphorus concentrations are somewhat higher in the fall (April) as compared to summer months. In Yaguareté Bay in November and December, total phosphorus was 12 to 26 μg/g fresh weight (FW) of sediment, and nitrogen was 33 to 88 μg/g FW. Higher values of N in April were 38 and 416 μg/g FW, respectively. Also, locally high concentrations of chromium and copper have been found in sediments downstream of urban centres.

The lower Río Uruguay supports more than 100 fish species of which17 species are captured regularly by the artisan fishermen of the area. The Uruguayan catch totals approximately 1,600 tons each year. Based on recent catch statistics, the most important species are sabalo, boga, mullet, tarira, dorado and various catfishes (pati, armed, yellow).

The benthic invertebrate community in some locations in the lower Río Uruguay is dominated by tubificid worms, midge larvae, or invasive mussels (golden mussel). Snails and clams were also common and were the dominant taxa in some samples. The tubificid worms are indicative of nutrient-enriched low oxygen conditions that many other species do not tolerate.

Low concentrations of contaminants in fish tissues in the vicinity of Fray Bentos include dioxins and furans, PCBs and organochlorine pesticides. All concentrations were below levels of concern for fish consumption.

Social Setting

The area of the CIS encompasses the eastern Uruguayan departments of Río Negro, Soriano and Paysandú as well as the Río Uruguay littoral in the Argentine department of Gualeguaychú. This entire area is characterized by a relatively homogeneous population concentrated in a small number of urban centers situated within a large agricultural area. The population is concentrated in urban areas, with almost nine out ten persons residing in cities or towns. The capital cities of Río Negro (Fray Bentos) and Soriano (Mercedes) account for about half of their respective departmental populations; three quarters of the departmental population of Paysandú and Gualeguaychú, live in the capital cities, which carry the same name as the departments.

The age profile of the population is similar among all four departments with approximately half the population being 30 years or older. Population forecasts suggest very low rates of population growth and a relative decline in the rural population.

Table ES-2: Population and Population Density in Paysandú, Río Negro, Soriano and Gualeguaychú

Location	Area (km^2)	2004 Population (000)	Population Density (per km^2)
Uruguay	175,016	3,164	18.1
Paysandú	13,922	113	8.1
Río Negro	9,282	54	5.8
Soriano	9,008	85	9.4
Argentina	273,699	36,577	13.4
Gualeguaychú	7,086	101	14.3

Quality of life indicators, including rates of poverty, literacy, infant mortality, access to drinking water and sanitation, are relatively high in all four departments in comparison to other Latin American countries. While literacy rates are high in all departments (averaging 97.7%), only an average of 22.3% of the population fourteen years and older have completed primary school and only 20% have completed secondary school in the three Uruguayan departments. In Gualeguaychú, the comparable levels of population over 15 years of age having completed primary school is nearly 50%, and the percentage having completed secondary school is nearly 23%. Household income levels in these departments are somewhat lower than the average for Latin American countries as a whole.

Approximately 56% of the population of the three Uruguayan departments is economically active while 68% of the population in Gualeguaychú is economically active. There are large differences in unemployment between Río Negro and the other departments with the unemployment rate in Río Negro at 3.6% of the workforce, 16.3% in Paysandú, 16.9% in Soriano, and a significantly higher 27% reported for Gualeguaychú. The service sector is by far the most significant employer with an average of 70% of the active workforce employed in transportation, hotels and restaurants, banking, domestic service and retail trade. About 20% of the workforce is employed in the industrial sector (including manufacturing, construction and public utilities) and agriculture (farming, cattle ranching, forestry, hunting) accounts for the remaining 10%.

Between 11% and 32% of the population in the four departments are living at or below the poverty line with the lowest percent in Gualeguaychú and the highest in Paysandú. This assessment of poverty is based on a measure of the extent to which the population is deprived of one or more basic needs including characteristics of housing, access to water and sanitation, access and achievement of education, dependency rate and other income-related indicators.

CUMULATIVE IMPACT ASSESSMENT

The cumulative impact assessments include the potential effects associated with existing projects and conditions, those of the proposed projects, and those of other developments that are realistically defined at the time the assessment is prepared and would impact directly on the project area. The timelines of the two proposed projects are offset by up to two years with Botnia currently under construction and ENCE not expected to commence construction until early in 2007.

Methodology

This study has employed specialized techniques and methodologies for the analysis of cumulative impacts such as computer modeling for the analysis of air emissions and effluents to water. Other methodologies used are generally quantitative to the extent that is feasible in the given discipline and within the constraints of this particular study, while some are qualitative in nature and rely significantly on the judgment of the relevant expert(s) on the CIS technical team.

The assessment of air quality and related impacts of pulp mill emissions primarily involved mathematical modelling of atmospheric dispersion and the prediction of ground level ambient air quality for comparison to air quality criteria. Both meteorological and air dispersion models were employed. Meteorological models were used to augment the available meteorological data to provide a complete representation of the three-dimensional wind field within the general area of the mill sites. This used the CALMET model coupled with a non-hydrostatic meso-scale weather forecast model referred to as FReSH. Air dispersion models were used to predict the change in ground level air quality attributed to the air emissions from the mill operations. Two air dispersion models were used for this assessment – the Industrial Source Complex Short Term version 3 (ISCST3) model and the CALPUFF model.

The assessment of water quality and related impacts of pulp mill effluents on the Río Uruguay primarily involved modelling of effluent dispersion in the river to determine resulting concentrations of effluent constituents for comparison to water quality guidelines and existing baseline concentrations. The assessment was supported by a literature review pertinent to some concerns, particularly dioxins and furans, endocrine disrupting compounds, and chemicals associated with fish tainting. The assessment of sediment quality impacts was based on consideration of the potential for change in water quality, including suspended sediment loads and on consideration of the conditions required for sediment mobilization.

Water quality modeling encompassed both the near-field and far-field environments relative to the discharge points. The CORMIX model developed by Cornell University was used as the primary near-field modelling tool. The far-field modeling was performed using the TABS-MD series of models, available from the U.S. Army Corps of Engineers. RMA-2 and

RMA-10 are two- and three-dimensional finite element hydrodynamic models. RMA-2 computes the lateral and longitudinal distribution of water surface elevation and horizontal velocity, while RMA-10 includes the vertical distribution of velocity to enable assessment of stratified waterbodies. RMA-11 is a water quality sub-model capable of calculating the transport, dispersion and fate of water quality constituents, using the hydrodynamic results from RMA-2 or RMA-10.

Plantations

The Government of Uruguay has been supporting the development of plantation forestry for nearly twenty years. Only those soils classified as having a priority for tree plantations could be utilized for the conversion of land to plantations. This criterion ensured that soils with a high capability for cultivation under row crops or high quality pasture were not converted to other uses. Generally, this resulted in the conversion of less productive lands that had predominantly been used as rough pasture for cattle and sheep grazing.

Botnia and ENCE have their own plantation companies (Forestal Oriental, or FOSA, and EUFORES, respectively) with significant plantation holdings. Both companies also purchase wood from other third-party plantation companies, under short or long-term contracts.

During full operation, Botnia's plant will require 3.5 million m^3 of wood per year, and the ENCE mill will need approximately 1.7 million m^3 per year, a total of 5.2 million m^3 per year for both. On the basis of average annual production rates, a total of 208,000 ha of plantation would be needed to supply this amount of wood, for these two plants. However, the area required during the first eight years of operation, as the two mills gradually come on-line, is estimated at approximately 175,000 ha.

As of the end of 2003, approximately 140,000 net (planted area only) ha, or 2.2%, of the total land area in the Littoral Region of western Uruguay was under eucalyptus plantation. Additional eucalyptus plantations located within an economically viable distance of the mills encompasses another 120,000 net ha. Although some additional plantations may be developed in these areas in the near future, this will be primarily for saw logs and export. Hence, the development of the two pulp mills is not expected to result in significant additional plantation development in western Uruguay.

In general, most of the impacts resulting from the operation of existing plantations and the development of any new plantations were considered minor and manageable. All of the company-owned plantations and most of those owned by third party contractors are certified under the Forest Stewardship Council sustainable forest management program which requires measurements and audits of social and environmental components. However, individual and cumulative impacts of potential significance may relate to water management issues – both surface water and groundwater. As such, the forestry companies supplying the two mills should continue their participation in on-going

Uruguayan State University studies pertaining to impacts on soils, surface water, and groundwater. In addition, both EUFORES and FOSA should ensure surface and groundwater monitoring is established at all of their large-scale plantations. Any plantations located within the recharge area of the Guarani Aquifer should also study and monitor and assess groundwater quality (e.g., for traces of pesticides, herbicides and nutrients) on their plantation lands.

Biodiversity

Uruguayan law prohibits the removal of natural forests or impacts to formally designated protected areas. As a result, the vast majority of lands converted to forest plantations have been converted from marginally productive areas that formerly supported mostly sheep and cattle grazing. Such areas may contain a greater diversity of individual species and gene pools than occur within the planted portion of eucalyptus plantations, but both areas largely contain exotic species.

Most of the plantations operated by the forestry companies owned by ENCE (EUFORES) and Botnia (FOSA) are managed under an agroforestry regime which often incorporates natural areas within a mix of land uses. On average 65% or so of these plantations are directly planted to eucalyptus with remaining areas used for cattle grazing, other agricultural activities, and natural areas. Plantations may not incorporate areas of natural forest, wetlands, and lands formally designated as protected areas. EUFORES and FOSA prepare management plans for the natural areas on their properties and undertake inventories and monitoring of flora and fauna.

Air Quality

Modeling of air dispersion and ground level ambient air quality were undertaken to determine the potential impact at nine locations of interest. The results were then compared to applicable standards and guidelines (Table ES-3) and used to estimate potential health and aesthetic effects. Air quality remains in compliance with ambient air quality criteria under all meteorological conditions and operating conditions at all receptor locations. It is therefore concluded that there is no potential for human health effects associated with mill emissions. However, it is possible that odour may be detected on occasion (4 to 10 times per year) within the areas adjacent to each mill and possibly within the city of Fray Bentos and at the international bridge.

Table ES-3: Summary of Potential Effects on Air Quality

Area of adjacent to the mill properties	• Greatest potential change in ground based ambient air quality; • Air quality remains in compliance with ambient air quality criteria under all meteorological conditions and operating conditions, therefore limited potential for human health effects associated with mill emissions; • Potential for infrequent (4 to 10 times per year) odour effects during start-up and upset conditions;
City of Fray Bentos	• Air quality remains well below ambient air quality criteria under all meteorological conditions and operating conditions, therefore no adverse human health effects associated with mill emissions; • Potential for infrequent (4 to 10 times per year) odour effects during start-up and upset conditions; • Recommend TRS monitoring in Fray Bentos;
City of Mercedes	• Immeasurable change in ambient air quality, well below any level that may cause any effect;
City of Nuevo Berlin	• Immeasurable change in ambient air quality, well below any level that may cause any effect;
Beach Resort of Las Cañas	• Immeasurable change in ambient air quality, well below any level that may cause any effect;
Beach Area of Playa Ubici	• Air quality remains well below ambient air quality criteria under all meteorological conditions and operating conditions, therefore no adverse human health effects associated with mill emissions; • Potential for infrequent (4 to 10 times per year) odour effects during start-up and upset conditions;
International Bridge	• Air quality remains well below ambient air quality criteria under all meteorological conditions and operating conditions, therefore no adverse human health effects associated with mill emissions; • Potential for infrequent (4 to 10 times per year) odour effects during start-up and upset conditions; • Recommend TRS monitoring at the international bridge;
City of Gualeguaychú, Argentina	• Immeasurable change in ambient air quality, well below any level that may cause any effect;
Beach Area at Ñandubaysal, Argentina	• Immeasurable change in ambient air quality, well below any level that may cause any effect;

The air monitoring programs recommended by ENCE and Botnia in their respective EISs are considered largely satisfactory. The only air quality issue which was not fully addressed is the potential for infrequent occurrences of odour in the immediate vicinity of the mills. Although both companies proposed monitoring of reduced sulphur compounds (TRS), they did not specify pertinent receptors. It is thus recommended that monitoring of TRS be undertaken in Fray Bentos and at the international bridge.

Noise

Both Botnia and ENCE recognize the potential for noise impacts related to the construction and operation of their proposed pulp mill developments in Fray Bentos. ENCE also evaluated potentially elevated noise levels resulting from plant decommissioning and as a result of their plantation operations.

ENCE notes that noise impacts associated with all phases and operations are reversible and generally of low magnitude. Construction and decommissioning noise impacts are considered short-term whereas operational phase impacts are long-term and plantation noise impacts are long-term but intermittent. The highest noise levels are anticipated to occur during the plant construction phase due to the presence of many workers along with the movement of vehicles and heavy equipment. They estimate a worse case condition of 84.9 dB(A) at source but rapidly falling-off with distance, reaching a level of 45 dB(A) at about 500 m from the source. It is likely this would exceed the IFC guideline at least in some locations at the property boundary; however the location of the island across from the proposed mill would minimize impacts to human receptors in Argentina. Mitigation measures proposed by ENCE to reduce the impact of elevated noise levels include the use of speed limits and signs to control vehicular traffic on-site and the planting of a vegetated border around the perimeter of the plant.

Maximum noise levels within plantation areas is estimated in the EIA as being in the order of 75 dB(A) due primarily to harvesting and handling machines. These levels would be confined to areas adjacent to the trees but, given the location of outer portions of the plantations relative to the property boundary, it is quite likely that the IFC standard for residential receptors would be exceeded for some adjacent properties and landowners.

The Botnia EIA provides a range of potential noise levels during construction and operation from between 72 and 97 dB(A), with short-term escalation up to 105 dB(A). These noise levels would not likely meet the IFC guidelines at the property boundary. Mitigation measures to be employed are noted as providing the workers with ear protection devices and notification of the local population when exceptionally loud noise will be anticipated during the construction phase.

Each company should undertake detailed monitoring of noise levels adjacent to plantations and the mills. In addition, they should prepare contingency plans to protect particularly sensitive receptors, such as recreational and residential areas, in the event of regular exceedences of IFC guidelines. These contingencies could include sound proofing and deflecting devices including vegetation planting and the construction of noise walls.

Water Quality

Modeling of effluent flows and loadings were undertaken to determine the potential impact at eleven locations of interest. The results were then compared to applicable standards and guidelines (Table ES-4) and used to estimate potential impacts to sediment quality, fish communities, and aquatic invertebrates. Potential effects are limited to the area within the immediate vicinity of each diffuser where the effluent initially mixes with the ambient water. Beyond this small area, the water quality standards are achieved with the exception of those parameters which exceed the standards under present conditions due to the discharge of untreated municipal wastewater and agricultural runoff.

Botnia is considering the option of treating the municipal wastewater for Fray Bentos at its wastewater treatment plant. This will effectively eliminate a significant source of phosphorus and bacteria to the beach area near Arroyo Fray Bentos, thereby improving the overall quality of the resource. This is considered a significant benefit that should be considered further by DINAMA, the city of Fray Bentos, Botnia and other stakeholders.

Botnia is also considering the option of treating the weak black liquor from the Papelera Mercedes (the Mercedes mill), which is a neutral sodium sulphite chemical (NSSC) mill and Kraft mill located along the Rio Negro in the community of Mercedes. The Mercedes mill does not have any form of chemical recovery or wastewater treatment, and all cooling and process waters are discharged directly to the Rio Negro where it then flows to the Rio Uruguay. Treatment of the weak black liquor by Botnia presents a significant environmental and social benefit. From an environmental perspective, the option results in a benefit to the Rio Negro as it will reduce this source of potentially harmful chemicals to the river. It also represents a small benefit to the Rio Uruguay as it will reduce the overall loadings to the river. From a social perspective, this option may ensure the economic viability of the mill since the cost of treatment on-site may not be viable considering the small production capacity of the mill.

No impacts to sediment quality, the health of fish communities, nor aquatic invertebrates were found at the locations of interest with the exception of minor sediment nutrient enrichment and possible change in the benthic macroinvertebrate community within the vicinity of the discharges. This area is small (extending approximately 35 m from each diffuser and along its 200 m length) and therefore will not adversely affect the aquatic resources within the Río Uruguay.

The cumulative assessment of water quality in the Río Uruguay indicates that no water quality standards or guidelines will be exceeded as a result of the discharge of effluents from the two mills. However, chemical and biological monitoring in the river, in conjunction with mill effluent monitoring, is recommended to demonstrate the lack of adverse impact. A plume delineation study is also recommended, to be completed when the mills are operating normally.

Table ES-4: Summary of Potential Effects on Water Quality

Vicinity of Botnia and ENCE Discharges	• Exposure Area extending approximately 35 m from each diffuser and 200 m along each diffuser. • Possible exceedance of surface water quality objectives within this exposure area during extreme low flow conditions. • Potential for aesthetic effect associated with visual detection of the effluent plume within a very small area at each diffuser during extreme low flow conditions.
Yaguareté Bay	• Water quality in compliance with DINAMA surface water quality standards (with the exception of phosphorus which exceeds the standard under background condition due to discharge of untreated municipal wastewater and agriculture runoff). • Trace levels of wastewater from mill operations will not adversely affect water quality.
Playa Ubici	• Water quality in compliance with DINAMA surface water quality standards (with the exception of phosphorus and possibly bacteria which exceed the standard under background condition due to discharge of untreated municipal wastewater and agriculture runoff). • Trace levels of wastewater from mill operations will not adversely affect water quality.
Fray Bentos Drinking Water Supply	• Water quality in compliance with DINAMA surface water quality standards for Class 1 waters (with the exception of phosphorus, ammonia and possibly bacteria which exceed the standard under background condition due to discharge of untreated municipal wastewater and agriculture runoff). • Trace levels of wastewater from mill operations will not adversely affect water quality.
Beach Area near Arroyo Fray Bentos	• Water quality in compliance with DINAMA surface water quality standards (with the exception of phosphorus and possibly bacteria which exceed the standard under background condition due to discharge of untreated municipal wastewater and agriculture runoff). • Trace levels of wastewater from mill operations will not adversely affect water quality. • Option to treat the municipal wastewater for the city of Fray Bentos at the Botnia mill will improve water quality within the beach area.
Beach Area near Las Cañas	• Potential for improved water quality if municipal wastewater for the city of Fray Bentos is treated at the Botnia mill.
Rio de la Plata	• Water quality unaffected.
Esteros de Farrapos e Islas del Rio Uruguay	• Water quality unaffected.
Rio Negro	• Potential improvement in water quality in Rio Negro if untreated wastewater from Papelera Mercedes is treated at Botnia mill.
Rio Uruguay along the Argentina Side	• Water quality unaffected.
Beach Area at Ñandubaysal, Argentina	• Water quality unaffected.

Water and sediment quality monitoring programs are recommended, including upstream reference and downstream plume exposure locations. Water quality would be monitored bimonthly, for a comprehensive suite of chemical parameters. Sediment quality would be monitored every two to three years, for total organic carbon (TOC), grain size, pH, nitrogen, phosphorus, adsorbable organic halides (AOX), extractable organic halides (EOX), total phenolics, chlorophenolics, and dioxins and furans. This program will track any sediment nutrification effects, as well as any accumulation of toxic contaminants of concern.

Monitoring of benthic invertebrate community composition is recommended, concurrent with the sediment quality monitoring program. In addition, a selected benthic invertebrate would be collected for analysis of tissues for bioaccumulative substances, including chlorophenols, resin and fatty acids, phytosterols, and dioxins and furans.

Solid Waste

Best available techniques for solid waste management involve minimizing the generation of solid waste by recovering, recycling and reusing waste materials wherever practicable. These actions, as well as innovative waste minimization techniques, will be adopted by the mills. Solid wastes generated by kraft pulp mill operations generally consist of wood preparation waste; raw water treatment sludge; green liquor dregs, grit and lime mud; effluent treatment sludge; ash/sands; municipal solid waste; and minor quantities of hazardous waste including oily rags, spill collection wastes (chemicals and fuel), laboratory wastes, cleaning solvents, and used containers.

Both projects propose to construct on-site landfills for disposal of non-hazardous solid waste. In general, both landfill designs will consist of a low permeability soil or geocomposite bentonite liner over the compacted subgrade; an impermeable geomembrane (plastic) liner; and a leachate collection system consisting of high permeability material and perforated plastic piping. The leachate collection systems will divert leachate to the effluent treatment plants. The Botnia landfill will have a design capacity of 19 years and the estimated capacity for the ENCE landfill is 30 years. There is sufficient space at both sites to extend the life span of these landfills as necessary.

