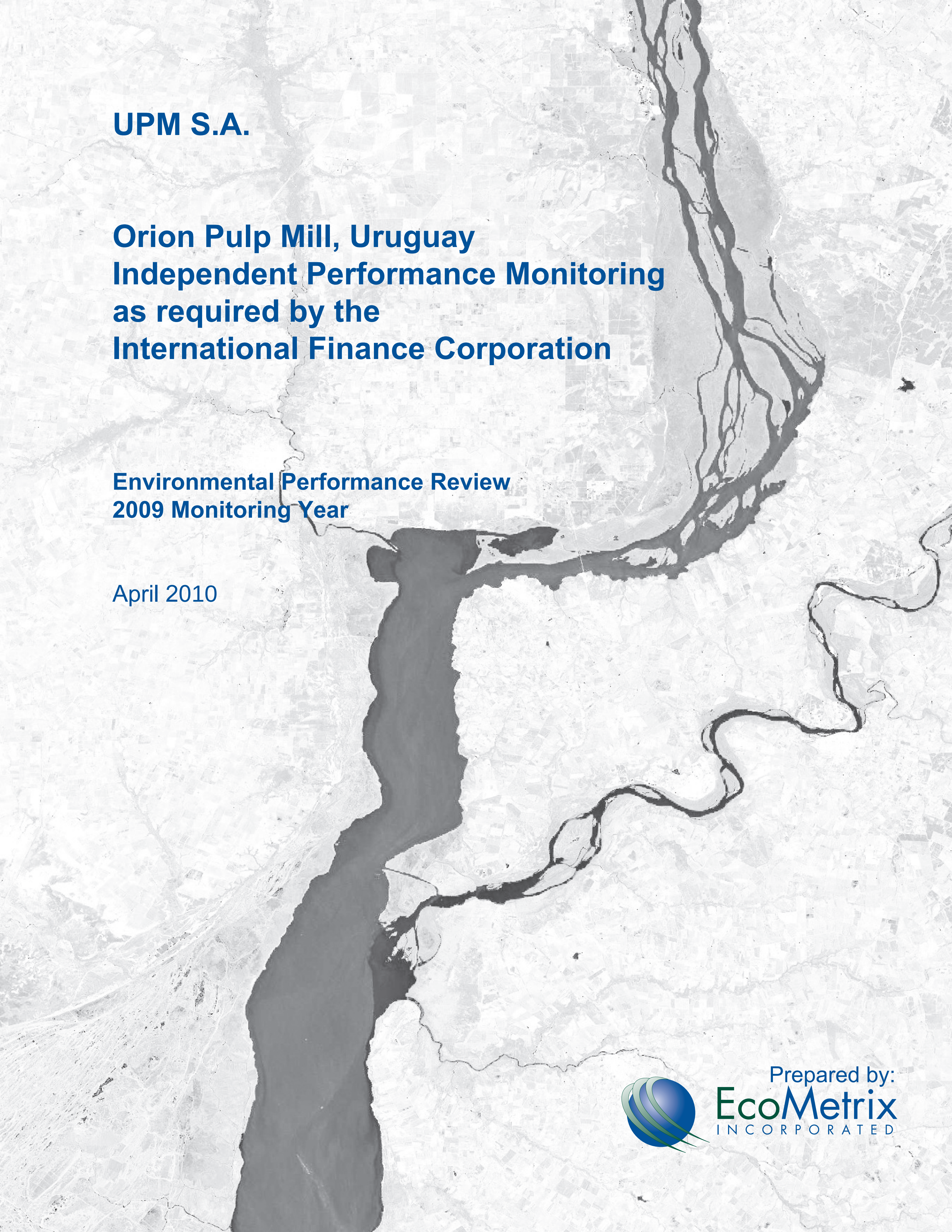

UPM S.A.

Orion Pulp Mill, Uruguay
Independent Performance Monitoring
as required by the
International Finance Corporation

Environmental Performance Review
2009 Monitoring Year

April 2010

Prepared by:
EcoMetrix
INCORPORATED

UPM S.A.

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Prepared by:

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April 2010

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EXECUTIVE SUMMARY

Overview

UPM S.A. (UPM), formerly Botnia S.A. (Botnia), developed the Orion project alongside the Río Uruguay approximately 5 km upstream (east) of the City of Fray Bentos in Uruguay. The project consists of a bleached Kraft pulp mill (the mill) designed to produce approximately 1,000,000 air dried tonnes of pulp on an annual basis (ADt/a). The mill was granted authorization to start production on 8 November 2007 from the Ministry of Housing, Territorial Planning and Environment (Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente, MVOTMA). Actual production began on 10 November 2007.

An environmental and social impact assessment (EIA) for the Orion project was prepared and publicly disclosed that describes the expected impacts of the project and the mitigation and enhancement measures to manage those impacts. The potential environmental and social impacts for the Orion project were also independently assessed and verified through a Cumulative Impact Study (CIS) commissioned by the International Finance Corporation (IFC). The CIS was completed in September 2006 by EcoMetrix Incorporated (EcoMetrix) and its consultants, SENES Consultants Limited (SENES) and Processys Incorporated (Processys).

To ensure that the key recommendations of the CIS were appropriately implemented and IFC environmental requirements complied with, Botnia and IFC prepared and agreed on an Environmental and Social Action Plan (ESAP) for the Orion project. This plan identified 16 actions which were achieved prior to the commissioning of the mill. For many of these actions, the minimum requirements specified in the ESAP were exceeded. In a few cases, additional actions were identified to ensure the intended long term outcome of the ESAP.

Purpose of Report

This report addresses a component of the ESAP, namely the Independent Monitoring of Environmental Performance of the mill. It is the fourth of a series of reports. The first report was prepared prior to commissioning of the mill to confirm compliance with the requirements of the ESAP. The second report was prepared following the first six months of operation to review the environmental performance of the mill during the initial start-up phase. The third report was prepared following the 2008 monitoring year and the first year of operation. This fourth report was prepared following the 2009 monitoring year and the second year of operation.

This report has the following specific mandate:

1. to provide an independent review and analysis of the data on air and water emissions based on actual performance of the mill during the twelve month period from 1 January 2009 to 31 December 2009;
2. to assess the actual environmental effects as compared to those predicted in the CIS.

These reports provide a comprehensive review of the environmental performance of the mill over the start-up phase. During this period, production was periodically interrupted to facilitate process changes to optimize operational efficiency and performance. Based on experience with other new modern pulp mills, these operational improvements continue through the first two years following initial start-up.

This evaluation draws upon the monitoring data obtained by UPM, the Dirección Nacional de Medio Ambiente (DINAMA), the Obras Sanitarias del Estado (OSE), the Laboratorio Tecnológico del Uruguay (LATU), and other independent laboratories. Baseline monitoring was undertaken prior to mill start-up by the Comisión Administradora del Río Uruguay (CARU) and is used in this report for water quality comparison purposes. The available monitoring data provide a direct measure of the emissions from the mill and the associated effects, if any, on the environment during the 2009 monitoring year.

Performance is measured through comparisons to specific benchmarks. For emissions, these benchmarks include the permit limits specified in the operating license, and the expected performance as predicted in the CIS and based on best available technologies (BAT) and experience with similar modern pulp mills. Performance measures account for the short-term variability expected during this start-up phase as process changes are implemented and operational efficiencies improve. These optimization measures were implemented over the past two years and, more recently, during the scheduled mill shut-down that occurred during November 2009.

From this review and to this point in time, all indications are that the mill is performing to the high environmental standards predicted in the EIA and CIS, and in compliance with Uruguayan and IFC standards. These results are also consistent with the performance measures for other modern mills. The bases of these conclusions are provided in the following sections.

Mill Production

During the 2008 monitoring year, the mill produced approximately 1,080,000 ADt of pulp, as compared to the reference annual production of 1,000,000 ADt.

Effluent Discharge Characteristics

The Orion mill discharges the treated final effluent to the Río Uruguay through a submerged, multi-port diffuser. The operating license for the mill requires that UPM monitor the rate and quality of this discharge. These data are reviewed in Section 3.0 for the purpose of quantifying the actual rate and quality of the final effluent as compared to the limits specified by DINAMA and to the expected loadings predicted in the CIS. The main findings from this review are summarized in the following points:

- The average discharge rate during the 2009 monitornig year was 0.80 m^3/s in comparison to an expected discharge rate of 0.83 m^3/s predicted in the CIS.
- The mill has complied with the maximum concentration limits specified by DINAMA for total phosphorus, total nitrogen, adsorbable organic halogens (AOX), pH, ammonia, nitrate, sulphide, oil and grease, mercury, arsenic, cadmium, copper, chromium, nickel, lead, zinc and dioxin and furan.
- The concentration of 5-day biochemical oxygen demand (BOD_5) exceeded the respective maximum concentration limits on four days in June 2009, and levels of fecal coliform exceeded the respective maximum concentration limits on two days in June 2009 and two days in December 2009. Corrective actions were taken and a contingency report was prepared and filed with DINAMA. Human health and aquatic life would have been fully protected at all times.

- The mill has complied with the allowable monthly maximum load limit as specified by DINAMA for all regulated parameters, which are BOD_5, chemical oxygen demand (COD), TSS, total phosphorus, total nitrogen and AOX.
- On a production basis, the monthly maximum load for COD, TSS, ammonia, total nitrogen, total phosphorus and AOX was below the expected load as predicted in the CIS. The monthly maximum load of BOD_5 was below the expected load predicted in the CIS for all months except June due to the events discussed above.
- The annual average load for COD, TSS, ammonia, total nitrogen, total phosphorus and AOX was below the expected long term average load as predicted in the CIS. The annual average load of BOD_5 was comparable to the expected long term average load, and the annual average load of color was greater than the expected long term average load for color. Color is an aesthetic parameter that does not affect aquatic life at the low values reported.

Water Quality of the Río Uruguay

Water quality of the Río Uruguay was monitored by DINAMA at 16 stations along the river. Data for five surveys were available for the 2009 monitoring year. The February 2009 survey was conducted during fairly typical summer low flows, and the other surveys were conducted during moderate to high flows. Water quality was also monitored by the OSE, who are responsible for the treatment and distribution of potable water to the community of Fray Bentos. These data are evaluated in Section 4.0 to determine the potential effect of the effluent discharge on the water quality of the Río Uruguay. Data are compared to surface water quality criteria, baseline water quality, and between upstream and downstream monitoring stations in order to classify the water quality and quantify any potential temporal or spatial change. These data are also compared to predictions from the CIS to verify its conclusions. The main findings are summarized in the following points:

- The water quality of the Río Uruguay is considered to be of high quality since the concentrations of indicator parameters are well below the most restrictive of the applicable Uruguayan and CARU standards. These parameters include: pH, dissolved oxygen, BOD_5, nitrate, turbidity, fluoride, chloride, sulfate, R.A.S., cyanide, arsenic, boron, copper, chromium, mercury, nickel, zinc, and total phenols. As noted in the CIS, exceptions include bacteria, total phosphorus and iron, which exceeded the most restrictive standard prior to commissioning of the mill due to natural and anthropogenic sources throughout the watershed.
- Mercury levels are generally below the analytical detection level and below the most restrictive water quality standard. However, mercury was detected at two monitoring stations during April 2009 at levels above the most restrictive water quality standard. DINAMA investigated these observations but the source was not identified. Elevated mercury levels were reported at one or more monitoring stations prior to start-up of the mill, and therefore sources of mercury unrelated to the mill may exist in the watershed.
- A comparison of the monitoring data pre- and post-commissioning of the mill shows that the water quality of the Río Uruguay has not changed as a result of the mill. Conductivity and AOX showed a small increase in the immediate vicinity of the

diffuser during two surveys that could be attributed to the mill discharge. Other differences are attributed to sources unrelated to the mill.

- The water quality between the mill and Fray Bentos is comparable to the water quality further upstream beyond the influence of the mill, indicating that the mill has not affected water quality within the Río Uruguay.
- The CIS concluded that the water quality within the Río Uruguay would remain in compliance with surface water quality standards of DINAMA and CARU (with the noted exception of total phosphorus due to its high baseline concentration due to natural and anthropogenic sources throughout the watershed); and that trace levels of wastewater from the mill would not adversely affect water quality. The water quality monitoring results from DINAMA confirm these conclusions.

Sediment Quality of the Río Uruguay

Sediments are an important component of the aquatic ecosystem as they provide habitat for a wide range of organisms that live in or on them. These organisms are an integral part of the aquatic food chain and therefore represent an important pathway for exposure to chemicals that may accumulate in the sediment. Sediment quality of the Río Uruguay is monitored by DINAMA at 9 of the 16 water quality monitoring stations. Data are available for February and June during the 2009 monitoring year. These data are evaluated in Section 5.0 to determine the potential effect of the effluent discharge on the sediment quality of the Río Uruguay. Data are compared to international sediment quality guidelines, baseline sediment quality, and between upstream and downstream monitoring stations in order to quantify any potential temporal or spatial change. These data are also compared to predictions from the CIS to verify its conclusions. The main findings are summarized in the following points:

- The sediment within the Río Uruguay is considered to be of high quality and protective of aquatic life. The sediment quality at monitoring locations near the mill discharge is within international sediment quality guidelines for indicator parameters, including: arsenic, cadmium, copper, chromium, mercury, lead, zinc, total PCBs, PAHs, and dioxin and furan.
- A comparison of the monitoring data pre- and post-commissioning of the mill shows that the sediment quality of the Río Uruguay has not changed as a result of the mill.
- The sediment quality near the discharge and within Yaguareté Bay is comparable to the sediment quality further upstream beyond the influence of the mill indicating that the mill has not affected sediment quality within the Río Uruguay.
- The available monitoring data verifies the conclusion of the CIS that the mill would not affect the sediment quality within the Río Uruguay.

Biota of the Río Uruguay

The water and sediment quality of the Río Uruguay is within standards considered suitable for the protection of aquatic life. This conclusion is verified based on the results of comprehensive biological monitoring programs undertaken by LATU, DINAMA and ÅF-Consult Oy. The results of these biological monitoring programs are presented in Section 6.0. They include comparisons of biological indicators and analyses of the biological communities within the Río Uruguay. The main findings are summarized in the following points:

- These monitoring programs conclude that the biological communities within the Río Uruguay have not been affected by the mill discharge.
- All indicators of the general health of the aquatic ecosystem have remained unchanged between periods pre- and post- mill start-up, and between areas near the discharge and areas beyond its influence.
- The algal community health within the Río Uruguay has not been affected by the mill discharge. Excessive growth of algae was reported in February 2009, although investigations by DINAMA concluded that the algal bloom was not attributed to the mill discharge nor was the effluent from the mill implicated in the expansion or growth of the bloom within the river.
- The zooplankton and benthic macroinvertebrate communities have not been affected by the mill discharge. Health indicators have remained unchanged between periods pre- and post- mill start-up, and between reference and exposed areas.
- The fish communities have not been affected by the mill discharge. Health indicators have remained unchanged since start-up of the mill. These indicators include species diversity, size class distribution, general condition, reproductive and metabolic indices, and chemical analysis of bile and tissue.
- Fish usability has remained unchanged since start-up of the mill. Levels of dioxin, furan, PCB, mercury and lead are well below limits set in the European Union and Canada. There is no limitation to human consumption of the studied fish.

Air Emissions

The air emissions for the Orion mill are routinely monitored as required by DINAMA. These data are reviewed in Section 7.0 to compare the actual air emissions to limits specified by DINAMA and to the expected loadings predicted in the CIS. The main findings from this review are summarized in the following points:

- The air emissions from the mill have remained well within the allowable permit limits specified by DINAMA. The concentrations of total particulate material (TPM), sulphur dioxide (SO_2), nitrogen oxide (NO_x) and total reduced sulphur (TRS) have remained below the respective threshold values within the required 90% frequency.
- The air emissions are well below the expected loads predicted in the CIS for SO_2, TPM, TRS and carbon monoxide (CO).
- The load for NO_x is below the World Bank Group emission guideline and below criteria identified as being best available technology (BAT) based on pulp production only (excluding emissions associated with power production). The emissions are comparable to, but generally above, the expected maximum value predicted in the CIS. Optimization measures have been implemented over the first two years of operation. Further optimization of the recovery boiler and lime kiln will continue in the future in an effort to further reduced emissions of NO_x.

- The emissions of TRS are below the expected emissions predicted in the CIS. Incidents of malodorous gas release are discussed in the section on ambient air quality.

Ambient Air Quality

Air quality is measured at a monitoring station located between Fray Bentos and the mill. The available data are evaluated in Section 8.0 to assess the potential effect of the mill operations on the ambient air quality. The main conclusions from this review are summarized in the following points:

- The air quality near the City of Fray Bentos is considered to be of high quality since the concentrations of the indicator parameters CO, NO_x, SO_2, inhalable particulate material (PM_{10}) and total suspended particulate (TSP) are well below the ambient air quality objectives specified by DINAMA in the Autorización Ambiental Previa (AAP).
- The slight variations in air quality near Fray Bentos between the periods pre- and post-start-up are within the range of natural variability. The pattern of variability is inconsistent since concentrations have increased for some parameters (e.g., CO, SO_2 and TRS) and decreased for others (e.g., NO_x). Differences are small relative to natural variability, remain well below the respective effects threshold, and do not adversely affect human health or the aesthetic environment.
- The air quality objective for TRS was exceeded on eight occasions and odors were detected on four occasions during the 2009 monitoring year. Objectionable odors were detected in the City of Gualeguaychú on 26 January and in the City of Fray Bentos on 27 February. These two incidents were attributed to upset conditions at the mill and were reported to DINAMA. DINAMA concluded that the company complied in all respects with the contingency response plan. Mild odors were detected on the Libertador General San Martin International Bridge on 13 March and in the City of Fray Bentos and Playa Ubici on 19 May but the source of odor was not identified.
- The frequency and intensity of incidents of odor detected at Fray Bentos, Playa Ubici, the Libertador General San Martin International Bridge and Ñandubaysal were predicted in the CIS. The one confirmed incident of odor from the mill detected in Gualeguaychú was not explicitly predicted in the CIS but does fall within the range of uncertainty invariably associated with modeling and projecting the most likely scenarios/impacts. These uncertainties include weather conditions, the duration of an upset condition, and the presence of other concurrent if uncommon conditions such as odors from the municipal sewers within the City of Gualeguaychú.
- The observations during the 2009 monitoring year are consistent with the conclusions of the CIS. The ambient air quality has remained well within the levels predicted in the CIS and objectives of the operating permit for the mill, and therefore there is no indication of adverse effects to human health.

1.0 INTRODUCTION

1.1 Overview

UPM S.A. (UPM), formerly Botnia S.A. (Botnia), developed the Orion project alongside the Río Uruguay approximately 5 km upstream (east) of the City of Fray Bentos in Uruguay. The project consists of a bleached Kraft pulp mill (the mill) designed to produce approximately 1,000,000 air dried tonnes of pulp on an annual basis (ADt/a). The wood is sourced from established eucalyptus plantations within western and central-north Uruguay. The mill was granted authorization to start production on 8 November 2007 from the Ministry of Housing, Territorial Planning and Environment (Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente, MVOTMA). Actual production began on 10 November 2007.

An environmental and social impact assessment (EIA) for the Orion project was prepared and publicly disclosed that describes the expected impacts of the project and the mitigation and enhancement measures to manage those impacts. The potential environmental and social impacts for the Orion project were also independently assessed and verified through a Cumulative Impact Study[1] (CIS) commissioned by the International Finance Corporation (IFC). The CIS was completed in September 2006 by EcoMetrix Incorporated (EcoMetrix) and its consultants, SENES Consultants Limited (SENES) and Processys Incorporated (Processys).

It is important to note by way of context, the CIS assessed the combined environmental and social impacts for the Orion project and a second proposed pulp mill nearby to have been built by ENCE (since relocated). Therefore, the study can be considered to have overstated the potential impacts given that the Orion mill is now the only one operating in the area of Fray Bentos.

To ensure that the key recommendations of the CIS were appropriately implemented and IFC environmental requirements were complied with, Botnia and IFC prepared and agreed on an Environmental and Social Action Plan (ESAP) for the Orion project. A copy of the ESAP is available at the websites of the IFC:

www.ifc.org/ifcext/disclosure.nsf/content/Uruguay_Pulp_Mills

The ESAP identifies 16 specific actions to be carried out, relating to the following: 1. ISO certification; 2. hazardous materials; 3. emergency preparedness and response; 4. transportation; 5. community development; 6. conservation; 7. solid waste; 8. groundwater monitoring; 9. independent verification of process and preparedness; 10. independent monitoring of environmental and social performance; 11. plantations; 12. public grievance; 13. public disclosure; 14. municipal water supply; 15. municipal wastewater; and 16. chemical recovery of black liquor from Pamer Papelera Mercedes S.A.

Prior to the commissioning of the mill, EcoMetrix undertook an independent review to confirm compliance with the commitments detailed in the ESAP[2]. It concluded that the

[1] EcoMetrix Incorporated, 2006. Cumulative Impact Study, Uruguay Pulp Mills. A report prepared for the International Finance Corporation. September 2006.

[2] EcoMetrix Incorporated, 2007. Orion Pulp Mill, Uruguay. Independent Performance Monitoring as Required by the International Finance Corporation. Phase 1: Pre-Commissioning Review. November 2007.

actions identified in the ESAP had been addressed, and, for many of the identified actions, the minimum requirements had been exceeded. EcoMetrix also undertook a review of the environmental performance of the mill following the first six-months of operation and following the 2008 monitoring year. These reviews showed that the mill performed to the high environmental standards predicted in the EIA and CIS, and the mill is in compliance with Uruguayan and IFC standards. These reports are available through the IFC website listed above.

1.2 Purpose of Report

This report addresses a component of Action No. 10, Independent Monitoring of Environmental and Social Performance. It is the fourth of a series of reports. The first report, referenced above, was prepared prior to commissioning of the mill to confirm compliance with the requirements of the ESAP. The second report[3] was prepared following the first six months of operation to review the environmental performance of the mill during the initial start-up. The third report[4] was prepared following the 2008 monitoring year and the first year of operation. This fourth report was prepared following the 2009 monitoring year and the second year of operation.

This report has the following specific mandate:

1. to provide an independent review and analysis of the data on air and water emissions based on actual performance of the mill during the twelve month period from 1 January 2009 to 31 December 2009;
2. to assess the actual environmental effects as compared to those predicted in the CIS.

These reports provide a comprehensive review of the environmental performance of the mill over the start-up phase. During this period, production was periodically interrupted to facilitate process changes to optimize operational efficiency and performance. Based on experience with other new modern pulp mills, these operational improvements continue through the first two years following initial start-up.

1.3 Methodology

Comprehensive monitoring of air and water emissions was undertaken by UPM, as outlined in Table 1.1. These data provide a detailed characterization of the quantity and quality of the air and water emissions, and a direct measure of the operational efficiency and performance of the mill to this point in time. This information is used by UPM to identify areas for further improvement and optimization. It is also used by the Dirección Nacional de Medio Ambiente (DINAMA) to verify that the mill is operating according to the authorization

[3] EcoMetrix Incorporated, 2008. Orion Pulp Mill, Uruguay. Independent Performance Monitoring as Required by the International Finance Corporation. Phase 2: Six-Month Environmental Performance Review. July 2008.

[4] EcoMetrix Incorporated, 2009. Orion Pulp Mill, Uruguay. Independent Performance Monitoring as Required by the International Finance Corporation. Phase 3: Environmental Performance Review, 2008 Monitoring Year. March 2009.

limits specified in the environmental authorizations for the mill (Autorización Ambiental Previa, AAP; Autorización de Desagüe Industrial, ADI).

Monitoring has also been conducted by DINAMA, the Obras Sanitarias del Estado (OSE), the Laboratorio Tecnológico del Uruguay (LATU), and other independent laboratories to evaluate the potential effects of the mill operations on the ambient environment. Baseline monitoring was undertaken prior to mill start-up by the Comisión Administradora del Río Uruguay (CARU) and is used in this report for water quality comparison purposes.

Comprehensive field surveys have been undertaken along the Río Uruguay to measure water quality, and an air monitoring station has been constructed near the City of Fray Bentos to measure ambient air quality. These data provide a basis to confirm that the authorization limits for air and water emissions from the mill are protective of human health and the environment, and provide a basis to confirm that the various predictions of environmental effect are valid to this point in time.

These data for emissions and environmental monitoring are reviewed and analyzed herein to provide an independent evaluation of environmental performance and assessment of potential environmental effects during the 2009 monitoring year.

Table 1.1: Summary of Emissions Monitoring Program

Media	Location	Parameter	Frequency
Effluent quality	• Outlet from the effluent treatment plant	• pH • COD • BOD_5 • SS • AOX • N • P • Conductivity • >40 additional parameters	• Daily • Daily • Daily • Daily • Weekly • Weekly • Weekly • Daily • Parameter specific
Air emission quality	• Stack recovery boiler • Lime furnace • Gas boiler GOL • Gas boiler GOS	• SO_2, TRS, NO_x, Dust, CO • SO_2, TRS, NO_x, Dust • SO_2, TRS • SO_2, TRS, NO_x	• Continuous • Continuous • Continuous • Continuous

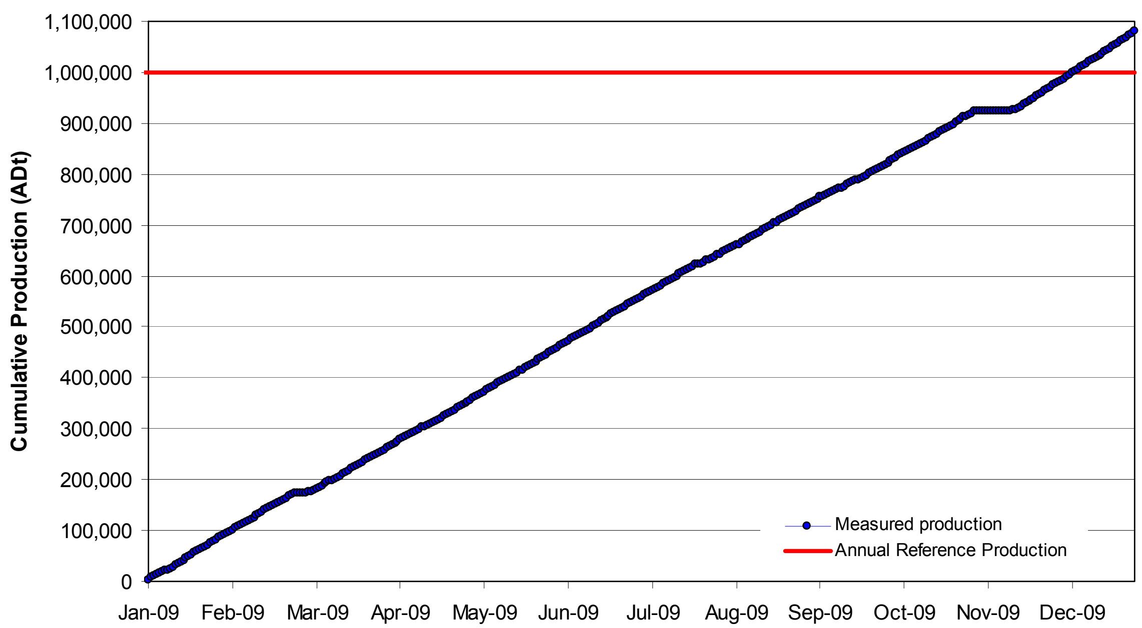
2.0 MILL PRODUCTION

During the 2009 monitoring year, the mill produced approximately 1,080,000 ADt of pulp, as summarized in Table 2.1 and Figure 2.1. In comparison, the reference annual production for the mill is 1,000,000 ADt (based on a reference daily production of 2,857 ADt/d and 350 operating days per year). Note that the production during November 2009 was reduced due to the scheduled shut-down of the mill to facilitate routine maintenance and further process optimizations.

Table 2.1: Mill Production during the 2009 Monitoring Year

Month	Average Daily Production (ADt/d)
January 2009	3,154
February 2009	2,700
March 2009	2,969
April 2009	3,024
May 2009	3,211
June 2009	3,234
July 2009	2,924
August 2009	3,021
September 2009	2,716
October 2009	3,174
November 2009	1,787
December 2009	3,529

Figure 2.1: Cumulative Mill Production during the 2009 Monitoring Year



3.0 EFFLUENT DISCHARGE CHARACTERISTICS

3.1 Overview

The Orion mill discharges treated final effluent to the Río Uruguay through a submerged, multi-port diffuser. The operating license for the mill requires that UPM monitor the rate and quality of this discharge. These data are reviewed in the following section to compare the actual loadings from the mill to limits specified by DINAMA in the ADI and to expected loadings predicted in the CIS. The main findings from this review are summarized in the following points:

- The average discharge rate during the 2009 monitoring year was 0.80 m^3/s in comparison to an expected discharge rate of 0.83 m^3/s predicted in the CIS.
- The mill has complied with the maximum concentration limits specified by DINAMA for total phosphorus, total nitrogen, adsorbable organic halogens (AOX), pH, ammonia, nitrate, sulphide, oil and grease, mercury, arsenic, cadmium, copper, chromium, nickel, lead, zinc and dioxin and furan.
- The concentration of 5-day biochemical oxygen demand (BOD_5) exceeded the respective maximum concentration limits on four days in June 2009, and levels of fecal coliform exceeded the respective maximum concentration limits on two days in June 2009 and two days in December 2009. Corrective actions were taken and a contingency report was prepared and filed with DINAMA. Human health and aquatic life would have been fully protected at all times.
- The mill has complied with the allowable monthly maximum load limit as specified by DINAMA for all regulated parameters, which are BOD_5, chemical oxygen demand (COD), TSS, total phosphorus, total nitrogen and AOX.
- On a production basis, the monthly maximum load for COD, TSS, ammonia, total nitrogen, total phosphorus and AOX was below the expected load as predicted in the CIS. The monthly maximum load of BOD_5 was below the expected load predicted in the CIS for all months except June due to the events discussed above.
- The annual average load for COD, TSS, ammonia, total nitrogen, total phosphorus and AOX was below the expected long term average load as predicted in the CIS. The annual average load of BOD_5 was comparable to the expected long term average load, and the annual average load of color was greater than the expected long term average load for color. Color is an aesthetic parameter that does not affect aquatic life at the low values reported.
- From this review and to this point in time, all indications are that the mill is continuing to performing to the high environmental standards predicted in the EIA and CIS, and in compliance with Uruguayan and IFC standards. These results are also consistent with the performance measures for other modern mills.

3.2 Mill Effluent Discharge Rate

The effluent discharge rate from the mill to the Río Uruguay has been monitored on a continuous basis since start-up of the mill. The available data are presented in Figure 3.1. The average effluent discharge rate during the 2009 monitoring year was 0.80 m^3/s. In comparison, the expected discharge rate predicted in the CIS was 0.83 m^3/s.

3.3 Mill Effluent Quality

The quality of the mill effluent is monitored on a routine basis as per the schedule presented in Table 1.1. Available data are presented in Figure 3.2 for conventional parameters associated with pulp mill effluents, and summarized in Tables 3.1, 3.2 and 3.3 for a more comprehensive list of parameters.

These data provide for a comprehensive evaluation of the liquid emissions from the mill during the 2009 monitoring year. They are compared to the respective concentration limits in Figure 3.2 and to the allowable maximum monthly load in Figure 3.3. Both of these limits are specified in the ADI. These data are also compared to the expected monthly maximum load from the CIS in Figure 3.3, which is based on best available technologies and experience with similar modern pulp mills. Together, these comparisons provide for a realistic assessment of the operational performance of the mill during this period.

Annual average loads during the 2009 monitoring year are presented in Table 3.4 and compared to the respective permit limits. The expected long-term average loads predicted in the CIS are also presented for reference but not directly compared since they are based on long term performance of the mill beyond the two year start-up phase and following mill optimization. These optimization measures were implemented throughout the year and, more recently, during the scheduled mill shut-down that occurred during November 2009.

The effluent quality is discussed in the following sections.

3.3.1 Conventional Parameters

The temperature of the mill effluent averaged 28ºC, and ranged from 19ºC to 31ºC based on a daily average. The temperature was 1ºC above the permit limit of 30ºC on 4 days during the summer of 2009. These occasions corresponded to a period when the water temperature within the Río Uruguay was near 30ºC. The permit limit of 30ºC is based on end-of-pipe quality standards from Article 11 of Decree 253/79 rather than site-specific environmental considerations. The expected maximum temperature from the CIS of 30ºC was also based on Decree 253/79, however, as discussed in the CIS, the Río Uruguay has considerable capacity to assimilate the thermal load from the mill and any potential change in water temperature would be minimal, limited to the immediate vicinity of the diffuser and not adversely affect the environment.

The conductivity of the mill effluent averaged 3,565 µS/cm, and ranged from 295 µS/cm to 7,308 µS/cm. The operating licence for the mill does not specify a permit limit for conductivity as it is generally not considered a parameter of environmental concern at the levels typically reported by pulp mills. In comparison, the expected daily maximum and annual average conductivities from the CIS were 8,000 µS/cm and 4,000 µS/cm, respectively.

The pH of the mill effluent ranged from 6.9 to 8.0, which is within the typical range for the ambient waters of the Río Uruguay and within the permit limits of 6.0 to 9.0. The expected pH from the CIS was also within the range of 6.0 to 9.0. (Note, several pH measurements are identified as erroneous since they were taken during period when the monitoring equipment was being serviced).

The color of the mill effluent averaged 679 u.c., and ranged from 250 u.c. to 2,000 u.c.. The permit does not specify a limit for color. The maximum monthly load of color was 27 kg/ADt which is higher than the expected monthly maximum load of 10 kg/ADt predicted in the CIS, and the annual average load of color was 17 kg/ADt which is also higher than the expected annual average load of 9 kg/ADt predicted in the CIS. The expected color within the Río Uruguay as predicted in the CIS will change proportionally, although the potential change remains small and within the natural variability of the river. Color loadings have remained comparable to those reported during the 2008 monitoring year.

