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ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

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PARACEL

Pulp Mill and Port in Concepción - Paraguay

VOLUME II – Book I - ENVIRONMENTAL DIAGNOSIS OF THE PHYSICAL ENVIRONMENT

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8 DELIMITATION OF AREAS OF INFLUENCE

According to Law 294/93, in its Article 1, *"the Environmental Impact Assessment is mandatory. For legal purposes, Environmental Impact shall be understood as any modification of the environment caused by human works or activities that have, as a positive or negative, direct or indirect consequence, to affect life in general, biodiversity, the quality or a significant amount of natural or environmental resources and their use, welfare, health, personal safety, habits and customs, cultural heritage or legitimate livelihoods"*.

Article 3°, paragraph c, of the mentioned law, "*determines the limits of the geographical area to be affected, with a physical, biological, socioeconomic and cultural description, detailed both quantitatively and qualitatively, of the area of direct influence of the works or activities and an environmental inventory of it, in such a way as to characterize its state prior to the projected transformations, with special attention to the determination of the watersheds.*"

Therefore, the environmental diagnosis was carried out in three areas of influence of the enterprise: Directly Affected Area (DAA), Direct Influence Area (DIA) and Indirect Influence Area (IIA), being, respectively, the areas affected locally, directly and indirectly by the incidence of environmental impacts.

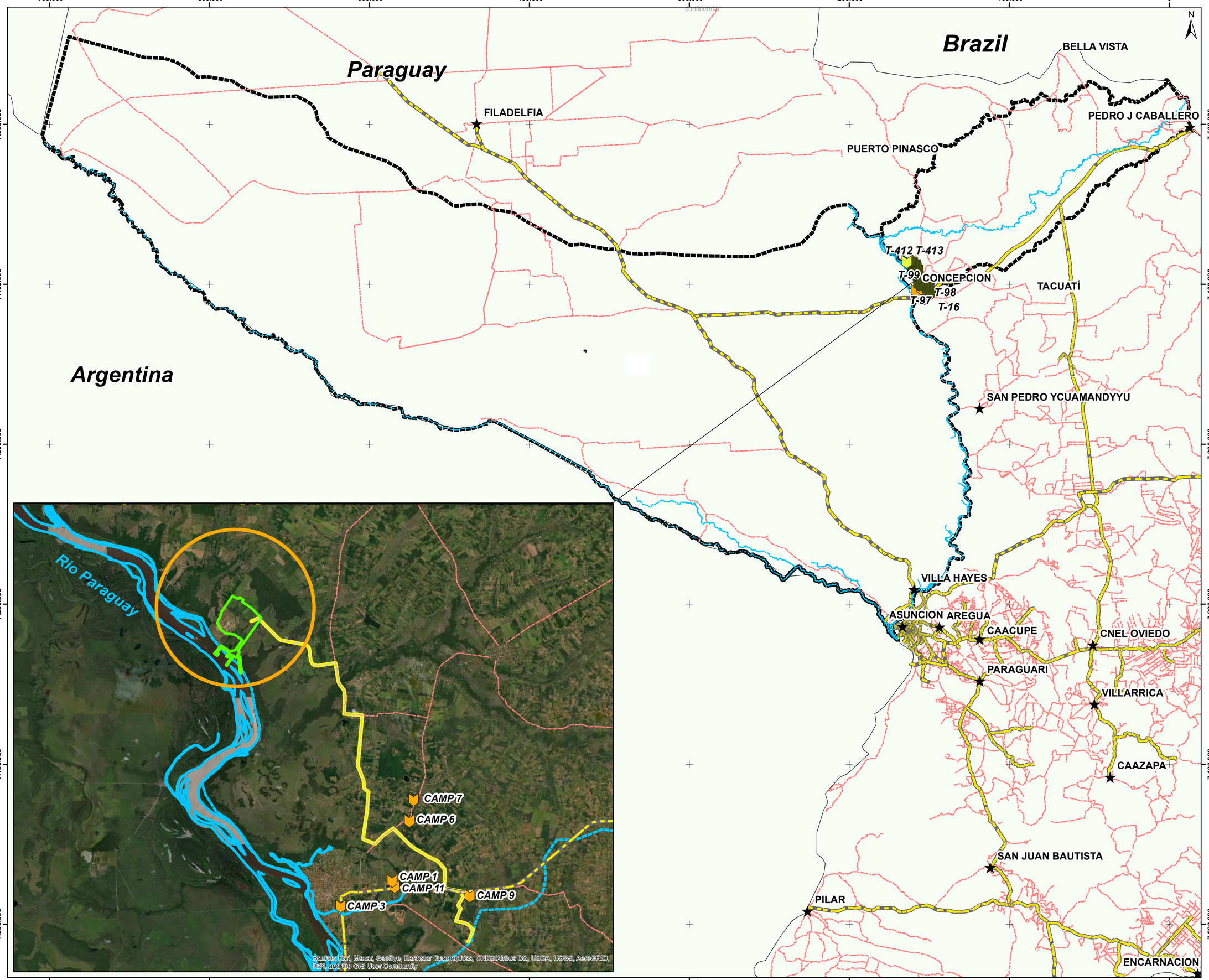
- ✓ DAA: area of installation of the project, including the industrial areas, accesses and support areas (port and transmission line). DAA also includes the 6 accommodation camps.
- ✓ DIA:
  - For the physical and biotic environment, a radius of 5 km is being considered in the surroundings of PARACEL pulp mill and 25 meters range of transmission line. The impacts of port, wood transport and accommodation camps on the Direct Influence Area were also considered, although they are not included in the map. The DIA was determined based on atmospheric dispersion study, water effluent discharge (the distance of effluent is smaller than boundary) and industrial noise impacts (in 5 km the noise emitted by the mill will be practically the same as the environment).
  - For the socioeconomic environment, DIA includes: the district of Concepción, 13 km radius from the mill that contains Belem, Horqueta and Loreto, accommodation camps and transmission line. The impacts of wood transportation on the DIA were considered
- ✓ IIA:
  - For the physical environment, the Hydrographic Units (department), defined according to Resolution n. 376/2012, were considered as the reference base. In this way, the DIA (radius of 5 km from the site - DAA) was overlaid on the limits of the Hydrographic Units. The overlay of this information resulted in the definition of the IIA as the CIH18-Rio Pilcomayo and CIH8-Aquidaban Units. These units cover part of the middle and lower Paraguay sub-basin. It is worth to observe that this sub-basin was not considered in its entirety in the IIA, because relevant users were not found close enough (in terms of water quality impact)

downstream of the point of discharge of the effluents, in the portion covering the sub-basin. Another factor that justifies the definition of this IIA limit refers to the dispersion of the treated effluents in the Paraguay River, which is rapid and occurs very close to the point of release (between 0.37 and 0.42 m), this point being located upstream of the pulp mill water intake.

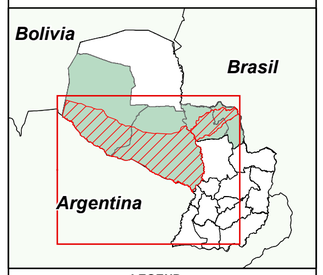
- For the biotic environment, the Indirect Influence Area considered the ecoregions that the Department of Concepción intercepts and, in part, the Aquidabán and Pilcomayo watersheds, namely Cerrado, Alto Paraná, Chaco Húmedo and Chaco Seco. The organization of information by ecoregions in the available bibliography justified the choice of this criterion.
- For the socio-economic environment, the IIA includes the three northern departments of the country: Concepción, San Pedro and Amambay

The following maps demonstrate the influence areas for physical, biotic and socioeconomic environment.

Figure 1 – Map of the Areas of Influence for Physical Environment



LOCATION MAP



LEGEND

- Structures - Transmission Line
- Accommodations (Camps)
- Capitals
- Transmission Line
- Hydrography
- Main routes
- Secondary routes
- IIA - Indirect Influence Area
- DAA - Directly Affected Area
- DIA - Diet Influence Area
- CIH Rio Pilcomayo and Aquidaban
- Easement Lane
- South America

ESCALA GRAFICA:
0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

DATA SOURCE:

- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).

PARACEL PÖYRY

ENVIRONMETAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

INFLUENCE AREA

ESCALA: 1:1.500.000		FECHA: 28/05/2021	
PROYECTO N°:	FOLHA:	FORMATO:	
RESP. TECNICO: Romualdo Hirata	FIRMA:		REV. 0

Figure 2 – Map of the Areas of Influence for the Biotic Environment

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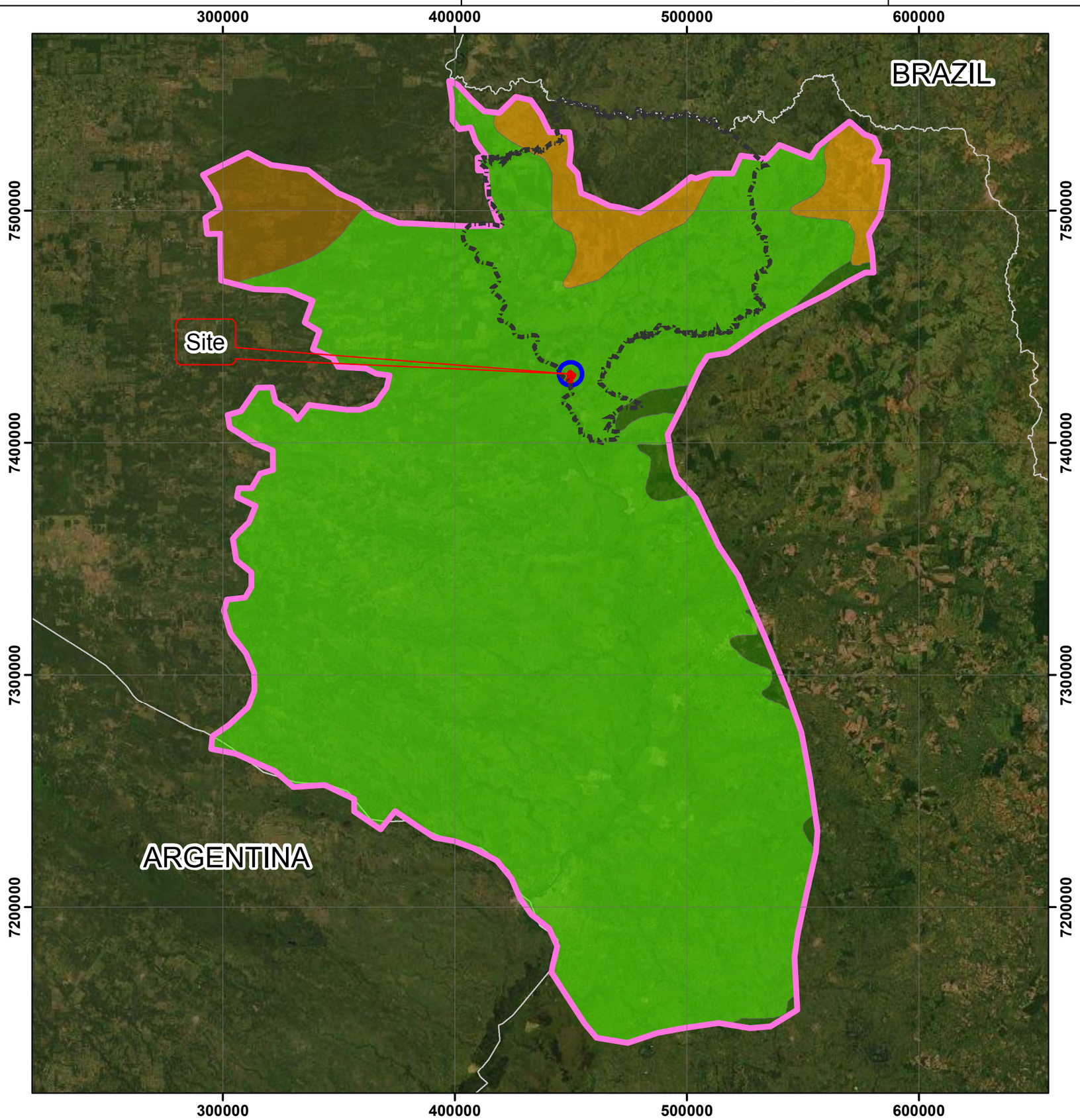


Coordinate System: SIRGAS 2000 - UTM Zone 23S
Projection: UTM - Universal Transverse of Mercator
Datum: SIRGAS 2000

SOURCES:

- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos). Informe Técnico Mapa de cobertura del Paraguay año 2011

Legend

- Concepcíón Department
- ADA
- DIA
- IIA
- Alto Parana Ecoregion
- Chaco Húmedo Ecoregion
- Chaco Seco Ecoregion
- Cerrado Ecoregion

N

0 25 50 100 150 Kilometers

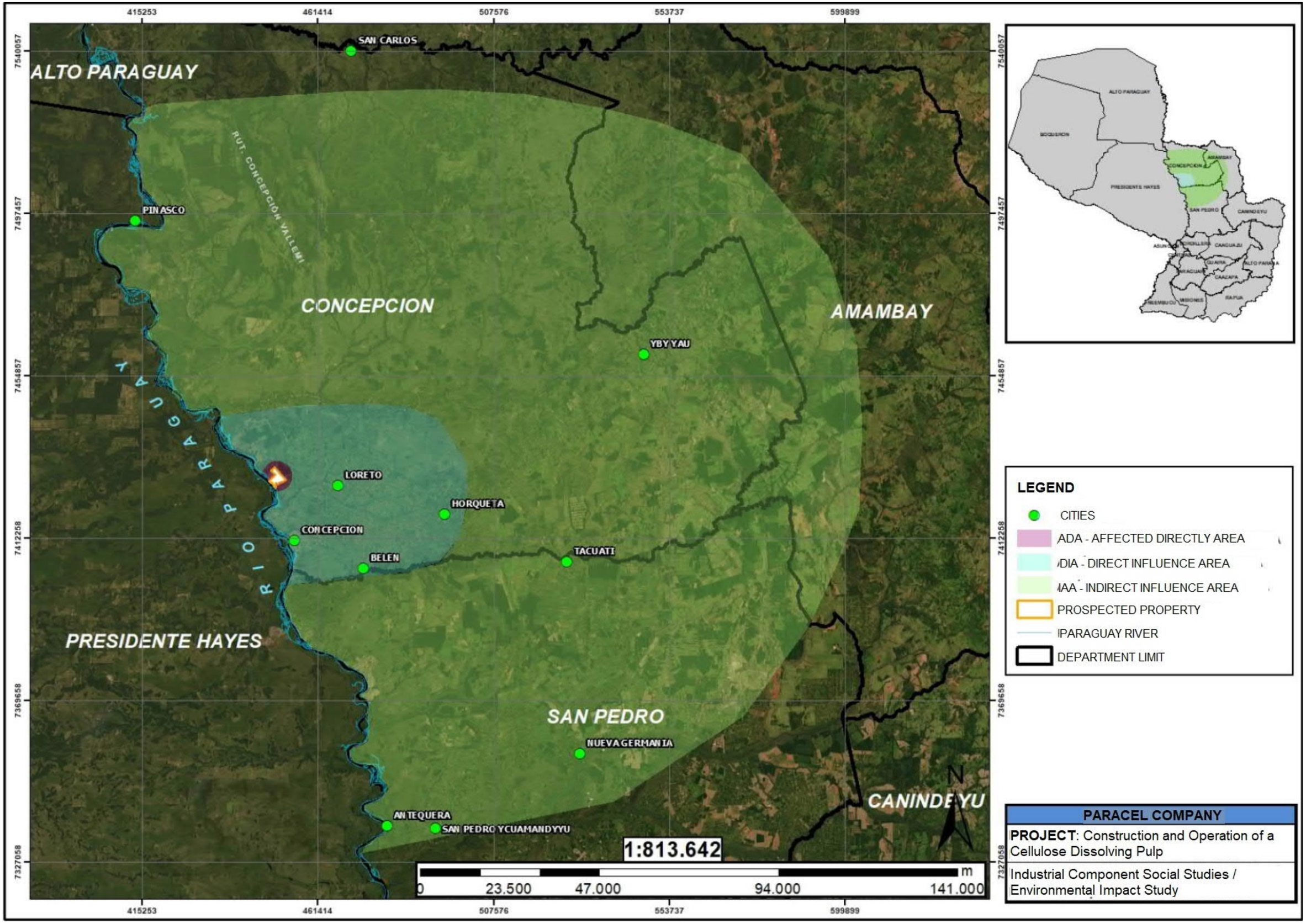
PARACEL PÖYRY

MAP TITLE:	BIOTIC ENVIRONMENT
PROJECT:	PARACEL
LICENSING PROCESS:	ENVIRONMENT IMPACT STUDY (EIAp-RIMA)
LICENSE TYPE	ENVIRONMENT LICENSE
LOCALIZATION	CONCEPCIÓN-PY
CIH	CIH8 Aquidaban and CIH18 Pilcomayo River
SCALE:	1:1.750.000
DATE:	2020/05/25
TECHNICAL MANAGER:	EDUARDO MARTINS Biologist
CRBio Nº:	26.063/01-D

confidential

Figure 3 – Map of the Areas of Influence for the Socioeconomic Environment

confidential



confidential

9 ENVIRONMENT DIAGNOSIS

9.1 Physical environment

The diagnosis of the physical environment allows us to observe the current states of climate and meteorology, air quality, noise, geology, geomorphology, pedology and hydrology (surface and underground water resources) of the areas of influence and thus obtain an adequate evaluation of the environmental impacts related to the implementation and operation of PARACEL pulp mill.

For the compilation of primary and secondary data, the areas of influence were considered as follows:

- IIA - Aquidabán (12,515 km^2) and Pilcomayo River (86,694 km^2) Hydrographic Units, according to MADES Resolution n. 376/2012
- DIA - Radius of 5 km around the DAA. This delimitation was due to atmospheric dispersion studies;
- DAA - Includes the internal region owned by PARACEL, where the industrial unit will be properly established, in addition to the water collection pipe and land effluent outlet.

9.2 Climate and Meteorology

The climate type in Paraguay is tropical to subtropical, governed by tropical air mass and polar air mass, with hot and rainy summers and low and less rainy winters. The average annual temperature is 23°C and the average annual maximum is 29°C. There is a marked difference between the distribution of rainfall in the two regions into which the country is divided. In the Eastern Region, the average annual temperature ranges from 21°C to 23°C. In the Western Region, the average annual temperature is 24°C. The average recorded rainfall is 1,700 mm in the eastern region and 400 mm in the western region, near the border with Argentina and Bolivia (DGEEC, 2011).

According to Grassi et al. (2005), the Eastern Region, has an undulating and humid feature confined between the Paraguay and Paraná rivers, has a rugged topography with good drainage and a growing rainfall regime to the east and where the climate varies from humid sub-humid to humid, in the same orientation, giving rise to the large subtropical forests of the Atlantic basin.

According to this classification Pasten et al. (2011), the Eastern Region is defined with two types of climates:

- Tropical Shroud/Dry Winter (Aw): covers much of the department of Concepción and a small portion of northwest San Pedro;
- Temperate/No Dry Season/Hot Summer (Cfa) includes the departments of Amambay, Canindeyú, Central, Cordillera, Caaguazú, Alto Paraná, Paraguarí, Guairá, Ñeembucú, Misiones Itapúa and much of San Pedro.

The result of Köppen's climate classification, which can be seen in the Figure below, determined that in Paraguay there are three types of climate: tropical savannah with dry winter (Aw), semi-arid (Steppe) warm during all year (Bsh) and temperate climate, without dry season and hot summer (Cfa), this is the predominant climate in much of Paraguay (Pasten et al. 2011).

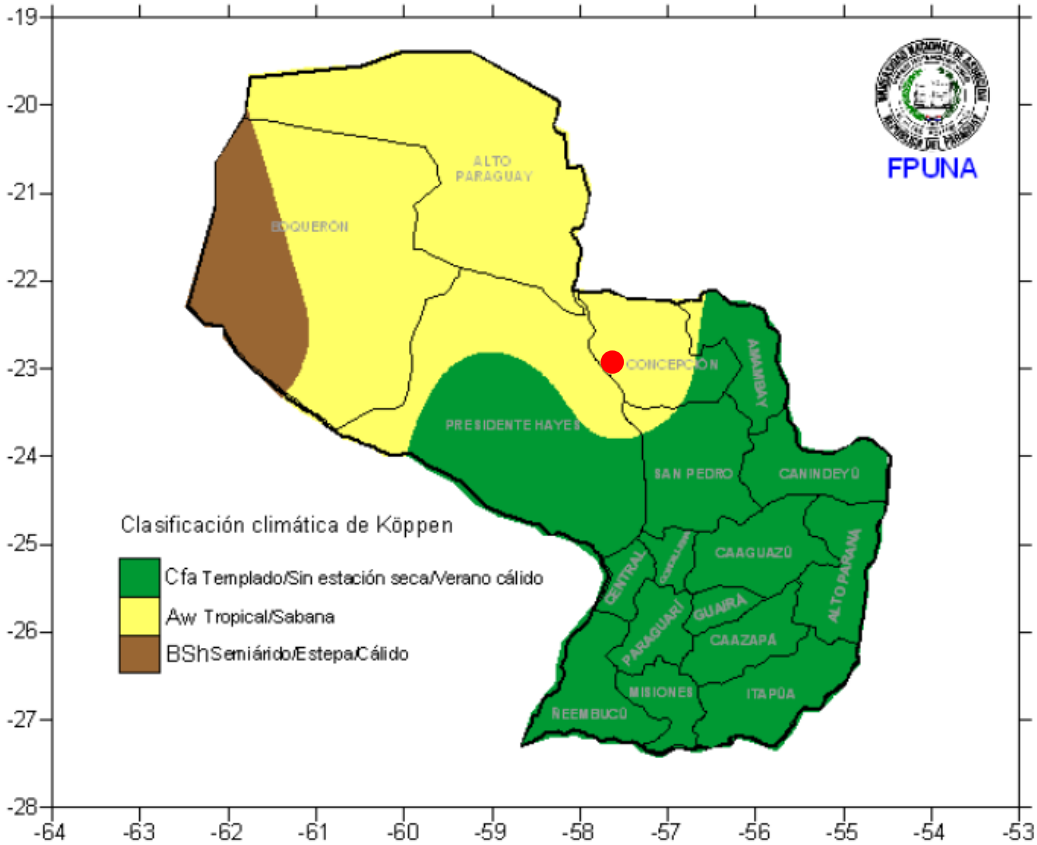


Figure 4 - Climate Classification of Köppen (1971-2010). Source: Pasten et al. (2011)

In the Figure below you can see the result of Thornthwaite's climate classification, where it’s possible to observe the 5 different types of climate of Paraguay.

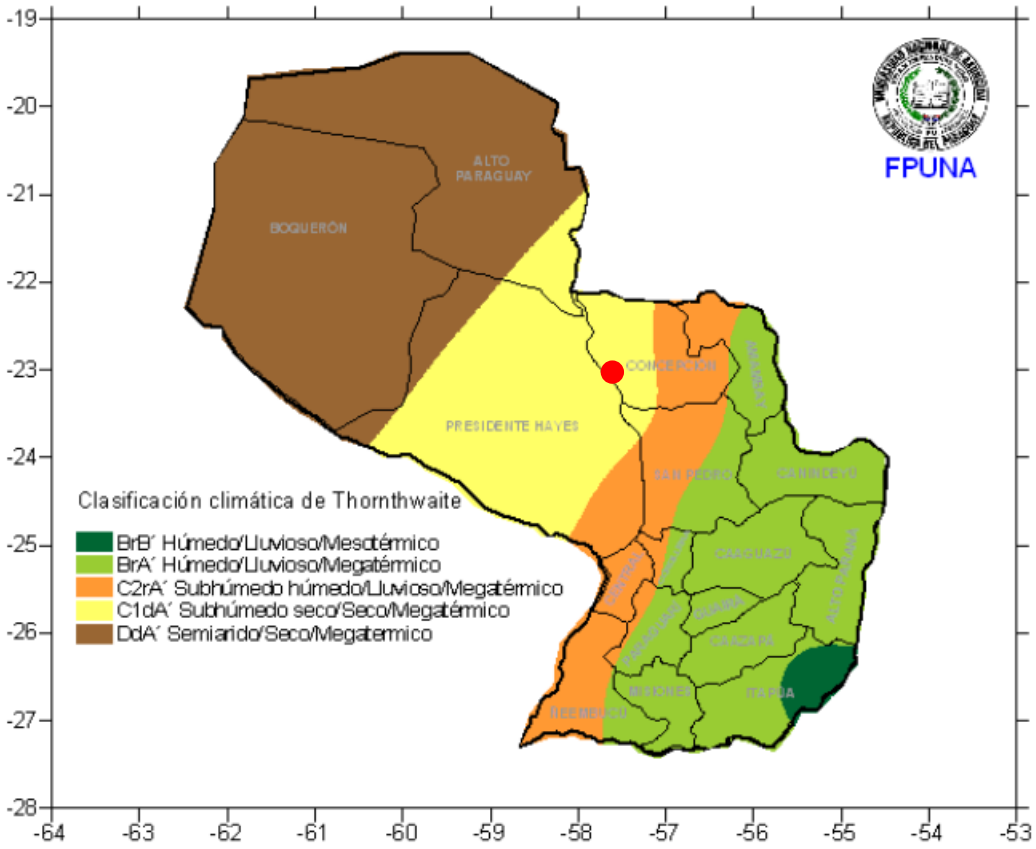


Figure 5 - Thornthwaite climate classification (1971-2010). Source: Pasten et al. (2011)

According to Pasten et al. (2011), the Western Region is defined considering four types of climate:

- Dry sub-humid/dry/megathermal (C1dA'): it includes the western part of the department of Concepción and a small portion of the department of San Pedro;
- Humid sub-humid/rainy/megathermal (C2rA'): covers the east of Concepción, a strip of San Pedro, Central department, west of Cordillera and west of Ñeembucú;
- Wet/Rain/Megathermal (BrA'): includes the departments of Canindeyú, Alto Paraná, Guairá, Caazapá, Misiones, east of Amambay, southeast of San Pedro, east of Cordillera, east of Ñeembucú and a large part of Itapúa;
- Wet/Rain/Mesothermal (BrB'): includes only a small part of Itapúa.

9.2.1 Metodology

The climatic characterization of the region where the pulp mill is located considered the analysis of the following parameters: temperature, relative humidity, wind direction and speed, precipitation, solar radiation and water balance.

The meteorological and climatic information presented comes from the Climatological and Meteorological Study, carried out by the Company "CATAVENTO AMBIENTALE METEOROLOGIA E MEIO AMBIENTE", the data were obtained by surface meteorological stations approved in the region of the company.

The data used for the study of the region's climate were obtained from the Integrated Surface Database (ISD), which can be consulted on the website of the National Oceanic and Atmospheric Administration (NOAA). Four surface weather stations were chosen for the analysis of climate conditions in the region, which were more representative of the company's area, as shown below.

- Puerto Casado (USAF:860860/ICAO:SGLV), located 116 km of the north of the project, installed in the coordinates 22°16'58.80 "S e 57°55'58.80 "W. The data series examined is composed of 7 years (from 01/01/2013 to 31/12/2019);
- Pozo Colorado (USAF: 861280/ICAO: SGPC), located 136 km west of the project, at coordinates 23°30'0.00 "S e 58°46'58.80 "W. The data series examined is composed of 7 years (from 01/01/2013 to 31/12/2019);
- San Pedro (USAF: 861850/ICAO: SGSP), 99 km south of the project, located at coordinates 24° 4'1.20 "S e 57° 4'58.80 "W The data series examined is composed of 7 years (from 01/01/2013 to 31/12/2019);
- Teniente Coronel Carmelo Peralta (USAF: 861340/ICAO: SGCO), used as a reference station for the region, about 21 km from the project, located at coordinates 23°26'31.20 "S e 57°25'37.20 "W. The data series examined is composed of 10 years (from 01/01/2010 to 31/12/2019).

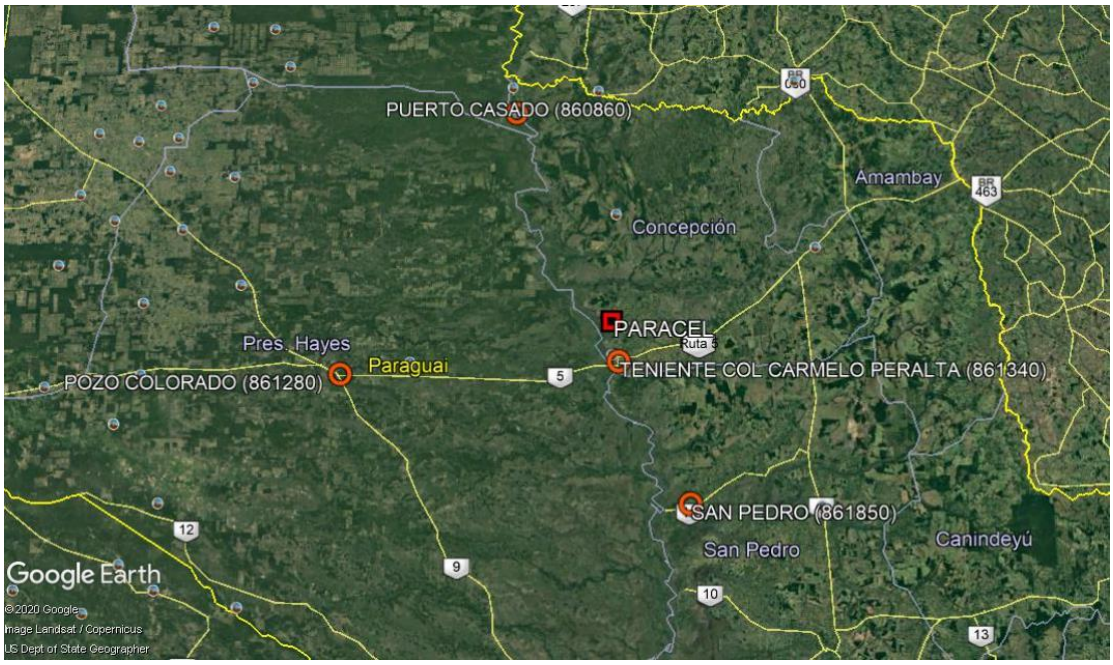


Figure 6 - Map of the location of the weather stations distant from the project. Source: Google Earth, 2020

9.2.2 Rainfall precipitation

No rainfall data are available in the database used for the study. Therefore, the study of rainfall precipitation was carried out by consulting the bibliography with information from previous studies of the region and the country.

Most of the country's rainfall is convective, produced by isolated storms or lines of instability that are frequent in spring and autumn. The average annual precipitation shows a great spatial variation. The greatest amplitude is towards the south of the country, varying zonally from 400 mm in the northwest of the Chaco to more than 1,800 mm in the Eastern Region.

The Paraná River basin is the wettest, with annual averages above 1800 mm, while the Paraguay River basin receives maximums of 1600 mm in the eastern region. Rainfall also shows great seasonal variability. They are lowest in July and August, and the average of the least rainy month usually does not reach 5% of the annual total. The highest volumes of precipitation occur during the months of October to April and are generally recorded in the form of storms or rainfall, as a result of atmospheric instability caused by strong warming of the lower layers of the atmosphere (Mayeregger and Romero 2017).

The highest precipitation rates in the region of Concepción occur in the summer. The month with the lowest rates is August, with an average of 28mm. In February and November, precipitation reaches its highest levels, between 128 and 152 mm on average. The average annual rainfall is approximately 1,190 mm[1].

[1] Source: https://es.weatherspark.com/

9.2.3 Atmospheric pressure

At the Puerto Casado station (860860), located 116 km north of PARACEL pulp mill, the atmospheric pressure varied between 1,001.4 and 1,004.9 hPa, while the average for the period from 2013 to 2019 was 1,002.9 hPa.

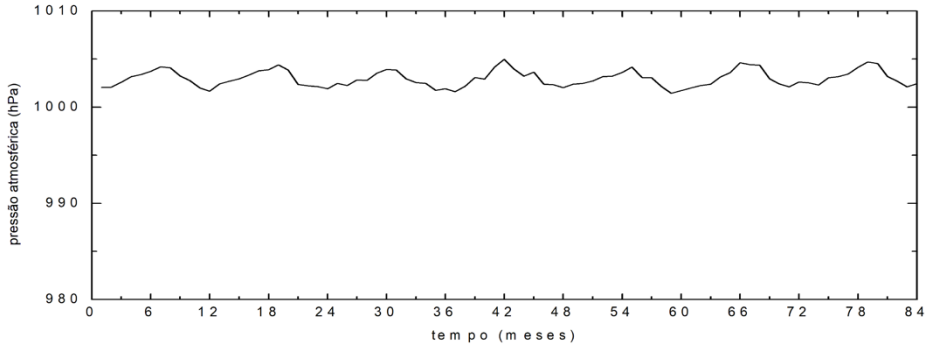


Figure 7 – Average monthly atmospheric pressure at the Puerto Casado station

At the Pozo Colorado station (861280), located 136 km west of the project, the atmospheric pressure varied between 999.4 and 1,002.7 hPa, while the average for the period from 2013 to 2019 was 1,000.8 hPa.

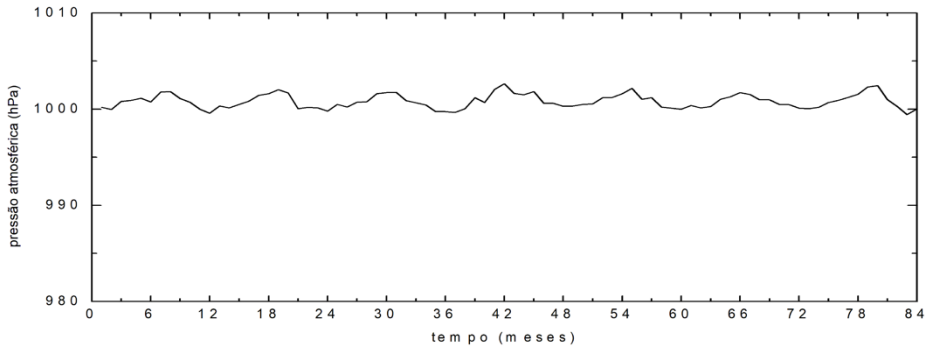


Figure 8 – Average monthly atmospheric pressure at the Pozo Colorado station

At the San Pedro station (861850), located 99 km southeast of the project, the atmospheric pressure varied between 1,002.1 and 1,005.5 hPa, while the average for the period from 2013 to 2019 was 1,003.6 hPa.

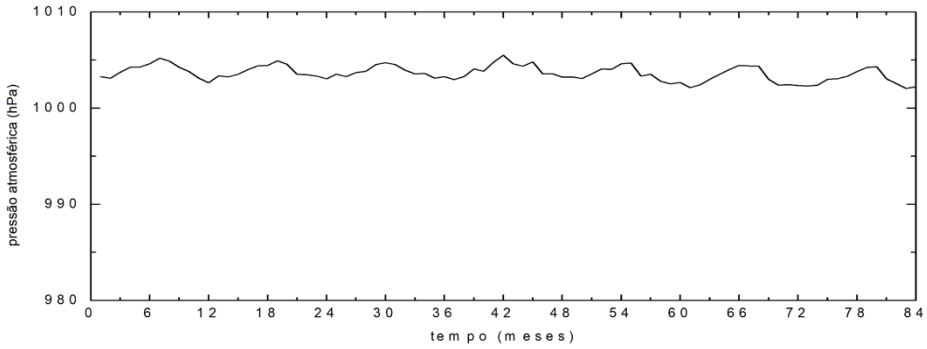


Figure 9 – Average monthly air pressure at San Pedro station

At the Lieutenant Colonel Carmelo Peralta station (861340), 21 km from the project, the atmospheric pressure varied between 1,001.5 and 1,007.5 hPa, while the provisional average climate for the period from 2010 to 2019 was 1,003.9 hPa.

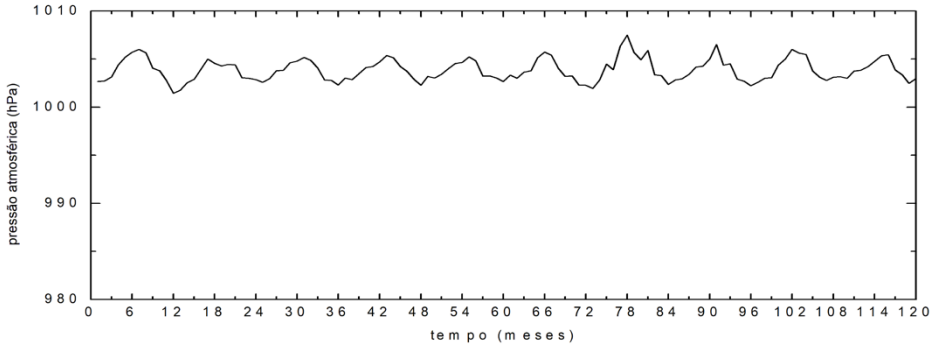


Figure 10 – Average monthly atmospheric pressure at the Teniente Coronel Carmelo Peralta station

Although the four weather stations cover a relatively large area and are separated by considerable distances, the atmospheric pressure behavior was similar in all stations and the average for the region was 1,002.8hPa.

9.2.4 Air temperature

At the Puerto Casado station, the average monthly temperature varied between 16.9˚C and 31˚C, while the average for the period from 2013 to 2019 was 25.7˚C.

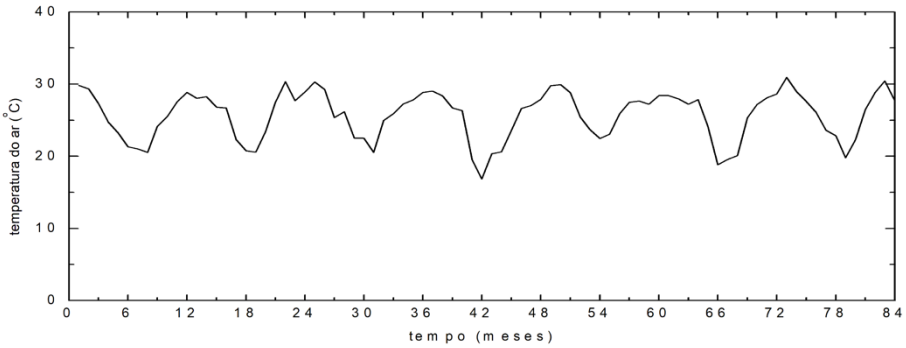


Figure 11 – Average monthly temperature at Puerto Casado station.

At Pozo Colorado station, the monthly average temperature varies between 15,5˚C and 31,2˚C, while the average for the period from 2013 to 2019 was 24.7˚C.

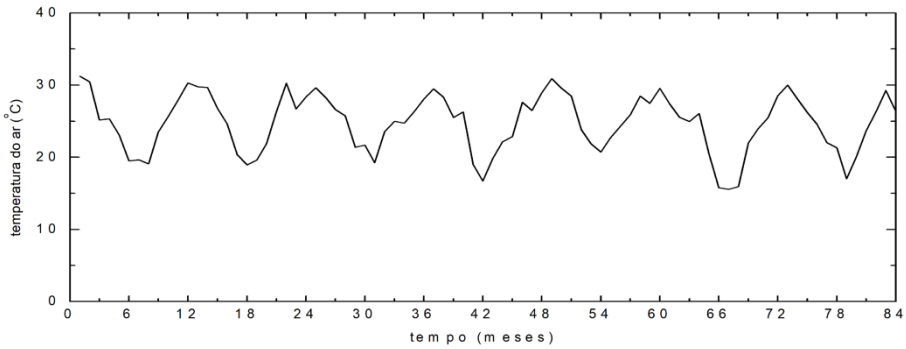


Figure 12 – Average monthly temperature at Pozo Colorado station

At the San Pedro station, the average monthly temperature varied between 16.5˚C and 30.5˚C, while the average climate for the period from 2013 to 2019 was 24.1˚C.

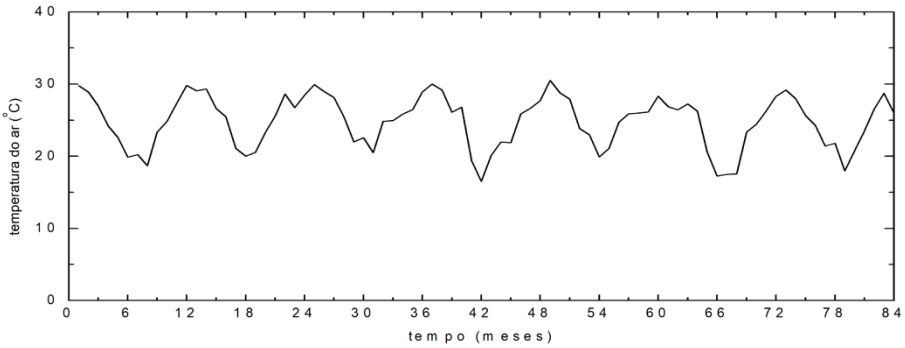


Figure 13 – Average monthly temperature at San Pedro station

At Teniente Coronel Carmelo Peralta station, the average monthly temperature varied between 15.5˚C and 29.6˚C, while the provisional average climate for the period from 2010 to 2019 was 24.3˚C.

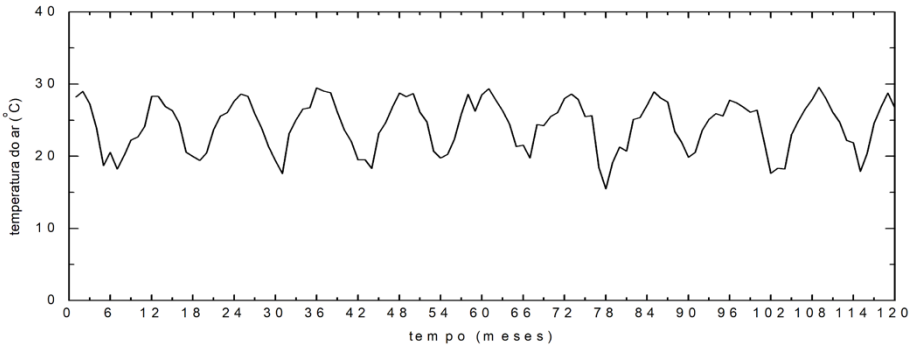


Figure 14 – Average monthly temperature at station Teniente Coronel Carmelo Peralta

The air temperature in the region is defined by the effect of continentality and topographic uniformity, presenting a great amplitude. In summer, as it is a tropical region, the maximum temperatures can exceed 30˚C, and in winter frost phenomena can be registered as a consequence of the entry of cold fronts.

The average temperatures are very similar in all the weather stations, from 24.1˚C in the San Pedro station, which is further south, to 25.7˚C in the Puerto Casado station, located further north. In the large region analyzed, the average temperature was 24.7˚C.

9.2.5 Relative humidity

At the Puerto Casado station, the monthly relative humidity varied between 46.7% and 79.6%, while the average for the period from 2013 to 2019 was 63%.

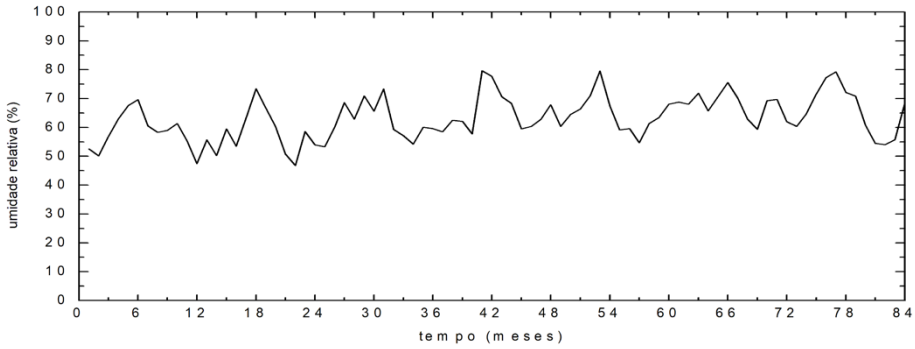


Figure 15 – Average monthly relative humidity at Puerto Casado station

At the Pozo Colorado station, the monthly relative humidity varied between 51.7% and 83.6%, while the average for the period from 2013 to 2019 was 70.2%.

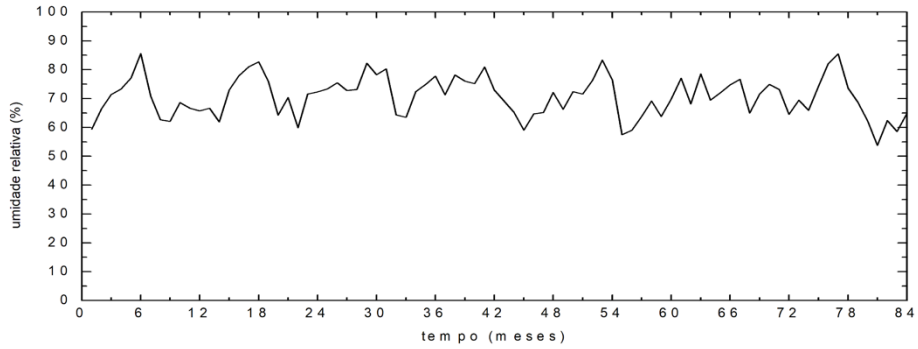


Figure 16 – Average monthly relative humidity at station Pozo Colorado

In the San Pedro station, the monthly relative humidity varied between 56.1% and 85.4%, while the average for the period from 2013 to 2019 was 70.5%.

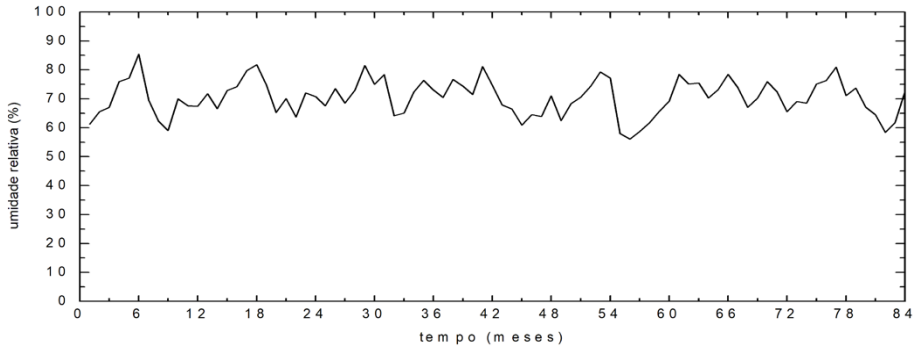


Figure 17 – Average monthly relative humidity at San Pedro station

At Teniente Coronel Carmelo Peralta station, the monthly relative humidity varied between 51.4% and 85.5%, while the provisional average for the period from 2010 to 2019 was 70.9%.