The only potential organic waste going to an industrial landfill is the sludge from Botnia's river water treatment system. However, the organic content of the raw water treatment sludge is relatively small compared to the amount of inorganic waste going to the industrial landfill. In addition, the alkaline lime mud, grits and dregs are expected to inhibit biological gas generation within the landfills. If required, passive landfill gas venting systems can be installed to allow decomposition gases to vent to the atmosphere and avoid potential subsurface migration. Alternatively, these gases could be collected for combustion.

A groundwater monitoring system will be installed at each site and will consist of a network of upgradient and downgradient wells to monitor potential impacts and implement corrective

actions as appropriate. Each load of waste will be inspected, weighed and recorded to verify waste generation rates and determine if corrective measures are required.

Botnia has estimated that 100 to 150 tons of hazardous materials will be generated on an annual basis whereas ENCE estimates 80 to 100 tons per year of hazardous waste will be generated. Both projects will transport these wastes to an appropriate off-site hazardous waste management facility, however the limited facilities currently existing in Uruguay will need to be augmented or supplemented in some way. The companies should be prepared to monitor the type and amount of hazardous waste generated as well as ensure that an appropriate waste transportation tracking procedures are implemented.

Social and Economic

There is expected to be a significant increase in local employment opportunities, both direct and indirect, during the construction of the two plants and their subsequent operations. As a result, there is likely to be an influx of job seekers into the department of Río Negro. The socio-economic impacts of the two projects are considered from the perspective of direct and indirect effects on the regional and national economy as well as on social services and quality of life in the vicinity of the two plants. It is expected that there will be no economic impact to Argentina, due to the Government of Argentine and its citizens' refusal to support employment and wood sales to the pulp mills on the Argentine side of Rio Uruguay.

The cumulative impacts of the two projects on the national and regional economy and on employment, as illustrated in Table ES-5, are likely to be significant in terms of economic performance, employment, balance of trade and tax revenue.

Both projects are expected to require 5,000 or more workers during their peak construction periods but these will not be required all at once since construction of Botnia's mill will be winding down as ENCE's ramps up. The increase in population during the three to four years required to construct both plants will be heavily weighted towards men, and in particular younger men. Both companies have discussed with community officials ways to mitigate and manage potential impacts of the influx of workers. Transportation will be provided from communities within commuting distance to encourage employees to remain in their home communities and not relocate to Fray Bentos. Housing integrated into the existing neighbourhoods in Fray Bentos, is provided for migrant workers and for workers with families. An agreement is in place with the government of Fray Bentos to acquire for its own use, the migrant worker housing once construction is complete.

The influx of labour will have some negative impacts to the community including a potential increase in traffic accidents due to reckless and drunk behaviours, increase in sexually transmitted diseases and pregnancy, shortage of rental properties and housing, and increased housing and rental costs. Also, the pace of life will increase with the influx of outsiders into the area; there will be an increase in traffic, with its attendant increase in

noise; an increase in tourist and commercial activities; and a greater demand for and supply of cultural and recreation events and activities.

Table ES-5: Cumulative Economic and Employment Impact for the Orion and CMB Pulp Mills

Impact	Region	Construction Phase (2005-2007)	Operational Phase (Typical Year)
Economic (USD Millions)	Uruguay	417 (3.2% of 2004 GDP)	331 (2.5% of 2004 GDP)
	Rio Negro	206 (112% of 2003 GDP)	223 (121% of 2003 GDP)
	Soriano	33 (14% of 2003 GDP)	13 (6% of 2003 GDP)
	Paysandú	41 (13% of 2003 GDP)	23 (7% of 2003 GDP)
Employment (Person-Years)	Uruguay	18,699 (1.4% of 2004 Total)	12,593 (0.9% of 2004 Total)
	Rio Negro	11,196 (109% of labor force)	4,773 (47% of labor force)
	Soriano	1,337 (6% of labor force)	1,108 (5% of labor force)
	Paysandú	2,421 (8% of labor force)	2,048 (7% of labor force)
Balance of Trade (USD Millions)	Uruguay	- 1,100 (Similar to "normal" annual average)	+244 (Approx. 22% of "normal" trade deficit)
	Uruguay	+83 (2% of 2004 revenues)	+39 (1% of 2004 revenues)
	Rio Negro	-1.8 (19% of 2004 revenues)	+0.9 (10% of 2004 revenues)

Table ES-6: Estimated Employment Generated during the Construction and Operations Phases of both Pulp Mills (person years of full time employment)

	Construction Phase			Operations Phase		
	Botnia	ENCE	Total	Botnia	ENCE	Total
Direct	4,200	5,000	9,222	300	300	600
Indirect	5,710	2,885	8,595	3,976	2,094	6,070
Induced	2,512	1,269	3,781	3,879	2,043	5,922
Total	12,422	6,277	20,598	8,155	4,437	12,592

With the influx of population associated with both direct and indirect employment related to the pulp mill projects, there will likely be a temporary increase in the cost of goods and services. This increase will affect local residents living on fixed incomes or below the poverty line. However, local wages are expected to increase for the working population.

These inflationary pressures are expected to be short-lived as the impact on the local economy passes and prices for goods and services stabilize. Long term benefits will also be experienced in the provision of additional public and private health care services and facilities.

Tourism, agriculture, fishing and apiculture are the principal natural resource-based activities in the area of the pulp mills. Such livelihoods are not likely will experience long term negative impacts as a result of the construction or operation of the two pulp mills as the need for new plantation areas to supply the mills will be minimal and the facilities will operate under Best Available Techniques, resulting in air and water emissions well below concentrations that are known to have any health effects.

A net benefit will result during the construction and, to a lesser extent, the operation phase, due to increased demand for agricultural, fishery, and apiculture products (milk, meat, vegetables, fish, honey, fruit etc). This increase in demand will benefit both the shop/ market owners primarily in Fray Bentos and farmers within the area of influence.

Tourism is well established in and around the area of the pulp mills. In Uruguay, the riverside beach at Las Cañas in the Rio Negro Department, and hot springs to the north of Paysandú province attracted more than 80,000 visitors in 2004 during the peak summer months of January to March. Approximately 80% of the tourists originate in Argentina.

Gualeguaychú in Argentina is also an important center of tourist activity attracting visitors to local beaches and the annual Carnival.

Potentially affects on the tourism sector include air and water pollution, visual effects, increased traffic (road and river), negative press resulting from controversy associated with an industrial development, and indirect positive impacts due to the increase of the number and quality of facilities (restaurants, accommodations). Impacts on recreation due to pollution will not likely occur as a result as all discharges from the mills will be below accepted air and water quality standards. Thus, visitors to the Las Cañas beach resort in Rio Negro and to Ñandubaysal beach resort in Gualeguaychú will not experience air quality, odour or water pollution impacts as a result of the pulp mills.

Botnia's plant will be a visible new feature in the landscape, especially for tourist traffic crossing the International Bridge en route to Las Cañas and other tourist destinations in Uruguay. ENCE's plant will also be visible from the bridge, but further away and less of a visual presence. The change to the landscape is a permanent impact, however the public's response to these new industrial features is subjective and may potentially change over time as the public becomes accustomed to the new landscape. Case studies have shown that tourism can co-exist with pulp mills.

Monitoring programs of air and water emissions already planned by the companies will assist in future assessments of social impact mitigation. In addition, Botnia has commenced a detailed social monitoring program based on a number of indicators. The

social and economic CIS assessment recommends that both companies co-operate in undertaking their monitoring programs. Specific monitoring program recommendations pertain to housing, policing, health care, education, employment, tourism, fishery resources, farm resources, and bee keeping. Generally, most of the monitoring is recommended for Fray Bentos, Río Negro, and Paysandú are on a quarterly, semi-annual, or annual basis.

Transportation

The transportation network in western Uruguay will be affected by the construction and operation of the Botnia and ENCE pulp mills. The two most important flows of traffic will be wood and other supplies delivered to the mills and pulp exported from the mills. In addition, there will be transport of personnel to and from the mills, and transport of domestic and hazardous waste to appropriate landfills.

The main modes of transport will be truck, barge or ship for wood and other supplies, and barge or ship for pulp. The operation of the two mills could result in a maximum of 650 additional barge trips per year on the Río Uruguay up to M'Bopicuá. This level of traffic would add an additional 1.8 barge trips per day to the existing 5.3 trips per day. Thus the increase in river traffic, when compared to traffic in 2004, will not be significant because the pulp export traffic will replace the current logs and wood chip volumes being exported or moved in river transport.

The impacts on the road network during construction of the two plants are not entirely additive since the construction for the Botnia mill will be winding down as construction for the ENCE mill will be gearing up. The impacts during the construction period that will be greatest in the immediate vicinity of each mill include a potential increase in road accidents, an increase in vehicular emissions, and increased demands for road maintenance. Both companies are developing management plans for road transportation in collaboration with the administration of the department of Río Negro.

The estimated annual average daily traffic (AADT) for the delivery of round wood to the Botnia mill is approximately 512, based on 256 daily return trips by truck on an annual basis between the mill and the surrounding forest plantations. The ENCE mill at full capacity will require approximately 137 return trips by truck per day, or an AADT of 274. These numbers imply a significant increase in truck traffic particularly on Highway 2 between the access road to the ENCE mill and the junction with the international bridge. There is a potential for congestion in this area, particularly at intersections. However, with the Botnia mill in place, wood transport to the port of Fray Bentos will be replaced by transport to the mill which will result in a significant decrease in truck traffic in the city itself.

The increase in truck traffic will require measures to control risks to pedestrians, including school children; the increase in truck traffic and traffic congestion can be minimized with dispatch systems that keep the trucks adequately spaced and also control speed; controlled spacing and continuously moving traffic should limit vehicle based air pollution; and the

need for more frequent road maintenance will result in increased costs to the affected department governments. Compensation methods to increase maintenance funding could be developed to charge users for the increased costs, by installing tolls with appropriate rates for log haulers.

Energy

Most of the wood by-products that are not converted to marketable pulp fiber are burned in the pulp mills to produce energy. The burning of black liquor in recovery boilers at both mills will also produce steam and electricity and enable the recovery of cooking chemicals. A biomass boiler at the ENCE mill will produce energy by burning bark and wood waste from wood preparation and primary sludge from the effluent treatment system.

Electricity from the national grid will be used during start-up of production, regular maintenance and unplanned shutdowns (about 15 days per year). Fuel oil will be required for the boilers (for start-up, shutdown and unbalanced conditions), the lime kiln, the incinerator of odourous gases, and for emergency power. However, Botnia is expected to produce a surplus of 35 MW and ENCE is expected to generate a surplus of 25 MW. The combined total of 60 MW could be sold to the grid when both mills are in operation. This is equivalent to around 500 GWh of energy to the national grid per year and would represent around 5% of electricity generation in Uruguay.

The electricity sold by the pulp mills to the national grid can be called green power because it is produced using biomass which is a renewable resource. The power sold by the mills to the national electricity grid can be considered to have a positive impact if it offsets environmental impacts associated with production of electricity by thermal power plants in Uruguay, Brazil or Argentina. The amount of surplus energy that may be sold to the national electricity grid is equivalent to more than the amount of energy consumed as fuel oil at the Botnia mill.

The collection and burning of wood waste to generate electricity would also virtually eliminate the environmental impacts associated with incineration of wood waste in low-technology burners or decomposition of wood waste in landfills.

Regional Development

The companies and local communities are working together to develop social and environmental action plans that will increase local and regional development opportunities as well as community programs and activities. These should result in net benefits related to education, training, employment opportunities, and improvements to community infrastructures relating to health care, recreation, and utilities. Alternatively, quality of life will be impacted both positively (increased wealth and services) and negatively (increased population, congestion, and demand for services). The companies are planning to institute a number of community communication actions to respond to problems as they may arise.

Environmental, Social, and Corporate Management Planning

Detailed environmental management plans are designed to cover all phases and activities of a development. Such plans are critical to ensuring that the results of the initial impact assessments are properly implemented and followed through with. They include specific actions to be taken with regard to on-going monitoring and responses to unplanned but predictable events; responsibilities and chain-of-command within the company; contact procedures (both in-plant and community, as required); staff actions to be taken (including both technical response and health and safety measures); reporting requirements; and follow-up. It is essential that such plans be kept up-to-date and they must be implemented via company policies which include staff orientation, education, and training (including simulations of events).

ENCE and Botnia are required to prepare environmental and social action plans (Plan de Acción Ambiental y Social – ESAP) as a requirement of their AAPs. These should cover both construction and operation phases and will be subject to approval by DINAMA. The ESAPs will include a summary of corporate environmental policies and specific project management plans for a variety of activities. In February 2006, Botnia provided a schedule for the completion of their ESAP. Most elements will be completed by the time the mill commences operations. The components of Botnia's ESAP include:

- Integrated Management System for Environmental + Occupational Health & Safety issues and achieve certification to ISO 14001 + OHSAS 18001;
- Hazardous Material Management Plan;
- Emergency Response Plan to cover expected emergency events and impacts on plant and on the surrounding communities;
- Transportation Plan including road and river transport of wood and pulp all the way to the export terminal;
- Community Development Plan to guide future community based actions;
- strategy and detailed plan for conservation areas set aside;
- detailed design and operational procedures for the solid waste landfill;
- implementation of the groundwater monitoring program in FOSA owned plantation holdings; and
- demonstration that IFC's standards on environmental and social impact assessment, as well as on issues of occupational health and safety, are fully met at the site to be used primarily for pulp exports.

A social and environmental action plan was prepared by ENSE in 2006 (August 2). This document provides a summary of corporate management policies pertaining to environmental and social responsibilities and to health and safety. Specific plans within their ESAP include:

- Pollution Abatement and Prevention;
- Construction Management;
- Hazardous Materials Handling;
- Emergencies;
- Transportation;
- Community Development Plan;
- Natural Resource Conservation;
- Solid Waste Management;
- Hydrological Resources;
- Environmental Monitoring; and
- Public Communication and Consultation.

Public Disclosure

ENCE and Botnia are committed to ensuring that data pertaining to the operation and potential influence of the mills is readily available for public dissemination and is in a form that the lay public can understand. As required, all routine monitoring program data will be provided to DINAMA at which time the information will be in the public domain. The mills should also disseminate key performance data in a proactive manner. DINAMA has also required that each company participate in a "Follow-Up Committee" once operations have commenced. These committees will be presided over by the Ministry of Housing, Territorial Planning, and Environment (MVOTMA), and will be made up of various governmental entities and representatives of the local communities. The committees will allow both the government and the local community to access information about the environmental impacts of the mills. In addition to the committees, the mills should use a public community centre in Fray Bentos, or similar mechanism, as a means to distribute information pertaining to effluent and air quality data as well as other environmental and health and safety information.

Effluent flow, COD, conductivity, and TRS data will be reported to the public to reflect daily operating performance. It is also proposed that acute toxicity data be reported to demonstrate the continued non-toxicity of the effluent. Along with the data itself, regulatory criteria (if applicable) and measures of "typical" mill performance will also be shown for comparative purposes.

Receiving environment quality data generated by the proposed routine monitoring will also be reported to the public in a timely manner. It is suggested that data for a few key water quality parameters (e.g., conductivity, dissolved oxygen, nutrients) be tracked and shown graphically as data permit for a subset of the proposed sampling stations such as for the stations upstream and downstream of the mill discharges, Yaguareté Bay, and the water

intake for the City of Fray Bentos. Other routine monitoring data (fish, benthos) would be available on a regular but less frequent basis (as defined by the proposed schedule for each), and would be brought forward when available. It is suggested that a quarterly information circular be used to track the environmental performance at the mills, summarize real time data that are also provided as stand-alone performance indicators, and describe major mill events that may have occurred. The internet should also be used to distribute this information to help broaden public/stakeholder access and hardcopies (paper) and electronic copies of all receiving environment and effluent-related studies should be maintained in a catalogued library at the proposed public information centre in Fray Bentos.

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1.0 INTRODUCTION

[Explanatory Note: Given an announcement by ENCE's President on September 21, 2006 indicating the company's intention to relocate, it is now not clear when or where ENCE may initiate operation of a pulp mill in Uruguay. This CIS was initiated well before this announcement and is based on the presumption that ENCE would initiate production at the Fray Bentos site.]

Uruguay's economy is characterized by an export-oriented agricultural sector, a well-educated workforce and high levels of social spending. Well into the 1980s, the economy was heavily dependent on livestock products and the vulnerability of this sectoral dependency was demonstrated when a two-year drought in 1988-1989 decimated the livelihood of livestock producers. In order to diversify the economy, and with the help of multilateral donors, successive Uruguayan governments have promoted the development of the forest products sector as a mainstay of its economy over the past two decades. With the successful development of forest plantations to provide a supply of fiber, Uruguay is now encouraging the next step of domestic production of wood pulp.

Beginning in the mid-to-late 1980s, a number of studies were carried out to support the planning for the forestry sector development in Uruguay that is now unfolding. These studies were funded by several multilateral and bilateral funding agencies, including the World Bank, Japan International Cooperation Agency (JICA), Inter-American Development Bank (IADB), the US Export-Import Bank, and the US Overseas Private Investment Corporation (OPIC), among others. The World Bank provided funding for initial economic sector work and for technical assistance in developing forestry sector regulations, and continues to be involved in funding the Forest Products Transport Project. This ongoing project has been supporting significant improvements in, and maintenance of, primary and secondary roads used to deliver round wood and sawn wood from plantation areas to key ports such as Fray Bentos and Montevideo for export.

Two major European pulp producers are now planning pulp mill projects on the left bank of the Río Uruguay upstream near the city of Fray Bentos, the capital of the western Uruguayan department of Río Negro. Wood supply to the plants will come primarily from plantations developed in western Uruguay for this purpose. Pulp will be exported by ocean-going freighter to paper producing plants in Europe, Asia and other regions.

Oy Metsä-Botnia Ab from Finland (Botnia), is developing the Orion project and Grupo Empresarial ENCE S.A. (ENCE), from Spain, is developing the Celulosas de M'Bopicuá (CMB) project. Both have prepared and publicly disclosed environmental and social assessments that describe the expected impacts of their projects and the mitigation and enhancement measures to manage those impacts. In addition to public consultations undertaken following the release of their assessments, both companies have ongoing programs to engage with their respective project's stakeholders.

1.1 Locations and Setting

Figure 1.1-1 indicates the location of each project. The photographs in Figures 1.1-2a and 1.1-2b provide the development of the sites as of August 2006. Figure 1.1-3 provides an artist's illustration of the two proposed plants when fully operational.

The Botnia mill is located alongside the Río Uruguay approximately 5 km upstream (east) of the city of Fray Bentos on a greenfield site adjacent to the Uruguayan end of the Libertador General San Martin International Bridge that connects Argentina and Uruguay. The Río Uruguay forms the international boundary between Uruguay and Argentina in this region. As shown in the photograph in Figure 1.1-2a, the site is under development with the port, stack and civil structures near completion.

The ENCE mill is located approximately 11 km upstream (east) of the city of Fray Bentos on a site that currently contains a wood chipping plant and port facilities of the Terminal Logistica de M'Bopicuá, which were developed in 1998. The chipping plant converts whole or round logs that are trucked to the plant from surrounding eucalyptus and pine plantations into wood chips, which are then exported for processing into pulp at offshore locations. As shown in the photograph in Figure 1.1-2b, the site is presently being prepared for construction.

1.2 Overview of the Projects

Botnia and ENCE are each proposing to develop a bleached Kraft pulp mill designed to produce approximately 1,000,000 tons of air dried pulp on an annual basis (ADt/a) and 500,000 ADt/a, respectively.

Pulp is a processed fibre derived from wood that can be used for making paper and other products. The wood source for these projects will be established eucalyptus plantations within western and central-north Uruguay. The wood is processed by mechanical chipping, screening, cooking, bleaching and drying to separate the wood fibre from the water and lignin (natural glue that holds the fibre together in the wood) to produce pulp. The pulp will be exported to markets in Europe, Asia and other countries.

In addition to the pulp mills, the projects include infrastructure for the supply of raw materials, water and energy, and for the storage, transport and disposal of waste and primary and final materials. Overall, the projects include the following infrastructural components: the Orion and CMB bleach Kraft pulp mills; the existing port facility for the ENCE mill and a newly constructed port facility for the Botnia mill; mostly existing plantation areas within Uruguay; water intake and wastewater discharge structures within the Río Uruguay; and workers accommodation facilities within the neighboring city of Fray Bentos.