The TSS of the mill effluent averaged 14 mg/L, and ranged from 4 mg/L to 76 mg/L. The maximum monthly load of TSS during this twelve-month period was 1.7 t/d, in comparison to a permit limit of 3.7 t/d. On a production basis the load was 0.63 kg/ADt which is below the expected load of 1.3 kg/ADt predicted in the CIS. TSS loadings during the 2009 monitoring year are lower than those reported during the 2008 monitoring year.

3.3.2 Oxygen Demand

Oxygen demand is characterized by COD and BOD_5. Both are used as indicators of the operating performance of the wastewater treatment system, whereas BOD_5 is also used as a basis to assess the environmental effect on dissolved oxygen levels within the receiving environment.

The COD of the mill effluent averaged 264 mg/L, and ranged from 136 mg/L to 590 mg/L. The maximum monthly load was 31.2 t/d, which is well below the permit limit of 56 t/d. On a production basis, the maximum monthly load was 9.6 kg/ADt in comparison to an expected load of 15 kg/ADt predicted in the CIS. The annual average load was 6 kg/ADt in comparison to an expected load of 8 kg/ADt and permit limit of 15 kg/ADt.

The BOD_5 of the mill effluent averaged 13 mg/L, although the concentration exceeded the daily maximum permit limit of 60 mg/L during four days in June 2009. A report was issued to DINAMA outlining the cause of these events and mitigation steps that have been taken to restore the level of treatment previously achieved. These exceedances are attributed to elevated influent loadings from brown stock washing. The exceedances occurred over four consecutive days because the test procedure for BOD_5 requires a timeframe of five days to complete. Corrective measures were implemented as soon as the first exceedance was identified. The mill has since implemented an alarm system based on instantaneous turbidity measures to enable early detection of and rapid response to elevated influent loadings. The mill has also implemented improved procedures for washing the Drum Displacer-washers in order to reduce the influent loadings from brown stock washing.

From an environmental perspective, these exceedances would have had a negligible effect on the dissolved oxygen levels and hence on aquatic biota within the Río Uruguay since the assimilative capacity of the river is significant. At the maximum concentration of 83 mg/L BOD_5, the consumption of dissolved oxygen is estimated to be have been less than 0.07 mg/L, which is significantly lower than the background level of dissolved oxygen of approximately 8 mg/L. Aquatic life within the Río Uruguay would have been fully protected at all times.

The maximum monthly load of BOD_5 was 2.5 t/d in comparison to the permit limit of 2.6 t/d, and, on a production basis, the maximum monthly load was 0.76 kg/ADt in comparison to the expected monthly maximum load of 0.7 kg/ADt predicted in the CIS. The maximum monthly load of BOD_5 was elevated as a result of the four exceedances previously discussed. On an annual basis, the BOD_5 load was 0.31 kg/ADt, in comparison to an expected load of 0.30 kg/ADt and well below the permit limit of 0.70 kg/ADt.

3.3.3 Nutrients

Nutrients are characterized by total nitrogen and total phosphorus. Elevated levels of nutrients promote the growth of algae and aquatic vegetation. Generally the rate of growth is limited by one or the other of these nutrients, but not both. Where the level of total nitrogen is the limiting nutrient for growth, the growth of algae is insensitive to small changes in the level of total phosphorus.

Total nitrogen is a measure of all organic and inorganic forms of nitrogen (TKN, nitrite and nitrate). The total nitrogen of the mill effluent averaged 2.1 mg/L, which is well within the permit limit of 8 mg/L based on an annual average. The maximum monthly load was 0.24 t/d, well below the permit limit of 0.74 t/d. On a production basis, the maximum monthly load was 0.09 kg/ADt, and the annual average was 0.05 kg/ADt. In comparison, the expected maximum monthly load and annual average load as predicted in the CIS were 0.26 kg/ADt and 0.15 kg/ADt, respectively.

Total phosphorus of the mill effluent averaged 0.53 mg/L, and ranged from 0.02 mg/L to 3.54 mg/L, in comparison to a permit limit of 5 mg/L. The maximum monthly load was 0.060 t/d, in comparison to the permit limit of 0.074 t/d. On a production basis, the maximum monthly load and annual average load were 0.022 kg/ADt and 0.010 kg/ADt, respectively. These compare to an expected load of 0.03 kg/ADt and 0.012 kg/ADt, respectively, as predicted in the CIS.

Total nitrogen and phosphorus loadings were lower during the 2009 monitoring year as compared to the 2008 monitoring year due to optimization of the mill process and effluent treatment. As discussed in the CIS, the anticipated treatment of municipal wastewater for the City of Fray Bentos will substantially offset these loadings.

3.3.4 Metals

Metals are generally not a concern in modern pulp mills. In some cases trace levels of metals may be associated with the wood supply and/or process chemicals. Metals routinely monitored by the mill include: arsenic, cadmium, copper, chrome, iron, mercury, nickel, lead and zinc. The concentrations of these metals in the final effluent are below the respective detection limits and well below the respective permit limits.

3.3.5 Resin Acids and AOX

Resin acids are generally not a concern for modern pulp mills due to improvements in process and treatment technologies. Resin acids are also less of a concern with eucalyptus than with softwood fibre sources. The concentration of resin acids averaged 0.06 mg/L and ranged from 0.01 mg/L to 0.16 mg/L. Baseline data presented in the CIS show concentrations ranging from 0.035 mg/L to 0.224 mg/L based on samples collected from the Río Uruguay prior to the commissioning of the mill (Tana, 2005, 2006). The measured concentrations in mill effluent fall within the range of natural variability.

The AOX of the mill effluent averaged 1.80 mg/L, and ranged from 0.72 mg/L to 3.92 mg/L, well below the permit limit of 6 mg/L. The monthly maximum load of AOX was 0.21 t/d, well below the permit limit of 0.56 t/d. On a production basis, the monthly maximum load and annual average load were 0.07 kg/ADt and 0.04 kg/ADt, respectively, both well below the expected value predicted the CIS of 0.15 kg/ADt and 0.08 kg/ADt, respectively.

3.3.6 Dioxins and Furans

Dioxins and furans are generally not associated with modern pulp mills. As reported in the CIS, experience at other modern ECF mills throughout the world has shown that the most toxic congeners of dioxins and furans are not produced in the bleaching process at detectable levels, and that the less toxic congeners, although potentially detectable, are generally not elevated above ambient levels.

This statement that dioxins and furans are not associated with modern mills is also true for the Orion mill. The most toxic congeners 2,3,7,8-TCDD and 2,3,7,8-TCDF were below the 1 pg/L (as I-TEQ) level based on six separate analyses.

3.3.7 Toxicity

Toxicity analysis, as summarized in Table 3.2, shows no lethal response. Monthly testing was completed following standard protocols using three separate test procedures. The results show that the effluent is non-toxic.

3.3.8 Bacteria

The levels of fecal coliform are typically low, although levels in the effluent exceeded the permit limit of 5,000 UFC/100 mL on two occasions in June 2009 and two occasions in December 2009. UPM undertook an investigation and have confirmed the bacteria are not fecal in original and are not attributed to the sanitary waste (since E. coli were not also present and since the bacteria were present upgradient from where the sanitary waste enters the treatment system. They have also confirmed through additional field monitoring that the water quality of the Río Uruguay remained unaffected and protective of aquatic life and human health.

A report was issued to DINAMA that provides the results of the investigation and further actions that will be taken by the mill to resolve the issue. Additional investigations are ongoing to better understand the cause of elevated bacteria within the treatment system, to validate the laboratory analysis of bacteria, and to provide additional monitoring of bacteria levels within the Río Uruguay.

Table 3.1: Summary of Effluent Quality for the 2009 Monitoring Year

Parameters	Units	Effluent Quality (2009 Monitoring Year)					Permit
		n	Minimum	Maximum	Average	95th Percentile	Limit Daily Max[1]
Physical Indicators							
Temperature	°C	364	19.2	30.8	27.9	30.2	30
pH	-	364	6.9	8.0	7.4	7.6	6.0 to 9.0
Conductivity	µS/cm	364	295	7,308	3,565	4,245	-
Color	n.c.	365	250	2,000	679	1,250	-
Chemical oxygen demand	mg/L	365	136	590	264	407	-
Biochemical oxygen demand	mg/L	365	2.5	83.2	12.6	28.6	60
Suspended solids	mg/L	365	4	76	14	35	150
Nutrients							
Ammonia	mg/L	52	0.02	2.31	0.19	0.8	5
Nitrate	mg/L	46	0.01	8.63	0.68	3.4	4[1]
Total nitgrogen	mg/L	52	0.86	12.50	2.52	6.4	8[1]
Total phosphorus	mg/L	51	0.02	3.54	0.58	1.6	5
Metals							
Arsenic	mg/L	12	<0.02	<0.2	<0.1	-	0.5
Cadmium	mg/L	12	<0.02	<0.05	<0.04	-	0.05
Chrome	mg/L	12	<0.02	<0.2	<0.09	-	1
Copper	mg/L	12	<0.02	<0.5	<0.3	-	1
Iron	mg/L	12	<0.2	1.0	<0.5	-	-
Mercury	mg/L	12	<0.002	<0.005	<0.005	-	0.005
Sodium	mg/L	12	460	890	695	863	-
Nickel	mg/L	12	<0.02	<0.05	<0.03	-	2
Lead	mg/L	12	<0.03	<0.1	<0.06	-	0.3
Sulphur	mg/L	12	<0.1	<0.1	<0.1	-	1
Zinc	mg/L	12	<0.02	<0.05	<0.04	-	0.3
Other							
AOX	mg/L	52	0.32	3.92	1.67	2.77	6[1]
Chlorophenols	µg/L	50	<0.05	0.5	0.10	-	-
Phenols	µg/L	51	<1	42.7	9.6	31.5	500
Chlorate	mg/L	51	<0.02	3.48	0.13	-	-
Resin acids, total	mg/L	12	0.01	0.16	0.06	0.12	-
Detergents (LAS)	µg/L	12	14	70	31	63	4000
Esteroles, total	µg/L	12	<1000	<1000	<1000	-	-
Fats	mg/L	12	<5	<10	<8	-	50
Cyanide	µg/L	12	<4	<5	<5	-	1000
Fecal coliforms	ufc/100 ml	37	<18	16,000	1,588	9,200	5,000
2,3,7,8-TCDD	pg/L	6	<1	<1	<1	-	15
2,3,7,8-TCDF (as I-TEQ)	pg/L	6	<0.1	0.1	<0.1	-	5

[1] Permit limits for nitrate, total nitrogen and AOX are on an annual basis.

Table 3.2: Summary of Toxicity Analysis for the Mill Effluent

Date	IC50 15min - Vibrio fischeri %	CL50 48hs - Daphnia magna %	CL50 96hs - Pimephales promelas %
Jan-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Feb-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Mar-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Apr-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
May-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Jun-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Jul-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Aug-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Sep-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Oct-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Nov-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)
Dec-09	>100 (non-toxic)	>100 (non-toxic)	>100 (non-toxic)

Table 3.3: Summary of Effluent Quality – Dioxin and Furan

Date	2,3,7,8-TCDD pg/L	2,3,7,8-TCDF pg I-TEQ/L
Feb-09	<1	<0.1
Apr-09	<1	<0.1
Jun-09	<1	<0.1
Aug-09	<1	<0.1
Oct-09	<1	<0.1
Dec-09	<1	<0.1

Table 3.4: Summary of Effluent Loadings for the 2009 Monitoring Year

Parameters	Units	Effluent Load (2009 Monitoring Year)		
		Annual Average Measured	Maximum Permit Limit of DINAMA	Expected Long-term Average from CIS
Flow	m^3/Adt	23	50	25
AOX	kg/Adt	0.04	0.15	0.08
Color	kg/Adt	16	-	9
Chemical oxygen demand	kg/Adt	6	15	8
Biochemical oxygen demand	kg/Adt	0.31	0.70	0.30
Suspended solids	kg/Adt	0.33	1.00	0.70
Ammonia	kg/Adt	0.005	-	0.016
Total nitgrogen	kg/Adt	0.05	0.20	0.15
Total phosphorus	kg/Adt	0.012	0.020	0.012

Figure 3.1: Effluent Monitoring Data – Discharge Rate

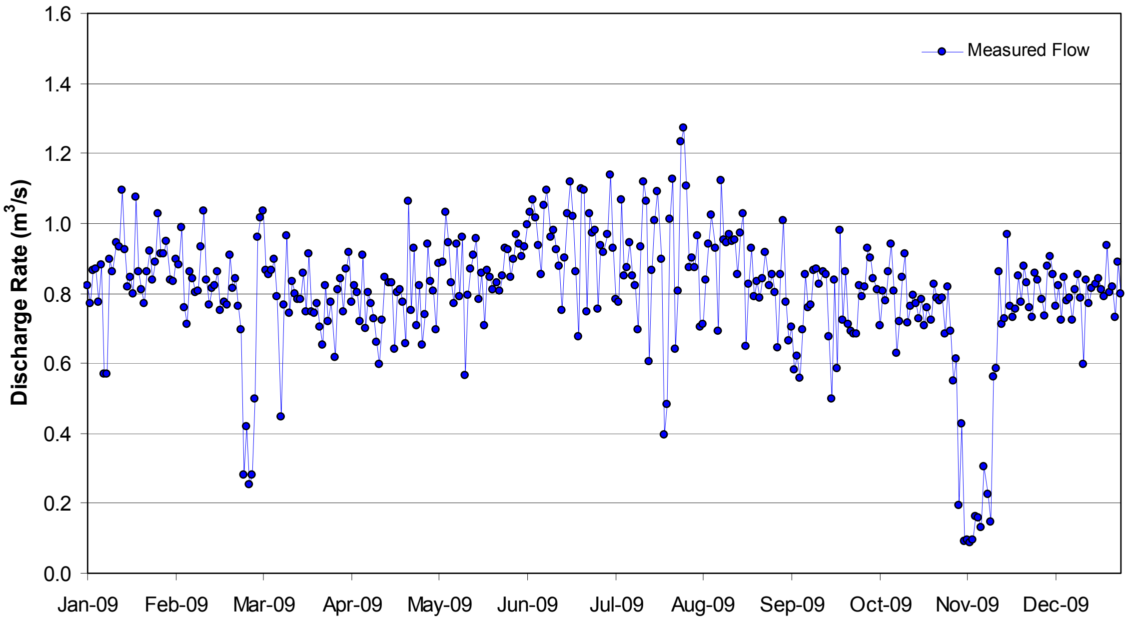
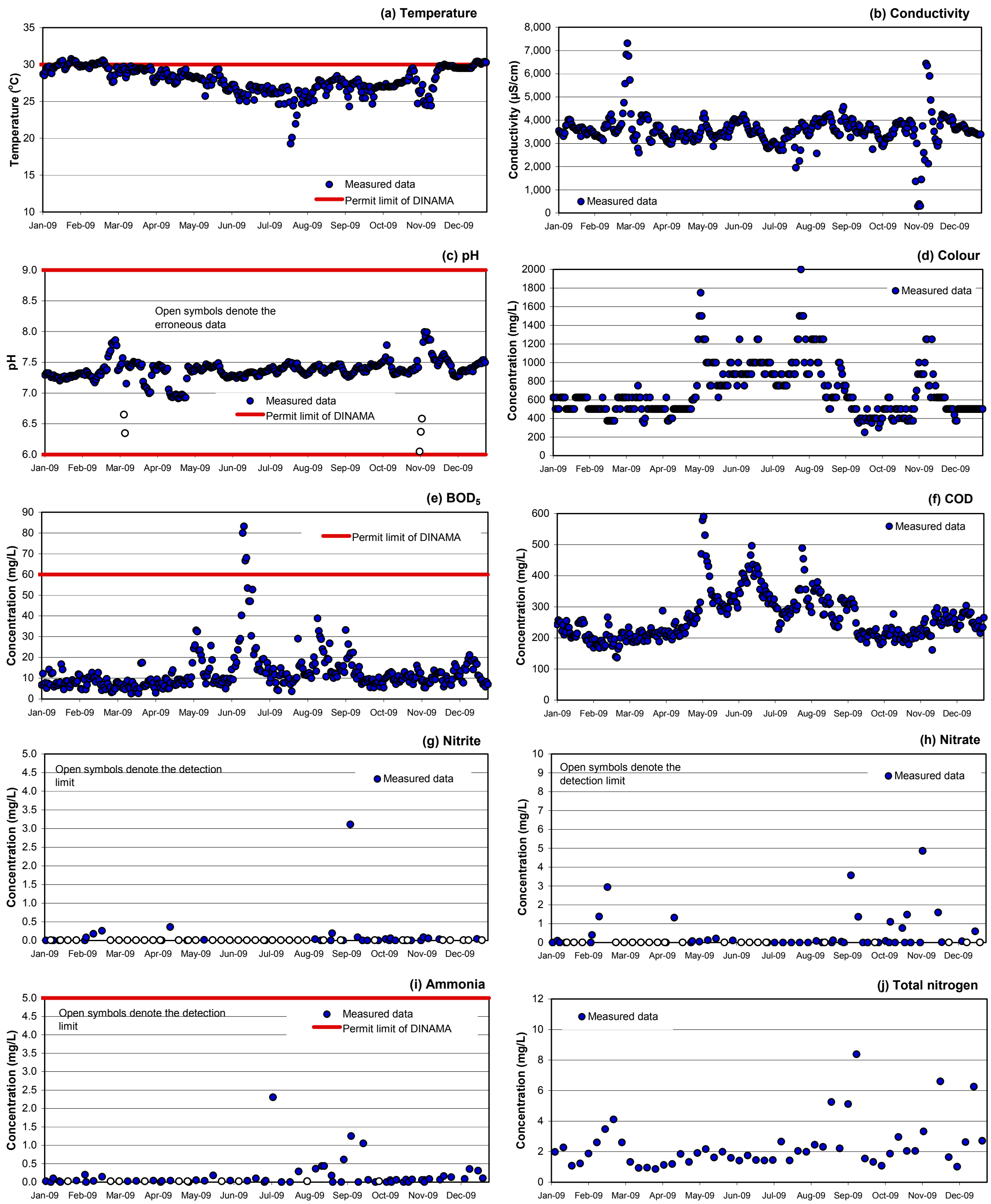
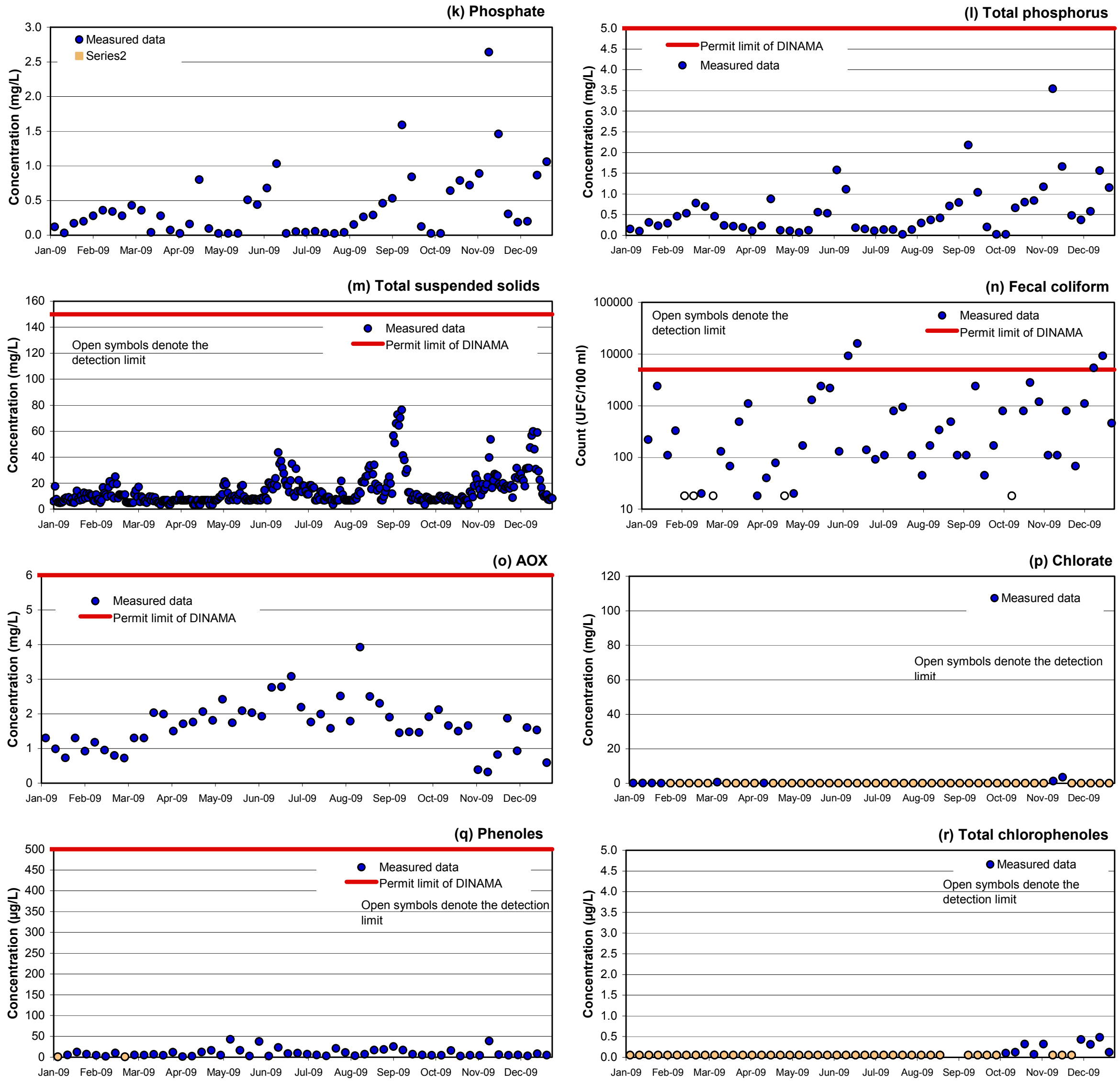


Figure 3.2: Effluent Monitoring Data – Discharge Quality[1]



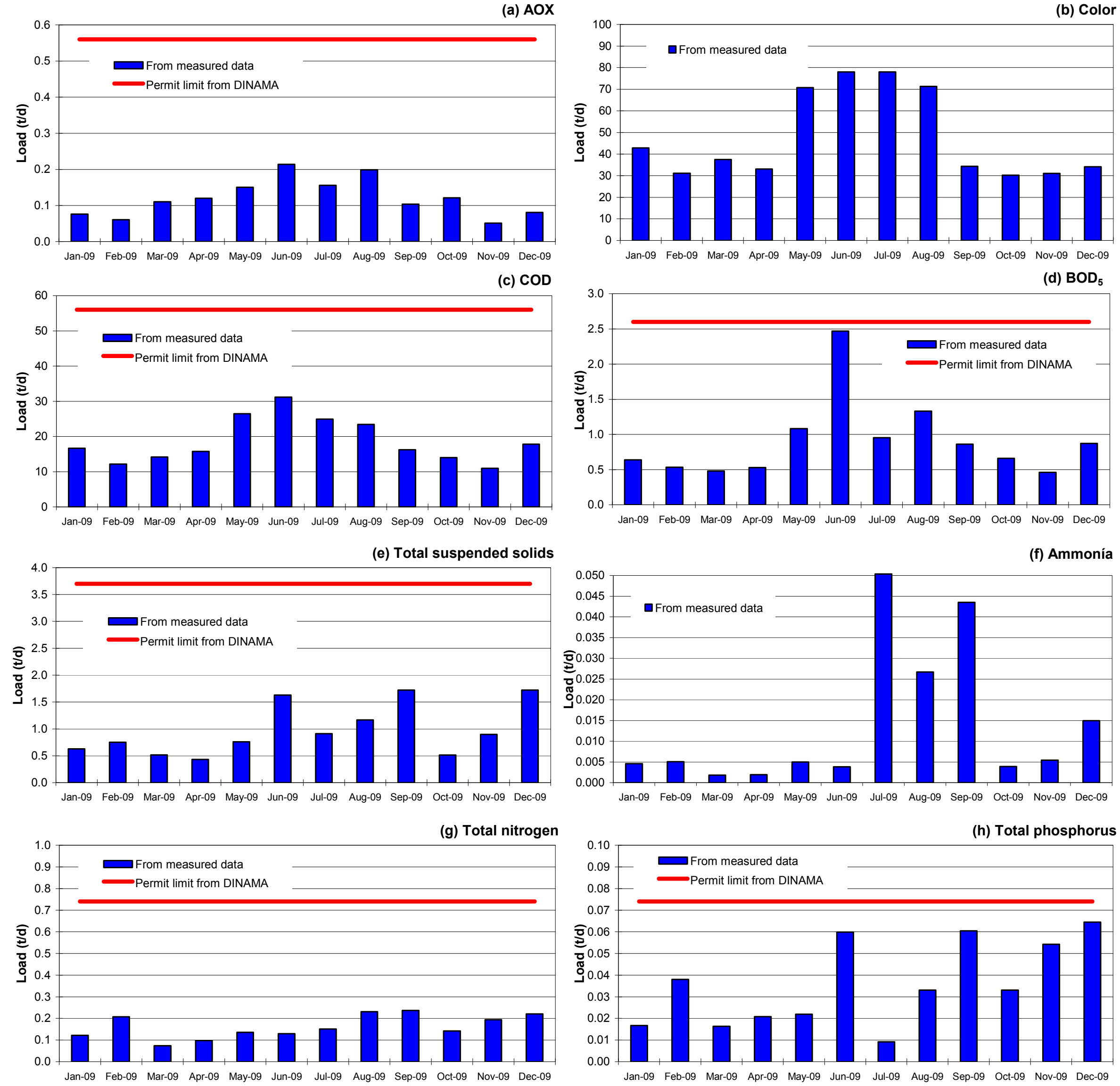
[1] Permit limit of DINAMA – allowable maximum concentration from DINAMA (Autorización de Desagüe Industrial, 4th July 2007)

Figure 3.2: Effluent Monitoring Data – Discharge Quality (continued)[1]



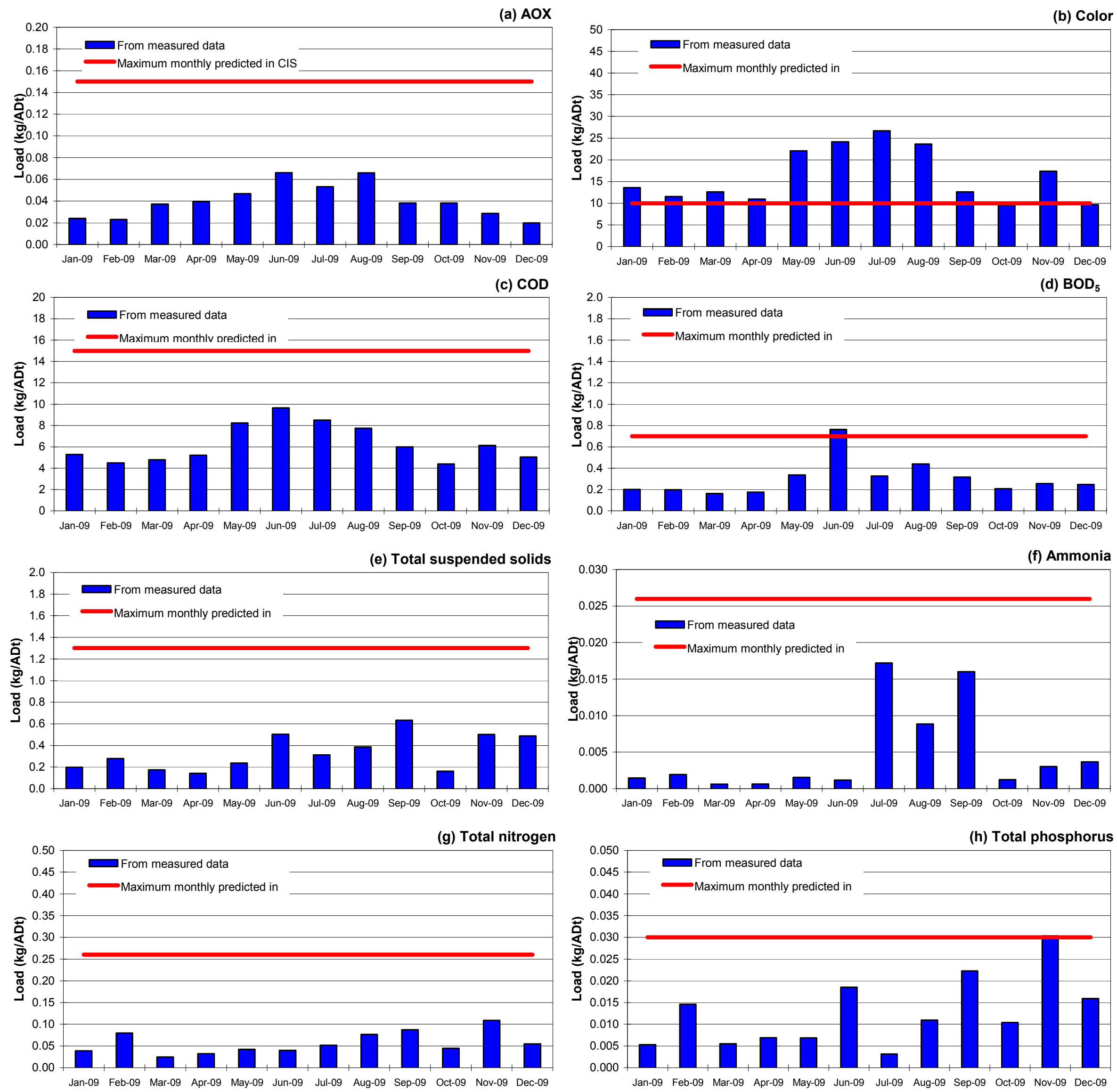
[1] Permit limit of DINAMA – allowable maximum concentration from DINAMA (Autorización de Desagüe Industrial, 4th July 2007)

Figure 3.3: Monthly Average Effluent Load per Day[1]



[1] Permit limit of DINAMA – allowable maximum concentration from DINAMA (Autorización de Desagüe Industrial, 4th July 2007)

Figure 3.4: Monthly Average Effluent Load per Unit Production[1]



[1] Expected maximum monthly load from the CIS.

4.0 WATER QUALITY OF THE RIO URUGUAY

4.1 Overview

Water quality of the Río Uruguay is monitored by DINAMA at 16 stations located as illustrated in Figure 4.1. Data were available for five surveys for this report of the 2009 monitoring year. The dates of these surveys are presented in Table 4.1 along with the corresponding river flow. Based on historic data, the February 2009 survey is representative of a fairly typical summer low flow period, whereas the other surveys are representative of moderate to high flow conditions. These data are presented in Figure 4.2 and summarized in Table 4.2 for metals and Table 4.3 for dioxin and furan.

Water quality is also monitored by the OSE, who are responsible for the treatment and distribution of potable water to the community of Fray Bentos. Water quality is routinely measured of the raw water supply which is drawn from the Río Uruguay approximately 5 km downstream from the mill and approximately 70 m from the shoreline. Data are available from OSE for the periods pre- and post-start-up of the mill, as presented in Table 4.4.

These data are evaluated in the following sections to determine the potential effect of the effluent discharge on the water quality of the Río Uruguay. Data are compared to surface water quality criteria, baseline water quality, and between upstream and downstream monitoring stations in order to classify the water quality and quantify any potential temporal or spatial change. These data are also compared to predictions from the CIS to verify its conclusions.

The main findings are summarized in the following points:

- The water quality of the Río Uruguay is considered to be of high quality since the concentrations of indicator parameters are well below the most restrictive of the applicable Uruguayan and CARU standards. These parameters include: pH, dissolved oxygen, BOD_5, nitrate, turbidity, fluoride, chloride, sulfate, R.A.S., cyanide, arsenic, boron, copper, chromium, mercury, nickel, zinc, and total phenols. As noted in the CIS, exceptions include bacteria, total phosphorus and iron, which exceeded the most restrictive standard prior to commissioning of the mill due to natural and anthropogenic sources throughout the watershed.
- Mercury levels are generally below the analytical detection level and below the most restrictive water quality standard. However, mercury was detected at two monitoring stations during April 2009 at levels above the most restrictive water quality standard. DINAMA investigated these observations but the source was not identified. Elevated mercury levels were reported at one or more monitoring stations prior to start-up of the mill, and therefore sources of mercury unrelated to the mill may exist in the watershed.
- A comparison of the monitoring data pre- and post-commissioning of the mill shows that the water quality of the Río Uruguay has not changed as a result of the mill. Conductivity and AOX showed a small increase in the immediate vicinity of the diffuser during two surveys that could be attributed to the mill discharge. Other differences are attributed to sources unrelated to the mill.

- The water quality between the mill and Fray Bentos is comparable to the water quality further upstream beyond the influence of the mill indicating that the mill has not affected water quality within the Río Uruguay.
- The CIS concluded that the water quality within the Río Uruguay would remain in compliance with surface water quality standards of DINAMA and CARU (with the noted exception of total phosphorus due to its high baseline concentration due to natural and anthropogenic sources throughout the watershed); and that trace levels of wastewater from the mill would not adversely affect water quality. The water quality monitoring results from DINAMA confirm these conclusions.

4.2 Comparison to Water Quality Criteria

Water quality standards have been established by DINAMA and CARU to ensure protection of the beneficial use of the resource, to protect aquatic life and to permit domestic water use. The most restrictive water quality criteria of either DINAMA or CARU are denoted in Figure 4.2.