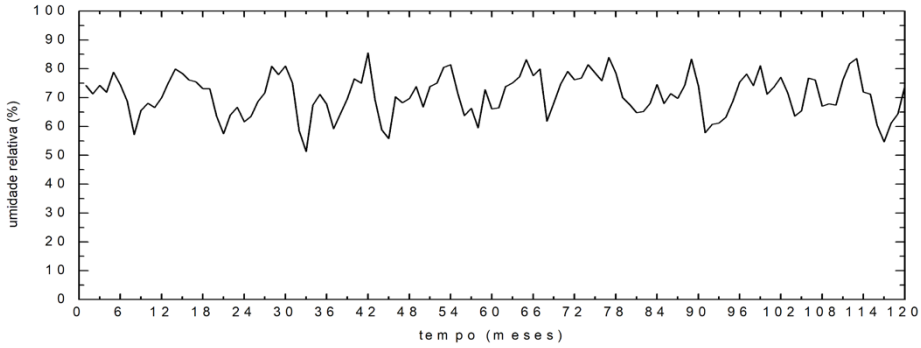


Figure 18 – Average monthly relative humidity at station Teniente Coronel Carmelo Peralta

The relative humidity at the Puerto Casado station, to the north of the future PARACEL factory, has an average relative humidity of 63%. The other regions presented values

between 70.2% and 70.9%, the highest value being at the station of Lieutenant Colonel Carmelo Peralta. This difference is due to the variability of rainfall among the regions.

9.2.6 Wind

At the Puerto Casado station, the average monthly wind speed varied between 0.76 and 2.49 m/s, while the average for the period from 2013 to 2019 was 1.47 m/s.

The wind rose generated with the data obtained at the Puerto Casado station proves the predominance of south and north winds.

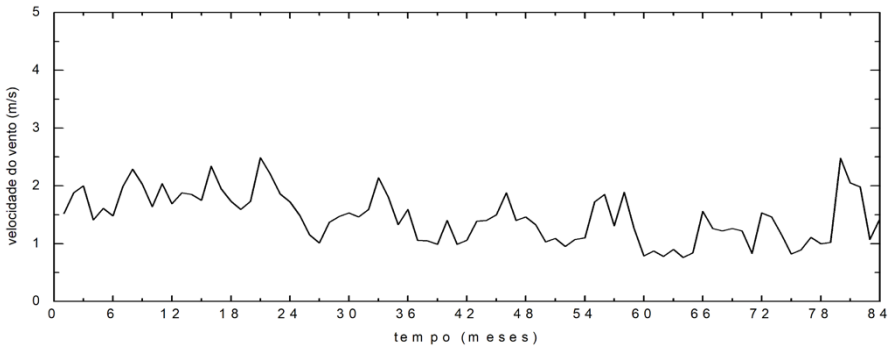


Figure 19 – Average wind speed at Puerto Casado station

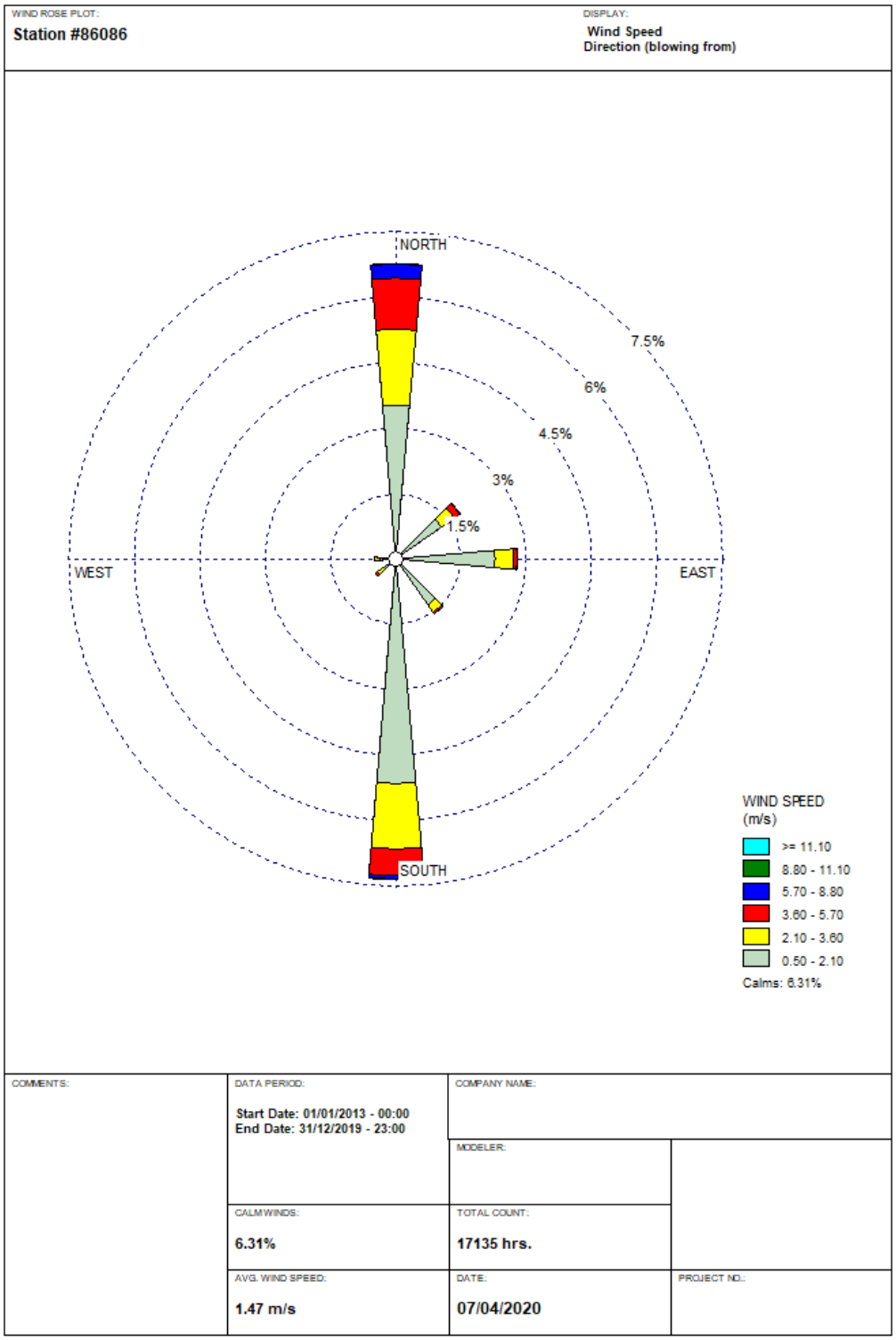


Figure 20 – Wind rose observed at the station Puerto Casado

At the Pozo Colorado station, the average monthly wind speed varied between 0.7 and 5.0 m/s, while the average for the period from 2013 to 2019 was 2.5 m/s.

The wind rose generated with the data observed at the Pozo Colorado station proves the predominance of south and north winds, with important components from the northeast and east.

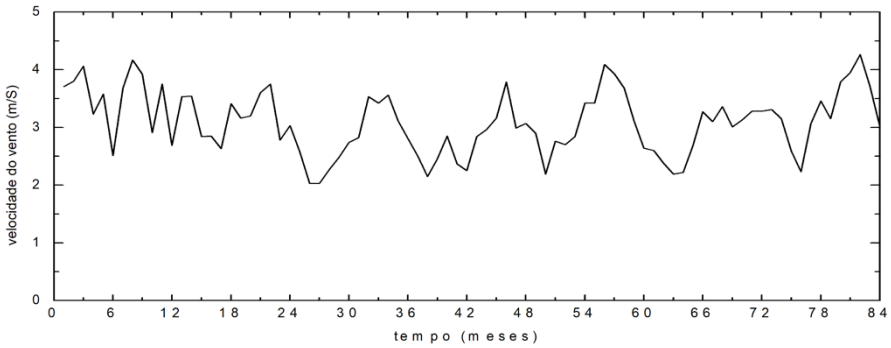


Figure 21 – Average wind speed at station Pozo Colorado

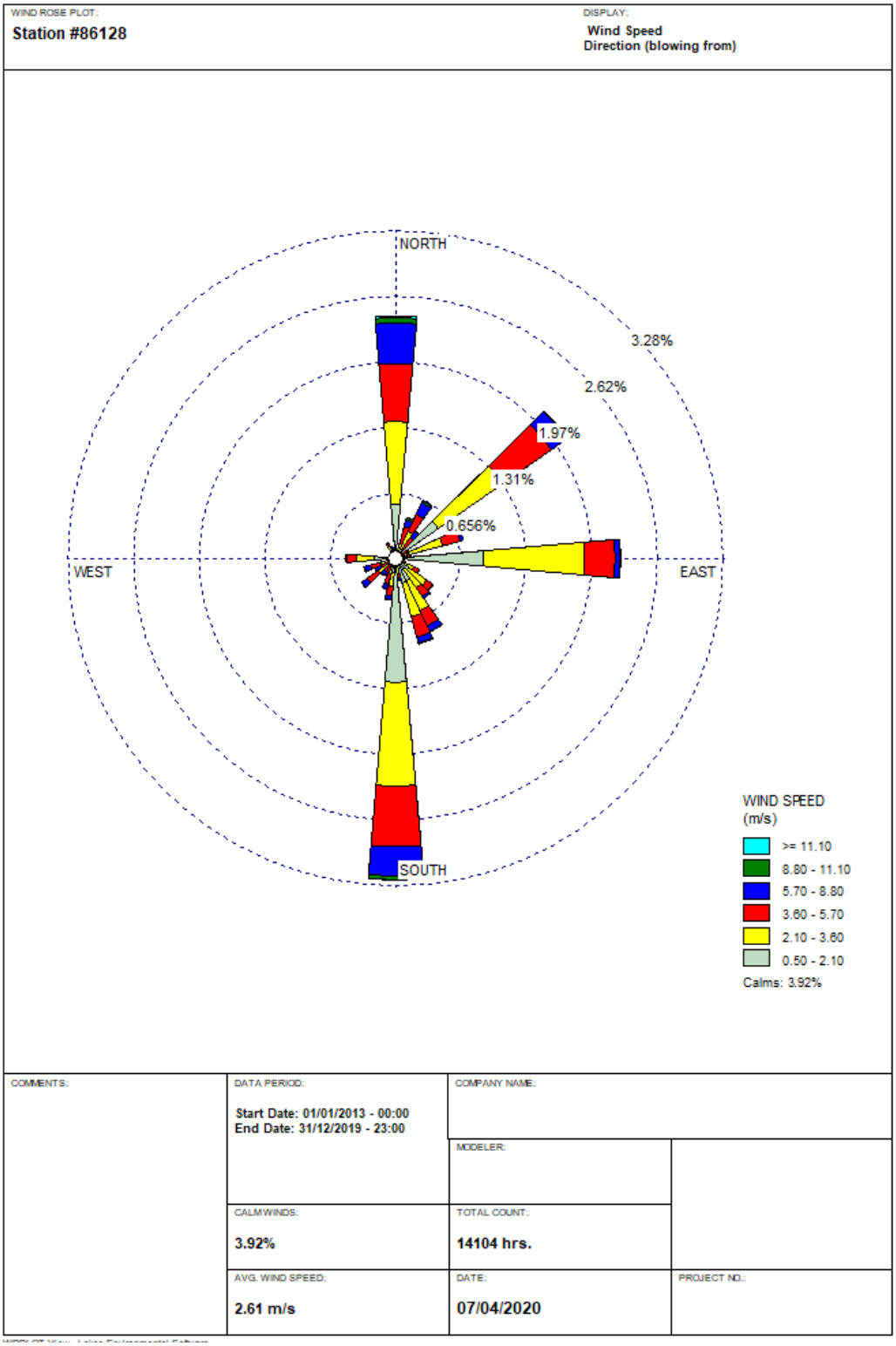


Figure 22 – Wind rose observed at Pozo Colorado station

At the San Pedro station, the average monthly wind speed varied between 0.5 and 3.7 m/s, while the average for the period from 2013 to 2019 was 1.9 m/s.

The wind rose generated with the data observed at the San Pedro station proves the predominance of two winds from the south and north, followed by winds from the east.

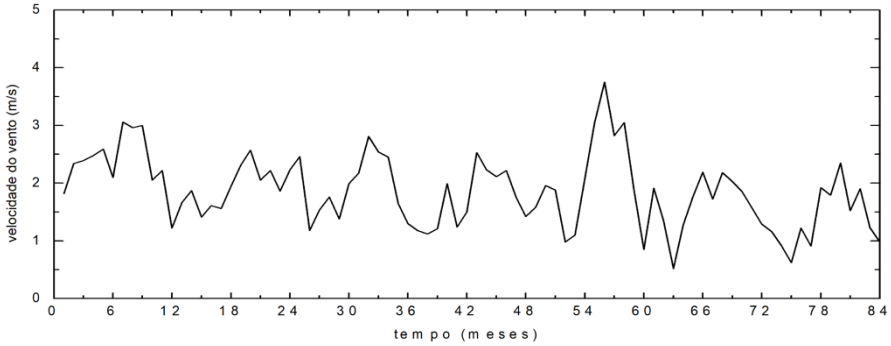


Figure 23 – Average wind speed at the station San Pedro

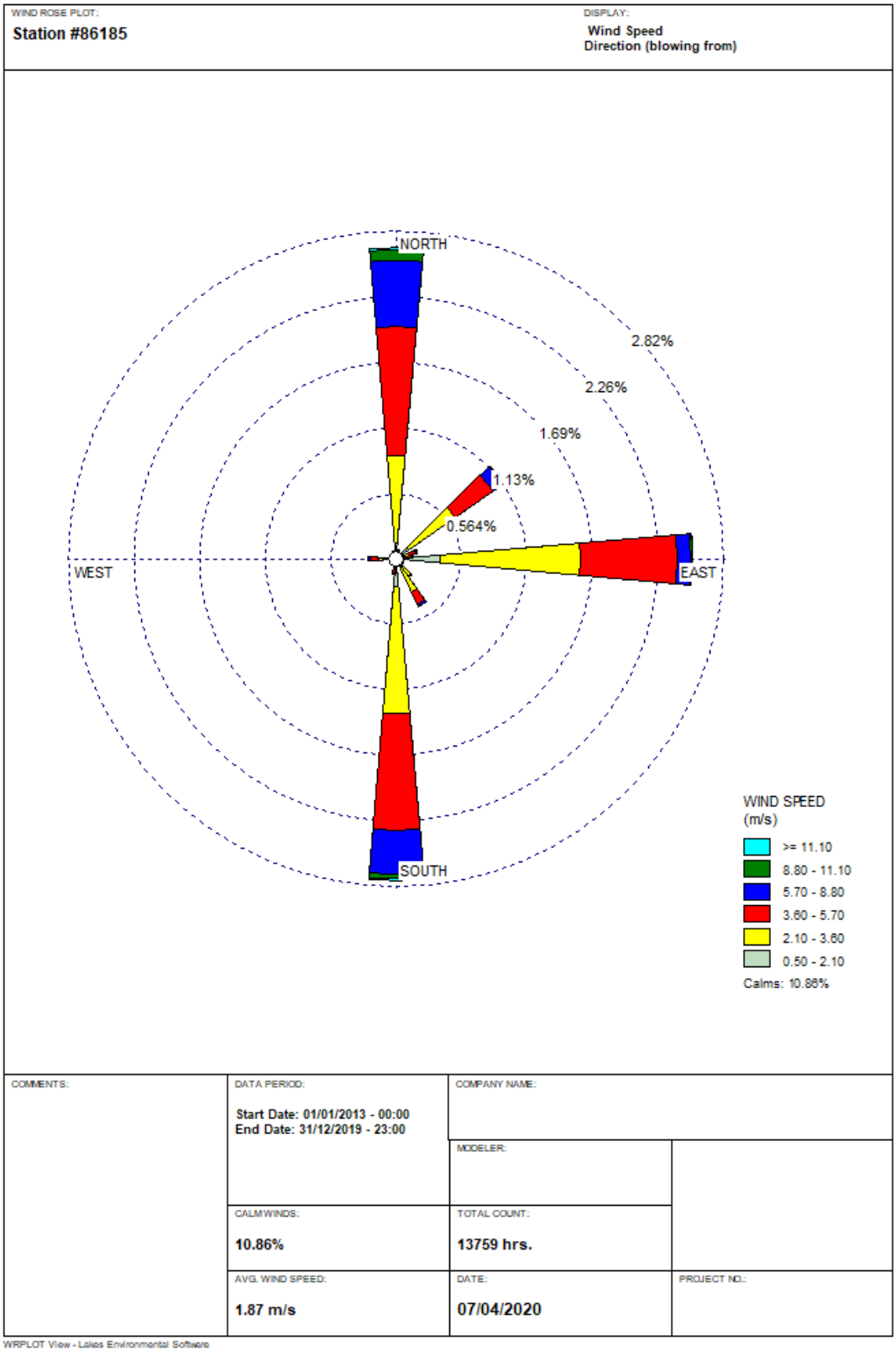


Figure 24 – Wind rose observed at the station San Pedro

At the Teniente Coronel Carmelo Peralta station, the average monthly wind speed varied between 1.8 and 4.9 m/s, while the provisional average for the period from 2010 to 2019 was 3.2 m/s.

The wind rose generated with the data observed at the Teniente Coronel Carmelo Peralta station proves the predominance of two winds from the south, followed by northeast and east, and with a less important component from the southeast.

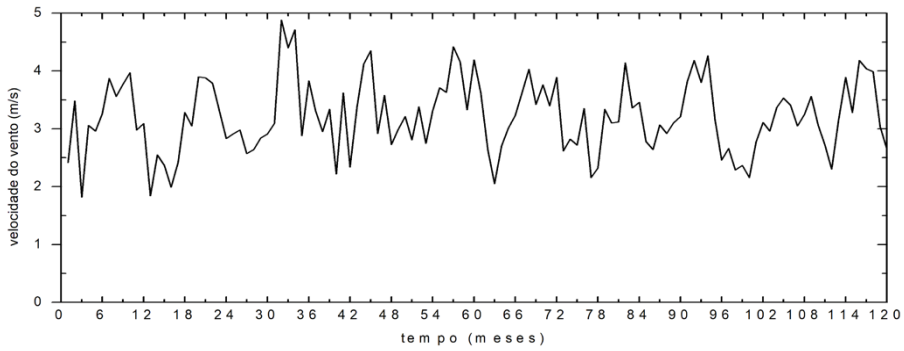


Figure 25 – Average wind speed at the station Teniente Coronel Carmelo Peralta

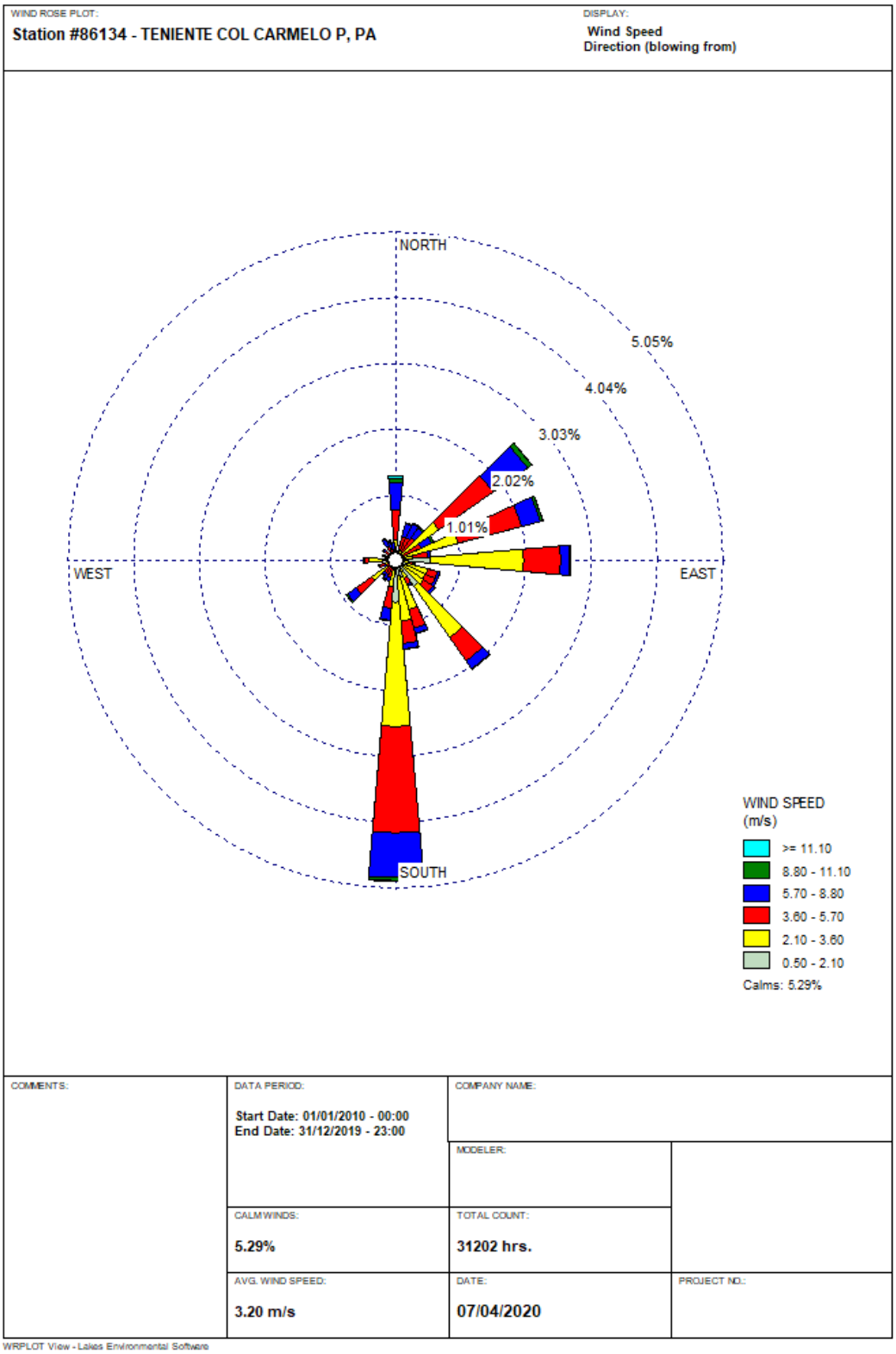


Figure 26 – Wind rose observed at the station Teniente Coronel Carmelo Peralta

The wind intensities in all regions are very similar and can be classified as weak winds, between 1.4 and 3.2 m/s. The highest wind speeds were registered at Teniente Coronel Carmelo Peralta station. The predominant wind directions are north and south, followed by northeast and east winds.

9.3 Air quality

This item presents the results of the Air Quality Monitoring report of the PARACEL pulp mill in the Municipality of Concepción, Department of Concepción, Paraguay.

The objective of the monitoring is to verify the air quality before the implementation and operation of the pulp mill (background).

The air quality monitoring was carried out through 2 campaigns, the first in the period from September 25 to October 16, 2019, and the second in the period from February 12 to March 4th, 2020.

This report was prepared using SEAM Resolution No. 259/2015, which establishes the air quality standard.

The complete report is presented in **ANNEX I** of this document.

9.3.1.1 Collection points

Three different points were defined to evaluate the air quality in the region where the PARACEL factory is installed, which are:

- Point 01 – SENACSA/ Departmental Animal Health Commission

  Address: Calle Gral. Díaz c/ Rufino Spika – Concepción/Paraguay

  Coordinates: UTM 21K 0454572 - 7410810

- Point 02 – Loreto Municipality/ Paraguay

  Address: Av. Eusebio Ayala Y Centro Corá – Loreto/Paraguay

  Coordinates: UTM 21K 0466753 - 7426022

- Point 03 – National Police Station – Comisaría nº18 Col. Roberto L. Petit

  Address: Puesto Policial Nacional – Comisaría nº18 – Col. Roberto L. Petit – Concepción/Paraguay

  Coordinates: UTM 21K 0457325 – 7434506

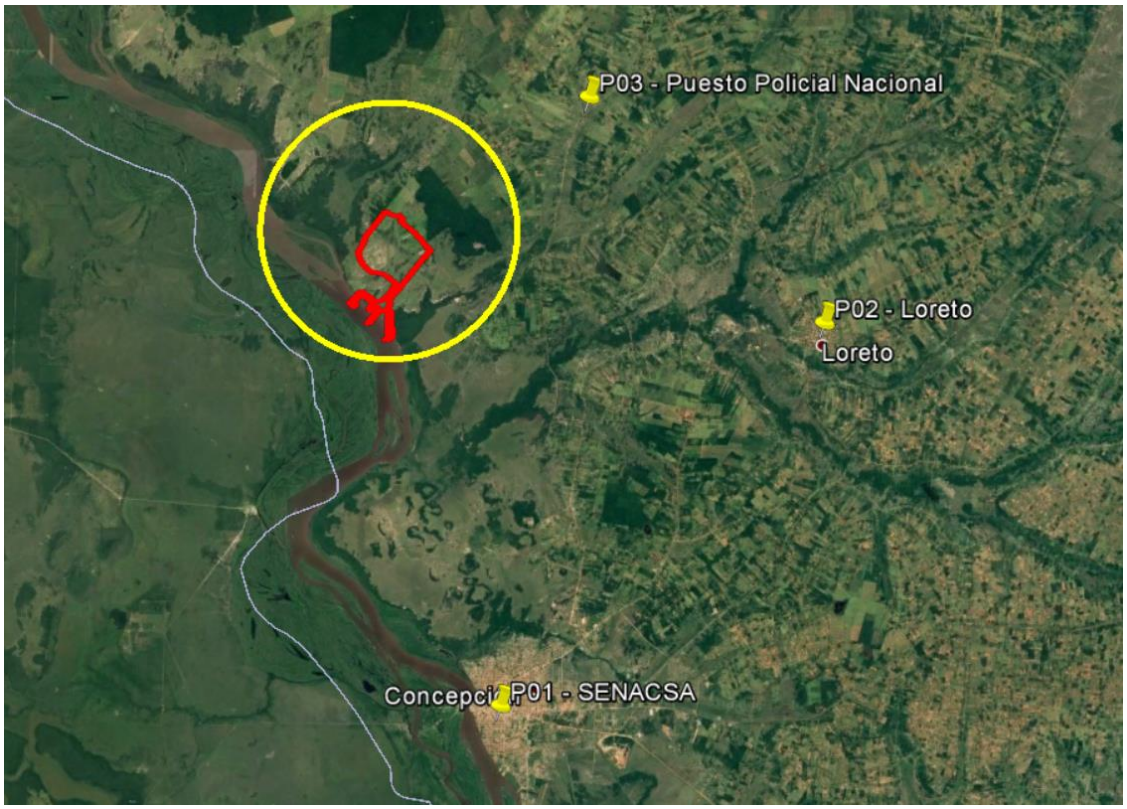


Figure 27 – Location of campaign monitoring points. Source: Pöyry Tecnologia (2021)

Figure 28 – Point P01. Source: Geoavaliar (2020)

Figure 29 – Point P02. Source: Geoavaliar (2020)

Figure 30 – Point P03. Source: Geoavaliar (2020)

9.3.1.2 Parameters

To monitor the current air conditions, the parameters were considered: Total Suspended Particles (TSP), Inhalable Particles (IP - PM_{10}), Respirable Particles (RP - $PM_{2.5}$), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Total Reduced Sulfur (TRS), Carbon Monoxide (CO), Ozone (O_3), Hydrogen Sulfide (H_2S) and Volatile Organic Compounds (VOC).

9.3.1.3 Methods

The samples were taken at 3 points, and 7 collections occurred at each of the sampling locations (points), with an approximate duration of 24 hours for the parameters Total Suspended Particles (TSP), Inhalable Particles (IP - PM_{10}), Respirable Particles (RP - $PM_{2.5}$), Nitrogen Dioxide (NO_2), Sulfur Dioxide (SO_2), Ozone (O_3), Hydrogen Sulfide (H_2S); approximately 1 hour for Total Reduced Sulfur (TRS) and Carbon Monoxide (CO) parameters; 20 minutes for Volatile Organic Compounds (VOC).

The references of the methodologies used are presented below.

- 40 CFR Appendix B to Part 50 - Reference Method for the Determination of Suspended Particulate Matter in the Atmosphere (High-Volume Method);
- 40 CFR Appendix J to Part 50 - Reference Method for the Determination of Particulate Matter as PM_{10} in the Atmosphere;
- 40 CFR Appendix L to Part 50 - Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere;
- ISO 4220:1983 - Ambient air — Determination of a gaseous acid air pollution index — Titrimetric method with indicator or potentiometric end-point detection;
- US EPA METHOD Nº QN 1277:1977 - Sodium Arsenite Method for the Determination of Nitrogen Dioxide in the Atmosphere/
- EQOA-0206-148 - Environment S.A Model O342M UV Photometric Ozone Analyzer;
- US EPA EMC Conditional Test Method (CTM-030) - Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Emissions from Natural Gas-Fired Engines, Boilers and Process Heaters Using Portable Analyzers;
- US EPA Method 16A - Total Reduced Sulfur – Impinger – Adapted Method for Air Quality Monitoring;
- US EPA Method 11 — Determination Of Hydrogen Sulfide Content Of Fuel Gas Streams In Petroleum Refineries – Adapted Method for Air Quality Monitoring;
- US EPA Method 18 - Volatile Organic Compounds by Gas Chromatography

In order to compare and assess the results registered, the limits stated by SEAM Resolution n. 259/2015 were considered and also the limits of the air quality standards presented by the US EPA - Environmental Protection Agency.

9.3.1.4 Results

The results are presented in the table below.

Table 1 – Results of first air quality campaign

Resultados del Análisis Concentración de Setiembre - Octubre/2019																					
Estación de Monitoreo	Colecta	Resultado del Monitoreo										En acuerdo con la Resolución SEAM nº 259 del 3 de júlio de 2015 (µg/m3)								CETESB	
		PTS (MP) µg/m³ (24 horas)	PI (PM10) µg/m³ (24 horas)	PI (PM2,5) µg/m³ (24 horas)	SO_2 µg/m³ (24 horas)	NO_2 µg/m³ (1 hora)	VOC µg/m³ (20 minutos)	O_3 µg/m³ (8 horas)	CO µg/m³ (8 horas)	TRS µg/m³ (1 hora)	H_2S µg/m³ (24 horas)	PTS	PI (PM10)	PI (PM2,5)	SO_2	NO_2	VOC	O_3	CO	TRS	H_2S
Punto 01 - Senacsa/ Comision Departamental de Salud Animal	1ª	69,37	42,39	31,96	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	2ª	136,99	70,90	56,31	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	3ª	201,09	93,51	65,84	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	4ª	150,55	78,23	58,41	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	5ª	113,27	53,59	42,82	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	6ª	130,91	64,34	52,52	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	7ª	178,64	63,88	50,36	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
Punto 02 - De Municipalidad de Loreto/ Paraguay	1ª	55,11	32,91	28,36	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	2ª	66,04	37,92	30,49	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	3ª	64,06	31,36	27,99	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	4ª	8,36	5,40	4,72	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.		150	30	20	200		120	10	6,55	6,55
	5ª	23,00	11,72	9,10	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	6ª	36,15	20,27	16,49	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	7ª	38,72	21,79	18,52	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
Punto 03 - Posto Policial Nacional - Comsaria nº18 Col. Roberto L. Petit	1ª	54,55	29,33	21,27	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	2ª	32,05	20,30	14,26	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	98,98										
	3ª	34,87	26,89	16,30	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	98,68										
	4ª	40,75	27,70	18,48	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	5ª	35,89	25,65	16,12	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	99,06										
	6ª	23,87	17,01	11,43	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	100,49										
	7ª	16,96	7,39	5,45	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	25,14										

Table 2 – Results of second air quality campaign

Resultados del Análisis
Concentraciones de Febrero-Marzo/2020

Estación de Monitoreo	Colecta	Resultado del Monitoreo										En acuerdo con la Resolución SEAM nº 259 del 3 de júlio de 2015 (µg/m3)								CETESB	
		PTS (MP) µg/m³ (24 horas)	PI (PM10) µg/m³ (24 horas)	PI (PM2,5) µg/m³ (24 horas)	SO_2 µg/m³ (24 horas)	NO_2 µg/m³ (1 hora)	VOC µg/m³ (20 minutos)	O_3 µg/m³ (8 horas)	CO µg/m³ (8 horas)	TRS µg/m³ (1 hora)	H_2S µg/m³ (24 horas)	PTS	PI (PM10)	PI (PM2,5)	SO_2	NO_2	VOC	O_3	CO	TRS	H_2S
Punto 01 - Senacsa/ Comision Departamental de Salud Animal	1ª	59,93	34,35	23,95	17,63	1,09	N.D.	N.D.	N.D.	N.D.	N.D.										
	2ª	64,74	32,77	25,38	19,48	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	3ª	53,56	34,77	21,81	16,82	N.D.	0,18	N.D.	N.D.	N.D.	N.D.										
	4ª	48,89	29,94	19,18	13,28	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	5ª	49,91	27,52	16,79	12,46	N.D.	0,11	N.D.	N.D.	N.D.	N.D.										
	6ª	70,10	36,31	23,16	14,14	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	7ª	56,08	30,55	17,31	11,94	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
Punto 02 - De Municipalidad de Loreto/ Paraguay	1ª	42,31	25,48	19,54	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	2ª	70,43	38,33	29,94	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	3ª	67,22	27,47	30,34	N.D.	N.D.	0,15	N.D.	N.D.	N.D.	N.D.										
	4ª	76,89	43,09	35,94	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.		150	30	20	200	20	120	10	6,55	6,55
	5ª	40,11	26,30	20,66	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	6ª	59,36	26,96	20,74	N.D.	N.D.	0,38	N.D.	N.D.	N.D.	N.D.										
	7ª	60,93	30,70	23,28	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
Punto 03 - Estación de Policía Nacional - Comisária nº18 Col. Roberto L. Petit	1ª	107,18	38,13	27,37	N.D.	N.D.	0,01	N.D.	N.D.	N.D.	N.D.										
	2ª	83,68	29,73	20,09	N.D.	N.D.	0,21	N.D.	N.D.	N.D.	N.D.										
	3ª	165,03	58,49	44,16	N.D.	N.D.	0,18	N.D.	N.D.	N.D.	N.D.										
	4ª	103,01	42,58	25,62	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.										
	5ª	133,13	49,92	27,51	N.D.	N.D.	0,18	N.D.	N.D.	N.D.	N.D.										
	6ª	74,95	31,48	19,22	N.D.	N.D.	0,24	N.D.	N.D.	N.D.	N.D.										
	7ª	132,30	45,49	26,11	N.D.	N.D.	0,15	N.D.	N.D.	N.D.	N.D.										

Nota 1. Límite establecido por medio de la Resolución SEAM 259/2015
Nota 2. No Existe límite en establecido en la Resolución SEAM 259/2015 para Compuestos Orgánicos Volatiles (COV). Asimismo, empleose el límite de exposición fijados por base horaria (TWA) por la "American Conference of Governmental Industrial Hygienists (ACGIH)" para Tolueno, el COV identificado en el análisis.
Nota 3. No existe límite para comparación fijados por la Resolución SEAM n 259/2015, para los parámetros TRS e H_2S. Asimismo, se empleo el límite de percepción del olor para H_2S presente en la FISPQ del producto.

PTS - Total Suspended Particles

Considering Resolution n. 259/2015, there is no limit for Total Suspended Particles (TSP), being therefore in charge of the environmental body the interpretation of the reported results.

Inhalable Particles (IP - PM_{10})

Considering the limit established by Resolution n. 259/2015, whose maximum permitted 24-hour concentration of Inhalable Particles (PM_{10}) is 150 µg/m^3, after comparing the results obtained in the two monitoring campaigns, it was confirmed that in the monitored period all data collections were below the limit established in the regulations.

Respirable Particles (PR - $PM_{2.5}$)

Considering the limit established in Resolution n. 259/2015, whose maximum concentration in the 24-hour period of Respirable Particles ($PM_{2.5}$) is 30 µg/m^3, after comparing the data obtained in the two monitoring campaigns, it was revealed that all the collections of Point 01, and one collection of Point 02, presented concentrations above the regulations. It is possible that this is material associated with re-suspension of particulate matter from unpaved roads and emissions from vehicles running on diesel fuel. Other data obtained showed concentrations below the limit established by the aforementioned resolution in the monitoring period.

According to GEOAVALIAR, the difference observed in the premises has its origin in circumstances around Point 01, in Concepción, Paraguay. That monitoring point has unpaved public roads and is largely diesel-fueled vehicles. Thus, the phenomenon of re-suspension of particulates and vehicle emissions contribute by the addition in the analyses performed, since Points 02 and 03 are located respectively in a small jurisdiction and rural area and show little or no influence on the events verified.

SO_2 - Sulfur Dioxide

Considering the limit established by Resolution n. 259/2015, and the maximum permitted 24-hour concentration of Sulfur Dioxide (SO_2) of 20 µg/m^3, after comparing the results obtained in the two monitoring campaigns, the concentration below the regulatory limit was verified, because it was not detected.

NO_2 - Nitrogen Dioxide

Considering the limit established by Resolution n. 259/2015, and the maximum permitted 1 (one) hour concentration of Nitrogen Dioxide (NO_2) of 200 µg/m^3, after comparing the data obtained in the two monitoring campaigns, it was verified that all data collected were presented below the limit, once the parameter was not detected.

O_3 - Tropospheric Ozone

It is verified that the data obtained in the two monitoring campaigns presented data below the limit established in Resolution n. 259/2015 whose average concentration of 8 (eight) hours is 120 µg/m^3.

CO – Carbon Monoxide

The results obtained in the two monitoring campaigns were below the limit established by Resolution n. 259/2015, whose 8 (eight) hour average concentration is 10 µg/ m^3.

H_2S - Total Reduced Sulfur and Hydrogen Sulfide

There is no reference to emission limits for these parameters in the technical literature. Therefore, the control body must establish a comparison between the data obtained and international environmental regulations.

According to Geoavaliar, in Point 03 of the first campaign, possible sources of hydrogen sulfide pollutant emissions through lagoons and water wells containing vegetation in the process of eutrophication and putrefaction were verified in the location near the monitoring equipment and devices. From that consideration it's possible to consider the emission of hydrogen sulfide originated from the Anaerobic Digestion process (process of conversion of organic matter in conditions of absence of oxygen), are employed inorganic electron acceptors such as NO_3 (reduction of Nitrate), SO_4 (reduction of Sulfate) or methane formation (CH_4). Anaerobic digestion can be considered as an ecosystem of different groups of microorganisms that are in interaction to convert complex organic matter into methane, carbon gas, water, hydrogen sulphide and ammonia gas, and other new bacterial cells. It should be noted that the results obtained are expressed in micrograms per cubic meter of air collected, and any source of contribution in the vicinity is capable of significantly altering the results.

In the second campaign, it was observed that the contaminants Hydrogen Sulfide and Total Reduced Sulfur are below the odour perception limit for H_2S by the IFCS (6.55 $\mu g/m^3$).

VOCs - Volatile Organic Compounds

The results obtained are significantly below the American Conference of Governmental Industrial Hygienists (ACGIH) average daily value for toluene exposure of 20 ppm. The comparative value was adopted since Resolution n. 259/2015 does not state a standard for that contaminant.

9.4 Noise

This item presents the results of the Environmental Noise Monitoring Report for the area surrounding the PARACEL pulp mill in Concepción - Paraguay, and aims to verify the environmental sound pressure level present in the area, prior to the implementation and operation of the plant (background levels).

The research work (in the field) to measure environmental sound pressure levels was carried out by the Pöyry team on October 24th and 25th, 2019.

Environmental sound pressure levels were measured at 05 different points in the day and night period, covering 10 measurements. The values obtained were compared with the limits established by the Law for the Prevention of Noise Pollution (Law n. 1,100/97).

The complete report is presented in **ANNEX I** of this document.

9.4.1 Relevant Law

Law n. 1,100/1997 aims to prevent noise pollution on public roads, squares, parks, sidewalks, exhibition halls, meeting centers, sports and social clubs and in all public and private activities that produce noise pollution in Paraguay.

Article 9th of the aforementioned law establishes the noise limits, according to the type of environment, as shown in the table below.

Table 3 – Noise limits established by Law 1100/97 (in decibel "A" dB (A))

Environment	Night (20:00 – 07:00)	Day (07:00 – 20:00)	Day (Occasional peak) (07:00 – 12:00 / 14:00 – 19:00)
Residential areas, specific use, public spaces: recreation areas, parks, squares and public roads	45	60	80
Hybrid areas, transition areas, city center areas, specific programs, service areas and public buildings	55	70	85
Industrial area	60	75	90

The article 9th states:

- Occasional Peaks: discontinuous noises and sounds that exceed the permitted levels and occasionally occur during the day, with a maximum of twenty peaks per hour. This noise and sound level will only be permitted at the following times: from 7:00 to 12:00 and from 14:00 to 19:00;
- The residential, mixed and industrial areas are those that will be defined in the regulatory plan of each Municipality with their characteristics and established activities.

The noise level guidelines, according to the World Bank Group General EHS Guidelines is shown in the table below.

Table 4 – Noise limits established by World Bank Group General EHS Guidelines

Receptor	Daytime (07:00 – 22:00)	Nighttime (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

9.4.2 Locations of point analysis

To define the measurement points, the area around the PARACEL pulp mill was considered, prior to implementation and operation (background).

A total of 05 (five) different points were defined for the measurement of the sound pressure level in the environment, in the daytime and nighttime periods, totaling 10 measurements, as described in the following table.

Table 5 – Points of analysis for environmental noise pressure.

Point	Place	Coordinates	
		Latitud	Longitud
NO01	Cerrito	23°15'4.62"S	57°29'36.53"O
NO02	Horno Carbón	23°13'31.85"S	57°29'33.20"O
NO03	Policía Laguna	23°12'4.55"S	57°27'20.60"O
NO04	Pyrendá	23°14'23.26"S	57°26'19.28"O
NO05	San Miguel	23°16'27.03"S	57°27'25.65"O

The following figure shows the map with the location of the 05 measurement points, while the other figures show images of each measurement point.

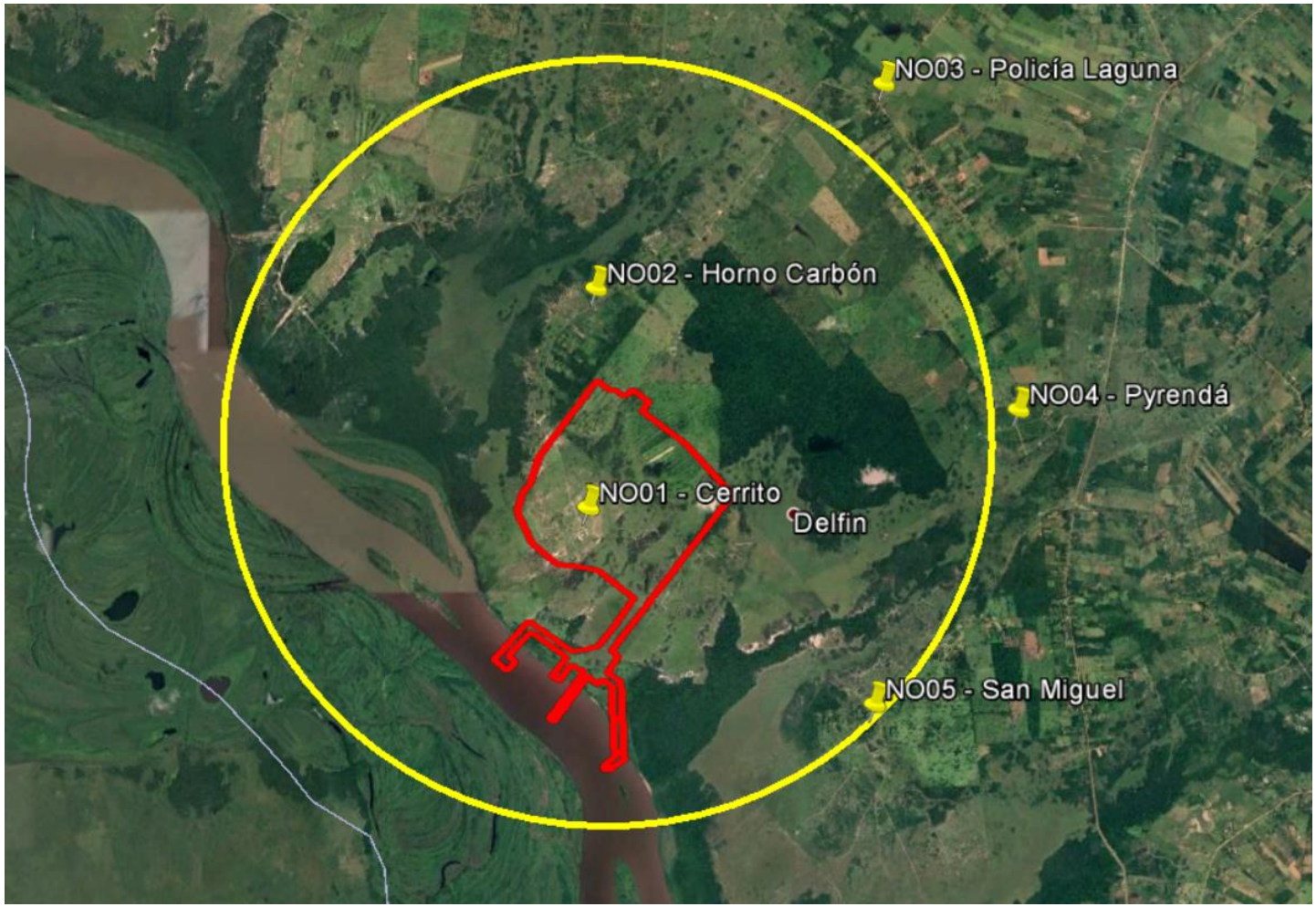


Figure 31 – Map of the location of the 5 ambient sound pressure level measurement points. Source: altered from Google Earth (2021)

Figure 32 – Point NO01 (23°15'4.62"S; 57°29'36.53"O). Source: Pöyry Tecnologia (2019)

Figure 33 – Point NO02 (23°13'31.85"S; 57°29'33.20"O). Source: Pöyry Tecnologia (2019)

Figure 34 – Point NO03 (23°12'4.55"S; 57°27'20.60"O). Source: Pöyry Tecnologia (2019)

Figure 35 – Point NO04 (23°14'23.26"S; 57°26'19.28"O). Source: Pöyry Tecnologia (2019)

Figure 36 – Point NO05 (23°16'27.03"S; 57°27'25.65"O). Source: Pöyry Tecnologia (2019)

9.4.3 Methods

The measurement methodology was based on the instructions of NBR 10.151/2019 (from Brazil). The evaluation method consisted in measuring the equivalent sound pressure level (LAeq) in A-weighted decibels, commonly called dB(A), as recommended in chapter 1.3 of NBR 10.151/2019.