1.3 Economic Development

Uruguay is characterized by the Inter-American Development Bank as a stable democratic system, with sound public institutions, and having one of the highest degrees of legitimacy in the region (Inter-American Development Bank, IDB Country Strategy with Uruguay, 2005-2009). These characteristics are considered assets by which to attract foreign investment and to further economic growth.

The economy of Uruguay has evolved over the past half century. The Uruguayan economy reached 3.2% of the regional gross domestic product (GDP) during the 1950s, but consistently declined down to 0.8% of the regional GDP by 2001. Proactive measures over the past several years have stimulated economic growth and the potential for recovery. To further its development, Uruguay identifies the need to[1]: strengthen international integration; expand exports; increase investment; develop its natural and human resources; increase and improve the production and service sectors; incorporate increased value-added processing through technology; stimulate innovation; and increase employment. Uruguay also identifies the need to diversify its economy through further foreign trade and commercialization of products related to livestock and agriculture.

Forestry is becoming one of the most important and expansive sectors of the Uruguayan economy. In spite of a climate particularly favorable to the growth of forests, Uruguay has begun to develop its own forestry sector only in the last 20 years. Today, Uruguay is producing several million tons per year of wood, which is being exported to markets in Europe, Asia and other parts of the world. Since 2001, this economic base has broadened to include the industrialization of wood products by processing wood chips for export. This base is now being further expanded by the direct foreign investment by ENCE and Botnia to build and operate their first two pulp mills in Uruguay. These mills will process wood harvested from Uruguayan forest plantations into pulp for export.

These mills represent the largest foreign investment in the history of Uruguay, and are considered an integral part of the country's strategic objectives for economic recovery. The mills will provide economic benefit through investment and creation of jobs, both directly and indirectly. Other companies have already begun to invest in response to contracts for supplies and services with the mill proponents. There is also considerable evidence of technological know-how being transferred from foreign suppliers to the local industry.

[1] Affidavit of Martín Ponce de Léon, Undersecretary of the Ministry of Industry, Energy and Mining in the Government of the Republic of Uruguay, Observations of Uruguay, Exhibit 3, International Court of Justice, the Hague, 13 July 2006.

1.4 Regulatory Context

There is considerable evidence indicating that ensuring protection of the environment is a high priority for Uruguay[2]. The Constitution of Uruguay, particularly Article 47, recognizes water as a natural resource that is essential for life and is therefore to be protected, and recognizes access to drinking water as a fundamental human right. These principles are the foundation upon which all water protection laws in Uruguay are based. The Department of the Environment (Dirección Nacional de Medio Ambiente, DINAMA), as part of the Ministry of Housing, Territorial Planning, and Environment (i.e., Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente, MVOTMA), is the agency directly responsible for the administration and enforcement of the environmental laws and regulations of Uruguay.

The specific laws and regulations are intended to ensure that industrial sources, including the ENCE and Botnia mills, do not cause unacceptable impacts to the water, air and other environmental media. They prohibit all facilities and activities from causing environmental harm, establish environmental standards for water bodies, and set forth detailed discharge limitations.

Specific laws also require project proponents to conduct an Environmental Impact Statement (EIS) which describes the project, evaluates the potential environmental effects, and proposes monitoring plans and mitigation strategies. The mill proponents have submitted comprehensive EISs for their respective projects. The EIS for the ENCE project was submitted to DINAMA on 08 January 2003 and, following review by DINAMA, was publicly released on 26 May 2003. A public hearing on the EIS was held in Fray Bentos on 21 July 2003. For the Botnia project, the EIS was submitted to DINAMA on 31 March 2004 with supplementary information and analysis provided on a range of topics including the cumulative impacts of the two mills in relation to water, air and odour. The EIS for the Botnia project was released to the public on 06 December 2004, and a public hearing was held in Fray Bentos on 21 December 2004. The consultation was announced in local newspapers and on radio and TV stations in the Fray Bentos area, including the adjacent towns, as well as across the river in the city of Gualeguaychú, Argentina.

Following DINAMA approval of the EIS, and after all Uruguayan conditions were met, the proponents were granted a “Previous Environmental Authorization” (Authorización Ambiental Previa (AAP)) for the project. The AAPs are an initial authorization for the mills. Separate authorizations are required for each phase of construction and before start-up of operations. The AAPs were granted by DINAMA on 09 October 2003 and 14 February 2005 for ENCE and Botnia, respectively, in compliance with the regulation for

[2] Affidavit of Alicia Torres, National Director for the Environment, Department of the Environment (DINAMA), Ministry of Housing, Territorial Planning, and Environment (MVOTMA), Observations of Uruguay, Exhibit 1, International Court of Justice, the Hague, 2 June 2006.

environmental impact assessment (Reglamento de Evaluacion del Impacto Ambiental). The AAPs impose certain restrictions on the mills, specifically: compliance with all effluent limitations set forth in Uruguayan law (i.e., Decree 253/79); compliance with limits on other water quality parameters (e.g., AOX, nitrogen and nitrates); and compliance with the commitments made in their respective EISs.

The AAPs also require the mills to comply with international surface water quality standards developed by the Administrative Commission of the Río Uruguay (Comision Administradora del Río Uruguay, CARU). These water quality standards are approved by the Governments of Argentina and Uruguay and are considered by these Governments as acceptable and adequately protective of the aquatic environment of the Río Uruguay.

For the construction and operation phases, the project proponents are required to submit detailed Environmental Management Plans (Plan de Gestión Ambiental, PGA) identifying the specific means by which negative environmental impacts will be avoided, and including plans for: mitigation and compensation measures; monitoring and reporting; prevention of accidents; emergency response; and abandonment. Additional requirements and safeguards may be stipulated by DINAMA at this time. To date, ENCE has received authorization to commence earth movement to prepare the site for further construction of the mill and associated infrastructure, and Botnia has received authorization to construct the port, stack, concrete plant, foundations, bleached cellulose plant, wastewater treatment plant, and to operate the harbor terminal during the construction phase of the mill.

A separate authorization is required before operations can begin. The Environmental Authorization of Operation (Autorización Ambiental de Operación, AAO) will only be issued after construction is complete and a compliance monitoring plan has been submitted and approved. To ensure that operating standards and procedures continue to be compliant with BAT and any revisions in Uruguayan regulatory requirements, the mills must request a renewal of their AAO every three years. Furthermore, at each renewal, Decree 349/005 empowers DINAMA to impose additional protective conditions on the project proponent, if additional requirements and safeguards are considered necessary.

1.5 Opposition to the Pulp Mills

The conflict between Argentina and Uruguay concerning the two mills has affected diplomatic relations, transportation, trade and tourism between two countries that have shared a long history and brotherhood. Argentina and Uruguay have jointly managed the Río Uruguay since 1975. Opponents of the two pulp mills are concerned that the pulp mills will harm human health, the environment and the region's economy. Protests by Argentine residents and environmental groups from Argentina and Uruguay have included blocking routes to international bridges, with the longest blockade lasting 45 days.

In May 2006, Argentina filed a formal complaint before the International Court of Justice (ICJ) of The Hague, accusing Uruguay of violating the Río Uruguay treaty by unilaterally

authorizing the construction of the two pulp mills on the Río Uruguay without prior consultation and consent with and from Argentina. Argentina also sought provisional measures requesting that construction be immediately suspended prior to a final ruling by the ICJ on the merits of the Treaty violation case. In July 2006, the ICJ ruled that there was not enough evidence to stop construction of the pulp mills (refusing to grant provisional measures). The judges at the ICJ found, by 14 votes to 1, "nothing in the record to demonstrate that the very decision by Uruguay to authorize the construction of the mills poses an imminent threat of irreparable damage to the aquatic environment of the River Uruguay or to the economic and social interests of the riparian inhabitants on the Argentine side of the river".

In August 2006, Uruguay presented its claim for damages against Argentina at the Mercosur (Southern Common Market) Tribunal for the blockades that allegedly cost the Uruguayan economy 400 million US dollars. Uruguay claimed that Argentina did not act to end the blockades and requested that Argentina take action to prevent future blockades. In September 2006, the Mercosur Tribunal found that Argentina did not take necessary action to guarantee free circulation of goods and services into Uruguay. However, the ruling did not specify obligations for future conduct if blockades resume nor define compensation for losses arising from the blockades.

1.6 The Cumulative Impact Assessment

The International Finance Corporation of the World Bank Group (IFC) is currently assessing the two pulp mill projects in Uruguay for financing. In addition, the Multilateral Investment Guarantee Agency (MIGA) is evaluating whether to provide political risk insurance to the Botnia mill.

To complete the assessment of the combined environmental and social impacts of the two proposed mills, IFC commissioned a Cumulative Impact Study (CIS) of the construction and operations of the two pulp mills and their respective raw material sourcing. The draft CIS was prepared by Pacific Consultants International and Malcolm Pirnie Incorporated and released in December 2005. Following a period of public review and professionally facilitated consultations in Argentina and Uruguay, the IFC commissioned a panel of independent experts to review existing project documentation and all comments provided by stakeholders. The results of this review are summarized in a report issued by the independent experts in April 2006. The report, referred to as the Hatfield Report, also identifies additional information and analysis required to complete the environmental assessment for the two mills.

EcoMetrix Incorporated (EcoMetrix) and its consultants, SENES Consultants Limited (SENES) and Processys Incorporated (Processys), revised the draft CIS in response to the recommendations of the Hatfield Report, the published Terms of Reference, original research and modelling, stakeholder commentary and other project related documentation. This report specifically addresses the following:

- Project Description – describes each project, including a description of: wood supply; project features; plant site selection; the Kraft process; ECF bleaching processes; emission and effluent characteristics; and project schedule and timelines;

- Environmental and Social Setting – presents an overview of the land features, air environment, aquatic environment and social setting to provide context for the project and a basis to assess potential change in the environmental and social state due to the proposed projects;

- Cumulative Effects Assessment – provides a detailed discussion of the potential change to the physical, biochemical and social environment resulting from the two projects; and

- Management Plan – provides the management plan for the two projects, including monitoring and reporting.

The CIS report is supported by a series of accompanying annexes that provide further information to support the assessment of cumulative effects. These annexes include the following:

- Annex A, Process Technologies – describes the process technologies for each mill and examines whether the mills are being designed using best available techniques;

- Annex B, Plantation – provides information regarding the adequacy of wood supply for the two mills and assesses the social and environmental effects of the plantation;

- Annex C, Air Quality Assessment – provides an assessment of the potential change in air quality within the neighbouring areas of Argentina and Uruguay resulting from the mill operations and compares the results to ambient air quality standards and odour detection thresholds;

- Annex D, Water Quality Assessment – provides an assessment of the potential change in water quality within the Río Uruguay and assessment of the potential effect on aquatic life and environmental quality;

- Annex E, Socio-Economic Assessment – provides base-line socio-economic and demographic information, an assessment of possible social impacts (e.g., health, education, housing, quality of life and public security), and a monitoring program;

- Annex F, Transportation – provides an assessment of how the road network and Rio Uruguay will be affected by the transport of wood and pulp for the mills;

- Annex G, Public Engagement – provides the stakeholder assessment prepared by Consensus Building Institute (CBI) in December 2005;
- Annex H, Terms of Reference – presents the published terms of reference for the draft and revised CIS report, and a copy of the Hatfield Report;
- Annex I, Glossary – presents a glossary of technical terms used throughout the CIS report and annexes.

1.7 Project Team

The CIS report was prepared by a diverse team of specialists as outlined in Table 1.7-1.

1.8 Cross Reference to the Hatfield Report

The issues identified in the Hatfield Report are crossed referenced to the CIS report and accompanying annexes in Table 1.8-1. The Hatfield Report is provided in Annex H.

Table 1.7-1: Project Team

Company / Personnel	Title / Other Role
EcoMetrix Incorporated	
Bruce Rodgers, M.Sc., P.Eng.	Project Manager; Aquatic assessment
Don Hart, Ph.D.	Senior Advisor; Aquatic assessment
Dean Fitzgerald, Ph.D.	Specialist; Aquatic assessment
Brian Fraser, M.Sc.	Specialist; Aquatic assessment
Janeen Tang, M.E.S.	Project coordinator
Processys Incorporated	
Paul Stuart, Ph.D., P.Eng.	Senior Advisor; Process technology
Peter Gleadow, B.Sc., P.Eng.	Specialist; Process technology
Jean-Martin Brault, M.Sc., P.Eng.	Specialist; Process technology
SENES Consultants Limited	
James Young, Ph.D.	Senior Advisor; Air quality assessment
Gwen Brice, B.Sc.	Senior Advisor; Socio-economic assessment
Michael Sills, Ph.D.	Project coordinator
Rich Urbanski, M.B.A.	Specialist; Air quality assessment
Dan Hrebenyk, M.Sc.	Specialist; Air quality assessment
Zivorad R. Radonjic, B.Sc.	Specialist; Environmental meteorology
Ana Luisa Covarrubias, M.Eng., M.B.A.	Specialist; Economic assessment
Harriet Phillips, Ph.D.	Specialist; Human health assessment
Independent Consultants	
Ismael Piedra Cueva, Ph.D.	Senior Advisor; Hydrodynamic model
Mónica Fosatti, M.Sc.	Specialist; Hydrodynamic model
Pieter Prange	Specialist; Plantation assessment
Daryl Cowell, M.Sc.	Specialist; Plantation assessment

Table 1.8-1: Cross Reference to the Hatfield Report

	Cross Reference to Expert Panel Report		Sections Headings for the CIS Report	Annex
A1	general lack of information	2.5	Bleached eucalyptus kraft pulp mill processes	A
A2	verification of discharge estimate	2.7	Evaluation of Emissions and Effluents	A
A3	comparison of mills with BAT	2.5	Bleached eucalyptus kraft pulp mill processes	A
A4	effluent treatment	2.5	Bleached eucalyptus kraft pulp mill processes	A
A5	effluent dioxin and furan	2.7	Evaluation of Emissions and Effluents	A, D
A6	minor factual inaccuracies	2.7	Evaluation of Emissions and Effluents	A
A6	minor factual inaccuracies	4.2	Plantations	B
A7	reference to European standards	2.7	Evaluation of Emissions and Effluents	A
A8	public criticism of air modeling	4.4	Air quality impacts	C
A9	expert's criticism atmospheric emissions modeling	4.4	Air quality impacts	C
A10	air quality - Argentina	4.4	Air quality impacts	C
A11	overview river water quality/aquatic resources	3.2	Overview of the Aquatic Environment	D
A12	the bay downstream of the Orion mill	4.6	Water quality impacts	D
A13	Fray Bentos water intake	4.6	Water quality impacts	D
A14	effluent and endocrine disrupting compounds	4.6	Water quality impacts	D
A15	effluent dioxin/furan and fish tissue	4.6	Water quality impacts	D
A16	effluent plume dispersion	4.6	Water quality impacts	D
A17	tourism	4.9	Tourism	E
A18	plantation - biodiversity	4.3	Biodiversity and Natural Habitats	B
A19	plantation - water management	4.3	Biodiversity and Natural Habitats	B
A20	elemental chlorine free versus totally chlorine free	2.6	ECF vs. TCF Bleaching Processes	A
A21	fish tainting	4.6	Water quality impacts	D
A22	effluent color and pH	4.6	Water quality impacts	D
A23	mill site selection	2.3	Selection of Mill Sites	A
B1	Monitoring of wastewater effluent discharge	5.1	Environmental and Social Monitoring	A, D
B2	Air monitoring	5.1	Environmental and Social Monitoring	A, C
B3	Confirmation studies on plume modeling	5.1	Environmental and Social Monitoring	D
B4	Toxicity-free effluent	5.1	Environmental and Social Monitoring	D
B5	Health impact			C
B6	Health standards for sulfur dioxide			C
B7	Regional energy balance	4.11	Energy	A
B8	Wood waste incineration	4.4	Air quality impacts	A
B9	Treatment of Fray Bentos municipal sewage	4.6	Water quality impacts	D
B10	Effluent/atmospheric discharges in a local context	2.7	Evaluation of Emissions and Effluents	A, C, D
B11	Effluent and atmospheric emission limits	5.1	Environmental and Social Monitoring	A
B12	Continuous monitoring of environmental parameters	5.1	Environmental and Social Monitoring	A
B13	Regular monitoring of effluents	5.1	Environmental and Social Monitoring	A
B14	Public access to information on mill discharge	5.3	Public disclosure	D
B15	Operating procedures and training	5.2	Environmental, social corporate management	
C1	Recycling alkaline effluent from the bleach plant	2.5	Bleached eucalyptus kraft pulp mill processes	A
C2	BAT and Eucalyptus pulp mills	2.5	Bleached eucalyptus kraft pulp mill processes	A
C3	Incineration of high-volume low-concentration	2.5	Bleached eucalyptus kraft pulp mill processes	A

Table 1.8-1: Cross Reference to the Hatfield Report (cont'd)

Cross Reference to Expert Panel Report		Sections Headings for the CIS Report		Annex
C4	Oxygen delignification	2.5	Bleached eucalyptus kraft pulp mill processes	A
C5	ECF bleaching with low AOX	2.5	Bleached eucalyptus kraft pulp mill processes	A
C6	"Low odor" design recovery boiler	2.5	Bleached eucalyptus kraft pulp mill processes	A
C7	Tanks to contain spills	2.5	Bleached eucalyptus kraft pulp mill processes	A
C8	Biological effluent treatment	2.5	Bleached eucalyptus kraft pulp mill processes	A
C9	Life of plants versus landfills	2.5	Bleached eucalyptus kraft pulp mill processes	A
C10	BAT 2006 - Effluent flows	2.5	Bleached eucalyptus kraft pulp mill processes	A
C11	BAT 2006 - Partial replacement of chlorine dioxide	2.5	Bleached eucalyptus kraft pulp mill processes	A
C12	Overly conservative estimates of discharges	2.5	Bleached eucalyptus kraft pulp mill processes	A