Based on these data, it is concluded that the water of the Río Uruguay is considered to be of high quality since the water quality is significantly better than the most restrictive criteria for pH, dissolved oxygen, BOD_5, nitrate, turbidity, fluoride, chloride, sulfate, R.A.S., cyanide, arsenic, boron, cadmium, copper, chromium, mercury, nickel, zinc, and total phenols. The few exceptions are discussed below.

Bacteria levels (fecal coliform, enterococos and E. coli) are below the most restrictive standard (i.e., CARU, Use 2, Recreation) at most monitoring stations during most surveys. The standard is routinely exceeded at the monitoring station located near the municipal discharge for the City of Fray Bentos (Station 13) and has been exceeded during one or more surveys across the waterfront of Fray Bentos and Las Cañas. These elevated levels are attributed to sources of bacteria from within the urban areas of the city, and are not attributed to the mill effluent since the observed levels within the Río Uruguay far exceed the levels measured in the treated mill effluent, particularly during the summer low flow surveys in February and April 2009.

Total phosphorus levels are comparable to the baseline levels previously reported for the Río Uruguay. As discussed in Section 4.3 and shown in Appendix A, the baseline concentration of total phosphorus (prior to commissioning the mill) ranged from 0.03 mg/L to 0.11 mg/L near Fray Bentos from 2005 to 2006 (Table A-4), and ranged from 0.02 mg/L to 0.31 mg/L at Salto from 1987 to 1990 (Table A-1). These levels exceed the most restrictive Uruguayan standard for total phosphorus, and are attributed to natural and anthropogenic sources derived throughout the watershed of the Río Uruguay, which extends over approximately 365,000 km^2 through portions of Uruguay, Argentina and Brazil. The present and past levels of total phosphorus are not attributed to the mill effluent discharge.

Iron levels exceeded the most restrictive standard (CARU, Use 1, Drinking water) at one or more monitoring stations during each survey during the 2009 monitoring year. Baseline water quality data collected in 2004 (Appendix A, Table A-2) report levels of iron that also exceed this standard. The high baseline level for iron is attributed to the geological characteristics of the watershed rather than anthropogenic sources, and is not attributed to the mill effluent discharge.

Mercury levels are generally below the analytical detection level and below the most restrictive standard (DINAMA, Class 1, Dinking water supply). During the April 2009 survey, mercury was detected at levels above the most restrictive standard adjacent to the mill discharge (Station 8) and east of Arroyo Yaguareté (Station 9). Mercury was non-detectable in the mill effluent throughout the 2009 monitoring year, although the detection limit is too high to be conclusive. DINAMA investigated these observations but the source was not identified. Elevated mercury levels were reported at one or more monitoring station during surveys in 2006 prior to start-up of the mill, and therefore sources of mercury unrelated to the mill may exist within the watershed.

Lead, nickel and selenium concentrations were below the respective analytical detection levels. The classification with respect to the most restrictive standard is uncertain since the analytical detection limit for these parameters was greater than the standard.

4.3 Comparison to the Baseline Water Quality

The baseline water quality within the Río Uruguay was measured by UPM at four locations along the river and on seven occasions over the period April 2005 to March 2006 (Table A-4). The 25th and 75th percentile of these observed values are delineated in Figure 4.2 for comparison to the field survey data for the 2009 monitoring year. Other baseline water quality data summarized in the CIS are reproduced in Appendix A.

The comparison of monitoring data pre- and post-start-up shows that the water quality characteristics of the Río Uruguay have not changed as a result of the discharge of mill effluent.

For most parameters, the concentrations have remained within the general range observed during the 2005-06 baseline monitoring period. These parameters include BOD_5, TSS, total nitrogen, nitrates, nitrites, turbidity and hardness.

For several parameters, the concentrations are comparable to the 2005-06 baseline although the concentration at one or more monitoring stations may be higher or lower than the 2005-06 baseline during one or more surveys. These parameters include conductivity, temperature, dissolved oxygen, fecal coliform, phosphate, total phosphorus, ammonia and AOX.

Conductivity levels were generally comparable to or lower than the 2005-06 baseline at all monitoring locations. Exceptions include elevated conductivity at the bottom of the river in the immediate vicinity of the mill diffuser (Station 7) during the February 2009 and June 2009 surveys, elevated conductivity near the outflow from Arroyo Yaguareté (Station 9) during the February 2009 survey and elevated conductivity near the municipal discharge for the City of Fray Bentos (Station 13) during the August 2009 survey. The elevated conductivity near the diffuser may indicate trace levels of mill effluent, whereas elevated conductivity near Arroyo Yaguareté and the municipal discharge are attributed to local sources unrelated to the mill.

Temperature is within the range of the 2005-06 baseline for summer and fall survey, and below the range of the 2005-06 baseline for the winter survey. This difference is related to season rather than mill effluent. Temperature was slightly above the 2005-06 baseline during the February 2009 survey at monitoring stations upstream from the discharge and at Las Cañas. Since conductivity is not also elevated at these same locations, the observed increase in temperature cannot be attributed to the mill discharge.

The 2005-06 baseline shows dissolved oxygen ranging from 8.3 mg/L to 8.8 mg/L, and data from CARU (Appendix A, Table A-3) shows baseline dissolved oxygen ranging from 6.6 mg/L to 9.0 mg/L near Fray Bentos and 6.4 mg/L to 7.8 mg/L near the Río Gualeguaychú. In comparison, the monitoring data post-start-up show a range from 7.7 mg/L to 12.2 mg/L. These high values are beneficial to aquatic organisms, and are consistent with those observed prior to commissioning of the mill. There is no indication of any potential effect on dissolved oxygen levels within the Río Uruguay due to the mill discharge.

Fecal coliform levels were generally well below the 2005-06 baseline levels. Levels downstream of the municipal discharge for the City of Fray Bentos (Station 13) were elevated above baseline, implicating the municipal discharge as the source. The planned treatment of the municipal wastewater at the mill will eliminate this source of bacteria. Levels were also elevated near the outlet of Arroyo Yaguareté during the February and April 2009 surveys, implicating the creek as the source.

Total phosphorus levels were generally lower during most surveys in 2009 as compared to the 2005-06 baseline. Elevated levels of phosphorus were recorded downstream from the municipal wastewater treatment plant for the City of Fray Bentos (Station 13), implicating it as the source. The planned treatment of the municipal wastewater at the mill will eliminate this source of phosphorus and reduce these levels. Elevated levels were also observed during the April 2009 survey near the Island Abrigo (Station 6), although this observation is not attributed to the mill discharge since conductivity was not also elevated.

Ammonia levels were generally below the 2005-06 baseline levels. The only exception was the ammonia concentration downstream from the municipal wastewater treatment plant for the City of Fray Bentos (Station 13), which was elevated beyond the range of the 2005-06 baseline. This exception is attributed to the municipal discharge and not the mill discharge. The planned treatment of the municipal wastewater at the mill will eliminate this potential source of ammonia.

AOX levels were generally within the range of 2005-06 baseline levels. During the February 2009 and June 2009 surveys, the levels of AOX were elevated near the bottom of the river in the immediate vicinity of the mill diffuser (Station 7) indicating trace levels of effluent.

4.4 Comparison of Upstream and Downstream Data

The water quality at monitoring stations upstream (Stations 1 through 6) and downstream (Stations 8 through 16) of the mill discharge are comparable. A statistical analysis of the available data shows that the concentrations are not significantly different between upstream and downstream monitoring stations at the 95% confidence level for the following parameters: temperature, conductivity, pH, sechi depth, dissolved oxygen, bacteria, BOD_5, TSS, phosphate, total phosphorus, organic nitrogen, total nitrogen, nitrite, nitrate, ammonia, AOX, color, turbidity, alkalinity, calcium, hardness, magnesium, sodium, potassium, fluoride, chloride, sulfate, silica, silicon, R.A.S, total cyanide, arsenic, boron, cadmium, copper, chromium, iron, mercury, nickel, lead, selenium, zinc, and total phenols.

The data indicate an increase in the level of bacteria and total phosphorus across the waterfront of the City of Fray Bentos, and an increase in the level of ammonia downstream from the city. As discussed above, this may indicate sources of bacteria, total phosphorus and ammonia from within the urban area and the municipal discharge of the city. The planned treatment of the municipal wastewater at the mill will reduce these levels.

4.5 Comparison to CIS Model Predictions

The CIS utilized comprehensive mathematical models to investigate the potential effects of the mill discharge on the aquatic environment within the Río Uruguay. The investigation concluded that the mill discharge would have minimal effect on water quality within the Río Uruguay under both average and extreme low flow conditions. The CIS recommended monitoring of water quality to verify this conclusion.

The available monitoring data obtained by DINAMA provides verification of the CIS model predictions. The conditions experienced during the February 2009 field survey approximately reflect the conditions represented by the summer low flow scenario described in the CIS.

4.5.1 Receptor 1, Río Uruguay at the Diffuser

The CIS concluded that the diffuser for the mill would achieve a high degree of mixing within its immediate vicinity, and that the water quality would comply with surface water quality standards of DINAMA and CARU beyond a relatively small and confined mixing zone. The monitoring data obtained by DINAMA during the 2009 monitoring year verifies these conclusions.

As shown in Figure 4.2, the water quality within the immediate vicinity of the diffuser (Station 7) complies with the most restrictive water quality standard with few exceptions. As described above, these exceptions are attributed to elevated baseline levels within the Río Uruguay and are unrelated to the mill discharge.

For most parameters, the concentrations measured within the immediate vicinity of the diffuser were comparable to or of better quality than the measured background water quality. These parameters include temperature, pH, color, TSS, dissolved oxygen, BOD_5, phosphate, nitrate, nitrite, ammonia, turbidity, bacteria, algae, cyanide, phenols, arsenic, cadmium, copper, chromium, mercury, nickel, lead and zinc.

Conductivity and AOX near the bottom of the river within the immediate vicinity of the diffuser were elevated during the February and June 2009 surveys but indistinguishable from background for the other surveys in 2009. Based on the quality of effluent at the time, the dilution is estimated to be in the range 90:1 to 110:1 and 50:1 to 90:1 for the February 2009 survey and June 2009 survey, respectively. For the April, August and October 2009 surveys, observed conductivity and AOX indicates dilutions greater than 1,000:1. These findings are consistent with the conclusions of the CIS.

Total nitrogen is marginally elevated within the immediate vicinity of the diffuser during the February 2009 survey and total phosphorus is marginally elevated within the immediate vicinity of the diffuser during the June 2009 survey, although both are indistinguishable from background levels observed during the 2005-06 baseline monitoring period.

These results confirm the conclusions of the CIS and demonstrate that the mill has negligible effect on water quality within the immediate vicinity of the diffuser. This finding is consistent with the 2008 monitoring report.

4.5.2 Receptor 2, Río Uruguay at Yaguareté Bay

The CIS concluded that: the water quality within Yaguareté Bay would remain in compliance with surface water quality standards of DINAMA and CARU (with the same exception as previously discussed); and that trace levels of wastewater from the mill would not adversely affect water quality. The water quality monitoring results from DINAMA confirm these conclusions.

As shown in Figure 4.2, measured water quality within Yaguareté Bay (Stations 9 and 10) complies with the most restrictive water quality standard (with the same exception as previously discussed). The measured water quality was generally comparable to or of better quality than the measured background water quality within the Río Uruguay. These parameters include: temperature, pH, BOD_5, TSS, dissolved oxygen, AOX, color, nitrate, ammonia, turbidity, cyanide, phenols, arsenic, cadmium, copper, chromium, mercury, nickel, lead and zinc.

Conductivity was marginally elevated in Yaguareté Bay (Stations 9 and 10) during the February, June and August 2009 surveys although AOX was not, indicating a source unrelated to the mill effluent. The concentration of total phosphorus, phosphate, total nitrogen, nitrite and bacteria were also marginally elevated above background levels during one or more survey, although mill effluent is not implicated as the source since AOX was not also elevated during these surveys. Furthermore, the level of bacteria within the mill effluent was below the observed values within Yaguareté Bay during these periods and therefore cannot be the cause. The Arroyo Yaguareté would appear to be the most likely source. It is recommended that the water quality monitoring program of DINAMA be modified to include sampling within the Arroyo Yaguareté to validate this assumption.

These results confirm the conclusions of the CIS and demonstrate that the mill has negligible effect on water quality within Yaguareté Bay.

4.5.3 Receptor 4, Río Uruguay at Water Intake

The monitoring results from DINAMA confirm the conclusion of the CIS that the quality of the drinking water supply for the City of Fray Bentos (Station 11) would remain protected.

The available monitoring data, presented in Figure 4.2, shows that the quality of water at the intake complied with the drinking water standards for all parameters (with the same exception as previously discussed). The quality of water at the location of the freshwater intake for the city is indistinguishable from the background water quality within the Río Uruguay for all parameters, including temperature, conductivity, pH, TSS, dissolved oxygen, BOD_5, AOX, color, ammonia, total phosphorus, total nitrogen, nitrate, turbidity, cyanide, phenols, arsenic, cadmium, copper, chromium, mercury, nickel, lead and zinc.

Bacteria levels were below the drinking water standard during most surveys, although elevated during the February 2009 survey. The mill effluent is not implicated since the bacteria levels were below detectable levels at the time.

4.5.4 Receptor 10, Río Uruguay along the Argentina Side

The CIS concluded that the water quality along the Argentina side of the Río Uruguay was unaffected by the mill discharge. This conclusion is confirmed by the monitoring data of DINAMA.

Water quality was measured along the centre channel of the Río Uruguay at river marker 100 km. The data presented in Figure 4.2 shows that the water quality at this location is indistinguishable from the background water quality within the Río Uruguay for all parameters including temperature, TSS, conductivity, dissolved oxygen, BOD_5, AOX, color, bacteria, total nitrogen, nitrate, ammonia, total phosphorus, turbidity, cyanide, phenols, arsenic, cadmium, copper, chromium, mercury, nickel, lead and zinc.

Bacteria levels were below the most critical water quality standard during most surveys, although elevated during the February 2009 survey. The mill effluent is not implicated since the bacteria levels were below detectable levels at the time.

4.6 Comparison of Freshwater Supply Pre- and Post-Start-up

The City of Fray Bentos obtains its drinking water from the Río Uruguay. The water intake is located approximately 5 km downstream from the mill, and approximately 70 m into the Río Uruguay. Freshwater is supplied to the community by the OSE, who are responsible for the treatment and distribution of the water.

OSE also monitors the quality of the raw water supply. A summary of these data for the period pre- and post-start-up are presented in Table 4.4. As shown, the quality of the raw water supply is unaffected by the discharge from the mill. The water quality pre- and post-start-up is comparable for most parameters including color, turbidity, pH, alkalinity, chloride, nitrite, ammonia, conductivity, total organic carbon (TOC), dissolved organic carbon (DOC), total phosphorus, trihalomethane, total coliforms, total Kjeldahl nitrogren (TKN), total nitrogen, and AOX. Elevated levels of phenolic substances were measured in January 2008 in the raw water supply, as previously reported (EcoMetrix, 2008). The mill does not appear to be the source since the concentration of phenols in the effluent was less than that measured in the raw water at the time.

Table 4.1: Water Quality Field Surveys, Río Uruguay

Dates of the Water Quality Field Surveys	Daily Average Flow, Río Uruguay at the Salto Grande dam (m^3/s)
10 to 11 February 2009	921 to 655
14 to 15 April 2009	1,340 to 1,576
9 to 10 June 2009	2,088 to 1,925
11 to 12 August 2009	7,709 to 7,547
6 to 7 October 2009	9,594 to 10,043

Table 4.2: Summary of Water Quality for Metals at Monitoring Stations along the Río Uruguay

							Feb-09					
STATION	N	Arsenic	Boron	Cadmium	Copper	Chromium	Iron	Mercury	Nickel	Lead	Selenium	Zinc
		µg /l	mg /l	µg /l	µg /l	µg /l	mg /l	µg /l	µg /l	µg /l	µg /l	µg /l
E of island Zapatero, center of channel	1	<5	<0.06	<1	<10	<3	0.83	<0.20	<6	<30	<10	<3
5 km upstream of M'bopicuá	2	<5	<0.06	<1	<10	<3	0.89	<0.20	<6	<30	<10	<3
Infront of the former location of M'Bopicuá	3	<5	<0.06	<1	<10	<3	0.87	<0.20	<6	<30	<10	<3
Inlet off Island Abrigo	4	<5	0.12	<1	<10	<3	1.10	<0.20	<6	<30	<10	<3
Main channel infront of Island Abrigo	5	<5	0.09	<1	<10	<3	0.87	<0.20	<6	<30	<10	<3
Costa uru. Infront of Island Abrigo	6	<5	<0.06	<1	<10	<3	0.97	<0.20	<6	<30	<10	5.0
At diffuser for Botnia	7	<5	<0.06	<1	<10	<3	0.94	<0.20	<6	<30	<10	<3
Adjacent to the diffuser of Botnia	8	<5	<0.06	<1	<10	<3	0.90	<0.20	<6	<30	<10	<3
E of Ayo Yaguareté	9	<5	<0.05	<1	<10	<3	0.84	<0.20	<6	<30	<10	<5
W of Ayo Yaguareté	10	<5	<0.05	<1	<10	<3	0.87	<0.20	<6	<30	<10	<3
Water intake of OSE	11	<5	<0.05	<1	<10	<3	0.96	<0.20	<6	<30	<10	<3
Marker 100 km, main channel of the Uruguay river	12	<5	<0.05	<1	<10	<3	0.85	<0.20	<6	<30	<10	<5
Municipal wastewater discharge	13	<5	<0.05	<1	<10	<3	1.20	<0.20	<6	<30	<10	<5
Downstream from Brio Las Cañas	14	<5	<0.05	<1	<10	<3	1.20	<0.20	<20	<30	<10	9.3
Offshore from Brio Las Cañas	15	<5	<0.05	<1	<10	<3	0.91	<0.20	<20	<30	<10	<3
Adjacent to Brio Las Cañas	16	<5	<0.05	<1	<10	<3	1.30	<0.20	<6	<30	<10	<3
							Apr-09					
STATION	N	Arsenic	Boron	Cadmium	Copper	Chromium	Iron	Mercury	Nickel	Lead	Selenium	Zinc
		µg /l	mg /l	µg /l	µg /l	µg /l	mg /l	µg /l	µg /l	µg /l	µg /l	µg /l
E of island Zapatero, center of channel	1	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
5 km upstream of M'bopicuá	2	<5	<0.05	<1	<10	<10	1.30	<0.20	<6	<10	<10	<3
Infront of the former location of M'Bopicuá	3	<5	<0.05	<1	<10	<3	1.30	<0.20	<6	<10	<10	<3
Inlet off Island Abrigo	4	<5	<0.05	<1	<10	<3	1.30	<0.20	<10	<10	<10	<3
Main channel infront of Island Abrigo	5	<5	<0.05	<1	<10	<3	1.30	<0.20	<10	<10	<10	11.0
Costa uru. Infront of Island Abrigo	6	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
At diffuser for Botnia	7	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
Adjacent to the diffuser of Botnia	8	<5	<0.05	<1	<10	<10	1.30	0.42	<10	<10	<10	<3
E of Ayo Yaguareté	9	<5	<0.05	<1	<10	<3	1.30	0.45	<10	<10	<10	<3
W of Ayo Yaguareté	10	<5	<0.05	<1	<10	<10	1.40	<0.20	<10	<10	<10	6.3
Water intake of OSE	11	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
Marker 100 km, main channel of the Uruguay river	12	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
Municipal wastewater discharge	13	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
Downstream from Brio Las Cañas	14	<5	<0.05	<1	<10	<10	1.30	<0.20	<10	<10	<10	<3
Offshore from Brio Las Cañas	15	<5	<0.05	<1	<10	<10	1.40	<0.20	<10	<10	<10	<3
Adjacent to Brio Las Cañas	16	<5	<0.05	<1	<10	<10	1.30	<0.40	<10	<10	<10	<5
							Jun-09					
STATION	N	Arsenic	Boron	Cadmium	Copper	Chromium	Iron	Mercury	Nickel	Lead	Selenium	Zinc
		µg /l	mg /l	µg /l	µg /l	µg /l	mg /l	µg /l	µg /l	µg /l	µg /l	µg /l
E of island Zapatero, center of channel	1	<5	<0.05	<1	<10	<3	0.60	<0.20	<6	<10	<2	<3
5 km upstream of M'bopicuá	2	<5	<0.05	<0.3	<3	<3	0.60	<0.20	<6	<10	<2	<3
Infront of the former location of M'Bopicuá	3	<5	<0.05	<0.3	<3	<3	0.59	<0.20	<6	<10	<2	<3
Inlet off Island Abrigo	4	<5	<0.05	<0.3	<3	<3	0.61	<0.20	<6	<10	<2	<3
Main channel infront of Island Abrigo	5	<5	<0.05	<0.3	<3	<3	0.58	<0.20	<6	<10	<2	<3
Costa uru. Infront of Island Abrigo	6	<5	<0.05	<0.3	<3	<3	0.58	<0.20	<6	<10	<2	<3
At diffuser for Botnia	7	<5	<0.05	<0.3	<3	<3	0.59	<0.20	<6	<10	<2	<3
Adjacent to the diffuser of Botnia	8	<5	<0.05	<0.3	<3	<3	0.58	<0.20	<6	<10	<2	<3
E of Ayo Yaguareté	9	<5	<0.05	<0.3	<10	<3	0.59	<0.20	<6	<10	<2	<3
W of Ayo Yaguareté	10	<5	<0.05	<0.3	<3	<3	0.59	<0.20	<6	<10	<2	<3
Water intake of OSE	11	<5	<0.05	<0.3	<3	<3	0.58	<0.20	<6	<10	<2	<3
Marker 100 km, main channel of the Uruguay river	12	<5	<0.05	<0.3	<3	<3	0.62	<0.20	<6	<10	<2	<3
Municipal wastewater discharge	13	<5	<0.05	<0.3	<3	<3	0.59	<0.20	<6	<10	<2	<3
Downstream from Brio Las Cañas	14	<5	<0.05	<0.3	<3	<3	0.61	<0.20	<6	<10	<2	<5
Offshore from Brio Las Cañas	15	<5	<0.05	<0.3	<3	<3	0.62	<0.20	<6	<10	<2	<3
Adjacent to Brio Las Cañas	16	<5	<0.05	<0.3	<3	<3	1.30	<0.20	<6	<10	<2	<3
							Aug-09					
STATION	N	Arsenic	Boron	Cadmium	Copper	Chromium	Iron	Mercury	Nickel	Lead	Selenium	Zinc
		µg /l	mg /l	µg /l	µg /l	µg /l	mg /l	µg /l	µg /l	µg /l	µg /l	µg /l
E of island Zapatero, center of channel	1	<5	<0.05	<0	<10	<10	2.10	<0.20	<20	<30	<10	<3
5 km upstream of M'bopicuá	2	<5	<0.05	<0.3	<10	<10	2.00	<0.20	<20	<30	<10	<5
Infront of the former location of M'Bopicuá	3	<2	<0.05	<0.3	<10	<10	1.90	<0.20	<20	<30	<10	<3
Inlet off Island Abrigo	4	<2	<0.05	<0.3	<10	<10	1.70	<0.20	<20	<30	<10	<3
Main channel infront of Island Abrigo	5	<5	<0.05	<0.3	<3	<10	2.00	<0.20	<20	<30	<10	<3
Costa uru. Infront of Island Abrigo	6	<2	<0.05	<0.3	<10	<10	3.10	<0.20	<20	<30	<10	<5
At diffuser for Botnia	7	<2	<0.05	<0.3	<10	<10	2.10	<0.20	<20	<30	<10	<5
Adjacent to the diffuser of Botnia	8	<2	<0.05	<0.3	<10	<10	1.80	<0.20	<20	<30	<10	<3
E of Ayo Yaguareté	9	<2	<0.05	<0.3	<10	<10	2.10	<0.20	<20	<30	<10	<3
W of Ayo Yaguareté	10	<2	<0.05	<0.3	<10	<10	2.10	<0.20	<20	<30	<10	<3
Water intake of OSE	11	<2	<0.05	<0.3	<10	<10	1.80	<0.20	<20	<30	<10	<3
Marker 100 km, main channel of the Uruguay river	12	<2	<0.05	<0.3	<3	<10	1.90	<0.20	<20	<30	<10	<3
Municipal wastewater discharge	13	<2	<0.05	<0.3	<10	<10	2.20	<0.20	<20	<30	<10	8.70
Downstream from Brio Las Cañas	14	<2	<0.05	<0.3	<3	<10	1.80	<0.20	<20	<30	<10	<3
Offshore from Brio Las Cañas	15	<2	<0.05	<0.3	<10	<10	2.70	<0.20	<20	<30	<10	<3
Adjacent to Brio Las Cañas	16	<5	<0.05	<0.3	<10	<10	1.30	<0.20	<20	<30	<10	<3
							Oct-09					
STATION	N	Arsenic	Boron	Cadmium	Copper	Chromium	Iron	Mercury	Nickel	Lead	Selenium	Zinc
		µg /l	mg /l	µg /l	µg /l	µg /l	mg /l	µg /l	µg /l	µg /l	µg /l	µg /l
E of island Zapatero, center of channel	1	--	--	--	--	--	--	<0.20	--	--	--	--
5 km upstream of M'bopicuá	2	--	--	--	--	--	--	<0.08	--	--	--	--
Infront of the former location of M'Bopicuá	3	--	--	--	--	--	--	<0.08	--	--	--	--
Inlet off Island Abrigo	4	--	--	--	--	--	--	<0.20	--	--	--	--
Main channel infront of Island Abrigo	5	--	--	--	--	--	--	<0.20	--	--	--	--
Costa uru. Infront of Island Abrigo	6	--	--	--	--	--	--	<0.08	--	--	--	--
At diffuser for Botnia	7	--	--	--	--	--	--	<0.08	--	--	--	--
Adjacent to the diffuser of Botnia	8	--	--	--	--	--	--	<0.08	--	--	--	--
E of Ayo Yaguareté	9	--	--	--	--	--	--	<0.20	--	--	--	--
W of Ayo Yaguareté	10	--	--	--	--	--	--	--	--	--	--	--
Water intake of OSE	11	--	--	--	--	--	--	--	--	--	--	--
Marker 100 km, main channel of the Uruguay river	12	--	--	--	--	--	--	--	--	--	--	--
Municipal wastewater discharge	13	--	--	--	--	--	--	<0.08	--	--	--	--
Downstream from Brio Las Cañas	14	--	--	--	--	--	--	<0.20	--	--	--	--
Offshore from Brio Las Cañas	15	--	--	--	--	--	--	--	--	--	--	--
Adjacent to Brio Las Cañas	16	--	--	--	--	--	--	<0.20	--	--	--	--

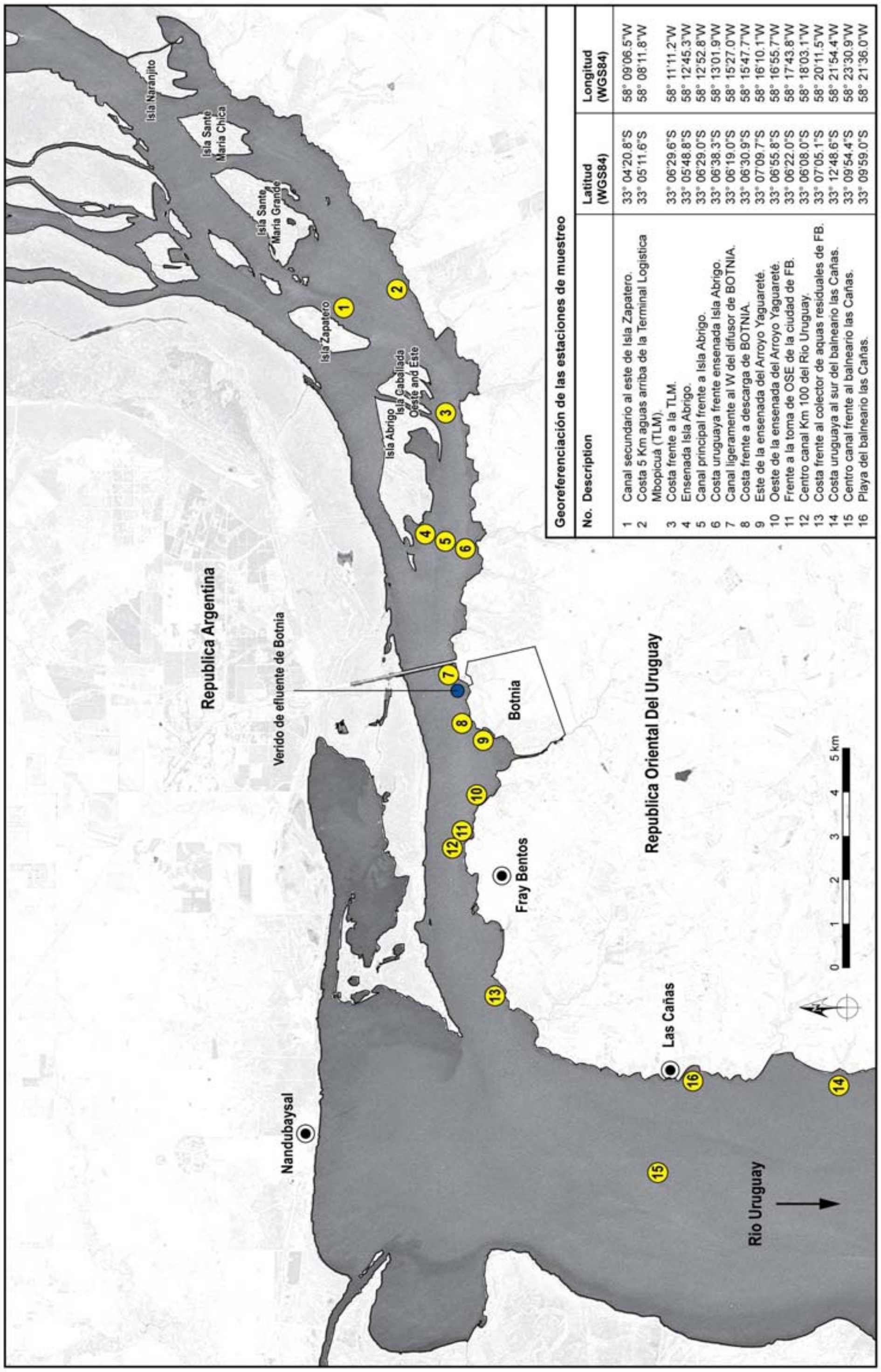
Table 4.3: Summary of Water Quality for Dioxin and Furan at Monitoring Stations along the Río Uruguay

STATION	N°	Toxic Equivalent (pg WHO-TEQs/l)							
		Feb-2009		Apr-2009		Jun-2009		Aug-2009	
		Including Detection Limit	Excluding Detection Limit	Including Detection Limit	Excluding Detection Limit	Including Detection Limit	Excluding Detection Limit	Including Detection Limit	Excluding Detection Limit
E of island Zapatero, center of channel	1	<5.25	0	<5.32	0.67	<5.25	0	<5.25	0
5 km upstream of M'bopicuá	2	<5.25	0.1	<5.25	0	<5.25	0	<5.26	0.041
Infront of the former location of M'Bopicuá	3	<5.25	0	<5.25	0	<5.25	0	<5.25	0
Inlet off Island Abrigo	4	<5.25	0	<5.25	0	<5.25	0	<5.26	0.21
Main channel infront of Island Abrigo	5	<5.25	0	<5.25	0	<5.25	0	<5.25	0
Costa uru. Infront of Island Abrigo	6	<5.25	0.1	<5.25	0	<5.25	0	<5.25	0
At diffuser for Botnia	7	<5.25	0	<5.25	0	<5.25	0	<5.25	0
Adjacent to the diffuser of Botnia	8	<5.25	0	<5.25	0	<5.25	0	<5.25	0
E of Ayo Yaguareté	9	<5.25	0	<5.25	0	<5.25	0	<5.25	0
W of Ayo Yaguareté	10	<5.25	0	<5.25	0	<5.25	0	<5.25	0
Water intake of OSE	11	<5.25	0	<5.25	0.035	<5.25	0	<5.25	0.0023
Marker 100 km, main channel of the Uruguay river	12	<5.25	0	<5.25	0	<5.39	0.34	<5.25	0
Municipal wastewater discharge	13	<5.25	0	<5.25	0	<5.25	0	<5.25	0
Downstream from Brio Las Cañas	14	<5.25	0	<5.25	0	<5.4	0.35	<5.25	0
Offshore from Brio Las Cañas	15	<5.34	0.69	<5.25	0	<5.25	0	<5.25	0
Adjacent to Brio Las Cañas	16	<5.29	0.24	<5.25	0	<5.25	0	<5.25	0