The measurements had been performed at points located about 1.2 meters from the ground and at least 2.0 meters from the property boundary and from any other reflective surface, such as walls, barriers, etc.

The time for measuring the ambient sound pressure level was 3 minutes for each point sampled. During the measurements, wind protection from the microphone was used.

The evaluation of the sound pressure was made in the 2 periods recommended by NBR 10.151/2019, that is, day and night periods.

9.4.4 Equipment

The characteristics of the sound level meter and acoustic calibrator used in this monitoring are presented below. The certificates are presented in VOLUME IV - Noise Monitoring Report.

Characteristics of the sound level meter device

- Model: Decibelimeter DT-8852
- Norm of Reference: IEC 61672-1 Class 2
- Precision: ± 1,4 dB
- Frequency Ray: 31.5 Hz ~ 8 KHz
- Dynamic scale: 50 dB
- Memory data: 32.700 data
- Scale levels:
    - Lo (low): 30 dB ~ 80 dB
    - Med (medium): 50d B ~ 100 dB
    - Hi (high): 80 dB ~ 130 dB
    - Auto: 30 dB ~ 130 dB
- Frequency shift: A/C
- Time shift: “fast” (125 ms) and “slow” (1s)
- Microphone: 1/2 inch with eletrical capacitor
- Resolution: 0,1dB
- Serial number: 150622900
- Calibration certificate n. 3547
- Calibration date: 08/03/2018

Characteristics of the acustic calibrator

- Model: Calibrator SC-05
- Norm of Reference: IEC 60942 Class 2
- Noise pressure levels outlet: 94 dB e 114 dB
- Frequency outlet: 1.000 Hz ± 4%
- Precision: ± 0,5 dB
- Serial number: 150621430
- Calibration certificate n. 3885
- Calibration date: 07/03/2018

9.4.5 Results and Conslusions

The results of the sound pressure level measurements at the 05 measurement points and the comparison with the limits defined by Law n. 1,100/97 are presented below.

The location of the PARACEL pulp mill has no defined zoning. Therefore, the comparison of the results will be made within the limits of the Mixed Areas and Industrial Areas stated by Law n. 1,100/97; and World Bank Group General EHS Guidelines references.

Table 6 – Results of environment sound pressure level measurements

Point	Distance from the pul mill (km)	Period	Time	Law n. 1,100/97 (legal standards)		World Bank Group General EHS Guidelines		Results LAeq (dB(A))
				Mixed area	Industrial area	Residential; institutional; educational	Industrial; commercial	
NO01 - Cerrito	0,0	Day	12:11	70	75	55	70	43,1
		Night	20:36	55	60	45	70	35,0
NO02 - Horno Carbón	1,0	Day	10:58	70	75	55	70	50,7
		Night	21:00	55	60	45	70	38,8
NO03 - Policía Laguna	4,9	Day	10:38	70	75	55	70	43,1
		Night	21:20	55	60	45	70	50,2
NO04 - Pyrendá	4,1	Day	10:16	70	75	55	70	34,5
		Night	21:48	55	60	45	70	35,9
NO05 - San Miguel	3,2	Day	09:50	70	75	55	70	43,5
		Night	19:35	55	60	45	70	46,9

The results of the environmental sound pressure level measurement in the area near the PARACEL pulp mill were between 34.5 dB(A) and 50.7 dB(A) during the daytime period; and between 35.0 dB(A) and 50.2 dB(A) during the nighttime period. These results are below the limits of the mixed and industrial areas, defined in Law n. 1,100/97.

The measurement points are located in houses up to 4.9 km away from the site where the PARACEL pulp mill will be located. In this campaign, which was intended to define the background of the area, the highest results, in the day and night periods, originated from the sounds emitted by animals, birds and the movement of people and vehicles.

9.5 Geology

From a geological point of view, Paraguay is located on two different formations: the Brazilian shield and the Andean Depression, which largely correspond to the regions already mentioned. The eastern region is more diverse in its origin, with formations originating in the Mesozoic, Paleozoic and even the Agnostozoic, one of the oldest formations, while the whole of the Chaco territory, with few exceptions, corresponds to

Tertiary layers, with relatively recent geological ages between two and 65 million years (DBEnvironnement, 1999).

The following figure presents a synthesis of the geology of Paraguay and the stratigraphic column of the geology of Paraguay. The regional geological characterization and the areas of influence of the PARACEL pulp mill are presented below, with data from the website of the Vice-Ministry of Mines and Energy.

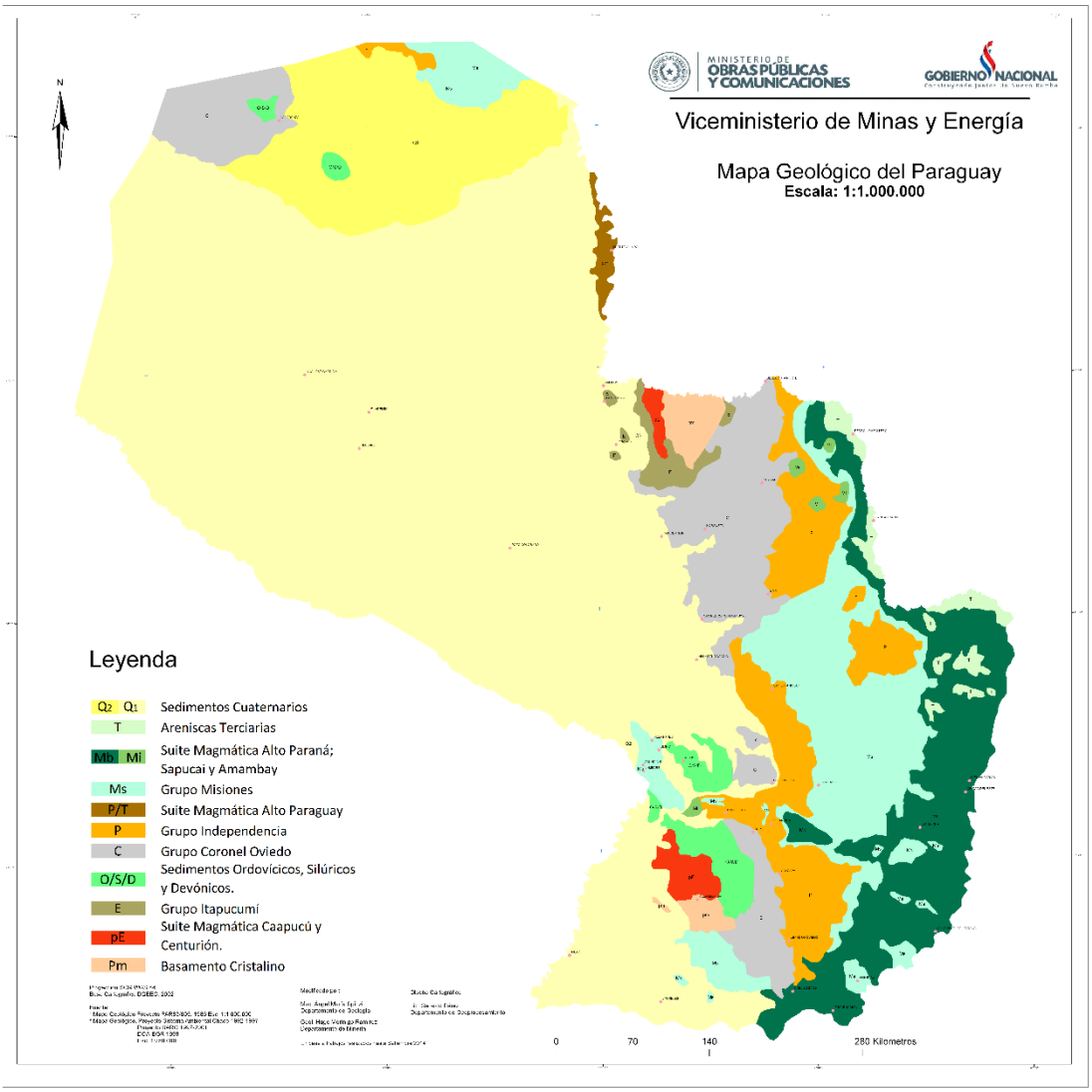


Figure 37 – Synthesis of the Geology of Paraguay. Source: González, 2000

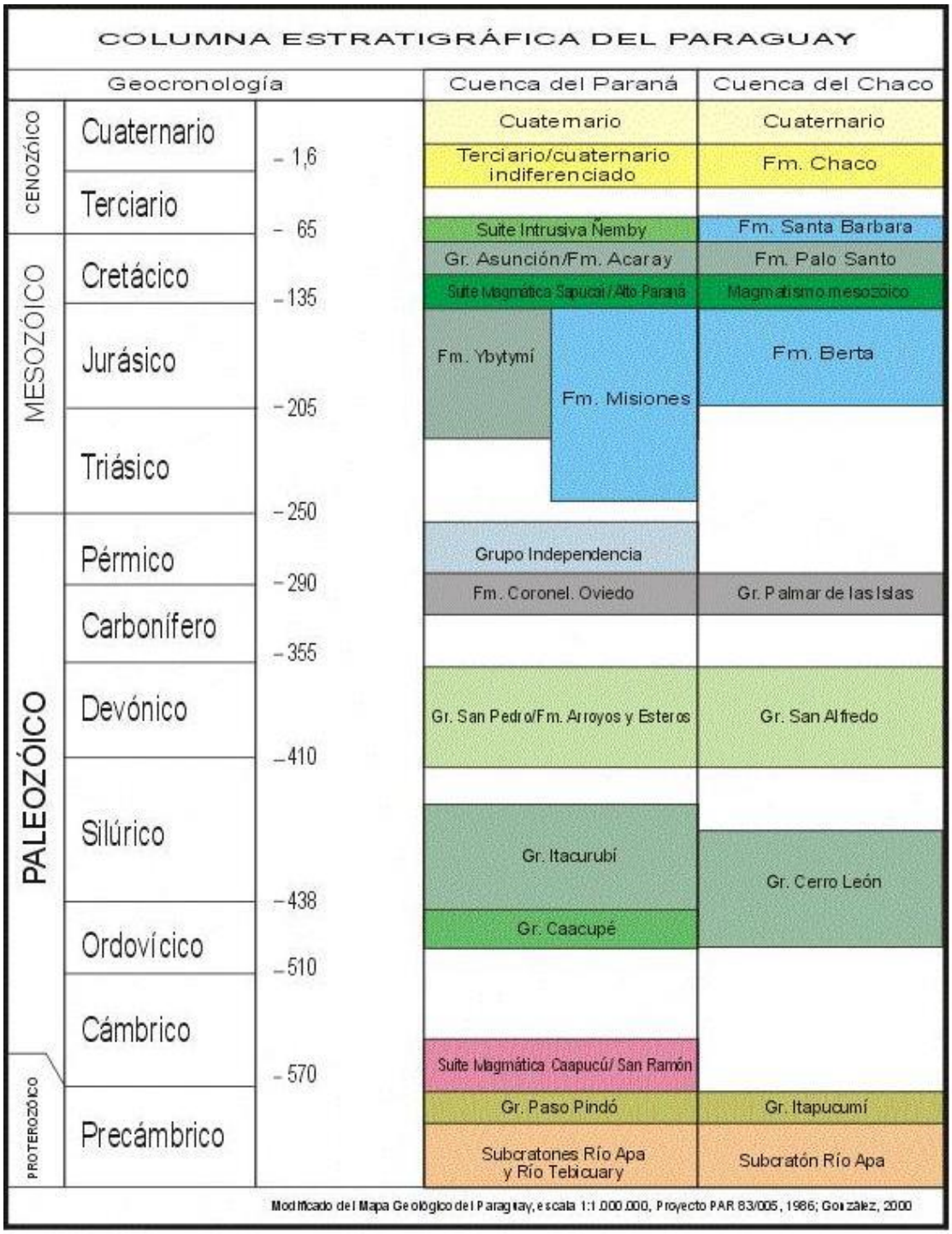


Figure 38 – Tectonic-Stratigraphic Column of Paraguay. Source: González, 2000

9.5.1 Regional Characterization (IIA)

9.5.1.1 Chratonical Provinces

The Chrathonic Provinces of Paraguay are located mainly in the Eastern Region and occur in two distinct areas. One to the north in the border area with Brazil, called the Province of Rio Apa and the other, the Province of Rio Tebicuary in the Central-South.

Both provinces are formed by chronic blocks that include the oldest units with Paleoproterozoic ages, Meso Proterozoic Folded Belts and Neoproterozoic-Eocambrian platform units.

The Apa River Block is made up of the homonymous complex and is represented mainly by gneiss, mafic and leukocratic, granite-gneiss, metasediments and granitic-pegmatic intrusives of Lower to Middle Proterozoic age and the Centurion Magmatic Suit corresponding to thick granite-type plutonic-volcanic rocks, sometimes porphyritic and acidic to intermediate pyroclastic metavolcanic rocks, of Middle Proterozoic age (K/Ar 1,650 ± 63 Ma).

The Apa River Complex is disproportionately covered by carstic metasedimentites of the San Luis Group, in its western portion, while in the eastern part it is superimposed by carbonate-classic rocks of the Itapucumi Group of Vendian age. Both units, in turn, are intruded by plutonic igneous and intermediate acidic volcanic rocks called San Ramon Magmatic Suites. This last magmatism is considered a non-detectonic event of the Brasiliano Cycle.

The Province of Rio Apa is mainly a producer of limestone, calcite, dolomitic and marble. It also presents anomalies of metallic minerals such as Ag-Pb-Zn and tin; in addition, there are quartz veins, pegmatites carrying large sheets of muscovite and other pegmatites carrying tourmaline and beryl.

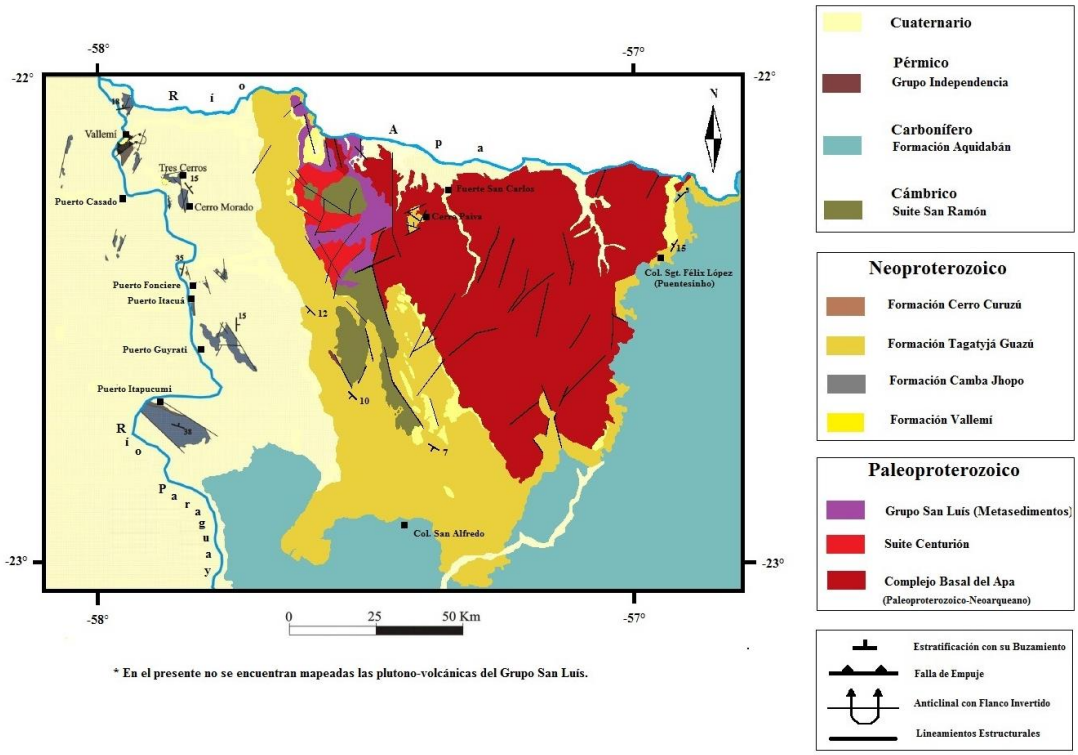


Figure 39 – Craton of Apa river. Source: website Geología del Paraguay

The Rio Tebicuary Block located southeast of Asuncion is represented by three lithostratigraphic units: Rio Tebicuary Complex, Paso Pindó Group and the Caapucu Magmatic Suite.

The Tebicuary River Complex includes two units: the Villa Florida Metamorphic Suite and the Centu-Cué Granodiorite. The first one gathers a set of crystalline rocks affected by regional metamorphism of medium to high degree, within the amphibolite and

granulite facies, of Lower Proterozoic age, Transamazonian Cycle (2,000 ± 200 Ma). Lithologically, this unit is constituted by paragneis and orthogneis, associated with quartzite, chalcosilicate, marble, amphibolite and ultrabasic rocks, transformed into talc shale and serpentinite. On the other hand, the second unit is represented by intruded porphyritic acid rock in the gneisses. This last event evidences intense deformations during the synthetodetectonic phase of the Trans-Amazonian Cycle, generating folding, migmatization and fracturing.

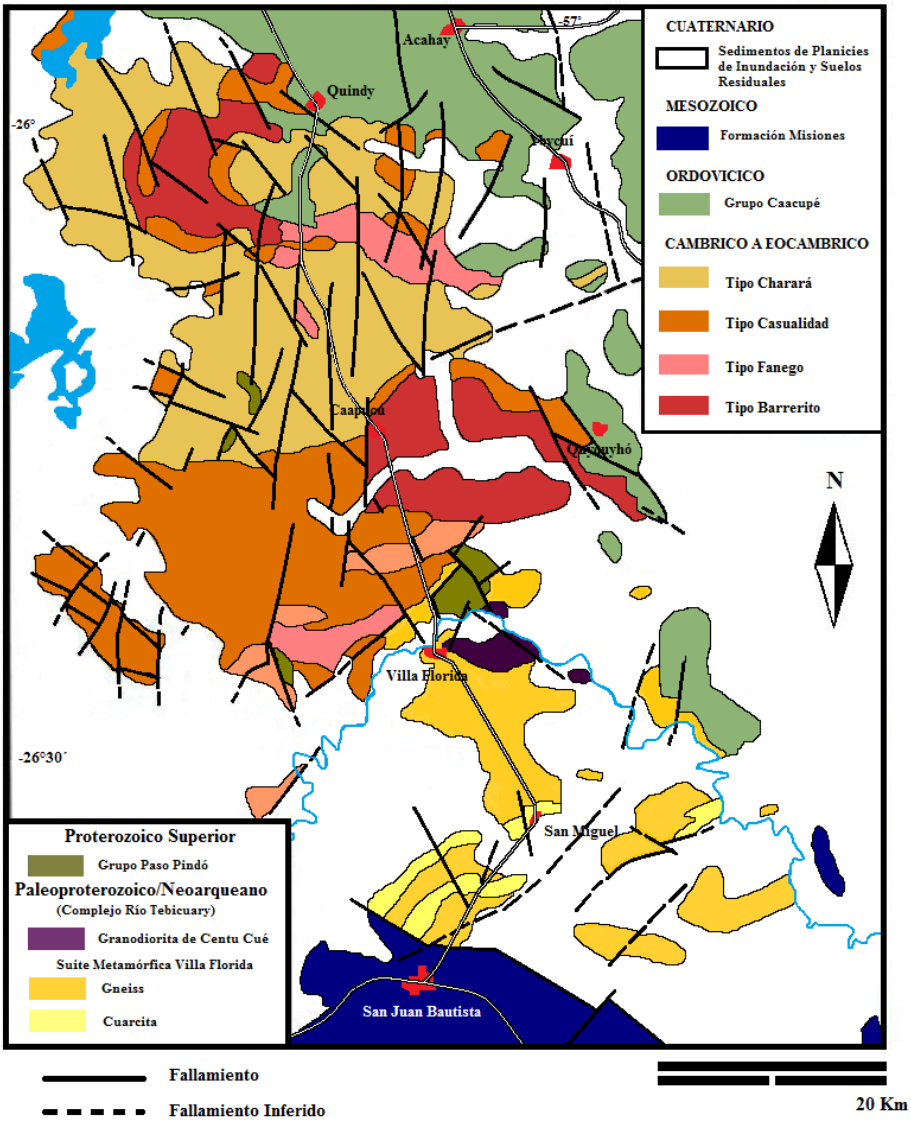


Figure 40 – Craton of Tebicuary river. Source: website Geología del Paraguay

The Paso Pindó Group takes a divergent position on the Tebicuary River Complex. This unit, made up of silica sediments and volcanic-clastic sediments, has been affected by a low grade metamorphism (easy from green shales), during the Brasiliano Cycle, in the Upper Proterozoic (± 600Ma).

The Caapucu Magmatic Suite intrudes in the post-tectonic phase of the Brasiliano Cycle to the Tebicuary River Complex and the Paso Pindó Group. This acidic magmatic event is constituted by rocks with several emplacement levels (plutonic, hypoabyssal and

effusive), mainly from coarse to porphyritic granites, granite/rhyolite porphyry and rhyolite, of Rb/Sr 531 ± 5 age (Cubas et al. 1997).

Small isolated occurrences of granitic rocks in the Caapucu Magmatic Suite, occur in the center of the Eastern Region, associated with the structuring of the Asuncion Rift.

With regard to tectonics, the Tebicuary River Block can be divided into two main events: the Trans-Amazonian Cycle (Tebicuary River Complex) and the Brazilian Cycle (Paso Pindó Group and Caapucú Magmatic Suite).

9.5.1.2 Phanerozoic Basin

The Phanerozoic in Paraguay is represented by two large basins: Chaco Basin and Parana Basin. In them, sedimentary sequences of ages: Ordovisic/silurian constitute the deposition base, in the marginal zone of the Paleo-Pacific Plate, before the subduction with the Gondwana continent.

9.5.1.2.1 Paraná Basin

The Paraná River Basin covers a vast area of the South American continent, approximately 1,500,000 km^2, occupying parts of southern Brazil, northeastern Argentina, eastern Paraguay and northern Uruguay. With its major axis oriented in the NNE-SSW direction and its structural depocenter located along the Paraná River, with a record of sedimentary and volcanic rocks, whose total thickness exceeds 7,000 meters.

In Eastern Paraguay, six wide-scale sedimentary sequences or super sequences are recognized, separated from each other by regionally discordant surfaces (MILANI, 1997).

The first super sequence of Ordovician/Silurian age is found in discordant contact on the crystalline basement, observed east of Asunción, in the Acahay Valley and bordering the northeast of the Tebicuary River Block. This is a group of sedimentary rocks deposited in a continental environment that is morphologically abrupt, in lateral contact with a transgressive sea, which reaches the maximum flooding in the Lower Silurian. In its coastal environment it deposits conglomerates, interspersed with conglomerate sandstones, which gradually turn into sandstones, forming a group of thick clastic rocks called the Caacupé Group. Concurrently, the sequence continues with clastic rocks of the Itacurubi Group, mainly made up of fine sandstones, shales and claystones, highly fossiliferous, constituting the geochronological supports of the sequence, with the inferior Silurian llandover age.

Devonian-age rocks are arranged in discordance with the previous one, in continental and marine deposits. Rocks of marine origin were not directly observed in the field, being identified only in the Asunción 1 and 2 exploratory wells (PECTEN, 1982), in which about 450 meters of these sediments were described. Those of continental origin rest in erosive discordance on the Silurian fossiliferous units. These have been first identified in wells and called Santa Elena Formation (GONZÁLEZ ET AL., 1994), later geological mapping works defined coarse sandstones as belonging to this unit, calling them Arroyos and Esteros Formation (DIONISI, 1999).

The deposition of the Devonian sequence is interrupted by continental readjustment tectonism (Eoherceric Orogenia). This event is responsible for the restructuring of the basin in the Lower Carboniferous, with sedimentation resuming from the Upper Carboniferous (Stephaniano), as the third Carboniferous/Permian super sequence. It is

environmentally influenced by very varied climatic conditions, beginning under glacial and periglacial dominance, depositing the Aquidaban and Coronel Oviedo formations, as a succession of continental and marine clastic sediments. The Permian deposits, in regional agreement, sediments of continental wind and fluvial, coastal and marine environments, which in a lithologic point of view are characterized by sandstones, siltstones, claystones and limestones, which agglutinate in the Independencia Group.

The continentalization of the Paraná Basin from the Upper Permian, in the Triassic, deposited continental fluvial and eolian sandstones, called Misiones Formation. This group is distributed in a north-south strip, deposited in discordance on carboniferous/Permian rocks.

The Misiones Formation windsand sandstones are characteristically quartz sandstone, homogeneous, with little clayey material as a matrix, little cemented, friable, saccharine and locally silicified. Overlying and interspersed with the aeolian sandstones there are intrusions and extrusions of basaltic rocks of the Upper Parana Magmatic Suite. These are presented as lava spills, sills and dikes in sediments of the pre-existing units, in preferential northwest-southeast directions. Petrographically the basaltic rocks show a subophytic texture, joint crystallization of pyroxene and plagioclase, of age between 127 and 108 million years. The upper divergent contact of the suite is deposited sandstones of the Acaray Formation and/or quaternary sediments.

9.5.1.2.2 Del Chaco Basin

The Chaco Basin is bounded on the west by the Andes Mountains and on the east and northeast by the Brazilian shield; it occupies an area of 246,725 km^2, in the Western Region of Paraguay. It is a pericratonic basin, formed by several depocenters or sub-basins separated by structural highs, each one of them with a unique tectonic-sedimentary record. To the NW the Curupayty and Carandayty sub-basins are accommodated, both representing areas with well-developed Paleozoic sequences. On the other hand, Mesozoic-Cenozoic subsidence areas occur mainly in the Pirity and Pilar sub-basins. The tectonic style of the Chaco Basin is characterized by the presence of NW and NE structural guidelines of Brazilian age. Later reactivations of these structures, during the Paleozoic, result in the characterization of four subsidence cycles: Lower Paleozoic, Upper Paleozoic, Upper Mesozoic and Cenozoic. The phases are separated by erosive discordances or absence of sedimentation.

The sedimentary cycle of the Lower Paleozoic is represented by continental and marine clastic deposits of Ordovician, Silurian and Devonian ages. The Ordovician-age sediments (Cerro León Group) are preserved in depth in the Carandayty sub-basin. In contrast, occurrences of sedimentary rocks attributed to the Silurian and Devonian are presented in the northwestern portion, associated with high structures (Cerro León and San Alfredo Range).

The sedimentary cycle of the Upper Paleozoic, carboniferous/permian sequence, constitutes the Group “Palmar de las Islas”, mainly composed of deposits in the Carandayty and Curupayty sub-basins, as well as some outcrops in the northern portion of the Chaco, associated with the Alto de Lagerenza. The Carboniferous age sediments are composed of two units, a lower one or San José Formation, made up of sandstones combined with claystones, sticks and diamictites. The upper unit or Cabrera Formation, starts with local conglomerates and mainly sandstones, with higher levels of clay and oolitic limestone.

The Mesozoic/Cenozoic unit, called the Adria Jara formation, is composed of sandstones with conglomerate levels and claystone, found mainly in the Curupayty sub-basin, in erosive discordance on carboniferous sediments.

On the other hand, the Mesozoic-Cenozoic sediments in the Pirity sub-basin comprise three formations: Berta, Palo Santo and Santa Barbara. The first is made up of sandstones interspersed with claystone, the second is made up of intercalations of conglomerate sandstones, sandstones, claystones, marls and evaporites; finally, the Santa Bárbara Formation consists of sandstones, siltstones, claystones, evaporites and calcareous.

In the Pirity sub-basin there are magmatic rocks of basaltic composition of Lower Cretaceous age (128 ±5 Ma).

During the Lower to Middle Eocene, between 500 and 1,000 meters of continental sediments were deposited in several depots of the Chaco Basin, in marine parts, called Chaco Formation. In general, this formation consists of alternating sandstones, silts and claystones.

The Quaternary period in the Chaco Basin is a continuity of the Chaco Formation sedimentation, with heterogeneous continental deposits.

9.5.1.3 Alkaline Magmatism

The alkaline rocks of Paraguay occur in various parts of Eastern Paraguay distributed in six provinces: Alto Paraguay, Rio Apa, Amambay, Central, Asuncion and Misiones, these rocks are tectonically associated with extensional structures (continental rifts, intersection of structural lines and lines in areas of chronic margins), which affected the western portion of the Parana Basin in the Mesozoic. The alkaline provinces of Paraguay differ from each other in their petrographic, chemical, geochronological and tectonic characteristics.

The petrographic composition of these rocks presents great variation, with greater predominance of alkaline silica rocks, unlike carbonatite rocks which are restricted to only one province (Amambay Province). Chemically, the silicatic lithologies vary from ultrabasic to acidic and in general represent differentiated petrographic terms. As for the Na/K ratio they can be differentiated in sodium alkaline provinces and potassium alkaline provinces.

Evidence from geology and geophysics indicates that the conditions of alkaline rocks in Paraguay are strongly controlled by a distensional tectonics developed during the Mesozoic, related to the fragmentation of the Gondwana and opening of the South Atlantic

In terms of geochronology, these rocks cover a wide age spectrum extending from 255 million years to 39 million years.

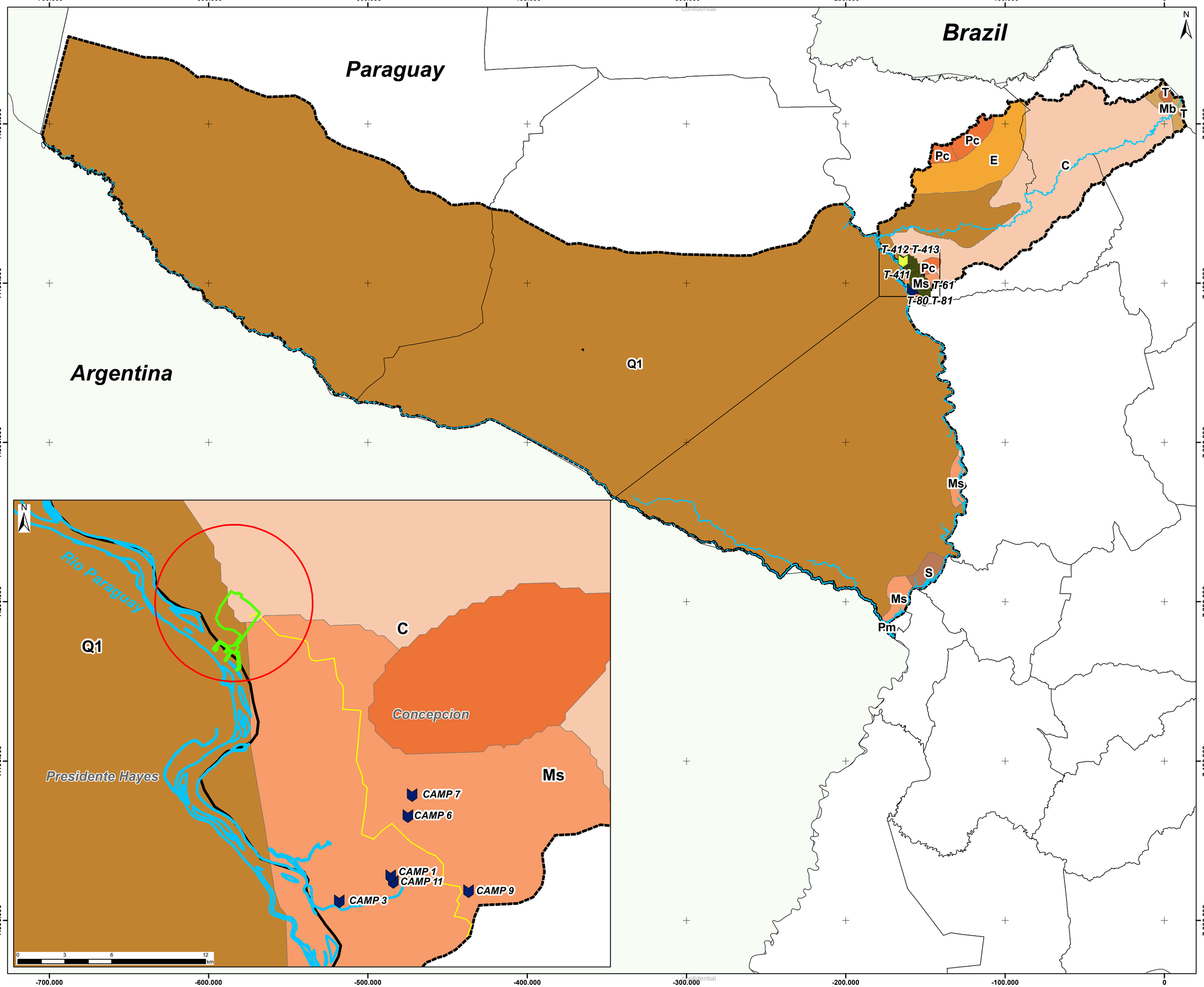
In general, alkaline rocks are associated with Paleozoic-Mesozoic sediments and are covered by recent alluvial deposits.

The mode of occurrence is also quite diversified and varies from province to province. The intrusive forms appear as annular complexes (Alkaline-Carbonate Complex) and stocks. The extrusive forms include lavas, domes and plug and the hypoabyssal forms generally in the form of embankments or swarms of embankments.

9.5.2 Local Characterization (DIA)

The PARACEL pulp mill is inserted in 3 different groups, which are C - Coronel Oviedo, Q1 - Quaternary Sediments and Ms - Missions Group, as shown in the map below.

Figure 41 – Geology map of the influence areas



LOCATION MAP

LEGEND

- Structures - Transmission Line
- Accommodations (Camps)
- Hydrography
- DAA - Directly Affected Area
- IIA - Indirect Influence Area
- DIA - Direct Influence Area
- CIH Rio Pilcomayo and Aquidaban

Geology

- C - Coronel Oviedo Group
- E - Itapucumi Group
- T - Sandstones
- Mb - Alto do Paraná Magmatic Suite
- Pm - Crystaline Basement
- Q1 - Quarternary Sediments
- S - Ordovician, Silurian and Devonian sediments
- Ms - Missiones Group
- Pc - Suite Magmatic Caapucú and Centurión
- Departaments
- South America

ESCALA GRAFICA: 0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

DATA SOURCE:
- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).
- USGS, 2020.
- Viceministerio de Minas y Energia, 2002.

PARACEL PÖYRY

ENVIRONMENTAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

GEOLOGY

ESCALA: 1:1.500.000		FECHA: 28/05/2021	
PROYECTO N°	FOLHA:	FORMATO:	
RESP. TECNICO: Romualdo Hirata	FIRMA:		REV. 0

9.5.2.1 C – Coronel Oviedo Group (Independencia Group)

The group is made up of the San Miguel and Tacuary formations, of Permian age, which emerge in Eastern Paraguay in an area of 7,996 km^2. The name Independencia Serie was used by Harrington (1980), to designate the sedimentary layers of the upper Permian. In 1956, the same author designated the same unit of the Independencia Formation, (ECKEL, 1959) he again used the denomination Independencia Series in a Gondwana or Santa Catarina system. Putzer (1962) called the Permian age layers the Passa Dois Serie.

In the description of the geology of grid 41, Coronel Oviedo (ANONYMOUS, 1966), the lower and middle Permian-age layers are called the Ybytyruzú Series, divided into the Pañetey and Independencia Formations. Wiens (1982) proposes for the Permian the division into San Miguel, Tacuary, Tapytá and Cabacuá formations. In the preliminary adaptation of the stratigraphic column of Paraguay, for the PAR-83/005 Project, these formations were gathered in the Independencia Group. In this explanatory text the Independencia Group is divided into the San Miguel and Tacuary formations with the elimination of the Tapytá and Cabacuá formations which, in reality, belong to the base of the Triassic/Jurassic age unit.

The group emerges maintaining the direction of the so-called Gondwanic layers, N-S/NNW-SSE, with dipping towards the E, in areas that are frequently faulty. North of the Jejuí/Aguaray Guazú Fault zone, in the Alto Apa, the Group is absent due to erosion in the Lower Triassic. The formations of the group are correlated with the units of the groups Guatá and Passa Dois, in the Paraná Basin, in Brazil.

9.5.2.2 Q1 – Quaternary Sediments - San Antonio formation

The accumulated sediments are grouped here, near the area of the Paraguay River and its tributaries, which are at a lower elevation of 70 meters, in the eastern region of the country. It covers an area of 60,782 km^2. It is made up of a light creamy sandstone, of medium to coarse granulation with scattered gravel, interspersed with shales. The sandstones, in contact with these shales, present clay clasts. There are also layers of clayey sandstones up to 1.5 metres thick. The sedimentation environment is essentially water-based (fluvial).

In Candú Creek, on the property of Señor Virgilio Larrea, there are vertebrate fossils that were described by Presser and Crosa (1984). These fossils found in the described place, in the locality of Ytororó, are contained in a sedimentary succession described by the mentioned authors as:

- Blue-green sediments, with good selection, predominance of medium-grained sands, apparently solid, associated with clay sheets;
- Poorly selected sediments with a predominance of medium to thick sand and secondary layers of clay. They present levels with fossils in contact with the previous sequence and;
- Spotted sediments, with good selection, with medium grain sands and subordinate fine sands and clay. Apparently massive.

According to the same authors, the fossils found are typical of a Pleistocene fauna and present three species of Glyptodonts, two of Lestodontes and one of Megatherion associated with other vertebrates not clearly systematized.

The name San Antonio formation is formally proposed for the lithostratigraphic designation of these sediments, based on a proposal by Palmieri and Velazquez (1982). In the valleys of the current drainage network of Eastern Paraguay, from the Apa River in the north to the Paraná River in the south and east, and the Paraguay River in the west, there is an extensive deposition of Holocene age sediments.

9.5.2.3 Ms – Missiones Group

The sediments of the Misiones Fm. have emerged in Eastern Paraguay according to the same structural direction of the previous Gondwanic units. It covers an area of approximately 35,000 km^2. The basal contact is by erosion discordance with the Carboniferous and Permian units.

The Misiones Fm. represents the diverse sub-environments of a great climatic desert of increasing aridity, whose existence was prolonged until the basaltic volcanism of the Trapp of the Paraná.

The winds that moved the desert dunes came from the north to the northeast of the source.

The Misiones Fm. is characterized by red sandstones of Mesozoic age, in which ancient units edge with a very subtle erosive disconformity, not recognizable at the surface level.

To the north of the Jejuí/Aguaray Guazú fault, the lower contact is over sediments of the Aquidabán Fm. (Permian-Carboniferous) and to the south of this structural element, with the Permian Tacuary Fm. The roof of the formation, throughout the country, is covered in erosive discordance by the basalts of the Upper Parana formation (Jurassic-Cretaceous).

In the geological map this formation is represented by a discontinuous strip of protrusions where the North (Pedro Juan Caballero), to the South, in the region of San Juan Bautista. It also appears inside the basaltic "plateau", as in the area adjacent to the Paraná River, between Encarnación and Trinidad (Route 6). The formation has two sedimentary layers, one of fluvial origin and the other, predominantly of wind origin. The sedimentary layer in the river environment occupies preferably a basal part of the formation, but it can also be found in the sandy sediments of wind origin. This basal layer (facies) is made up of essentially solid sandstones, locally with crossed stratification, fine to medium grain and interspersed clayey layers. There are also conglomerate levels or breccias with clay clasts, siltstone and shales, with a small lateral continuity of the sandy bodies.

The basal part thus represents a facies of alluvial plains associated with a river environment. This section of the formation was divided by Wiens (1982), into two formations, called Tapyta and Cabacuá, with about 325 meters thick and its definition was made based on in-depth descriptions. In the Paraná Basin, a fluvial depositional phase associated with the base of the Misiones Formation has been known for a long time. Sometimes this basal fluvial phase is separated into a specific formation, as in Brazil, the Pirambóia Formation. At regional level this separation in mapping becomes difficult to demonstrate. Taking into account a good aquifer and the maps distinguishing the two formations, it is concluded to erroneous interpretations. More detailed studies, especially in groundwater prospecting, show that the two units, river and wind, are interdigitated.

The wind part is characterized by a remarkable bi-modality in the granulometric distinction in blades of a few millimeters. They present larger cross stratifications with crossed "sets" starting with grains of 500-700µ and ending with 177-250µ. In the region of Colonia Independencia, in the locality called Salto Boni, you can observe sandstones with bimodal granulation (350-500µ and 500-710µ) with wide sets of crossed stratification, with more than 4 meters long by 1.5 meters high. The sandstone is strongly silicified and has an intrusive saddle at the bottom. The slope of the strata is between 10 and 20° and the face of the escarpment is exposed to about 25 meters in height. Under the intrusive body, the sandstones show sets of crossed strata over 12 meters long and up to 3 meters high.

The Misiones formation is transgressive over all other sedimentary units in the basin, including the Crystalline Basement. This transgressive is due to extensive tectonic movements of a vertical nature, which devastated the basin at the end of the Permian or at the beginning of the Triassic, caused simultaneously by the fragmentation of the Pangaea and the uplift of the Paleozoic Andes (Permo-Triassic). The sedimentary environment, predominant for this formation (wind), is also an important factor in the transgressive character, especially because of the advance of the sand dunes over the paleo-topography.

Locally, it may present conglomerate layers at its base, made up of quartz and quartzite cobbles, as in the vicinity of San Juan Bautista, never exceeding 2 meters (GÓMEZ DUARTE, verbal information).

These layers can also run along the column next to more fluvial facies. The edges commonly show wind work, all of them being quite polished (result of wind erosion).

The Triassic age, proposed for the beginning of the sedimentation of this unit, is based on the contact of this formation with the lower unit, Tacuary Formation, well described in the literature on this matter, in the Paraná Basin. In the E margin of the Basin, the contact zone is characterized by a level of fossil regolith (fossil soil) indicating, in its conformation, an almost gradual passage towards different sedimentation conditions. Towards the interior of the basin, the passage is transitional. On the W margin of the basin, in Eastern Paraguay, the contact between the Tertiary Formations and Misiones can be observed on the Mbocayaty route and Colonia Independencia, 17 km from the first city, on the route and on a lateral road that starts in this place.

At this point, the base of this unit (Misiones formation), presents clayey sandstones with crossed stratification and clasts of shales from the Tacuary Formation, in the "foresets" of the crossed strata. The granulometry of the sandstones that carry the shale clasts is between 250-350 µ and between 500-710 µ for the sandstones with crossed stratifications of greater size. However, the area is very faulted these sandstones with shale clasts of the oldest unit constitute a basal breccia of the Misiones formation, well described in the fossil regolith level of the basin. As in Eastern Paraguay, the Misiones formation is crossed by alkaline intrusions from the Upper Jurassic, a Triassic - Jurassic age is admitted for this formation. In the front of the cliffs covered by the Alto Paraná formation (basalts), as in the Northern (area of Pedro Juan Caballero and Capitán Bado) and Central regions (area of the Cordillera and Ybytyruzú), the erosion that continues in the front of the cliff provides a great amount of sand grains of this formation, which is going to be deposited in the adjacent low area, making that an extensive sandy cover is formed, frequently confused, in mapping works, with the Misiones formation.

9.5.3 Geological characterization of DAA

In May 2020, the Paraguayan company GEOSTAN GEO-ENGINEERING carried out 25 surveys in the area of the PARACEL (DAA) pulp mill.

In general, studies at depths of 15 to 20 meters show a constant stratigraphy composed of layers of sand and sandstone in different degrees of alteration.

In the first 4 meters, the profile often presents a layer of silty sands in gray, yellow or brown, with low resistance and SPT (Standard Penetration Test) values between 6 and 11 meters.

In the sequence, new layers of silty clay sand are found, with significantly higher strengths ($16 \leq SPT \leq 72$) or, still, sandstone layers with thicknesses greater than 4 meters interposed to the main layer or continuous up to the drilling limit.

The water level was not reached in 20 of the 25 wells, up to the drilling limit. It should be noted that, in order to obtain more information on the water level, mechanized excavations will be carried out in the project area.

The following figures show the location of the drilling points and also a stratigraphic profile of one of the points (as an example) where it was possible to reach the water level (SM5).