Figure 1.1-1: Location of Projects

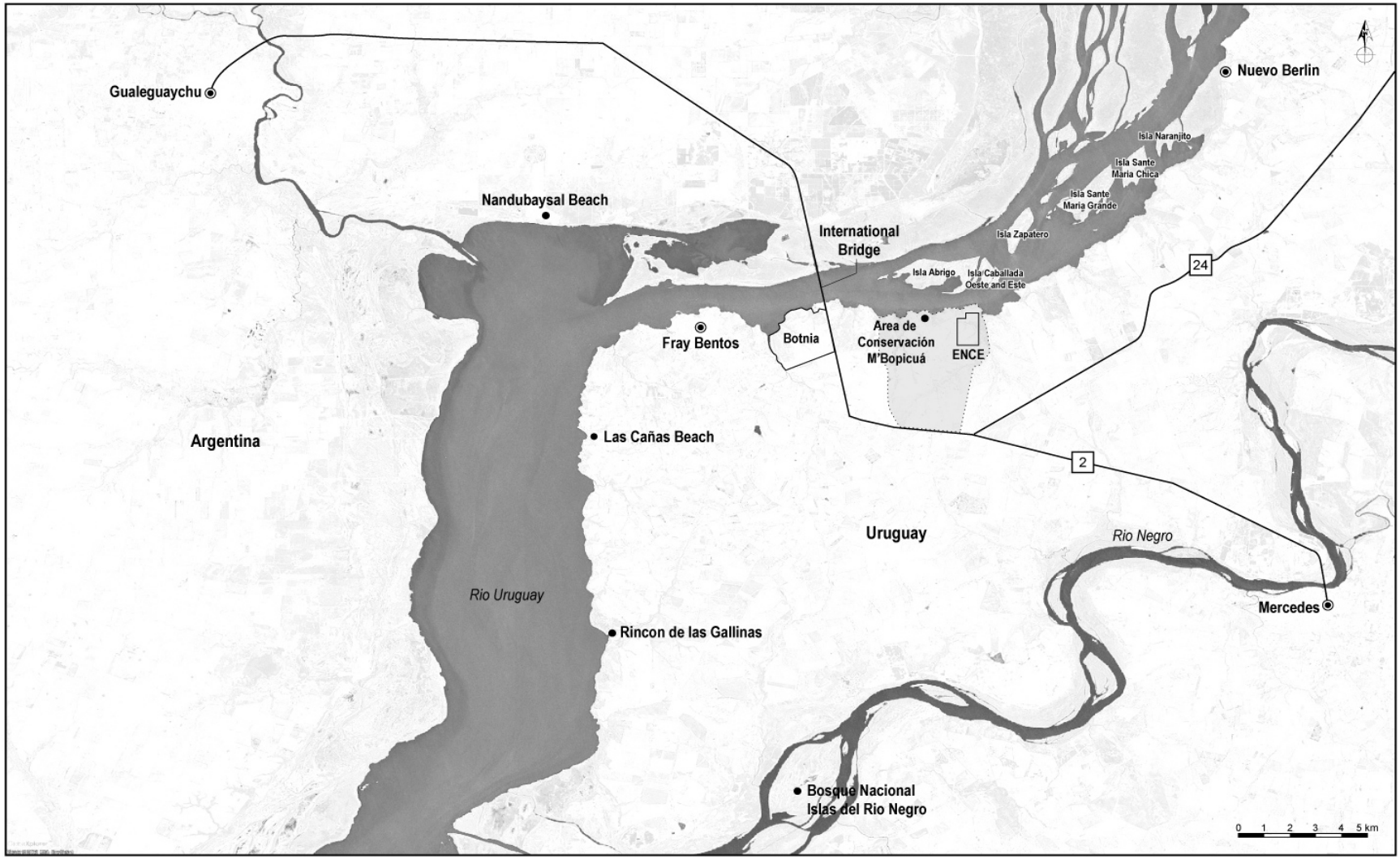


Figure 1.1-2a: The Botnia Site, August 2006

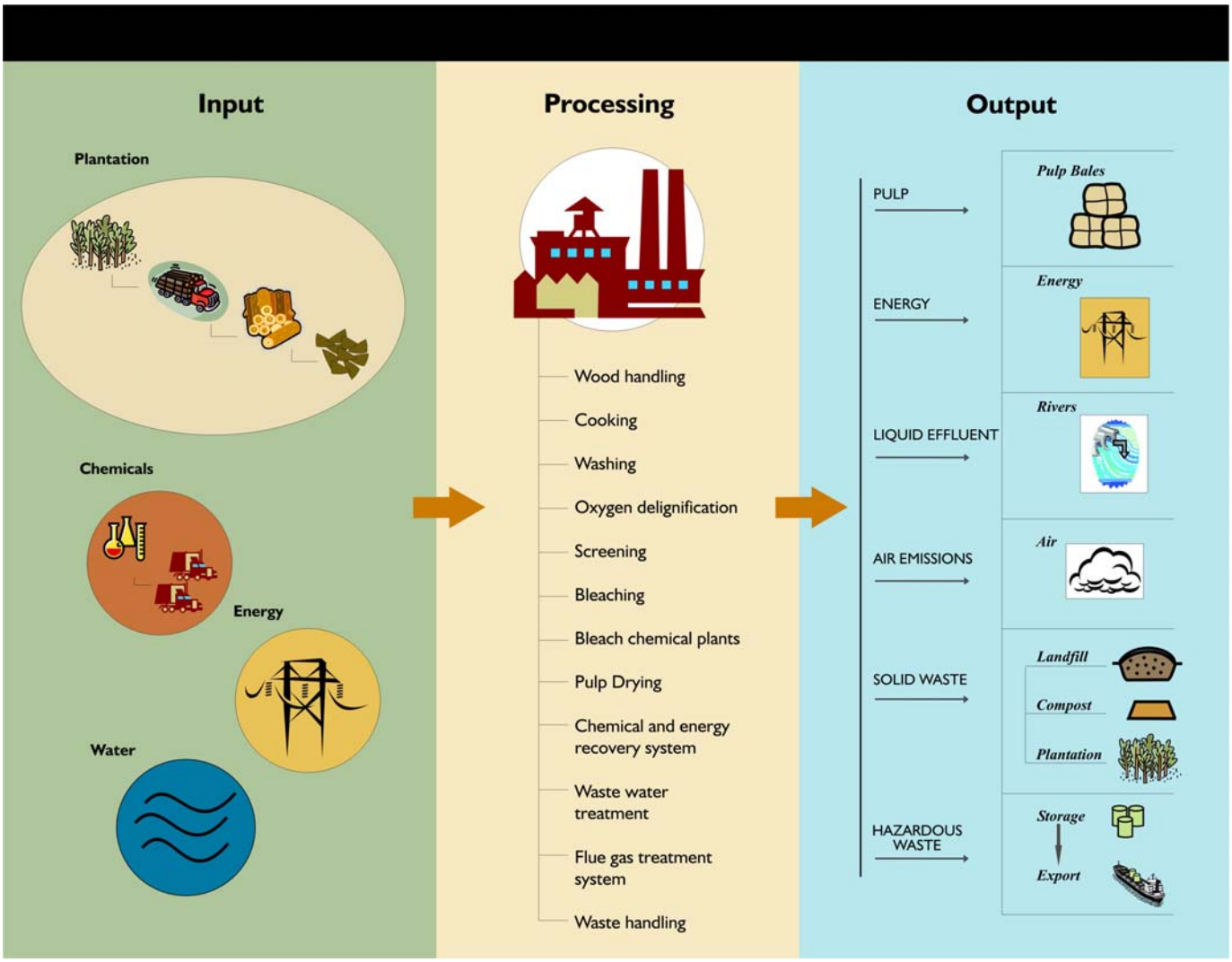
Figure 1.1-2b: The ENCE Site, August 2006

Figure 1.1-3: Illustration of Final Aspect of the Botnia and ENCE Sites

2.0 PROJECT DESCRIPTIONS

Botnia and ENCE are each proposing to develop a bleached Kraft pulp mill designed to produce 1,000,000 and 500,000 ADt/a, respectively. In addition to the pulp mills, the projects include infrastructure for the supply of raw materials, water and energy, and for the storage, transport and disposal of waste and primary and final materials. These project components are schematically represented in Figure 2.0-1, and are described in further detail in the following sections. Annex A, Process Technologies, and Annex B, Plantations, provide further detail on each project.

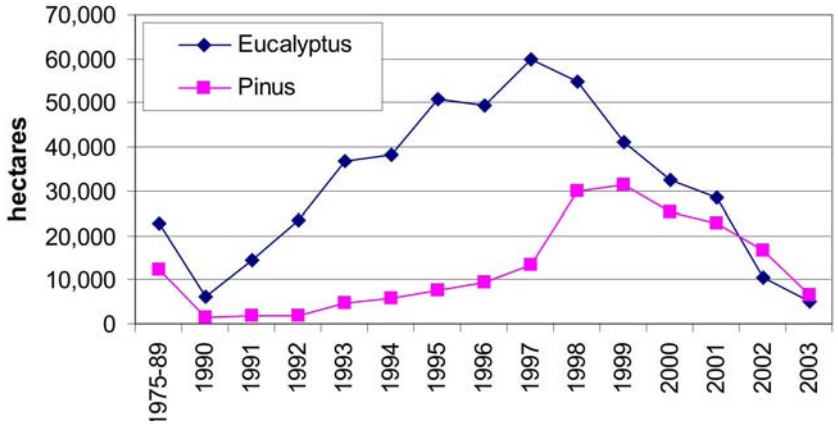
Figure 2.0-1: Schematic of the Pulp Mill Projects



2.1 Wood Supply

The two pulp mills are designed to produce pulp primarily from wood sourced from eucalyptus plantations that began to be established in Uruguay in the late 1980s in response to the Uruguayan Forestry Act of 1987. World Bank funding provided technical assistance to the Government of Uruguay in developing appropriate regulations for creating a higher value forestry industry to complement the existing agriculture and cattle ranching, and to develop a road network to facilitate the export of forest products. By the end of 2003, over 470,000 ha of suitable land for forest production were in eucalyptus production. Approximately 77% of the commercial forest plantations developed in Uruguay are subject to the Government's forestry promotion legislation, which requires each plantation operator to have an approved forest management plan. The wood supply for the two mills will come from company owned plantations and third party suppliers. All of the company owned plantations and most of the plantations owned by independent suppliers to the mills are certified through the Forest Stewardship Council's (FSC) sustainable forest management certification system.

Figure 2.1-1: Plantation Establishment in Uruguay 1975 to 2003



Source: Dirección Forestal

Establishment of new eucalyptus plantations peaked in Uruguay in 1997 at approximately 60,000 ha, but fell to an annual rate of less than 10,000 additional ha in 2003 (Figure 2.1-1).

As outlined in Annex B to this report, at full production, Botnia's plant will require 3.5 million m^3 of eucalyptus per year and ENCE's plant approximately 1.7 million m^3 for a total of 5.2 million m^3 per year. This production level will require approximately 17,500 ha/year and 8,500 ha/year, respectively of plantation area and a total of 208,000 ha over an eight year rotation cycle. Production will be lower during the first eight years of operation as the mills gradually reach their full output levels and during this period an estimated 175,000 ha of

eucalyptus plantations will be required. In the western and center-north areas of Uruguay, within convenient transportation distance of the pulp mills, are approximately 260,000 net ha of plantation. Both companies anticipate that supplies from their own lands, along with those from third party contractors will be sufficient to ensure adequate supply within an economically viable range for transport.

Figure 2.1-2 shows plantation areas in the region of Uruguay that will supply wood to the pulp plants. Short-term shortages resulting from unforeseen events and possible age/harvesting relationships in available plantations may require some sourcing of wood from Argentina. The economic viability of this imported fibre will depend on the relative price competitiveness of this wood versus other sources available from Uruguayan plantations located beyond 150 km or so of the mills.

Both ENCE and Botnia are committed to ensuring that their own and associated supplier plantations are sustainably managed and do not have detrimental environmental and social impacts. The companies are requiring their suppliers to obtain independent certification of their forest management practices, through Forest Stewardship Council (FSC) certification.

There is increasing market pressure on international pulp producers to demonstrate that their product comes from environmentally and socially sustainable forests. In order for these companies to compete in the European market place, which is increasingly demanding a “green label” for forest products, manufacturers of those products need to ensure that their products are certified, and that this certification is maintained.

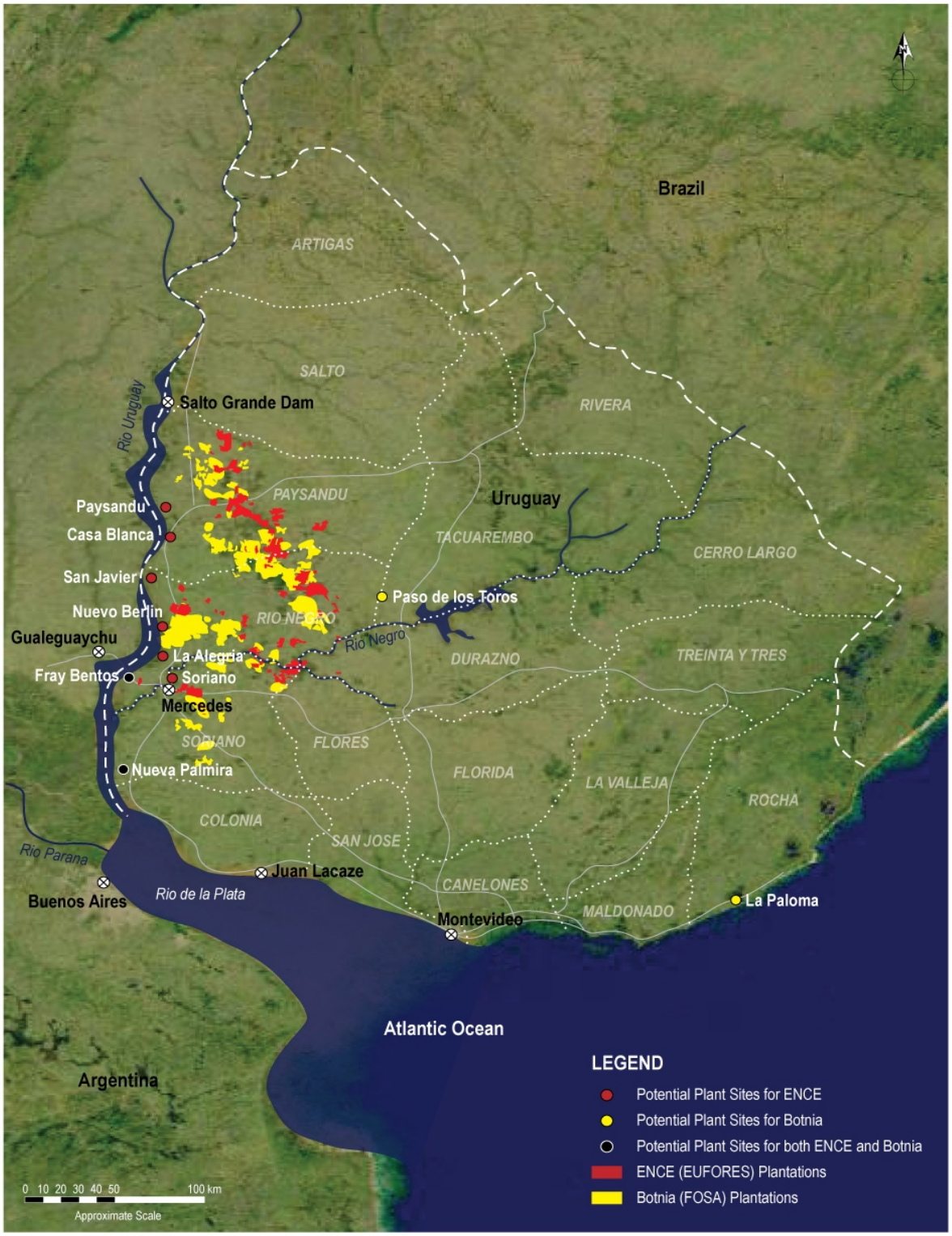
Both projects plan to transport wood from their respective plantations to their mills by truck. Some of the wood materials such as bark, branches and tops, not used in the pulping process may be removed in the field and left for compost, or, if removed at the mill, may be returned to the plantations or burned in the bark boiler.

In addition, plant equipment and machinery as well as certain chemicals utilized in the plants’ operations will be brought to the sites by truck; others will come by barge (sea and river transport).

All of the pulp produced at both mills will be exported from Uruguay by ocean going vessels. Botnia is planning to first barge all of its pulp to a port at Nueva Palmira or Montevideo where it will be transferred into larger vessels. ENCE will partially load ocean going vessels at the TLM facility adjacent to its proposed plant site and top them off at Montevideo port (which will receive the product by barge or truck).

An estimated 1.5 million tons of pulp (1 million tons produced by the Orion mill, 500,000 tons produced by the CMB mill) will be transported on the Río Uruguay from the two plants combined each year. The amount of traffic required to move this tonnage will be nearly fully offset by the decrease in river traffic of pulp log and woodchip exports that are estimated to be of comparable volumes by the time the projects start operations.

Figure 2.1-2: Plantations Supplying the Projects



2.2 Project Features

The general features of the two projects are summarized in Table 2.2-1.

Table 2.2-1: General Features of the Projects

	BOTNIA - ORION	ENCE - CMB
Property surface area (hectares)	550	2,200
Project surface area (hectares)	80	55
Estimated investment (US$ million)	1,100	500
Annual Production (ADt/y) (tonnes of air-dried pulp per year)	1,000,000	500,000
First year in production (projected)	2007	2009
Service life (in years)	40	40
Wood consumption (millions of m^3ssc/year)	3.5	1.7
Species	*Eucalyptus grandis* mainly and *Eucalyptus dunnii*. During first years, also *E. globulus* and *E. maidenii* will be processed.	During first 4 years, *Eucalyptus globulus* spp *globulus*, *maidenii* and *bicostata*, and *Eucalyptus grandis*. After this period, 100% *Eucalyptus globulus* will be processed.
Raw material transport (wood, fuel, chemical products, finished product)	Trucks, railroad, and/or cargo or barge. Project includes a harbor construction.	Road transportation of chemical products (to be defined). Chips are conveyed to silos by means of conveyor belts from M´Bopicuá Wood Park. Pulp shipment (on cargo) in TLM.
Process water supply	Río Uruguay	Río Uruguay
Effluent receiver	Río Uruguay	Río Uruguay
Effluent volumes (absolute and per unit of production)		
Flow (m^3/ADt)	25	29
COD (kg/ADt)	8.0	8.7
BOD_5 (kg/ADt)	0.3	0.6
AOX (kg/ADt)	0.08	0.1
N (kg/ADt)	0.15	0.17
P (kg/ADt)	0.012	0.017
SS (kg/ADt)	0.7	0.9
Air emissions		
Particulate or dust (kg/ADt)	0.30	0.34
SO_2 (as S) (kg/t)	0.30	0.23
NO_x (kg/t)	1.35	1.3
TRS (kg/t)	0.05	0.03
Greenhouse Gases (tonsCO_2/year)	1,700,000	1,544,000
Generated Power (MW)	119	72
Electrical Power consumption (MW)	71.5	41
Excessive Power (MW) (not including chemical production)	47.5	31
Power Boiler (biomass)	No	Yes
Brightness (% ISO)	89-92	91
Employment – peak construction period	4,200	5,050
Direct employment -- operations	300	300

2.3 Selection of Mill Sites

ENCE and Botnia decided to develop their pulp mills in Uruguay because of its forestry policy, natural resources, trained human resources, and social, political and economic stability. The government of Uruguay has promoted forestry plantations since the 1980s. The Forestry Act of 1987 (Law 15939) enabled large areas to be forested with fast growing eucalyptus and pine species by providing tax benefits and financial subsidies to companies that developed plantations within areas designated as "Forest Priority Soils". The afforestation program enabled agricultural diversification and provided employment opportunities in rural areas through the development of lands with poor agricultural productivity. The development of a competitive local wood processing industry was made possible by the large supply of wood resulting from the afforestation program.

The success of the afforestation program led to infrastructure improvements for transporting forestry products to ports for export. The Fray Bentos port was identified as a main corridor for transport of forestry products based on logistics, such as proximity to plantations (World Bank, 1997[1]). The investments in road, rail and port infrastructure were consistent with the government's objective of improving the economic potential of Uruguay's forestry products. Making wood chips and pulp are also consistent with Uruguay's economic objectives since they add value to forestry products and develop Uruguay's wood processing industry.

In 1985, a feasibility study for establishing a pulp mill in Uruguay was performed by the Japan International Cooperation Agency (JICA)[2]. Juan Lacaze (on the Río de la Plata), Fray Bentos, Casa Blanca (Paysandú) and Nueva Palmira were identified as potential plant sites. Shallow water depth around Juan Lacaze and Casa Blanca made these locations unsuitable for navigation of large cargo vessels. Frequent flooding was a concern for Casa Blanca. Distance from the afforestation area and lack of suitable industrial areas were identified as disadvantages for Juan Lacaze and Nueva Palmira. The planned industrial zone (west of the old Anglo meat factory), proximity to the afforestation area, no flooding, good conditions for ports, and good infrastructure (electricity, water, railway and road) were cited as advantages for Fray Bentos.

Site selection studies for the pulp mills were conducted in 1995 for ENCE[3] and in 2003 for Botnia[4]. The following summary of the site selection processes is based on the studies conducted by Jaakko Pöyry and additional information provided in the EIAs for the ENCE and Botnia mills. The plantation locations and potential plant sites for ENCE and Botnia are shown in Figure 2.1-2. Figure 1.1-1 shows the location of the selected project sites in their regional setting.

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[1] World Bank. 1997. Project Appraisal Document, Republic of Uruguay, Forest Products Transport Project.
[2] Japan International Cooperation Agency (JICA). 1985. The Feasibility Study Report on the Establishment of a Paper Pulp Plant in the Oriental Republic of Uruguay.
[3] Jaakko Pöyry Consulting Oy. 1995. Empresa Nacional de Celulosas, S.A. (ENCE) Prefeasibility Study of a Pulp Mill in Uruguay.
[4] Jaakko Pöyry Consulting Oy. 2003. Project Orion. Selection of Macro Location.

The site selection processes for ENCE and Botnia included the consideration of logistical, infrastructural, social and environmental aspects. Proximity to existing plantation operations and relatively deep navigable waters were the most important logistical factors. Infrastructural aspects such as transportation (road, railway, port), power lines, housing and their services for personnel were taken into account. The social aspects considered included access to labour, industrial legacy, impact on existing livelihoods (e.g., tourism and fishing) and impacts on existing communities. The environmental aspects considered in the site selection process included water supply, effluent dilution, noise, aesthetics, air emissions, sensitive natural or cultural areas, and acceptance of the industry.