Table 4.4: Summary of Potable Water Quality for the City of Fray Bentos

		Pre-Start-up (18 April 2007 to 06 November 2007)			Post-Start-up (13 November 2007 to 13 May 2009)		
Aqua Bruta (Raw Water)	**Units**	**Minimum Value**	**Maximum Value**	**Average**	**Minimum Value**	**Maximum Value**	**Average**
Color (true)	U Pt - Co	7	98	43	5	101	46
Turbidity	NTU	13	46	24	7.3	65	26
pH	-	7.1	7.9	7.6	7	8.4	7.5
Oxides	mg/l O_2	1.5	8	4.9	1.6	6.3	3.8
Total Hardness	mg/l $CaCO_3$	27	55	38	17	45	28
Hardness, permanent	(mg/l $CaCO_3$	0	24	7	-	-	-
Hardness, temporary	mg/l $CaCO_3$	20	40	31	-	-	-
Alkalinity, total	mg/l $CaCO_3$	20	40	31	19	38	27
Alkalinity, carbonate	mg/l $CaCO_3$	0	0	0	-	-	-
Chloride	mg/l Cl	1.4	5.4	2.9	1.5	6.3	3.0
Nitrite	mg/l NO_2	<0.01	<0.01	<0.01	<0,02	0.03	0.02
Ammonia	mg/l NH_4	0.04	0.13	0.06	<0,4	<0,4	<0.4
Conductivity	µS/cm 25º C	65	99	80	53	110	70
TOC	mg/l C	1.24	4.7	2.76	0.62	4.31	2.6
DOC	mg/l C	1.66	5.04	2.92	1.75	4.06	2.66
Absorbancia (254 nm)	-	0.211	0.556	0.35	0.112	0.558	0.270
SUVA (Absorbancia/DOC)	-	0.08	0.184	0.13	0.07	0.14	0.10
Total phosphorus (mg/l P)	mg/l P	0.051	0.109	0.08	0.04	0.54	0.09
Trihalometan $CHBr_3$	µg/l	<1	<1	<1	<1	<1	<1
Trihalometan $CHClBr_2$	µg/l	<1	<1	<1	<1	<1	<1
Trihalometan $CHCl_3$	µg/l	<1	<1	<1	<1	<1	<1
Trihalometan $CHCl_2Br$	µg/l	<1	<1	<1	<1	<1	<1
Total coliforms	NMP/100 ml	273	6500	1838	250	26100	3076
Coliformes Termotolerantes	NMP/100 ml	10	121	39	<1	1200	78
Nitrogen Kjeldahl	mg/l N	0.2	0.62	0.37	-	-	-
Nitrogen Total	mg/l N	0.79	1.49	1.05	0.56	1.52	0.92
Phenolic substances	µg/l fenol	<1	<1	<1	<1	20.7	3
AOX	µg/l Cl	<8.1	17.9	9.8	<8,1	13.1	8.4
Aqua Tratada (Treated Water)	**Units**	**Minimum Value**	**Maximum Value**	**Average**	**Minimum Value**	**Maximum Value**	**Average**
Color (true)	U Pt - Co	<5	5	<5	5	6	5
Turbidity	NTU	0.2	1.4	0.5	0.2	1,4(*)	0.4
pH	-	6.5	9.5	7.9	7.1	8.7	7.4
Oxides	mg/l O_2	0.8	3.2	1.2	0.3	1.7	1.1
Chloride	mg/l Cl	4.1	5	4.5	-	-	-
Nitrates	mg/l NO_3	<2.6	<8.1	<4.1	<1.5	5.0	3.0
Nitrites	mg/l NO_2	<0.01	<0.01	<0.01	<0,02	0.09	<0,02
Ammonia	mg/l NH_4	0.04	0.09	0.05	<0,4	<0,4	<0,4
Free residual chlorine	mg/l Cl_2	1	1.2	1.1	0.8	1.3	1.1
Conductivity	µS/cm 25º C	103	205	155	78	171	131
TOC	mg/l C	1.06	2.09	1.59	1	3.6	1.7
Total phosphorus (mg/l P)	mg/l P	0.005	0.019	0.01	-	-	-
Nitrogen Total	mg/l N	0.51	0.98	0.78	0.42	1.13	0.65
Trihalometanos $CHBr_3$	µg/l	<1	<1	<1	<1	<1	<1
Trihalometanos $CHClBr_2$	µg/l	<1	<1	<1	<1	<1	<1
Trihalometanos $CHCl_3$	µg/l	12	46	25	3	36	19
Trihalometanos $CHCl_2Br$	µg/l	2	7	3	1	29	3
Total coliforms	NMP/100 ml	<1	<1	<1	<1	<1	<1
Coliformes Termotolerantes	NMP/100 ml	<1	<1	<1	<1	<1	<1
Pentacloro Fenol	µg/l	-	-	-	<0,1	<0,1	<0,1
Tricloro Fenol	µg/l	-	-	-	<1	<1	<1
Phenolic substances	µg/l fenol	<1	1.6	1.1	-	-	-
AOX	µg/l Cl	<8.1	68	38.3	<8.1	374	60

Figure 4.1: Water Quality Monitoring Stations along the Río Uruguay



No.	Description	Latitud (WGS84)	Longitud (WGS84)
1	Canal secundario al este de Isla Zapatero.	33° 04'20.8"S	58° 09'06.5"W
2	Costa 5 Km aguas arriba de la Terminal Logistica Mbopicuá (TLM).	33° 05'11.6"S	58° 08'11.8"W
3	Costa frente a la TLM.	33° 06'29.6"S	58° 11'11.2"W
4	Ensenada Isla Abrigo.	33° 05'48.8"S	58° 12'45.3"W
5	Canal principal frente a Isla Abrigo.	33° 06'29.0"S	58° 12'52.8"W
6	Costa uruguaya frente ensenada Isla Abrigo.	33° 06'38.3"S	58° 13'01.9"W
7	Canal ligeramente al W del difusor de BOTNIA.	33° 06'19.0"S	58° 15'27.0"W
8	Costa frente a descarga de BOTNIA.	33° 06'30.9"S	58° 15'47.7"W
9	Este de la ensenada del Arroyo Yaguareté.	33° 07'09.7"S	58° 16'10.1"W
10	Oeste de la ensenada del Arroyo Yaguareté.	33° 06'55.8"S	58° 16'55.7"W
11	Frente a la toma de OSE de la ciudad de FB.	33° 06'22.0"S	58° 17'43.8"W
12	Centro canal Km 100 del Rio Uruguay.	33° 06'08.0"S	58° 18'03.1"W
13	Costa frente al colector de aquas residuales de FB.	33° 07'05.1"S	58° 20'11.5"W
14	Costa uruguaya al sur del balneario las Cañas.	33° 12'48.6"S	58° 21'54.4"W
15	Centro canal frente al balneario las Cañas.	33° 09'54.4"S	58° 23'30.9"W
16	Playa del balneario las Cañas.	33° 09'59.0"S	58° 21'36.0"W

Figure 4.2: Water Quality Monitoring Data, Río Uruguay

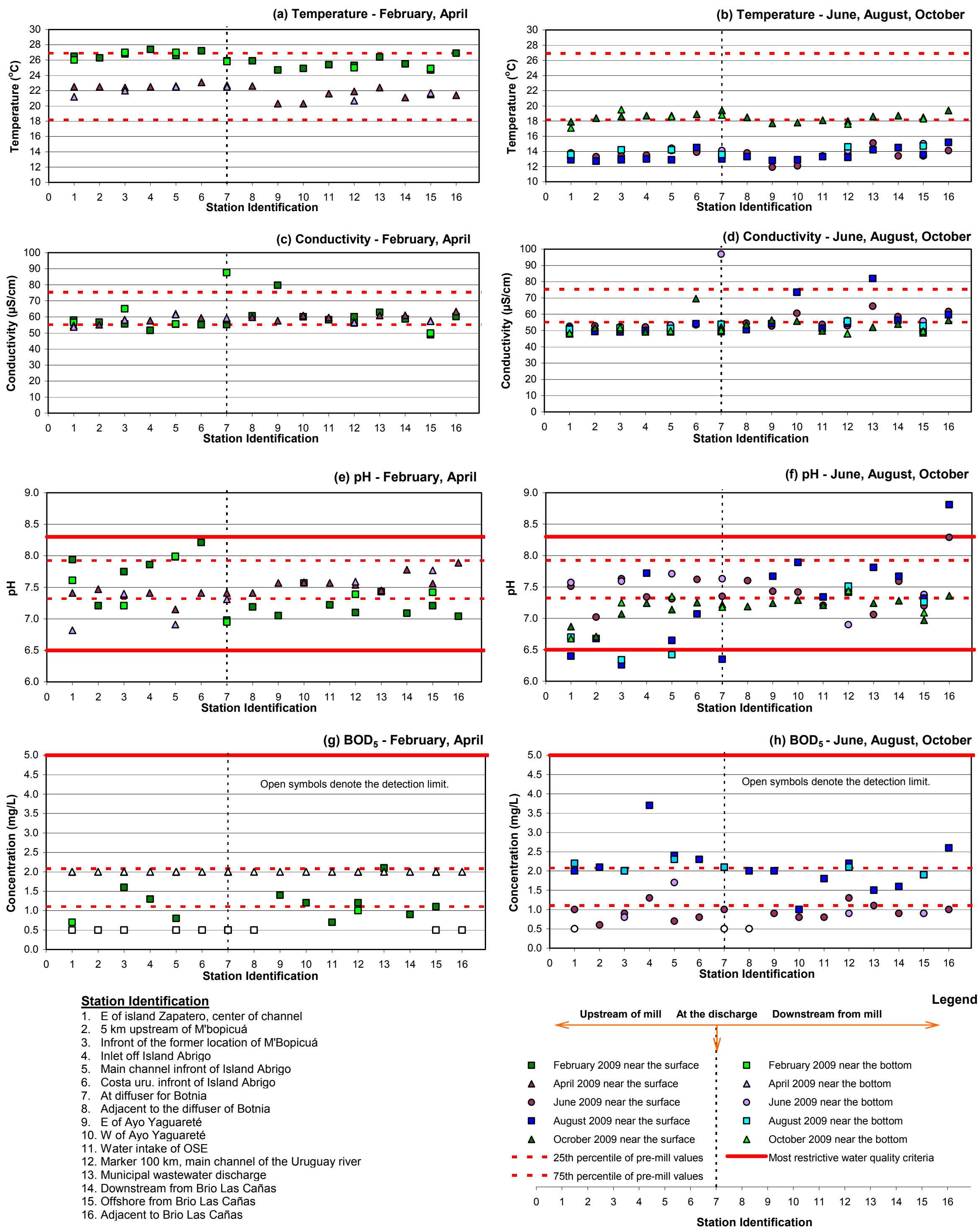
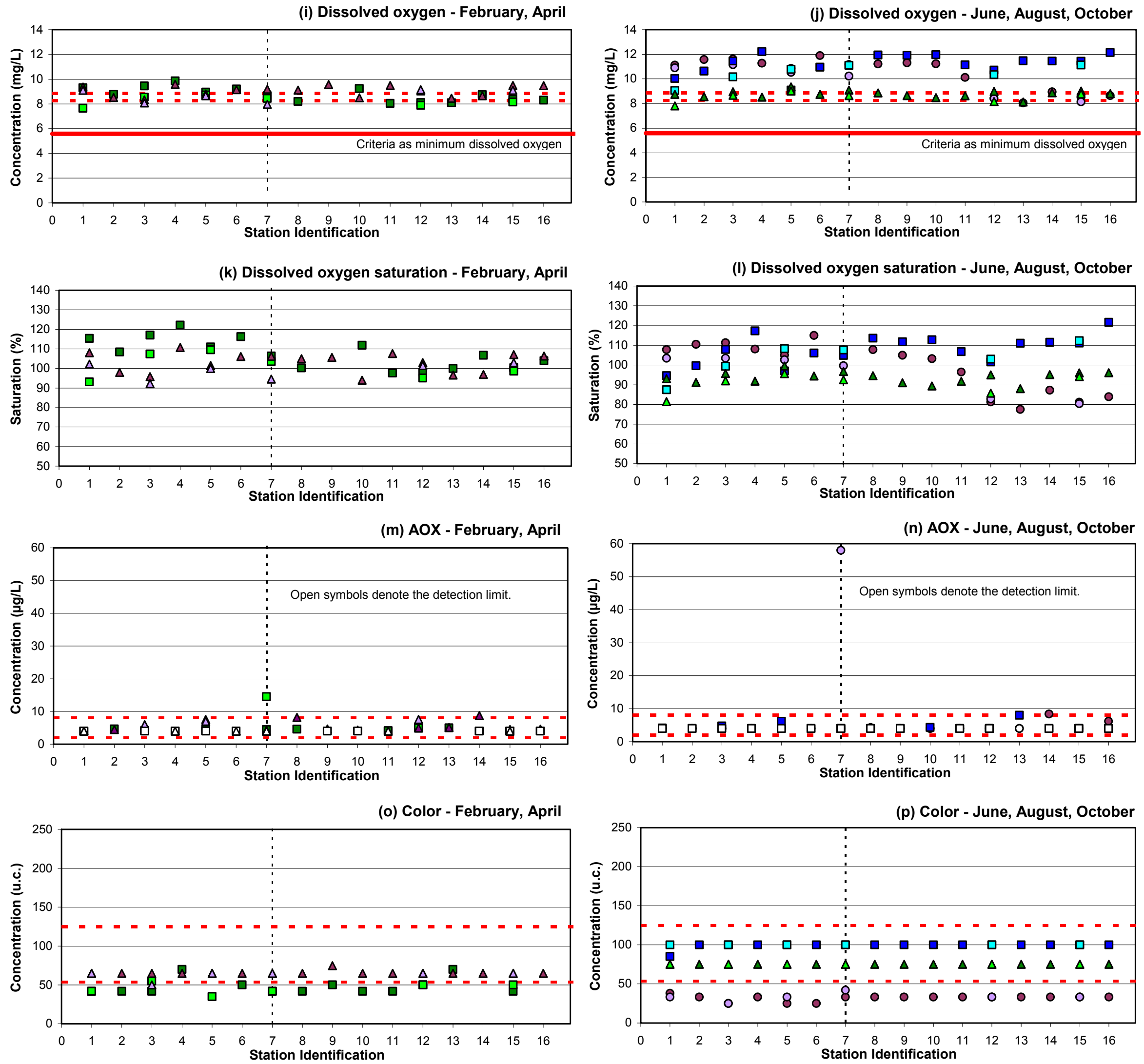


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

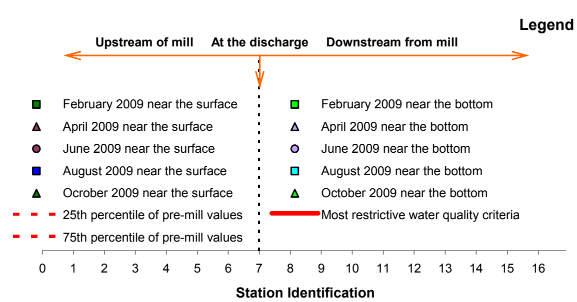
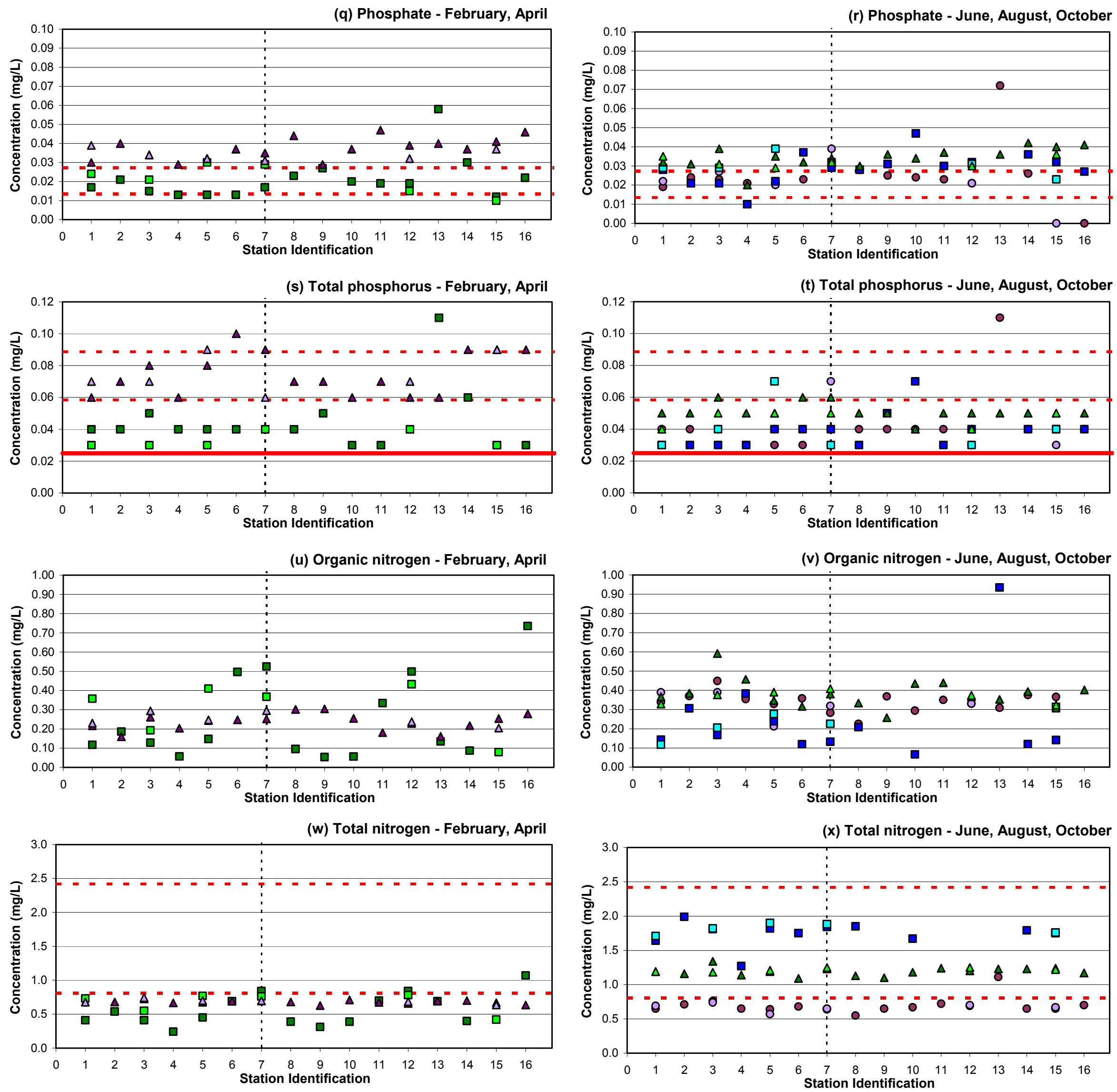


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

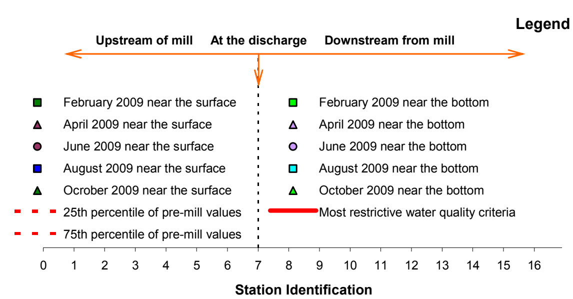
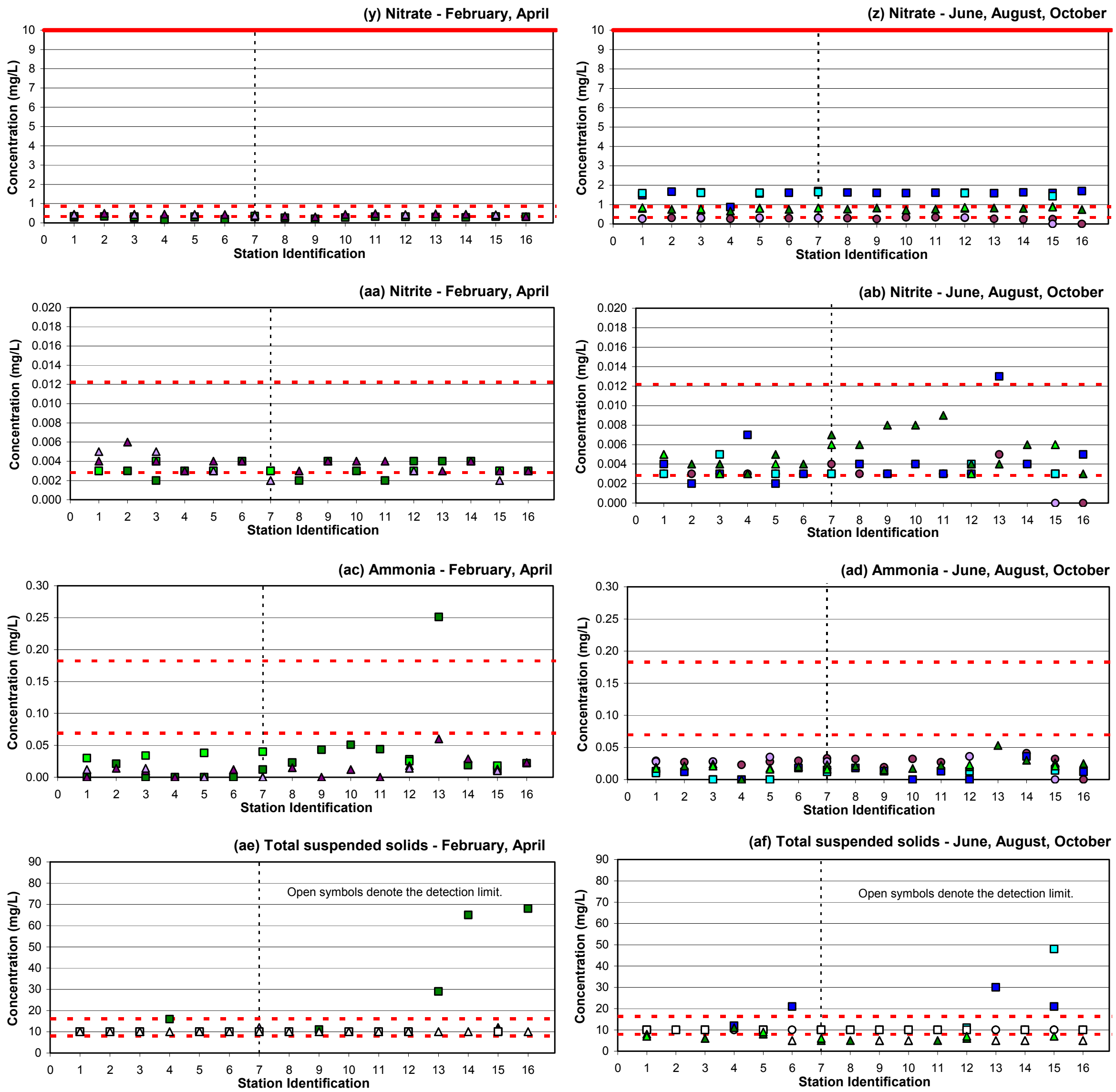


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

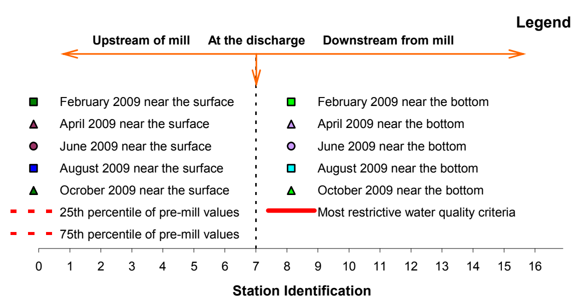
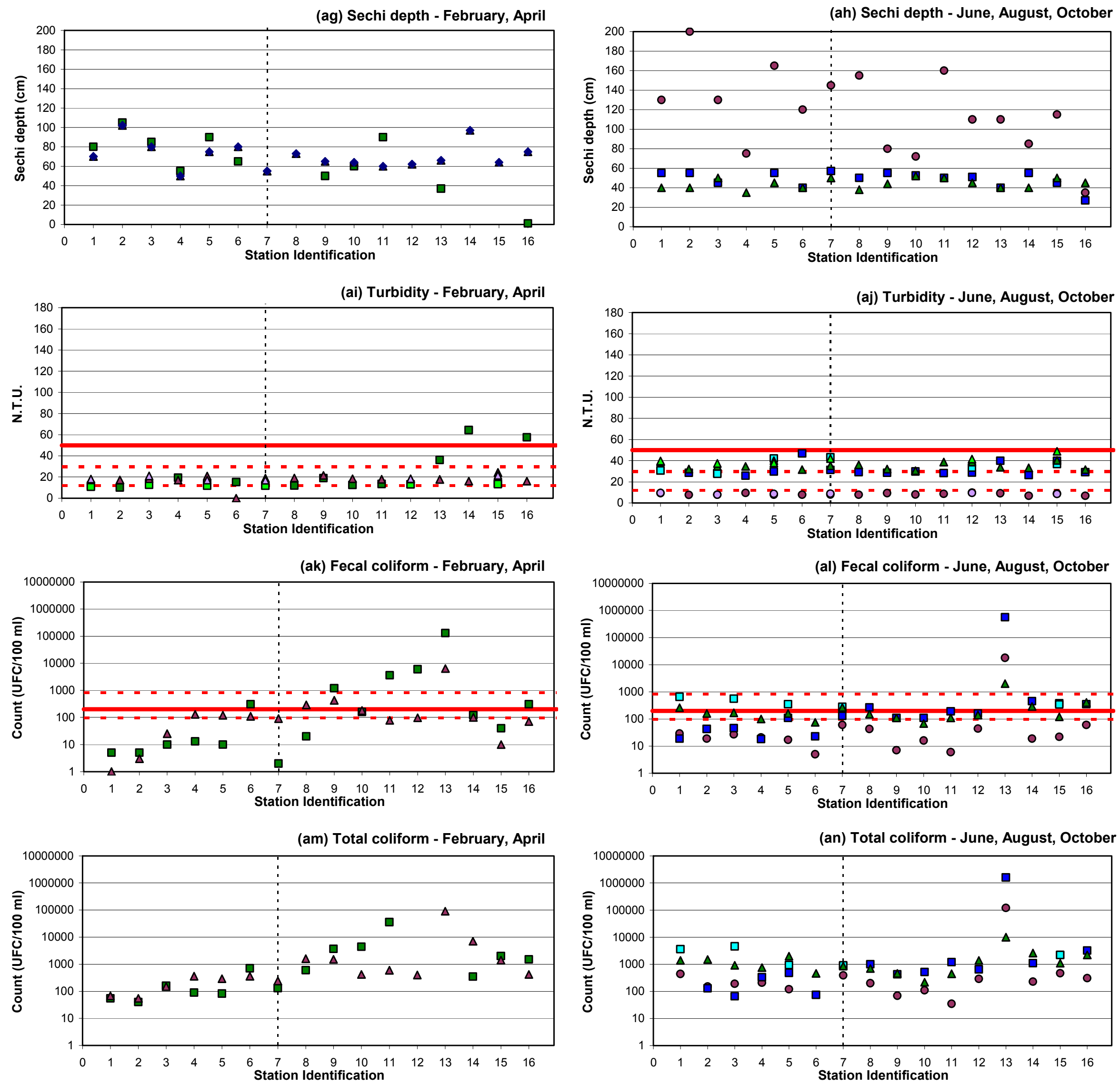


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

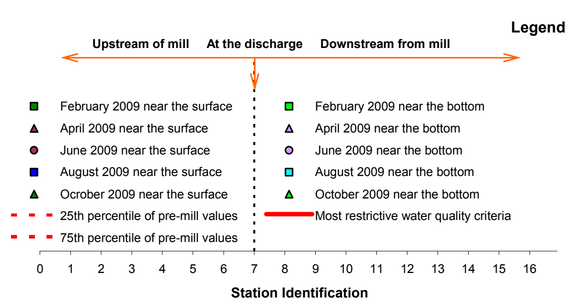
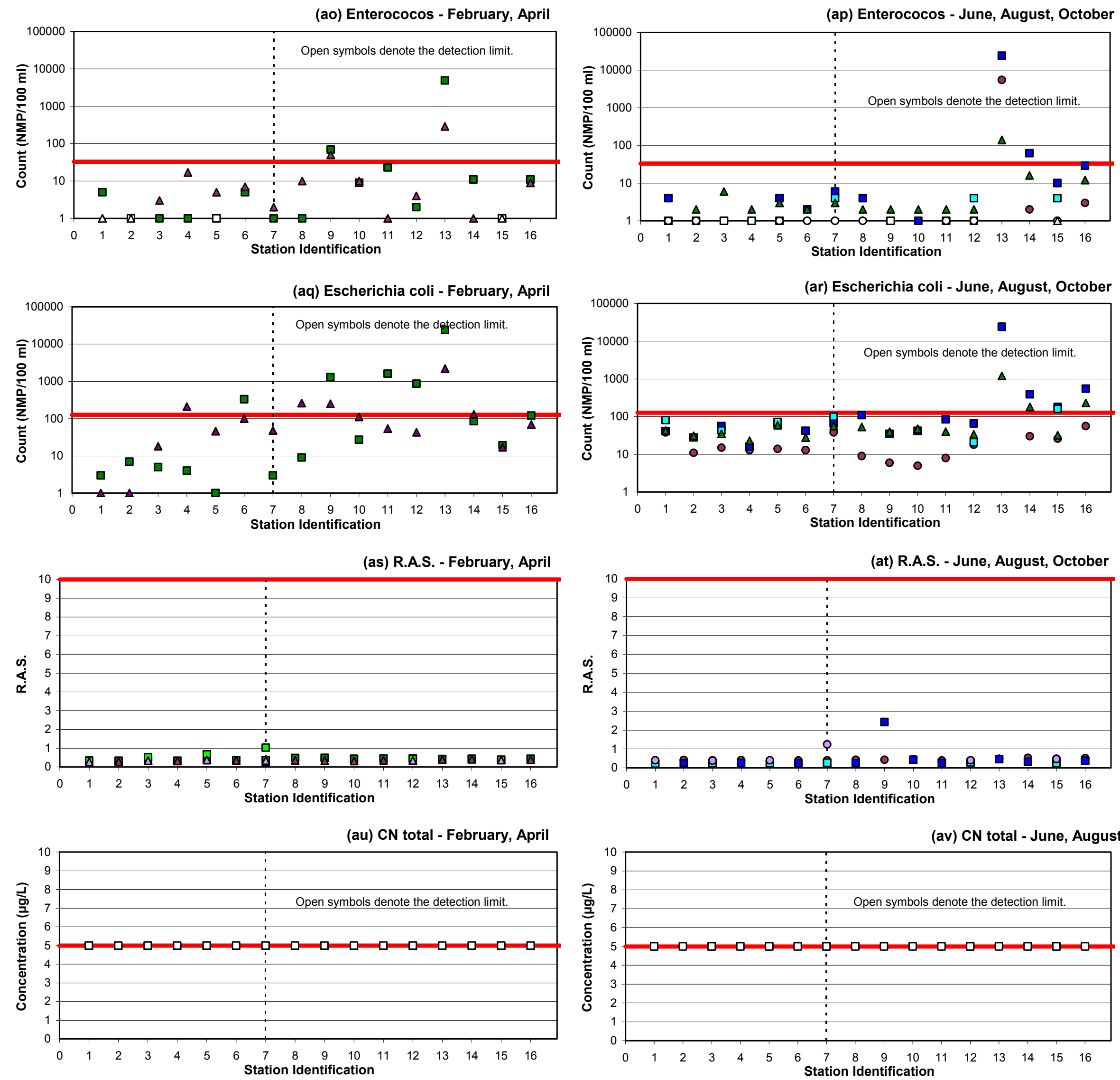


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

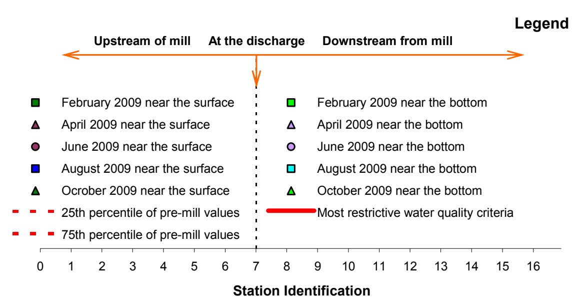
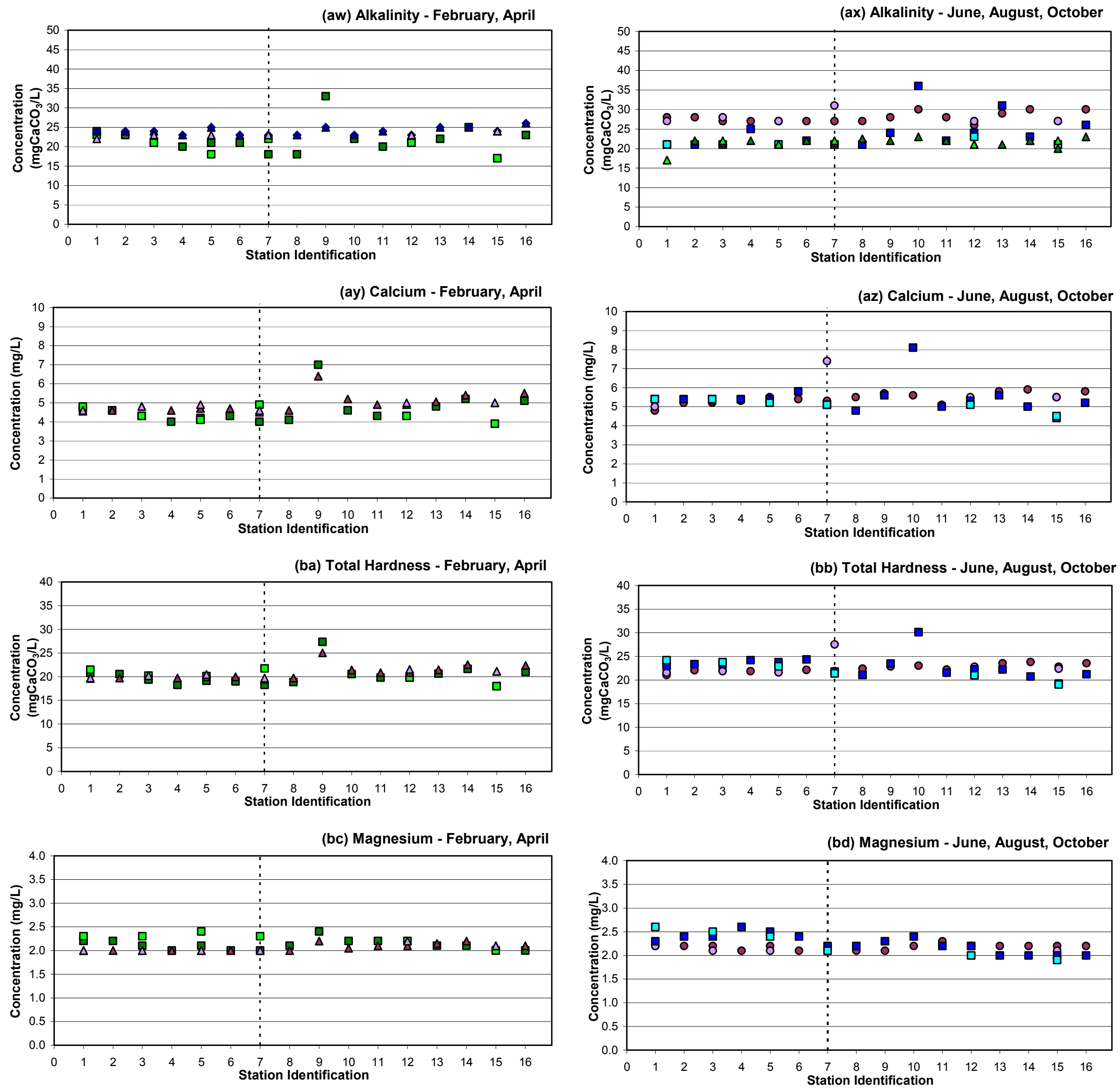


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification
1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
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13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

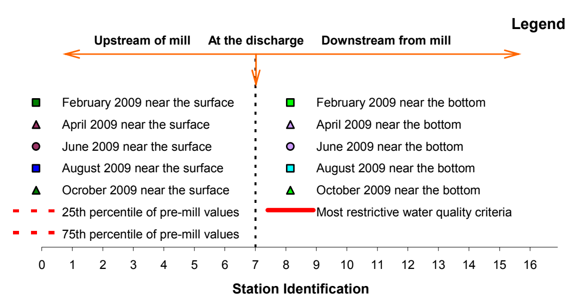
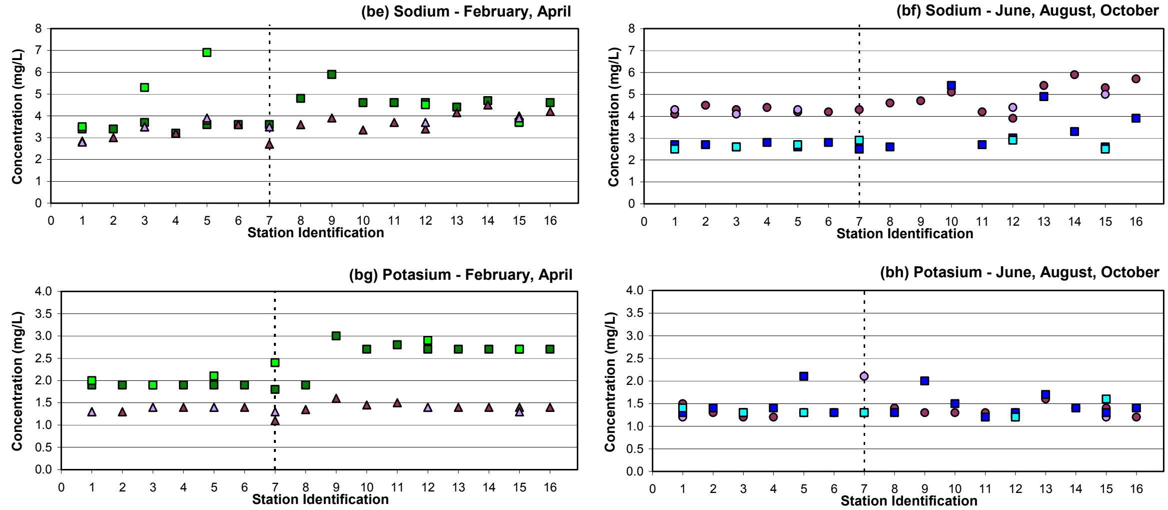


Figure 4.2: Water Quality Monitoring Data, Río Uruguay (continued)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
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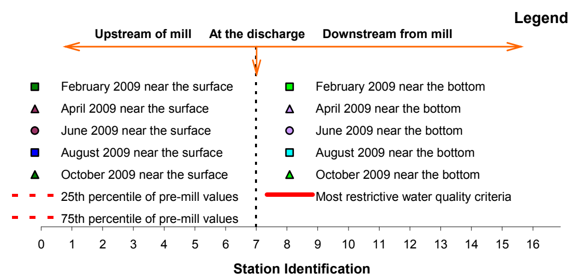


5.0 SEDIMENT QUALITY OF THE RIO URUGUAY

5.1 Overview

Sediments are an important component of the aquatic ecosystem as they provide habitat for a wide range of organisms that live in or on them. These organisms are an integral part of the aquatic food chain and therefore represent an important pathway for exposure to chemicals that may accumulate in the sediment.