Figure 42 – Location of drilling points

MIXED DRILLING

PROBE	NORTH COORDINATE	EAST COORDINATE	QUOTA
SM-01	7,430,267.0000	449,690.0000	95.00
SM-02	7,429,745.0000	449,649.0000	86.00
SM-03	7,429,695.0000	449,944.0000	86.00
SM-04	7,429,823.0000	450,221.0000	95.00
SM-05	7,429,198.0000	450,229.0000	82.00
SM-06	7,428,926.0000	450,651.0000	88.00
SM-07	7,427,414.0106	450,165.4044	0.00
SM-08	7,427,206.5208	448,911.2046	0.00
SM-09	7,426,678.9950	449,566.8453	0.00
SM-10	7,426,256.7747	449,880.3004	0.00

PERCUSSION DRILLING

PROBE	NORTH COORDINATE	EAST COORDINATE
SB-01	7,430,271.4821	449,693.6408
SB-02	7,429,500.0000	450,650.1083
SB-03	7,429,699.6898	449,946.9646
SB-04	7,429,827.8844	450,224.5607
SB-05	7,428,664.9626	450,260.9695
SB-06	7,428,930.5798	450,654.4998
SB-07	7,429,912.6732	450,500.0000
SB-08	7,428,676.4803	450,004.6518
SB-09	7,429,028.8564	449,534.9940
SB-10	7,428,594.1624	449,479.0414

SPT DRILLING

PROBE	NORTH COORDINATE	EAST COORDINATE
SPT-01	7,429,976.5233	449,956.0681
SPT-02	7,429,914.4936	450,035.3369
SPT-03	7,429,897.1334	449,881.0575
SPT-04	7,429,791.2037	450,018.3335
SPT-05	7,429,726.3521	450,279.7255
SPT-06	7,429,707.4752	450,128.5456
SPT-07	7,429,618.7451	450,046.0631
SPT-08	7,429,638.0471	450,234.7088
SPT-09	7,429,520.0924	450,149.0097
SPT-10	7,429,502.3819	450,263.8857
SPT-11	7,429,617.7804	449,882.5707
SPT-12	7,429,498.2133	450,024.0090
SPT-13	7,429,418.2143	450,173.2194
SPT-14	7,429,828.4763	449,667.5170
SPT-15	7,429,630.7433	449,669.7808
SPT-16	7,429,527.3918	449,833.2510
SPT-17	7,429,443.8227	449,850.2326
SPT-18	7,429,426.1520	449,927.6346
SPT-19	7,429,375.5356	450,000.9159
SPT-20	7,429,966.1148	450,500.0000
SPT-21	7,430,039.9813	449,973.4728
SPT-22	7,430,043.0534	449,852.1041
SPT-23	7,429,843.9923	449,944.8036
SPT-24	7,429,584.6382	450,193.5522
SPT-25	7,429,753.8889	449,786.8386
SPT-26	7,429,552.9091	449,946.4558
SPT-27	7,428,870.2486	450,732.4581
SPT-28	7,428,779.6525	450,844.3783
SPT-29 (NOTE 8)	7,428,690.2934	450,226.1047
SPT-30 (NOTE 8)	7,428,679.8600	450,000.0000
SPT-31 (NOTE 8)	7,428,420.9578	450,324.6052

WELLS

PROBE	NORTH COORDINATE	EAST COORDINATE	QUOTE
GW-01	7,430,729.0000	449,839.0000	100.00
GW-02	7,430,301.0000	450,165.0000	91.00
GW-04	7,428,109.0000	448,716.0000	74.00

MECHANIZED DRILLING

PROBE	NORTH COORDINATE	EAST COORDINATE
EM-01	7,430,271.4821	449,693.6408
EM-02	7,429,744.1802	449,648.9074
EM-03	7,429,699.6898	449,946.9646
EM-04	7,429,827.8844	450,224.5607
EM-05	7,429,198.3284	450,224.2436
EM-06	7,428,929.5672	450,655.0734
EM-07	7,429,966.1148	450,500.0000

REVISION TABLE

CODE:
PR -PRELIMINARY
PA -FOR APPROVAL
PI -FOR INFORMATION
PC -FOR QUOTATION
CO -FOR COMMENTS
LE -RELEASED FOR CONSTRUCTION
LD -RELEASE FOR DETAILING
CC -AS BUILT
CA -CANCELED

REV.	DATE	PROJ.	VERIF.	APPROV.	AUTHOR.	CODE	DESCRIPTION
0	10/06/20	fvy	leu	itf/brt	rmq	PI	FOR INFORMATION

NOTES

1. Dimensions, dimensions and coordinates in meters, except where indicated;
2. Coordinate System WGS84;
3. All services must be performed according to the Official Technical Standards of Paraguay and, failing that, according to ASTM standards.;
4. All the specifications and definitions contained in the document PARACEL N: 109001759-001-1000-F-0701 must be respected;
5. In percussion soundings, the rejection criteria defined in item 7.2, p. 5, of the ASTM D.2113-99 standard. Only after the rejection is reached, the rotary probes should be started;
6. With the 20 samples collected in the auger drilling, the following laboratory tests must be carried out:

- Grading with sedimentation;
- Atterberg limits (LL, LP);
- Grain Density;
- Moisture in situ of sample to be taken to the laboratory in an aluminum capsule;

Normal Proctor (5 points) and CBR (5 points) in laboratory compacted samples;

7. The mechanized excavation must reach a depth of 7.0m or until the water table has been found. All occurrences must be photographed and presented in a technical report. At the end of the day the excavation should be filled with the soil from your own excavation.
8. SPT-29, SPT-30 and SPT-31 polls should be done as first priority.

LEGEND

SP-01 — PERCURSSION DRILLING - SPT TYPE (REF.: ASTM D.1586-11)

SB-01 — SOUNDING DRILLING - 25cm IN DIAMETER AND 5.0m DEPTH WITH SAMPLE COLLECTION EACH 1.0m DEPTH

SM-01 — MIXED DRILLING - SPT FOLLOWED BY ROTATION (REF.: ASTM D.2113-99)

GW-01 — ENVIRONMENTAL MONITORING WELLS

EM-01 — MECHANIZED DRILLING (SEE NOTE 7))

PENDENCIES

CONSULTED DOCUMENTS

TITLE	NUMBER	REV.
Monitoring Well Surveys - GEOSTAN	2615	

REFERENCE DOCUMENTS

TITLE	NUMBER
General Mill Site Layout - Master Plan - General Layout	109001759-001-1000-M05-0001

DISTRIBUTION

TO	REVISION 0	a	b	c	d	e	f
PARACEL	E						
PÖYRY	E						

H- PRINT/PLOT (HARD COPY) E- ELECTRONIC FILE

PÖYRY

PARACEL
PARACEL PROJECT
LOCAL: ZAPATERO CUÉ - MUNICIPALIDAD DE CONCEPCIÓN

RESP./TITLE/CREA NUMBER | CUSTOMER NUMBER | REV.

TITLE
PARACEL PROJECT - BASIC ENGINEERING SERVICES
LOCATION OF DRILLING POINTS
MAP

SCALE	UNIT	PROJECTION	PÖYRY NUMBER	REV.
1:5000	m		109001759-001-1000-Z03-0005	0

0 500m 1000m

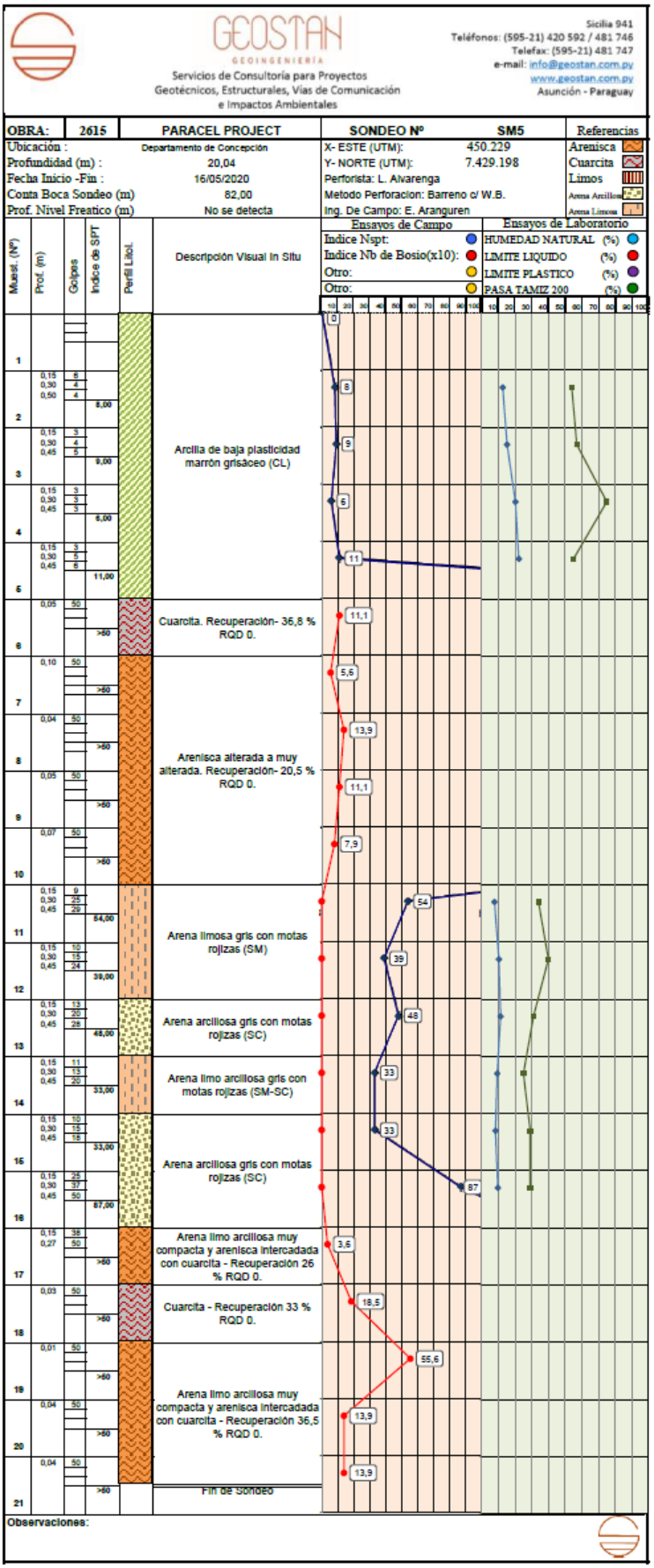


Figure 43 – Stratigraphic profile of the probe point SM05

9.6 Geomorphology (Relief and Orography)

The Paraguay River divides the country into two distinct regions: the Gran Chaco or Western Region in the west and the Jungle or Eastern Region in the east, which is considerably mountainous. The Gran Chaco is part - except for the western end - of an alluvial plain that extends from Paraguay to the bordering countries and is covered with grasslands, swamps and bushes. The jungle is formed mainly by the southern portion of the Paraná plateau, at an elevation of 305 to 610 m, which constitutes a basin where numerous tributaries of the Paraguay and Paraná rivers originate; and by the gentle mountain ranges that are part of the Brazilian system that penetrate this area, creating wild valleys.

To the west, the plain drops precipitously into a region of hills covered with fertile pastureland that ends at the Paraguay River. The main mountain system is made up of the Amambay, Mbaracayú and Caaguazú mountain ranges, which have altitudes that rarely exceed 800 meters. Another secondary mountain system, located in the center of the country, is formed by the Cordillera de los Altos, Ybytypanema and the so-called Cordillerita. Among the most outstanding peaks are the Tres Kandú (842 m), Capii (816 m) and Peró (815 m) mountains, all in the department of Guairá. Some authors consider, however, that Paraguayan territory is structured in three regions: the aforementioned Chaco and Selva regions, and the region known as Campo, which extends through the most depressed sector of the Paraguayan valley and the final stretch of the river courses that drain into it, that is, the central and southern area of the country.

The following is a geomorphological characterization of the influence areas of the PARACEL pulp mill.

9.6.1 Regional Characterization (IIA)

Most of the Eastern region has a slightly undulating topography, with an elevation that varies between 50 and 750 meters above sea level. Its major orographic systems are the Amambay, Mbaracayú, Ybytyrusú and Caaguazú mountain ranges. The highest point is Cerro Pero (Cerro Tres Kandu), with 842 meters, located in the IV Department of Guairá.

The western region has an average elevation of 130 m above sea level and its maximum height sporadically reaches 300 m and constitutes a flat plain, with a slight slope from the Andean counter-fronts. The slope of this vast plain over 550 kilometers long is only 1%, from its most northern point towards the Paraguay River, containing isolated heights that do not belong to any system, such as Cerro León, Chovoreca and Jara and closer to the Paraguay River the Olimpo, Celina, Confuso, Galván, Siete Cabezas and Desolación.

The following figure shows the topography map of Paraguay, highlighting the points of highest elevation.

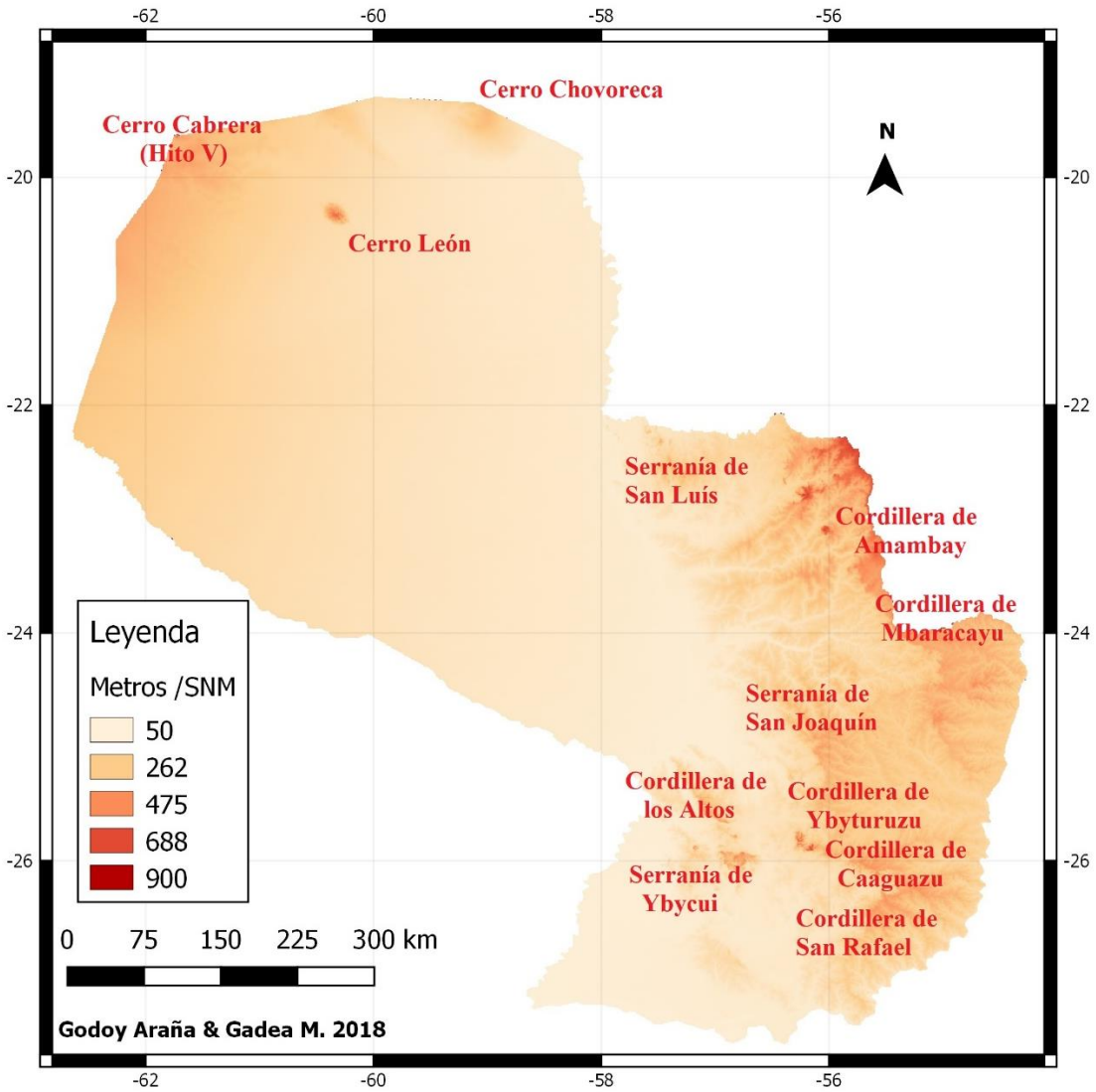


Figure 44 – Map of Topography and Orography of Paraguay. Source: Godoy Araña & Gadea (2018)

9.6.2 Caracterización Local (DIA y DAA)

The topography of the areas of influence of the PARACEL pulp mill has plateaus and valleys, which are flat to almost flat lands that receive the drainage water from the high places, which are the hills and mountains.

The valley is flanked by higher places and is narrower than it is long, while the plain, also called the "llanura", is a large area both wide and long (flatlands), further away from the high places.

According to the Geology of Paraguay site, in the Department of Concepción, on Route n. 5, on the way to Pedro Juan Caballero, you can see Cerro Memby, which geomorphologically, according to its characteristics, would be assigned the name of Butte (isolated hills with cliffs). It is constituted essentially by red sandstones of the Triassic - Jurassic known as the sandstones of the Misiones Formation. To acquire this form, an intense material removal (erosion) had to have occurred in the course of geological time.

Below is the topography map in relation to the areas of influence of the PARACEL pulp mill (DAA, DIA and IIA). In addition, the most representative points of highest elevation are presented.

Visual impacts

The pulp mill will be located in the municipality of Concepción, about 15 km from the city center. City people may not see the impact on the landscape, however, everyone who lives nearby, or uses the roads and/or waterway near the company may feel the impact on the landscape.

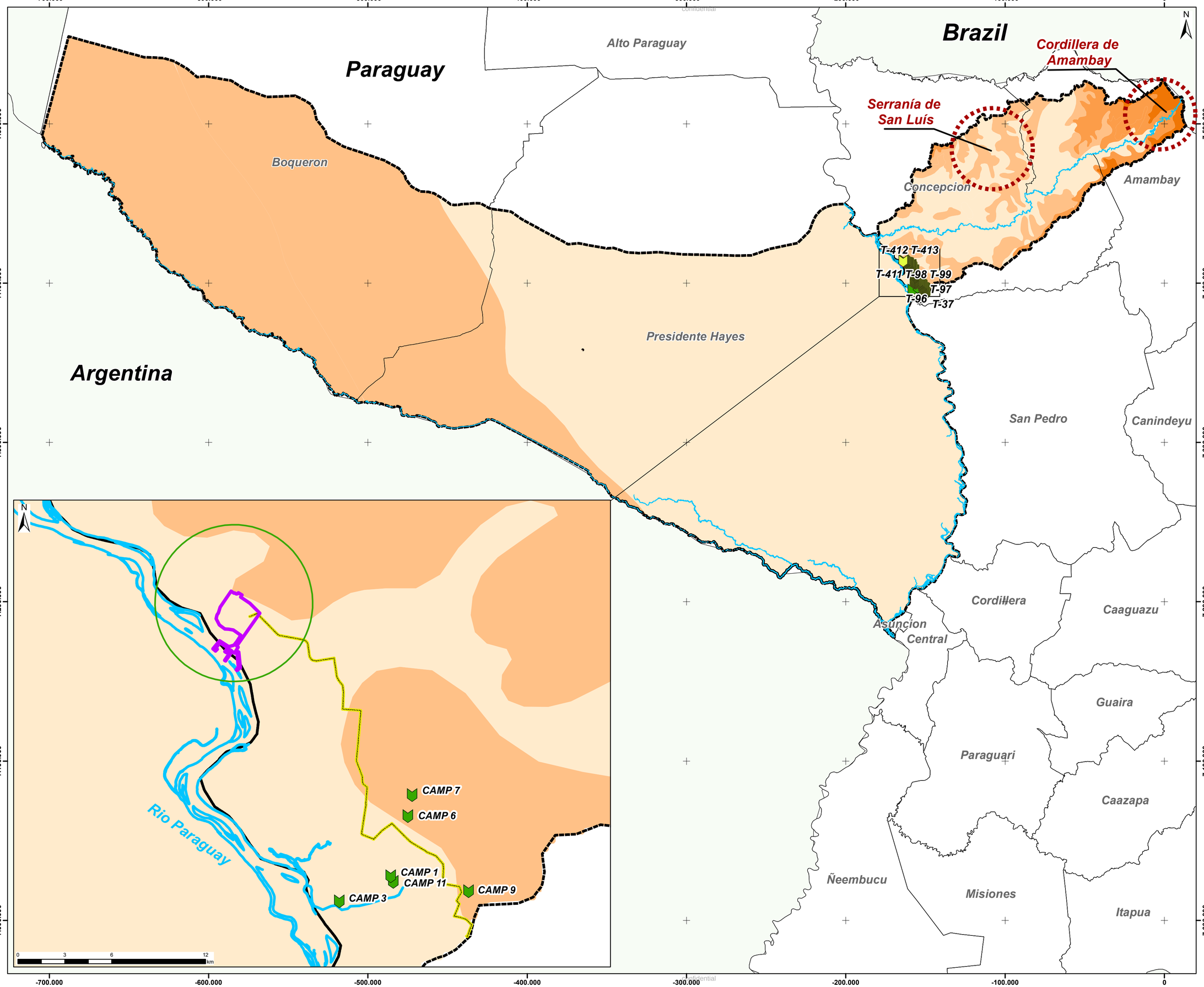
According to the environmental diagnosis, the existing agricultural routes and activities throughout the study area have historically already led to a modification of the landscape, favoring generalist species, rather than those more sensitive to changes in the environment.

The area planned for the implementation of PARACEL's industrial unit is located in a rural area of the cattle activity, however part of the water intake area, effluent emissary and river port are located in areas of natural vegetation.

Obviously, the industrial unit consisting of buildings, towers and chimneys will change the local landscape.

To mitigate the impact on the landscape the project must be implemented to favor the integration of the plant with the environment, such as the implementation of tree curtains and reuse of the soil from earthworks in gardens within the industrial area in accordance with the Landscape Rehabilitation Program besides revegetation of riparian forests.

Figure 45 – Topography and orography map of the areas of influence



LOCATION MAP

LEGEND

- Structures - Transmission Line
- Accommodations (Camps)
- DAA - Directly Affected Area
- DIA - Direct Influence Area
- IIA - Indirect Influence Area
- Hydrography
- CIH Rio Pilcomayo and Aquidaban
- Geomorphological Unit

Height (m/SNM)

- 50
- 270
- 480
- 700
- Departaments
- South America

ESCALA GRAFICA: 0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

DATA SOURCE:
- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).
- Geología del Paraguay, 2020. (https://www.geologiadelparaguay.com.py)

PARACEL PÖYRY

ENVIRONEMTAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

GEOMORPHOLOGICAL UNITS

ESCALA: 1:1.500.000	FECHA: 28/05/2021	
PROYECTO N°:	FOLHA:	FORMATO:
RESP. TECNICO: Romualdo Hirata	FIRMA:	REV. 0

9.7 Edaphology (Soils)

The soil we see around us has taken a long time, several thousand years, to form and acquire the characteristics and properties it has today. Soil formation depends on several factors. Firstly, any soil has first been a solid rock formed in previous geological eras, and on which numerous decomposition agents have been acting, such as water, gases in the atmosphere, living organisms and their remains. These agents have acted together and continue to do so over the years, breaking up and pulverizing the rocks, releasing chemical elements to form new compounds and providing organic remains (humus). Soil particles such as sand, silt and clay are the remnants of that initial rock. These, with the humus, house the chemical elements essential for the nutrition of all plants and by extension the animals that feed on them, thus contributing to the formation of more complex compounds, initiated by photosynthesis.

As a result of these interactions and taking into account the great diversity of geological materials (rocks and minerals) that exist on the planet, a great diversity of soil types was produced, each with its own characteristics. Paraguay has a great variety of geological materials, which has given rise to a very notable diversity of soils. All these soils have been classified and inventoried considering the two natural regions of the country, the eastern and the western or chaco regions. The soils presented in this chapter group the soils according to the general physiography where they are found and their geological origins.

9.7.1 Regional Characterization (IIA)

The two natural regions of the country belong to well-differentiated geological basins: the eastern region is part of the great geological basin of the Paraná, while the western region or “chaco” is located in the most northern portion of another great geological basin, called the “chaco paranaense”. The figure below shows the two geological basins and the location of the country in them.

The geological and geomorphological development of these basins resulted in very varied soil conditions, which, with the climatic gradients of precipitation and temperature, accommodated different ecosystems. Due to its central-southern location in the South American continent and because it is located in two geological basins with very different characteristics, the Paraguayan territory is the meeting place of several ecosystems, such as the Atlantic Forest of the Alto Paraná, the Cerrado, the high forests of the Central Forest, the low fields and wetlands of the Pantanal Chaqueño, those of the banks of the Paraguay River and those of the Ñeembucú, the extensive hydromorphic savannas of the depressed Chaco and the xerophytic forest of the Chaco, among the main ones that are found in the Paraguayan territory.

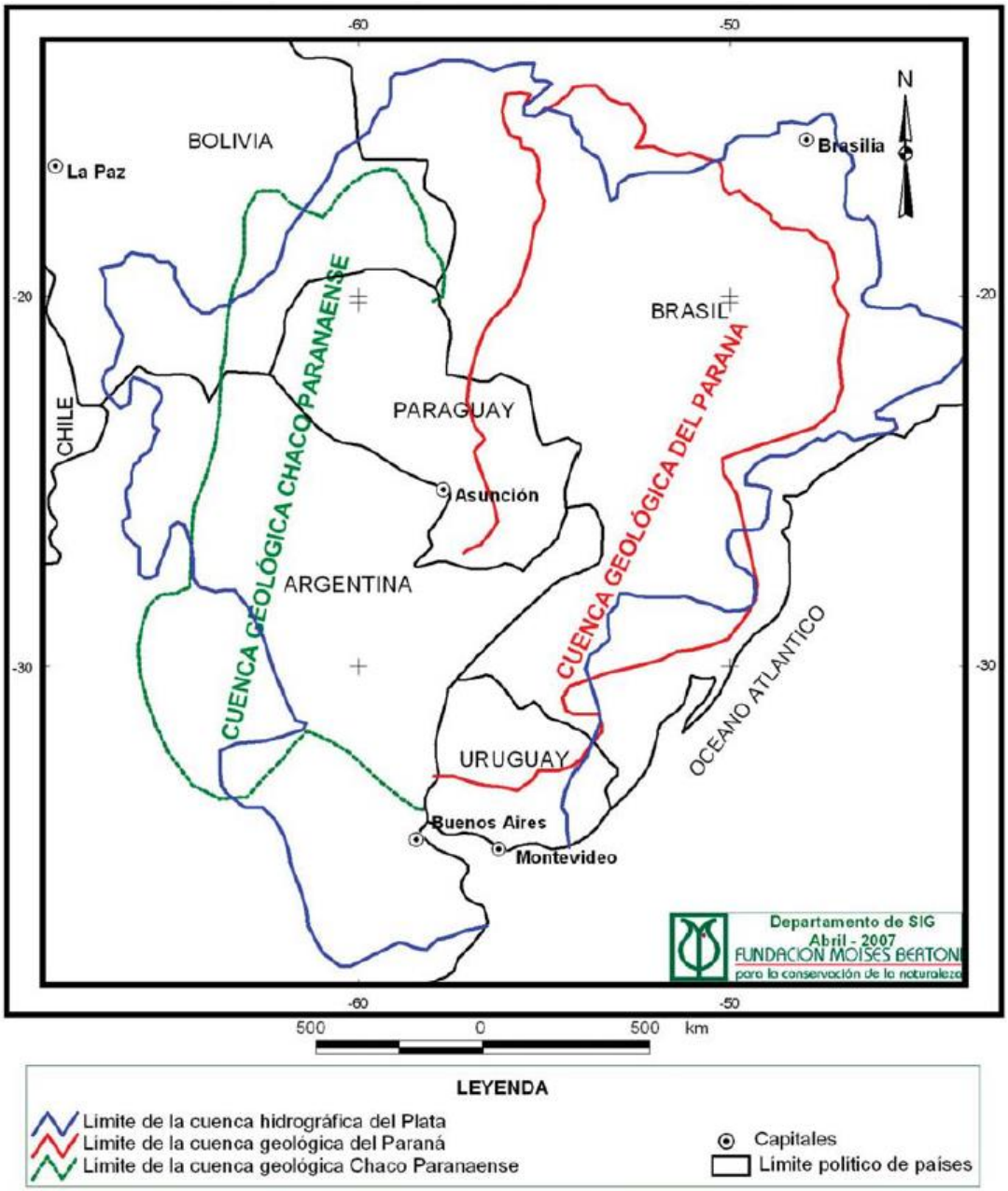


Figure 46 – Location of Paraguay in geological basins and in the Rio de la Plata river basin. Source: Fundación Moisés Bertoni (2007)

In the eastern region is the most western edge of the Paraná geological basin. This border follows a flexure line located east of the current course of the Paraguay River. This river can be considered the border between the Paraná geological basin and the Chaco geological basin, although portions of the Chaco slightly penetrate the eastern region and vice versa.

The figure also shows the limits of the Rio de la Plata basin, formed by the Paraná, Paraguay and Uruguay rivers. The geological basin line is different from the river basin line, thus illustrating the difference between geological basin and river basin.

The national territory is almost equally divided between the two geological basins, which explains the division of the country into its two natural regions: eastern and

western. The following description of the soils follows this separation of its natural regions.

9.7.1.1 Eastern Region of Paraguay

According to the Moisés Bertoni Foundation (2007), the map below provides guidance by considering the physiography of the eastern region first and the geological origin of the soils second. The map has been adapted from the "Mapa de Reconocimiento de Suelos de la Región Oriental" (LÓPEZ, O. ET AL, 1995) to the Revised Soil Legend System of the FAO (United Nations Food and Agriculture Organization), of 1990, which is the official classification of the world's soils. The cartographic units of the Geological Map of Paraguay were used as a basis (FÚLFARO, V.J. AND D. ALVARENGA, 1986).

By physiography, it is meant the natural topography of the land, such as mountain range, hills, valleys and plains.

9.7.1.2 Paraguay's Western Region

The physical characteristics of the western region or Paraguayan Chaco are very different from those of the eastern region, to such an extent that in spite of possessing 61% of the country's surface area it is home to only about 2% of the human population and produces 3% of the agricultural crops. It is, however, a large producer of cattle and still maintains continuous masses of xerophytic forest (FUNDACIÓN MOISÉS BERTONI, 2007).

The Paraguayan Chaco is located entirely in the northern part of the great geological basin of the Paraná Chaco. This geological basin has diffuse boundaries, determined by the very nature of a very extensive geographical basin, formed by active geological periods. It is a region that has not been studied with the detail of the eastern region, but certain knowledge has been acquired that allows its characterization. Its general physiography corresponds to a vast plain or prairie, whose general slope goes unnoticed by the human eye, except in certain areas towards the border with Bolivia. The slope of this plain is directed towards the Paraguay River, the common collector of the waters of existing watercourses. Despite its apparent uniformity, it is possible to distinguish several sub-regions (MAP OF CHACO SUB-REGIONS, 1986), with soil characteristics related to their geological past and current physiography.

The figure below is an adaptation of the Soil Map of the Western Region (HOFFMAN, R. ET AL, 1999) and the Geological Map of Paraguay (FÚLFARO, V.J. AND D. ALVARENGA, 1986).

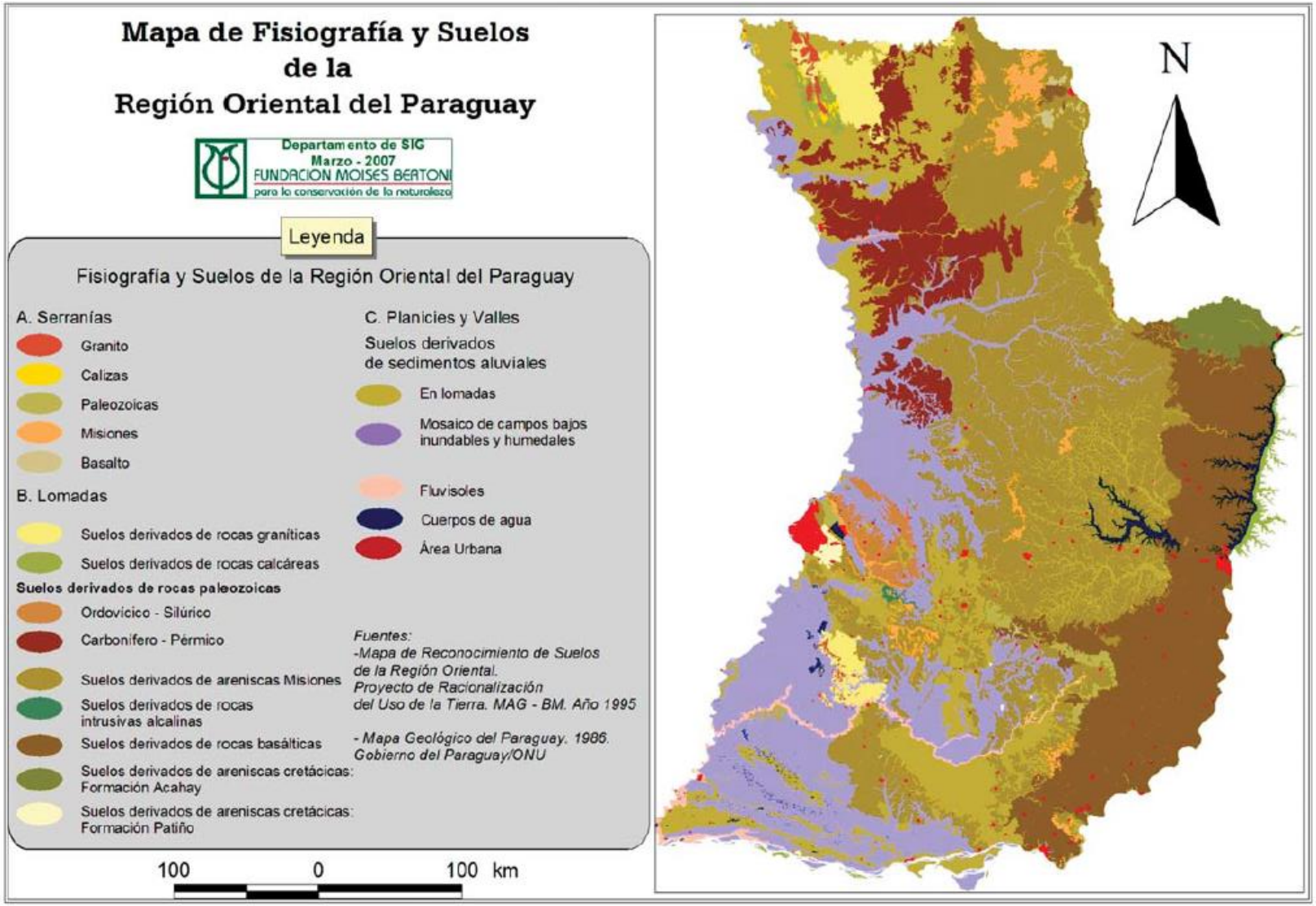


Figure 47 – Physiography and soil map of the Eastern Region of Paraguay. Source: Fundación Moisés Bertoni (2007)

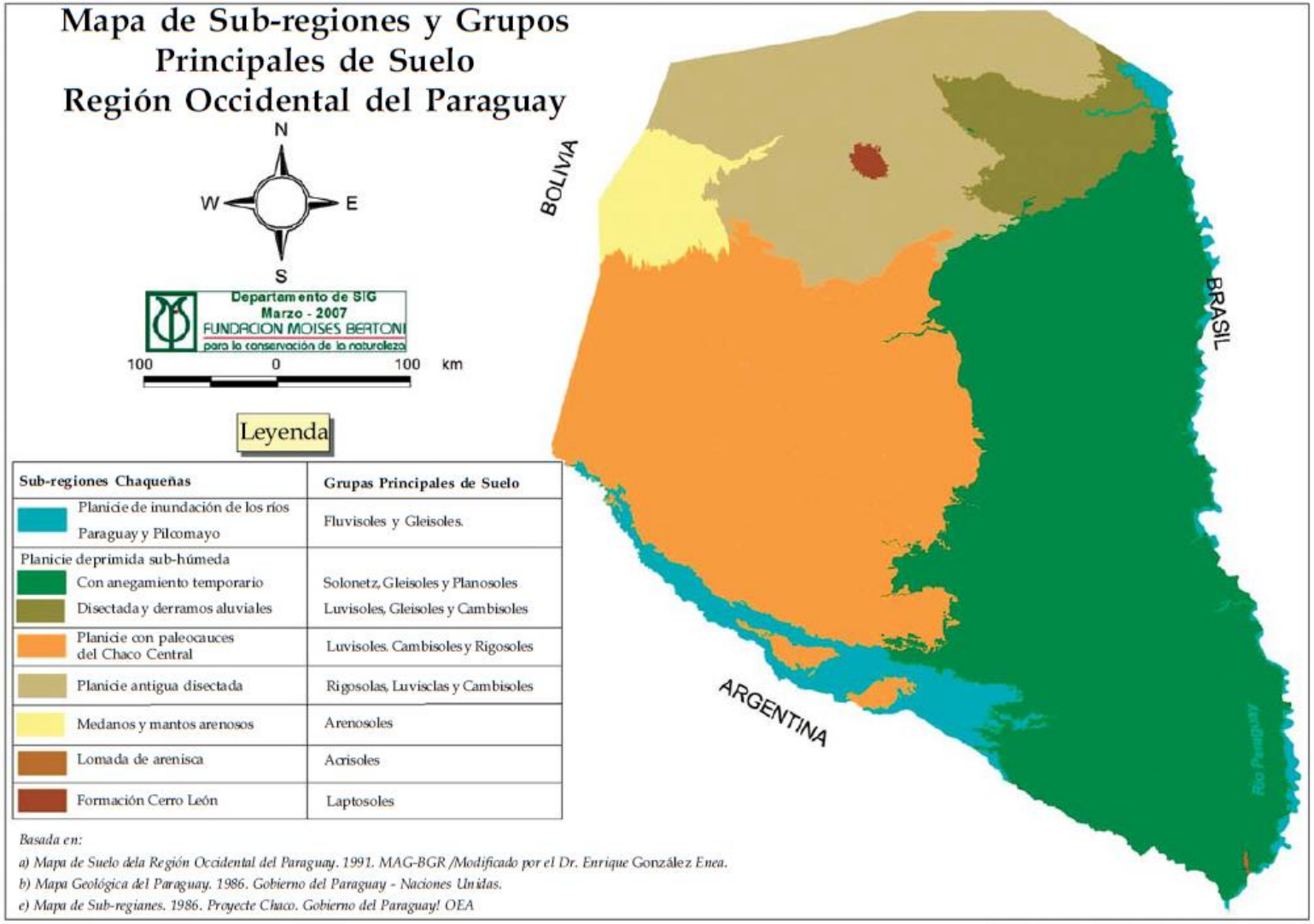


Figure 48 – Physiography and soil map of the Western Region of Paraguay. Source: Fundación Moisés Bertoni (2007)

9.7.2 Local Characterization (DAA and DIA)

The soils of Paraguay are fertile in the Chaco and of medium fertility in the Eastern region, predominantly Podzolic Soils (Ultisols), Structured Red Soils (Oxisols and Alfisols), Planosols (Alfisols), Quartz Sands and Lithosols (Entisols) and Solonetz (Aridisols).

The aptitude of the soils of the Eastern region is predominantly agricultural, while in the Western region or Chaco it is predominantly pastoral, existing lands of forest aptitude and for environmental conservation in the two regions of the country.

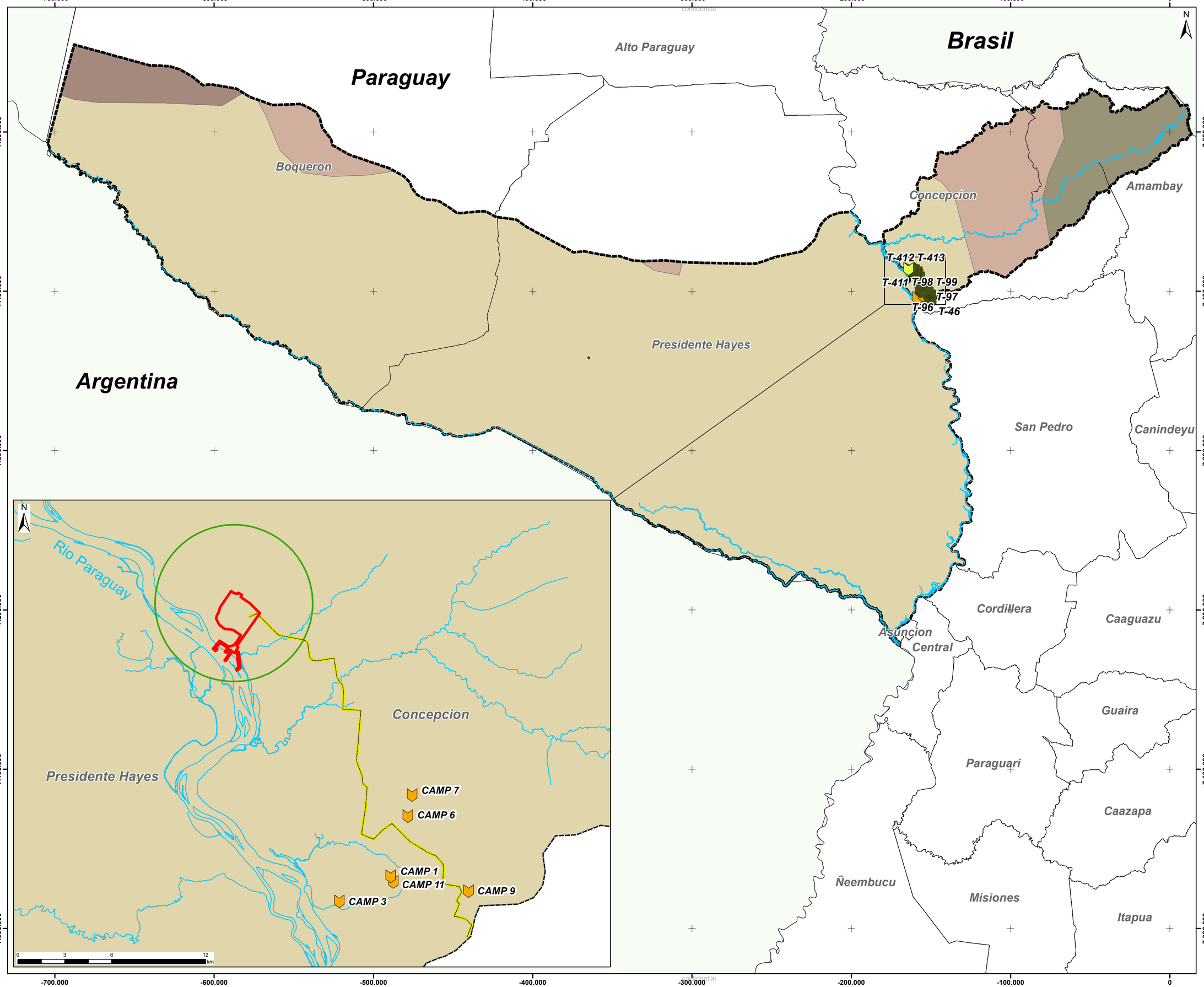
The areas of influence of the PARACEL pulp mill have basically two types of soil: sandy and clay (figure below).

The sandy soils are suitable for forestry. Normally, this type of soil has little capacity to retain water, although it can improve depending on the concentration of organic matter it possesses. Water erosion has devastating effects on sandy soil.

Clay soils are harder and heavier, dark red in color, and when wet they become extremely slippery precisely because of their ability to retain water. Clayey soils are excellent for agricultural production, as they are less prone to erosion. Likewise, loamy soils - a mixture of sand and clay - are also suitable for agriculture. The most outstanding feature of this type of soil is the accumulation of sandy sediments and of white and granular marl. The igneous rocks come from the depths of the earth and have melted to the surface. The sedimentary rocks were formed from clay by pressure from the earth's layers.

Specifically on the riverbanks of the Paraguay in the eastern region and the Pilcomayo in the western region, periodic contributions and depositions of alluvial materials transported by these watercourses are formed, which is reflected in the variety of successive layers of soil that accumulate. The content of organic matter is also very variable from one layer to the next. These soils are not stable for agricultural use, due to the constant danger of flooding, and are covered with grass vegetation and species from humid places. They are used in extensive cattle raising.

Figure 49 – Soil map of the areas of influence



LOCATION MAP

LEGEND

- Structures - Transmission Line
- Accommodations (Camps)
- Hydrography
- DAA - Directly Affected Area
- DIA - Direct Influence Area
- IIA - Indirect Influence Area
- CIH Rio Pilcomayo and Aquidaban

Soils types

- Mix of residuals and transported soils silty clay, silty sand
- Fine to meddium sand soils
- Transported floodplain soils, predominantly clayey
- Generally transported wind soils, fine sands
- Departaments
- South America

ESCALA GRAFICA:
0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

FUENTE DE DATOS:
- Geología del Paraguay, 2020.
(http://www.geologiadelparaguay.com.py)

PARACEL PÖYRY

ENVIRONMENTAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

PEDOLOGY

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9.8 Speleology

According to Warnes (2002), in the extreme northeast of the Department of Concepción, on the border with the Federative Republic of Brazil, we find the largest karst area in Paraguay, which extends over 1,070 km^2 within the department, forming part of the Aquidabán ecoregion.

This area represents the only karstic landscape in Paraguay, with well-defined characteristics typical of this type of geography. It is an extremely rich area of great biological diversity where most of the typical phenomena of this type of terrain are found: caves, caverns, lakes, sinkholes, dolines, and carcavas.

The environmental laws of Paraguay protect the natural resources, thus defending the tourist-scientific heritage. There is Resolution n. 4577/2011 that declares several areas called caverns, located in the zone of Vallemi, Department of Concepción, as a protected wild area under the category of natural monument. The figure below shows the areas defined by Resolution n. 4577/2011, mentioned above.