2.3.1 ENCE Site Selection Process

Macro-scale Considerations

For ENCE, the site selection process described by Jaakko Pöyry (1995) began with the identification of the western part of Uruguay as having the highest cutting potential and the Rio Uruguay as providing access to international markets. Eight locations along the Rio Uruguay were identified: Nueva Palmira, Soriano, Fray Bentos, La Alégria, Nueva Berlin, San Javier, Casa Blanca and Paysandú. In the preliminary screening, factors such as access to a deep water harbour, road and rail connections, and existing infrastructure were considered. This resulted in Nueva Palmira and Fray Bentos being identified as suitable for further evaluation. Although locations north of Fray Bentos had limited navigability for ocean-going vessels, Paysandú was included for the comparison of transportation costs.

The more detailed evaluation of Nueva Palmira, Fray Bentos and Paysandú showed that the overall costs for transporting wood and pulp were lowest in Fray Bentos. Wood transport costs were highest for Nueva Palmira while pulp transport costs were highest for Paysandú. Infrastructural aspects for Nueva Palmira and Fray Bentos were then evaluated. Nueva Palmira and Fray Bentos were considered to be equally good for aspects such as road connections, availability of industrial land, raw water intake and power supply. Fray Bentos was considered to be better for rail connections, housing and services (e.g., retail, medical, educational, recreational).

Micro-scale Considerations

Sites within Fray Bentos were evaluated based on environmental considerations such as noise, aesthetics, air emissions from vehicles, and potential accidental release of malodourous gases. The southern part of Fray Bentos town (the site of the former Anglo meat packing plant) was identified as a good harbour but was found to be less suitable than other locations because of its proximity to recreational and tourist areas (golf course and Las Cañas beach). The northern part of town was identified as having good road and rail connections and being adjacent to the municipal harbour, however its proximity to a residential area made it less suitable. Based on environmental factors, it was found that sites north of Fray Bentos (close to the international bridge) were most favourable. ENCE

decided to locate its plant a considerable distance from Fray Bentos. The selected plant site is shielded from the Argentine shore by a wooded island and surrounded by land owned by ENCE. The minimization of visual impacts from both the Argentine and Uruguayan sides was an important factor for ENCE during the site selection process.

2.3.2 Botnia Site Selection Process

Macro-scale Considerations

The Botnia site selection process described by Jaakko Pöyry (2003) evaluated four macro-locations (regions): La Paloma, Paso de los Toros, Nueva Palmira and Fray Bentos. The four regions were evaluated in terms of the following environmental issues: water supply, wastewater assimilation, possible conflict with other water uses, sensitive areas (for nature or recreation), and problems with acceptance of the industry.

- The limited amount of fresh water, the presence of important natural features for migrating birds, and the importance of the area for tourism reduced the suitability of the coastal region of La Paloma.

- The water supply for the Paso de los Toros region was considered to be sufficient for a major pulp mill. However, complications related to its location between two reservoirs made effluent dilution during low flow periods an issue for the Paso de los Toros region. Potential conflict with other water uses (i.e., agriculture, municipal potable water) and the need for infrastructure development were also identified, thereby reducing the suitability of this area.

- The Nueva Palmira and Fray Bentos regions are situated on the Río Uruguay, which would provide a good supply of fresh water and good effluent dilution. However, because of their location, there would be guidelines established by CARU (Comisión Administradora del Río Uruguay) and the interest of environmental groups to address. The potential for problems with the acceptability of the industry by the population of Fray Bentos was identified based on some of the negative attention given by local people and NGOs to the ENCE project in Fray Bentos.

- The presence of two culturally important areas (Desembarco de los 33 Orientales; Obelisco 12 Oct 1880 and Bateria de Rivera 1841) and a high-end residential/recreational area (Carmelo) further discouraged the consideration of the Nueva Palmira region. Las Cañas and Ñandubaysal were identified in the Fray Bentos region. For both the Nueva Palmira and Fray Bentos regions, recreational areas would need to be considered when selecting the location of the mill. The need for infrastructure development in Nueva Palmira was identified.

Jaakko Pöyry (2003) conducted an analysis of the potential strengths, weaknesses, opportunities and threats (referred to as a SWOT analysis) for Paso de los Toros, Nueva Palmira and Fray Bentos. La Paloma was not included in the SWOT analysis because of the potential problems identified during the environmental evaluation. The SWOT analysis identified characteristics of the location that were positive and negative (strengths and weaknesses), as well as external factors that may be helpful or harmful (opportunities and threats). The potential strengths, weaknesses, opportunities and threats for each region that were identified in Jaakko Pöyry's analysis have been organized by topic and summarized in Table 2.3-1.

Table 2.3-1: Comparison of the Regions of Paso de Los Toros, Nueva Palmira and Fray Bentos for the Location of the Orion Mill (based on Jaakko Pöyry, 2003)

	Paso de los Toros	Nueva Palmira	Fray Bentos
Land for Mill Site	• low land price • good availability of land	• lack of suitable sites because of recreational areas	• potential to find a suitable area for mill • distance from sensitive areas
Plantations	• good availability of land for plantations • good growing conditions (potential "forest priority" areas) • need to relocate FOSA's plantations	• limited availability and high cost for plantations • plantations further away	• proximity to FOSA's plantations, as well as independent growers and Argentine growers • good conditions for growth of plantations • limited availability of land for new plantations
Transportation Logistics	• wood transport by truck, potential for train • pulp transport by railroad to Montevideo (potential rail link to mill) • long transport distance to Montevideo • lack of rail cars and locomotives (need to transport pulp by truck) • large storage capacity needed in Montevideo	• wood transport by trucks mainly, potential for barges • pulp transport by Rio Uruguay (ocean-going vessels, port in Nueva Palmira would need to be extended) • higher wood transportation cost and environmental impacts because of distance from plantations • no major union disputes foreseen at the port • good for transportation of chemicals and equipment • improvement of road between Fray Bentos and Nueva Palmira • poor road network in east west direction	• wood transport by trucks mainly, potential for train and barges • pulp transport by Rio Uruguay (dredging not completed so topping off and barging required, port in Nueva Palmira) • lowest transportation costs and impacts because of proximity to wood supply • potential cooperation with ENCE in port project • good connections to Argentina, Paysandu and Montevideo for access to goods and services • potential rail improvement from east • improvement of road between Fray Bentos and Nueva Palmira • poor road network in east west direction

	Paso de los Toros	Nueva Palmira	Fray Bentos
Labour and Infrastructure	• low population density • under-developed infrastructure • potential high costs for development	• near to most developed population areas • existing infrastructure	• technically skilled labour force • acceptable social infrastructure • industrial history
Energy		• existing electrical grid restricted	• 150 kV power line close to Fray Bentos • high-pressure gas pipeline on Argentine side
Water	• insufficient flow during the dry season for raw water supply and dilution of effluents	• ample supply of water	• ample supply of water • city water intake located downstream of mill
Acceptance of Industry		• potential problems with Argentina • possible negative attitude of other provinces (Río Negro, Paysandu)	• potential problems with Argentina • increased opposition because of recreation areas downstream • negative attitude towards forestry industry based on a response to ENCE project
Other	• priority location for development in government's plan (potential financial support)	• tax-free zone • existing pulp and paper mills in south west	• further away from port in Montevideo (as backup)

Micro-scale Considerations

Based on logistics, environmental considerations and the SWOT analysis, the Fray Bentos region was selected. Botnia decided to locate its mill near the old industrial city of Fray Bentos because of its workforce and social services. Allowing people to live in a city instead of the rural areas was an important factor for Botnia. The use of modern technology to reduce environmental impacts now enables pulp mills to be safely located near cities and potentially sensitive cultural and touristic areas.

Various locations along the river bank near Fray Bentos were considered based on access to a sufficiently deep river channel near shore. The possible location upstream from the international bridge was already occupied by ENCE. Further north, the river is very shallow and closer to the conservation area, *Esteros de Farrapos e Islas del Río Uruguay*. The possible location downstream of the city of Fray Bentos was not considered to be suitable based on its proximity to the tourist areas of Las Cañas and Ñandubaysal and other recreational areas.

The location downstream of the international bridge was selected because potential dredging of the Río Uruguay in the future would allow the passage of ocean-going vessels.

In addition, the location did not have significant natural features (mainly pastureland) and it was a large property on the river whose owners were willing to sell. Other positive characteristics included: road connections, proximity to the international bridge, potential railroad connections, national electric grid and substation (150 kV) nearby, sand stone (easy to build), and elevation above flood level.

2.3.3 Summary of the Site Selection Processes

The key factors considered in the macro-scale site selection process included: location on the Río Uruguay (transportation, water supply and wastewater assimilation), proximity to eucalyptus plantations (wood transport costs and transportation impacts), and existing infrastructure (roads, electrical grid, educated workforce and services). Both companies decided to locate their pulp mills in Fray Bentos. It appears that logistical factors played a key role in the companies' decision making, however environmental and infrastructural aspects were also important. Challenges related to acceptance of the industry were identified by Botnia, however they seem to have been outweighed by the strengths of the Fray Bentos location.

In their micro-scale site selection processes, distance from sensitive natural and cultural areas was an important consideration. Both companies decided not to locate their pulp mills near the old Anglo meat plant because of its proximity to recreational areas such as Las Cañas and Ñandubaysal. ENCE decided to minimize visual impacts by locating its site at a distance from urban areas. The options for Botnia were more limited because Botnia began its site selection process after ENCE was already established at M'Bopicua. Enabling people to live within the city instead of in the rural areas was an important consideration for Botnia in their micro-scale site selection process.

2.4 Ports

Ports at M'Bopicuá, Nueva Palmira, the Botnia mill and Montevideo will be used for the export/import of pulp and other supplies for the mills. Ports along the Río Uruguay have already experienced increased traffic because of increased log and woodchip exports. A brief description of each port, including environmental and social impacts, is provided below.

2.4.1 M'Bopicuá Port

The M'Bopicuá port is located 11 km north of the town of Fray Bentos, and 5.5 km upstream from the international bridge. It is situated on a secondary channel of the river, to the south of the Island of Horses and the Ñandubaysal step. The port in the city of Fray Bentos was partially relieved of increased demand when the M'Bopicuá port was built in 1998.

The M'Bopicuá site contains a chipping plant for the export of Eucalyptus wood products. Other facilities on site include: storage esplanade, parking lots, access roads, wastewater treatment plant, pump house (fire prevention), wharf and sanitary landfill. Ships are loaded at the port and navigate along the main channel of the Río Uruguay. ENCE plans to partially load ocean vessels with pulp at this port and fill the remainder at the Montevideo port. Botnia does not plan to use the M'Bopicuá port.

The port is located on a natural bluff which is part of the Fray Bentos formation (sandstone rock formation). The site had limited agricultural potential and was used mostly for grazing. Prior to development, the site consisted mostly of a prairie ecosystem of native and exotic species that was partially removed for the port development. Two ecosystem types were preserved: remnant riverine forests along the river and creeks on the Uruguayan plain. There are three archaeological sites present at the port: the De Baja findings, *las ruinas del saladero de M'Bopicuá*, and M'Bopicuá Prehistoric Site.

Prior to approval and development of the M'Bopicuá port, numerous environmental, economic, and social studies were completed. The environmental studies examined the impacts during construction and operation, and included the topics of air quality, noise, flora and fauna, runoff, sedimentation, waste management, water quality (including potential for contamination), flow, morphology, fish habitat and health in the Rio Uruguay. The social and economic impact assessments for the construction and operation phases of the port included the topics of population, economic activities, employment, services, quality of life, traffic (terrestrial and marine), visual impact, indigenous populations, and archaeological and historical heritage.

The Environmental Impact Assessment by Constructora Santa Maria Ltd. outlined the main permanent positive and negative changes (environment, social) during the construction and operation of the port. During construction, the removal of vegetation, grading, quarry operation, and construction of roads and buildings were predicted to have an adverse permanent impact on soil, natural landscape, water quality, and natural drainage. The dredging and disposal of sediments were also predicted to negatively affect the benthic fauna of the river.

Benefits include the creation of a nature reserve and preservation of archaeological sites. The operation of the new wharf was expected to improve the regional transportation system (roads and waterways), stimulate the economy, and create new jobs. Potential changes to water quality, fish habitat, benthic macroinvertebrate community, and terrestrial fauna populations and habitat were identified.

ENCE's subsidiary, EUFORES, manages nature zones, old forest reserves, water-meadows and palm groves. Conservation areas and breeding areas for endangered species have been established at M´Bopicuá and Santo Domingo. The Ecoschool program promotes environmental awareness by providing visits for school children to the

conservation areas. These naturalized areas provide compensation for potential effects of the port development on terrestrial faunal populations and habitat.

2.4.2 Nueva Palmira Port

In 1956, the Nueva Palmira port was constructed at the terminal of the Paraná-Paraguay waterway (confluence of the Río Parana and Río Uruguay). Wood, grains, ore, sugar, salt, citrus fruit and fertilizers are shipped from this port. There are both state and private wharfs at the Nueva Palmira port.

Currently, Botnia plans to barge all its pulp to the Nueva Palmira port. The Nueva Palmira port is being expanded to accommodate Botnia's operations as well as those of other local industries. The port will have an esplanade of 55,000 m^2, a cellulose warehouse of 30,000 m^2 and dock 180 m long and 40 m wide to accommodate ocean-going vessels. Many of the same environmental and social impacts described for the construction and operation of M'Bopiqua port have been identified as issues for the expansion of the Nueva Palmira port. Negative impacts include loss of biodiversity and natural habitat, potential change in water quality, contamination of water from ship and port activities, loss of beach tourists, decline in local fisherman catch volumes, and increase in fluvial traffic. Positive impacts include job creation and an improved economy.

2.4.3 Port at Botnia Mill

Botnia has constructed a port at its mill site to transport pulp by barge to the Nueva Palmira port. At the Nueva Palmira port, the pulp will be transferred to ocean-going vessels. The port enables construction materials and chemicals for the mill to be shipped directly to the site.

The use of either the Fray Bentos or M'Bopicuá ports instead of construction of a new port at the Botnia mill was considered, however the use of an existing port was not selected due to concerns relating to the transport of chemicals and other materials between the mill and the off-site port facility. There were also concerns regarding traffic of ships and barges passing under the international bridge.

The size of the mill port was minimized to reduce impacts. The original design was for a port large enough to support ocean-going vessels with a dock structure similar to those of other major ports along the Río Uruguay. The port design and construction was discussed with DINAMA and design changes were made to take DINAMA's suggestions into account. Daily monitoring have shown that there are no impacts to the water quality of the Río Uruguay during construction of the port.

The main issues associated with the construction and operation of the port included the loss of connectivity between spawning and rearing habitat, loss of habitat for the protected river otter and vulnerable catfish species, and the destruction of terrestrial vegetation communities that contain rare species. Baseline fisheries studies revealed that on either

side of the proposed port site are creek inlets which are rearing areas for local and migratory fish. They include the Las Cañas Creek, Los Perros Stream and the Yaguareté Creek inlet. Some local species, such as carp and catfish, likely spawn here, as in other shallow embayments up and down the river. These inlets are also feeding zones for the river otter (*Lutra longicaudis)*, and tracks of this species were found during mammal surveys.

The hydrodynamics of the Rio Uruguay were investigated by Botnia as part of their EIS to determine the potential effect of the port development on current velocities and sedimentation within Yaguareté Bay. Water velocities were found to be lower in Yaguareté Bay as compared to the main channel, and as such, sedimentation may occur more readily in the embayment than further offshore. However, the port development is not expected to significantly affect sedimentation within the embayment since periodic high flows and wave action is sufficient to prevent accumulation of sediment.

The location of the port was comprised of scrub and forest vegetation communities. Impacts on the terrestrial environment were identified relating to rare floral species. Some vegetation communities and species were recognized as ecologically or socially significant and conservation areas were recommended. The coastal forest contains tall (7 to 8 m) mature *Myrsine coriacea*, *Hexachlamys edulis* and *Sapium haematospermum* trees, and an old specimen of *Luehea divaricata* along the shore that is well loved by the citizens will be preserved (Botnia, 2004). Location and size of the port were adjusted according to the suggested area to be conserved. Before construction began, an archeological study was completed within the coastal and underwater areas. No artifacts of cultural or historical value were found. The river and creek water quality was also closely monitored during the port construction.

2.4.4 Fray Bentos Port

The Fray Bentos port is 8 km south of the international bridge and is connected to a road and railway system. Products that go through the port include wood products, grain, and citrus fruit. It is expected that with the development of the pulp mills, the volume of wood products passing through this port will decrease, leaving port space available for other activities.

2.4.5 Montevideo Port

Montevideo's port is located in the Río de la Plata and originated pre-independence (1828). It is Uruguay's largest port and its extensive wharfs and facilities service many South American countries. Environmental and social impact studies are underway for a proposed addition of a new wharf.

The ENCE project intends to use this port. It plans to partially load ocean-going vessels with pulp at the M'Bopicuá port and top off the vessels in Montevideo with pulp shipped via barge, truck or rail. Botnia has no plans to use this port.

2.5 Bleached Eucalyptus Kraft Pulp (BEKP) Mill Processes

This section summarizes the technology to be implemented at the Botnia-Orion and ENCE-CMB bleached eucalyptus kraft pulp (BEKP) mills, highlights features that are pertinent to their environmental performance, and compares these features with the IPPC Best Available Technology (BAT) requirements related to emissions to water and air. Specifically for the kraft pulp sector, the IPPC-BAT (2001) systematically a) reviews typical current processes and techniques implemented in the sector, b) summarizes the emissions from mills, and identifies environmental concerns, c) describes techniques for emission abatement, waste minimization and energy savings that should be considered in the determination of BAT emission levels, d) defines the range of emissions to water and air that result from the implementation of BAT, and e) discusses emerging techniques.

The kraft or sulphate process is the dominant pulping process worldwide, due to superior pulp strength properties, its applicability for most wood species, the ability to recover and reuse the main process chemicals and its energy efficiency. The main environmental concerns with kraft pulping include wastewater effluent, emissions to air including malodorous gases, the management of solid waste residuals, and energy consumption. The main raw materials for the process include wood fibre, water, energy, and chemicals for cooking and bleaching. The process consists of five main components: 1) wood handling; 2) pulping; 3) chemical recovery; 4) bleaching; and 5) pulp drying. These are described in the next section, followed by a discussion of BAT issues. Annex A of this report contains the detailed BAT analysis.

2.5.1 Mill Processes: Woodhandling and Biomass Management

Wood handling is the first step of the kraft process. In this step, logs are debarked and cut into manageable sizes.

At the Botnia-Orion pulp mill, logs will be dry-debarked at the plantations so that the residuals can be returned to the soil, and thus the debarking drums at the mill must remove only the remaining bark and impurities such as remnant soil and sand. Because the mill will use different eucalyptus species, there will be two separate chipping lines and storage. Bark residues and fines from screening will be returned to the plantations.

At the ENCE-CMB facility, two parallel wood preparation lines will be used. Eucalyptus logs arrive by truck with bark and are fed to a dry debarker and washed to remove sand, dirt and other materials, prior to the chipper. Accepted chips will be sent to two storage silos while fines will be mixed with bark and burned in the woodwaste boiler. This boiler is designed to burn bark from debarking operations, as well as waste produced during subsequent wood processing. A bubbling fluidized bed (BFB) combustion technology will be employed. The primary sludge from the wastewater treatment plant as well as biosolids from wastewater treatment (when it cannot be burned in the recovery boiler), can also be burned in the biomass boiler. Ammonia injection will be used in order to minimize the discharge of NO_x

from the biomass boiler. Flue gases leaving the boiler are cleaned in an electrostatic precipitator (ESP) before the gases are released to the atmosphere. Fly ash separated from the flue gases, as well as the bottom ash from the furnace, are taken to the landfill.

2.5.2 Mill Processes: Pulping

Pulping at the Botnia-Orion mill will be done in a Downflow Lo-Solids® continuous digester. Brown stock pulp will be washed first in the digester, then in 3 high-efficiency drum displacement washers in parallel before oxygen delignification, and there will be two more washers in parallel after oxygen delignification and before bleaching. Washing efficiency is more than 99% and the open cycle wash losses are about 8kg COD/ADt. Brown stock screening will be done in a three-stage closed cycle system, with slotted pressure screens. Before bleaching, pulp will be delignified in a two-stage oxygen delignification unit, after which the kappa number will be under 11.