Sediment quality of the Río Uruguay is monitored by DINAMA at 9 of the 16 water quality monitoring stations. The locations of these stations are illustrated in Figure 5.1. Data are available for February and June during the 2009 monitoring year. These data are presented in Figure 5.2 and summarized in Tables 5.1 through 5.3.

The sediment quality data are evaluated in the following sections to determine the potential effect of the effluent discharge on the sediment quality of the Río Uruguay. Data are compared to international sediment quality guidelines, baseline sediment quality, and between upstream and downstream monitoring stations in order to quantify any potential temporal or spatial change. These data are also compared to predictions from the CIS to verify its conclusions.

The main findings are summarized in the following points:

- The sediment within the Río Uruguay is considered to be of high quality and protective of aquatic life. The sediment quality at monitoring locations near the mill discharge is within international sediment quality guidelines for indicator parameters, including: arsenic, cadmium, copper, chromium, mercury, lead, zinc, total PCBs, PAHs, and dioxin and furan.
- A comparison of the monitoring data pre- and post-commissioning of the mill shows that the sediment quality of the Río Uruguay has not changed as a result of the mill.
- The sediment quality near the discharge and within Yaguareté Bay is comparable to the sediment quality further upstream beyond the influence of the mill indicating that the mill has not affected sediment quality within the Río Uruguay.
- The available monitoring data verifies the conclusion of the CIS that the mill would not affect the sediment quality within the Río Uruguay.

5.2 Comparison to Sediment Quality Guidelines

The sediment quality within the Río Uruguay in the vicinity of Fray Bentos and the Orion mill are considered of high quality and protective of aquatic life. This conclusion is based on a comparison of the measured sediment quality data to the interim freshwater sediment quality guidelines[5] (ISQG) developed by the Canadian Council of Ministers of the Environment (CCME).

[5] Canadian Council of Ministers of the Environment, 2002. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. (http://ceqg-rcqe.ccme.ca/)

The ISQG provide a scientific benchmark for evaluating the potential for biological effects within aquatic systems. They are derived from the available toxicological information according to the formal protocol established by the CCME. The resulting ISQG are defined as the threshold levels below which effects are not expected to occur. The guidelines also identify a probable effects level (PEL) above which adverse biological effects may occur.

The 2009 monitoring data indicates that the sediment quality is below the PEL for monitored parameters at all monitoring locations (with one exception noted below). These parameters include arsenic, cadmium, copper, chromium, mercury, lead, zinc, total PCBs, PAHs, and dioxin and furan. Aquatic organisms living in or on the sediments are therefore protected from adverse biological effects.

The one exception is an exceedance of the PEL for lead at and attributed to the municipal wastewater treatment plant for the City of Fray Bentos (Station 13). The sediment quality at this monitoring station also exceeds the ISQG for several parameters, including copper, PAHs, total PCBs, dioxin and furan. Adverse biological effects are possible at the discharge for municipal wastewater treatment plant, but such effects are attributed to the municipal discharge and are unrelated to the mill effluent discharge. The planned treatment of the municipal wastewater at the mill will eliminate this potential effect.

At other monitoring stations, the sediment quality is generally below the ISQG. The two exceptions include an exceedance of the ISQG for copper at the former location of M'Bopicuá (Station 3) and an exceedance of the ISQG for acenaphthene adjacent to the mill discharge (Station 8). The former location of M'Bopicuá (Station 3) is approximately 7 km upstream from the mill and is not prone to exposure by mill effluent. Elevated levels of copper at this location are therefore unrelated to the mill discharge. Levels of acenaphthene are generally below detectable levels at this and all other monitoring locations, but have been recorded at levels above the ISQG at background monitoring stations in the past.

5.3 Comparison to the Baseline Sediment Quality

The baseline sediment quality within the Río Uruguay was measured by UPM and DINAMA over the period 1998 to 2007. The range of observed values is delineated in Figure 5.2 for comparison to the field survey data for the 2009 monitoring year.

The comparison of monitoring data pre- and post-start-up shows that the sediment quality characteristics of the Río Uruguay have not changed as a result of the discharge of mill effluent.

Sediment quality with respect to EOX, TOX, total phenols, total PCBs, arsenic, cadmium, copper, chromium, mercury, nickel, lead, zinc, total PAHs, hydrocarbon, dioxin and furan have remained within the range observed prior to the operation of the mill.

This conclusion pertains to all monitoring stations, excluding the station at the discharge for the municipal wastewater treatment plant for the City of Fray Bentos (Station 13). As discussed in Section 5.2, the sediment quality at this location is impacted by the municipal discharge, although, as also discussed, this impact is unrelated to the mill discharge.

5.4 Comparison of Upstream and Downstream Data

The sediment quality at monitoring stations upstream (Stations 2, 3, 4 and 6) and downstream (Stations 8, 9, 10 and 14) of the mill discharge are comparable. A statistical analysis of the available data shows that the concentrations are not significantly different between upstream and downstream monitoring stations at the 95% confidence level. Parameters include: water content, loss on ignition, fraction <63 µm, EOX, TOX, total phenols, total PCBs, arsenic, cadmium, copper, chromium, mercury, nickel, lead, zinc, total PAHs, hydrocarbon, dioxin and furan.

The data indicate an increase in the pH level across the waterfront of the City of Fray Bentos, and an increase in the level of TOX, total PCBs, mercury, lead, zinc, total PAHs, dioxin and furan at the discharge for the municipal wastewater treatment plant for the City of Fray Bentos (Station 13), although these observations are unrelated to the mill discharge.

The sediment quality at monitoring stations near the mill discharge and within Yaguareté Bay (Stations 8, 9 and 10) is also comparable to upstream sediment quality at the 95% confidence level, and therefore shows no measureable effect due to the mill discharge.

5.5 Comparison to CIS Model Predictions

The CIS concluded that the mill discharge would have minimal effect on sediment quality within the Río Uruguay. The available monitoring data obtained by DINAMA provides verification of this conclusion. The data for the 2009 monitoring year indicates no change in sediment quality and shows sediments remain protective of aquatic life.

Table 5.1: Summary of Sediment Quality for Metals at Monitoring Stations along the Río Uruguay

STATION	N	Arsenic µg/g dw	Cadmium µg/g dw	Copper µg/g dw	Chromium µg/g dw	Iron µg/g dw	Mercury µg/g dw	Nickel µg/g dw	Lead µg/g dw	Zinc µg/g dw
Feb-09										
E of island Zapatero, center of channel	1	-	-	-	-	-	-	-	-	-
5 km upstream of M'bopicuá	2	<10	<1.4	17	<20	17	<0.1	<6.5	<15	25
Infront of the former location of M'Bopicuá	3	<10	<1.4	36	31	28	<0.1	<6.5	<15	48
Inlet off Island Abrigo	4	<10	<1.4	19	<20	16	<0.1	<6.5	<15	36
Main channel infront of Island Abrigo	5	-	-	-	-	-	-	-	-	-
Costa uru. Infront of Island Abrigo	6	<10	<1.4	<14	<20	3.2	<0.05	<6.5	<15	<15
At diffuser for Botnia	7	-	-	-	-	-	-	-	-	-
Adjacent to the diffuser of Botnia	8	<10	<1.4	20	<20	21	<0.1	<6.5	<15	36
E of Ayo Yaguareté	9	<10	<1.4	<6	<15	6.6	<0.05	<4	<10	<20
W of Ayo Yaguareté	10	<10	<1.4	<6	<15	3.9	<0.05	<4	<10	<20
Water intake of OSE	11	-	-	-	-	-	-	-	-	-
Marker 100 km, main channel of the Uruguay river	12	-	-	-	-	-	-	-	-	-
Municipal wastewater discharge	13	<10	<1.4	39	<15	15	0.16	<10	94	92
Downstream from Brio Las Cañas	14	<10	<1.4	<6	<15	4.8	<0.05	<4	<10	<20
Offshore from Brio Las Cañas	15	-	-	-	-	-	-	-	-	-
Adjacent to Brio Las Cañas	16	-	-	-	-	-	-	-	-	-
Jun-09										
STATION	N	Arsenic µg/g dw	Cadmium µg/g dw	Copper µg/g dw	Chromium µg/g dw	Iron µg/g dw	Mercury µg/g dw	Nickel µg/g dw	Lead µg/g dw	Zinc µg/g dw
E of island Zapatero, center of channel	1	-	-	-	-	-	-	-	-	-
5 km upstream of M'bopicuá	2	<10	<1	18	15	62	<0.5	12	<10	59
Infront of the former location of M'Bopicuá	3	<3	<1	47	35	50	<1	14	<10	66
Inlet off Island Abrigo	4	<3	<1	29	14	22	<0.5	10	<10	36
Main channel infront of Island Abrigo	5	-	-	-	-	-	-	-	-	-
Costa uru. Infront of Island Abrigo	6	<3	<1	16	11	17	<0.5	6.2	<10	19
At diffuser for Botnia	7	-	-	-	-	-	-	-	-	-
Adjacent to the diffuser of Botnia	8	<3	<1	35	25	40	<0.5	11	<10	47
E of Ayo Yaguareté	9	<3.5	<1	<10	5	5.2	<1	<5	<10	7.4
W of Ayo Yaguareté	10	<3.5	<1	<10	<5	4.5	<1	<5	<10	4.8
Water intake of OSE	11	-	-	-	-	-	-	-	-	-
Marker 100 km, main channel of the Uruguay river	12	-	-	-	-	-	-	-	-	-
Municipal wastewater discharge	13	<3.5	<1	48	22	32	<1	13	50	70
Downstream from Brio Las Cañas	14	<3.5	<1	<10	<5	5.6	<1	<5	<10	6.4
Offshore from Brio Las Cañas	15	-	-	-	-	-	-	-	-	-
Adjacent to Brio Las Cañas	16	-	-	-	-	-	-	-	-	-
Baseline Sediment Quality (CARU, 1997 to 2004)										
		Arsenic µg/g dw	Cadmium µg/g dw	Copper µg/g dw	Chromium µg/g dw	Iron µg/g dw	Mercury µg/g dw	Nickel µg/g dw	Lead µg/g dw	Zinc µg/g dw
Baseline, Río Uruguay at Fray Bentos		-	0.1 to 1.0	17 to 81	5 to 53	-	-	20 to 28	4 to 39	36 to 111
Baseline, Río Uruguay at Paysandú		-	).005 to 0.5	12 to 69	9 to 297	-	-	2 to 9	5 to 42	17 to 20
Baseline, Río Uruguay at Gualeguaychú		-	0.1 to 1.0	28 to 43	23 to 35	-	-	11 to 20	13 to 22	100 to 112
Canadian Sediment Quality Guidelines (CCME, 2002)										
		Arsenic µg/g dw	Cadmium µg/g dw	Copper µg/g dw	Chromium µg/g dw	Iron µg/g dw	Mercury µg/g dw	Nickel µg/g dw	Lead µg/g dw	Zinc µg/g dw
Canadian Sediment Quality Guidelines - ISQG		5.9	0.6	35.7	37.3	-	0.17	-	35	123
Canadian Sediment Quality Guidelines - PEL		17.0	3.5	197	90	-	0.49	-	91.3	315

Table 5.2: Summary of Sediment Quality for PAHs at Monitoring Stations along the Río Uruguay

STATION	N	Acenafteno µg/g dw	Acenaftileno µg/g dw	Antraceno µg/g dw	Benzo (a) antraceno µg/g dw	Benzo (b+j) fluoranteno µg/g dw	Benzo (k) fluoranteno µg/g dw	Benzo (g,h,i) perileno µg/g dw	Benzo (a) pireno µg/g dw	Criseno µg/g dw	Dibenzo (a,h) antraceno µg/g dw	Fenantreno µg/g dw	Fluoranteno µg/g dw	Fluoreno µg/g dw	Indeno (1,2,3-cd) pireno µg/g dw	Naftaleno µg/g dw	Pireno µg/g dw
Feb-09																	
E of island Zapatero, center of channel	1																
5 km upstream of M'bopicuá	2	<0.005	<0.005	0.001	<0.001	0.002	<0.001	<0.002	0.001	<0.001	<0.002	0.004	0.002	0.008	<0.002	0.017	0.002
Infront of the former location of M'Bopicuá	3	<0.005	<0.005	0.001	<0.001	0.003	0.001	<0.002	0.002	<0.001	<0.002	0.007	0.003	0.013	<0.002	0.021	0.003
Inlet off Island Abrigo	4	<0.005	<0.005	<0.001	<0.001	0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.003	0.002	<0.005	<0.002	0.011	0.002
Main channel infront of Island Abrigo	5																
Costa uru. Infront of Island Abrigo	6	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.001	<0.001	<0.005	<0.002	<0.010	<0.001
At diffuser for Botnia	7																
Adjacent to the diffuser of Botnia	8	<0.005	<0.005	0.001	<0.001	0.003	<0.001	<0.002	0.001	<0.001	<0.002	0.004	0.003	<0.005	<0.002	0.013	0.002
E of Ayo Yaguareté	9	<0.005	<0.005	0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.001	<0.001	<0.005	<0.002	<0.010	<0.001
W of Ayo Yaguareté	10	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	<0.001	<0.001	<0.005	<0.002	<0.010	<0.001
Water intake of OSE	11																
Marker 100 km, main channel of the Uruguay river	12																
Municipal wastewater discharge	13	<0.005	0.005	0.014	0.023	0.048	0.022	0.019	0.031	0.033	0.004	0.103	0.049	0.012	0.013	0.066	0.040
Downstream from Brio Las Cañas	14	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.001	<0.001	<0.005	<0.002	<0.010	<0.001
Offshore from Brio Las Cañas	15																
Adjacent to Brio Las Cañas	16																
Jun-09																	
STATION	N	Acenafteno µg/g dw	Acenaftileno µg/g dw	Antraceno µg/g dw	Benzo (a) antraceno µg/g dw	Benzo (b+j) fluoranteno µg/g dw	Benzo (k) fluoranteno µg/g dw	Benzo (g,h,i) perileno µg/g dw	Benzo (a) pireno µg/g dw	Criseno µg/g dw	Dibenzo (a,h) antraceno µg/g dw	Fenantreno µg/g dw	Fluoranteno µg/g dw	Fluoreno µg/g dw	Indeno (1,2,3-cd) pireno µg/g dw	Naftaleno µg/g dw	Pireno µg/g dw
E of island Zapatero, center of channel	1																
5 km upstream of M'bopicuá	2	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.002	0.001	<0.005	<0.002	<0.010	0.001
Infront of the former location of M'Bopicuá	3	<0.005	<0.005	0.002	0.002	0.008	0.001	0.003	0.004	0.002	<0.002	0.010	0.007	0.006	0.002	0.010	0.006
Inlet off Island Abrigo	4	<0.005	<0.005	0.001	0.002	0.005	0.001	<0.002	0.020	0.001	<0.002	0.004	0.004	0.012	<0.002	<0.010	0.004
Main channel infront of Island Abrigo	5																
Costa uru. Infront of Island Abrigo	6	<0.005	<0.005	0.001	<0.001	0.002	<0.001	<0.002	<0.001	<0.001	<0.002	0.002	0.002	<0.005	<0.002	<0.010	0.002
At diffuser for Botnia	7																
Adjacent to the diffuser of Botnia	8	0.013	0.006	0.003	0.001	0.003	<0.001	<0.002	<0.001	0.001	<0.002	0.007	0.003	0.030	<0.002	0.010	0.003
E of Ayo Yaguareté	9	<0.005	<0.005	0.001	<0.001	0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.001	<0.001	<0.005	<0.002	<0.010	<0.001
W of Ayo Yaguareté	10	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.001	<0.001	<0.005	<0.002	<0.010	<0.001
Water intake of OSE	11																
Marker 100 km, main channel of the Uruguay river	12																
Municipal wastewater discharge	13	<0.005	0.028	0.011	0.046	0.151	0.019	0.049	0.056	0.044	0.008	0.067	0.092	0.014	0.046	0.042	0.093
Downstream from Brio Las Cañas	14	0.005	<0.005	0.001	<0.001	<0.001	<0.001	<0.002	<0.001	<0.001	<0.002	0.003	<0.001	0.012	<0.002	<0.010	<0.001
Offshore from Brio Las Cañas	15																
Adjacent to Brio Las Cañas	16																
Baseline Sediment Quality (CARU, 1997 to 2004)																	
		Acenafteno µg/g dw	Acenaftileno µg/g dw	Antraceno µg/g dw	nzo (a) antrace µg/g dw	zo (b+j) fluoran µg/g dw	nzo (k) fluorant µg/g dw	nzo (g,h,i) peril µg/g dw	Benzo (a) piren µg/g dw	Criseno µg/g dw	nzo (a,h) antra µg/g dw	Fenantreno µg/g dw	Fluoranteno µg/g dw	Fluoreno µg/g dw	no (1,2,3-cd) p µg/g dw	Naftaleno µg/g dw	Pireno µg/g dw
Baseline, Río Uruguay at Fray Bentos																	
Baseline, Río Uruguay at Paysandú																	
Baseline, Río Uruguay at Gualeguaychú																	
Canadian Sediment Quality Guidelines (CCME, 2002)																	
		Acenafteno µg/g dw	Acenaftileno µg/g dw	Antraceno µg/g dw	Benzo (a) antraceno µg/g dw	Benzo (b+j) fluoranteno µg/g dw	Benzo (k) fluoranteno µg/g dw	Benzo (g,h,i) perileno µg/g dw	Benzo (a) pireno µg/g dw	Criseno µg/g dw	Dibenzo (a,h) antraceno µg/g dw	Fenantreno µg/g dw	Fluoranteno µg/g dw	Fluoreno µg/g dw	Indeno (1,2,3-cd) pireno µg/g dw	Naftaleno µg/g dw	Pireno µg/g dw
Canadian Sediment Quality Guidelines - ISQG		0.007	0.006	0.047	0.032	-	-	-	0.032	0.057	0.006	-	0.111	0.021	-	0.035	0.053
Canadian Sediment Quality Guidelines - PEL		0.089	0.128	0.245	0.385	-	-	-	0.782	0.862	0.135	-	2.355	0.144	-	0.391	0.875

Table 5.3: Summary of Sediment Quality for Dioxin and Furan at Monitoring Stations along the Río Uruguay

STATION	N	Dioxin 2,3,7,8 TCDD pg/g dw	Dioxin 1,2,3,7,8 - PeCDD pg/g dw	Dioxin 1,2,3,4,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,6,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,7,8,9 - HxCDD pg/g dw	Dioxin 1,2,3,4,6,7,8 - HpCDD pg/g dw	Furan 2,3,7,8 -TCDF pg/g dw	Furan 1,2,3,7,8 - PeCDF pg/g dw	Furan 2,3,4,7,8 - PeCDF pg/g dw	Furan 1,2,3,4,7,8 - HxCDF pg/g dw	Furan 1,2,3,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,7,8,9 - HxCDF pg/g dw	Furan 2,3,4,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,4,6,7,8 - HpCDF pg/g dw	Furan 1,2,3,4,7,8,9 - HpCDF pg/g dw	Toxic Equivalent Including Detection Limit pg/g WHO-TEQ	Toxic Equivalent Excluding Detection Limit pg/g WHO-TEQ
E of island Zapatero, center of channel	1																	
5 km upstream of M'bopicuá	2	<0.2	<0.3	<0.5	<0.5	<0.5	2.00	0.25	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.07	0.05
Infront of the former location of M'Bopicuá	3	<0.2	<0.3	<0.5	<0.5	<0.5	5.00	0.51	<0.3	0.31	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.14	0.26
Inlet off Island Abrigo	4	<0.2	<0.3	<0.5	<0.5	<0.5	0.92	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.01
Main channel infront of Island Abrigo	5																	
Costa uru. Infront of Island Abrigo	6	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
At diffuser for Botnia	7																	
Adjacent to the diffuser of Botnia	8	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	0.22	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.02
E of Ayo Yaguareté	9	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	0.24	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.02
W of Ayo Yaguareté	10	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Water intake of OSE	11																	
Marker 100 km, main channel of the Uruguay river	12																	
Municipal wastewater discharge	13	<0.2	0.60	<0.5	0.89	<0.5	4.10	0.61	0.41	0.61	<0.5	0.56	<0.5	0.69	4.30	<0.7	<1.69	1.28
Downstream from Brio Las Cañas	14	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Offshore from Brio Las Cañas	15																	
Adjacent to Brio Las Cañas	16																	

STATION	N	Dioxin 2,3,7,8 TCDD pg/g dw	Dioxin 1,2,3,7,8 - PeCDD pg/g dw	Dioxin 1,2,3,4,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,6,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,7,8,9 - HxCDD pg/g dw	Dioxin 1,2,3,4,6,7,8 - HpCDD pg/g dw	Furan 2,3,7,8 -TCDF pg/g dw	Furan 1,2,3,7,8 - PeCDF pg/g dw	Furan 2,3,4,7,8 - PeCDF pg/g dw	Furan 1,2,3,4,7,8 - HxCDF pg/g dw	Furan 1,2,3,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,7,8,9 - HxCDF pg/g dw	Furan 2,3,4,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,4,6,7,8 - HpCDF pg/g dw	Furan 1,2,3,4,7,8,9 - HpCDF pg/g dw	Toxic Equivalent Including Detection Limit pg/g WHO-TEQ	Toxic Equivalent Excluding Detection Limit pg/g WHO-TEQ
E of island Zapatero, center of channel	1																	
5 km upstream of M'bopicuá	2	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Infront of the former location of M'Bopicuá	3	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	0.32	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	1.70	<0.7	<1.08	0.05
Inlet off Island Abrigo	4	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Main channel infront of Island Abrigo	5																	
Costa uru. Infront of Island Abrigo	6	0.27	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	0.95	<0.7	<1.13	0.28
At diffuser for Botnia	7																	
Adjacent to the diffuser of Botnia	8	<0.2	<0.3	<0.5	<0.5	0.54	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	1.10	<0.5	<0.7	<0.7	<1.12	0.16
E of Ayo Yaguareté	9	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
W of Ayo Yaguareté	10	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Water intake of OSE	11																	
Marker 100 km, main channel of the Uruguay river	12																	
Municipal wastewater discharge	13	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	0.39	<0.3	<0.5	0.51	<0.5	<0.5	3.60	<0.7	<1.09	0.11
Downstream from Brio Las Cañas	14	<0.2	<0.3	<0.5	<0.5	<0.5	<0.7	<0.2	<0.3	<0.3	<0.5	<0.5	<0.5	<0.5	<0.7	<0.7	<1.06	0.00
Offshore from Brio Las Cañas	15																	
Adjacent to Brio Las Cañas	16																	

		Dioxin 2,3,7,8 TCDD pg/g dw	Dioxin 1,2,3,7,8 - PeCDD pg/g dw	Dioxin 1,2,3,4,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,6,7,8 - HxCDD pg/g dw	Dioxin 1,2,3,7,8,9 - HxCDD pg/g dw	Dioxin 1,2,3,4,6,7,8 - HpCDD pg/g dw	Furan 2,3,7,8 -TCDF pg/g dw	Furan 1,2,3,7,8 - PeCDF pg/g dw	Furan 2,3,4,7,8 - PeCDF pg/g dw	Furan 1,2,3,4,7,8 - HxCDF pg/g dw	Furan 1,2,3,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,7,8,9 - HxCDF pg/g dw	Furan 2,3,4,6,7,8 - HxCDF pg/g dw	Furan 1,2,3,4,6,7,8 - HpCDF pg/g dw	Furan 1,2,3,4,7,8,9 - HpCDF pg/g dw	Toxic Equivalent pg/g WHO-TEQ dw
Toxic Equivalent Factor, TEF		1.00	1.00	0.10	0.10	0.10	0.01	0.10	0.05	0.50	0.10	0.10	0.10	0.10	0.01	0.01	
Canadian Sediment Quality Guideline - ISQG		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.85
Canadian Sediment Quality Guideline - PEL		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.5

Figure 5.1: Sediment Quality Monitoring Stations along the Río Uruguay

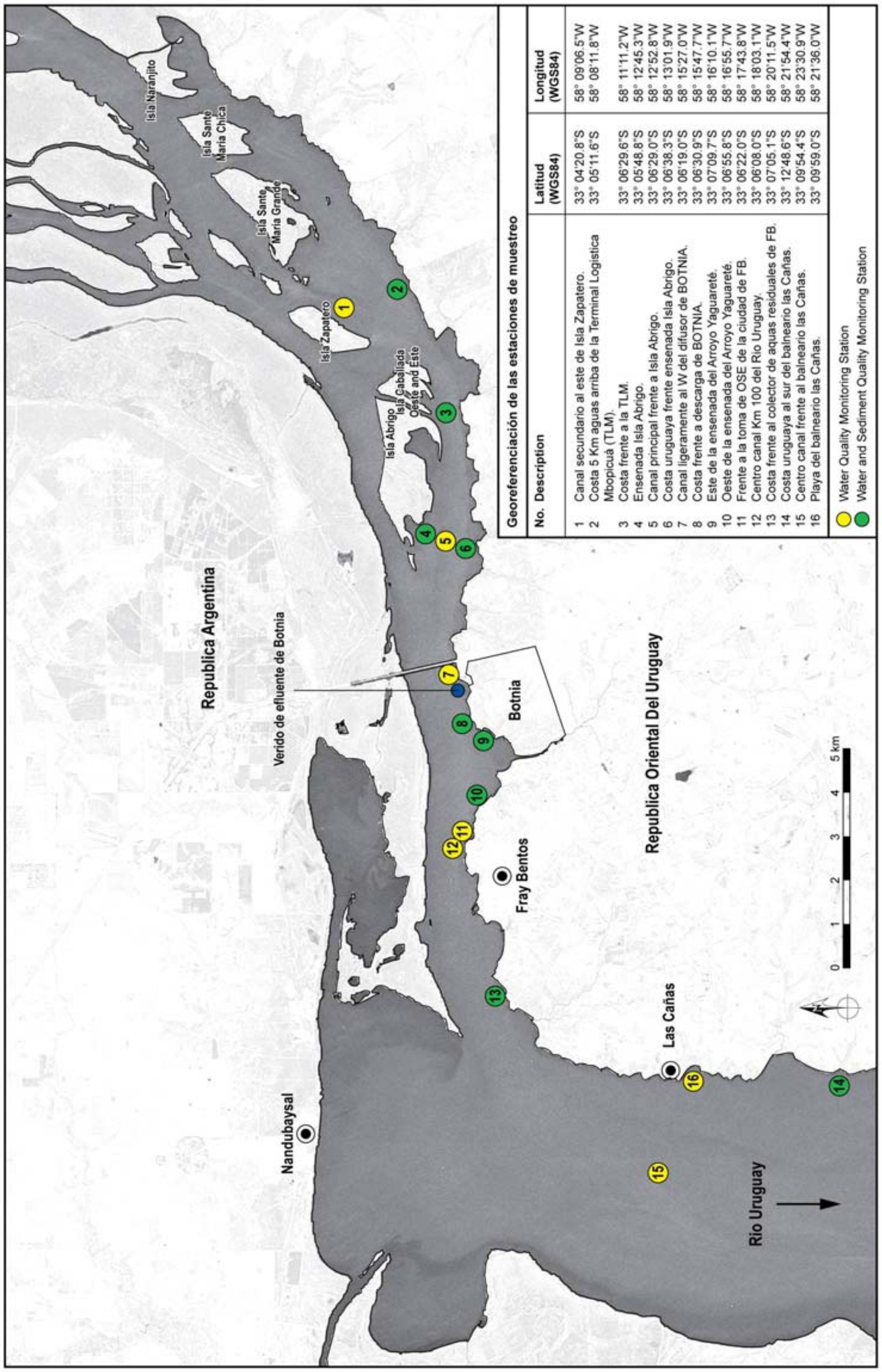
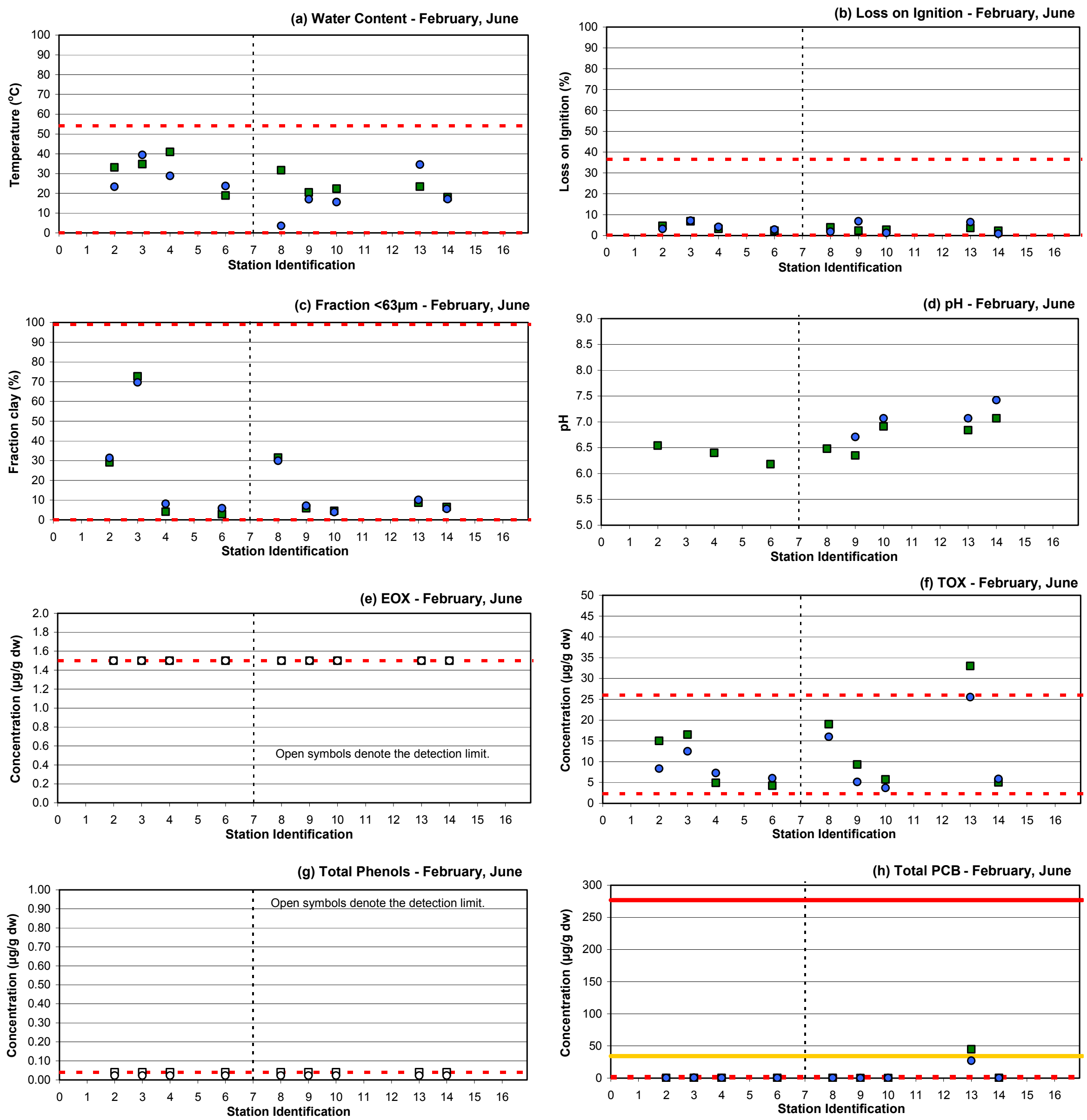