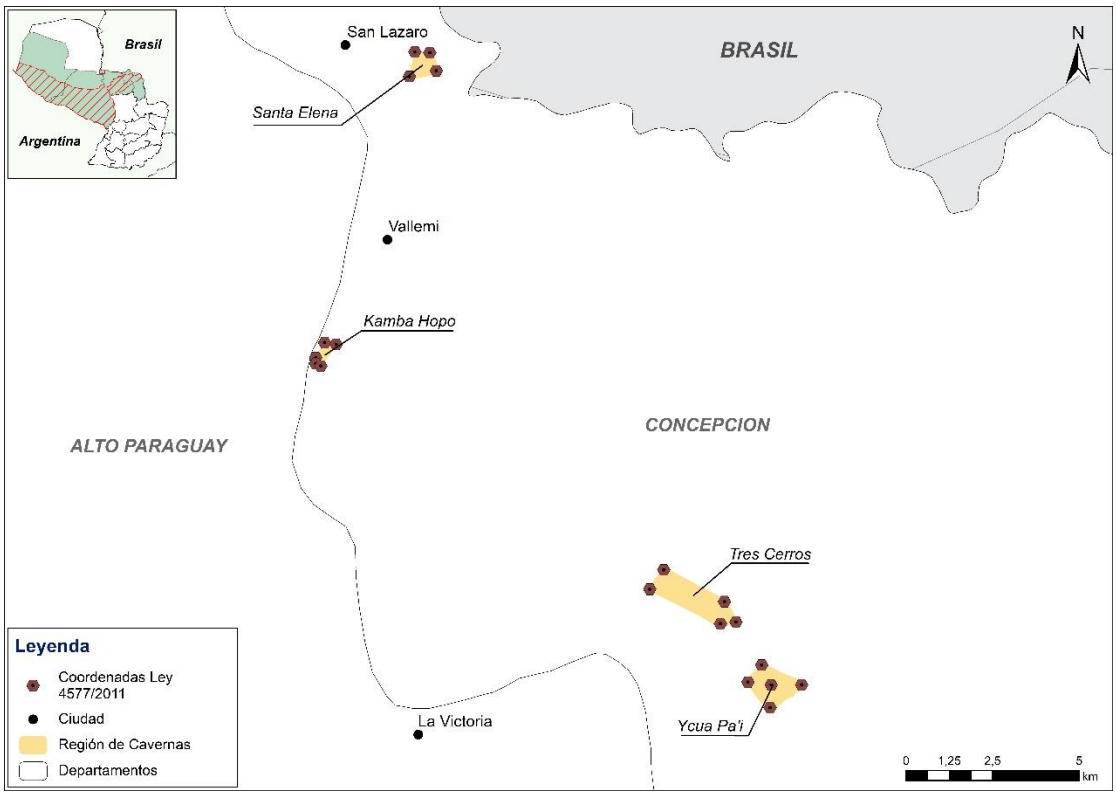
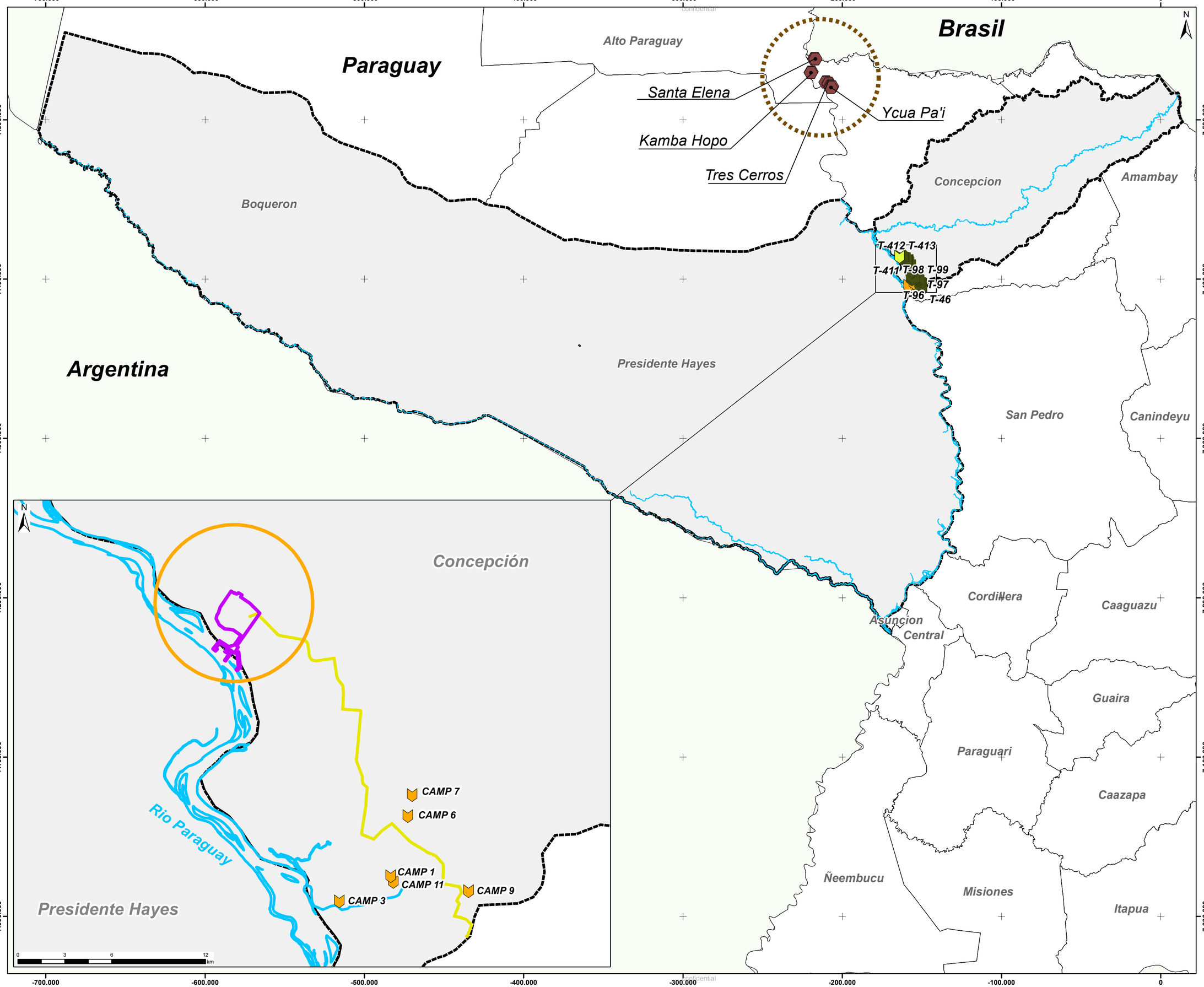


Figure 50 – Location of the caves according to the Resolution n. 4577/2011

The location of these caves in relation to the areas of influence of the PARACEL pulp mill is presented below. Therefore, the region of the caves is not included in the areas of influence (DAA, DIA or IIA). It should be noted that the nearest cave (Ycua Pa'i) is 115 km northwest of the area of the future pulp mill.

Figure 51 – Map of the caves in relation to the areas of influence



LOCATION MAP

LEGEND

- Structures - Transmission Line
- Accommodations (Camps)
- Caves
- Transmission Line
- Hydrography
- IIA - Indirect Influence Area
- DAA - Directly Affected Area
- DIA - Direct Influence Area
- CIH Rio Pilcomayo and Aquidaban
- Caves Region
- Departaments
- South America

ESCALA GRAFICA:
0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

DATA SOURCE:
- Ley Nº 4577, 2011.
- Geología del Paraguay, 2020.
(https://www.geologiadelparaguay.com.py)

PARACEL PÖYRY

ENVIRONMENTAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

SPELEOLOGY

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PROYECTO Nº	FOLHA:	FORMATO:	
RESP. TECNICO: Romualdo Hirata	FIRMA:		REV. 0

9.9 Hydrology (Surface Water Resources)

Paraguayan territory belongs entirely to the great basin of the River Plate, one of the largest rivers in the American hemisphere, as well as in the whole world, due to the extension, the flows it produces, and its natural resources (PMCIC, 2014).

The basin of the Plata is, by its geographical extension and the flow of its rivers, one of the most important in the world. Its importance also lies in the fact that it is a territory shared by five countries (CIC, 2020).

With its 3.1 million square kilometers, the Plata Basin occupies one fifth of South America, including territories of Argentina, Bolivia, Brazil, Paraguay and Uruguay, as seen in the following figure (CIC, 2020).

The waters of two large rivers converge in the Río de la Plata: the Paraná and the Uruguay, both of which, by their turn, collect the flow of other very important rivers, such as the Paraguay, the Bermejo, the Pilcomayo and the Iguazú, among many others (CIC, 2020).

Through its wide estuary in the Atlantic Ocean, the Plata Basin delivers a flow of 25,000 m^3/s to the sea.

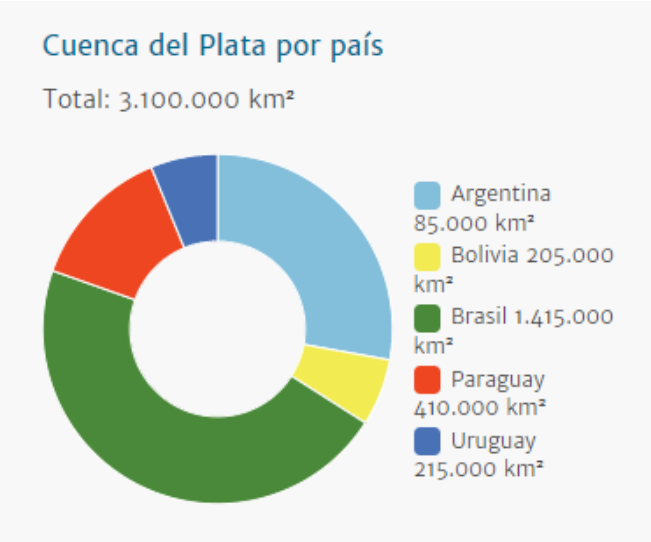

Figure 52 – Basin of the Plata by country. Source: CIC (2020)

<u>Water resources management</u>

Thus, in Paraguay, there is concern about water resources highlighted by the extensive legal framework, among which are SEAM Resolution n. 222/2002 (Standard of Water Quality in the Entire National Territory), SEAM Resolution n. 50/2006 (National Water Resources Management), SEAM Resolution n. 255/2006 (Classification of All Waters of Paraguay in Class 2) and Law n. 3239/2007 (Water Resources of Paraguay).

In accordance with Law n. 3239/2007, the integrated and sustainable management of Paraguay's water resources is governed by the following principles:

a) Water, whether surface or underground, is the public property of the State and its ownership will not be subject to any form of limitation.

b) Access to water for the satisfaction of basic needs is a human right and must be guaranteed by the State, in adequate supply and with appropriate quality

c) Water resources have multiple uses and functions and this characteristic must be adequately addressed, respecting the hydrological cycle and always favoring, in the first place, the use for consumption by the human population.

d) The hydrographic unit is the basic unit for water resources management.

e) Water is a natural good that conditions the survival of all living beings and the ecosystems that shelter them.

f) Water resources are a finite and vulnerable good.

g) Water resources have a social, environmental and economic value.

h) Water resources management should be carried out within the framework of sustainable development, and should be decentralized, participatory and gender-sensitive.

i) The Paraguayan State possesses the non-transferable and non-delegable function of property and guardianship of national water resources.

The management of water resources in Paraguay occurs through the hydrographic units, which are the basic management units, according to Law n. 3239/2007.

In Paraguay, there are 19 Hydrographic Units (Figure above) classified in two regions: the Western Region and the Eastern Region, according to Resolution n. 376/2012.

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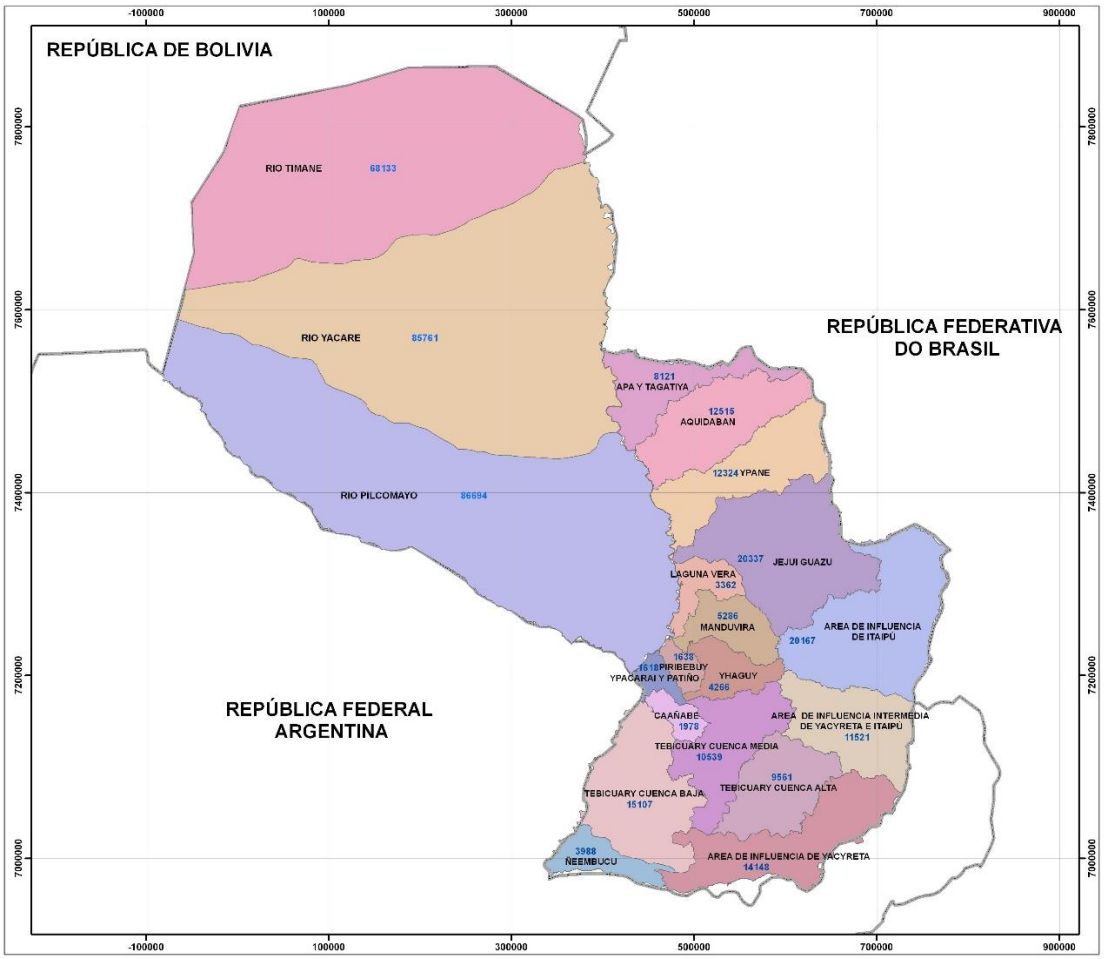

Figure 53 – Hydrographic Units of Paraguay. Source: MADES (2020)

The following table presents the characteristics (region, name and area) of the Hydrographic Units of Paraguay.

Table 7 – Hydrographic Units of Paraguay

Region	Name	Area (km²)
Eastern	Apa and Tagatiya	8,121
	Aquidabán	12,515
	Area of Intermediate Influence of Yacyreta and Itaipu	11,521
	Influence Area of Itaipu	20,167
	Influence Area of Yacyreta	14,148
	Caanabe	1,978
	Jeiui Guazu	20,337
	Laguna Vera	3,362
	Oriental Manduvirá	~ 5,286
	Neembucú	~ 3,988
	Piribebuy	1,638
	Tebicuary Cuenca Alta	9,561
	Tebicuary Cuenca Baja	15,107
	Tebicuary Cuenca Media	10,539
	Yhaguy	4,266
	Ypacaraí and Patinc	1,618
	Ypané	12,324
Western	Rio Pilcomayo	86,694
	Rio Yacaré	85,761
	Rio Timme	68,133

Source: Resolution SEAM n. 376/2012.

The planned site for the implementation of the PARACEL pulp mill will be in Concepción, near the Paraguay River. For ESIA, the Aquidabán and Pilcomayo River hydrographic units were adopted as an Indirect Influence Area. Thus, these hydrographic units will be addressed in this chapter on water resources.

The following figure shows the location of the future PARACEL pulp mill on the water resources map.

Figure 54 – Map of water resources.

LOCATION MAP

LEGEND

- Structures - Trsnmission Line
- Accommodations (Camps)
- Hydrography
- DAA - Directly Affected Area
- DIA - Direct Influence Area
- IIA - Indirect Influence Area
- CIH Rio Pilcomayo and Aquidaban
- Departaments
- South America

ESCALA GRAFICA:
0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

DATA SOURCE:
- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).

PARACEL PÖYRY

ENVIRONMENTAL AND SOCIAL STUDY

CIH8 Aquidaban and CIH18 Rio Pilcomayo

WATER RESOURCES

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RESP. TECNICO: Romualdo Hirata		FIRMA:	REV. 0

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9.9.1 Regional Characterization (IIA)

9.9.1.1 Aquidabán Hydrographic Basin

The Aquidabán River basin has an area of approximately 1,254,812 ha (SEAM & DIGESA, 2006), within the departments of Amambay and Concepción, and flows into the Paraguay River north of the city of Concepción, as illustrated in the figure below.

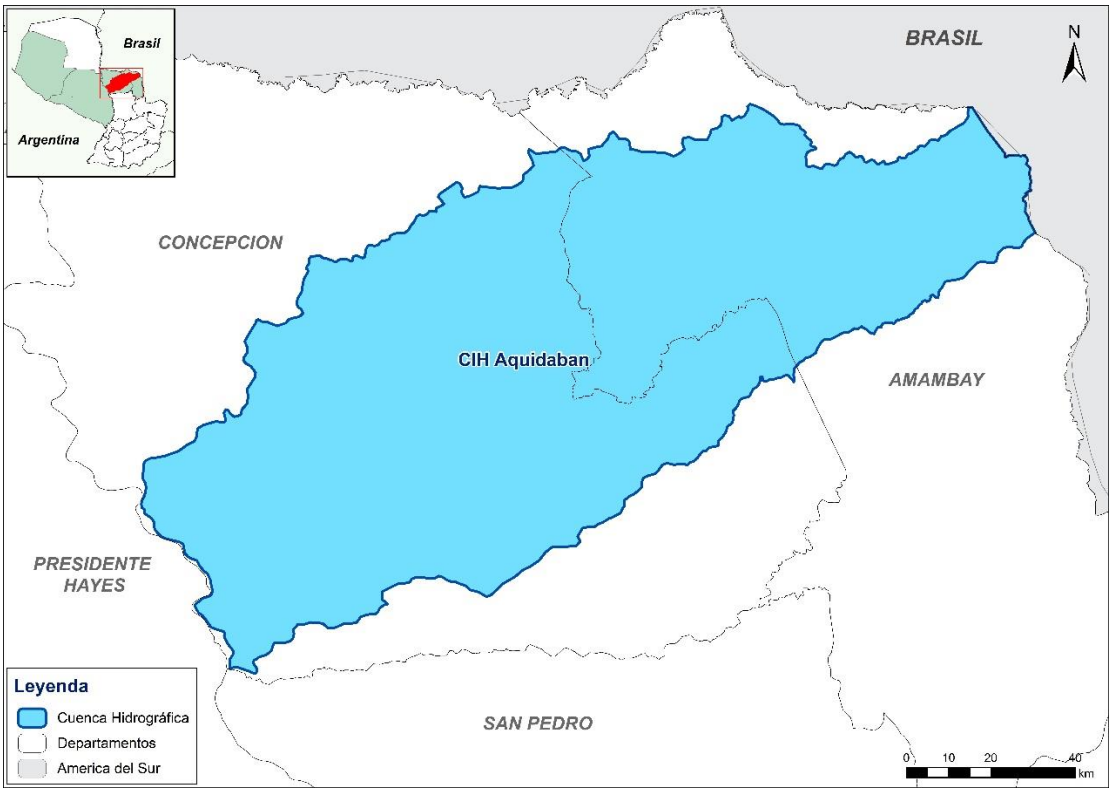

Figure 55 – Map of the Hydrographic Basin of Aquidabán

The basin is 59.3% occupied by cattle and 28.6% by forest, which includes approximately 87.9% of the entire basin area. Small rural producers occupy 7.6% of the basin area, mechanized cultivation 2.6%, flooded areas 1.6% and water and city occupy approximately 0.1%, as presented in the following table.

With respect to pollution loads, there are three districts with a total population of 36,150 inhabitants, of which 19% reside in urban areas, which constitutes the potential contributor to sanitation loads. The diffuse load from agricultural areas is 2 to 10 times higher than the sanitary load. With regard to industrial loads, there are no significant sources in this basin (SEAM & DIGESA, 2006).

Table 8 – Aquidabán River Basin Occupations

Mechanized cultivation	Cattle raising	Forest	Water	Small area ranchers	Flood	City	Total
32,408	744,261	359,133	1,810	95,613	20,042	1,810	1.254,812
2.6%	59.3%	28.6%	0.1%	7.6%	1.6%	0.1%	100.0%

Source: SEAM & DIGESA (2006).

Figure 56 – Aquidabán River Basin Occupations

The Aquidabán River rises in the Amambay mountain range after traveling approximately 250 km through the departments of Amambay and Concepción, in an east-west direction. This river is a tributary of the Paraguay River and its mouth occurs north of the city of Concepción, 35 km from the central region. Its main tributaries are the Trementina and Negla Rivers.

The Aquidabán River as well as all surface water resources in Paraguay are classified as a Class 2 river, according to SEAM Resolution n. 255/2006.

The relevant characteristic of this river's water is the relatively high concentration of total and dissolved solids, depending on the time of collection, and the presence of significant nutrient contents. The cause of the high solids value can be attributed, mainly, to the recurrent diffuse loads of agricultural activities, also carrying nitrogen and phosphorus that are components of chemical fertilizers. The variation in concentration, especially of solids, is closely correlated to the recorded precipitation (SEAM & DIGESA, 2006).

9.9.1.2 Pilcomayo river basin unity

The Pilcomayo river basin, which belongs to the Plata Basin system, with an area of approximately 290,000 km², covers an important natural resource region of Latin America, shared by Argentina, Bolivia and Paraguay, with an estimated population of 1,500,000 inhabitants (CTDCRP, 2020).

The spatial distribution is Upper, Middle and Lower Basin from Northwest to Southeast. Some 44% of the total area of the Basin is in Paraguay, 31% in Bolivia and 25% in Argentina, as illustrated in the following figure (CTDCRP, 2020).

Figure 57 – Map of Pilcomayo hydrographic basin.

In the High Basin, the Pilcomayo is a mountain river that when leaving the Andes (or "sub-Andean") in the city of Villa Montes, enters the Chaco plain, in a southeasterly direction, extending about 1,000 km to the Paraguay River (of which 835 km are the border between Argentina and Paraguay). In this section it becomes a river of flat land - "llanura" (CTDCRP, 2020).

The so-called "Lower Pilcomayo", one of the numerous streams that drain the Chaco and flow into the Paraguay River, seems hydrologically disconnected from the upper river. Another of its singularities is that in this flat course (the Chaco of Paraguay and Argentina) the river is lost, that is to say, it does not flow directly into the Paraguay river. This occurs due to sedimentation or siltation (CTDCRP, 2020).

The Pilcomayo River in the plains (llanura) is one of the best examples of river mega-fan, frequent in the eastern slopes of the Andes in South America. It is also the largest of them (>200,000 km^2) and the only one in the world that presents the phenomenon of extinction of the riverbed by siltation. It is not simply an endorheic river which disappears at some point, of which there are examples in the world, but where the river disappears there is still a remarkable flow that extends to form wetlands (CTDCRP, 2020).

The Pilcomayo River as well as all surface water resources in Paraguay are classified as a Class 2 river, according to SEAM Resolution n. 255/2006.

The upper basins of the Bermejo and Pilcomayo rivers are responsible for most of the sediment production in the del Plata Basin, the main cause of the need for clarification of water for consumption by the riparian cities. Sediments are deposited in the waterways and cause the progressive advance of the Paraná River Delta over the Plata River. Another determining process in the phenomena of production and transport of sediments is related to anthropic activities of land use (CIC, 2017).

The Pilcomayo River has an average annual flow of 203 m^3/s and an annual contribution of sediments of the same order of magnitude as the Bermejo, but does not have enough energy to transport its solid load to the Paraguay River (CIC, 2017).

The Pilcomayo river basin is particularly critical because of centuries of mining pollution in the upper basin, with the presence of significant environmental liabilities.

9.9.1.3 Wetlands

Still in the context of water resources, wetlands are important ecosystems, protected by the Ramsar Convention, a Convention on Wetlands of International Importance, which is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and sustainable use of wetlands and their resources (WCRP, 2014).The characteristics of the natural resources of the Río de la Plata Basin indicate that the wetlands represent the main ecosystems of the region (WCPIC, 2014).

The La Plata Basin has the largest system of river wetlands on the planet, covering almost 3,500 km^2, made up of a corridor of wetlands connected by the axis of the large Paraguay, Paraná and La Plata rivers (CIC, 2017).

Paraguay has large areas of wetlands such as the Paraguayan Pantanal, the Central Chaco Lagoons, the Humid Chaco Lagoons, the Cerrado wetlands, those belonging to Arroyos and Esteros, those of the Atlantic Forest, the Ñeembucú wetland, and the flooded pastures (PMCIC, 2014).

These wetland areas are recognized as highly productive ecosystems and one of the most obvious indicators of their wealth and diversity are the wetland birds; these birds constitute a natural resource of great intrinsic human and ecological value, throughout history they have appeared prominently in human culture, as a source of food or ornamentation as well as in the folkloric sense (PMCIC, 2014).

These ecosystems perform extremely important functions such as: water reserve and purification, flood buffering, carbon sinks, sediment, organic matter and nutrient storage and/or export sites. In addition, they play a critical role in the life cycle of numerous species of fauna and flora and support trophic chains of adjacent ecosystems (WCPI, 2014).

Paraguay currently has 6 Ramsar sites or Wetlands of International Importance covering 785,970 hectares and the designation of Asunción Bay is expected to cover 2,585 hectares (WCPIC, 2014).

In the Indirect Influence Area, in the Pilcomayo River Hydrographic Unit, is the Tifunque Ramsar Site, located 235 km from the pulp mill site. In addition, there is the Estero Milagro Ramsar Site (35 km from the factory), located outside the Indirect Influence Area, as shown on the map below.

Tifunque Ramsar site

Created in June 7th, 1995, it is located in the department of Presidente Hayes (24°15'S 059°30'W) and has 280,000 ha (Ramsar, 2020).

An alluvial plain along the Pilcomayo River that is flooded most of the year and is characterized by the presence of patches of forest, extensive lakes and palm tree savannas. The water courses follow the old riverbeds, with gallery forests growing alongside. Another sector is made up of vast dry plains of grasses and bushes. Located in the biogeographical region of tropical deciduous forest, the site, in excellent condition, is a good representative of biodiversity. Located along the migration route, birds are abundant in species and number. Several endangered wildlife species (rhea, caiman, turtle and jaguar) and fish species breed here. The site is important for Potamogeton striatus, a critically endangered plant, and is compatible with a distinct mammal fauna. There are extensive farming, extraction of forest products and poaching. The site shares a border with Argentina (RAMSAR, 2020).

Figure 58 – Map pointing Ramsar sites in the PARACEL pulp mill area

LOCATION MAP

LEGEND

- Structures -Transmission Line
- Accommodations (Camps)
- Site Ramsar Tifunque
- Site Ramsar Estero Milagro
- Hydrography
- DAA - Directly Affected Area
- DIA - Direct Influence Area
- IIA - Indirect Influence Area
- CIH Rio Pilcomayo and Aquidaban
- Departaments
- South America

ESCALA GRAFICA:
0 20 40 80 km

DATUM SIRGAS 2000
PROYECCION: UTM

FUENTE DE DATOS:
- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).

PARACEL PÖYRY

ENVIRONMENTAL AND SOCIAL STUDY

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RAMSAR SITES

ESCALA: 1:1.650.000		FECHA: 28/05/2021	
PROYECTO N°:	FOLHA:		FORMATO:
RESP. TECNICO: Romualdo Hirata	FIRMA:		REV. 0

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9.9.2 Local Chacarterization (DIA and DAA)

The future PARACEL pulp mill will be located in Concepción, near the Paraguay River, where the treated effluent will be discharged through an emissary system. In addition, the Arroyo Seco river is also within the direct influence area of the ESIA. Thus, for the studies of local water resources, the two rivers were considered.

9.9.2.1 Paraguay river

The water intake and discharge of treated effluents from the PARACEL pulp mill will be carried out over a stretch of approximately 1.0 km (which is part of the DAA and DIA) on the Paraguay River. However, there are no data available for only this 1.0 km stretch of the Paraguay River describing its demand, mining, navigation and demand/availability data. Therefore, the data presented here are related to the Paraguay river as a whole.

Paraguay has a very important and extensive hydrographic network throughout its territory. In fact, the Paraguay river separates and limits two natural regions with very different natural and socioeconomic characteristics (MADES, 2020).

The hydrography of the River Plate Basin is made up of three large water systems: the Paraná, Paraguay and Uruguay, in addition to the River Plate itself, into which some smaller rivers flow. Paraguay is a tributary of the Paraná, while the latter joins with Uruguay to form the Plata river. The drainage areas of each of them form the main sub-basins of the system (CIC, 2020).

The Paraguay River Basin has an area of 1,095,000 km², which covers about 35% of the entire area of the Plata Basin, which is 3,100,000 km², as illustrated in the figure below.

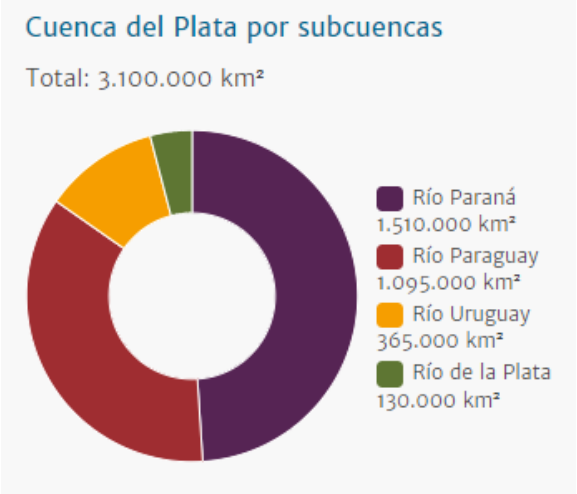

Figure 59 – The Plata Basin by sub-basin. Source: CIC (2020)

The Paraná and Paraguay rivers run from north to south and form an axis that divides the Basin into two parts: to the east there is a dense river network with abundant rivers, while to the west the contributions are from flatlands with low flow (CIC, 2020).

One third of the basin of the Paraguay river corresponds to Brazil (370,000 km²), another third to Paraguay (355,000 km²) and the rest is divided between Argentina (165,000 km²) and Bolivia (205,000 km²) as illustrated in the figure below. Almost all of it extends over a vast alluvial plain, with very little slope and extensive flood plains (CIC, 2020).

Figure 60 – Distribution of Paraguay river basin among the countries. Source: CIC (2020)

The Plata Basin can be subdivided into 7 sub-basins, among which the Upper Paraguay sub-basin and the Middle and Lower Paraguay sub-basin are located in Paraguay (CIC, 2017), as shown in the figure below.

Figure 61 – Map of Plata sub-basins. Source: CIC (2017)

According to CIC (2017), the Upper Paraguay Sub-basin (Figure below) includes two large environments, the highlands (so called "Planalto") and the enormous wetland (so called "Pantanal"). The Pantanal formation acts as a large water reservoir at the waters' source for the Plata system that also retains increased amounts of sediment, arising from agriculture in the "Planalto" highlands. Sedimentation is a major threat to the ecosystem because of the wide variety of species that have their natural habitat in this wetland. Maintaining the slow runoff of the Pantanal is key to preventing a greater incidence of flooding downstream of the Paraguay river and in the already affected Paraná river.

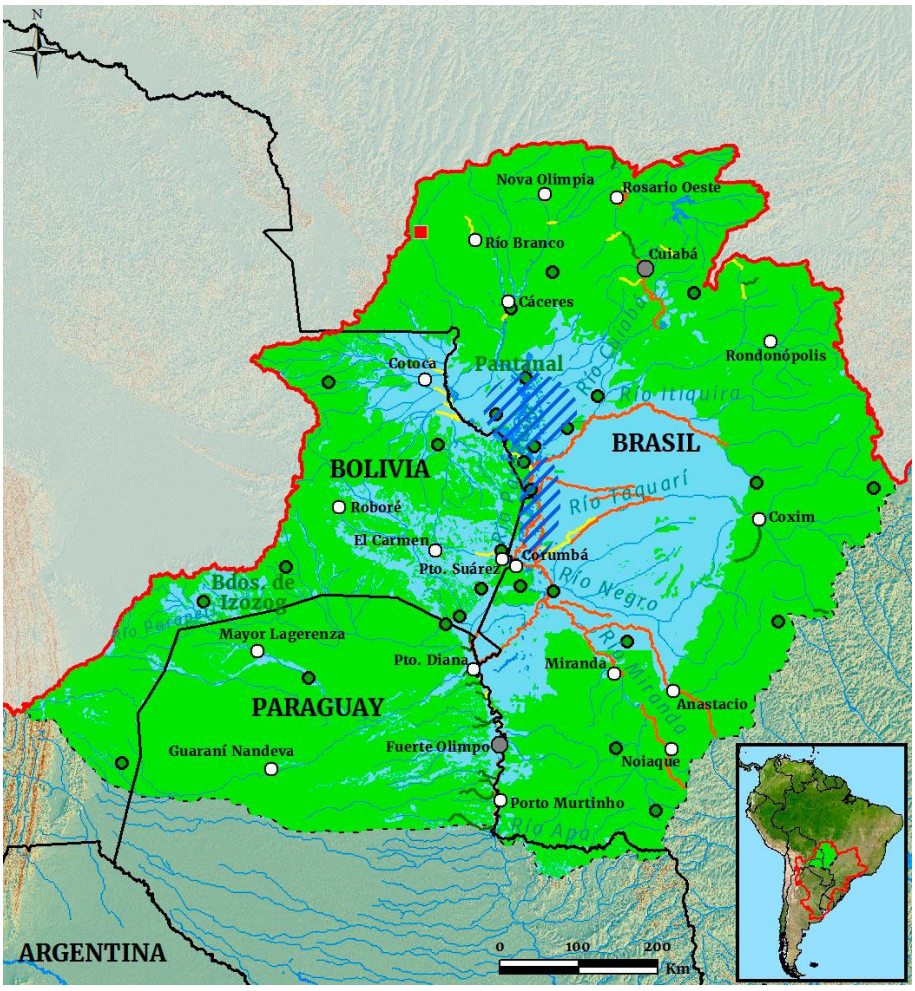

Figure 62 – Map of sub-basin of Alto Paraguay. Source: CIC (2017)

The Middle and Lower Paraguay Sub-basin (Figure below) is defined from the estuary of the Apa river to the confluence with the Paraná river. It should be noted that the location of the PARACEL pulp mill is in this sub-basin. The Paraguay river, in spite of the contributions it receives in its upper basin, would present a negative water balance in part of this section, if only its right bank tributaries were considered, since its overflows do not return to the main channel, recharging lateral depressions in which water is retained until it evaporates. However, its left bank tributaries - Aquidabán, Jejui, Aguaray and Tebicuary- generate important contributions. Along the main course of Paraguay, the city of Asunción is located in the sub-basin, affected by frequent flooding. This section is an important part of the Paraguay-Paraná Waterway and receives, on its right bank, two tributaries: the lower Pilcomayo and Bermejo rivers.

This sub-basin includes part of the Hydrographic Units CIH18-Rio Pilcomayo and CIH8-Aquidaban, used as the reference unit for defining the IIA for the physical environment. The entire sub-basin was not considered in the IIA because no relevant users were found downstream, sufficiently close (in terms of affecting its quality) to the point of discharge of the effluents. Furthermore, the dispersion of treated effluents in the Paraguay River is very fast and occurs very close to the discharge location (between 0.37 and 0.42 m), and this point is located upstream of the water intake for the pulp mill.

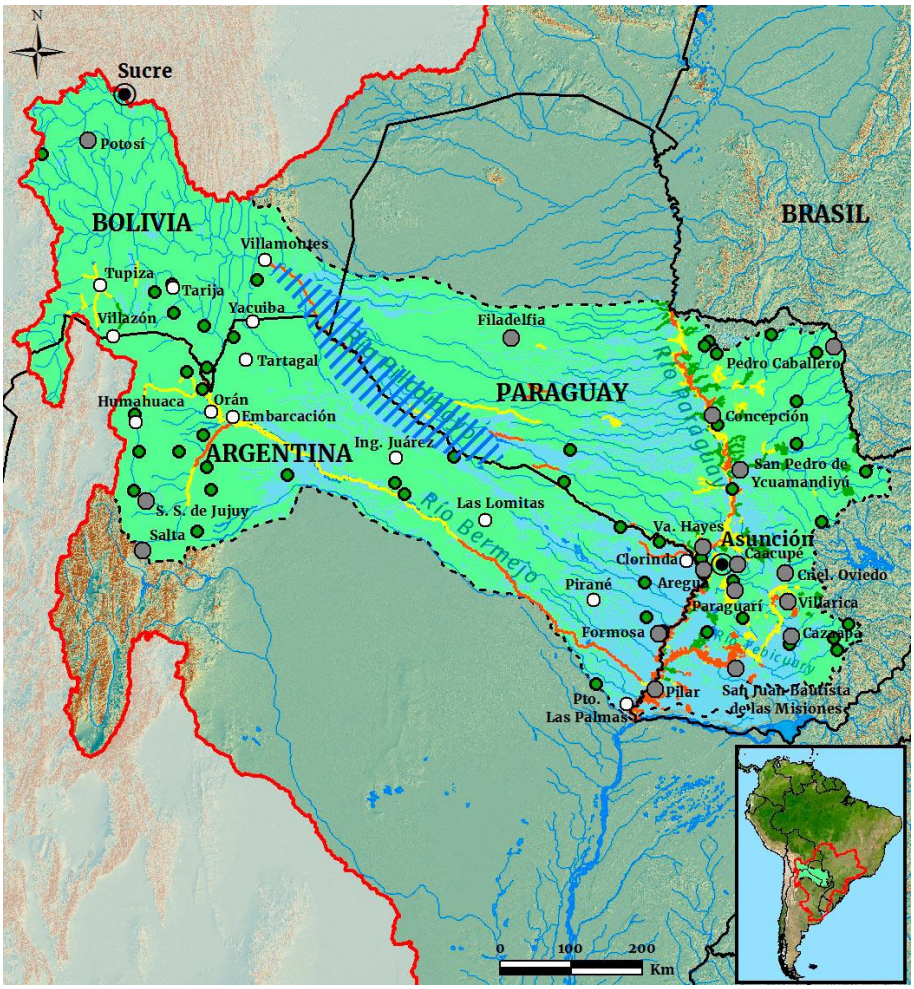

Figure 63 – Map of sub-basins of Medio and Bajo Paraguay. Source: CIC (2017)

The Paraguay river rises in the Chapada de Parecís (Brazil) and, after 2,550 km, flows into the Paraná River, at the height of the city of Resistencia (Argentina) (CIC, 2020). The city of Asunción, the capital of Paraguay, is located along the main course of the river (CIC, 2017).

The Paraguay river and all Paraguay's surface water resources are classified as a Class 2 river, according to SEAM Resolution n. 255/2006.

Its left bank tributaries are the Aquidabán, Jejui, Aguaray, and Tebicuary rivers and its right bank tributaries are the Pilcomayo and Bermejo rivers (CIC, 2017).

Figure 64 – Paraguay river. Source: Pöyry Tecnologia (2019)

The floodplains on the banks, the enormous volume of solid material carried by the Bermejo river and the backwaters produced by the waters of the Paraná River, which cause irregularities in the river's regime and changes in its year-on-year variation, are its main characteristics (CIC, 2020).

The flood plain of the Paraguay river and its continuation in the Paraná river determine a hydrological continuum of wetlands and a biological corridor that extends from north to south from the great Pantanal in the Upper Paraguay, through the wetlands (CIC, 2017).

A summary of average annual flows (period 1971-2010) of the Paraguay river is presented in the table below.

Table 9 – Summary of average annual flows of the Paraguay river to its confluence with the Paraná river

Points	Simulated flow rate (m^3/s)	Observed flow rate (m^3/s)	Period
Paraguay river at Puerto Pilcomayo	3,805	3,964	1971-2010
Paraguay river in Puerto Bermejo	5,091	4,696	
Paraguay river at Concepción Hydrological Station	-	2,179	-

Source: Adapted from CIC (2017)

Demand for Water Resources

The main activities related to water use in the basin are consumptive demands (population, livestock, irrigation and industrial), mining, hydroelectricity and navigation.

Consumption demands

Urban services related to water demand involve drinking water and sanitation services. The demand for drinking water supply -depending on the location of the urban area in question- is met by large rivers such as Paraguay and also by groundwater (CIC, 2017).

With respect to sanitary sewerage, low coverage is a critical problem. Every day, 2.9 million cubic meters of untreated sewage are discharged into the Paraguay river and only 11% of the sewage is treated before reaching the river (ESSAP, 2020).

Land use is changing rapidly, in the Paraguay river system, in Brazilian territory, leading to the opening or extension of the agricultural and livestock frontier, due to the cultivation of soybeans and the exploitation of livestock (CIC, 2017).

Agriculture in Paraguay occupies the eastern region of the country, with a high participation of mechanized activities, due to the predominance of soybean cultivation. Pasture cultivation areas have experienced considerable variation in recent years due to changes in land use (CIC, 2017).

The industrial sector accounts for most of the country's industrial production in the Paraná systems (CIC, 2017).

The values of consumer demand presented in the Paraguayan sub-basin indicate higher consumption in terms of population, livestock and irrigation. The irrigation demand is higher with 552 Hm^3/year (37%), followed by livestock with 484 Hm^3/year (32%) and population 443 Hm^3/year (30%) (CIC, 2015). The consumption by industry is the lowest with 10 Hm^3/year (1%), as presented in the table and figure below.

The participation of the Paraguayan sub-basin in the River Plate Basin corresponds to only 4.5%.

Table 10 – Consumption demand by usage in Hm^3/year

Population	Cattle raise	Irrigation	Industrial	Others	Total	Percentage of the Plata basin
443	484	552	10	-	1.489	4.5%

Source: Adapted from CIC (2015)

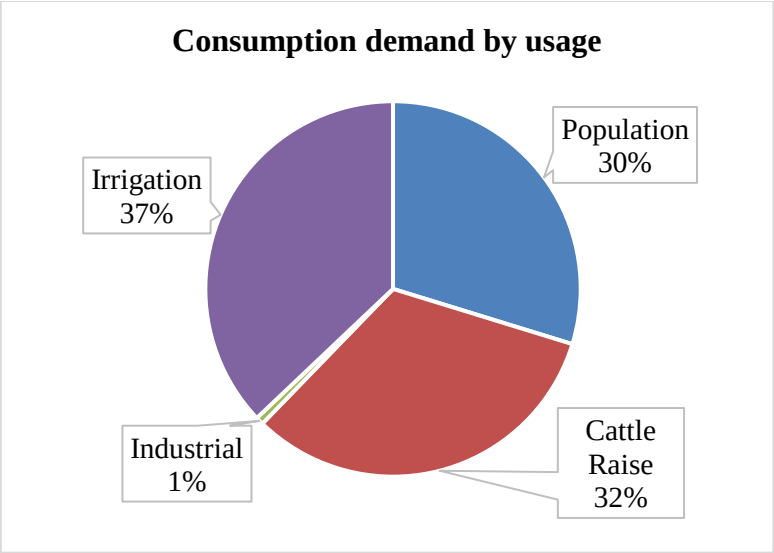

Figure 65 – Consumption demand by usage. Source: Adapted from CIC (2015)

Mining

One of the important environmental aspects of mining is the products used in the activity, which are deposited in the sediments of the rivers in the Basin and generate accumulated effects historically downstream from the production areas (CIC, 2017).

On a larger scale, the pollution generated by mining is mainly observed in the Paraguay River system, particularly in two of the main tributary sub-basins, the Bermejo and the Pilcomayo (CIC, 2017).

Hydroelectricity

The Plata Basin has a very important hydroelectric generation capacity. Its use means a relevant portion of the energy generation in the countries involved. For Paraguay in particular, it represents the largest percentage of its GDP (CIC, 2017). There are also two hydroelectric plants, Iguazú and Acaray, located entirely in Paraguay. Of course, there is no hydroelectric plant on the Paraguay River in the factory's area of influence.

Navigation

For Paraguay, the waterways of the Paraguay and Paraná rivers represent a fundamental factor in its foreign trade, given its status as a Mediterranean country, since they have provided access to the sea since colonial times (CIC, 2014).

In the regional context, these routes are now a fundamental pillar of integration of the regions of the Plata Basin, and have become an important means of transporting cargo, due to the advantages of river transport (CIC, 2014).

The Paraguay river, the most important waterway in the country, has the characteristics of a plain river, where, due to the natural process of the river, subject to erosion, transport and sedimentation, morphological changes occur in the bed, which changes the navigation channel during time (CIC, 2014).

The variable levels of the river, subject to the precipitation regime in its basin, determine a hydrological cycle of the Paraguay river that we can classify into Low Waters (November, December, January, February), High Waters (May, June, July, August), and Medium Waters (March, April, September, October) (CIC, 2014).

In periods of low-level water there are usually difficulties in navigation, because the low levels of the river produce the appearance of the critical crossings. It should be noted that the Paraguay river does not have any artificial flow regulation system but due to anomalies its hydrological cycle is sometimes altered (CIC, 2014).

Navigation in the Plata Basin is done in a complex system on the Paraguay river. Based on this, there is a program called waterway Paraguay-Paraná (CIC, 2014).

This waterway is the main route that connects the countries of the La Plata Basin, being an important route because of its capacity to transport large loads (CIC, 2017).

The Paraguay-Paraná Waterway is a regional agreement between Argentina, Bolivia, Brazil, Paraguay and Uruguay to facilitate navigation and foreign and domestic trade. It is made up of the Paraguay, Paraná and Uruguay Rivers. It is one of the longest natural waterways in the world: 3,442 km, and extends from Puerto Cáceres (Brazil) to Nueva Palmira (Uruguay), as illustrated in the figure below. It is one of the most significant transport routes for the integration of Mercosur (MAGYP. 2020).

Figure 66 – Map with waterways of Plata Basin. Source: CIC (2017)

The Availability-Demand Ratio

Water resource uses can lead to conflicts when there is no balance between availability and demand for consumptive uses or when non-consumptive uses alter the conditions of the water system, with its variability in time and space (CCC, 2017).

The following table presents a qualitative evaluation of water uses in the Upper and Lower Paraguay sub-basins. In the Upper Paraguay sub-basin there are problems of navigation, recreation/tourism and aquaculture/fishing, and some problems of irrigation and conflict of uses. In the Lower Paraguay sub-basin there are problems of navigation, and some problems of human supply, irrigation and conflict of uses, Recreation/Tourism, Aquaculture/Fishing and conflict of uses.

Table 11 – General qualitative evaluation of water usage

Water usage	Sub-basin	
	Upper Paraguay	Lower Paraguay
Human supply	There are no dominant problems	There are only a few problems
Irrigation	There are only a few problems	There are only a few problems
Hydropower	There are no dominant problems	There are no dominant problems
Navigation	There are problems	There are problems
Recreation/Tourism	There are problems	There are only a few problems
Fishing/Water farming	There are problems	There are only a few problems
Conflict of Uses	There are only a few problems	There are only a few problems

Source: Adapted from CIC (2017).

Quality

Special consideration should be given to mining activity in the upper basin of the Paraguay river in Bolivia and Brazil. There are tin deposits in the form of cassiterite and acid drainage, a consequence of mining activity and its environmental liabilities, which contaminate rivers and groundwater (CIC, 2017).

Downstream, in Paraguay, the greatest loads of pollutants come from agricultural activity (crops and pastures) and, mainly, from discharges of domestic and industrial effluents in areas near large urban centers such as Concepción (CIC, 2017).

For the ESIA, three water quality monitoring campaigns were carried out on the Paraguay River at two points, one upstream and the other downstream from the raw water intake and treated effluent discharge locations of the future pulp mill, respectively.

9.9.2.2 Arroyo Seco

Arroyo Seco is part of the Aquidabán Hydrographic Unit and is a tributary of the Paraguay river. It flows downstream from the water intake point of the PARACEL pulp mill.

Arroyo Seco, as well as all of Paraguay's surface water resources are classified as a Class 2 river, according to SEAM Resolution n. 255/2006.

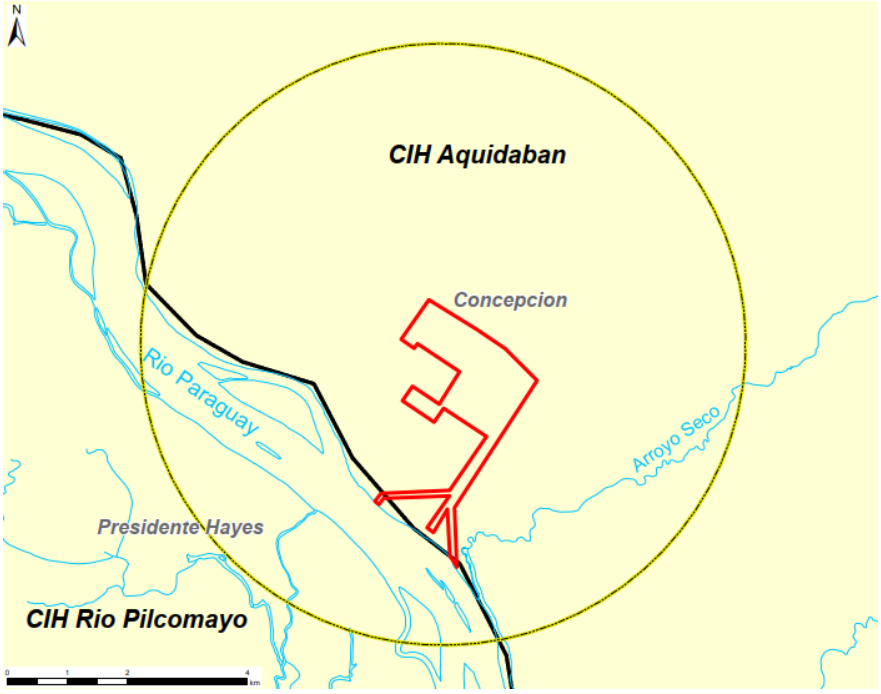

Figure 67 – Location map of Arroyo de Seco.