The cooking plant (COMPACT COOKING™ process) at the ENCE-CMB pulp mill consists of a chip bin, a pre-impregnation vessel, a high pressure feeder, a continuous digester and a blow tank of 1 000 m^3. The digester is of a compact design and comprises a bottom counter-current washing section. The oxygen delignification takes place in a two-stage oxygen reactor where oxidized white liquor will be used as the alkaline agent. Brown stock washing is carried out with two displacement wash presses and another two displacement wash presses are used for post oxygen washing. The second of the post-oxygen wash presses is located after the high density storage tower, to take advantage of a soaking and leaching process that can occur here. Washing efficiency is more than 99% and the open cycle wash losses are about 8kg COD/ADt The final pulp kappa number to the bleach plant is expected to be lower than 10.

2.5.3 Mill Processes: Chemical Recovery

Weak black liquor collected from the brownstock washing system is concentrated by evaporation to produce strong black liquor which is sent to the recovery boiler. In the recovery boiler, organic solids are burned for energy generation and the chemicals are recovered in the form of smelt. Green liquor is formed by dissolving the smelt into weak liquor and is then clarified to remove contaminated solids, known as dregs. The dregs are washed prior to disposal and the resulting weak liquor is used for dissolving the smelt. White liquor is produced in the recausticizing plant. The clarified green liquor is first passed through a slaker where sodium carbonate is converted into sodium hydroxide using lime. The white liquor is clarified to remove precipitated lime mud. Lime mud is converted into lime through calcination in the lime kiln. The lime mud filtered out from the white liquor clarifier is washed, and the resulting weak liquor is used for dissolving the smelt from the recovery boiler.

At the Botnia-Orion pulp mill, a seven-effect evaporator train will be used. In addition to evaporating weak back liquor from brown stock washing, it will treat biosolids from the

effluent treatment plant and salt cake from the ClO_2 plant. The evaporation plant was designed with an additional capacity of 20% above normal operation to allow for a sufficient margin to recover intermittent discharges including liquor spills, and for the future possibility of bleach filtrate recycle. The black liquor will be concentrated to a minimum level of 75% dry solids for firing into the recovery boiler. High levels of dry solids help ensure higher lower furnace temperatures and low sulphur dioxide emissions from the recovery boiler. From the evaporators, the clean primary condensates will be returned to the feed water tank of the recovery boiler while secondary condensates will be used in the fiberline and the white liquor plant. The foul condensates, with a higher content of volatile organics, are purified in a steam stripping column to be reused in the process. Non-condensable gases from stripping enter the methanol separation system, where methanol is separated and purified, and the remaining gases enter the collection system for concentrated odorous gases. The stripping column was designed for foul condensate TRS and methanol reduction efficiencies of 98%.

The recovery boiler treats heavy black liquor which is fired into the furnace at high solids. The boiler, which will require fuel oil only for start-up and as support, is a state-of-the-art low odour design with low emissions of TRS, sulphur dioxide and nitrogen oxides. Dust in the flue gas is separated by an electrostatic precipitator. The recovery boiler will be equipped with a burner for low volume high concentration (LVHC) odorous gases. Gases from the smelt dissolving tank will be fed directly into the recovery boiler and all high volume low concentration (HVLC) odorous gases will also be burnt in the recovery boiler. A single lime kiln will be installed. The lime mud will be washed efficiently and dried prior to the kiln, and the lime kiln will be equipped with an electrostatic precipitator to control particulate emissions. The kiln capacity will be fired with fuel oil, and limestone will be used for purchased lime make-up.

At the ENCE-CMB pulp mill, a 6-effect free flow falling film evaporation train will be used which was also designed to treat biosolids and salt cake from the ClO_2 plant. The evaporation plant capacity is 15% above normal continuous operation which is sufficient for recovery of intermittent discharges and for recovery of some bleaching filtrates. The weak black liquor will be evaporated to a minimum level of 75% dry solids. The clean primary condensates from the first effect will be collected and returned to the main condensate tank. Secondary condensates will be extracted from the fourth evaporation stage and reused mainly for pulp washing after the oxygen delignification stage. Intermediate secondary condensates will be taken out of the sixth effect and the surface condenser, and introduced into the causticizing plant for lime mud washing and dilution. The foul condensates will be collected from the segregated surface condenser and the vacuum system. They will subsequently be treated in the integrated steam stripper, returned to the intermediate secondary condensate tank, and reused in process.

Gases from the steam stripper are taken to a methanol column where the methanol content is concentrated up to 80%. Concentrated methanol vapour is condensed and stored as

liquid in a methanol tank before it is burned in the recovery boiler. LVHC gases collected from the evaporation train and the methanol plant are incinerated in the recovery boiler.

The recovery boiler has been designed for an additional 20% capacity over normal continuous operation of the mill. Concentrated black liquor produced at the evaporation plant is fed to the recovery boiler at a dry solids content of approximately 75% and will be mixed with biosolids from the effluent treatment plant. Oil is used only for boiler start-up and shutdown. The recovery boiler will be equipped with a burner for low volume high concentration (LVHC) odorous gases. Gases from the smelt dissolving tank vent will be fed into the recovery boiler and all high volume low concentration (HVLC) odorous gases will also be burnt in the recovery boiler. Burning vent gases from the smelt dissolving tank decreases the total emissions from the recovery boiler area. In order to control the potassium and chloride content of the mill liquor systems, most of the fly ash collected in the electrostatic precipitators is treated in an ash leaching system in order to remove chlorine and potassium from the process. This leaching system helps ensure that the recovery cycle can accommodate a certain level of alkaline filtrate recycle from the bleach plant. A single lime kiln will be installed. Flue gases leaving the kiln are treated by an ESP and a flue gas scrubber prior to discharge.

2.5.4 Mill Processes: Bleaching

A typical bleaching plant consists of three to five stages which form a bleaching sequence. The bleaching sequence can be divided into two functions: delignification and brightening. In the delignification operation, lignin is removed, while in the brightening operation, higher brightness is achieved.

The 4-stage Botnia-Orion ECF bleaching sequence will be AD-PO-D-P, with DD-washers used in the intermediate washing stages. Botnia-Orion has a low kappa number to the bleach plant, and uses peroxide and oxygen to reinforce bleaching. This results in a comparatively low predicted consumption of chlorine dioxide (less than 10 kg/ADt) compared with most ECF mills. For this reason, the mill may be more accurately described as having an “ECF-light” bleach sequence.

The ENCE-CMB 3-stage ECF bleaching sequence will be D_{Hot} – PO – D1. It is expected that once the plant has started up and is in stable operation mode that 20% or more of the alkaline filtrate will be recycled and recovered. ENCE-CMB has a low kappa number to the bleach plant, and uses peroxide and oxygen to reinforce bleaching. This similarly is expected to result in a low consumption of chlorine dioxide (less than 10 kg/ADt) compared with most ECF mills.

The ENCE-CMB and Botnia-Orion bleach plants are using other chemicals to partially replace some of the chlorine dioxide based bleaching. For ENCE-CMB, this is through use of a hot acidic stage integrated into the first dioxide stage ($D_{Hot,}$) and through a second stage reinforced with oxygen and peroxide. Botnia-Orion achieves this through the use of

an acidic stage integrated into the first dioxide stage (AD), a second stage reinforced with oxygen and peroxide (PO), and a final peroxide stage (P). The bleaching sequence development is discussed in greater detail in Section 2.5 of this CIS.

Alkaline bleaching filtrate recycled to post-oxygen washing is recognized as a developing technology by both IPPC-BAT (2001) and Tasmanian-AMT (2004) and is discussed further in Section 2.5. The planned use of 20 – 25 % alkaline filtrate recycle by ENCE-CMB is a measure beyond BAT for a bleached eucalypt kraft mill.

2.5.5 Mill Processes: Pulp Drying

The bleached pulp is dried and baled before being shipped. The pulp is first dewatered with a drying machine and then further dried with steam.

Two drying machines will be used at the Botnia-Orion pulp mill with each a capacity of 60% of the fiberline capacity, which will help with controlling the mill water and steam balance. The ENCE-CMB mill will use a single pulp drying machine with slot screening, double wire, combipress and shoepress design.

2.5.6 Mill Processes: Water Usage and Effluent Treatment

Both the Botnia-Orion and ENCE-CMB effluent treatment plants will employ the activated sludge treatment (AST) process, treating average discharge flows of approximately 73 000 m^3/d (25 m^3/ADt) and 46 000 m^3/d (29 m^3/ADt) respectively.

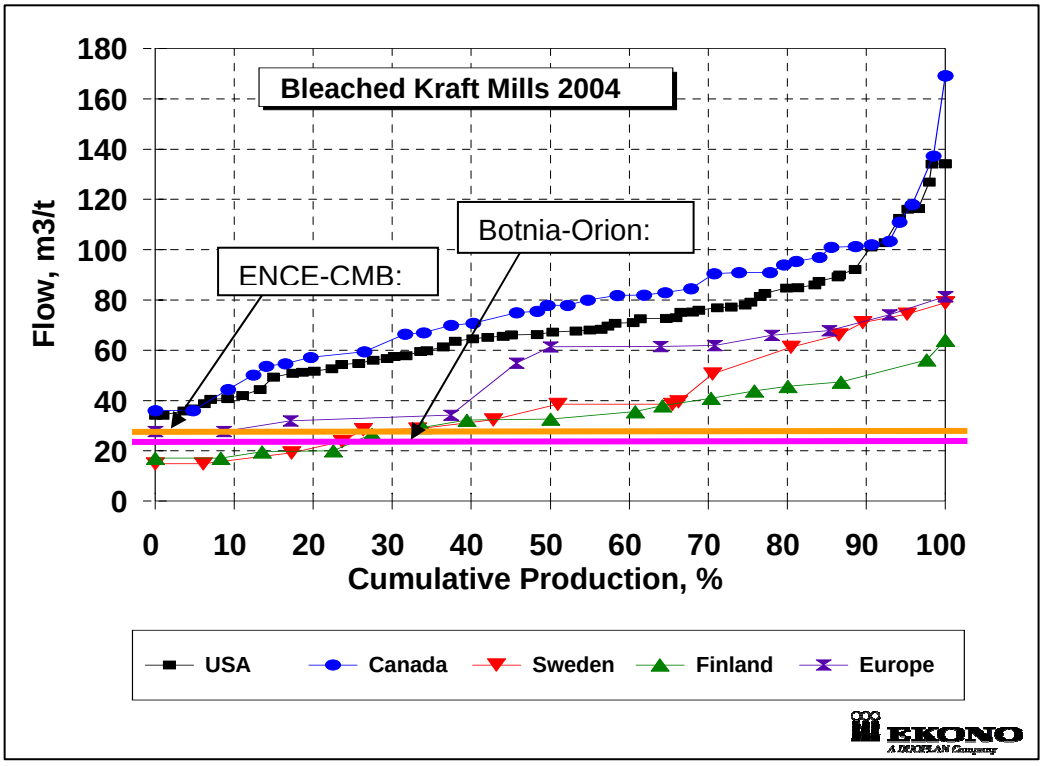
Mill Water Usage and Effluent Flows

In the following figure the effluent flows of Botnia-Orion (in pink) and ENCE-CMB (in orange) are compared with data from North American and European bleached kraft pulp mills. In each of the four countries represented, the medians for effluent flow rates are in the 30 to 80 m^3/ADt range. While a number of mills in North America discharge more than 120 m^3/ADt, all Swedish mills had an effluent flow discharge within the 18–80 m^3/ADt range. The top 10% performing mills discharge under 40 m^3/ADt in North America. It can thus be seen that lower effluent flows than specified by the mill proponents are achievable in some mills, even though both mills would be in the top 5% of performing mills in North America and Europe.

The estimated effluent flows were also compared with modern well operated bleached eucalyptus kraft pulp (BEKP) mills in Brazil. The table below shows that Botnia-Orion's expected average flow matches that of the most modern Brazilian mill effluent flows, namely Veracel's 24 m^3/ADt. ENCE-CMB also performs similarly amongst the best mills in Brazil with an effluent flow of 29 m^3/ADt.

The effluent flows of Botnia-Orion and ENCE-CMB comply with the IPPC-BAT (2001) range and are among the best in the world at the levels estimated for the CIS. Lower effluent

flows are achievable but difficult to justify, especially when set in the overall context of concentration-based regulations.



	Botnia Orion	ENCE CMB	Veracel BA, Brazil	Aracruz Barra do Riacho ES, Brazil	Aracruz Guaiba RS, Brazil	Suzano Mucuri BA, Brazil
Flow (m^3/ADt)	25	29	24	35	28	34

Mill Effluent Treatment Processes:

An efficient biological effluent treatment system is a critical element of BAT. Secondary or biological wastewater treatment by the activated sludge treatment (AST) process is widely implemented in the pulp and paper industry for the removal of organic matter, and both Botnia-Orion and ENCE-CMB plants will employ a form of the AST process, commonly referred to as "extended aeration" which is considered BAT. A design basis review and analysis of the major equipment to be used by the mill proponents for wastewater treatment was made as part of the CIS. It was found that Botnia-Orion and ENCE-CMB will implement the IPPC-BAT (2001) recommendations for biological treatment. There is no justification for the implementation of tertiary treatment at either of the two proposed mills.

According to the IPPC-BAT (2001) standard, a modern pulp mill must implement biological wastewater treatment in order to be considered BAT. Wastewater treatment must not only comprise biological or secondary treatment, but must also include primary treatment for the removal of solids, neutralization for pH adjustment, effluent cooling, and equalization to minimize the impact of upstream contaminated effluent on the treatment efficiency. Additional recommended technology in IPPC-BAT (2001) and Tasmanian-AMT (2004) includes the addition of a selector, and an anoxic stage for the biological reduction of chlorate. AST systems that implement all of these features can achieve stable and high removal efficiencies for the removal of organic contaminants. Botnia-Orion and ENCE-CMB will both implement the AST process at their facility, namely, they will employ extended aeration AST technology, and include an anoxic zone for chlorate removal and a selector stage. In particular, Botnia-Orion has an innovative design to avoid high organic loads to be charged into the AST. The table below presents the expected removal efficiencies for both WWTP's and compares them with the recommended IPPC-BAT (2001) and Tasmanian (2004) recommended levels. Note that the final selection of the WWTP technology had not been made at the time of the CIS, and their predicted removal efficiencies should be considered conservative.

Parameter	IPPC-BAT (2001) recommended removal (%)	Botnia-Orion removal (%)	ENCE-CMB removal (%)
COD	60 – 85	85	70
BOD	85 – 98	98	95
AOX	40 – 65	73	50
Suspended Solids	85 – 90	93	85
ClO_3^-	90 – 100[1]	99	90

Tertiary treatment has been implemented in the pulp and paper industry at a few mills, particularly for additional nutrient and color removal from the effluent. On the other hand, a

number of studies and reports regarding the performance of tertiary treatment systems indicate that, for various reasons, tertiary treatment should not be considered BAT. It can for example, increase the chemical load on the environment and add cost and complexity to the treatment system. Since both Botnia-Orion and ENCE-CMB will implement the state-of-the-art effluent treatment plants, and discharge into the Río Uruguay where the impact from marginal additional reduction in color and nutrients is likely to be insignificant, tertiary treatment was not considered to be necessary in either mill case.

2.5.7 Summary Statement Regarding BAT Analysis for the Botnia-Orion Pulp Mill

The detailed BAT analysis for the Botnia-Orion mill is presented in Annex A. The mill will incorporate state-of-the-art technology which is BAT, and in some cases goes beyond IPPC-BAT (2001) and Tasmanian-AMT (2004) definitions of BAT.

2.5.8 Summary Statement Regarding BAT Analysis for the ENCE-CMB Pulp Mill

The detailed BAT analysis for the ENCE-CMB mill is presented in Annex A. The mill will incorporate state-of-the-art technology which is BAT, and in some cases goes beyond IPPC-BAT (2001) and Tasmanian-AMT (2004) definitions of BAT.

2.6 Bleaching Processes

For a bleached eucalyptus kraft pulp (BEKP) mill, liquid effluent from the bleaching area typically contributes about half of the flow, and most of the organic load. Selection of the chemical stages, and conditions to be used in them, comprise critical environmental design decisions. Design considerations regarding these issues include wood type, required final product characteristics and special knowledge developed by the owner, and available equipment. In reviewing the bleaching processes we have used knowledge of recent BEKP mills (in Brazil, South Africa, and Chile), other new or rebuilt bleached kraft mills (in Germany, China, and Finland), and knowledge developed by ENCE and Botnia (for example in mill and laboratory trials, and operating mill experience). Members of the CIS project team have visited many of these mills within the last year, and have also used the IPPC-BAT (2001), Tasmanian-AMT (2004) and the USEPA Cluster Rule in reviewing the mills. This section discusses the key areas associated with bleach plant technology selection and emissions from bleaching including oxygen delignification, dioxin and furan generation, bleaching, ECF, TCF and ECF-Light bleaching and recycling of alkaline filtrates to post oxygen washing.

Oxygen Delignification: Oxygen delignification reduces the lignin content of pulp prior to bleaching, through the use of oxygen gas and sodium hydroxide. Organic material is dissolved and recycled back from the post oxygen washers to the brown stock area and

then to the chemical recovery system. Modern two-stage delignification is proposed by both the Botnia-Orion and ENCE-CMB mills.

Dioxins and Furans Generation in Bleaching; From the 1950's through to the 1980's bleached pulp manufacture employed primarily chlorine (Cl_2) as the main delignification chemical after cooking, followed by caustic, sodium hypochlorite and possibly chlorine dioxide stages. Bleaching sequences from this period were typically CEH, CEHD and CEHDED. The use of chlorine for delignification in sequences such as these has been found to produce dioxins and furans. Preventing the formation of 2,3,7,8-TCDD and 2,3,7,8-TCDF in bleaching is achieved mainly by decreasing the amount of chlorine used in the first bleaching stage. The bleaching processes used at Botnia-Orion and ENCE-CMB use no elemental chlorine in bleaching, and are not expected to produce dioxin and furans at significant or quantifiable levels[5].

ECF and TCF Bleaching: Two approaches have been taken by pulp manufacturers in response to concerns on dioxin emissions in mills using chlorine bleaching in the 1980s. One approach was to eliminate molecular or elemental chlorine-based chemicals, referred to as ECF bleaching [i.e. bleaching sequences in which molecular chlorine (Cl) and hypochlorite are not used]. The second approach was to bleach with no chlorine-based chemicals, which is called TCF bleaching (i.e. bleaching that uses only oxygen-based chemicals such as oxygen, ozone, alkaline or acidic peroxide). Botnia and ENCE were leaders in the adoption of TCF technologies, and today 21% of Botnia's and 38% on ENCE's production is manufactured using the TCF process. In selecting a bleaching technology for Uruguay, both companies investigated a range of ECF, TCF and ECF-Light technologies (an "ECF-Light" technology essentially has attributes of both ECF and TCF production). The ECF-Light technologies were selected as pulp from the TCF sequences has lower yields and poorer final quality than the ECF and ECF-Light pulps.

ENCE has found that pulp using the same TCF method that they use in the Pontevedra mill in Northern Spain could not reach the necessary market brightness, and that the final brightness reduces during transportation of product (a phenomenon called reversion). If ozone was used in the sequence, full brightness could be made but the pulp had much reduced papermaking properties that would render it unacceptable for market. Botnia has found that TCF bleaching produces inferior fibre quality, namely fibre strength. The inferior strength properties translate to less recyclability of the fibre, which is environmentally undesirable. Cooking yield is lower for TCF sequences, as they require a lower Kappa to bleach plant, and this results in higher wood consumption.

The ECF versus TCF question was recently examined by the Government Agency (RPDC) responsible for permitting new pulp mills in Tasmanian, Australia. This study examined issues raised in a World Wildlife Fund (WWF) report on the Valdivia pulp mill in Chile.

[5] The level of quantification for 2378 TCDD is set by the USEPA at 10 ppq. a ppq or pg/L (parts per quadrillion (10^{-15}), the time scale equivalent of a ppq is 1 second in 31 709 790 years).