Figure 5.2: Sediment Quality Monitoring Data, Río Uruguay



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

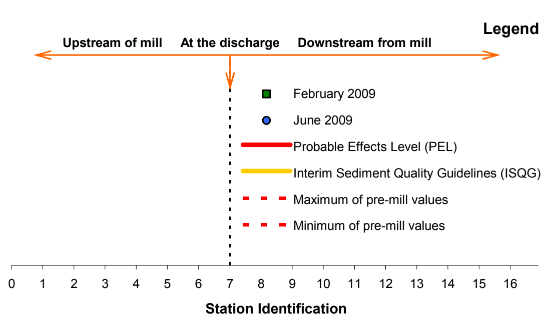
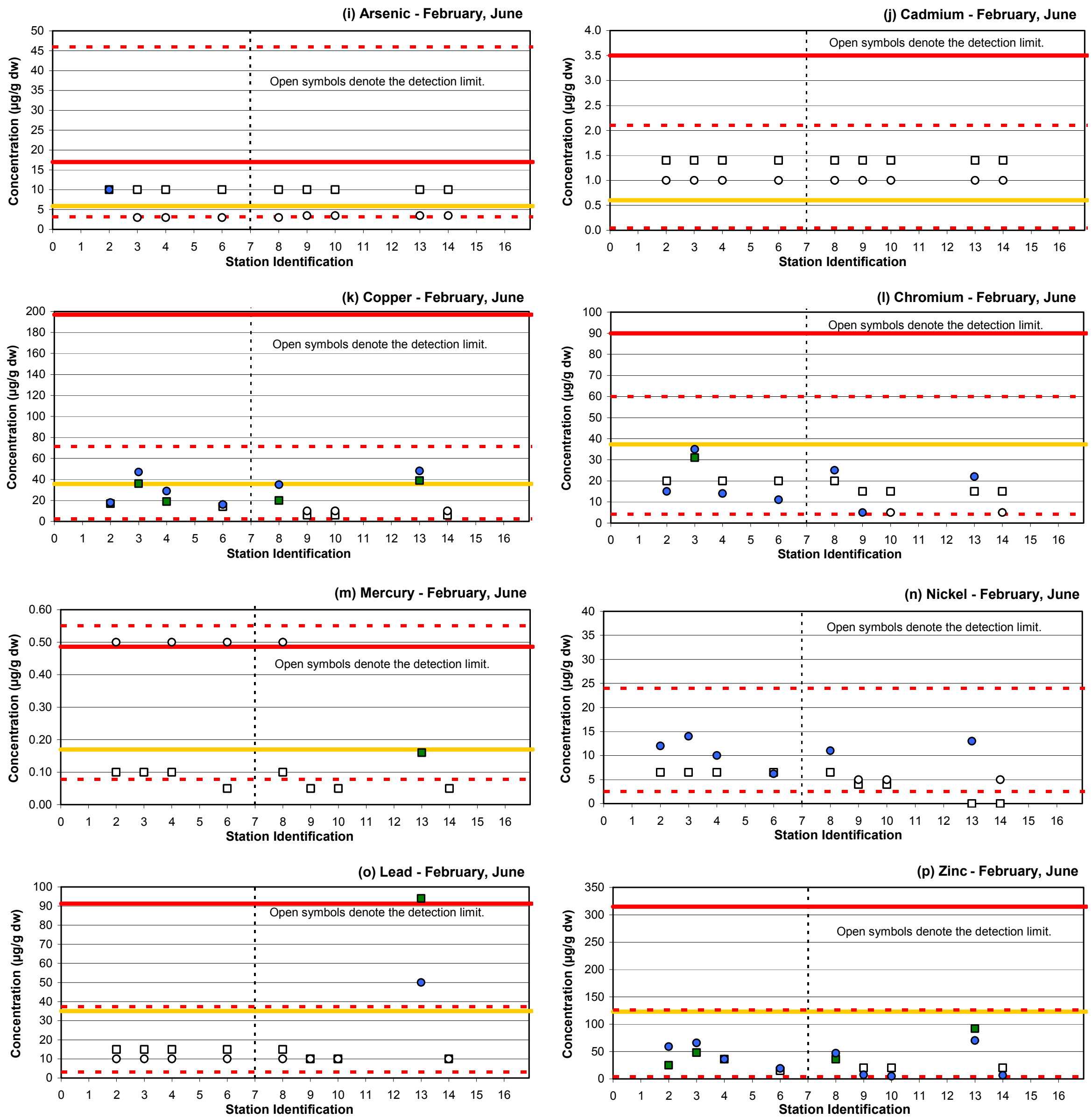


Figure 5.2: Sediment Quality Monitoring Data, Río Uruguay (… continue)



Station Identification

1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas

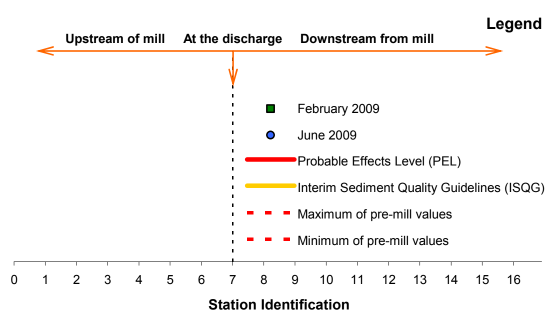
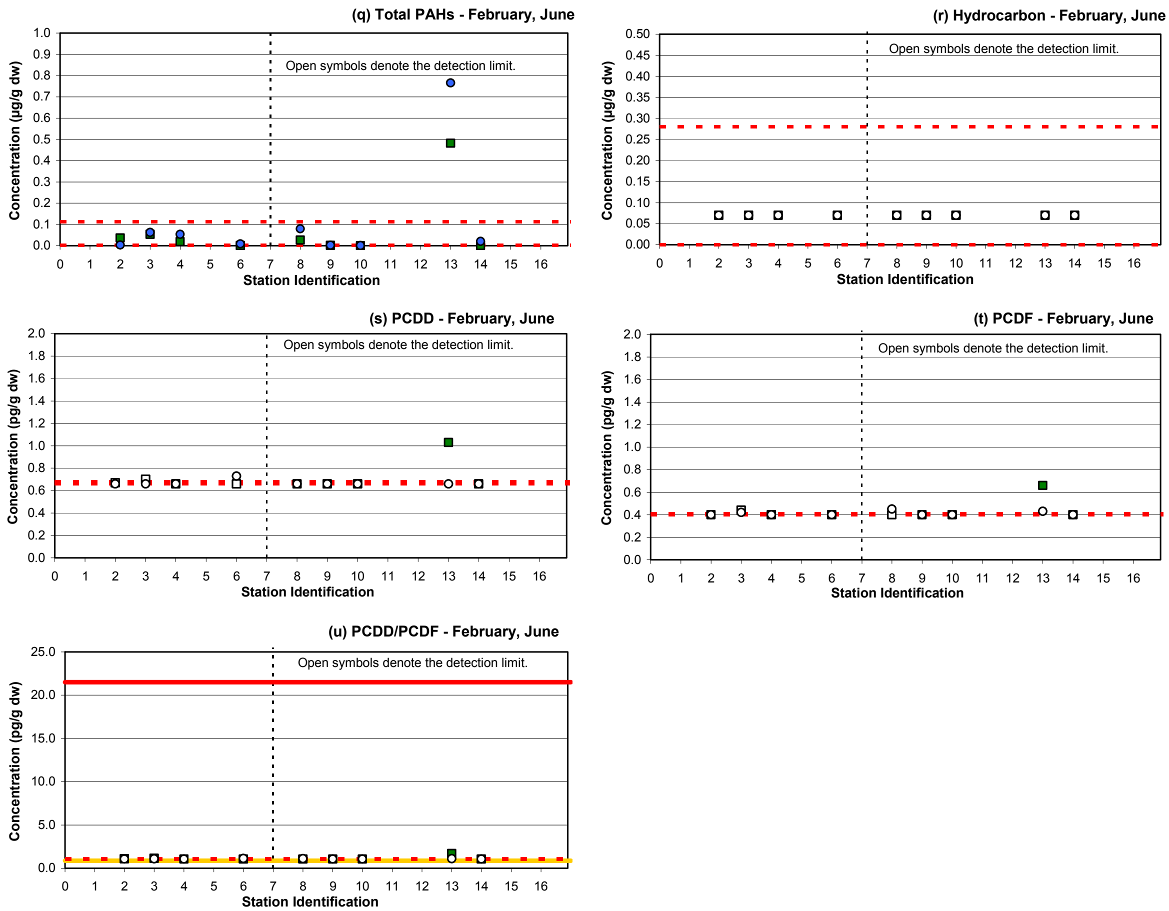
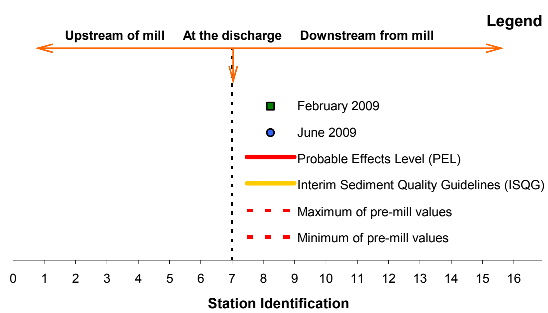


Figure 5.2: Sediment Quality Monitoring Data, Río Uruguay (… continue)



Station Identification
1. E of island Zapatero, center of channel
2. 5 km upstream of M'bopicuá
3. Infront of the former location of M'Bopicuá
4. Inlet off Island Abrigo
5. Main channel infront of Island Abrigo
6. Costa uru. infront of Island Abrigo
7. At diffuser for Botnia
8. Adjacent to the diffuser of Botnia
9. E of Ayo Yaguareté
10. W of Ayo Yaguareté
11. Water intake of OSE
12. Marker 100 km, main channel of the Uruguay river
13. Municipal wastewater discharge
14. Downstream from Brio Las Cañas
15. Offshore from Brio Las Cañas
16. Adjacent to Brio Las Cañas



6.0 BIOTA OF THE RIO URUGUAY

6.1 Overview

Sections 4.0 and 5.0 conclude that the water and sediment quality of the Río Uruguay is within standards considered suitable for the protection of aquatic life. This conclusion is verified based on the results of comprehensive biological monitoring programs undertaken by LATU, DINAMA and ÅF-Consult Oy.

The results of these biological monitoring programs are presented in the following sections. They include comparisons of biological indicators and analyses of the biological communities within the Río Uruguay. The main findings are summarized in the following points:

- These monitoring programs conclude that the biological communities within the Río Uruguay have not been affected by the mill discharge.
- All indicators of the general health of the aquatic ecosystem have remained unchanged between periods pre- and post- mill start-up, and between areas near the discharge and areas beyond its influence.
- The algal community health within the Río Uruguay has not been affected by the mill discharge. Excessive growth of algae was reported in February 2009, although investigations by DINAMA concluded that the algal bloom was not attributed to the mill discharge nor was the effluent from the mill implicated in the expansion or growth of the bloom within the river.
- The zooplankton and benthic macroinvertebrate communities have not been affected by the mill discharge. Health indicators have remained unchanged between periods pre- and post- mill start-up, and between reference and exposed areas.
- The fish communities have not been affected by the mill discharge. Health indicators have remained unchanged since start-up of the mill. These indicators include species diversity, size class distribution, general condition, reproductive and metabolic indices, and chemical analysis of bile and tissue.
- Fish usability has remained unchanged since start-up of the mill. Levels of dioxin, furan, PCB, mercury and lead are well below limits set in the European Union and Canada. There is no limitation to human consumption of the studied fish.

6.2 Algae

Algae are tiny aquatic plants that are an essential part of the aquatic ecosystem. They are the base of the food chain, converting nutrients to organic matter.

The algal community health within the Río Uruguay was investigated by LATU[6] in order to analyze spatial differences between Nuevo Berlin, Fray Bentos and Las Cañas, and

[6] LATU, 2010. Tercer año de estudio de las comunidades biológicas y variables abióticas en el tramo inferior del Río Uruguay. Laboratorio Technologico del Uruguay. Febrero de 2010.

temporal trends over the period 2006 to 2009. Indicators of community health include abundance, diversity, species richness and relative distribution.

The analysis concludes that the algal community health has not been affected by the mill discharge. Health indicators have remained unchanged between periods pre- and post- mill start-up and between reference and exposed areas.

Although algae are an essential part of a health aquatic ecosystem, problems arise when the balance is upset. This can occur when the water temperature is warm, the sun is bright and nutrient levels are high. Such conditions can result in an excessive growth of algae, commonly referred to as a "bloom". Algae blooms can affect the aesthetic quality of the aquatic environment, resulting in unpleasant tastes or odors, reduced water clarity and discoloration of the water. It can also foul beaches, clog water intakes, stain boats and marine structures, and in certain cases cause illness and even mortality.

An algal bloom occurred within the Río Uruguay on 4 February 2009 during a period of prolonged hot summer conditions. The bloom caused an intense green discoloration over an approximately 60 kilometer stretch of the river extending from upstream of Nuevo Berlin to downstream of Fray Bentos. The bloom extended across the river and was observed from both banks.

DINAMA investigated the incident to determine the possible cause[7]. DINAMA concluded that the algal bloom was not attributed to the mill discharge nor was the effluent from the mill implicated in the expansion or growth of the bloom within the river.

DINAMA commissioned the Coast Guard Command at Fray Bentos to conduct sampling to verify the material. Analysis confirmed the presence of high concentrations of colonial organisms (over 10^6 cell/mL) of the genus *Microcystis* represented primarily by two species: *Mycrocystis aeruginosa* and *Microcystis wesenbergii*. Also forming part of this community, but in a notably smaller proportion, were filaments of the cyanobacteria *Anabaena spiroides*. These species are reportedly to be common in the Río Uruguay and to have formed blooms in this and other systems in the region in previous years.

The bloom was reported over a 2 to 3 day period during which time there were no complaints of adverse effects on biota, on human health, or on the supply of potable water for Fray Bentos or other communities.

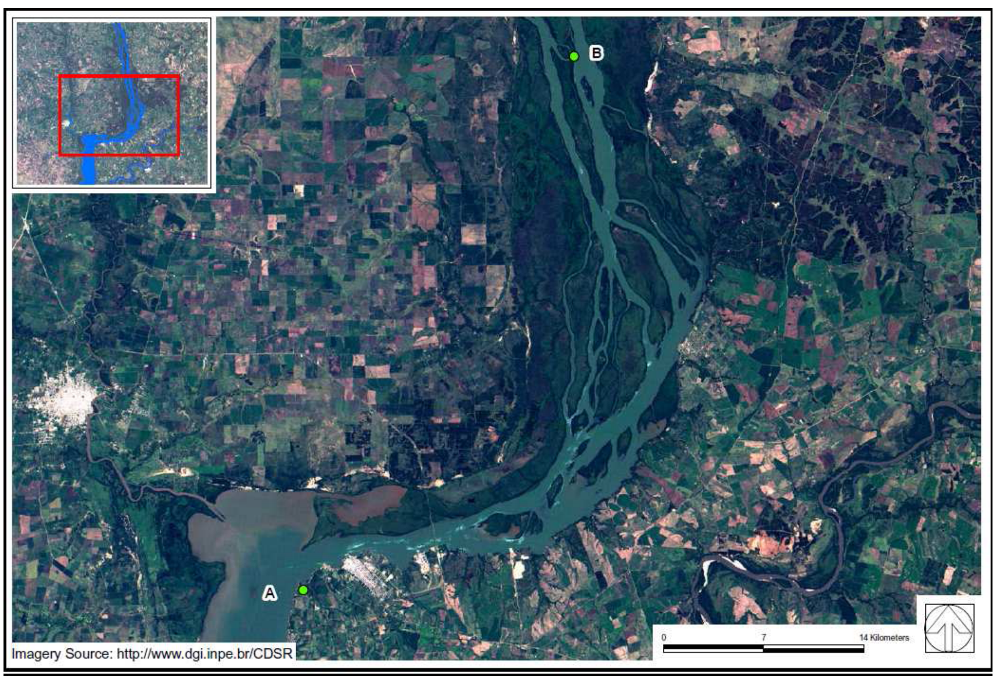
DINAMA concluded that the mill was not implicated in the bloom based on the following evidence:

- Satellite imagery clearly shows that the bloom occurred throughout the river and extended upstream from the mill far beyond the influence of the mill discharge, as illustrated in Figures 6.1 through 6.3.
- The distribution of chlorophyll$_a$ in the Río Uruguay on 4 February 2009 confirms that the bloom did not originate from a single point or from the vicinity of the mill discharge, as illustrated in Figure 6.4.
- Satellite images taken on 2 February 2009 indicate Ñandubaysal Bay and upper reaches of the Río Uruguay as the possible origins of the bloom.

[7] DINAMA, 2009. Report, Cyanobacteria bloom in the Uruguay River, 4 February 2009. A report prepared by DINAMA, July 2009.

- Elevated levels of phytoplankton and cyanobacteria were first reported in Paysandú, approximately 100 km upstream, a few days before the bloom was visible in Fray Bentos.
- Numerous literature citations provide record of algal blooms dating back thirty years prior to the start-up of the mill and identify the occurrence of algal blooms throughout the Río Uruguay including locations within Uruguay and Argentina.
- OSE records document the presence of cyanobacteria within the Río Uruguay dating back prior to the construction of the Salto Grande dam, and show variability from year to year with higher and lower levels in past years as compared to that recorded in February 2009.
- Algal blooms are correlated with hot summer temperatures and low flow within the Río Uruguay, such as occurred in February 2009.
- The mill was operating within their permit limits during February 2009 and there is no evidence an unusual discharge occurred.
- Routine water quality monitoring provides direct evidence the mill discharge has no effect on temperature or nutrient levels within Río Uruguay and hence does not contribute to factors that can affect the growth of algal.

Figure 6.1 Satellite image showing the extent of the bloom on 4 February 2009



Algae Bloom on the true-color combination of Landsat-5 TM (04-02-2009 13:29)

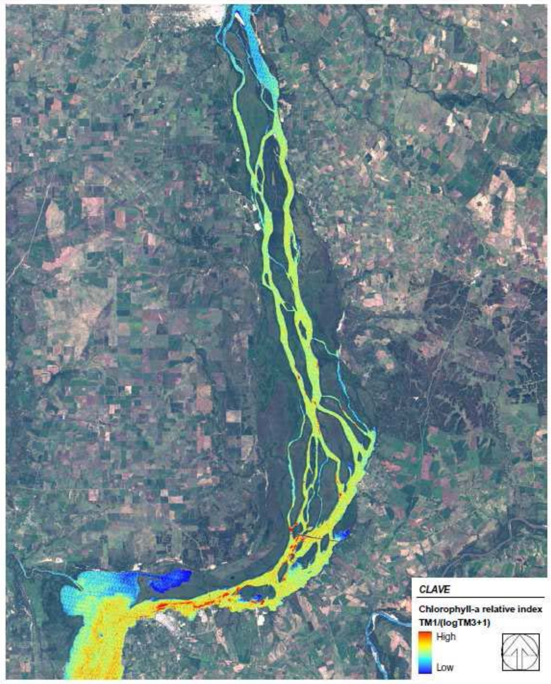
Figure 6.2 Close up of the upper extent of the bloom on 4 February 2009

Algae Bloom on the true-color combination of Landsat-5 TM (04-02-2009 13:29)

Figure 6.3 Close up of the lower extent of the bloom on 4 February 2009

Algae Bloom on the true-color combination of Landsat-5 TM (04-02-2009 13:29)

Figure 6.4 Distribution of chlorophyll$_a$ in the Río Uruguay on 4 February 2009



Chlorophyll-a concentration from Landsat 5 (TM) image on 04-02-2009 13:29

6.3 Zooplankton

Zooplankton are microscopic animals that live suspended in the water. They are grazers that feed on primary producers (algae), and are an integral part of the food chain for many higher order organisms.

The zooplankton community health within the Río Uruguay was investigated by LATU[6] in order to analyze spatial differences between Nuevo Berlin, Fray Bentos and Las Cañas, and temporal trends over the period 2006 to 2009. Indicators of community health include abundance, diversity, species richness and relative distribution.

The analysis concludes that the zooplankton community health has not been affected by the mill discharge. Health indicators have remained unchanged between periods pre- and post- mill start-up and between reference and exposed areas.

Rotifera continue to be the dominant group based on the number of taxa. The zooplankton community follows a seasonal pattern typical of the region, with higher densities in warmer months and lower densities in the colder months. This natural variability is attributed to seasonal differences in flow rate, water clarity and water temperature, and is not attributed to the mill discharge.

6.4 Benthic Macroinvertebrates

Benthic macroinvertebrates (benthos) are small animals without backbones that live on or in the sediment during some stage of their life. They include crustaceans, mollusks, aquatic worms and the immature forms of aquatic insects. They feed on algae, bacteria, plant material or other organic matter, and thereby serve a critical role in the natural flow of energy and nutrient for higher order organisms within the food chain, especially fish.

Benthos are important indicators of the state of the aquatic ecosystem. Unlike fish, benthos cannot move over large distances, so they are intimately connected with the water and sediment within the immediate area in which they live. There are many different types of benthic animals. Some are tolerant of various pollutants, while others are not. Therefore, a change in the benthic community structure over time or between locations provides an indication of a change in health of the aquatic ecosystem.

The benthic macroinvertebrate community was investigated by LATU[6] in order to assess potential changes in the general health of the aquatic ecosystem within the lower Río Uruguay. The investigation included seasonal (summer, fall, winter and spring) sampling at three locations along the Río Uruguay over the period 2006 to 2009. The sample locations include a reference area at Nuevo Berlin and exposure areas at Fray Bentos and Las Cañas.

The analysis concludes that the benthic macroinvertebrate community health has not been affected by the mill discharge. Health indicators have remained unchanged between periods pre- and post- mill start-up, and between reference and exposed areas.

The benthic community continues to be dominated by the golden mussel (*Limnoperna fortunei*) throughout the period of record and at all monitoring locations. The diversity and species richness has remained unchanged between periods pre- and post- mill start-up. Seasonal variations are evident, although a consistent variation is observed at all three monitoring stations irrespective of exposure. There is also evidence abundance has increased since 2006, however, this trend is also observed at all three monitoring stations and therefore is not attributed to the mill discharge. Flow and sediment composition are identified as the most significant factors affecting the distribution and abundance of benthic organisms.

6.5 Fish

The lower Río Uruguay contains more than 100 species of fish. The more common species include the sábalo (*Prochilodus lineatus*, Prochilodontidae), the boga (*Leporinus obtusidens*, Anostomidae), the pati catfish (*Luciopimelodus pati*, Pimelodidae), and the dorado (*Salminus maxillosus*, Characidae). These valued resources support commercial and sports fisheries in both Uruguay and Argentina.

The assessment of water quality of the Río Uruguay described in Section 4.0 concludes that the water quality is within standards considered suitable for the protection of aquatic biota and preservation of fish.

This conclusion is verified based on the results of comprehensive fish monitoring programs undertaken within the lower Río Uruguay. These investigations have been undertaken independently by DINAMA[8 9] and by ÅF-Consult Oy[10 11]. Both have concluded there are no identifiable effects attributed to the mill discharge.

These fish monitoring programs follow the general elements and/or principles described in the CIS and currently used as part of the environmental effects monitoring program for pulp mills in Canada. They follow the sentinel species approach, and are based on measures of survival, energy use, energy storage, and fish usability. The assessment of effect is based on a comparison between pre- and post- mill start-up, and between areas exposed to mill effluent and reference areas beyond the influence of mill effluent.

The monitoring program of DINAMA is based on exposure areas in Yaguareté Bay, Fray Bentos at Anglo and further downstream at Arroyo Caracoles, and a reference area upstream at Arroyo Laureles. The monitoring program of ÅF-Consult Oy is based on exposure areas in Yaguareté Bay and Las Cañas, and a reference area upstream at Nuevo Berlin. Both programs have chosen the Bagre trompudo (*Iheringichthys labrosus*) as the indicator species.

The conclusion that there are no identifiable effects attributed to the mill discharge is based on the following observations:

- Species diversity has remained unchanged since start-up of the mill. Both monitoring programs show variability in the number of species between monitoring stations and over time, however both monitoring programs show no discernable trend or correlation with proximity to the mill or with mill start-up.
- The number of fish caught during each survey (per unit effort) was highly variable and does not provide evidence to support a conclusion of either effect or no-effect. ÅF-Consult Oy demonstrates that the unit catch varies significantly from week to week and between the littoral zone (i.e., shallow areas near the shoreline) and medium zone (i.e., deeper waters further offshore), and that these variations often exceed the variation between reference and exposure areas and between pre- and post- mill start-up.
- The size class distribution was the same between exposure and reference areas, which demonstrates that the age distribution of the fish population has not been affected by the mill discharge.
- The general condition of the fish caught during these monitoring programs has not changed since start-up of the mill. There is no indication of any macroscopic deformities, abnormalities or fish diseases.

[8] DINAMA, 2008. Informe del monitoreo de la fauna íctica en el area de la planta de celulosa de Botnia: 1er. año de operativa.

[9] DINAMA, 2009. Informe del monitoreo de la fauna íctica en el area de la planta de celulosa de Botnia: 2do. año de operativa.

[10] Tana, J., 2010a. Fish community and species diversity in Rio Uruguay. Monitoring studies in the recipient of UPM pulp mill, December 2009. ÅF-Consult report ENVI-,535, January 2010, Vantaa, Finland.

[11] Tana J., 2010b. Concentrations of resin acids, chlorinated phenols and plant sterols in fish from Rio Uruguay. Monitoring studies in the recipient of Botnia pulp mill, December 2009. ÅF-Consult report, ENVI-, February 2010.

- Reproductive and metabolic indices based on gonad, liver and body weight are comparable between exposure and reference areas based on a statistic comparison (ANOVA, $P<0.05$). Seasonal variations are evident although these are related to reproductive cycles and are unrelated to the mill.
- The concentrations of chlorinated phenols, resin acids and phytosterols in fish bile are comparable between pre- and post- mill start-up. Differences exist between stations, although there is no indication these differences are attributed to the mill discharge. Differences also exist between fish species, although these differences are related to feeding habits.
- The concentrations of dioxin, furan, PCB, mercury and lead in fish tissue are comparable between pre- and post- mill start-up. Differences exist between stations, with the lowest levels observed in Yaguareté Bay and highest levels observed near Las Cañas. These spatial differences are unrelated the mill discharge.
- Fish usability has remained unchanged since start-up of the mill. Levels of dioxin, furan, PCB, mercury and lead are well below the maximum limits set in the European Union and Canada. There is no limitation to human consumption of the studied fish.

7.0 AIR EMISSIONS

7.1 Overview

The air emission data for the Orion mill are reviewed in the following section to compare the actual air emissions during the 2009 monitoring year to limits specified by DINAMA in the AAP (Table 7.1) and to the expected loadings predicted in the CIS (Table 7.2). The main findings from this review are summarized in the following points:

- The air emissions from the mill during the 2009 monitoring year have remained well within the allowable permit limits specified by DINAMA. The concentrations of total particulate material (TPM), sulphur dioxide (SO_2), nitrogen oxide (NO_x) and total reduced sulphur (TRS) have remained below the respective threshold values within the required 90% frequency.
- The air emissions are well below the expected loads predicted in the CIS for SO_2, TPM, TRS and carbon monoxide (CO).
- The load for NO_x is below the World Bank Group emission guideline and below criteria identified as being best available technology (BAT) based on pulp production only (excluding emissions associated with power production). The emissions are comparable to, but generally above, the expected maximum value predicted in the CIS. Optimization measures have been implemented over the first two years of operation. Further optimization of the recovery boiler and lime kiln will continue in the future in an effort to further reduced emissions of NO_x.
- The emissions of TRS are below the expected emissions predicted in the CIS. Incidents of malodorous gas release are discussed in Section 8.4.

7.2 Air Emission Quality

The quality of the air emissions from the mill is monitored on a routine basis as per the schedule presented in Table 1.1. The available data are reviewed in the following sections to identify compliance with the air emission limits of DINAMA (Figure 7.1), and to compare with the expected maximum daily load (Figure 7.2), expected maximum monthly load (Figure 7.3) and the expected annual average load (Figure 7.4) predicted in the CIS.

The monitoring program for air emissions is comprehensive and provides for a detailed evaluation of the performance of the mill during the 2009 monitoring year. These data show that the mill is operating within the permissible limits of its operating license and near the expected level of performance.

Air emissions are discussed in the following sections for TPM, SO_2, NO_x, TRS and CO. The emission values presented are based on a weighted average of all emission sources.

7.2.1 Particulate Material (TPM)

The mill is operating in full compliance with DINAMA’s permit limits for TPM and well within the emission rates predicted in the CIS.

The threshold concentration for TPM is 150 mg/Nm^3. Since the mill began operation, the concentration of TPM has remained below this threshold approximately 99.7% of the time (on an annualized basis). This is well below the 10% frequency of exceedance permitted by DINAMA.

The maximum daily loading of TPM was below the expected maximum daily load of 2,290 kg/d predicted in the CIS, with one exception in April 2009. The maximum monthly loading of TPM was 0.21 kg/ADt, below the expected maximum monthly load of 0.5 kg/ADt predicted in the CIS. During the 2009 monitoring year, the annual average load was 0.15 kg/ADt, well below the expected annual average load of 0.30 kg/ADt.

7.2.2 Sulphur Dioxide (SO_2)

The mill is operating in full compliance with DINAMA's permit limits for SO_2 and is within the annual average emission rate predicted in the CIS.

The concentration of SO_2 has been below the threshold concentration of 500 mg/Nm^3 approximately 97.6% of the time (on an annualized basis), well below the permissible 10% frequency of exceedance.

The maximum daily loading of SO_2 was below the expected load of 7,140 kg/d predicted in the CIS, with one exception in November 2009 due to the burning of fuel oil in the recovery boiler during start-up of the mill following the scheduled annual maintenance.

The maximum monthly load of SO_2 was below the expected load of 0.6 kg/ADt, and the annual average load was below the expected long-term average load of 0.30 kg/ADt predicted in the CIS.

7.2.3 Nitrogen Oxide (NO_x)

The mill is operating in full compliance with DINAMA's permit limits for NO_x.

The concentration of NO_x has been below the threshold concentration of 300 mg/Nm^3 approximately 96.1% of the time (on an annualized basis), well below the permissible 10% frequency of exceedance.

The load for NO_x is below the World Bank Group emission guideline of 2.0 kg/ADt and below criteria identified as being BAT based on pulp production only (excluding emissions associated with power production). The emissions are comparable to, but generally above, the expected maximum values predicted in the CIS. Optimization measures have been implemented over the first two years of operation. Further optimization of the recovery boiler and lime kiln will continue in the future in an effort to further reduced emissions of NO_x

7.2.4 Total Reduced Sulphur (TRS)

The mill is operating in full compliance with DINAMA's permit limits for TRS and is within the emission rates predicted in the CIS.

The concentration of TRS has been below the threshold concentration of 10 mg/Nm^3 from the recovery boiler and 20 mg/Nm^3 from the lime kiln approximately 99.8% and 99.9% of the time (on an annualized basis), respectively. In comparison, the permissible frequency of exceedance is 10%.