9.9.3 Surface water and sediment quality

This item presents the results of the Surface Water and Sediment Quality Monitoring report of the Paraguay River, in the location planned for the collection of raw water and treated effluent disposal from the PARACEL pulp mill.

The purpose of the monitoring is to verify the quality of the water and sediments of the Paraguay River before the implementation and operation of the pulp mill (background).

Surface water and sediment sampling was performed at two (2) points and three (3) campaigns, covering the region's dry and rainy periods. The campaigns were carried out on the following dates:

- 1st Campaign, October 25, 2019, dry season
- 2nd Campaign, December 15, 2019, rainy season;
- 3rd Campaign, February 17, 2020, rainy season.

It is worth mentioning that a total of 6 campaigns have been planned, yet, due to the coronavirus pandemic, it was not possible to execute the collection of water and sediment samples.

This report was prepared using SEAM Resolution n 222/2002, which determines the standard for water quality in the national territory.

The complete report is presented in **ANNEX I** of this document.

9.9.3.1 Monitoring points

The sampling points were established with the objective of knowing the quality of surface water and sediments in the region where the PARACEL pulp mill is located before its operation - that is why it is considered a background for future monitoring studies. The definition of the sampling points was based on the raw water intake and treated liquid effluent discharge points of the future pulp mill, located on the Paraguay River, as shown in the figure below.

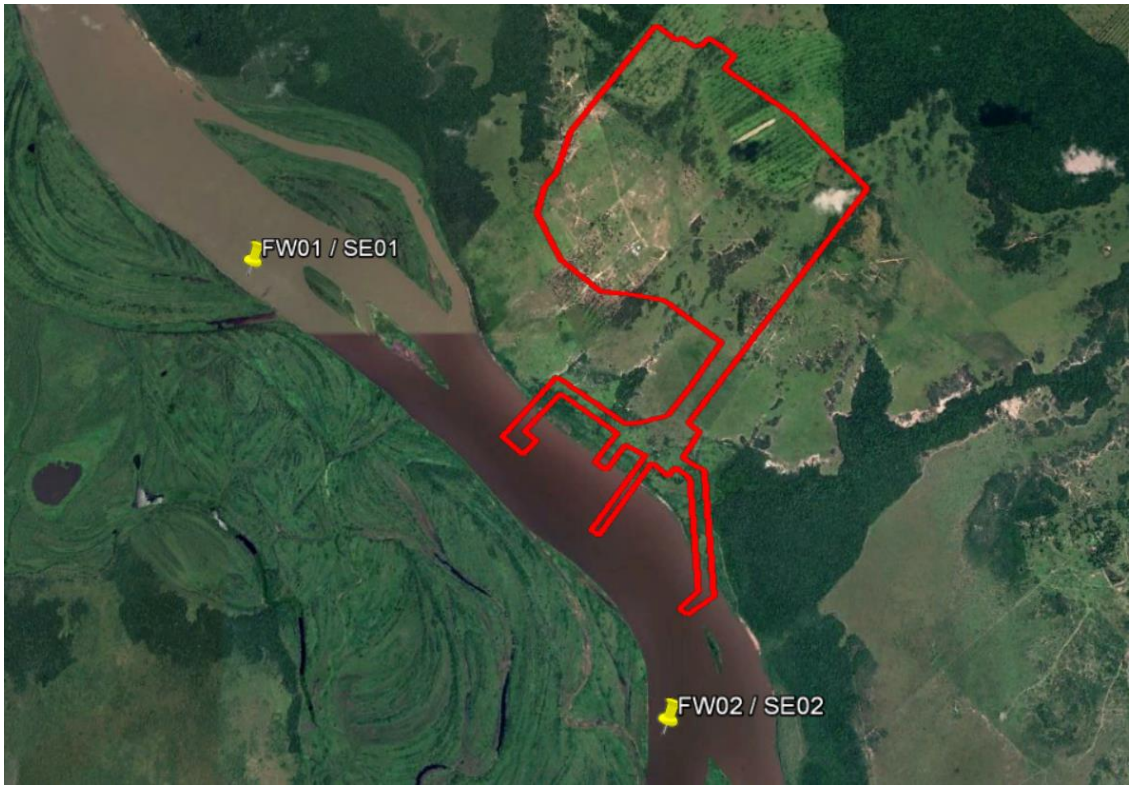

Figure 68 – Location of surface water and sediment sampling points. Source: Pöyry Tecnologia (2021)

Table 12 – Coordinates of surface water and sediment sampling points

Point	Coordinates
FW01 / SE01	23°15'16.51"S, 57°31'31.62"O
FW02 / SE02	23°17'17.54"S, 57°29'32.41"O

Source: Pöyry Tecnologia (2020)

Figure 69 – Point FW01 / SE01. Source: Pöyry Tecnologia (2020)

Figure 70 – Point FW02 / SE02. Source: Pöyry Tecnologia (2020)

9.9.3.2 Standards

To monitor current surface water and sediment conditions in the Paraguay river, in the region of intake water and discharge of treated effluents from the pulp mill, the main control parameters for Class 2 rivers of SEAM Resolution n. 222/2002 were considered.

9.9.3.3 Methods

The sampling of surface water and sediments was verified according to the rules and procedures of the Standard Methods for the Examination for Water and Wastewater of the EPA/USA. The type of sampling was simple (exact), i.e., sampling surface water or sediment in sufficient quantity for analysis.

Most of the sampling and analysis of the parameters were executed by INYMA CONSULT Laboratory, with the exception of the analysis of Chlorates, AOX, Paraquat and 2.4D (surface water); Percentage of Solids and 2.4D (sediment) were executed by BIOAGRI AMBIENTAL LTDA. (Mérieux NutriSciences).

The Paraguayan laboratory INYMA CONSULT is in the process of accreditation, currently interrupted due to the COVID-19 pandemic. INYMA's professional solvency is recognized by several government agencies, such as ERSSAN, for drinking water analysis and all analysis protocols were presented at MADES. INYMA is also the reference laboratory for CONALAYPA (National Commission for the Management of Lake Ypacaraí) and is the only one in Paraguay that participates since 2009 in annual evaluations of interlaboratory analysis with the samples provided by INTI (National Institute of Industrial Technology) of Argentina.

Part of the tests conducted by INYMA were referred to laboratories accredited in these determinations. The analysis of some heavy metals was performed by MULTILAB Laboratory and the analysis of pesticides and glyphosates in water and sediments in ANALÍTICA S.A.

The Brazilian laboratory BIOAGRI AMBIENTAL LTDA (Mérieux NutriScience) is accredited for testing and calibration by ISO 17025, with certificate issued by CGCRE (General Coordination of Accreditation of INMETRO - Brazil).

Figures below presents INYMA's certificates of participation in INTI's interlaboratory tests (year 2017) and the accreditation certificate of BIOAGRI AMBIENTAL LTDA. The other certificates can be found in the attached files of VOLUME IV - Analytical Reports (Surface Water and Sediment Monitoring Report).

Instituto Nacional de Tecnología Industrial INTI

Ministerio de Producción Presidencia de la Nación

INTI Química INTERLABORATORIOS

INTI SAI

Programa de Ensayos de Aptitud

"Aguas – Parámetros Básicos"

Ensayo Nº 8 – Año 2017 (PRQ-03/2017)

Por cuanto el laboratorio ***INYMA CONSULT S.R.L.***

ha participado en este ensayo de aptitud reportando datos de medición satisfactorios para los parámetros: ***dureza, alcalinidad, pH, cloruro, nitrato, sulfato, calcio, potasio, sodio, sólidos totales***
se extiende el presente certificado que así lo acredita.

Lic. Pablo Álvarez *Lic. Ariel Galli* *Ing. Sofía Frangie*

Figure 71 – Certificate INYMA Laboratory in attendance to sampling realized by INTI among labs (year 2017)

Instituto Nacional de Metrologia, Qualidade e Tecnologia – Inmetro
Coordenação Geral de Acreditação

Signatário dos Acordos de Reconhecimento Mútuo da International Laboratory Accreditation Cooperation (ILAC), da Interamerican Accreditation Cooperation (IAAC) e International Accreditation Forum (IAF).

Certificado de Acreditação

Acreditação nº CRL 0677

Acreditação Inicial: 03-02-2014

Bioagri Ambiental Ltda
Rua Dr. José Elias, 98 - Alto da Lapa - São Paulo/SP

A Coordenação Geral de Acreditação do Inmetro (Cgcre) concede acreditação ao Organismo de Avaliação da Conformidade acima identificado, no endereço citado, segundo os requisitos estabelecidos na ABNT NBR ISO/IEC 17025:2017. Esta acreditação constitui a expressão formal do reconhecimento de sua competência para realizar atividades de ensaios, conforme Escopo de Acreditação.

Assinado de forma digital por ALDONEY FREIRE COSTA:54879590720
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Aldoney Freire Costa
Coordenador Geral de Acreditação

A situação atual da acreditação e seu escopo devem ser verificados no endereço eletrônico www.Inmetro.gov.br/credenciamento/laboratoriosAcreditados.asp

MOD-CGCRE-024 – Rev. 06 – Apr. MAR/19 – Pg. 01/01

Figure 72 – Certificate of accreditation of the Bioagri Ambiental Ltda

For the execution of the analysis, a specific analytical method was used for the parameters evaluated, as presented in the following tables:

Table 13 – Methods of analysis for surface water

Tests	Methods of analysis
Total Alkalinity	SM 2320 B
Aluminium (Al)	@ICP-MS
Total Arsenic (As)	@ICP-MS
Barium (Ba)	@ICP-MS
Cadmium (Cd)	@ICP-MS
Calcium	SM 3500 Ca D. EDTA
Lead (Pb)	@ICP-MS
Free Cyanide (CN^-)	SM 4500-CN. E Colorimetric method
Chlorine	SM 4500-Cl Argentometric method
Copper (Cu)	@ICP-MS
Fecal Coliforms	SM 9222 D. Fecal Coliform Membrane Filter
Electrical conductivity at 25°C	SM 2510. Laboratory Method
True colour	SM 2120 B. Visual Comparison Method
Total chrome (Cr)	SM 3500-Cr. Colorimetric Method
Hexavalent chromium (Cr^{6+})	SM 3500-Cr. Colorimetric Method
Trivalent Chromium (Cr^{3+})	Calculation
Biochemical Oxygen Demand (BOD_5)	SM 5210. 5-Day BOD Test
Total Hardness ($CaCO_3$)	SM 2340. EDTA Titrimetric Method
Tin (Sn)	@ICP-MS
Soluble iron (Fe^{2+}) (in situ)	SM 3500-Fe D
Total Phosphorus (P)	SM 4500-P. Ascorbic Acid Method
Glyphosate	@LC-MS/MS
Phenol Index (C_6H_5OH)	SM 5530. Chloroform Extraction Method
Magnesium	SM 3500 Mg E. Calculation
Manganese (Mn)	Hach method 8149
Total Mercury (Hg)	@ICP-MS
Nickel (Ni)	@ICP-MS
Nitrate ($N\text{-}NO_3^-$)	EPA method 352.1
Nitrite ($N\text{-}NO_2^-$)	SM 4500-NO_2. Colorimetric Method
Ammonia Nitrogen (NH_3)	SM 4500-NH_3. Phenate Method
Total Kjeldahl Nitrogen (NTK)	SM 4500-N_{org}. Semi-Micro-Kjeldahl Method

Tests	Methods of analysis
Oils and Fats	SM 5520. Partition-Gravimetric Method
Dissolved Oxygen	SM 4500-O. Membrane Electrode Method
Polychlorinated Biphenyls (PCB's)	@GC-MS
Pesticides in water	@SPME-GC-MS
pH (on site)	SM 4500-H^+. Electrometric Method
Potassium	SM 3500-K. Flame Emission Photometric Method
Selenium (Se)	@ICP-MS
Silica	SM 4500 –Si D
Sodium (Na)	SM 3500-Na. Flame Emission Photometric Method
Total Dissolved Solids	SM 2540 C. Total Solids Dried at 180ºC
Sulphate (SO_4^{-2})	SM 4500 - SO_4^{-2}. Turbidimetric Method
Turbidity	SM 2130. Nephelometric Method
Zinc (Zn)	@ICP-MS
Semi-volatile organic compounds SVOC	EPA 8270 D:2014, POP PA 076 - Rev. 17 / Preparation: EPA 3510 C:1996, 3535 A:2007
Anions	EPA 300.0: 1993, 300.1: 1999, POP PA 032 - Rev. 13
Paraquat	POP 05.192/05 - LC-MS/MS

SM: Standard Methods for the Examination of water and wastewater. 17th Edition. APHA, AWWA, WPCF. 1989.

Table 14 – Methods of analysis of sediments

Tests	Methods of analysis
Aluminium (Al)	SM 3500-Al D
Antimony (Sb)	@ICP-MS
Total Arsenic (As)	SM 3500-As C. Silver Diethyldithiocarbamate Method
Barium (Ba)	@ICP-MS
Boron (B)	@ICP-MS
Cadmium (Cd)	@ICP-MS
Copper (Cu)	ICUMSA
Total Chrome (Cr)	SM 3500 - Cr. Colorimetric Method
Hexavalent Chromium (Cr^{6+})	SM 3500 - Cr. Colorimetric Method
Trivalent Chromium (Cr^{3+})	Cálculo
Biochemical Oxygen Demand (BOD_5)	SM 5210. 5-Day BOD Test
Tin (Sn)	@ICP-MS
Total Phosphorus (P)	SM 4500-P. Ascorbic Acid Method
Glyphosate	@LC-MS/MS
Total Mercury (Hg)	@ICP-MS
Nitrate ($N\text{-}NO_3^-$)	EPA method 352.1
Nitrite ($N\text{-}NO_2^-$)	SM 4500-NO_2. Colorimetric Method
Total Kjeldahl Nitrogen (NTK)	SM 4500-N_{org}. Semi-Micro-Kjeldahl Method
Nickel (Ni)	@ICP-MS
Polychlorinated biphenyls (PCBs)	@GC-ECD
Chlorinated Pesticides in Sediments	@LC/MS/MS
Silver (Ag)	@ICP-MS
Lead (Pb)	SM 3500-Pb C.
Selenium (Se)	Osburn, R. L., A. D. Shendrikar, and P. W. West, Anal. Chem., 43 (4), 594-597 (1971)
Zinc (Zn)	@ICP-MS
Percentage of Solids	SMWW, 22ª Edition, 2012 - Method 2540 G
Semi-Volatile Organic Compounds (SVOCs)	EPA 8270 D:2014, POP PA 076 - Rev. 17 / Preparation: EPA 3550 C:2007

SM: Standard Methods for the Examination of water and wastewater. 17th Edition. APHA, AWWA, WPCF. 1989.

Figure 73 – Surface water sampling. Source: Pöyry Tecnologia (2020)

Figure 74 – Equipment for sampling surface water at depth. Source: Pöyry Tecnologia (2020)

Figure 75 – pH and temperature measurement *in situ*. Source: INYMA (2019)

Figure 76 – Dredging for sampling of the sediments. Source: Pöyry Tecnologia (2020)

9.9.3.4 Results

The following tables present the results of the surface water and sediment analysis for the three campaigns. The results of the surface waters were compared with the standards established for class 2 water bodies by SEAM Resolution n. 222/02. With regard to sediments, it should be noted that there is no legal reference for comparing the results.

9.9.3.4.1 Surface waters

Table 15 – Results of 1st, 2nd and 3rd campaigns – Surface waters – FW01 (Parameters *in situ*)

Parameters *in situ*	Unit	Results			Resolution n. 222/02*
		1st	2nd	3rd	
Depth: 0.5 meters					
pH	-	7.66	7.16	7.15	6.0 – 9.0
Temperature	ºC	26.5	31.1	32.7	-
Conductivity at 25ºC	µS/cm	162	322	3182	-
Dissolved Oxygen	mg/L	7.06	6.60	5.80	≥ 5
Oxygen Saturation	%	89	81	80	-
Depth: 2.5 meters **					
pH	-	7.53	7.32	7.70	6.0 – 9.0
Temperature	ºC	26.9	31.5	32.4	-
Conductivity at 25ºC	µS/cm	141.5	313	203	-
Dissolved Oxygen	mg/L	7.29	7.20	6.00	≥ 5
Oxygen Saturation	%	92	91	83	-
Depth: 5.5 meters ***					
pH	-	7.60	7.12	7.15	6.0 – 9.0
Temperature	ºC	27.3	30.6	32.5	-
Conductivity at 25ºC	µS/cm	150	346	183	-
Dissolved Oxygen	mg/L	7.80	7.26	6.11	≥ 5
Oxygen Saturation	%	100	96	85.4	-

* Resolution SEAM n. 222/02, article 3rd for surface water Class 2.

** In the 2nd campaign, the Depth was 3.0 meters and in the 1st campaign was 2.5 meters.

*** In the 2nd campaign, the Depth was 6.0 meters and in the 1st campaign was 5.0 metros.

Table 16 – Results of 1st, 2nd and 3rd Campaigns – Surface waters – FW01

Parameter	Unit	Results			Detection Limits	Limits of Resolution SEAM n. 222/2002 *
		1st	2nd	3rd		
Physicochemicals						
Oils and Fats	mg/L	ND	ND	ND	2	Absent
Total Alkalinity ($CaCO_3$)	mg/L	34.7	30.8	34.7	0.56	-
AOX**	µg/L	120	220	110	20	-
Free Cyanates (CN^-)	mg/L	ND	ND	ND	0.01	Max. 0.2
Chlorates**	mg/L	ND	0.04	0.02	0.02	-
Chlorides (Cl)	mg/L	28.5	64.8	23.6	0.25	Max. 250
Color	uPtCo	75	65	**82**	< 1	≤ 75
Biochemical Oxygen Demand (BOD_5)	mg/L	ND	1.6	1.4	0.5	≤ 5
Total Hardness ($CaCO_3$)	mg/L	32	41	36.5	0.5	Max. 300
Total Phosphorus (P)	mg/L	0.021	**0.090**	**0.160**	0.004	Max. 0.05
Phenol Index (1)	mg/L	ND	ND	ND	0.024	Max. 0.5
Fluctuating Materials	mg/L	Absent	Absent	Absent	-	Absent
Nitrate ($N\text{-}NO_3^-$)	mg/L	0.30	1.98	1.01	0.03	Max. 10
Nitrite ($N\text{-}NO_2^-$) in situ	mg/L	0.003	0.004	ND	0.002	Max. 1.0
Ammonia Nitrogen (N)	mg/L	ND	ND	0.014	0.006	-
Non-ionized ammonia (NH_3) (calculation)	mg/L	ND	ND	ND	-	Max. 0.02
Total Kjeldahl Nitrogen (NTK)	mg/L	**0.84**	**1.18**	**1.01**	0.03	Max. 0.6
Potassium (K)	mg/L	2.38	3.22	2.50	0.1	-
Sodium (Na)	mg/L	18.3	44.0	21.5	0.5	Max. 200
Total dissolved solids	mg/L	124	220	139	5	Max. 500
Sulphate (SO_4^{-2})	mg/L	3.6	12	17	1	Max. 250
Turbidity	UNT	36.98	61.43	35.8	0.02	≤ 100
Bacteriological						
Fecal Coliforms	UFC/100ml	< 10	11	< 10	10	≤ 1000
Metals						
Total Aluminium (Al)	mg/L	**3.55**	**7.00**	**3.00**	0.05	Max. 0.2
Arsenic (As)	mg/L	0.008	0.006	0.003	0.001	Max. 0.01
Barium (Ba)	mg/L	ND	0.06	ND	0.05	Max. 2.0
Cadmium (Cd)	mg/L	ND	ND	ND	0.0005	Max. 0.001
Copper (Cu)	mg/L	ND	ND	ND	0.01	Max. 1.0
Total Chrome (Cr)	mg/L	ND	ND	ND	0.005	Max. 0.55
Hexavalent Chromium (Cr^{6+})	mg/L	ND	ND	ND	0.005	Max. 0.05
Trivalent Chromium (Cr^{3+})	mg/L	ND	ND	ND	0.005	Max. 0.5

Parameter	Unit	Results			Detection Limits	Limits of Resolution SEAM n. 222/2002 *
		1st	2nd	3rd		
Tin (Sn)	mg/L	ND	ND	ND	0.005	Max. 2.0
Soluble iron (Fe^{+2}) in situ	mg/L	**0.35**	0.17	**0.55**	0.05	Max. 0.3
Manganese (Mn)	mg/L	0.08	0.08	ND	0.025	Max. 0.1
Total Mercury (Hg) (2)	mg/L	ND	ND	ND	0.001	Max. 0.002
Nickel (Ni)	mg/L	0.006	0.003	0.005	0.001	Max. 0.025
Lead (Pb)	mg/L	0.002	0.004	ND	0.001	Max. 0.01
Selenium (Se)	mg/L	0.003	0.002	ND	0.001	Max. 0.01
Zinc (Zn)	mg/L	0.07	ND	ND	0.05	Max. 3.0
Pesticides						
2.4 D**	µg/L	ND	ND	0.005	0.005	-
Alaclor	mg/L	ND	ND	ND	0.014	0
Anthracine	mg/L	ND	ND	ND	0.008	0.003
Gamma Chlordane	mg/L	ND	ND	ND	0.012	0
4.4' - DDT	mg/L	ND	ND	ND	0.007	0.002
Endosulfan	mg/L	ND	ND	ND	0.019	0.056
Endrin	mg/L	ND	ND	ND	0.009	0.002
Glyphosate	mg/L	ND	ND	ND	2.7	0.7
Heptachlor	mg/L	ND	ND	ND	0.005	0
Lindane (BHC)	mg/L	ND	ND	ND	0.002	0.0002
Methoxychlorine	mg/L	ND	ND	ND	0.005	0.04
Paraquat**	µg/L	ND	ND	ND	0.1	-
Polychlorinated Biphenyls (PCB's) (3)	mg/L	ND	ND	ND	0.2	0
Propanil	mg/L	ND	ND	ND	0.132	0.02
Simazine	mg/L	ND	ND	ND	0.027	0.004

* Resolution SEAM n. 222/02, article 3 for surface water – class 2.

**Analysis by Bioagri Laboratory.

(1) Maximum rate of Phenols allowed for the discharge of effluents into surface water bodies, article 7 of SEAM Resolution n. 222/02.

(2) Sum of organic and inorganic mercury.

(3) The outsourced laboratory reports the PCB result as less than 0.2 microgram/L, which is the limit of quantification of the method used.

ND: no detectable.

The detection limits of organic compounds are expressed in micrograms per liter (µg/L).

Table 17 – Results of 1st, 2nd and 3rd Campaigns – Surface Waters – FW02 (Parameters *in situ*)

Parameters *in situ*	Unit	Results			Limits of Resolution n. 222/02*
		1st	2nd	3rd	
Depth: 0.5 meters					
pH	-	7.56	7.11	7.12	6.0 – 9.0
Temperature	ºC	26.8	30.7	32.4	-
Conductivity at 25ºC	µS/cm	177	322	-	-
Dissolved Oxygen	mg/L	7.11	6.37	5.93	≥ 5
Oxygen Saturation	%	89.5	85	82	-
Depth: 2.5 meters **					
pH	-	7.50	7.17	7.12	6.0 – 9.0
Temperature	ºC	26.8	30.7	32.6	-
Conductivity at 25ºC	µS/cm	164	318	174	-
Dissolved Oxygen	mg/L	7.70	7.18	6.05	≥ 5
Oxygen Saturation	%	97.2	91	82.4	-
Depth: 5.0 meters ***					
pH	-	7.50	7.14	7.08	6.0 – 9.0
Temperature	ºC	26.7	31.0	32.8	-
Conductivity at 25ºC	µS/cm	174	319	162	-
Dissolved Oxygen	mg/L	7.80	7.14	6.20	≥ 5
Oxygen Saturation	%	100	91	86	-

* Resolution SEAM n. 222/02, article 3rd for surface Waters Class 2.

** In the 2nd campaign, the Depth was 2.0 meters and in the 1st campaign was 2.5 meters.

*** In the 2nd campaign, the Depth was 4.0 meters and in the 1st campaign was 5.0 meters.

Table 18 – Results of 1st, 2nd and 3rd Campaign – Surface Waters – FW02

Parameters	Unit	Results			Detection limits	Limits of Resolution n. 222/02*
		1st	2nd	3rd		
Physicochemicals						
Oils and Fats	mg/L	ND	ND	ND	2	Absent
AOX**	µg/L	100	250	62	20	-
Free Cyanides (CN^-)	mg/L	ND	ND	ND	0.01	Max. 0.2
Chlorates**	mg/L	ND	0.04	ND	0.02	-
Color	uPtCo	70	**80**	75	1	≤ 75
Biochemical Oxygen Demand (BOD_5)	mg/L	ND	1.6	1.5	0.5	≤ 5
Total Hardness ($CaCO_3$)	mg/L	34	41	35.0	0.5	Max. 300
Total Phosphorus (P)	mg/L	**0.063**	**0.080**	**0.135**	0.004	Max. 0.05
Phenol Index (1)	mg/L	ND	ND	ND	0.024	Max. 0.5
Fluctuating Materials	mg/L	Absent	Absent	Absent	-	Absent
Nitrate ($N\text{-}NO_3^-$)	mg/L	0.28	1.92	0.27	0.03	Max. 10
Nitrite ($N\text{-}NO_2^-$) in situ	mg/L	0.008	0.006	ND	0.002	Max. 1.0
Ammonia Nitrogen (N)	mg/L	ND	ND	0.015	0.006	-
Non-ionized ammonia (NH_3) (calculation)	mg/L	ND	ND	ND	-	Max. 0.02
Total Kjeldahl Nitrogen (NTK)	mg/L	**1.63**	**1.63**	**1.03**	0.03	Max. 0.6
Sodium (Na)	mg/L	19.7	42.6	22.0	0.5	Max. 200
Total Dissolved Solids	mg/L	130	213	124	5	Max. 500
Sulphate (SO_4^{-2})	mg/L	4.2	12.4	13.5	1	Max. 250
Turbidity	UNT	38.97	66.74	38.1	0.02	≤ 100
Bacteriological						
Fecal Coliforms	UFC/100ml	< 10	13	< 10	10	≤ 1000
Metals						
Aluminum Total (Al)	mg/L	**4.07**	**5.9**	**4.00**	0.05	Max. 0.2
Arsenic (As)	mg/L	0.008	0.005	0.003	0.001	Max. 0.01
Barium (Ba)	mg/L	ND	0.06	ND	0.05	Max. 2.0
Cadmium (Cd)	mg/L	ND	ND	ND	0.0005	Max. 0.001
Copper (Cu)	mg/L	ND	ND	ND	0.01	Max. 1.0
Total Chrome (Cr)	mg/L	ND	ND	ND	0.005	Max. 0.55
Hexavalent Chromium (Cr^{6+})	mg/L	ND	ND	ND	0.005	Max. 0.05
Trivalent Chromium (Cr^{3+})	mg/L	ND	ND	ND	0.005	Max. 0.5
Tin (Sn)	mg/L	ND	ND	ND	0.005	Max. 2.0
Soluble iron (Fe^{+2}) in situ	mg/L	**0.61**	0.18	**0.79**	0.05	Max. 0.3

Parameters	Unit	Results			Detection limits	Limits of Resolution n. 222/02*
		1st	2nd	3rd		
Manganese (Mn)	mg/L	0.08	0.09	0.056	0.025	Max. 0.1
Total Mercury (Hg) (2)	mg/L	ND	ND	ND	0.001	Max. 0.002
Nickel (Ni)	mg/L	0.006	0.003	0.006	0.001	Max. 0.025
Lead (Pb)	mg/L	0.002	0.003	ND	0.001	Max. 0.01
Selenium (Se)	mg/L	0.003	0.002	ND	0.001	Max. 0.01
Zinc (Zn)	mg/L	0.07	ND	ND	0.05	Max. 3.0
Pesticides						
2.4 D	µg/L	ND	ND	ND	0.005	-
Alachlor	mg/L	ND	ND	ND	0.014	0
Atrazine	mg/L	ND	ND	ND	0.008	0.003
Gamma Chlordane	mg/L	ND	ND	ND	0.012	0
4.4' - DDT	mg/L	ND	ND	ND	0.007	0.002
Endosulfan	mg/L	ND	ND	ND	0.019	0.056
Endrin	mg/L	ND	ND	ND	0.009	0.002
Glyphosate	mg/L	ND	ND	ND	2.7	0.7
Heptachlor	mg/L	ND	ND	ND	0.005	0
Lindane (BHC)	mg/L	ND	ND	ND	0.002	0.0002
Paraquat**	µg/L	ND	ND	ND	0.1	-
Methoxychlorine	mg/L	ND	ND	ND	0.005	0.04
PCBs (Polychlorinated biphenyls) (3)	mg/L	ND	ND	ND	0.2	0
Propanil	mg/L	ND	ND	ND	0.132	0.02
Simazine	mg/L	ND	ND	ND	0.027	0.004

* SEAM Resolution n. 222/02, Article 3 for class 2 surface waters.

**Analysis carried out by the Bioagri laboratory.

(1) Maximum rate of Phenols allowed for the discharge of effluents in surface water bodies, article 7 of SEAM Resolution n. 222/02.

(2) Sum between organic mercury and inorganic mercury.

(3) The outsourced laboratory reports the PCB result as less than 0.2 micrograms/L, which is the limit of quantification of the method used.

ND: not detectable.

Limits of detection of organic compounds are expressed in micrograms per liter (µg/L).

9.9.3.4.2 Sediments

Table 19 – Results of 1st, 2nd and 3rd Campaigns – Sediments – SE01

Parameter	Unit	Results			Detection limit	Legal limits
		1st	2nd	3rd		
Physicochemicals						
Humidity	% p/p bu	24.55	25.20	22.80	0.1	SR
Biochemical Oxygen Demand (BOD_5)	mg/kg bu	193	121	128	10	SR
Total Phosphorus (P)	mg/kg bs	51.3	217	235	12	SR
Nitrate (NO_3^-)	mg/kg bs	42.3	17.1	58.2	3.3	SR
Nitrite (NO_2^-)	mg/kg bs	ND	ND	ND	0.2	SR
Total Kjeldahl Nitrogen (NTK)	mg/kg bs	467	570	314	80	SR
Percentage of solids**	% p/p	11.5	73.1	74.4	0.05	SR
Metals						
Aluminium (Al)	%p/p bs	1.88	1.64	4.00	0.2	SR
Antimony (Sb)	mg/kg bs	ND	ND	ND	1	SR
Arsenic (As)	mg/kg bs	2.1	1.8	1.8	1	SR
Barium (Ba)	mg/kg bs	110	72	97	5	SR
Boron (B)	mg/kg bs	5	ND	ND	5	SR
Cadmium (Cd)	mg/kg bs	ND	ND	ND	1	SR
Copper (Cu)	mg/kg bs	ND	4	ND	4	SR
Total Chrome (Cr)	mg/kg bs	21.1	14	20	3	SR
Hexavalent Chromium (Cr^{6+})	mg/kg bs	ND	ND	ND	3	SR
Trivalent Chromium (Cr^{3+})	mg/kg bs	21.1	14	20	3	SR
Total Mercury (Hg)	mg/kg bs	ND	ND	ND	1	SR
Nickel (Ni)	mg/kg bs	5	10	10	1	SR
Silver (Ag)	mg/kg bs	ND	ND	ND	1	SR
Lead (Pb)	mg/kg bs	24	2.7	ND	2	SR
Selenium (Se)	mg/kg bs	< 4	1.8	1.9	0.8	SR
Zinc (Zn)	mg/kg bs	24	24	24	4	SR
Pesticides						
2.4 D**	mg/kg	ND	ND	ND	0.0035	SR
Alachlor	mg/kg bs	ND	ND	ND	0.00380	SR
Atrazine	mg/kg bs	ND	ND	ND	0.00010	SR
Carbofuran	mg/kg bs	ND	ND	ND	0.00016	SR
Diazinon	mg/kg bs	ND	ND	ND	0.00014	SR
Glyphosate	mg/kg bs	ND	ND	ND	0.0027	SR

Parameter	Unit	Results			Detection limit	Legal limits
		1st	2nd	3rd		
PCBs	mg/kg bs	ND	ND	ND	0.2237	SR

bu: sediment drained with humidity from the pores. (wet basis). bs: dry basis (no humidity).

SR: no references.

** Analyses carried out by the laboratory Bioagri.

Table 20 – Results of 1st, 2nd and 3rd Campaigns – Sediments – SE02

Parameter	Unit	Results			Detection limit	Legal limits
		1st	2nd	3rd		
Physicochemicals						
Humidity	% p/p bu	26.43	25.35	24.15	0.1	SR
Biochemical Oxygen Demand (BOD_5)	mg/kg bu	283	247	102	10	SR
Total Phosphorus (P)	mg/kg bs	104	18.1	263	12	SR
Nitrate (NO_3^-)	mg/kg bs	157	ND	52.2	3.3	SR
Nitrite (NO_2^-)	mg/kg bs	ND	865	ND	0.2	SR
Total Kjeldahl Nitrogen (NTK)	mg/kg bs	560	247	271	80	SR
Percentage of solids**	% p/p	70.5	47.9	74.2	0.05	SR
Metales						
Aluminium (Al)	%p/p bs	2.00	1.79	2.60	0.2	SR
Antimony (Sb)	mg/kg bs	ND	ND	ND	1	SR
Arsenic (As)	mg/kg bs	2.6	2.2	1.0	1	SR
Barium (Ba)	mg/kg bs	57	70	107	5	SR
Boron (B)	mg/kg bs	ND	ND	ND	5	SR
Cadmium (Cd)	mg/kg bs	ND	ND	ND	1	SR
Copper (Cu)	mg/kg bs	ND	6	ND	4	SR
Total Chrome (Cr)	mg/kg bs	19.4	13	19	3	SR
Hexavalent Chromium (Cr^{6+})	mg/kg bs	ND	ND	ND	3	SR
Trivalent Chromium (Cr^{3+})	mg/kg bs	19.4	13	19	3	SR
Total Mercury (Hg)	mg/kg bs	ND	ND	ND	1	SR
Nickel (Ni)	mg/kg bs	ND	13	9	1	SR
Silver (Ag)	mg/kg bs	ND	ND	ND	1	SR
Lead (Pb)	mg/kg bs	15	2.3	ND	2	SR
Selenium (Se)	mg/kg bs	4	0.8	ND	0.8	SR
Zinc (Zn)	mg/kg bs	9	26	20	4	SR
Pesticidas						
2.4 D**	mg/kg	ND	ND	ND	0.0035	SR
Alachlor	mg/kg bs	ND	ND	ND	0.00380	SR
Atrazine	mg/kg bs	ND	ND	ND	0.00010	SR
Carbofuran	mg/kg bs	ND	ND	ND	0.00016	SR
Diazion	mg/kg bs	ND	ND	ND	0.00014	SR
Glyphosate	mg/kg bs	ND	ND	ND	0.0027	SR
PCBs	mg/kg bs	ND	ND	ND	0.2237	SR

bu: sediment drained with humidity from the pores. (wet basis). bs: dry basis (no humidity).

SR: no references.

** Analyses carried out by the laboratory Bioagri.

9.9.3.5 Conclusions

In order to define the quality of the surface waters of the Paraguay River before the implementation and operation of the PARACEL dissolving and bleached pulp mill, to be considered as a background and reference for future monitoring studies, three campaigns were carried out to collect and investigate surface water and sediments at two points during dry and rainy seasons.

The results of the surface waters were compared with the standards established for class 2 water bodies by SEAM Resolution n. 222/2002. With regard to sediments, it should be noted that there is no legal reference for comparing the results.

It should be noted that most of the parameters analyzed presented concentrations below the limits established by SEAM Resolution n. 222/2002. In the following, only the results of the parameters in disagreement with the legislation will be commented.

In point FW01, of the physicochemical parameters, total phosphorus showed a concentration of 0.0160 mg/L in the third campaign and 0.09 mg/L in the second, results above the limit of 0.05 mg/L. In the first campaign, the value obtained was 0.021 mg/L, below the limit allowed by legislation. Total Kjeldahl nitrogen showed a concentration above the value permitted by legislation in all three campaigns (limit of 0.06 mg/L): 1.01 mg/L in the third campaign, 1.18 mg/L in the second and 0.84 mg/L in the first.

Also in the third campaign, the recorded color value was 82 uPtCo, above the established limit (≤ 75 uPtCo). In the first two campaigns, the values obtained did not exceed the limit established in SEAM Resolution n. 222/2002.

With regard to metals, the concentration of aluminum obtained was 3.00 mg/L, the lowest recorded in the three campaigns at that time, but still above the limit of 0.2 mg/L. Soluble iron had the highest concentration of the three campaigns, 0.55 mg/L (limit of 0.3 mg/L). Bacteriological and pesticide parameters did not show values higher than those allowed by SEAM Resolution n. 222/2002 in the three campaigns.

In point FW02, of the physicochemical parameters analyzed, in the first campaign, total phosphorus and total Kjeldahl nitrogen showed values higher than those permitted. Unlike the second campaign, the results of the color parameter were kept within the established limit.

With regard to total phosphorus, a concentration of 0.135 mg/L (limit of 0.05 mg/L) was obtained, the highest value recorded in the three campaigns already carried out. For total Kjeldahl nitrogen a concentration of 1.03 mg/L (limit 0.6 mg/L) was obtained, the lowest value recorded in the three campaigns.

For metals, aluminum had a concentration of 4.00 mg/L (limit of 0.2 mg/L), the lowest value recorded in the three campaigns. Soluble iron had the highest concentration in all three campaigns: 0.79 mg/L, above the limit of 0.3 mg/L. It should be noted that a concentration of 0.61 mg/L (above the limit) was obtained in the first campaign and 0.18 mg/L in the second (below the limit).

Bacteriological and pesticide parameters do not exceed the values allowed by SEAM Resolution n. 222/2002.

As was observed in the 3 campaigns, when comparing the results obtained at Point FW01, located upstream of the effluent discharge points of the future PARACEL pulp mill; and at Point FW02, located downstream of the raw water intake point, it is observed that Point FW02 presents higher concentrations, mainly when the parameters

that exceeded the limits of SEAM Resolution n. 222/2002 are observed. It should be noted that there are no sources of contribution that justify the increase in concentrations between the two points. Therefore, it is believed that this fact may be associated with sampling or discharge matters from Arroyo Seco, which should be better explained in the future through the analysis of the results of subsequent campaigns.

Phosphorus and nitrogen are nutrients naturally derived from the dissolution of compounds present in the soil and the decomposition of organic matter, which can contribute to the results found. As this is a region where agricultural activities take place, nutrient concentrations above the permitted limit may also be associated with the use of fertilizers.

As for the values of aluminum and iron in disagreement with the legislation, these can be related to the substrate layer of the soils of the region and therefore can be considered as natural from the surface waters.

Regarding the color parameter at point FW01, it is believed that such non-conformity is associated with the time of harvesting, the rainy period of the region, because there may be an increase in dissolved and suspended solids, mainly material in organic and inorganic colloidal state, thus corroborating the alteration of this parameter.

It should also be noted that, in the third campaign, carried out in February/2020, the Paraguay River showed a higher concentration of dissolved and suspended substances than in the first and second campaigns, held in October and December/2019, respectively. This is due to the severe drought in October, November and December. The increase in precipitation in the region contributed to the alteration of the concentrations of the parameters analyzed, reducing electrical conductivity and all cations and anions.

9.9.4 Water quality provided by ESSAP

To complement the ESIA monitoring campaign, the results of the analysis of raw water from the Paraguay River in the Concepción section, provided by ESSAP (Paraguayan Health Service Company), carried out between 2017 and 2018, will be presented below.

Table 21 – Water quality results by ESSAP

Parameters	Unit	feb/17	apr/17	aug/17	sep/17	dec/17	feb/18	mar/18	apr/18	jul/18	dec/18
pH	-	7.1	7.1	6.9	7	7.3	6.7	6.8	7	7	6.8
Turbidity	NTU	99.4	21.9	16.9	15.4	20.4	21.1	8.96	5.32	13.6	24.5
Color	Pt-Co	250	75	80	50	240	300	100	90	100	120
Total alkalinity	$mgCaCO_3/L$	40	30	30	31	31	34	35	39	30	34
Conductivity	µS/cm	119.6	81.4	76	77.8	91	94.3	100.1	147	156	105
Total dissolved solids	mg/L	60	41	38	39	45	47	50	50	73	52
Aluminium	mg/L	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006
Calcium	mg/L	9.3	8.8	8.8	7.6	8.8	13.2	9.6	10.8	8	18.6
Magnesium	mg/L	4	1.68	1.9	2.4	2.6	3.1	2.9	2.6	1.7	2.7
Total hardness	$mgCaCO_3/L$	47	29	30	29	33	46	36	38	27	28
Chloride	mg/L	12.5	25	2.5	3	5	0.5	9.5	16.5	2	5
Sulphate	mg/L	1	0.992	0.98	1.01	1.2	4.24	1.9	0.67	9.17	18
Silice	mg/L	18.97	16.99	18.31	19.89	20.4	23.86	22.9	36.24	16.32	17
Ammonia Nitrogen	mg/L	0.036	0.033	0.023	0.063	0.036	0.046	0.037	0.021	0.041	0.03
Nitrite	mg/L	0.045	0.048	0.042	0.026	0.039	0.029	0.023	0.02	0.013	0.003
Nitrate	mg/L	<2.00	<2.00	<2.00	<2.00	0.833	1.342	0.97	0.105	0.62	1
Iron	mg/L	1.98	2.26	2.19	0.504	1.92	1.307	1.47	1.38	0.02	0.107

Parameters	Unit	feb/17	apr/17	aug/17	sep/17	dec/17	feb/18	mar/18	apr/18	jul/18	dec/18
Sodium	mg/L	11.24	6.09	2.1	5.1	5.3	4.82	4.88	4.9	4.89	4.89
Potassium	mg/L	0.94	1.02	1.84	1.4	1.6	1.52	1.6	1.6	1.69	1.69
Chrome	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Manganese	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Zinc	mg/L	ND	ND	ND	ND	ND	ND	<0.5	ND	ND	ND
Copper	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
lead	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Cadmium	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total Mercury	mg/L	**	**	**	**	**	**	**	**	**	**
Arsenic	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Synthetic detergents	mg/L	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Fats and oils and hydrocarbons	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Temperature	ºC	25	26	21	22	25	23.2	23	25	19	28
Total Coliforms	UFC/100 mL	3,500	3,800	1,200	2,300	1,600	3,100	1,900	2,000	3,000	2,700
Fecal coliforms	UFC/100 mL	290	220	10	190	150	300	150	180	400	480
Chemical Oxygen Demand	mg/L	22	20	27	21	19	25	24	20	20	23
Biochemical Oxygen Demand	mg/L	1.0	0.6	1.7	1.6	1.0	2.4	2.0	1.7	2.6	1.6

9.10 Hydrogeology (Groundwater Resources)

Paraguay not only has extensive natural surface water resources, but also a wealth of groundwater. Groundwater is the most important water resource in Paraguay, because of its easy access and availability in terms of quality and quantity (PMCIC, 2014).

Paraguay has great potential in terms of groundwater, which is contained in aquifers that are strategic for the country's socioeconomic development and for the social well-being of its inhabitants (PMCIC, 2014).

Paraguay's main aquifers are located in the subsoil of the country's two regions, the Eastern Region and the Western Region. Some of these aquifers are locally distributed and are restricted to the national territory, as is the case with the following aquifers: Patiño, Caacupé, Arroyos and Esteros, Itacurubí, while others, such as the Guaraní (Misiones aquifer), Yrendá, Independencia, Col. Oviedo, Alto Paraná, Pantanal and Acaray, are shared with neighbouring countries and have been classified as transboundary aquifers (PMCIC, 2014).

The Plata Basin is also rich in groundwater resources. It largely coincides with the Guarani Aquifer System (SAG in Spanish), one of the largest groundwater reservoirs in the world, with an area of 1,190,000 km². To the west of the Basin is the Yrendá-Toba-Tarijeño Aquifer System (SAYTT), which in the majority is located in the semi-arid zone of the Basin, the Gran Chaco American Biome, with an area of 410,000 km² (CIC, 2017).

The following figure shows the map of the transboundary aquifers of the Plata Basin.

Figure 77 – Map of the transboundary aquifers of the Plata Basin. Source: CIC (2017)

In the La Plata Basin, the natural development of urban and rural populations, associated with the strong increase in agricultural and industrial activities, has significantly increased the use of water resources, particularly those of underground origin. This growth, as expected, in addition to demographic parameters, is due to the intrinsic characteristics of the aquifers, such as the occurrence of potentially productive units and the quality of the groundwater (CIC, 2017).

In Paraguay, too, groundwater is widely used for human and industrial supply, as for example in the outskirts of its capital, Asunción. In other regions, it is mainly used for livestock and for public supply in dispersed locations (CIC, 2017).

The following figure shows the annual volumes of groundwater exploited in the Basin.