WWF had recommended that TCF bleaching technologies should be used for new mills. The RPDC review was carried out in May 2006, and the report has more than 140 references, covering experiences in North America, Europe and South America[6]. The report concluded that TCF pulp and ECF pulp have similar environmental impacts from air and water emissions, and neither emit dioxins at environmentally significant levels. The report also concluded that TCF pulps generally have poorer strength at equivalent brightness, and lower yields than comparative ECF pulps. Neither technology offers significant advantages in terms of operating risk, safety and occupational health considerations. Both technologies are acceptable under the Stockholm Convention of POPs, IPPC-BAT, USEPA and all significant permitting authorities.

ECF and ECF-Light Bleaching: A conventional cooked hardwood pulp, without oxygen delignification may use 35 kg/ADt of chlorine dioxide. The sequences proposed by the Botnia-Orion and ENCE-CMB mills are expected to use about 8 kg/ADt and less than 10 kg/ADt of chlorine dioxide, respectively. These bleach sequences are termed “ECF-Light”. The expected color, COD and AOX discharges from the bleach plants are subsequently expected to be extremely low compared to conventionally bleached pulp mills.

Recycling alkaline bleaching filtrate from the bleach plant; Both Botnia-Orion and ENCE-CMB are taking a cautious approach with respect to recycling alkaline bleaching filtrates to the recovery cycle. Both mills will recycle filtrates within the bleach plant. This practice reduces water consumption, effluent flow and reuses chemical residues within the bleach plant. Botnia-Orion and ENCE-CMB have installed equipment and connections to enable alkaline bleaching filtrate back to post-oxygen washing. This recovers bleaching chemicals used and may reduce effluent flow. ENCE-CMB plan to recycle about 20-25% of the alkaline filtrate under standard operation. Botnia-Orion will test alkaline filtrate recycle after the new mill operation is started-up and stabilized, likely within two years of start-up. Alkaline bleaching filtrate recycle was identified as an emerging technology by IPPC-BAT (2001) and Tasmanian AMT (2004).

EcoMetrix has not identified any BEKP mills which recycle alkaline bleaching filtrates to brown stock. This is not practiced for example in the most recent installations in Veracel and Aracruz C Line in Brazil, which also were built with the IPPC-BAT (2001) as a guideline. Alkaline filtrate recycle is not as effective with eucalyptus furnish, and potential problems are more severe than with softwoods due to the following reasons:

1. Eucalyptus has a higher Hexenuronic acid content than other woods, and this results in higher levels of oxalate formation (the oxidation product of Hexenuronic acid), and higher oxalate levels in alkaline filtrates. Oxalate causes both bleach plant and evaporator scaling (forming calcium oxalates).

[6] www.rpdc.tas.gov.au/projects_state_signif/pulp_mill/pm_reports_publications.html.

2. In softwood mills the alkaline bleaching stage generally has a high load of organics (color and COD) compared with the first bleaching stage (the D stage). The modern BEKP mill bleaching sequences often contain two separate functions in the first bleaching stage. These are a specific Hexenuronic acid removal stage, and a regular oxidation stage (for example A/D D_{HOT} or Z/D). This results in the first stage effluent having more organic content (color, COD) and the second stage (the alkaline extraction stage) less organic content (color, COD) than for other wood furnishes. The effluent load reduction potential from recycling alkaline filtrate is thus comparatively less.

3. Eucalyptus mills have higher potassium inputs than softwood and northern hardwood mills. This results in a lower tolerance for chloride inputs from bleaching filtrates, before recovery boiler operation problems are encountered, or increases the requirement to purge chlorides and potassium from the liquor cycle. ENCE-CMB has a precipitator dust leaching stage to reduce liquor cycle potassium and chloride levels.

Summary

ENCE and Botnia have combined their operating experience and process knowledge with vendor offers to develop fiberline (and complete mill) configurations that would be welcomed in Canada, the USA or Europe. The companies in almost all respects have put together the best process technologies, and are likely to perform better than any of their existing mills with respect to environmental performance. The selection of two-stage oxygen delignification, ECF-Light bleaching and the cautious approach to alkaline filtrate recycling taken by both mills is consistent with BAT for BEKP mills, and the mills will implement state-of-the-art Hexenuronic acid removal stages. The expected performance with respect to bleaching effluent flow, COD content and color will be among the best in the world.

2.7 Evaluation of Emissions and Effluents

Kraft pulping process effluents contain oxygen-consuming organic substances that are measured as Chemical Oxygen Demand (COD) and 5-day Biological Oxygen Demand (BOD_5). Effluent from the bleach plant, where chlorine-containing bleaching chemicals are used, can contain organically-bound chlorine compounds, measured as Absorbable Organic Halides (AOX). AOX is a measure of a wide range of chlorinated organic compounds, many of which are found naturally in the environment. The AOX measurement may also include polychlorinated, persistent compounds. Emissions of coloured substances may affect aquatic ecosystems through decreased transparency of water. Emissions of nutrients (nitrogen and phosphorus) can result in eutrophication of water bodies. Individual metals extracted from the wood can also be detected in low concentrations in effluents.

The treated effluent from kraft pulp mills contains principally dissolved inorganic solids or salts of sodium and calcium (i.e. sodium chloride, calcium bicarbonate, and sodium and

calcium sulphates), and low concentrations of residual organics measured as BOD_5 and AOX. Discharge of inorganic salts is typically regulated only in locations with low rainfall, and low stream flows which may be used for agricultural irrigation, such as in South Africa, Australia and Thailand.

Kraft pulp mill emissions to the atmosphere may originate from chip storage, the cooking digester, pulp washing, the bleach plant, bleaching chemical preparation, chemicals recovery, evaporation, biomass boiler, recovery boiler, white liquor preparation, lime kiln, tanks and pulp drying. They consist mainly of products of combustion, including particulate matter, NO_x and SO_2, as well as malodorous reduced sulphur compounds, commonly referred to as Total Reduced Sulphur (TRS) compounds. Nitrogen oxides are emitted from furnaces as well as small amounts of dust (solid particulates) as fly ash. From the bleach plants and preparation of bleaching chemicals, chlorine compounds may escape to the atmosphere.

Generally speaking, modern kraft pulp mills, such as those being evaluated in this CIS, should have discharges which are significantly less than those of older smaller mills, due to the implementation of state-of-the-art process technology suitable for large throughputs. Discharges are lower not only in specific terms, on a per tonne of production basis, but also in absolute terms (in a tonne per day basis), compared with older mills. Implementation of state-of-the-art technology alone is not enough to guarantee "best available technology" or BAT; it is critical that the equipment is well-operated and maintained so that operating objectives are consistently met over the longer term. Both the process technology and its future operation have been addressed in this BAT assessment.

Key emission issues for state-of-the-art kraft pulp mills are related to the collection and management of TRS-containing odorous gases, and effluent color. TRS collection and management is being addressed to a great extent by the implementation of state-of-the-art non-condensable gas (NCG) collection systems at both mills that go beyond IPPC-BAT (2001), and effluent color reduction is being addressed by selection of modern pulping and bleaching technologies and an extensive spills collection systems that are systematically designed using principles similar to those defined in the Best Management Practices (BMP) requirement of the USEPA Cluster Rule (2000).

Botnia-Orion and ENCE-CMB were asked to provide long term annual average, monthly maximum and daily maximum estimates for parameters listed in the IPPC-BAT (2001) guidelines as well as for a number of additional parameters that will either be regulated by DINAMA or of general concern. The IPPC-BAT (2001) standard establishes achievable emission levels for a certain number of key parameters for bleached kraft pulp mills. For this BAT analysis, the range of discharges rates was compared with the estimates provided by the mill proponents as shown in Table 2.7-1. The summary of mill emissions in the table is for the total emissions to each of the air and water receiving environments. As for fugitive emissions, in particular those from the wastewater treatment plant (including primary clarifier), these are expected to be very low for both the Botnia-Orion and ENCE-CMB

because of the low sulphidity level of the eucalyptus pulping process and because of the extensive spills collection system to be implemented at both mills.

Table 2.7-1: Comparison of Emission Rates (annual average)

	IPPC-BAT (2001) Guidelines	World Bank Group Emission Guidelines	Botnia-Orion Long term average	ENCE-CMB Long term average
Effluent				
Flow (m^3/ADt)	30 – 50	-	25	29
BOD_5 (kg/ADt)	0,3 – 1,5	-	0,3	0,6
COD (kg/ADt)	8 – 23	15	8,0	8,7
AOX (kg/ADt)	< 0,25	0,20	0,08	0,10
Suspended solids (TSS, kg/ADt)	0,6 – 1,5	-	0,7	0,9
Total nitrogen (kg/ADt)	0,1 – 0,25	0,4	0,15	0,17
Total phosphorus (kg/ADt)	0,01 – 0,03	0,05	0,012	0,017
Air emissions				
Particulate matter (kg/ADt)	0,2 – 0,5	-[7]	0,30	0,34
Total S (kg/ADt)	0,3 – 0,6	1,0	0,35	0,26
SO_2 (as S) (kg/ADt)	0,2 – 0,4	-	0,30	0,23
NO_x (as NO_2) (kg/ADt)	1,0 – 1,5	2,0	1,35	1,30
TRS (as S) (kg/ADt)	0,1 – 0,2	-	0,05	0,03
CO (kg/ADt)	-	-	1,7	1,7

The mill proponents' water and air discharge estimates were then compared with the average discharges from some of the best bleached eucalyptus kraft pulp (BEKP) mills in South America. It was found that the proposed emission rates for the new pulp mills were, for the most part, in the same order as these mills. Of particular interest for these projects, the proposed mills should achieve lower colour discharge rates in the long term than all compared mills in Brazil. Botnia-Orion and ENCE-CMB were also compared with the best

[7] The World Bank Group has a guideline for particulate matter in the recovery boiler of 100 mg/Nm^3. Where achieving 100 mg/Nm^3 is not cost-effective, an emissions level up to 150 mg/Nm3 is acceptable. Air emissions requirements are for dry gas, at 0°C and 1 atmosphere.

comparable company mills in Finland and Spain, and showed that the design experience of each company has been incorporated into the design process of the Orion and CMB BEKP.

The permit-setting process used by DINAMA was evaulated and found to be practical and rigorous and, through DINAMA's receiving environment monitoring program and permit renewal process, it will be ensured that the proposed pulp mills will have a minimum impact on the receiving environment. When benchmarked against other jurisdictions, DINAMA's standards were found to be amongst the world's most stringent.

Based on this comparative review and the experience of the CIS project team, the emission rate estimates provided by Bontia-Orion and ENCE-CMB are reasonable, and are consistent with BAT. Both mills have been designed to perform at or better in almost all cases, than the IPPC-BAT (2001) and Tasmanian-AMT (2004) standards, and will perform at world-class levels with regards to water and air emission rates.

Summary

The most widely accepted definition of BAT, and the basic standard that has been used for the design of the Botnia-Orion and ENCE-CMB pulp mills is the so-called IPPC-BAT (2001). IPPC-BAT (2001) is the design standard for new mills in the European Union, however has also been used by many other leading mills around the world, including the following:

- the Veracel mill in Brazil was designed to IPPC-BAT (2001);
- Arauco in Chile is in the process of retrofitting their Valdivia mill to the IPPC-BAT (2001) standard (particularly for their odorous gas systems); and
- Aracruz and Suzano in Brazil benchmark their mill environmental performance against the IPPC BAT (2001) standard.

In order to assess BAT for the Botnia-Orion and ENCE-CMB mills, a methodology was systematically executed for the purposes of this CIS. The methodology and results can be summarized as follows:

1. *Assessment of the mill's compliance with the emission levels achievable with the use of BAT:* Based on emission levels from the IPPC-BAT (2001) and Tasmanian-AMT (2004) standards, it was found that the mills are implementing BAT. Furthermore, a comparison was made between the proposed mill emission rates and other mills including state-of-the-art BEKP mills in Brazil, as well as other well-operated Botnia and ENCE mills. It was found that the proposed emission rates for the new pulp mills were generally in the same order or better than these mills.
2. *Assessment of whether the environmental regulating body in Uruguay, DINAMA, has a comprehensive plan to ensure the BAT standard will be met through their permitting process and requirements:* DINAMA is employing a staged process to issue management plans for each of the two pulp mills as engineering and

construction activities progress, which should eventually lead to the AAO or operating permit for the mills. Both concentration-based and loading-based discharge requirements are expected for the effluent, and well-defined atmospheric emission limits. The mill proponents and DINAMA are currently discussing monitoring and reporting requirements, which will be used as the basis for the operating permit renewal required every 3 years.

3. *Assessment of whether BAT has been included in the mill equipment design:* The summary of IPPC-BAT (2001), Tasmanian-AMT and certain USEPA Cluster Rule (2000) requirements has been summarized, and targeted issues have been discussed in greater detail in sections of Annex A. Both mills will employ state-of-the-art process technology.
4. *Assessment of BAT operating requirements:* The Botnia-Orion and ENCE-CMB mills were evaluated regarding their plans for solid waste management practices, monitoring plans including those implemented in other operating mills, training and motivation of mill personnel, process control, equipment maintenance, environmental management systems (EMS), and plans for communication with the community. Expectations for state-of-the-art practices in regards to these issues are in place for both mills.

In summary, based on the above analysis, the BEKP mills proposed by Botnia-Orion and ENCE-CMB are considered by EcoMetrix to be IPPC-BAT (2001) or better.

2.8 Schedules and Timelines

Figure 2.8-1 provides a timeline of present plans (current at the time of writing) for construction, first operations and full production for the two plants.

The worker numbers and traffic volume over time have been estimated for four project scenarios: the “no projects” scenario; Botnia only; ENCE only; and both Botnia and ENCE together. The employment and traffic trends are shown in Figures 2.8-2 and 2.8-3, respectively.

Figure 2.8-1: Projected Timeline for the Two Plants (Construction to Full Production)

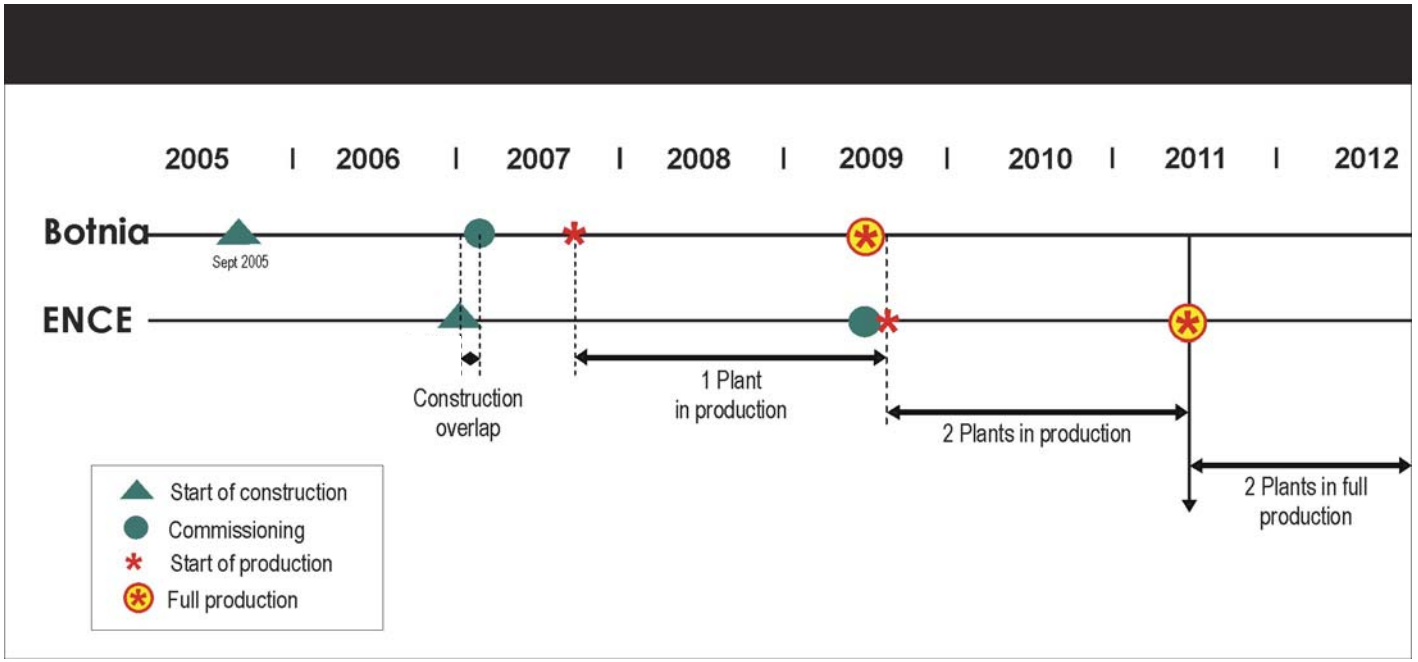


Figure 2.8-2: Projected Number of Workers

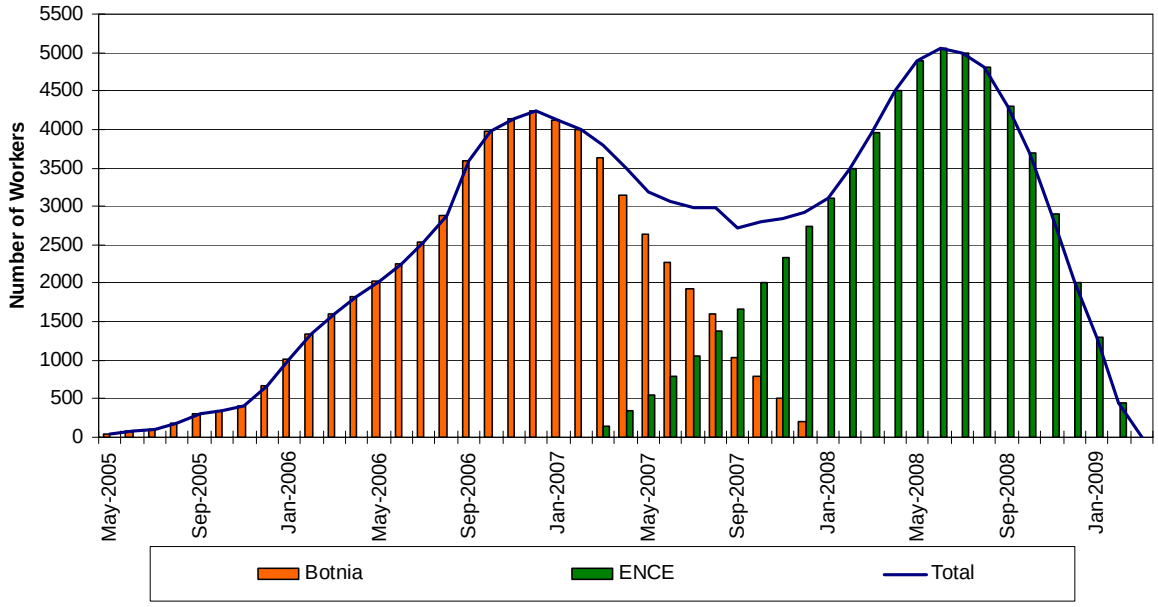
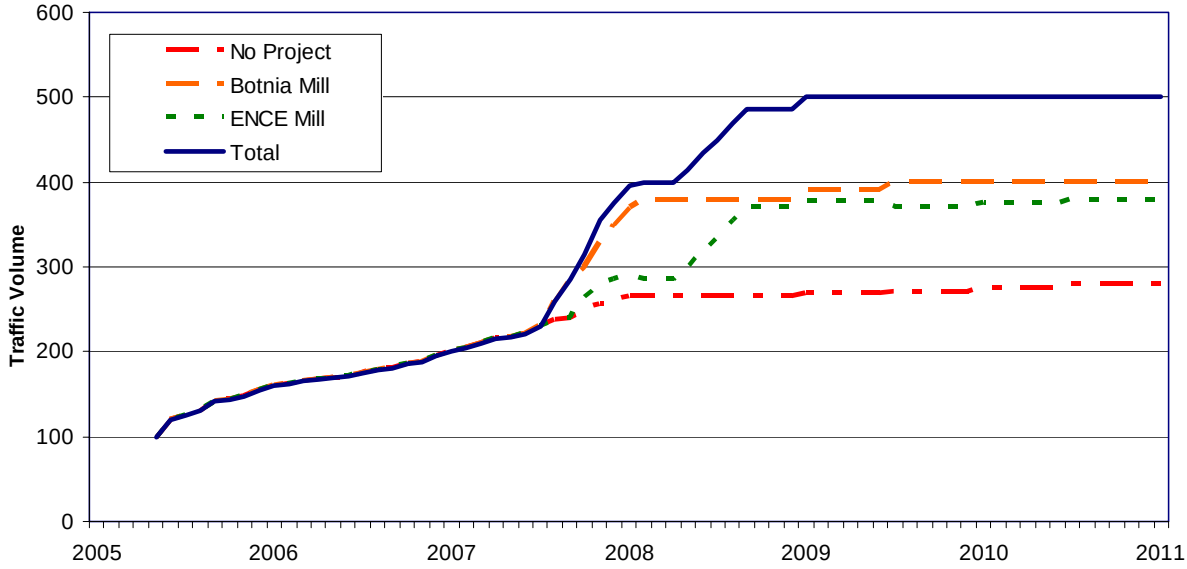


Figure 2.8-3: Projected Traffic Volume



3.0 ENVIRONMENTAL AND SOCIAL SETTING

The baseline environmental and social setting for the projects is presented in the following sections. This information provides the context from which the potential cumulative effects of the projects are assessed. It includes an overview of land features, air environment, aquatic environment, and social setting. Additional details are provided in Annexes C, D and E, relating to air quality assessment, water quality assessment and socio-economic assessment, respectively.