The maximum daily load of TRS was 106 kg/d, well below the expected maximum daily load of 860 kg/d from the recovery boiler and lime kiln, and below the expected maximum event load of 1,070 kg/event from the concentrated NCG system. The maximum monthly load of TRS was 0.005 kg/ADt, well below the expected maximum monthly loading of 0.1 kg/ADt predicted in the CIS. During the 2009 monitoring year, the annual average load of TRS was 0.001 kg/ADt, well below the expected long term average load of 0.05 kg/ADt predicted in the CIS.

TRS emissions are further discussed in Section 8.4.

7.2.5 Carbon Monoxide (CO)

The mill does not have a permit limit for CO, nor did the CIS provide an estimate of the expected maximum daily load. The CIS did provide an estimate of the expected maximum monthly load of CO at 2.0 kg/ADt and annual average load at 1.7 kg/ADt. Over the 2009 operating period, the maximum monthly and annual average loads of CO were 0.76 kg/ADt and 0.26 kg/ADt, respectively, both well below the expected values.

Table 7.1: Summary of Air Emissions Concentration Threshold from DINAMA

Parameter	Source of Emission	Instantaneous Concentration	Frequency
• Particulate material (TPM)	All sources	150 mg/Nm^3	Less than 10% of the annual operating time
• Sulphur dioxide (SO_2)	All sources	500 mg/Nm^3	
• Nitrogen oxides (as NO_2)	All sources	300 mg/Nm^3	
• Total reduced sulphur (TRS)	Stack recovery boiler Lime kiln	10 mg/Nm^3 20 mg/Nm^3	

Table 7.2: Estimated Air Emissions for the Mill from the CIS

Parameter	Annual average[1] (kg/ADt)	Monthly maximum (kg/ADt)	24-h maximum (kg/ADt)	24-h maximum (kg/d)[2]
• Carbon monoxide (CO)	1.70	2.00	-	-
• Sulphur dioxide (SO_2)	0.30	0.60	2.50	7,140
• Nitrogen oxides (as NO_2)	1.35	1.50	1.60	4.570
• Particulate material (TPM)	0.30	0.50	0.80	2,290
• Inhalable particulate material(PM_{10})	0.26	0.45	0.75	2,143
• Total reduced sulphur (TRS)	0.05	0.10 -	0.30 -	860[3] 1,070[4]

[1] Annual average load based on long-term operating conditions post start-up phase.
[2] 24-h maximum load per day is calculated based on a reference production of 1,000,000 ADt/a and 350 operational days per year.
[3] TRS emissions from the recovery boiler and lime kiln.
[4] TRS emissions from the concentrated NCG system, based on a predicted emission rate of 140 g/s for the first 15-minutes of the event and 70 g/s thereafter over a 4-hour event duration. The CIS predicted two 4-hour events, four 15-minute events and ten 15-second events during the first year of operation.

Figure 7.1: Frequency of Exceedance of Concentration Threshold of DINAMA

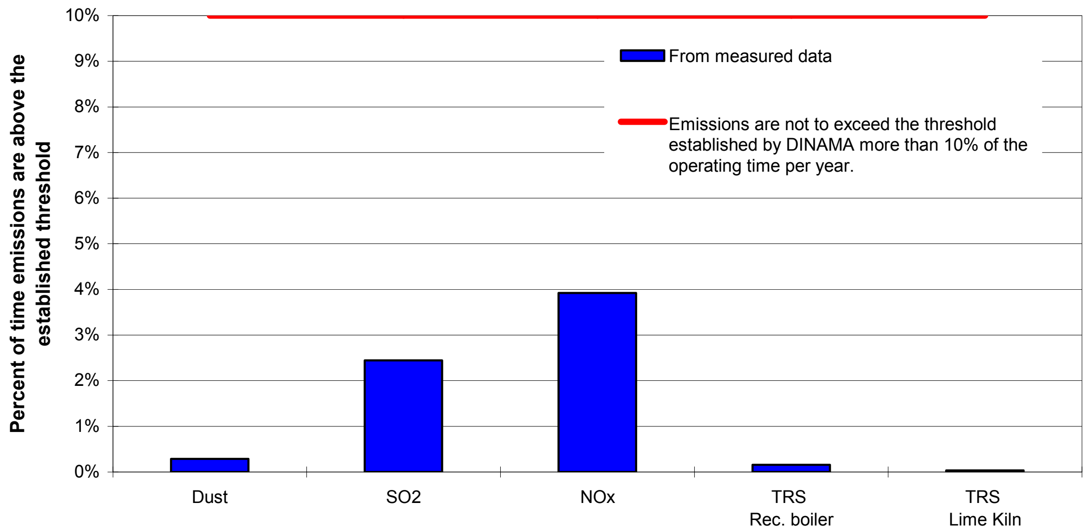


Figure 7.2: Daily Average Air Emission – Load Per Day

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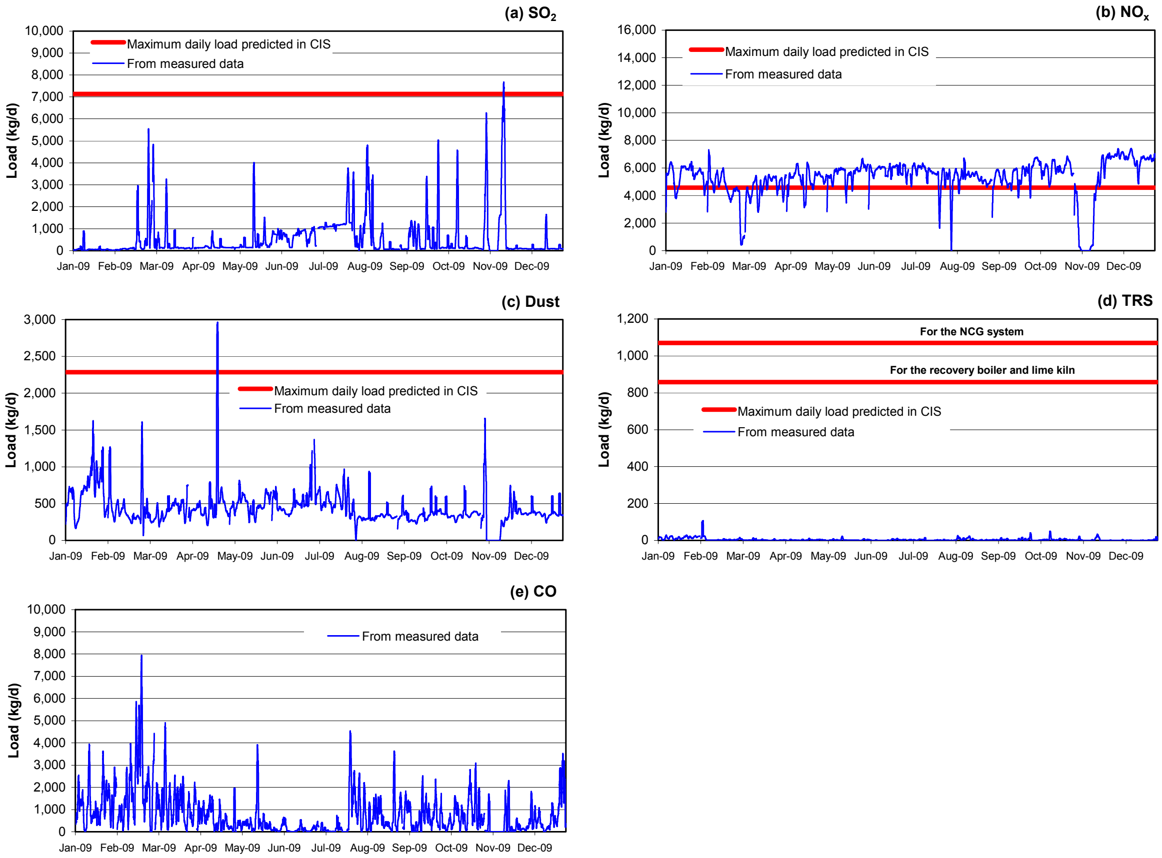


Figure 7.3: Monthly Average Air Emissions – Load per Unit Production

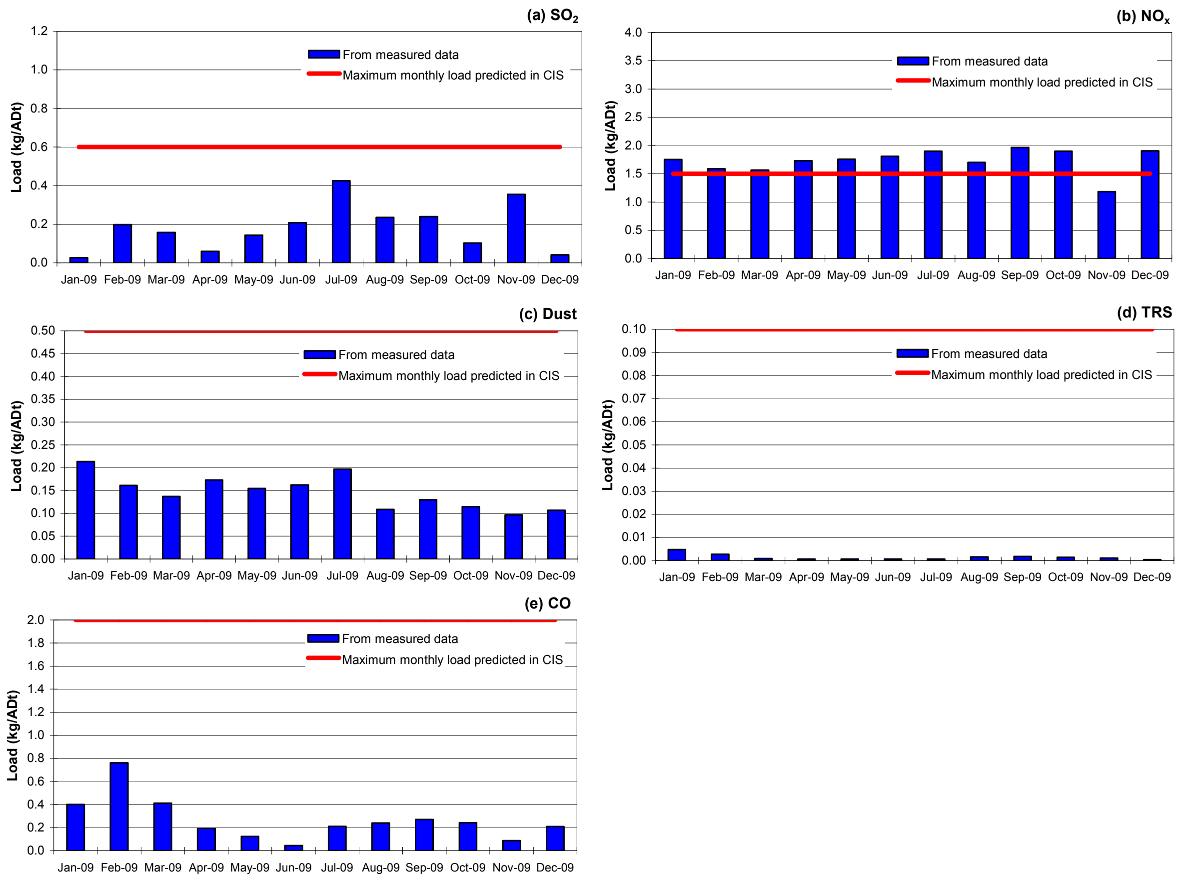
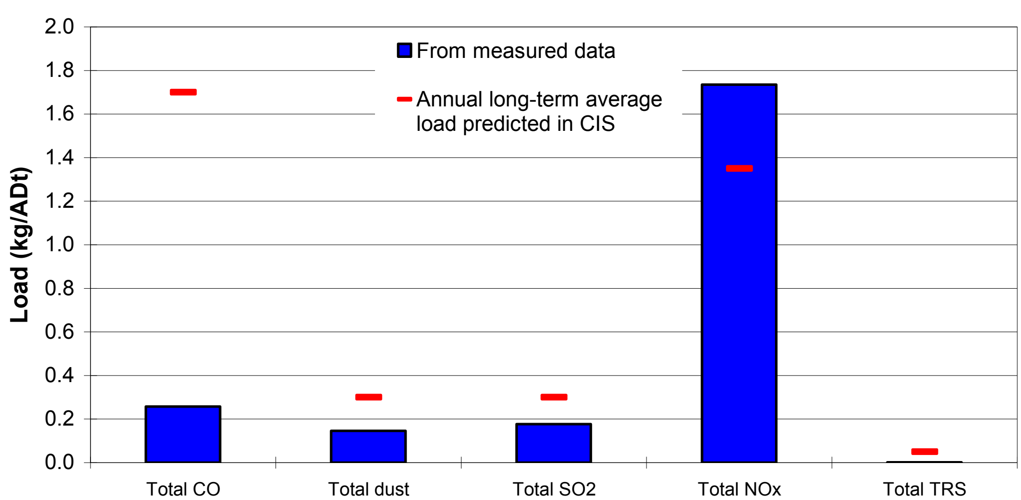


Figure 7.4: Annual Average Air Emissions – Load per Unit Production



8.0 AMBIENT AIR QUALITY

8.1 Overview

Air quality is measured by LATU at a monitoring station located between Fray Bentos and the mill (Figure 8.1). Parameters routinely monitored include CO, NO_x, SO_2, TRS, PM_{10} and TSP. The available data for the 2009 monitoring year are presented in Figure 8.2. Monitoring data for the twelve-month period prior to mill start-up are presented for comparison. The air quality objectives of DINAMA and baseline air quality are also shown, where applicable or available.

The monitoring data are reviewed in the following sections to assess the potential effect of the mill operations on the ambient air quality. The main conclusions from this review are summarized in the following points:

- The air quality near the City of Fray Bentos is considered to be of high quality since the concentrations of the indicator parameters CO, NO_x, SO_2, inhalable particulate material (PM_{10}) and total suspended particulate (TSP) are well below the ambient air quality objectives specified by DINAMA in the AAP.
- The slight variations in air quality near Fray Bentos between the twelve month period prior to mill start-up and the 2009 monitoring year post-start-up are within the range of natural variability. The pattern of variability is inconsistent since concentrations have increased for some parameters (e.g., CO, SO_2 and TRS) and decreased for others (e.g. NO_x). Differences are small relative to natural variability, remain well below the respective effects threshold, and do not adversely affect human health or the aesthetic environment.
- The air quality objective for TRS was exceeded on eight occasions and odors were detected on four occasions during the 2009 monitoring year. Objectionable odors were detected in the City of Gualeguaychú on 26 January and in the City of Fray Bentos on 27 February. These two incidents were attributed to upset conditions at the mill and were reported to DINAMA. DINAMA concluded that the company complied in all respects with the contingency response plan. Mild odors were detected on the Libertador General San Martin International Bridge on 13 March and in the City of Fray Bentos and Playa Ubici on 19 May but the source of odor was not identified.
- The frequency and intensity of incidents of odor detected at Fray Bentos, Playa Ubici, the Libertador General San Martin International Bridge and Ñandubaysal were predicted in the CIS. The one confirmed incident of odor from the mill detected in Gualeguaychú was not explicitly predicted in the CIS but does fall within the range of uncertainty invariably associated with modeling and projecting the most likely scenarios/impacts. These uncertainties include weather conditions, the duration of an upset condition, and the presence of other concurrent if uncommon conditions such as odors from the municipal sewers within the City of Gualeguaychú.
- The observations during the 2009 monitoring year are consistent with the conclusions of the CIS. The ambient air quality has remained well within the levels

predicted in the CIS and objectives of the operating permit for the mill, and therefore there is no indication of adverse effects to human health.

8.2 Comparison to Air Quality Objectives from the AAP

The air quality objectives specified by DINAMA in the AAP are presented in Table 8.1. The air quality criteria used in the CIS (Table 8.2) and air quality standards for other agencies (Table 8.3) are also summarized for comparison.

The air quality near the City of Fray Bentos is considered to be of high quality based on the available monitoring data. During the 2009 monitoring year, the recorded air quality has remained well below the air quality objective, as well as the standards from other agencies, for SO_2, NO_x, CO, TSP and PM_{10}.

8.3 Comparison to Air Quality Pre- and Post-Start-up

Air quality has been measured near Fray Bentos since June 2006. The available data for the twelve month period prior to mill start-up is compared to the data for the 2009 monitoring year post-start-up in Figure 8.2 and summarized in Figure 8.3. The summary shows the minimum, maximum, average and 95th percentile for the pre- and post-start-up periods. The pre-start-up data are summarized for the full period of available data and for the summer period to account for potential seasonal variability. For the post-start-up period, the data are summarized according to the operating condition of the mill. Periods having air emissions similar to or less than the expected emissions based on the CIS are representative of normal operating conditions, and periods exceeding the expected emissions are considered upset conditions.

The slight variations in air quality near Fray Bentos between the periods pre- and post-start-up are within the range of natural variability. The pattern of variability is inconsistent since concentrations have increased for some parameters (e.g., SO_2, CO and TRS) and decreased for others (e.g. NO_x). These differences are considered significant from a statistical perspective since the large number of observations enable resolution of minor differences. However, these differences are small relative to natural variability, remain well below the respective effects threshold, and therefore do not adversely affect human health or the aesthetic environment.

The annual average 24-hour concentration of TSP was 28 μg/m^3 (for all data) prior to start-up of the mill, and varied from 2 μg/m^3 to 122 μg/m^3. During the 2009 monitoring year, the annual average 24-hour concentration was 26 μg/m^3 and varied from 3 μg/m^3 to 163 μg/m^3 during normal operating conditions and was 15 μg/m^3 during an upset condition. The change in TSP concentration post-start-up is small relative to natural variability and well below DINAMA's air quality objective of 240 μg/m^3.

The annual average 24-hour concentration of PM_{10} was 21 μg/m^3 (for all data) pre-start-up and 20 μg/m^3 during the 2009 monitoring year. In comparison, the PM_{10} concentration varied from 0 μg/m^3 to 82 μg/m^3 during the prior year before mill start-up. The concentration of PM_{10} under conditions pre- and post-start-up are well below DINAMA's air quality objective of 150 μg/m^3.

The annual average 24-hour concentration of SO_2 was 2.8 μg/m^3 pre-start-up and 3.4 μg/m^3 during the 2009 monitoring year. The annual average 24-hour concentration of NO_x was 8.2 μg/m^3 pre-start-up and 2.0 μg/m^3 during the 2009 monitoring year. During upset conditions, the maximum 24-hour concentration of SO_2 and NO_x was 8.5 μg/m^3 and 27.5 μg/m^3, respectively. The concentrations of SO_2 and NO_x during the 2009 monitoring year are within the range of natural variability observed prior to start-up of the mill, and are well below the respective air quality standards of DINAMA.

The annual average 24-hour concentration of CO increased from 158 μg/m^3 pre-start-up to 212 μg/m^3 post-start-up. Although statistically significant, this change is within the natural variability ranging from 14 μg/m^3 to 1,105 μg/m^3, and is 140 times below the respective air quality objective.

8.4 TRS and the Detection of Odor

The annual average 24-hour concentration of TRS at the monitoring station near Fray Bentos was 0.2 μg/m^3 pre-start-up and 0.3 μg/m^3 during the 2009 monitoring year, below the 24-hour ambient air quality criteria of 10 μg/m^3 of DINAMA. The maximum 1-hour average concentration of TRS during the 2009 monitoring year was 4.3 μg/m^3, below the 1-hour ambient air quality criteria of 15 μg/m^3 of DINAMA.

The 15-minute average concentration of TRS exceeded the odor effect level on eight occasions during the 2009 monitoring year although only four incidents of odor were reported during the year. Odorous releases were predicted in the CIS and reported to the community as possibilities prior to the commissioning of the mill.

Objectionable odors were detected in the City of Gualeguaychú, Argentina, on 26 January 2009. Evidence[12] suggests these odors could be attributed to the municipal sewer but could also be attributed to the mill. At the time of the incident a water seal in the concentrated odorous gases collection system at the mill had gone dry causing a leak of malodorous gases. The leak was not detected immediately by plant personnel due to the direction of the wind and the limited volume of the leak. Once detected, the problem was resolved. Levels within the city were estimated to fall within the olfactory perception threshold range established by the World Health Organization (0.2 to 20 μg/m^3 H_2S average over 20 minutes) but far below the lowest observable adverse effect level (15,000 μg/m^3 average over 24 hours). The incident was investigated by DINAMA and concluded that the company complied in all respects with the contingency response plan approved by DINAMA. Notwithstanding this, the company was required to implement additional TRS monitoring and to review the maintenance protocols for the gas lines that contain TRS. Both actions have been taken by the company.

Objectionable odors were detected in some areas of the City of Fray Bentos on 27 February 2009. The incident was caused by an explosion in the dilute odorous gases line during start-up procedures following a maintenance shutdown. Odors were perceived

[12] International Court of Justice, the Hague, 02 October 2009 in the case concerning Pulp Mills on the River Uruguay, Vice-President Tomka, Acting President, residing. www.icj-cij.org/docket/files/135/15509.pdf.

following the initial incident and again the following day while the gas line was being repaired and mill restarted. The company filed a report with DINAMA, and DINAMA concluded that the company complied in all respects with the contingency response plan. The company has implemented a series of operational actions as per the accident prevention plan.

Odors were detected on the Uruguayan side of the Libertador General San Martin International Bridge on 13 March 2009. The incident was investigated by DINAMA, but the source of the odorous gases could not be determined. The mill had a short duration release of dilute odorous gases earlier in the morning, but operations of the mill were normal for several hours prior to the incident.

Mild odors were detected in some areas of the City of Fray Bentos and at Playa Ubici on 19 May 2009. Inspections of the mill did not identify any possible source of odorous gas emission from within the mill during this time period.

8.5 Comparison to CIS Model Predictions

The CIS utilized comprehensive mathematical models to investigate the potential effects of the air emissions on air quality within the surrounding area. These model predictions are presented in Table 8.4. Based on these predictions, the CIS concluded that the mill operations would have minimal effect on ambient air quality. The air quality monitoring data obtained by LATU during the 2009 monitoring period provides further validation of this conclusion.

The CIS concluded that human health and aesthetic environment remained protected since the predicted change in air quality for CO, NO_x, SO_2, PM_{10} and TSP was small relative to the natural variability and since the concentrations remained well below the respective air quality standards. These predictions are validated by the measured air quality data. The ambient air near the City of Fray Bentos remains of high quality irrespective of the operation of the mill.

The CIS identified the potential for infrequent detections of odor near the mill and surrounding area. It estimated the potential for 10 incidents per year, in comparison to four odor incidents that were reported during the 2009 monitoring year, although only two of these were attributed to the mill. The frequency and intensity of incidents of odor detected at Fray Bentos, Playa Ubici, the Libertador General San Martin International Bridge and Ñandubaysal were predicted in the CIS. The one confirmed incident of odor from the mill detected in Gualeguaychú was not explicitly predicted in the CIS but does fall within the range of uncertainty invariably associated with modeling and projecting the most likely scenarios/impacts. These uncertainties include weather conditions, the duration of an upset condition, and the presence of other concurrent if uncommon conditions such as odors from the municipal sewers within the City of Gualeguaychú.

Table 8.1: Summary of Air Quality Objectives of DINAMA from the AAP

Parameter	Unit	Interval	Concentration	Period
• TSP	µg/m^3	Daily	240	Daily average
• PM_{10}	µg/m^3	Daily	150	Daily average
• SO_2	µg/m^3 µg/m^3	Daily	125 365	95% of the time Not more than once per year
• NO_x	µg/m^3	Hourly	320	Hourly average
• TRS	µg/m^3	15-minute	3	2% of time on annual basis
• CO	µg/m^3	Hourly	30,000	Hourly average

Table 8.2: Summary of Air Quality Criteria used in the CIS

Parameter	Unit	Interval	Concentration	Period
• TSP	µg/m^3	Daily	120	Daily average
• PM_{10}	µg/m^3	Daily	50	Daily average
• SO_2	µg/m^3 µg/m^3 µg/m^3	Hourly Daily Annual	690 125 50	Hourly average Daily average Annual average
• NO_x	µg/m^3 µg/m^3 µg/m^3	Hourly Daily Annual	200 200 40	Hourly average Daily average Annual average
• TRS	µg/m^3 µg/m^3	Hourly Daily	15 10	Hourly average Daily average

Table 8.3: Summary of Health-Based Ambient Air Quality Standards

Air Contaminant	Averaging Period	California Standards[a] (µg/m^3)	Ontario Standards[b] (µg/m^3)	Other Jurisdictions (µg/m^3)	WHO Guidelines[c] (µg/m^3)
SO_2	10 minute 1-hour 24-hours Annual	- 655 105 -	- 690 275 -	- - - -	500 - 20 -
NO_2	1-hour 24-hours Annual	470 - -	400 200 -	- - -	200 - 40
PM (TSP) PM_{10} $PM_{2.5}$	24-hour 24-hour Annual 24-hour Annual	- 50 - - -	120 50 - - -	- - - - -	- 50 20 25 10
TRS	30-minute 1-hour 24-hours	-	-	40-141 7-40 3-10	7[d] - 150[d]

[a] California Air Quality Standards (www.arb.ca.gov)
[b] Ontario Regulation 419/05 Standards (www.ene.gov.on.ca)
[c] WHO, Air Quality Guidelines Global update (2005)
[d] WHO, Air Quality Guideline for hydrogen sulfide, (for Europe, 2nd edition, 2000)

Table 8.4: Incremental Effect of the Mill on Air Quality at Fray Bentos, Predicted in the CIS

Parameter	Unit	Interval	Predicted incremental change in air quality from the CIS	
			Under Normal Operation	Under Upset Conditions
• TSP	μg/m^3 μg/m^3	Daily Annual	1.0 0.1	2.7 0.2
• PM_{10}	μg/m^3 μg/m^3	Daily Annual	0.9 0.1	2.5 0.1
• SO_2	μg/m^3 μg/m^3 μg/m^3	Hourly Daily Annual	8 1.9 0.1	62 14.5 0.9
• NO_x	μg/m^3 μg/m^3 μg/m^3	Hourly Daily Annual	19 5.1 0.3	24 6.7 0.4
• TRS	μg/m^3 μg/m^3 μg/m^3	10-min Hourly Daily	- - -	10 6 1

Figure 8.1: Air Quality Monitoring Station

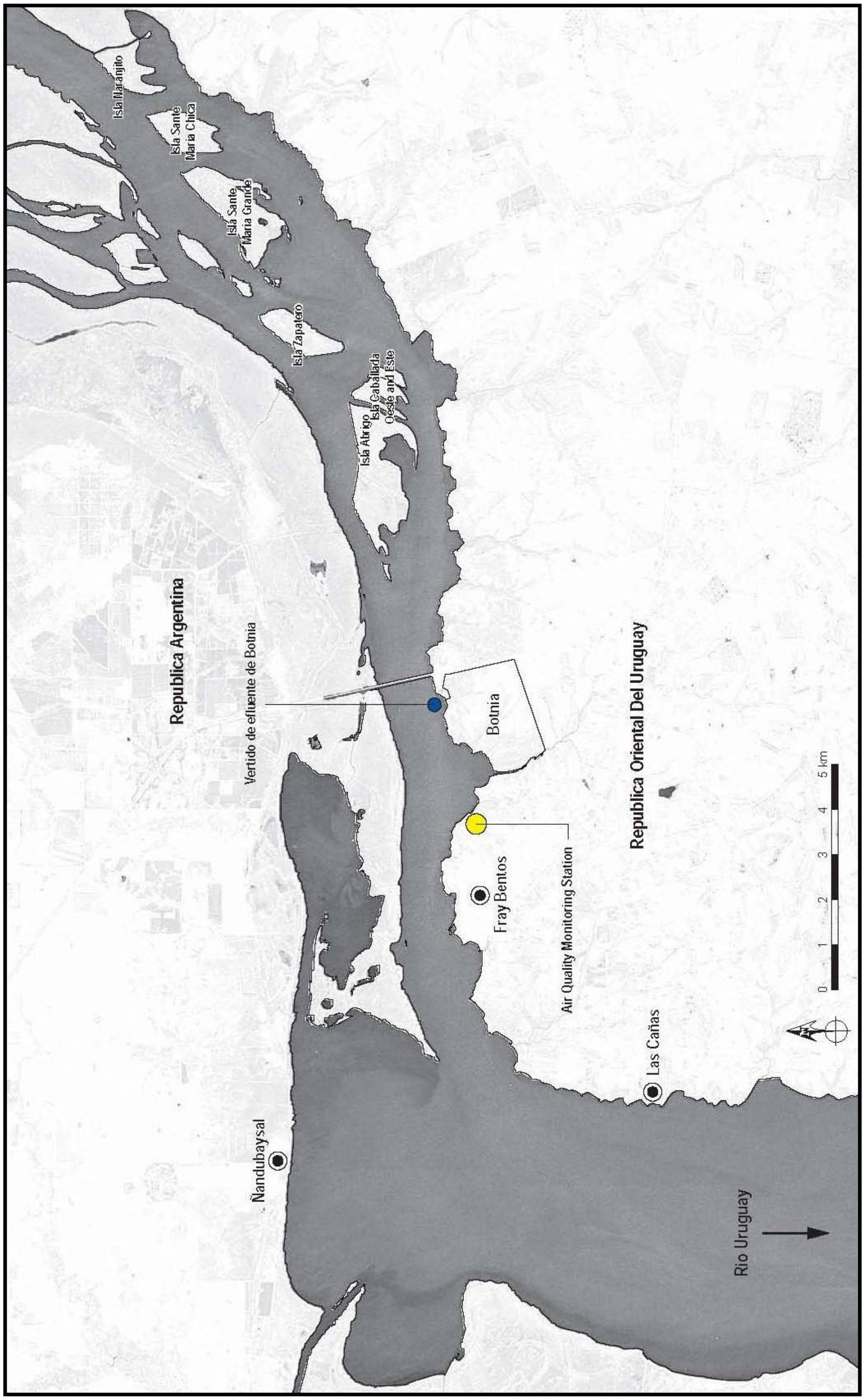


Figure 8.2: Air Quality Monitoring Data, near Fray Bentos

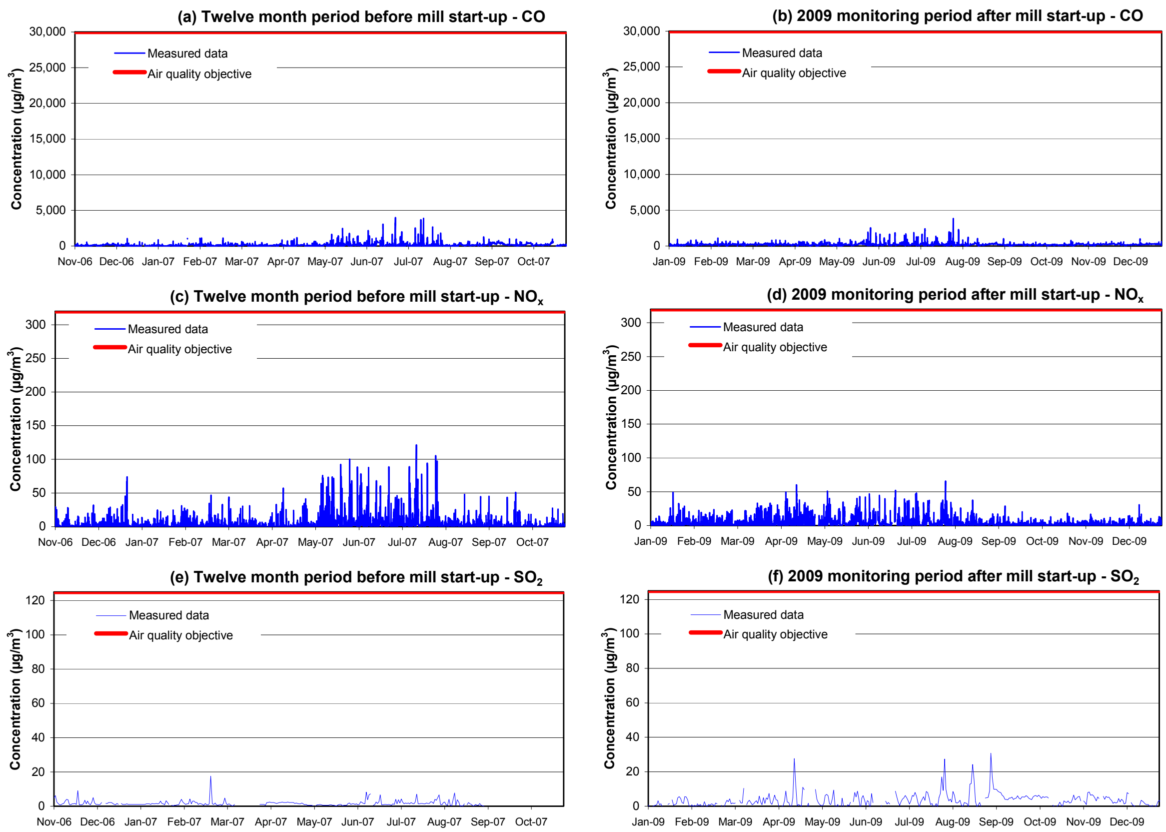


Figure 8.2: Air Quality Monitoring Data, near Fray Bentos (continued)