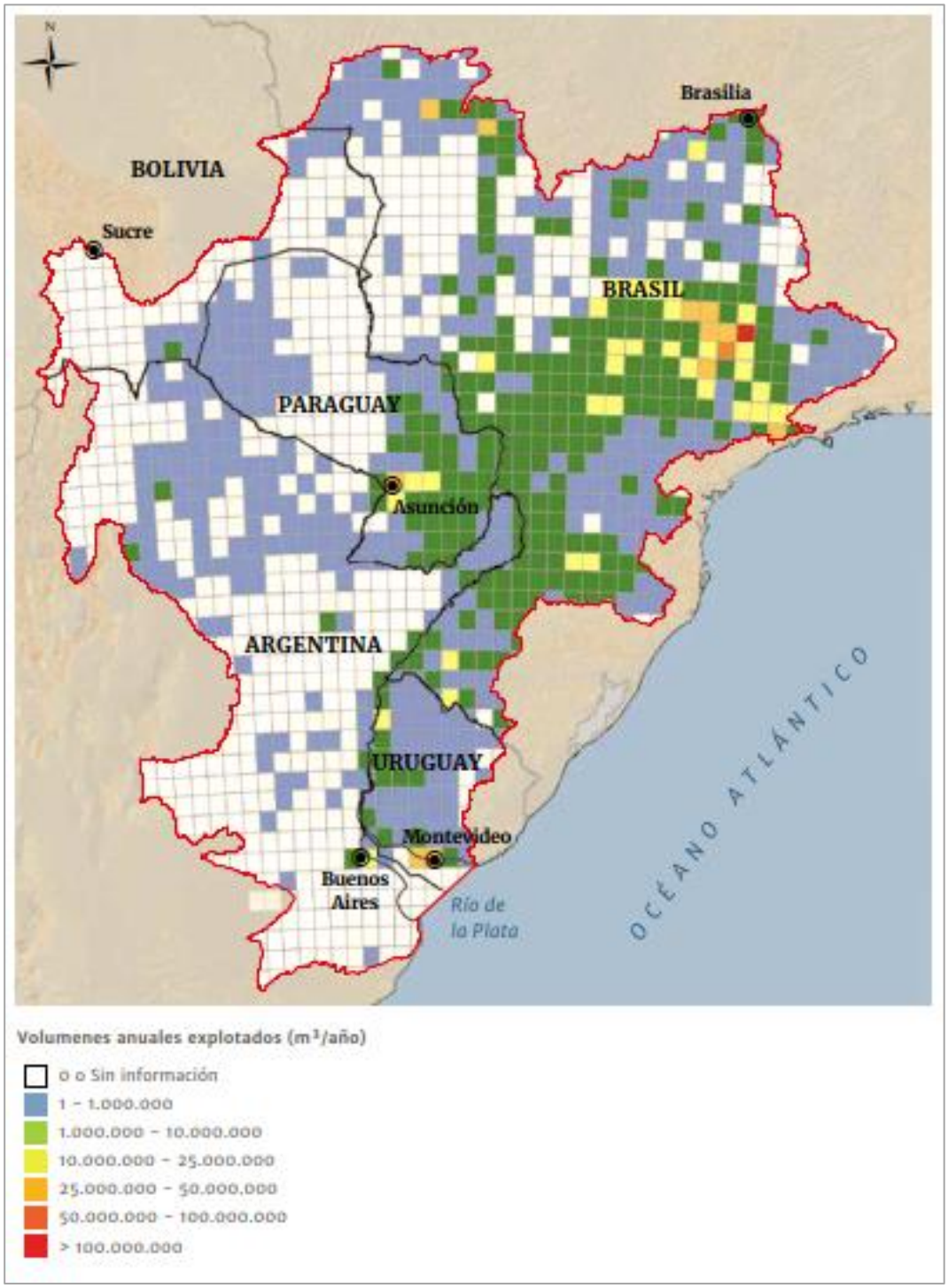


Figure 78 – Volumes of groundwater exploited annually. Source: CIC (2017)

The potability of the groundwater in the Basin was analyzed, in terms of salinity, taking into account the values of the electrical conductivities of the samples analyzed, given that they represent an approximation of the total dissolved salt content.

The concentrations of these salts, expressed in µS/cm were arranged in regular intervals distributed throughout the area of the Basin, and present the following results:

- 0 – 100 µS/cm – Registered only in the extreme North and Northeast regions of the Brazilian territory;
- 100 – 500 µS/cm – Widely predominant throughout the Basin, mainly in the Paraná Sub-basin in Brazil, and smaller portions in other countries;
- 500 – 1000 µS/cm – This interval occurs as strips aligned in a north-south direction, separating the Paraná Basin from those located further west in the region, also extending over part of Bolivian territory, the Brazilian Pantanal area and the eastern and western regions of Argentina;
- 1000 – 3000 µS/cm – This concentration interval, which marks the beginning of the occurrence of waters with inadequate quality for human health, is available in the Argentine and Paraguayan Chaco, in addition to the central and southern portion of Argentina;
- 3000 µS/cm – the area of occurrence of this interval of highly saline waters is restricted to a region of the Paraguayan and Argentine Chaco, corresponding to the fraction of the area of occurrence of the SAYTT Aquifer.

The following figure shows the geographical distribution of occurrence of these intervals.

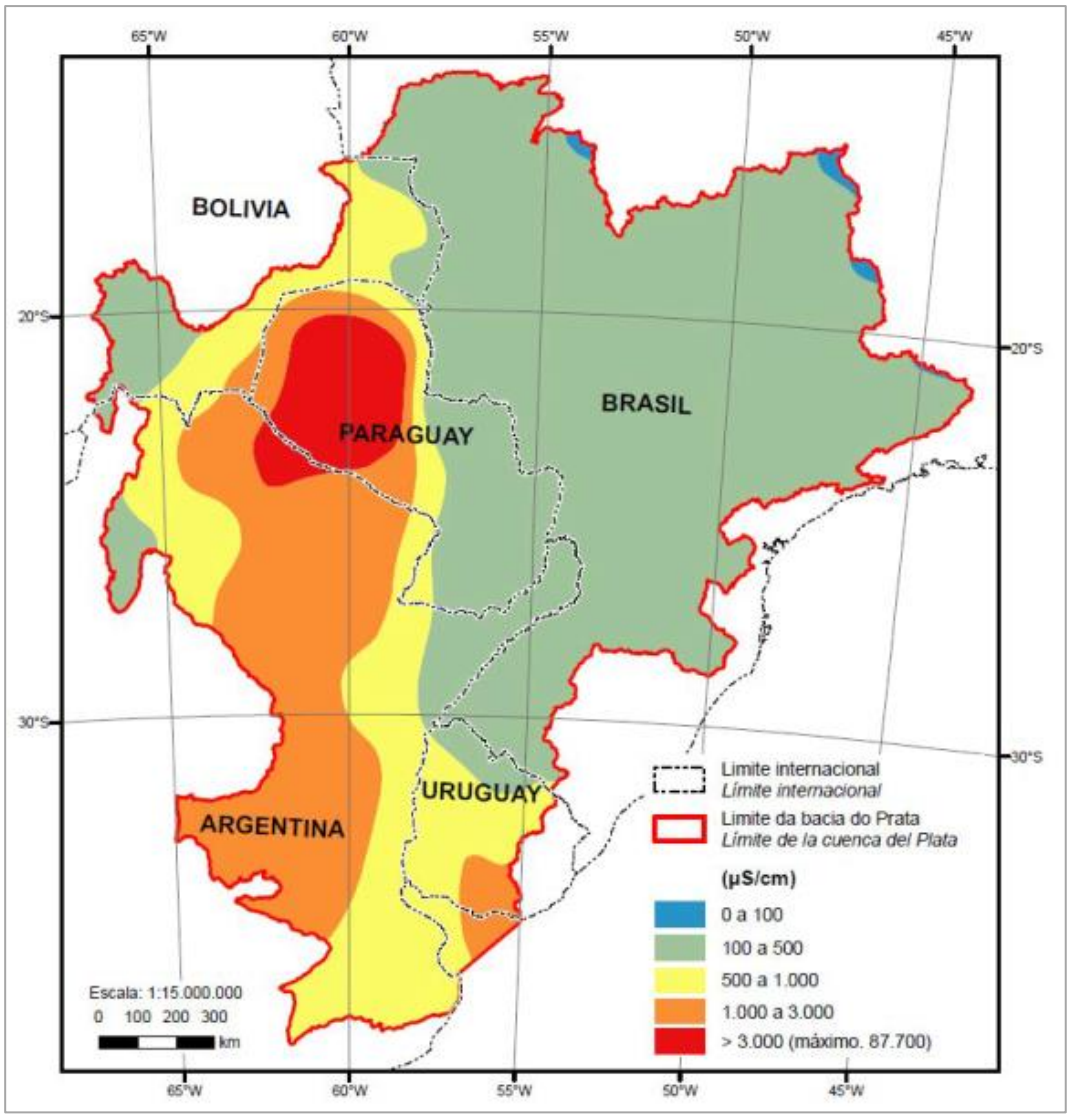


Figure 79 – Groundwater salinity distribution. Source: Diniz *et al.* (2015)

The natural vulnerability of groundwater is presented in the figure below. The lower regions or those with more dense drainage, such as the Chaco, Pantanal and the main drainage areas, present high to extreme vulnerabilities. The compartment represented by the Paraná Sedimentary Basin has medium to low vulnerability in relation to the others and high portions such as the Bolivian Andes present Low vulnerability index.

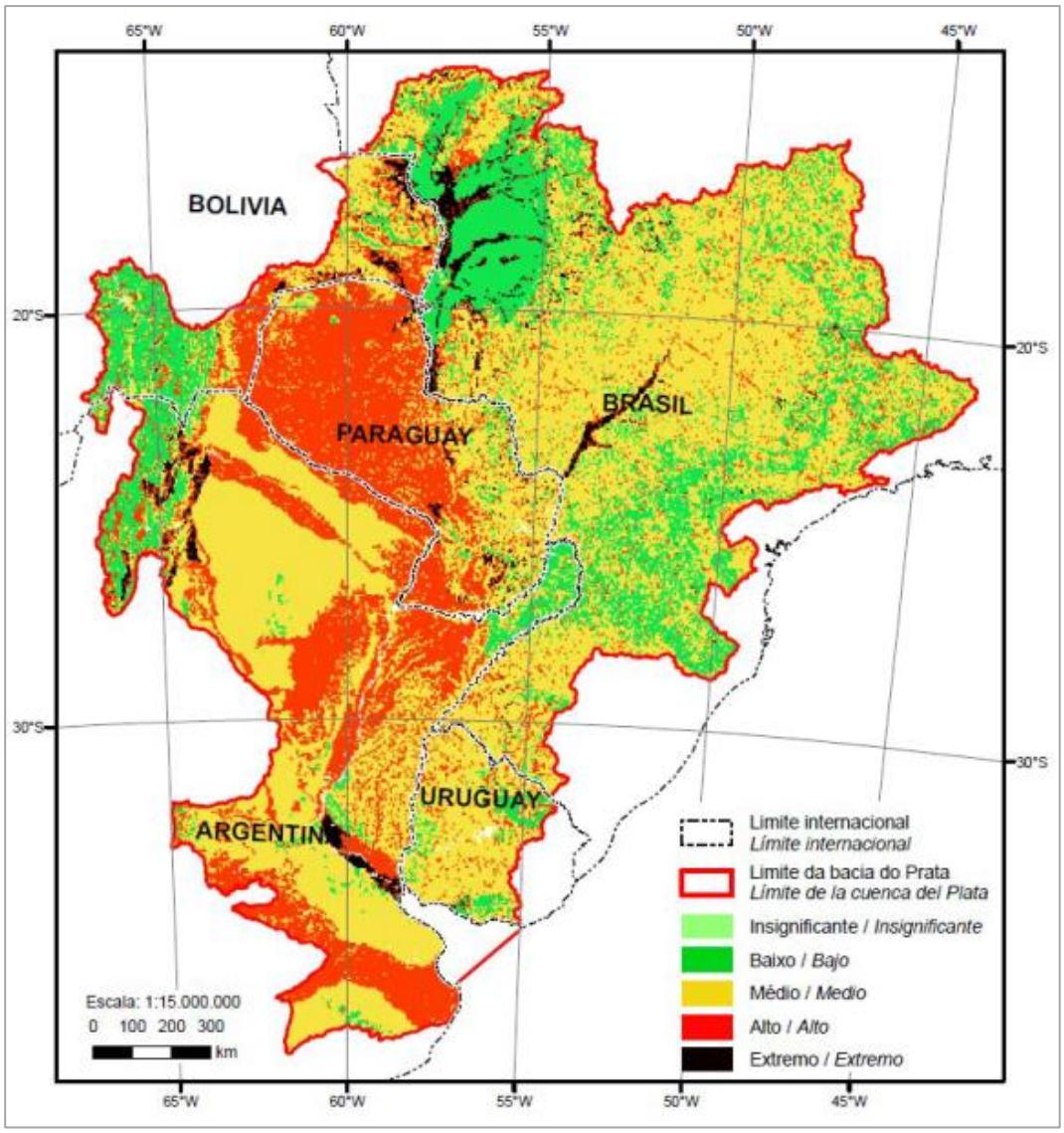
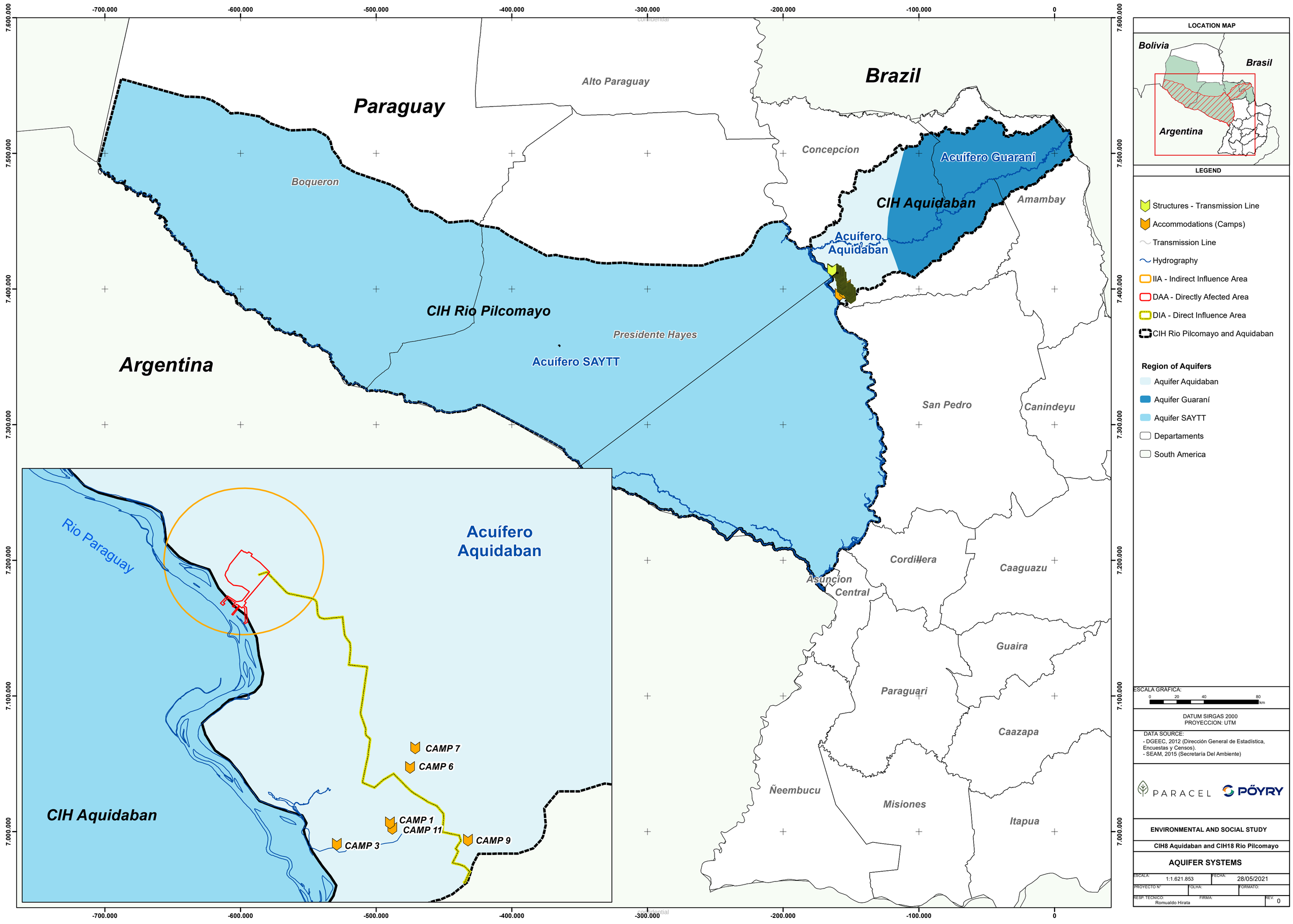


Figure 80 – Natural vulnerability of the groundwater of the Plata Basin. Source: Diniz *et al.* (2015)

The planned location for the implementation of the PARACEL pulp mill will be in the city of Concepción, near the Paraguay River. For ESIA, the Aquidabán and Pilcomayo River hydrographic units were adopted as an indirect area of influence. Thus, the aquifers present in these hydrographic units will be addressed in this chapter on groundwater.

The following figure shows the location of the future PARACEL pulp mill on the aquifer systems map.

Figure 81 – Map of Aquifer Systems


Paraguay
Brazil
Argentina
Alto Paraguay
Concepcion
Boqueron
Amambay
CIH Aquidaban
Acuífero Guaraní
Acuífero Aquidaban
CIH Rio Pilcomayo
Presidente Hayes
Acuífero SAYTT
San Pedro
Canindeyu
Cordillera
Caaguazu
Asuncion Central
Guaira
Paraguari
Caazapa
Ñeembucu
Misiones
Itapua
Rio Paraguay
Acuífero Aquidaban
CIH Aquidaban
CAMP 7
CAMP 6
CAMP 1
CAMP 11
CAMP 3
CAMP 9
LOCATION MAP
Bolivia
Brasil
Argentina
LEGEND
Structures - Transmission Line
Accommodations (Camps)
Transmission Line
Hydrography
IIA - Indirect Influence Area
DAA - Directly Afected Area
DIA - Direct Influence Area
CIH Rio Pilcomayo and Aquidaban
Region of Aquifers
Aquifer Aquidaban
Aquifer Guaraní
Aquifer SAYTT
Departaments
South America
ESCALA GRAFICA:
0 20 40 80 km
DATUM SIRGAS 2000
PROYECCION: UTM
DATA SOURCE:
- DGEEC, 2012 (Dirección General de Estadística, Encuestas y Censos).
- SEAM, 2015 (Secretaría Del Ambiente)
PARACEL
PÖYRY
ENVIRONMENTAL AND SOCIAL STUDY
CIH8 Aquidaban and CIH18 Rio Pilcomayo
AQUIFER SYSTEMS
ESCALA: 1:1.621.853
FECHA: 28/05/2021
PROYECTO N°
FOLHA:
FORMATO:
RESP. TECNICO: Romualdo Hirata
FIRMA:
REV. 0

9.10.1 Regional Characterization (IIA)

For this study, the main aquifers considered were the Yrendá-Toba-Tarijeño Aquifer System (SAYTT) and the Guaraní Aquifer System (SAG).

9.10.1.1 Aquifer System Yrendá-Toba-Tarijeño - SAYTT

According to CIC (2015), the SAYTT is shared by the three countries of the South American Gran Chaco, which are Argentina, Bolivia and Paraguay. Each of the countries that contain the aquifer has given it a name to identify it within its territory. So we have to: Argentina: Acuífero Toba (T), Bolivia: Acuífero Tarijeño (T) and Paraguay: Acuífero Yrendá (Y).

The SAYTT is an aquifer system of great regional importance due to the existing expectations in a region with water shortage, semi-arid climate and with other aquifers where its supply is brackish or salt water, not suitable for human consumption or agricultural production. Its knowledge and subsequent sustainable management would favor a correct management of the soil, which, undeniably, the services provided by both natural resources are integrated for the development of the region.

The rocks assigned to the Quaternary that appear in the SAYTT region extend over some 521,904 km^2, distributed among the following countries in order of surface area: Argentina: 303,220 km^2 (58.1%), Paraguay: 196,988 km2 (37.7%) and Bolivia 21,696 km2 (4.2%) (GULISANO 2014).

In Paraguay the Yrendá Aquifer System is located in three departments (Boquerón, Pte. Hayes and Alto Paraguay).

The most important river in the SAYYT, in Paraguay, is the Pilcomayo river, with an area of 272,000 km^2 (approx. 8.4% of the Plata basin). It is the natural border between Argentina - Bolivia and Argentina - Paraguay. This river is characterized by its permanent wandering due to the large volume of sediments it carries. This has created through thousands of years a great continental delta, with apex in the triple border and its maximum opening on the Paraguay River from Bahía Negra in Paraguayan territory, to Route 81 in the province of Formosa, which has remained practically as a division of the Pilcomayo and Bermejo basins.

This gigantic alluvial fan could be divided into two types of morphology. To the north in Paraguayan territory, a dense network of deactivated-clogged paleo-catchment areas has been formed, which today constitutes one of the sources of water supply for human consumption. These paleo-channels present a direct recharge of rainwater and since a few decades ago the artificial recharge of this phreatic aquifer, superimposed on the SAY, has been carried out in the area. On the other hand, towards the south there is a series of streams and rivers that constitute the active network of paleo-catchment areas and new channels. All the watercourses finally discharge into the Paraguay River which is the great receiver of all the waters that descend from the Andes. The surface of this great continental paleo-delta is about 200,000 km^2, located almost entirely in Paraguayan territory.

According to CIC (2015), in Paraguay, the compilation of data from the Yrendá aquifer (SAY), in Paraguayan territory, presented 382 deep wells in Excel spreadsheets and 227 wells with less than 50 meters deep in SISAG origin sheets. A map of the location of the wells was presented where the quality of the water is defined according to its salinity

(fresh, brackish and salty, as well as dry wells), in addition to a sheet with physical-chemical data of some wells.

Under the denomination of SAY, it is understood that confined and/or semi-confined aquifers extend throughout the Chaco at various levels and at different depths, constituting multi-layer systems, formerly called the Yrendá Aquifer Complex (GODOY, 1990), constituting at the regional level a single hydrogeological system, although differences in detail may occur at the local level, occupied by different groundwater flow systems. South of the 20th parallel, the SAY is below a depth of 50 m to the west, bordering Bolivia, and below 5 - 3 m to the east, in the Humid Chaco, even overcoming the phreatic level near the Paraguay River, causing the flow of the aquifers to be confined to the phreatic level. The piezometric levels range from 25 m to close to rising, in the channels that run in a west-east direction, tributaries of the Paraguay River.

In the area between the Bolivian Sub-Andean and the Parapetí River, the permeability (K) of the deep aquifers varies from 8.6 - 17.3 m/day; the transmissibility (T) from 1,075 - 2,150 m^2/day and the storage coefficient (S) from 5.10-4 - 6. 10-6; in the Bolivian-Paraguayan border area permeability varies from 6 to 8 m/day and transmissibility from 400 to 200 m^2/day and in the central Paraguayan Chaco permeability varies from 0.3 to 8.0 m/day and transmissibility from 50 to 100 m^2/day. The wells that capture these aquifers have specific flows that vary from 2.0 to 3.6 m^3/h/m. Their maximum total porosity is 40% and the effective porosity is between 7 and 10%. The actual underground flow rate varies from approximately 20 m/year to 46 m/year. (GODOY V. EUGENIO, 1990).

The large hydraulic load of the confined aquifers indicates that the recharge zone is at a much higher level than the land where the well is located, and as the area is semi-arid with a strong water deficit it is difficult for these aquifers to receive fresh water by direct infiltration of rainfall. As well, the isolated freatic aquifers are insufficient to feed the deep aquifers that contain large volumes of fresh water. It is strong to think that the recharge is produced by infiltration of rainfall and rivers in Bolivian territory, mainly along a strip of thick piedmont sediments about 15 to 20 km wide, which runs parallel to the sub-Andean mountain ranges, as well as by infiltration of the Pilcomayo River during floods through its alluvial fan. (GODOY V. EUGENIO, 1990).

In times of low water, the salinity of the surface courses and wetlands increases, indicating a subterranean source of water. The discharge zone is characterized by the occurrence of brackish to salty wetlands in the direction of underground flow. The formation of evaporative minerals in discharge areas produced by regional flow systems of mineralized (salt) groundwater is a characteristic of the area.

9.10.1.2 Guaraní Aquifer System (Sistema Aquifero Guarani – SAG, in Spanish)

According to CIC (2015), the transboundary Guarani Aquifer System (SAG) has an area of 1,087,879.15 km^2, extending over the Chaco - Paranaense sedimentary basin. It is the most important hydro-stratigraphic unit in the southern portion of the South American continent, and is associated with the siliciclastic rocks of the Plata Basin (Brazil and Paraguay), the Chaco - Paranaense Basin (Argentina) and the Northern Basin (Uruguay), which represent an evolutionary history common to the eastern portion of the Bolivian Chaco (FRANCA ET AL, 1995).

The regional climate in its area of occurrence is characterized as humid, with rainfall ranging from 1,200 to 1,500 mm/year.

Its waters are widely used for human and industrial supply and for thermal tourism, due to their thermal properties in the places where the aquifer is confined by the basalts of the Serra Geral formation.

The Guarani Aquifer System is formed by sandstones of the Jurassic period (Brazil), of the Tacuarembó formation (Uruguay), Misiones (Paraguay) and by the fluvio-lake sandstones of the Piramboia/Rosario do Sul formation (Brazil) and Rivera (Uruguay).

Outcrop zones occur in two bands located to the west and east of the zone of occurrence and correspond to approximately 10% of the total area of the aquifer, being confined to 90%.

The average thickness is 250 meters and the flows vary between 60 and 200 m^3/h in areas close to the outcropping zones and from 200 to 400 m_3/h in the confined areas. Locally it can present much lower values in the outcrop areas.

The waters are calcium and magnesium bicarbonate near the outcropping areas and sodium in the deeper areas. The pH is alkaline and dry residue values vary from 200 to 600 mg/l. The temperature varies from 18 to 63°C, depending on the depths of occurrence of the aquifer.

This aquifer system is of great importance at the regional and transnational level, representing a fundamental resource for socioeconomic development and in the operation and maintenance of associated ecosystems.

9.10.2 Local Characterization (DIA and DAA)

According to the hydrogeological map, the areas of direct influence and directly affected by the PARACEL pulp mill are located in the Aquidauana - Aquidaban Aquifer System.

According to PMCIC (2015), the Aquidauana-Aquidaban Transboundary Aquifer System is located in the Paraná River Basin, with an area of approximately 27,000 km^2, of which 14,600 km^2 are in Brazil and 12,300 km^2 in Paraguay extending in a NE-SW direction, being used for human and animal supply both in Brazil and Paraguay.

The aquifer is of the semi-confined type, made up of glassy-marine sediments with intense variations in facies, presenting flows that are also quite dispersed, with average values oscillating between 10-20 m^3/h/well.

From the chemical point of view, it also presents waters with quite variable characteristics. Its use in the short term has become essential for human supply and to allow the economic development of the region, with agricultural and livestock characteristics.

9.10.3 Groundwater quality

According to GODOY and PAREDES (1995), practically all the potential aquifers in the Eastern region have water suitable for human consumption, irrigation and industry. In the Western region, or Chaco of Paraguay, the chemical quality of the waters of the Yrendá Aquifer System is a limiting factor for domestic, livestock, agricultural and industrial use. The presence in most of the area of water with high salt content is due to

the fact that, among the sediments that fill the basin, there are evaporite salts (mainly gypsum), which, due to their solubility, give rise to brackish or salty water.

As part of this study, groundwater wells located near the PARACEL pulp mill area was tested. Groundwater Quality Monitoring was conducted to verify the quality of the groundwater prior to the implementation and operation of the pulp mill (background).

Groundwater sampling collection was performed at 06 (six) points, covering the region's dry and rainy periods. The figure and table below show the location of the points.

The results of these 6 points are presented in ESIA Plantations report, Volume II, Tomo I.

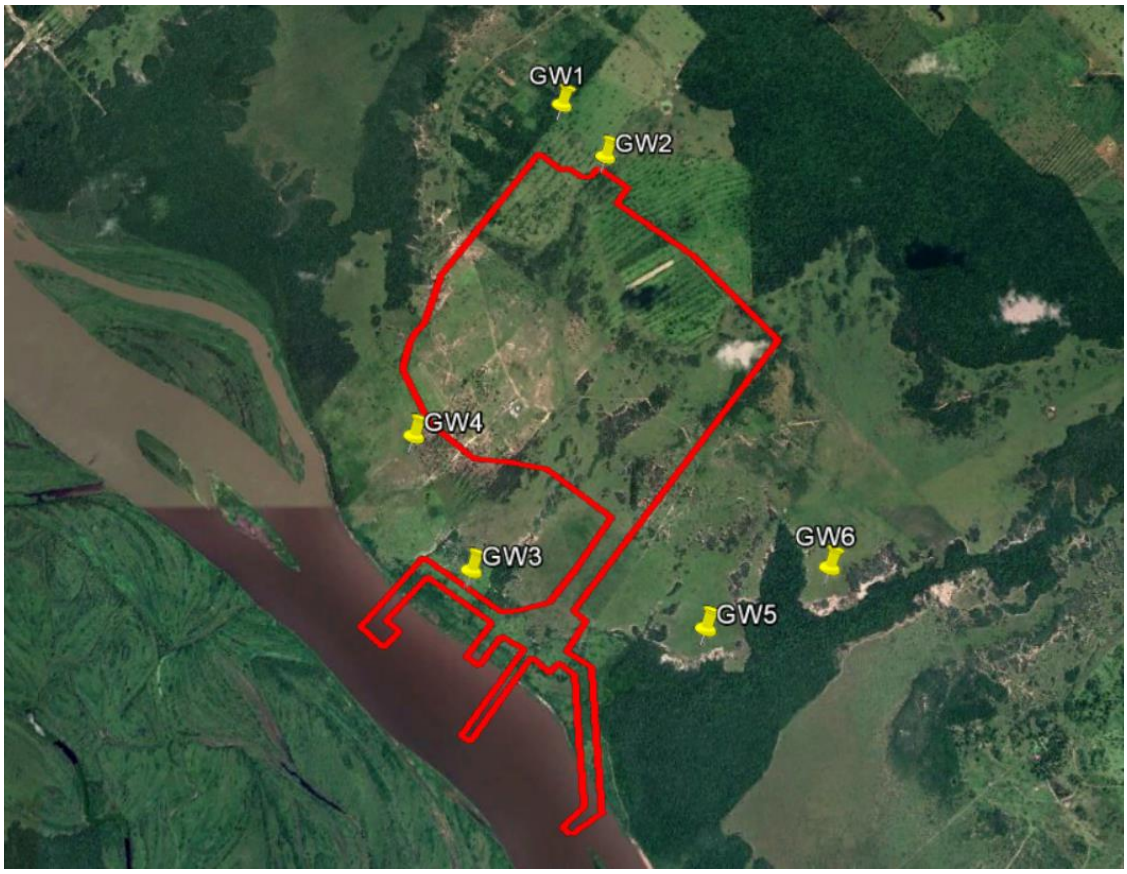


Figure 82 – Location of monitoring points for groundwater collection campaigns Source: Adapted from Google Earth (2021)

Table 22 – Coordinates of groundwater monitoring points

Point	Coordinates
GW1	23°13'54.71"S 57°29'25.08"O
GW2	23°14'8.63"S 57°29'13.66"O
GW3	23°15'51.86"S 57°29'50.26"O
GW4	23°15'19.78"S 57°30'4.88"O
GW5	23°16'5.34"S 57°28'51.63"O
GW6	23°15'51.16"S 57°28'19.73"O

Source: Pöyry Tecnologia (2020)

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ANNEX I
ANALYSIS REPORTS

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SURFACE AND GROUNDWATER QUALITY MONITORING

TECNOAMBIENTAL
•INGENIERÍA Y CONSULTORÍA•

1ST MONITORING CAMPAIGN REPORT

CONTRACTING COMPANY:	PARACEL SA.
DEPARTMENT:	CONCEPCIÓN AND AMAMBAY
DISTRICTS:	CONCEPCIÓN, SGTO. JOSÉ FELIX LÓPEZ, LORETO AND BELLA VIST
CONSULTANT:	TECNOAMBIENTAL S.R.L.
REPORTED PERIOD:	RAINY SEASON (JANUARY-FEBRUARY)

APRIL 2021

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I. INTRODUCTION

The terms of reference of the water quality monitoring consulting service prepared by PARACEL SA defines this report's guidelines. The firm is in charge of the project "Construction and operation of a plant for the manufacture of BKP cellulose pulp on the Paraguay River", which is developing approximately 15 km north of the city Concepción. This report also responds to the International Finance Corporation (IFC) environmental requirements, the financing entity, that requires a baseline of the environmental conditions before implementing the project to collect useful data to monitor potential changes resulting from the project's implementation.

The purpose of this document is to establish a baseline of the surface and groundwater quality in the project's direct area of influence (DAI) and indirect area of influence (IAI) before the conversions to industrial zone and plantation forestry respectively occur.

The main objectives of the monitoring are the following:

- Obtain quantitative information of the River Paraguay's water quality at 2 points located in DAI of the future Industrial plant, before and after the treated effluent's discharge point from the future factory located 20 km upstream port of the city of Concepción.
- Measure the groundwater level and analyse the groundwater quality of 6 existing monitoring wells in the future BKP cellulose pulp manufacturing plant's DAI.
- Obtain quantitative information of the surface water quality (streams and rivers running through the so-called "Farm Zone" in the Departments of Concepción and Amambay) at 18 monitoring stations.
- Analyse and, where technically feasible, measure the groundwater level of 14 artesian wells distributed in the "Farm Zone" of the Departments of Concepción and Amambay.

The samplings take place in two campaigns covering the dry and rainy seasons. The preliminary results presented in this report belong to the latter.

PARACEL SA selected and provided the monitoring points that correspond to sites of interest where land-use changes will occur in the short term, mainly the transformations of pastures for livestock converted to an industrial zone or forest plantations as the case may be.

A certified laboratory, the Multidisciplinary Centre for Technological Research (CEMIT) of the National University of Asunción (UNA), analysed the samples. CEMIT's calibrated equipment and standardised procedures were used during sampling and transporting samples.

The National Accreditation Body (ONA), dependent on the National Council of Science and Technology (CONACYT), accredited the CEMIT's laboratory.

II. METHODOLOGY

2.1 General information about the study area

This section collects some data mentioned in the environmental impact assessment report of the future industry prepared by the consultancy POYRY in 2020 and aims to establish the hydrological and hydrogeological context in which the monitoring carries out.

The project's location is in the city of Concepción; therefore, the surface and groundwater monitored are part of the Aquidabán River Basin. This basin has an approximate area of 1,254,812 ha and flows into the River Paraguay to the north of Concepción. Its main tributaries are the Trementina and Negla streams, and it is characterised by its relatively high concentration of total and dissolved solids, depending on the time of collection and the presence of significant nutrient contents.

2.1.1 Surface water

The future factory's location is in the Middle and Lower Paraguay sub-basin, which is part of the hydrographic units mentioned above.

In the area of direct influence is the River Paraguay, from which raw water is to be collected and which is the main body of surface water to receive the wastewater treated and generated by the project, in a stretch of approximately 1 km, through a submarine wastewater discharge pipe.

Dispersion of treated effluents in the River Paraguay expects to occur very close to the discharge point between 0.37 and 0.42 m upstream of the factory's water intake.

In the AII is the Tinfunqué Ramsar site, which is 235 km from the future factory. Likewise, the Estero Milagro Ramsar site is 35 km away but outside the area of indirect influence.

Hydrographically, the most critical watercourses for the present study are the Trementina stream, Napegue stream, Negla stream, Hermosa stream, Pitanohaga stream, Aquidabán River and Paraguay River.

2.1.2. Groundwater

Regarding the hydrogeological characteristics, the factory is in the Aquidauana-Aquidabán Aquifer System.

This system is in the River Paraná basin, covering approximately 27,000 km^2, of which 12,300 km^2 are in Paraguay and the rest in Brazilian territory. It is used mainly for human and animal supply in both countries.

The aquifer is a semi-confined type, made up of glaciomarine sediments with significant facies variations, and has very dispersed flows rates with average values ranging between 10-20 m^3/h/ well.

The water's chemical characteristics are very variable also.

2.2 Location and details of monitoring points

There are 40 sampling points selected to monitor water quality in the DAI and IAI, 20 of which are surface watercourses and 20 are groundwater.

As for the political-administrative limits of the study area, 4 points are in the district of Bella Vista in the Department of Amambay and 36 points are distributed in the districts of Concepción, Sgt José Felix López and Loreto in the Department of Concepción.

PARACEL provided the coordinates of the 20 monitoring points for surface waters; 18 points are existing watercourses located in the so-called "Farm Zone" of the project's AII, and 2 points are on the River Paraguay in the DAI of the future industry. The number of sampling points is detailed below, according to the denominations given to the surface waters:

- One point corresponds to the Hermosa stream, a tributary of the Apa River.
- One point corresponds to the Napegue stream, a tributary of the Negla stream.
- One point is on the Negla stream, a tributary of the Aquidabán River.
- Ten points are on the Trementina stream, a tributary of the Aquidabán River.
- One point is on an unnamed stream, a tributary of the Aquidabán River.
- Two points are on the Aquidabán River.
- One point corresponds to the Laguna Penayo stream.
- One point corresponds to the Pitanohaga stream.
- Two points are on the Paraguay River at the DAI of the future's industrial plant.

Regarding groundwater monitoring points:

- Fourteen points are deep tubular wells located in the "Farm Zone", these wells are currently in service. Their waters are extracted with submersible pumps and are used to supply drinking water to the area's human populations.
- Six points are located in the future industry's DAI and relate to deep tubular wells built exclusively for groundwater quality monitoring.

In the existing properties in the so-called "Farm Zone", the land use is changing from cattle pasture to *Eucalyptus sp.* plantation while in the DAI from floodplain pasture to an industrial zone.

The 40 monitoring points were selected to verify the existing surface, and groundwater quality in the DAI and the "Farm Zone" (IAI) before land-use conversions occur due to project implementation.

The following map shows the properties' boundaries and the spatial distribution of the monitoring points, classifying between surface water and groundwater points. The hydrography layer of the study area is also displayed.

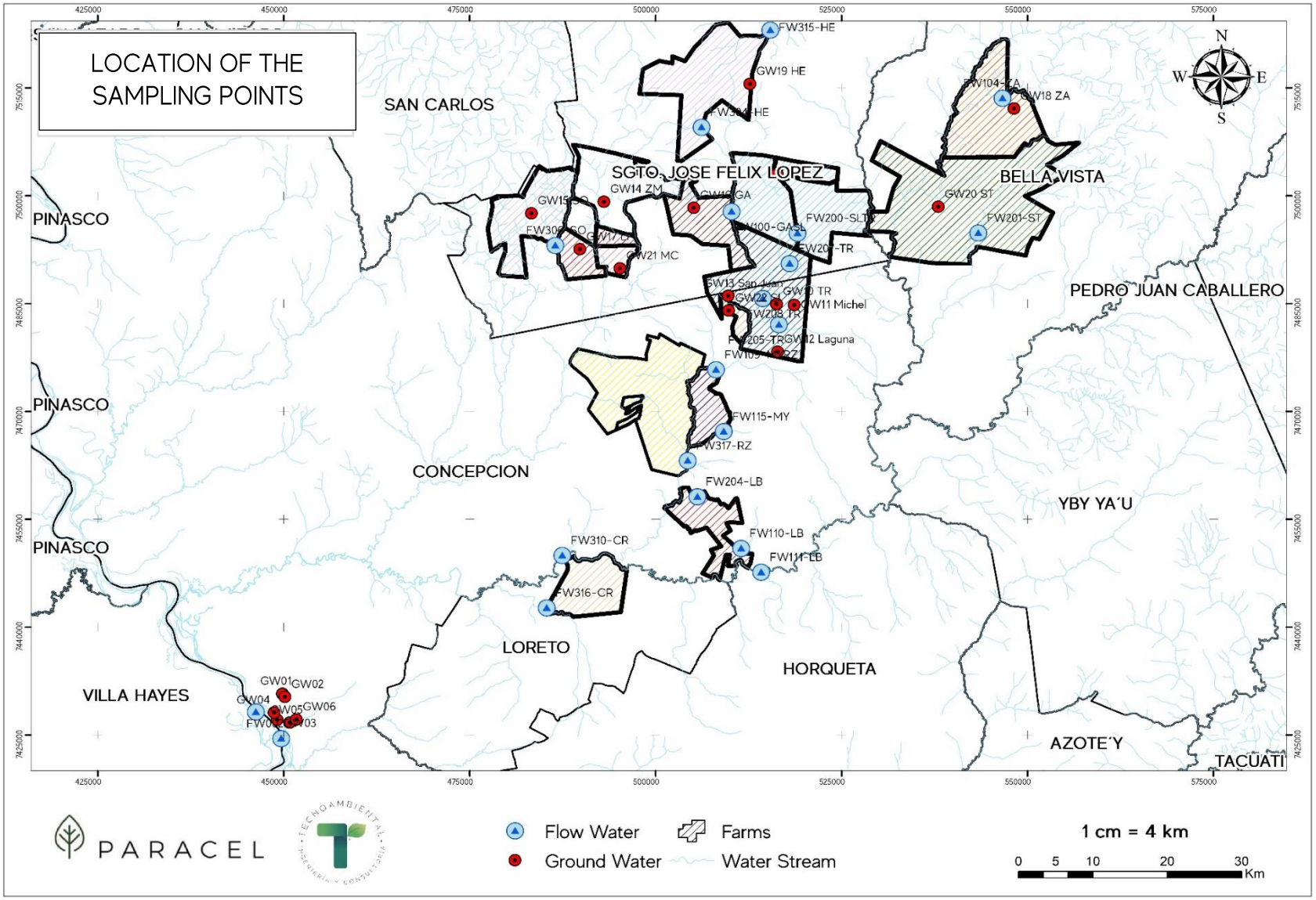

LOCATION OF THE SAMPLING POINTS
SAN CARLOS
SGTO. JOSE FELIX LOPEZ
BELLA VISTA
PINASCO
PEDRO JUAN CABALLERO
CONCEPCION
YBY YA´U
LORETO
HORQUETA
VILLA HAYES
AZOTE´Y
TACUATI
FW315-HE
GW19 HE
GW14 ZM
GW20 ST
FW201-ST
FW200-SLT
GW21 MC
GW11 Michel
GW02 Laguna
FW115-MY
FW317-RZ
FW204-LB
FW110-LB
FW111-LB
FW310-CR
FW316-CR
GW01
GW02
GW04
GW05
GW06
Flow Water
Ground Water
Farms
Water Stream
1 cm = 4 km
0 5 10 20 30 Km
PARACEL

TABLE 1. SAMPLING POINTS

	№	CODE	UTM COORDINATES	TYPE OF SAMPLE	MONITORED PARAMETERS	LOCATION, DESCRIPTION, OBJECTIVES
NEGLA STREAM MICRO-WATERSHED	1	FW 104 - ZA	21K 546639,23 mE 7513553,82 mS	F.W.	Described in Table 2	Negla stream – Upper part of the micro-watershed – Determine the surface water quality of the Farm "Zapallo".
	2	G.W. 18-ZA	21K 548201.00 mE 7512128.00 mS	G.W.	Described in Table 3	Headquarters of the "Zapallo" farm – Deep tubular well used for water drinking supply - Determine the groundwater quality of Farm "Zapallo".
	3	F.W. 201-ST	21K 543911.54 mE 7497910.60 mS	F.W.	Described in Table 2	Napague stream - Upper middle part of the Negla stream micro-watershed - Determine Farm "Santa Teresa's surface water quality.
	4	G.W. 20-ST	21K 537999.00 mE 7498476.00 mS	G.W.	Described in Table 3	Headquarters of the "Santa Teresa" farm - Deep tubular well used for drinking water supply - Determine the groundwater quality of Farm "Santa Teresa".
HERMOSA STREAM MICRO-BASIN	5	FW 315-HE	21K 515424,99 mE 7523026,00 mS	F.W.	Described in Table 2	"Hermosa" stream - Upper watershed of the "Hermosa" creek micro-watershed - Determine the surface water quality at the outlet of Farm "Hermosa".
TREMENTINA. STREAM MICRO-WATERSHED	6	GW 19-HE	21K 512695.00 mE 7515558.00 mS	G.W.	Described in Table 3	Headquarters of the "Hermosa" farm - Deep tubular well for drinking water supply - Determine the current groundwater quality of Farm "Hermosa".
	7	FW 304-HE	21K 506172,99 mE 7509505,00 mS	F.W.	Described in 2	Trementina stream – Upper watershed of the Trementina stream micro-watershed – Determine surface water quality at the outlet of Farm "Hermosa."
	8	G.W. 23-SL	21K 516367.00 mE 7503054.00 mS	G.W.	Described in 3	Headquarters of the "San Liberato" farm – Deep tubular well for water provision for human consumption – Determine groundwater's current quality in the "San Liberato" farm.
	9	G.W. 16-GA	21K 505125.00 m E 7498320.00 m S	G.W.	Described in 3	Headquarters of the "San Gavilán" farm at 200 metres from *Eucalyptus sp.* plantations – Deep tubular well to provide water for human consumption – Determine the current groundwater quality of the "Gavilán" farm.
	10	FW 100-GASL	21K 510205.03 mE 7497780.65 mS	F.W.	Described in 2	Trementina stream – Middle/upper catchment of the Trementina stream micro-watershed runs through approximately 7 km of *Eucalyptus sp.* plantations – Determine the surface water quality at the plantation's exit.
TREMENTINA STREAM MICRO-WATERSHED	11	FW 200-SL	21K 519072.00 mE 7494784.00 mS	F.W.	Described in 2	Tributary of the Trementina stream at the southeast of the headquarters of the "San Liberato" farm – middle catchment of the Trementina stream – Determine surface water quality at the outlet of Farm "San Liberato".
	12	F.W. 207-TR	21K 518004.00 mE 7490567.00 mS	F.W.	Described in 2	Tributary of the Trementina stream, 5 km at the north of the headquarters of the "Trementina" farm – middle catchment of the Trementina stream – Determine the current surface water quality of the property.
	13	F.W. 208-TR	21K 514416.00 mE 7485700.00 mS	F.W.	Described in 2	Trementina stream, 2 km northwest of the Trementina farm's headquarters – Middle catchment of the Trementina stream – Determine the property's current surface water quality.
	14	GW 11-MICHEL	21K	GW	Described in 3	Deep tubular wells located in new plantations of *Eucalyptus sp* – Middle basin

TABLE 1. SAMPLING POINTS

	Nº	CODE	UTM COORDINATES	TYPE OF SAMPLE	MONITORED PARAMETERS	LOCATION, DESCRIPTION, OBJECTIVES
			518643.00 mE 7484801.00 mS			of the Trementina stream – Well for water for human consumption.
	15	G.W. 10-TR	21K 516254.00 mE 7484946.00 mS	G.W.	Described in 3	Trementina farm headquarters –Middle basin of the Trementina stream, dairy farm and corrals within 200 metres of the All of the well, use for drinking water supply – Determine current groundwater quality.
	16	G.W. 13-SAN JUAN	21K 509767.00 mE 7486076.00 mS	G.W.	Described in 3	"San Juan" farm, the middle basin of the Trementina stream – Well for drinking water supply – Determine the "San Juan" farm's current groundwater quality.
	17	G.W. 22-SILVA	21K 509830.00 m E 7484037.00 m S	G.W.	Described in 3	"Silva" farm, the middle basin of the Trementina stream – Well for drinking water supply – Determine current groundwater quality of the "Silva" farm.
	18	F.W. 205-TR	21K 516574.00 mE 7482061.00 mS	F.W.	Described in 2	Trementina stream, 2.7 km east of the Trementina farm headquarters, middle catchment of the Trementina stream micro-catchment – Determine the property's current surface water quality.
	19	G.W. 12-Laguna	21K 516419.00 mE 7478307.00 mS	G.W.	Described in 3	"Laguna" farm, the middle basin of the Trementina stream micro-basin – Well for drinking water supply and irrigation of seedlings, currently developing a forest nursery and plantation of new crops of *Eucalyptus sp* – Determine the current quality of groundwater in the "Laguna" farm.
TREMENTINA STREAM MICRO-WATERSHED	20	F.W. 109-MYRZ	21K 508110.00 mE 7475784.00 mS	F.W.	Described in 2	Trementina stream, point located between the "Mandyju" and "Rancho Z" property boundaries – middle catchment of the "Trementina" stream micro-watershed – Determine the current surface water quality of the property.
	21	F.W. 115-MANDYJU	21K 509155.00 mE 7467194.00 mS	F.W.	Described in 2	Trementina stream, a point located 11 km southeast of the "Rancho Z" forest plantations – middle catchment of the Trementina stream micro-watershed – Determine Mandyju's ranch current surface water quality.
	22	F.W. 317-RZ	21K 503324.00 mE 7459243.00 mS	F.W.	Described in 2	Trementina stream – lower catchment of the Trementina stream micro-catchment – Determine the current surface water quality at the exit of "Rancho Z".
	23	F.W. 204-LB	21K 498840.00 mE 7451514.00 mS	F.W.	Described in 2	Trementina stream point located 5 km upstream of the outflow point of the Trementina stream to the Aquidabán River – The lower watershed of the "Trementina" stream micro-watershed – Representative point of the quality of water discharging from the Trementina stream into the Aquidabán River.
REPRESENTATIVE POINTS OF THE RIVER AQUIDABÁN	24	FW 110-LB	21K 511487.00 mE 7450940.00 mS	F.W.	Described in 2	Unnamed Stream – Tributary of the Aquidabán River – Determine surface water quality.
	25	F.W. 111-LB	21 K 514185.37 mE 7447625.56 mS	F.W.	Described in 2	Aquidabán River – Lower-middle basin of the Aquidabán River catchment – Determine the current surface water quality.
	26	F.W. 310-CR	21 K 487444.00 mE 7449950.00 mS	F.W.	Described in 2	Aquidabán River – Lower basin of the Aquidabán River catchment – Determine the current Surface water quality in the All of the "Cristo Rey" farm.