3.1 Overview of the Land Features

The western Uruguay region where the pulp mill sites and many of the eucalyptus plantation operations are located is characterized by gently rolling terrain primarily in agricultural use. About 50% of farms tend to be very large, and agricultural production is a mix of cattle grazing land, corn and soy production, and forest plantations (in descending order of importance). There are areas of natural tree growth in the landscape, usually in floodplains or low-lying areas (gallery forest), but such natural areas are mostly open-canopy, low-growing, deciduous forests that have been modified by grazing activity over the centuries since initial colonization.

There are no designated protected natural areas in the immediate vicinity of the pulp mill sites. The nearest are Potrero del Burro (or, Rincón de las Gallinas) (see Figure 3.1-1) about 12 km southwest of Fray Bentos, and Bosque Nacional Islas del Río Negro located south of Fray Bentos. Other designated protected areas include Esteros de Farrapos (a designated Ramsar site) and Islas Fiscales del Río Uruguay, located further upstream of the project sites.

Nearly 38% of the total land area of Paysandú, Río Negro and Soriano is dedicated to agriculture and 70% of all agricultural operations in the three departments involve dairy, beef cattle and sheep ranching. Approximately half of all agricultural operations in each of the departments – 2,400 in Paysandú; 1,361 in Río Negro and 2,197 in Soriano – constitute 100 ha or less. From 1985 to 2000, the three departments together experienced a 14-fold increase in the amount of land area devoted to plantation forestry in response to government legislation promoting forestry. At present, forest plantation accounts for 6.8% of cultivated land in Paysandú, 7.4% in Río Negro and 2.5% in Soriano. In Gualeguaychú department, approximately 30% of the total land area is dedicated to agriculture of which crop farming represents 19% of land use, cattle pasture represents 52%, and forestry represents 12%.

The primary road network in the Fray Bentos and Paysandú area is paved with widening and improvements still occurring in some areas. These activities have been funded in part by the World Bank through its Forest Transport Sector project loan to the Government of Uruguay. Many of the secondary roads are paved, and tertiary roads have gravel surfaces, but these are generally in good condition and well maintained. In this region (and

throughout Uruguay) the north-south road network is well developed and maintained, whereas the road network is not well developed in the east-west direction.

Figure 3.1-1: Major Watersheds and Natural Features

Large and small beach areas along the Río Uruguay are used for recreational purposes. The closest established recreational area to the project sites is Playa Ubici, on the east side of Fray Bentos, about 5 km from and within view from the Botnia project site. There are other recreational sites within and south of Fray Bentos; all are out of view of the Botnia Plant. Balneario Ñandubaysal is located to the west-northwest on the Argentina side of the river about 13 km from the Botnia project area (see Figure 1.1-1). Given its distance, the presence of the low-lying islands along the Argentina shoreline, and the difference in elevation between the Botnia site and the beach, some components of the Botnia project, especially the chimney, are visible in the distance from the Ñandubaysal beach, as is the international bridge and chimney of the now defunct meat processing plant in Fray Bentos.

3.2 Overview of the Aquatic Environment

The Río Uruguay is the aquatic environment of primary interest with respect to potential mill impacts, since this river will receive the treated effluents from both mills. The existing condition of the aquatic environment of the river is described in detail in Annex D, Section 3. It is summarized here, with respect to river setting and hydrology, water and sediment quality, and fish and invertebrate communities.

3.2.1 River Setting and Hydrology

The Río Uruguay is, after the Río Paraná, the most important river draining to the Río de la Plata. The watershed for the Río Uruguay covers a surface area of approximately 365,000 km^2, of which 51% is in Brazil, 33.5% is in Argentina and 15.5 % is in Uruguay. Figure 3.1-1 presents a map of the basin for the Río Uruguay which shows the locations of the project sites.

The morphology of the river changes along its approximately 1,800 km length. The upper and middle reaches above the Salto Grande Dam, are characterized as riverine environments with relatively narrow channel width, steep channel slope and various rapids. In contrast, the lower reaches are characterized as estuarine environments with a relatively wide and flat channel with numerous islands. It is within the lower reach where the two projects are located.

Through the lower reaches, the channel continues to change as the river travels across the lowlands of Uruguay and Argentina. The width of the river is the most obvious indicator of this change. Near the Salto Grande Dam, the river is generally less than 0.5 km wide. The river continues to widen to 1.8 km near Fray Bentos, to 6.0 km near Las Cañas, to a maximum of 20 km near Nueva Palmira.

As the river widens, its capacity to carry sediment gradually diminishes. This is most evident by the formation of the Río Uruguay Island Delta located below Paysandú. By Fray Bentos, most of the coarse sediment load is depleted, although the river still carries a considerable load of fine suspended sediment as evident by the high turbidity of the water.

Some of this fine sediment may settle in shallow embayments and sheltered areas such as Yaguareté Bay.

The average flow in the Río Uruguay at the Salto Grande dam is approximately 6,230 m^3/s, based on historic records over the period 1983 to 2003. However, flows can vary substantially based on season, precipitation and operation of the dam. As an example, the monthly average flow varied from a minimum of 500 m^3/s to a maximum of 22,500 m^3/s over the 20-year period of record.

The flow at Fray Bentos is expected to be somewhat higher than the flow at Salto Grande Dam due to the increased drainage area between the two locations. Prorating flow on a drainage area basis yields an estimate of the drought flow for the Río Uruguay at Fray Bentos. The annual, 5-year and 20-year drought flows are estimated to be 950, 640 and 400 m^3/s, respectively.

The flow in the river can be influenced by wind effects when the flow at the Salto Grande dam is very low. Regional winds over the Atlantic Ocean and local winds over the Río de la Plata cause wind seiche (which is a rise and fall of the water elevation in response to the wind). This wind seiche in turn can cause the flow within the Río Uruguay to temporarily increase or decrease in response. On rare occasions, the flow can reverse direction and travel upstream for short periods of time. These flow reversals have only been observed during extreme low flow conditions at the Salto Grande Dam and last for a few hours in duration. Flow reversals are not expected to occur when the flow at the dam is greater than 1,000 m^3/s (pers. comm. Piedra-Cueva, 2006).

3.2.2 Existing Water Quality

In general, the quality of water in the Río Uruguay is considered good but there are localized issues and exceedances of water quality criteria. In 1992, Estudio Nacional Ambiental (OPP-OEA-BID) concluded that the Río Uruguay is in good general condition, but noted water quality problems in some areas, including Bella Union, Salto, Concordia, Paysandú and the mouth of the Río Gualeguaychú. This localized deterioration of water quality was primarily attributed to runoff from areas of intense agricultural use and discharges from urban centers and industries with inadequate effluent treatment.

The quality of water in the Río Uruguay has been extensively studied by CARU from 1987 to date (e.g., CARU, 1993, 2005a). In addition, baseline water quality sampling has been conducted by the mills in association with each of the two projects. Water quality sampling has also been conducted for the CMB port facility.

Based on a review of the data contained in these documents, monitoring data for the vast majority of constituents shows compliance with applicable water quality standards, with the possible exception of fecal coliforms, dissolved oxygen, ammonia, phosphorus, chromium, iron and zinc. These exceedances can pose a risk to human health and aquatic life, affect

the aesthetic quality of recreational waters, and increase growth of aquatic plants in shallow embayments.

Water quality data for the 1997-2004 period in the vicinity of the two mill projects were summarized by CARU (2005a) and updated by GTAN (2006). Of particular interest, phenolics were found to frequently exceed the water quality criterion of 1 μg/L, with the highest values on the Argentina side of the river.

Some chemical parameters considered relevant to mill operations do not have water quality criteria, and have not been routinely measured in the Río Uruguay. These parameters include adsorbable organic halides (AOX), chlorophenolics, resin and fatty acids, dioxins and furans, and phytosterols. Special studies commissioned by Botnia (Tana, 2005, 2006) have documented baseline levels of these constituents in the river.

Table 3.2-1 presents a summary of water quality data for the Río Uruguay in the vicinity of the mill projects for parameters of particular interest to mill operations, based on a synthesis of data from the various sources.

Table 3.2-1: Summary of Water Quality Data for Key Parameters on the Rio Uruguay in the Vicinity of Fray Bentos

Parameter		
Total suspended solids (TSS)	Average 16 mg/L (2-58 mg/L) 4-41 mg/L	CARU (1993) Algoritmos (2006)
Biological oxygen demand (BOD)	Average 4 mg/L (1-10 mg/L) 3-5 mg/L 0.1-1.8 mg/L	CARU (1993) GTAN (2006) Algoritmos (2006)
Chemical oxygen demand (COD)	1-2 mg/L 20 mg/L <5-15 mg/L	Botnia (2004) GTAN (2006) Algoritmos (2006)
Total nitrogen (N)	Average 0.45 mg/L (0.19-0.93 mg/L) 0.35-1.10 mg/L	CARU (1993) Algoritmos (2006)
Total phosphorus (P)	Average 0.1 mg/L (0.04-0.24 mg/L) 0.13-0.22 mg/L	CARU (1993) Algoritmos (2006)
Nitrate (NO_3)	1-2 mg/L 0.2-5.9 mg/L 0.36-0.79 mg/L	Botnia (2004) Botnia (2005/06) Algoritmos (2006)
Adsorbable organic halides (AOX)	2-8 μg/L <2-12 μg/L <1-6.8 μg/L	Botnia (2004) Botnia (2005/06) Algoritmos (2006)
Chlorophenols	0.08-0.11 μg/L 1-12 μg/L	Tana (2005, 2006) Algoritmos (2006)
Phytosterols	ND[1] – 22 μg/L	Tana (2005, 2006)
Dioxins and Furans	ND[2] – 50 pg/L	Tana (2005, 2006)

[1] ND = <1 to <3 μg/L.
[2] ND = <0.2 to <2 pg/L.

3.2.3 Existing Sediment Quality

The sediments of the Río Uruguay were studied in the nearshore zone near Nuevo Berlin, Fray Bentos and Las Cañas (CELA, 2005, 2006) and specifically in Yaguareté Bay (CELA, 2005a,b), as part of Botnia's baseline characterization of the river. At most locations, the substrate type was predominantly sand, containing organic matter in the 1 to 6% range. Nitrogen and phosphorus were measured as indicators of nutrient enrichment. Both tended to be somewhat higher in the fall (April) as compared to summer months. In Yaguareté Bay in November/December, total phosphorus was 12 to 26 μg/g fresh weight (FW) of sediment, and nitrogen was 33 to 88 μg/g FW. Higher values of N in April were 38 and 416 μg/g FW, respectively.

Metal and organic contaminant data for Río Uruguay sediments have been collected over the years by CARU at various locations of interest. They indicate generally good sediment quality, with some locally high concentrations of chromium and copper, particularly downstream of urban centres.

3.2.4 Fish Community

The lower Río Uruguay supports more than 100 fish species. Generally, 17 species are captured regularly by the artisan fishermen of the area. The Uruguayan catch totals approximately 1,600 tons each year (DINAMA, 2003; CARU, 2005b). Based on recent catch statistics, the most important species are sabalo, boga, mullet, tarira, dorado and various catfishes (pati, armed, yellow). Sport fishing is also important. Favoured sportfish species include the golden dorado and some catfishes.

The fish community includes both mainstem and tributary species. The mainstem species reproduce and complete their life history in the main river channel, while tributary species migrate into tributaries, like the Río Paraná, to spawn and produce larvae. The sabalo and boga are both migratory, using the Río Paraná for spawning. Another migratory movement for the sabalo seems to be upriver towards the Salto Grande Dam. Spawning occurs both above and below the dam. The golden dorado is known to spawn directly below the dam, primarily in October to December.

Non-migratory fish species, such as carp and some catfishes, will spawn throughout the Río Uruguay, particularly in shallow embayments. Therefore, embayments in the vicinity of the mill projects, such as Yaguareté Bay, will likely be used for this purpose. They will also be used as nursery or feeding areas for the fry and juveniles of many species, including some migratory species. However, no major migratory fish species or species important to the fishery are known to spawn in the vicinity of the proposed mills.

3.2.5 Aquatic Invertebrates

The benthic invertebrate community in the lower Río Uruguay was characterized by CELA (2005, 2006). In most samples collected, dominant taxa were either tubificid worms, midge larvae or invasive mussels (golden mussel). Snails and clams were also common and were the dominant taxa in some samples. The tubificid worms are indicative of nutrient-enriched low oxygen conditions that many other species do not tolerate. Low oxygen conditions may exist in and near the sediments, even though the water column is well oxygenated.

The phytoplankton community is limited by the turbid condition of the Río Uruguay, which limits light penetration. The dominant species are diatoms and nanoplanktonic phytoflagellates, which are characteristic of turbulent and turbid environments. Blue-green algae also comprise a significant portion of the phytoplankton community, particularly in the summer months when algal blooms can occur. Green algae are present but less important.

The zooplankton community on the Río Uruguay consists of micro-crustaceans and rotifers, with larval forms of other invertebrates also numerically important. These larval forms are dominated by golden mussel larvae, but also include larvae of snails and hydroid coelenterates.

3.2.6 Contaminants in Aquatic Biota

Levels of contaminants in fish tissues in the vicinity of Fray Bentos were investigated by Tana (2005, 2006), and provide a baseline for chemicals of interest with respect to mill operations. These include dioxins and furans in fish flesh. In addition, CARU (2005b) has sampled fish flesh for levels of PCBs and organochlorine pesticides. All concentrations were below levels of concern for fish consumption.

3.3 Overview of the Social Setting

The area of the CIS encompasses the eastern Uruguayan departments of Río Negro, Soriano and Paysandú as well as the Río Uruguay littoral in the Argentine department of Gualeguaychú. This entire area is characterized by a relatively homogeneous population concentrated in a small number of urban centers situated among large areas of farmland, cattle pasture and forest plantations. The following section summarizes the key findings of a Social Assessment of this area, which is attached as Annex E.

Table 3.3-1 illustrates the population and population density of the four departments compared to the national populations of both countries. Within these departments there is a high concentration of population in urban areas, with almost nine out ten persons residing in cities or towns. The capital cities of Río Negro (Fray Bentos) and Soriano (Mercedes) account for about half of their respective departmental populations; three quarters of the departmental population of Paysandú and Gualeguaychú, live in the capital cities, which carry the same name as the departments.

Table 3.3-1: Population and Population Density in Paysandú, Río Negro, Soriano and Gualeguaychú

Location	Area (km^2)	2004 Population (000)	Population Density (per km^2)
Uruguay	175,016	3,164	18.1
Paysandú	13,922	113	8.1
Río Negro	9,282	54	5.8
Soriano	9,008	85	9.4
Argentina	273,699	36,577	13.4
Gualeguaychú	7,086	101	14.3

The age profile of the population is similar among all four departments with approximately half the population being 30 years or older. Each department shows a similar breakdown of population by sex, with a slight predominance of men in Río Negro and of women in Paysandú, Soriano and Gualeguaychú. However there are significant differences in the relative numbers of men and women according to the urban/rural location of the population: in urban areas there is a similar proportion of men and women; in rural areas men predominate, for example, by as much as 1.6:1.0 in Paysandú. Population forecasts for the Uruguayan departments to 2025 by the National Institute of Statistics show very low rates of population growth and a relative decline in the rural population, conforming to long-term national trends of steadily increasing urbanization.

Quality of life indicators – including rates of poverty, literacy, infant mortality, access to drinking water and sanitation – in all four departments are relatively high in comparison to other Latin American countries. Measured in terms of the United Nations Index of Human Development (IHD)[1], Uruguay ranked 46th of 177 countries with an IHD of 0.833 (including rankings of 0.837 for Río Negro, 0.835 for Soriano and 0.831 for Paysandú, respectively with the top ranking equal to 1.00). The latest available disaggregated data for Argentina (1999) shows an IHD of 0.826 for the entire country and 0.801 for the Province of Entre Ríos in which the department of Gualeguaychú is located. Life expectancy in the three Uruguayan departments averages 74.5 years and 71.6 years in Gualeguaychú.

While literacy rates are high in all departments (averaging 97.7%), only an average of 22.3% of the population fourteen years and older have completed primary school and only 20% have completed secondary school in the three Uruguayan departments. In Gualeguaychú, the comparable levels of population over 15 years of age having completed primary school is nearly 50%, and the percentage having completed secondary school is nearly 23%.

Table 3.3-2 illustrates household income in the three Uruguayan departments compared to levels recorded for the national capital. Household income levels in these departments are somewhat lower than the average for Latin American countries as a whole, which may in part be attributable to the economic crisis of 2002.

[1] The UN Human Development Index (HDI) is a comparative measure of poverty, literacy, education, life expectancy, and other factors for countries worldwide. It is a standard means of measuring well-being, especially child welfare. The index has been used since 1993 by the United Nations Development Programme in its annual report.

Table 3.3-2: Comparison of Monthly Household Income in CIS Study Area, 2004 (in current USD)

	Average	Median
Uruguay	702	509
Montevideo	853	617
Paysandú	556	447
Río Negro	476	395
Soriano	623	437
Argentina	1,285	-
Buenos Aires	1,394	-
Gualeguaychú	-	-

Approximately 56% of the population of the three Uruguayan departments is economically active while 68% of the Gualeguaychú department is economically active. There are large differences in unemployment between Río Negro and the other departments: the unemployment rate for Río Negro is 3.6% of the workforce, whereas in Paysandú it is 16.3% of the workforce and in Soriano the unemployment rate reaches 16.9% with a significantly higher 27% reported for Gualeguaychú.[2] An occupational profile of the area reveals that 22.4% of the active workforce in Gualeguaychú is employed in the public sector. The corresponding figures in Uruguay are: 21.4% for Río Negro, 17.7% for Paysandú, and 17.6% for Soriano.

In terms of employment by sector, the service sector is by far the most significant employer with an average of 70% of the active workforce of the four departments employed in this sector, which includes transportation, hotels and restaurants, banking, domestic service and retail trade. About 20% of the workforce is employed in the industrial sector (including manufacturing, construction and public utilities) and agriculture (farming, cattle ranching, forestry, hunting) accounts for the remaining 10%.

A much larger percentage of the population in the three Uruguayan departments are living at or below the poverty line than in Gualeguaychú (see Table 3.3-3). This assessment of impoverishment is based on the Unsatisfied Basic Needs method, which measures the extent to which the population is deprived of one or more basic needs including characteristics of housing, access to water and sanitation, access and achievement of education, dependency rate and other income-related indicators.

[2] Unemployment rate recorded in 2001, i.e., during the Argentine financial crisis.

Table 3.3-3: Percentage of Population and Households with Unsatisfied Basic Needs

Department	Percentage of Population	Percentage of Households
Paysandú	32	22
Río Negro	17	10
Soriano	27	17
Gualeguaychú	11	13

An indicator associated with the incidence of poverty for homes in the area is the existence of irregular settlement or non-permanent housing. The percentage of resident population in irregular settlements is close to zero in the three departments. Soriano presents the largest figure (0,08%) twice that of Paysandú (0.04%) and is four times greater than for Río Negro (0.02). The population in irregular settlements is concentrated in the urban locations. There are only two locations in Río Negro that register people in irregular settlements, three in Paysandú, and one in Soriano. In the two last departments, only the capital city registers irregular settlements.