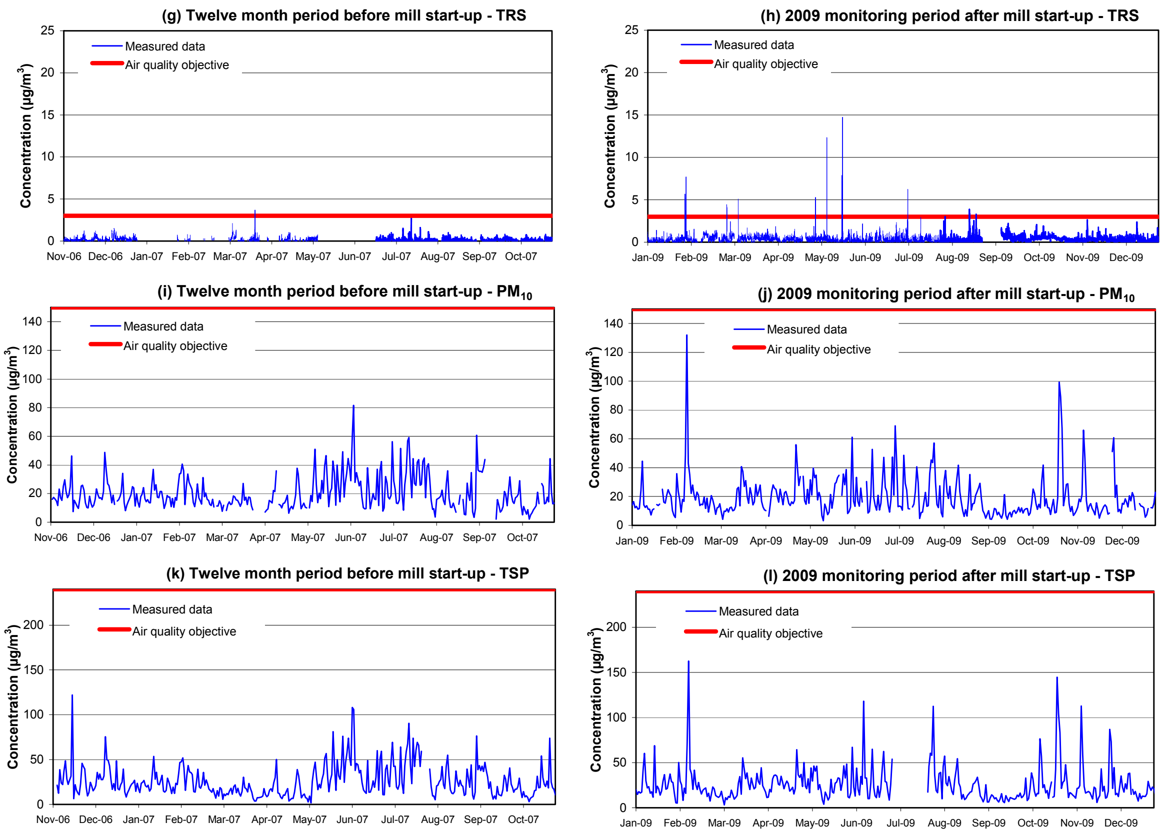
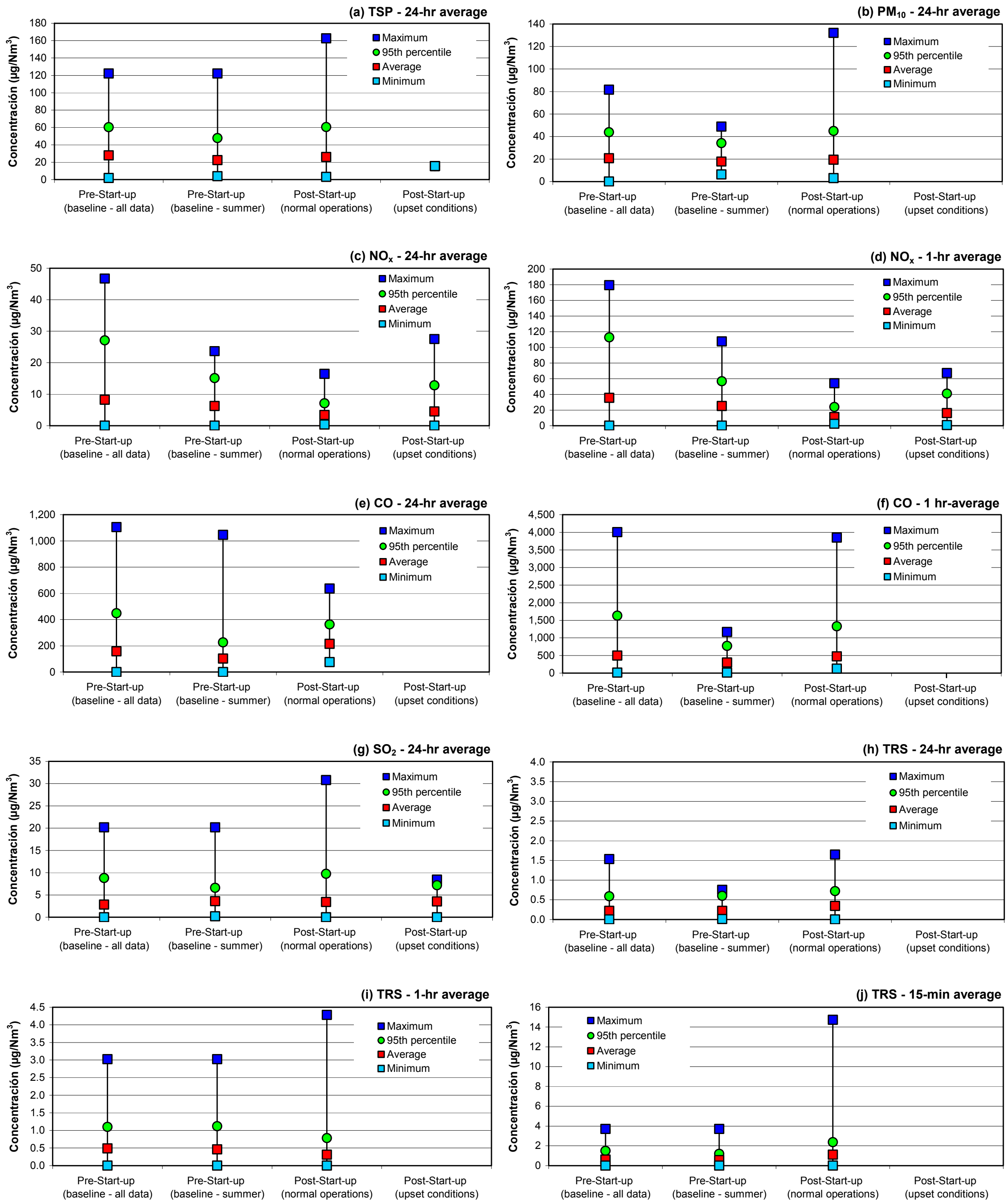


Figure 8.3: Comparison of Air Quality Pre- and Post-Start-up, near Fray Bentos



Note: For the post-start-up period, data are summarized according to the operating condition of the mill. Periods having air emissions similar to or less than the expected emissions based on the CIS are considered representative of normal operating conditions, and periods exceeding the expected emissions are considered upset conditions. Emissions of PM_{10}, CO and TRS remained within expected levels during the 2009 monitoring year.

APPENDIX A

Baseline Water Quality for the Río Uruguay

Table A-1: Water Quality on the Rio Uruguay (CARU Program, 1987-90; CARU, 1993)

Parameter		Salto (Station 40) (n=36)	Paysandu (Station 50) (n=13)	Gualeguaychú (Station 60) (n=26)	Fray Bentos (Station 70) (n=26)
pH	Average	6.9	7.1	7.1	7.4
	Maximum	7.8	7.9	7.8	9.0
	Minimum	5.8	6.5	6.4	6.6
Dissolved oxygen (mg/L)	Average	7.1	7.9	7.5	7.9
	Maximum	10.2	10.1	9.9	10.0
	Minimum	3.1	4.4	3.6	4.5
BOD_5 (mg/L)	Average	3	3	3	4
	Maximum	9	7	9	10
	Minimum	1	1	1	1
Total suspended solids (mg/L)	Average	26	14	12	16
	Maximum	162	29	38	58
	Minimum	3	6	2	2
Total dissolved solids (mg/L)	Average	75	102	106	126
	Maximum	217	158	279	705
	Minimum	21	38	42	29
Alkalinity $CaCO_3$ (mg/L)	Average	24	26	27	28
	Maximum	74	54	70	110
	Minimum	5	2	12	6
Hardness (mg/L)	Average	26	27	29	34
	Maximum	50	42	53	70
	Minimum	9	9	6	13
Conductivity (μS/cm)	Average	65	69	67	71
	Maximum	160	150	160	160
	Minimum	35	40	35	35
Total Kjeldahl nitrogen (mg/L)	Average	0.521	0.590	0.402	0.445
	Maximum	1.37	2.09	0.96	0.93
	Minimum	0.12	0.10	0.01	0.19
Nitrate (mg/L)	Average	0.710	0.586	0.549	0.535
	Maximum	1.400	0.770	0.950	1.870
	Minimum	0.340	0.370	0.001	0.070
Total ammonia (mg/L)	Average	0.080	0.216	0.088	0.077
	Maximum	0.304	1.075	0.542	0.369
	Minimum	0.009	0.023	0.020	0.007
Total phosphorus (mg/L)	Average	0.097	0.093	0.130	0.097
	Maximum	0.310	0.320	0.720	0.240
	Minimum	0.020	0.040	0.010	0.040
Chlorophyll “a”	Average	1.11	1.472	1.37	5.47
	Maximum	11.280	3.300	4.250	55.110
	Minimum	0.050	0.050	0.460	0.050
Fecal coliforms (CFU/100 mL)	Average	500	250	200	100
	Maximum	6,300	12,600	3,200	5,000
	Minimum	15	160	40	10

Table A-2: Historical Record from CARU of Rio Uruguay Water Quality at Points Relevant to the Project (GTAN, 2006)

Location	Station	TSS (mg/L)	n	BOD_5 (mg/L)	n	Dissolved oxygen (mg/L)	n	Dissolved oxygen (% sat.)	n	COD (mg/L)	n	Conductivity (µS/cm)	n	pH (units)	n	N_{total} (mg/L)	n	P_{total} (mg/L)	n	Period of Record
Discharge of Gualeguaychú River[1]	6 GUAY (71)	20.37	40	5.29	35	8.4	40	88.5	14	25.5	42	90.82	39	7.3	40	0.549	43	0.102	39	1987/2005
Main Channel (km 93)	72	12.14	37	4.53	37	8.4	37	89.6	13	25.0	42	67.17	39	7.2	39	0.609	43	0.084	40	1987/2005
Playa La Concordia	81	29.64	14	3.33	12	8.4	14	85.1	4	24.4	12	63.58	12	7.9	11	0.449	11	0.130	10	1987/90-2003/05
Playa La Concordia	82	12.26	13	3.31	14	8.3	13	86.8	4	19.5	15	64.79	15	7.9	14	0.493	15	0.107	15	1987/90-2003/05
Playa La Concordia	83	11.35	9	4.01	14	8.5	9	-	0	20.3	14	78.32	14	7.7	12	0.775	15	0.086	15	1987/1990
Balneario Las Cañas	7 FRAY	8.00	10	4.49	8	8.6	10	81.9	9	16.6	9	62.28	7	7.4	8	0.361	8	0.101	10	1998/2005
Collector Fray Bentos	1 FRAY	14.40	10	4.75	11	8.4	10	83.0	10	26.8	10	83.81	10	7.1	11	0.347	11	0.069	11	1998/2005
1 km above M'Bopicuá	1 BOPI	9.00	5	3.58	3	8.6	5	73.2	5	20.0	3	70.70	5	7.3	5	0.376	4	0.061	4	2003/2005
Zone of emission M'Bopicuá	2 BOPI	10.00	4	3.63	2	8.3	4	65.1	4	20.0	2	66.80	4	7.2	4	0.380	3	0.062	3	2003/2005
1 km below M'Bopicuá	3 BOPI	10.80	5	4.05	3	8.3	5	71.2	5	20.0	3	69.20	4	7.3	5	0.762	4	0.104	4	2003/2005
Water Intake Fray Bentos	4 FRAY	15.20	6	3.90	2	7.9	6	64.0	4	20.0	2	69.65	4	7.0	4	0.325	3	0.123	3	1995-2004-2005
SW Isla Sauzal	3 GUAY	26.67	4	5.00	3	7.9	4	69.1	4	23.3	2	103.53	4	7.4	3	0.373	4	0.077	4	2004/2005
Balneario Ñandubaysal	5 GUAY	18.40	4	3.73	2	8.6	4	63.6	4	20.0	3	66.15	4	6.8	4	0.342	3	0.105	3	2004/2005
		15.25		**4.12**		**8.3**		**76.8**		**21.64**		**73.60**		**7.34**		**0.472**		**0.093**		

[1] In 2005, the Planta Depuradora de Liquidos Cloacales de Gualeguaychú was brought on-line.

Table A-3: Rio Uruguay Water Quality from the EIA (2004)

	Point 1 – Main Channel Near Fray Bentos Intake		Point 2 – Main Channel in Front of	Point 3 – Main Channel East of International Bridge	Point 6 – Main Channel in Front of Fray Bentos		Point 7 – Las Canas
Parameter	Botnia	OSE	Botnia	Botnia	CARU (Station 70)	CARU (Station 72)	CARU
Date	16 Dec 03	2000-2003	16 Dec 03	16 Dec 03	1987-1990	2003	22 Oct 02
Colour (Colour Pt. Units)	276 (260-295)	61 (24-137)	253 (240-275)	252 (250-255)	n	n	n
Turbidity (NTU)	32 (32-33)	27 (12-52)	32 (31-33)	32 (31-34)	n	n	n
pH	7.2	7.3 (6.7-7.8)	7.2 (7.2-7.3)	7.2	7.4 (6.6-9.0)	7	7.3
Dissolved oxygen (mg/L)	7.19 (7.17-7.20)	7.9 (7.0-8.8)	7.41 (7.4-7.41)	7.55 (7.47-7.60)	7.9 (4.5-10.0)	8.3	7.7
BOD_5 (mg/L)	1.5 (<1-1.5)	n	<1	<1	4 (1-10)	n	<5
Detergents (LAS mg/L)	0.06 (0.05-0.07)	n	<0.05	<0.05	n	n	n
Phenolics (mg/L)	N.D.	n	N.D.	N.D.	n	0.0004	<0.001
Ammonia (mg N-NH_3/L)	0.03 (0.01-0.05)	n	0.04 (0.03-0.04)	0.03 (0.02-0.04)	n	n	n
Nitrites (mg N-NO_2/L)	<0.01	<0.01 (<0.01-0.01)	<0.01	<0.01	0.0028 (0.001-0.007)	n	0.007
Phosphorus (mg P/L)	0.03 (0.02-0.03)	n	0.05 (0.04-0.06)	0.03 (0.02-0.05)	0.1	n	0.05
Fecal coliforms (CFU/100 mL)	N	310 (200-691)	n	n	100 (10-5,000)	n	270
Arsenic (mg/L)	<0.010	n	<0.010	<0.010	n	n	N
Cadmium (mg/L)	<0.010	n	<0.010	<0.010	0.00015 (0.0001-0.0002)	n	<0.00001
Copper (mg/L)	0.018 (0.015-0.025)	n	0.056 (0.050-0.069)	0.044 (0.027-0.065)	0.0105 (0.009-0.012)	n	0.00438
Chromium (mg/L)	0.08 (0.07-0.11)	n	0.06 (0.05-0.07)	0.04 (0.03-0.05)	0.004 (0.002-0.009)	0.001	0.002
Mercury (mg/L)	<0.0005	n	<0.0005	<0.0005	n	n	n
Nickel (mg/L)	<0.020	n	0.050 (0.030-0.067)	<0.020	n	n	0.0056
Lead (mg/L)	<0.010	n	<0.010	<0.010	n	n	0.00373
Zinc (mg/L)	<0.010	n	0.061 (0.059-0.063)	0.107 (0.042-0.169)	0.018 (0.002-0.035)	n	0.029

Table A-3: Rio Uruguay Water Quality from the EIA (2004) (cont'd)

	Point 1 – Main Channel Near Fray Bentos Intake		Point 2 – Main Channel in Front of	Point 3 – Main Channel East of International Bridge	Point 6 – Main Channel in Front of Fray Bentos		Point 7 – Las Canas
Parameter	Botnia	OSE	Botnia	Botnia	CARU (Station 70)	CARU (Station 72)	CARU
Temperature (°C)	24.1 (24.1-24.2)	22.5	24	23.9 (23.9-24)	n	18	19.4
% Oxygen saturation	85.6 (85.5-85.7)	n	87.9 (87.8-88.1)	89.5 (88.5-90.4)	n	n	83
Conductivity (μS/cm)	42 (40-45)	55 (34-73)	43 (40-45)	42 (40-45)	71 (35-160)	62	60
Total hardness ($CaCO_3$ mg/L)	N	33.8 (30-42)	n	n	34 (13-70)	n	26
Alkalinity ($CaCO_3$ mg/L)	N	34 (22-52)	n	n	28 (6-110)	29	24.1
Total nitrogen (mg N/L)	<2	n	<2	<2	0.445 (0.19-0.93)	n	0.52
Nitrate (mg N-NO_3/L)	1.1	<11 (<11)	1.1 (1.0-1.2)	1.2 (1.1-1.3)	0.549 (0.001-0.950)	n	0.36
Phosphorus (mg P-PO_4/L)	0.08 (0.06-0.09)	n	0.08 (0.09-0.12)	0.07 (0.06-0.09)	0.044 (0.005-0.139)	n	0.02
Ammonia (NH_4 mg/L)	N	0.09 (<0.04-0.42)	n	n	0.077 (0.007-0.369)	n	0.05
COD (mg/L)	<1	n	1	2	n	n	<40
Sulphate (mg SO_4/L)	4.5 (4.0-4.8)	n	4.7 (4.0-5.0)	4.4 (3.9-4.7)	20 (3-80)	2	3.75
Chloride (Cl mg/L)	2.2 (1.9-2.4)	3.63 (1.9-6.4)	2.1 (2.0-2.2)	2.0 (1.9-2.2)	2.8 (0.0-7.0)	2	1.8
Iron (mg/L)	2.29 (2.20-2.39)	1.3 (1.0-1.7)	2.38 (2.20-2.52)	2.18 (2.00-2.30)	0.12	n	0.67
Manganese (mg/L)	<0.010	n	0.054 (0.048-0.057)	0.036 (0.030-0.046)	0.038 (0.030-0.045)	n	0.0598
Fluoride (mg/L)	n	n	n	n	n	n	n
Selenium (mg/L)	n	n	n	n	n	n	n
AOX (mg/L)	0.0075	n	>0.002 detec. lim. <0.006 quant. lim.	-	n	n	n

N.D. – not detectable.
n – not analyzed.

Table A-4: Water Quality Observations by Botnia at Four Rio Uruguay Locations in 2005/06

		Nuevo Berlín Date of Sampling							Bridge							Botnia							Las Cañas						
Parameter	Units	04/05	06/05	08/05	10/05	12/05	01/06	03/06	04/05	06/05	08/05	10/05	12/05	01/06	03/06	04/05	06/05	08/05	10/05	12/05	01/06	03/06	04/05	06/05	08/05	10/05	12/05	01/06	03/06
Temperature	°C	18.2	18.2	15.6	22.3	26.8	27.9	24.6	18.2	18.2	15.8	22.4	27.4	28.5	24.4	18.0	18.4	15.8	21.9	27.3	29.7	24.4	18.0	18.1	15.7	23.2	27.4	29.8	23.9
Conductivity	µS/cm	109	54.7	81.0	51.0	66.2	84.5	71.3	69.0	51.6	79.9	52.0	57.7	74.3	66.1	73.0	53.9	103.4	55.0	55.3	69.6	69.8	75.0	55.9	101.3	55.0	56.4	76.0	74.5
Colour	Pt-Co	ND[1]	125	75	125	55	55	30	ND	125	75	125	55	55	35	ND	125	75	125	50	55	35	ND	125	75	125	50	55	30
DO	mg/L	8.31	8.71	9.32	8.18	8.22	8.61	8.58	8.14	8.46	9.27	8.13	8.30	9.23	8.55	8.36	8.34	9.16	8.03	8.27	9.15	8.54	8.45	8.05	9.54	8.36	8.26	9.55	8.74
pH	-	7.8	7.04	7.40	7.14	7.92	8.32	7.67	7.7	7.05	7.49	7.24	8.00	8.80	7.75	7.8	7.20	7.58	7.14	8.03	8.98	7.73	7.8	6.96	7.58	7.35	7.72	9.19	7.94
Turbidity	NTU	36.9	23	21	35	9.0	12	11	27	59	20	32	9.3	11	15	19.2	35	17	28	9.4	12	13	20.1	49	29	23	8.5	16	39
TDS	mg/L	43.0	77.0	43.5	64.5	37	54	73.5	66.0	84.5	42.5	49.5	30.0	41.5	65.5	45.0	90.0	91.0	55.0	42	35	73	65.0	86.2	115	54.5	61.0	29.5	66.5
TSS	mg/L	12.0	28.5	7.2	13.8	<5	10.8	<5	16.0	32.5	6.2	8.8	<5	13.4	8.2	8.0	16.0	<5	6.0	<5	7.8	7.2	<5	24.0	17.0	<5	<5	11.0	60.3
Hardness	mg/L	26.6	20.7	30.5	20.0	22	30.2	25.0	27.4	20.2	32.2	20.3	20.8	24.4	24.2	28.0	23.7	44.2	20.8	20.3	23.7	23.4	30.2	22.7	45.8	20.6	34.4	22.4	35
Chloride	mg/L	2.0	1.98	2.15	2.99	2.56	1.96	1.53	2.7	1.36	1.80	1.75	1.59	4.38	1.49	1.3	1.56	3.31	2.45	1.62	2.47	1.61	1.6	1.75	2.11	2.17	2.48	2.73	1.73
Sulphate	mg/L	1.3	1.36	1.32	1.44	2.17	3.04	1.28	1.2	1.31	1.23	1.23	1.95	6.83	1.28	1.4	0.92	1.68	0.94	2.01	3.10	1.44	1.5	1.52	1.54	1.09	2.56	3.54	1.76
Nitrate	mg/L	4.5	0.87	0.56	0.44	0.39	0.17	0.23	2.4	0.93	0.58	0.71	0.37	0.55	0.21	5.9	0.90	0.58	0.46	0.36	0.16	0.24	2.3	0.95	0.66	0.50	0.38	0.04	0.16
Nitrite	µg/L	2.7	3.6	12.2	ND	<5	8.8	44.8	3.5	2.4	12.2	ND	<5	<5	40.0	2.7	1.9	7.7	ND	18.1	<5	31.3	3.2	2.8	8.2	ND	<5	<5	2.9
TKN	mg/L	2.4	0.6	0.01	0.80	1.1	1.2	0.23	1.5	0.8	0.45	0.42	0.37	1.3	0.20	1.5	0.8	0.04	0.48	1.5	1.3	0.47	2.4	0.9	0.47	0.26	1.8	1.6	0.36
Ammonia	mg/L	0.19	ND	0.069	ND	0.12	<DL[2]	0.07	0.54	ND	ND	ND	0.15	<DL	0.06	0.16	ND	ND	ND	0.13	<DL	0.06	0.34	ND	0.06	ND	0.21	<DL	0.07
TP	µg/L	73.7	88.0	49	86.2	26.7	115	68.9	77.8	105	58.8	91.3	29.3	109	90.1	57.0	74.4	88.0	81.0	31.9	75.8	114	43.9	84.7	81.6	83.6	26.7	81.0	94.8
SRP	µg/L	26.6	8.0	15	9.5	23.7	54.2	46.9	27.7	9.0	7.3	18.5	14.6	31.2	42.1	24.8	12.2	14	15.9	6.9	19.8	39.8	27.2	5.5	19	19.8	19.8	24.2	68.2
Arsenic	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL[1]	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Cadmium	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Copper	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Zinc	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Chromium	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Iron	mg/L	ND	4.2	2.2	1.8	0.9	1.2	0.74	ND	4.5	1.4	2.3	1.0	0.69	0.53	ND	3.9	1.8	1.6	1.2	1.2	0.59	ND	3.5	2.9	1.7	1.5	0.69	0.46
Magnesium	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Mercury	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Nickel	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
Lead	mg/L	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL	ND	<DL	<DL	<DL	<DL	<DL	<DL
COD	mg/L	ND	<11	<11	<11	<11	<11	<11	ND	<11	<11	<11	<11	<11	<11	ND	<11	<11	<11	<11	<11	<11	ND	<11	<11	<11	<11	<11	<11
BOD$_7$	mg/L	4.8	1.4	1.3	1.0	1.1	1.9	0.8	4.4	1.8	1.1	2.3	0.8	1.5	0.7	4.8	1.3	1.2	2.3	1.2	2.0	0.6	2.8	1.4	1.2	1.5	1.0	2.4	1.2
AOX	µg/L	ND	7	ND	ND	8	ND	7	ND	7	ND	ND	8	ND	7	<2	8	12	ND	7	ND	<DL	ND	8	9	ND	11	ND	8
Phenolics	µg/L	ND	<1	<1	<1	<1	5.7	<1	ND	<1	<1	<1	<1	ND	<1	ND	<1	<1	<1	<1	ND	<1	ND	1.2	<1	<1	<1	ND	<1
Coliforms[3]	MPN/ 100 mL	ND	232	2600	312	130	19.6	62	ND	256	3280	460	58	19.4	54	ND	230	804	196	31.4	266	108	ND	940	1960	1340	640	276	1980

[1] No determination of this parameter on this date.
[2] Below analytical detection limit.
[3] Total fecal coliforms, average of five replicate samples per day per site.

Table A-5: Water Quality on the Rio Uruguay from the ENCE EIA (2002)

Parameter (units)	Point 1 – Above Discharge	Point 2 – Yaguareté Bay – Playa Ubici	Fray Bentos Water Intake	Fray Bentos Municipal Discharge	Beach near Arroyo Fray Bentos	Las Cañas Water Intake	Beach near Arroyo Las Cañas
Alkalinity (mg/L $CaCO_3$)	32	35.5	32	33	32.5	30	31.5
Ammonia (mg/L $N\text{-}NH_3$)	0.175	0.16	0.13	0.155	0.155	0.195	0.09
Arsenic (mg/L As)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Chloride (mg/L Cl)	4.2	4.15	4.1	2.1	5.15	5.65	4.1
Copper (mg/L Cu)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
True colour (Pt-Co)	125	125	125	125	125	125	125
Total chromium (mg/L Cr)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
BOD_5 (mg/L)	3	4	3.5	3.5	4	4	4
Detergents (mg/L SAAM)	0.4	0.425	0.285	0.365	0.41	0.24	0.9
Total hardness (mg/L $CaCO_3$)	19.8	21.7	18.1	19.55	19.7	19.85	19.8
Fluoride (mg/L F)	0.12	0.13	0.115	0.12	0.11	0.11	0.11
Iron (mg/L Fe)	3.74	2.89	4.24	3.795	3.525	3.385	3.3
Manganese (mg/L Mn)	0.04	0.02	0.04	0.035	0.03	0.02	0.025
Nickel (mg/L Ni)	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrate (mg/L $N\text{-}NO_3^-$)	0.81	0.78	0.845	0.845	0.85	0.855	0.9
Dissolved oxygen (mg/L)	8.5	8.7	8.7	8.1	8.1	8.25	8.4
pH	7	7.345	7.17	7.12	7.105	7.03	6.6
Lead (mg/L Pb)	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Selenium (mg/L Se)	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Temperature (°C)	19.9	19.15	18.9	19.05	19.4	19.95	19.4
Zinc (mg/L Zn)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Fecal coliforms (NMP/100 mL)	42.5	170	50.5	9,100	7,400	720	950
AOX (μg/L)	NQ	ND	ND	ND	-	-	-

NQ = Not Quantifiable
ND = Not Detectable

Table A-6: Water Quality on the Rio Uruguay (Algoritmos, 2006)

Parameter	Sampling Locations[1]									
	1	M	2	3	B	4	5	6	7	8
BOD_5 (mg/L)	0.7	0.5	1.8	0.2	0.2	0.1	0.2	0.5	0.1	0.2
COD (mg/L)	<5	<5	14	15	6	<5	<5	<5	24	6
N total (mg/L)	<0.04	<0.04	0.68	1.10	1.02	0.95	0.35	0.97	0.85	0.74
P (mg/L)	0.14	0.14	0.21	0.20	0.15	0.22	0.13	0.14	0.10	0.15
NO_3^- (mg/L)	0.63	0.63	0.54	0.79	0.63	0.36	0.59	0.61	0.38	0.61
Ammonia (mg/L)	<0.01	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	0.26	<0.01	0.23
SST (mg/L)	4	11	12	5	8	14	8	8	41	10
C_6H_5OH (μg/L)	<40	<40	<40	<40	<40	<40	<40	<40	<40	<40
ClO_3^- (μg/L)	<20	<20	<20	40	30	<20	<20	<20	<20	<20
As (μg/L)	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Cu (μg/L)	11	10	10	8	12	8	6	7	8	8
Fe (μg/L)	1,400	1,500	1,600	1,880	1,800	2,070	1,730	1,670	2,000	1,640
Cr (μg/L)	3	3	3	3	3	3	2	3	3	2
Hg (μg/L)	0.4	0.6	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.6
Ni (μg/L)	<3	<3	<3	<3	<3	<3	<3	<3	<3	<3
Pb (μg/L)	39	16	17	23	24	<5	<5	<5	<5	<5
Zn (μg/L)	18	84	22	15	15	11	8	10	15	12
Cd (μg/L)	2	1	1	1	1	<0.5	<0.5	<0.5	<0.5	<0.5
Chlorophenols (μg/L)[2]	1.0	8.3	11.6	3.4	1.4	1.4	2.9	<1.0	11.9	4.9
AOX (mg/L)	0.003	<0.001	<0.001	0.005	0.004	0.004	0.003	0.0068	0.002	<0.001

[1] Identification of sampling locations:
1: Near Arroyo M'Bopicuá
M: 50 m below ENCE discharge
2: Puerto Unzué
3: International Bridge
B: 50 m above Botnia discharge
4: Near Arroyo Yaguareté
5: Playa Ubici Nearshore
6: Fray Bentos Water Intake
7: Balneario Ñandubaysal Nearshore
8: Balneario Las Cañas Nearshore

[2] Chlorophenols shown as a sum of compounds with values above detection limits.

Table A-7: Baseline Concentrations of AOX, Chlorophenols, Resin and Fatty Acids, Phytosterols, and Dioxins and Furans in Rio Uruguay Water (Tana, 2005, 2006)

Location	AOX (μg/L)	Chlorophenols (ng/L)	Resin Acids (μg/L)	Fatty Acids (μg/L)	Phytosterols[2] (μg/L)	Dioxins/Furans[1] (pg/L)	
						Sum	I-TEQ
April 2005							
Nuevo Berlin	11	94	163	786	ND	1.04	0.46
Yaguareté Bay	12	114	183	738	ND	ND	ND
Las Cañas	12	106	202	742	ND	ND	ND
December 2005							
Nuevo Berlin	10	89	224	231	22	ND	ND
Yaguareté Bay	6	80	35	172	ND	ND	ND
Las Cañas	<5	89	53	145	ND	49.8	0.31

[1] Detection limits 0.2 to 2 pg/L.
[2] Detection limits 1 to 3 μg/L.

Table A-8: Nutrient Water Quality on the Rio Uruguay (CELA, 2005, 2006)

Location	Secchi (m)	pH (-)	DO (mg/L)	Temp. (°C)	Conductivity (μS/cm)	NH_4 (μg/L)	NO_2 (μg/L)	NO_3 (μg/L)	DIN (μg/L)	N_{total} (μg/L)	PO_4 (μg/L)	P_{total} (μg/L)
April 2005												
NB 2	0.5	6.7	-	-	70.1	15.8	3.8	204.7	224.3	485.7	16.9	49.5
NB 3	0.5	7.1	-	-	73.4	38.1	4.5	171.0	213.6	509.3	21.7	95.7
FB 1	0.5	7.2	-	-	83.4	21.1	4.8	168.6	194.5	599.7	22.2	84.3
FB 2	0.5	7.1	-	-	72.2	25.0	4.8	177.2	207.1	587.2	20.5	70.4
FB 3	0.5	7.1	-	-	76.9	42.3	3.7	184.5	230.4	694.5	38.6	82.3
LC 1	0.6	7.2	-	-	75.7	27.6	4.7	163.9	196.2	534.5	31.4	71.0
LC 2	0.5	7.0	-	-	69.5	22.0	4.2	182.8	209.0	522.5	25.5	62.5
LC 3	0.4	7.0	-	-	69.1	26.6	4.6	190.1	221.2	623.4	29.0	66.3
January 2006												
NB 1	3.7	0.8	0.0	0.4	2.6	18.3	17.5	15.4	13.0	6.0	-	2.4
NB 2	3.5	0.7	0.0	0.2	0.3	11.5	15.5	6.8	6.7	10.6	-	15.5
NB 3	0.0	0.5	1.5	0.2	0.4	2.4	17.1	15.0	13.6	20.3	-	13.1
FB 1	0.0	0.4	0.8	0.2	5.4	22.7	8.0	1.6	6.1	10.2	-	15.5
FB 2	3.9	1.2	4.3	0.2	8.0	39.5	4.2	3.3	7.9	1.6	-	19.8
FB 3	3.7	1.6	0.0	0.4	16.9	40.3	1.4	16.6	8.3	1.7	-	1.5
LC 1	6.7	0.5	0.8	0.0	1.4	52.9	5.4	5.2	12.9	24.1	-	4.0
LC 2	4.6	0.5	1.2	0.0	2.3	80.7	7.5	3.5	12.0	14.9	-	24.0
LC 3	0.0	2.0	0.7	0.2	4.9	31.1	4.9	15.3	17.4	16.6	-	13.0

NB = Nuevo Berlin, FB = Fray Bentos, LC = Las Cañas