TABLE 1. SAMPLING POINTS						
	Nº	CODE	UTM COORDINATES	TYPE OF SAMPLE	MONITORED PARAMETERS	LOCATION, DESCRIPTION, OBJECTIVES
	27	F.W. 316-CR	21K 485341.00 mE 7442662.00 mS	F.W.	Described in 2	"Laguna Penayo" stream – Lower basin of the Aquidabán River – Determine the "Soledad" farm's surface water quality.
PITANOHAGA STREAM MICRO-WATERSHED	28	G.W. 14-ZM	21K 493064.00 mE 7499176.00 mS	G.W.	Described in 3	Headquarters of the "Zanja Morotí" farm - Deep tubular well for drinking water supply – Determine the current groundwater quality of the "Zanja Morotí" farm.
	29	G.W. 15-SO	21K 483316.00 mE 7497562.00 mS	G.W.	Described in 3	Headquarters of the "Soledad" farm - Deep tubular well for drinking water supply – Determine the current quality of the groundwater of the "Soledad" farm.
MICROCUENCA DEL AO PITANOHAGA	30	FW 306 -SO	21K 486496.00 mE 7493077.00 mS	FW	Described in 2	Tributary of the Pitanohaga stream– Upper catchment of the Pitanohaga stream micro-watershed – Determine the surface water quality of the Soledad farm.
	31	G.W. 17-LP	21K 489833.00 mE 7492572.00 mS	G.W.	Described in 3	Headquarters of "La Paraguaya" farm – Deep tubular well for water provision for human consumption – Determine the current quality of the farm's groundwater.
	32	G.W. 21-MC	21K 495202.00 mE 7489899.00 mS	G.W.	Described in 3	Headquarters of the "Machuca-cue" farm - Deep tubular well for drinking water supply – Determine the farm's groundwater's current quality.
ADA	33	GW 01	21K 449839.00 mE 7430729.00 mS	GW	Described in 3	The directly affected area by the future PARACEL industry, currently a floodable grassland area – Deep tubular wells built exclusively for the periodic and systematic monitoring of the groundwater quality of the aquifer, to detect possible chemical alterations of the water as a consequence of the implementation and operation of the industrial plant.
	34	GW 02	21K 450165.00 mE 7430301.00 mS			
	35	GW 03	21K 449136.00 mE 7427123.00 mS			
	36	GW 04	21K 448716.00 mE 7428109.00 mS			
	37	GW 05	21K 450803.00 mE 7426714.00 mS			
	38	GW 06	21K 451708.00 mE 7427153.00 mS			
	39	F.W. 01	21K 446252.08 mE 7428199.87 mS	F.W.	Described in 4	Paraguay River – Project's ADA – To monitor a point located 2.5 km upstream before the effluent discharge point.
	40	F.W. 02	21K 449651.97 mE 7424489.86 mS			Paraguay River – Project's ADA – To monitor point located 2.5 km downstream of the effluent discharge point.

2.3 Monitored parameters determined by sample type

The table below shows the monitored parameters for each sample or monitoring points according to terms of reference. It was analysed 67 parameters (physicochemical, agrochemical, hydrobiological and bacteriological) for 18 surface water points.

TABLE 2. MONITORED PARAMETERS FOR SURFACE WATER	
IN SITU MONITORING PARAMETERS	
1- Water temperature	4- Dissolved oxygen
2- Hydrogen potential	5- Turbidity
3- Electrical conductivity	

PHYSICO-CHEMICAL ANALYTICAL DETERMINATIONS			
PARAMETERS INCLUDED IN THIS REPORT		**PARAMETERS THAT INCLUDES THE FINAL REPORT OF THE FIRST CAMPAIGN**	
6- Suspended sediments	14- Ammonia	22- Aluminium	30- Selenium
7-Total dissolved solids	15- Nitrites	23- Cadmium	31- Zinc
8- Oil and grease	16- Hardness	24- Hexavalent chromium	32- Arsenic
9- COD (oxygen demand chemical)	17- Sodium	25- Trivalent chromium	33- Barium
10- BOD5 (oxygen demand biochemical)	18- Sulphates	26- Tin	34- Total mercury
11- Total phosphorus	19- Cyanides	27- Nickel	
12- Total nitrogen	20- Copper	28- Manganese	
13- Nitrates	21- Soluble iron	29- Lead	
AGROCHEMICALS			
35- Glyphosate	43- DDE	51- 2,4-D	59- Imidacloprid
36- AMPA	44- DDD	52- Lambda-cyhalothrin*	60- Methyl-paraoxon
37- Aldrin	45- Atrazine	53- Bifenthrin	61- Thiamethoxam*
38- Endrin	46- Simazine	54- Cypermethrin	62- Sulfluramide*
39- Dieldrin	47- Carbaryl	55- Chlorpyrifos	63- Fipronil*
40- Lindane	48- Carbofuran	56- Dichlorvos	
41- Chlordane	49- Heptachlor	57- Methamidophos	
42- DDT	50- Methomyl	58- Tebuconazole	
*Notes: This document does not report the following parameters: Lambda-cyhalothrin, Thiamethoxam, and Sulfluramide.			
HYDROBIOLOGICAL PARAMETERS			
64- Phytoplankton diversity: ▪ Genus ▪ Species composition ▪ Dominance		65- Zooplankton diversity: ▪ Genus ▪ Species composition ▪ Dominance	
BACTERIOLOGICAL PARAMETERS			
66- Faecal coliforms		67- Total coliforms	

TABLE 3. PARAMETERS DETERMINED FOR GROUNDWATER		
IN SITU MONITORING PARAMETERS		
1- Water temperature		3- Electrical conductivity.
2- Hydrogen potential		
PHYSICO-CHEMICAL ANALYTICAL DETERMINATIONS		
4- Total dissolved solids	10- Bicarbonates	16- Total phosphorus
5- Organic matter	11- Carbonates	17- Total nitrogen
6- Hardness	12- Sulphates	18- Sodium
7- Nitrates	13- Calcium	19- Potassium
8- Chlorides	14- Magnesium	20- Boron
9- Alkalinity	15- Fluorine	
BACTERIOLOGICAL PARAMETERS		
21- Faecal coliforms	21- Total coliforms	23- *Escherichia coli*

Table 3 shows the parameters analysed for groundwater monitoring that are 23 determinations for the twenty samples extracted from the artesian and monitoring wells.

The two sampling points on the Paraguay River are crucial monitoring points for the PARACEL's future industry. According to POYRY's environmental impact assessment report (2020), this river will work as a waterway to transport raw materials, chemical inputs, and products.

The future industry's port will be on the Paraguay River (All). At the same time, raw water will be extracted from this river for treatment and use in the industrial processes and will also be the receiving body for the treated effluents generated at the paper mill.
Given the particular importance of the points on the River Paraguay, 68 analytical determinations, including a broader range of agrochemicals and halogenated organic compounds (AOX), were carry out in points F.W01 and F.W02. Table 4 shows in detail the parameters determined for these points.

TABLE 4. PARAMETERS DETERMINED FOR THE PARAGUAY RIVER
IN SITU MONITORING PARAMETERS

1- Water temperature		4- Dissolved oxygen	
2- Hydrogen potential		5- Turbidity	
3- Electrical conductivity			
PHYSICO-CHEMICAL ANALYTICAL DETERMINATIONS			
PARAMETERS INCLUDED IN THIS REPORT		**PARAMETERS THAT INCLUDES IN THE FINAL REPORT OF THE FIRST CAMPAIGN**	
6- Floating materials	16- Hardness	25- Aluminium	34- Zinc
7- Total dissolved solids	17- Sodium	26- Cadmium	35- Arsenic
8- Oil and grease	18- Sulphates	27- Hexavalent chromium	36- Barium
9- COD (oxygen demand chemical))	19- Cyanides	28- Trivalent chromium	37- Total mercury
10- BOD5 (oxygen demand biochemical	20- Copper	29- Trivalent chromium	
11- Total phosphorus	21- Soluble iron	30- Tin	
12- Total nitrogen	22- Colour	31- Manganese	
13- Nitrates	23- Phenols index	32- Lead	
14- Ammonia	24-PCBs (Polychlorinated Biphenyls)	33- Selenium	
15- Nitrites			
AGROCHEMICALS			
38- Glyphosate	46- DDE	54- 2,4-D	62- Imidacloprid
39- AMPA	47- DDD	55- Lambda-cyhalothrin*	63- Methyl-paraoxon
40- Aldrin	48- Atrazine	56- Bifenthrin	64- Thiamethoxam*
41- Endrin	49- Simazine	57- Cypermethrin	65- Sulfluramide*
42- Dieldrin	50- Carbaryl	58- Chlorpyrifos	66- Fipronil*
43- Lindane	51- Carbofuran	59- Dichlorvos	
44- Chlordane	52- Heptachlor	60- Methamidophos	
45- DDT	53- Methomyl	61- Tebuconazole	
*Notes: This document does not report the following parameters: Lambda-cyhalothrin, Thiamethoxam, and Sulfluramide.			
BATERIOLOGICAL PARAMETERS			
67- Faecal coliforms		68- Total coliforms	

2.4. Sample collection procedures

2.4.1 Surface water (FW.)

In situ measurements were performed (pH, temperature, conductivity and dissolved oxygen) and were collected samples for the rest parameters to be analysed in the laboratory (Tables 1 and 3) by immersing plastic containers to a depth of 30 cm below the surface of the water. For bacteriological sampling, a sterile sampling cup was submerged to a depth of 30 cm, fill it with water and closing it tightly underwater to avoid external contamination.

The cups, duly identified, were placed in coolers with ice to avoid altering the samples' composition before analysis. The surface sampling procedure and the preservation of the samples until they arrived at the laboratory (Table 5), for each point, was based on the Standard Methods 22nd. Ed. For surface water (Tables 6, 7 and 8).

2.4.2 Groundwater (GW.)

Groundwater samples were taken to determine physicochemical and bacteriological parameters in the laboratory (Table 2). On the other hand, parameters as pH, temperature and conductivity were measured on-site.

2.4.3 Sample containers and preservatives

Table 5 details all the parameters, sample containers, volumes and preservatives applied according to the parameter's analysis method.

TABLE 5. FLASKS AND PRESERVATIVES PER SAMPLE TYPE						
SAMPLE CONTAINER	**MATERIAL**	**VOLUME**	**PRESERVATIVE**	**PARAMETERS**	**FW**	**GW**
Bacteriology	Plastic	100 mL	s/p	Total coliforms Faecal coliforms *Escherichia coli*	✓	✓
BOD5	Plastic	1L	s/p	COD, BOD5	✓	
CF	Plastic	2L	s/p	Solids, Turbidity, Alkalinity, Nitrite, Nitrate, Colour, Chloride, Magnesium, Calcium, Sulphate	✓	✓
Phenols	Plastic	1L	H_2SO_4 1+1, up to pH<2	Phenols, Cr^{+6}	✓F W PY	
Metals	Plastic	1L	HNO_3 1+1, up to pH<2	CrT, Hg, Zn, Cd, Pb, Se, Sn, Al, Cu, Mn, Ni	✓	✓
NTK	Plastic	1L	H_2SO_4 1+1, hasta pH<2	P.T., NTK, N-NH_3	✓	✓
Iron	Plastic	250 mL	HCl 1+1, up to pH<2	Iron, sodium, potassium	✓	
Sulphides	Plastic	500 mL	Zn acetate + NaOH up to pH>9	Sulphur	✓	
Multi-waste	Amber glass	1L	s/p	Multi-waste	✓	
Sulphuramid and lambda-cyhalothrin	Amber glass	1L	s/p	Sulphuramid and Lambda-cyhalothrin	✓	
Bifenthrin y Thiamethoxam	Plastic	1L	s/p	Bifenthrin y Thiamethoxam	✓	
Glyphosate and AMPA	Plastic	1L	s/p	Glyphosate and AMPA	✓	
Fipronil	Amber glass	1L	s/p	Fipronil	✓	
PCBs	Amber glass	1L	s/p	PCBs	✓ FW PY	
FITO	Plastic	250 mL	Lugol	Phytoplankton	✓*	
ZOO	Plastic	100 L	Formaldehyde 10%	Zooplankton	✓*	

Sample collection and preservation conditions. Ref.: s/p (Without preservative), BOD5 (Biochemical Oxygen Demand); COD (Chemical Oxygen Demand); FQ (Some Physicochemical parameters); NTK (Total Nitrogen Kjeldahl); CrT (Total Chromium) and AMPA (α-Amino-3-hydroxy-5-methyl-4-isoxazole propionic acid), FITO (Phytoplankton) y ZOO (Zooplankton).

2.5 Applied analytical methods

The tables below detail the analytical methods applied for the determination of each parameter.

TABLE 6. METHODS FOR HYDROBIOLOGICAL-BACTERIOLOGICAL PARAMETERS			
HYDROBIOLOGICAL			
PARAMETERS	**METHODS**	**LIMITS OF QUANTIFICATION IN WATER**	**PERMISSIBLE LIMITS AS PER SEAM REGULATION 222/02 CLASS 2**
Phytoplankton	Phytoplankton counting techniques - SM 10200 F	<100 Cells	No limits

Zooplankton	Zooplankton counting techniques – SM 10200 G	Not applicable	No limits
MICROBIOLOGICAL PARAMETERS - GROUNDWATER			
PARAMETERS	**METHODS**	**LIMITS OF QUANTIFICATION IN WATER**	**PERMISSIBLE LIMITS AS PER NP REGULATION 2400180**
Total coliforms	Standard fermentation technique for Total coliforms SM 9221 B Bacterial density estimation SM 9221 C	>23 NMP/100mL	<1,1 NMP/100mL
Faecal coliforms	Standard fermentation technique for Total coliforms SM 9221 B Bacterial density estimation SM 9221 C	>23 NMP/100mL	<1,1 NMP/100mL
E. coli	Escherichia coli SM 9260 F	Presence/100mL	Absence/100mL
MICROBIOLOGICAL PARAMETERS – SURFACE WATER			
PARAMETERS	**METHODS**	**LIMITS OF QUANTIFICATION IN WATER**	**PERMISSIBLE LIMITS AS PER SEAM REGULATION 222/02 CLASS 2**
Faecal coliforms	Standard fermentation technique for Total coliforms SM 9221 B Bacterial density estimation SM 9221 C	>160.000 NMP/100mL	≤ 1.000 NMP/100mL
Total coliforms	Standard fermentation technique for Total coliforms SM 9221 B Bacterial density estimation SM 9221 C	>160.000 NMP/100mL	Not applicable

TABLE 7. METHODS APPLIED TO PHYSICO-CHEMICAL PARAMETERS

PARAMETERS	METHODS	MONITORING EQUIPMENT	LIMITS OF QUANTIFICATION IN WATER	PERMISSIBLE LIMITS AS PER SEAM REGULATION 222/02 CLASS 2
Water temperature	Laboratory and field methods SM-2550 B	Conductimeter/Oximeter/pHmeter WTW MULTI 350	Not applicable	No limits
Dissolved oxygen	Membrane electrode method SM-4500-O G	Conductimeter/Oximeter/pHmeter WTW MULTI 350	0,10 mg O2/L	No less than 5 $mg.L^{-1}$
pH	Electrometric method SM-4500 - H^+	Conductimeter/Oximeter/pHmeter WTW MULTI 350	0 a 14	6 a 9
Conductivity	Laboratory method SM-2510 -B	Conductimeter/Oximeter/pHmeter WTW MULTI 350	0 a 199,9 mS/cm	No limits
Alkalinity	Titration method SM-2320 B	Current calibrated glass material	1,0 $mg.L^{-1}$	No limits
Turbidity	Nephelometric method SM-2130 B	THERMO ORION AQ 4500 Turbidimeter	0,10 NTU	100 NTU
Floating materials	Visual	Not applicable	Not applicable	Visually absent
Oil and grease	Method SM 5520-B	QUIMIS 01317M-53 stove and rotary evaporator EYELA SB1000	0,020 $mg.L^{-1}$	Visually absent
Total phosphorus	Ascorbic acid method SM-4500-P E	Schimadzu - UV Spectrophotometer 1700	0,025 mg $PO4^{-3}.L^{-1}$	0,05 $mg.L^{-1}$
NTK	Macro-Kjeldahl SM-4500-N B; phenate method SM-4500 F	Gerhardt Turbosog/ Schimadzu Digester - UV Spectrophotometer 1700	0,025 mg $N.L^{-1}$	0,6 $mg.L^{-1}$
Nitrate nitrogen	AOAC Official Method 973.50 Brucine Colorimetric Method	Schimadzu - UV Spectrophotometer 1700	0,10 mg $N(NO3^-).L^{-1}$	10 $mg.L^{-1}$
Nitrite nitrogen	Colorimetric method SM-4500 ($NO2^-$) B	Schimadzu - UV Spectrophotometer 1700	0,0025 mg $N-NO2^-.L^{-1}$	1,0 $mg.L^{-1}$
Ammonia nitrogen	Phenol salt method SM-4500 (NH3) F	Schimadzu - UV Spectrophotometer 1700	0,015 mg $N-NH3.L^{-1}$	0,02 $mg.L^{-1}$
BOD5	5-day BOD test - SM-5210 B	WTW OXI 3310 Oximeter	0,10 mg $O2.L^{-1}$	5 $mg.L^{-1}$
COD	Closed reflux, colorimetric method - SM-5220 D	Schimadzu - UV Spectrophotometer 1700	5,0 $mgO2.L^{-1}$	SLE
Dissolved solids totals	Gravimetric method SM-2540 C	Sartorius Analytical Balance / Stove QUIMIS 0317M-S3	2,0 $mg.L^{-1}$	500 $mg.L^{-1}$
Colour	Visual comparison method SM-2120 B	Schimadzu - UV Spectrophotometer 1700	5 mg $Pt.L^{-1}$	75 $mgPt.L^{-1}$
Trivalent chromium	Calculation method (Total chromium – Hexavalent chromium)	Not applicable	0,05 $mg.L^{-1}$	0,5 $mg.L^{-1}$
Hexavalent chromium	Colorimetric method (SM-3500-Cr B)	Schimadzu - UV Spectrophotometer 1700	0,05 $mg.L^{-1}$	0,05 $mg.L^{-1}$
Copper	AAS-Air-Acetylene Flame (SM-3111-B)/GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	0,05 $mg.L^{-1}$	1,0 $mg.L^{-1}$
Arsenic	Colorimetric method (SM-3500-As B)	Schimadzu - UV Spectrophotometer 1700	<0,01 $mg.L^{-1}$	0,01 $mg.L^{-1}$
Boron	Colorimetric method (SM-4500-B C)	Schimadzu - UV Spectrophotometer 1700	1,0 $mg.L^{-1}$	No limits
Manganese	AAS- Air-Acetylene Flame (SM-3111-B)/GFA (SM-3113)	AA-7000 Shimadzu	0,05 $mg.L^{-1}$	0,1 $mg.L^{-1}$
Nickel	AAS- Air-Acetylene Flame (SM-3111-B)/GFA (SM-3113)	AA-7000 Shimadzu	0,010 $mg.L^{-1}$	0,025 $mg.L^{-1}$
Zinc	AAS- Air-Acetylene Flame (SM-3111-B)	AA-7000 Shimadzu	0,05 $mg.L^{-1}$	3,0 $mg.L^{-1}$
Cadmium	AAS-GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	0,0008 $mg.L^{-1}$	0,001 $mg.L^{-1}$
Lead	AAS-GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	0,002 $mg.L^{-1}$	0,01 $mg.L^{-1}$
Selenium	AAS-GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	0,005 $mg.L^{-1}$	0,01 $mg.L^{-1}$
Tin	AAS-GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	1,0 $mg.L^{-1}$	2,0 $mg.L^{-1}$
Aluminium	AAS-GFA (SM-3113)	AA-7000 Shimadzu / GFA -7000	0,10 $mg.L^{-1}$	0,2 $mg.L^{-1}$

TABLE 7. METHODS APPLIED TO PHYSICO-CHEMICAL PARAMETERS				
PARAMETERS	**METHODS**	**MONITORING EQUIPMENT**	**LIMITS OF QUANTIFICATION IN WATER**	**PERMISSIBLE LIMITS AS PER SEAM REGULATION 222/02 CLASS 2**
Fluorine	Method SM 4500 F C Ion-selective electrode	Multiparameter with selective fluoride electrode OAKTON	0,05 $mg.L^{-1}$	No limits
Phenols	Direct photometric method SM-5530 D	Schimadzu - UV Multiparameter with selective fluoride electrode OAKTON 1700	0,04 $mg.L^{-1}$	No limits
Total hardness	EDTA titrimetric method - SM-2340 C	Current calibrated glass material	1,0 $mg.L^{-1}$	300 $mgCa.L^{-1}$
Chlorides	Argentometric SM-4500 -Cl^- B	Current calibrated glass material	0,5 mg $Cl^-.L^{-1}$	No limits
Magnesium	Calculation method SM-3500 B	Not applicable	0,2 mg $Mg.L^{-1}$	No limits
Calcium	EDTA titrimetric method SM-3500 B	Current calibrated glass material	0,4 $mg.L^{-1}$	No limits
Potassium	AAS-Flame nitrous oxide-acetylene (SM-3111-D)/GFA (SM- 3113)	AA-7000 Shimadzu	0,25 $mg.L^{-1}$	No limits
Sodium	AAS-Air-acetylene flame (SM-3111-B)	AA-7000 Shimadzu	0,25 $mg.L^{-1}$	200 $mg.L^{-1}$
Soluble iron	Phenanthroline method SM-3500-Fe B	Schimadzu - UV Spectrophotometer 1700	0,05 mg $Fe.L^{-1}$	No limits
Sulphates	Turbidimetric method SM-4500 - $SO4^{-2}$ E	THERMO ORION AQ 4500 Turbidimeter	1,0 mg $SO4^{-2}.L^{-1}$	250 $mg.L^{-1}$
Cyanides	SM 4500-CN E – Standard method – Standard methods used to analyse drinking and wastewater, 17th Edition (APHA-AWWA-WPCF).	Thermo Scientific Evolution 60S UV-Visible Spectrophotometer	0,02 mg. L^{-1}	0,07 mg. L^{-1}
PCB	Determination of PCBs residues in an aqueous matrix by GC-ECD *Gas Chromatography - Electron Capture Detector*	Gas Chromatography	0,2237 mg. L^{-1}	0 (zero)
Total mercury	Method ICP/MES *"Inductively Coupled Plasma Mass Spectrometry"*	Spectrophotometer.	0,05 mg. L-1	No limits
Barium	Method icp/mes *"inductively coupled plasma mass spectrometry"*	Spectrophotometer.	<0,001 mg. L-1	2 mg. L^-

TABLE 8. APPLIED METHODS FOR THE DETERMINATION OF AGROCHEMICALS			
AGROCHEMICALS			
PARAMETERS	**METHODS**	**LIMITS OF QUANTIFICATION IN WATER**	**PERMISSIBLE LIMITS AS PER REGULATION 222/02 SEAM CLASS 2**
OC- Aldrin	Extraction US-EPA 8081B and 3510 with modifications. Quantification by EPA 608.1 with modifications - GC-MS/MS	<1,00	No limits
OC-Endrin		<1,25	2
OC-Dieldrin		<1,50	No limits
2,4-D		<2,50	30
Atrazine		<2,00	3
Carbaryl		<3,50	No limits
Carbofuran		<3,00	40
Cypermethrin		<1,20	No limits
Chlordane		<0,9	0
Chlorpyrifos		<5,00	No limits
DDD		<2,00	No limits
DDE	Extraction US-EPA 8081B and 3510 with modifications. Quantifications by EPA 608.1 with modifications - GC-MS/MS	<2,00	No limits
DDT		<2,00	2
Dichlorvos		<10,0	10
Heptachlor		<1,50	0
Imidacloprid		<5,00	No limits
Lindane		<0,200	0,2
Methamidophos		<25,0	No limits
Methylparaoxon		<25,0	No limits
Methomyl		<25,0	No limits
Simazine		<2,50	4
Tebuconazole		<2,00	No limits
Sulfluramid	*		No limits
Lambdacyalothrin	*		No limits
Lambdacyalothrin	*		No limits
Thiamethoxam	*		No limits
Glyphosate/AMPA in water	Extraction: In-house method (According to Amarante, J. et al; 2002) Quantification by HPLC/FLD	0,3 µg/L	0,7
Fipronil	Method: LC-MS/MS *Liquid Chromatography Mass Spectrometry*	0,0100 mg. L^{-1}	

***Notes:** Due to the pandemic, the suppliers of the reagents and laboratory chemicals necessary to determine Sulfluramid, Lambdacyalothrin, Lambdacyalothrin and Thiamethoxam, have not yet been delivered causing delays in the determination of these agrochemicals (Appendix E. Supplier's note).

2.6 Data quality control

As established in the National Water Quality Standard (Regulation SEAM No. 222/02 – Art. 13), the sampling techniques and respective analysis were carried out according to the internationally recognised methodology: The Standard Methods – To examine water and wastewater – APHA – AWWA – WPCF. Tables 6, 7 and 8 show the methods and equipment used for each parameter's analytical determination.

A team of technicians from the CEMIT's laboratory and TECNOAMBIENTAL performed the field sampling. The samples were taken according to the methodology previously described, ensuring the correct application of procedures, flasks, preservatives and cold chain maintenance from the sampling site to the laboratories.

Using a "field blank" eliminates the possibility that the flasks are a source of contamination. Field blanks are containers filled with deionised water free of the analyte in question and are preserved and analysed in the same wat as any other sample for the same determination.

If the analytical determinations made on the field blanks show results close to zero (0), the flasks did not contaminate during the trip, and the samples are representative of the points analysed.

The CEMIT Water Quality Laboratory, which belongs to the National University of Asunción (UNA), has been accredited since 2015 by the Paraguay National Accreditation Body (ONA). The professional responsible for the processing and analysis of the results is the chemist Claudia Ávalos de Enciso.

Other laboratories also accredited by the ONA analysed the following parameters; Total mercury, Barium, Cyanides, Fipronil and PCBs.

ANALITICA SA tested Total mercury and Barium. This laboratory is also accredited by the ONA, according to Standard NP-ISO/EIC 17025:2018.

The Water Quality Laboratory of the Faculty of Exact and Natural Sciences of the National University of Asunción (FACEN-UNA) analysed Cyanides.

Eco Natura laboratory, which is part of the MULTI LAB group, analysed FIpronil and PCBs. This institute is accredited according to NO-ISO/EIC 17025:2018 by the ONA.

2.7 Data interpretation models

The steps followed for the presentation and interpretation of the results of the analytical determinations are the following:

- Processing the results and comparing with the limits established in Regulation SEAM No. 222/02 "By which the water quality standard is established in the national territory" for Class 2, a category in which all surface waters are classified.
- The series of determinations at the different sampling points are shown on graphs and descriptive statistics for each parameter. The sampling point's parameters that are out of range are reported.
- For each point, the percentage of parameters that complies and does not comply with Regulation SEAM No. 222/02 was determined.

III. RESULTS

3.1 General performance of surface water's parameters

Table 9 shows a summary of the results obtained for each parameter analysed in surface water; it also highlights the points that present some deviation and the percentage of monitoring points that complies with Regulation SEAM No. 222/02 "Establishing the water quality standard in the national territory" and those beyond the permissible limits.

TABLE 9. SUMMARY OF SURFACE WATER QUALITY ANALYSIS

Nº	PARAMETER	AVERAGE	MONITORING POINTS WITH DEVIATIONS	COMPLY WITH THE LIMITS		BEYOND THE LIMITS	
				Nº	%	Nº	%
1	Temperature	24,5 ºc	No limits				
2	pH	6,87	FW317-RZ, FW 11-LB	18	90%	2	10%
3	Electrical conductivity	130,50 µS/.cm	No limits				
4	Dissolved oxygen	5,7 mg O2/L	FW 207-TR, FW 208-TR, FW 115-MY, FW 110-LB FW 109-MYRZ	15	75%	5	25%
5	Turbidity	140,154 NTU	FW 200-SLTR, FW 205-TR FW 111-LB, FW 310-CR	16	80%	4	20%
6	Floating materials	51,36	No limits				
7	Total dissolved solids (TDS)	161,7	All the points complies with the limits	20	100%	0	0%
8	Oil and grease	8,78 mg/L	No limits				
9	COD	78,2 mg O_2/L	No limits				
10	BOD5	3,15 mg O_2/L	FW 205-TR, FW 310-TR, FW 316-CR	16		3	
11	Total phosphorus	0,07 mg/L	FW 315-HE, FW 304-HE, FW 207-TR, FW205-TR, FW 109-MYRZ, FW 115-MY FW 110-LB, FW 111-LB FW310-CR, FW01	9	45%	11	55%
12	Total nitrogen	0,77 mg/L	FW 315-HE, FW 208-TR FW 316-CR	16	80%	4	20%
13	Nitrates	2,7 mg/L	All the points complies with the limits	20	100%	0	0%
14	Ammonia	0,12 mg/L	All the points exceeds the maximum limits	0	0%	20	100%
15	Nitrites	0,12 mg/L	All the points complies with the limits	20	100%	0	0%
16	Hardness	30,70 mg CaCO3/L	All the points complies with the limits	20	100%	0	0%
17	Sulphates	>2 mg/L	All the points complies with the limits	20	100%	0	0%
18	Sodium	7,42 mg/L	All the points are under the limits of quantification in water; therefore complies with the limits	20	100%	0	0%
19	Aluminium	--	All the points are under the limits of quantification (LOQ=0,1)	20	100%	0	0
20	Cadmium	---	All the points are under the limits of quantification (LOQ=0,0008)	20	100%	0	0
21	Hexavalent chromium	--	All the points are under the limits of quantification (LOQ=0,0500)	20	100%	0	0%
22	Trivalent chromium	--	All the points are under the limits of quantification (LOQ=0,0500)	20	100%	0	0%
23	Copper	--	All the points are under the limits of quantification	20	100%	0	0%
24	Tin		All the points are under the limits of quantification (LOQ=1)	20	100%	0	0

TABLE 9. SUMMARY OF SURFACE WATER QUALITY ANALYSIS							
Nº	PARAMETER	AVERAGE	MONITORING POINTS WITH DEVIATIONS	COMPLY WITH THE LIMITS		BEYOND THE LIMITS	
				Nº	%	Nº	%
25	Nickel	0,098 mg/L	18 points under the limits of quantification and only 2 determinations beyond the limits	18	90%	2	10%
26	Manganese	0,207 mg/L	FW315-HE, FW205-TR FW110-LB, FW111-LB FW310-CR, FW01, FW02	13	65%	7	35%
27	Lead	0,0118 mg/L	FW317-RZ, FW316-CR FW306-SO	17	85%	3	15%
28	Selenium	--	All the points are under the limits of quantification (LOQ=1)	20	100%	0	0
29	Zinc	0,14 mg/L	-	20	100%	0	0%
30	Arsenic	--	-	20	100%	0	0%
31	Soluble iron	1,3 mg/L	All the surface water sampling points exceeds the maximum limits	0	0%	20	100%
32	Total mercury	--	All the points are under the limits of quantification (LOQ=0,001)	20	100%	0	0%
33	Barium	0,139 mg/L	All the points are under the limits of quantification	20	100%	0	0%
34	Cyanides	>0,02 mg/L	All the points complies with the limits and are under the limits of quantification	20	100%	0	0%
35	Faecal coliforms	3677,4 NMP/100 mL	All points are beyond the limits except FW 316-CR, FW01 and FW02.	4	20%	16	80%
36	Total coliforms	9129,6 NMP/100 mL	FW104-ZA, FW315-HE, FW304-HE, FW200-SLTRE, FW207-TR, FW208-TR, FW205-TR, FW109-MYRZ, FW115-MY, FW317-RZ, FW204-LB, FW110-LB, FW310-CR	6	30%	14	70%

3.2 Analysis and interpretation of results

The next graphs show each parameter's behaviour determined at the 19 monitoring points, contrasting them with limits established by Regulation SEAM No. 222/02, according to the objectives.

Details per sampling point are in Appendix C.

3.2.1 Water temperature

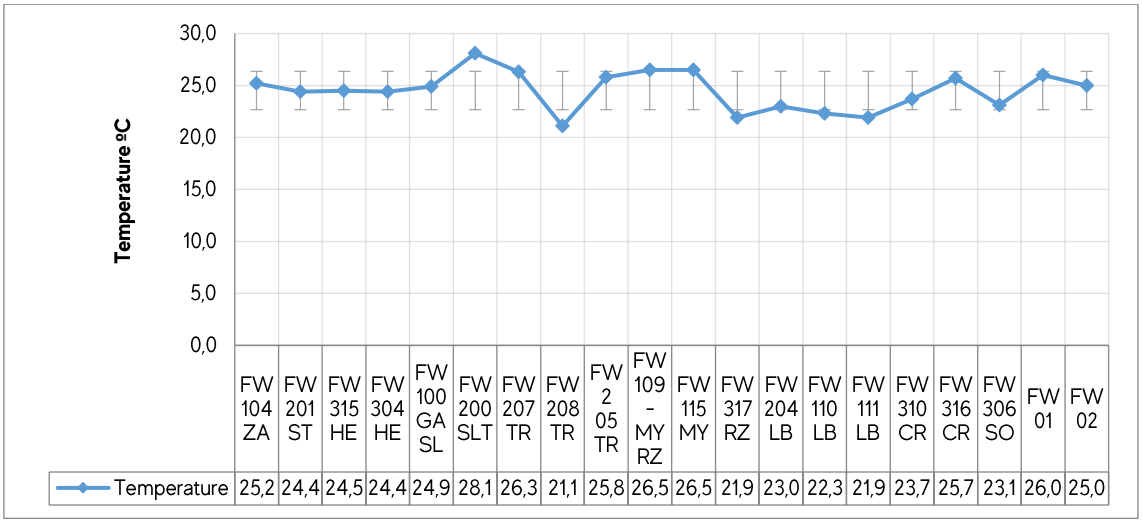


Figure 1. Comparative analysis of water temperature at monitoring points

SEAM Regulation No. 222/02 does not establish limit values for the temperature of Class water 2; only for effluents discharge to water bodies, whose limit value is 40 ºC. The average water temperature recorded in the first campaign was 24.5 ºC. The maximum value was measure at the point FW200-SLTR (28.1 ºC) and the minimum at FW208-TR (21.1 ºC).

3.2.2 Hydrogen potential (pH)

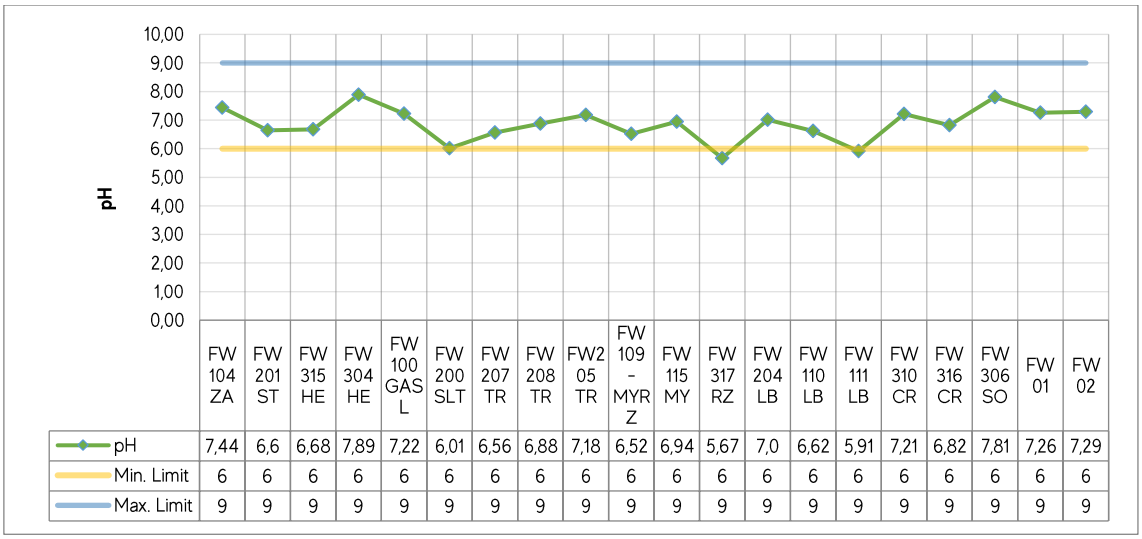
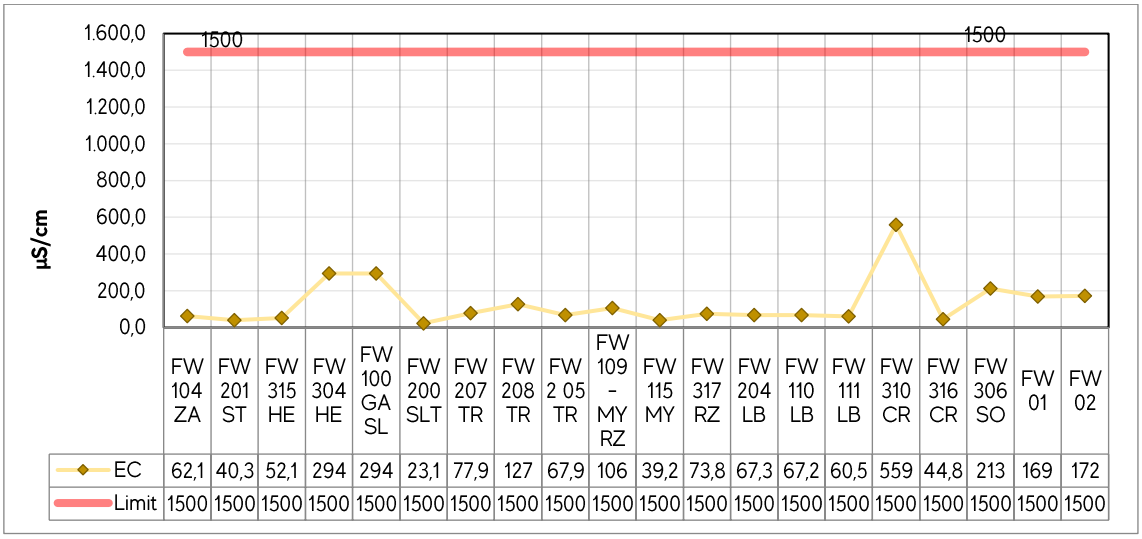


Figure 2. Comparative analysis of pH values at different monitoring points

The SEAM Regulation No. 222/02 establishes a minimum and maximum limit of 6 and 9. Figure 2 shows that none point exceeds the upper limit; as for the lowest, points FW317-RZ and FW111-LB show slightly acid pH values.

The 90% of the points comply with Regulation 222/02. The average pH magnitude in the first campaign is 6.8 which is very close to the ideal value of 7.

3.2.3 Electrical conductivity



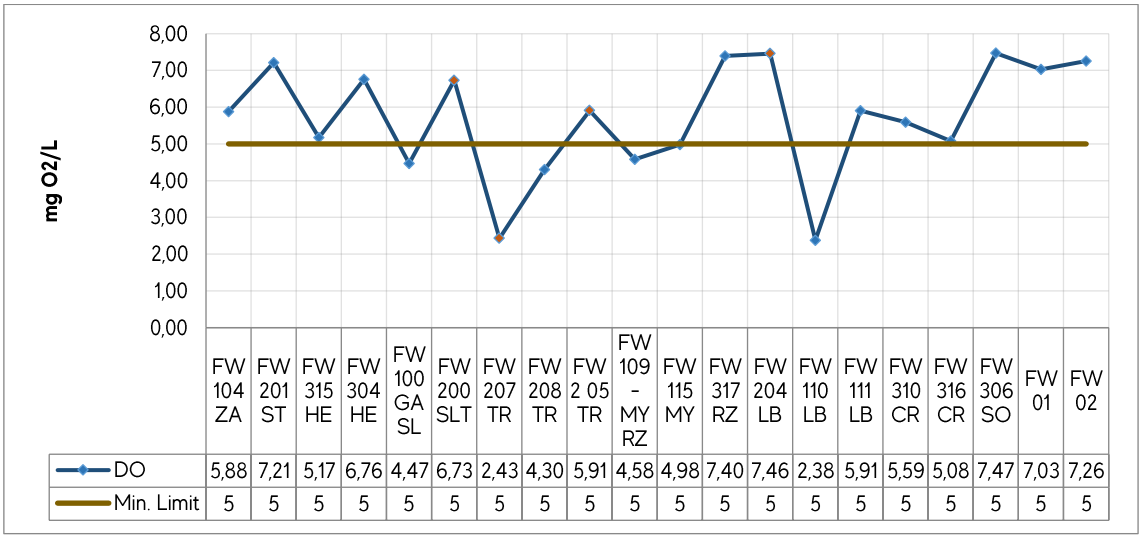
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
EC	62,1	40,3	52,1	294	294	23,1	77,9	127	67,9	106	39,2	73,8	67,3	67,2	60,5	559	44,8	213	169	172
Limit	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Figure 3. Comparative analysis of electrical conductivity values at different monitoring points

Regulation 222/02 does not set any limit for the electrical conductivity parameter for Class 2 water. The limit of 1500 µS/cm established in the regulation NP 24 001 80 "General requirements for drinking water" is taken as a reference. None determination carried out exceeds the mentioned number.

The average value of the parameter evaluated in the first campaign was 130,5 µS/cm. The point FW316-CR has the maximum value which is at the "Laguna Penayo" stream.

3.2.4 Dissolved oxygen



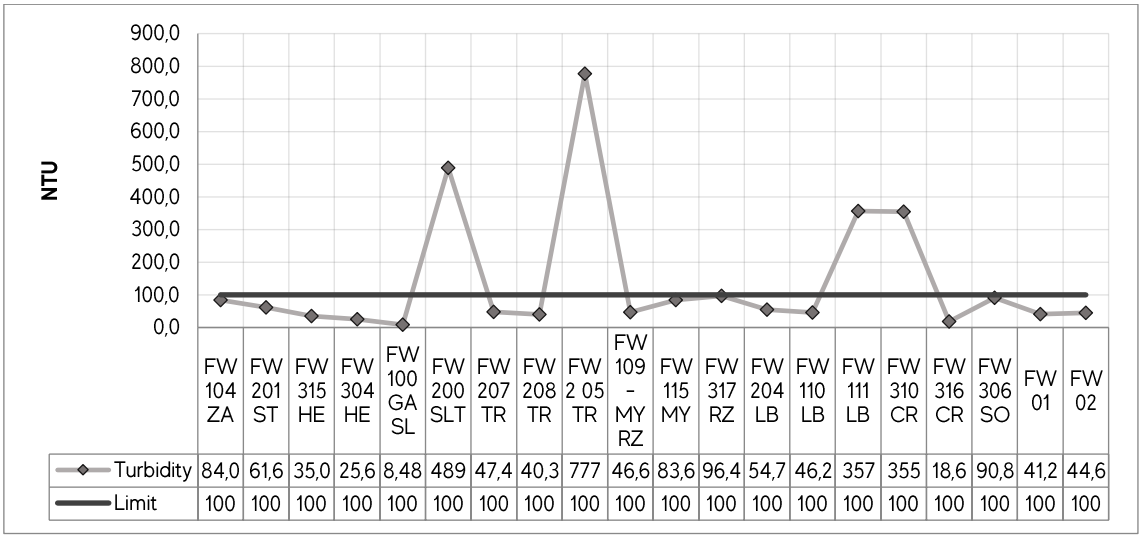
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
DO	5,88	7,21	5,17	6,76	4,47	6,73	2,43	4,30	5,91	4,58	4,98	7,40	7,46	2,38	5,91	5,59	5,08	7,47	7,03	7,26
Min. Limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Figure 4. Comparative analysis of dissolved oxygen at different monitoring points

According to Regulation 222/02, dissolved oxygen of waters classify as Class 2 should not be less than five (5 mg O_2/l). At points FW207-TR, FW208-TR, FW115-MY, FW110-LB and FW109-MYRZ, the value is lower.

The 74% of the 19 points comply with the regulation. The average DO in the first campaign is 5.8 mg O_2/l.

3.2.5 Turbidity



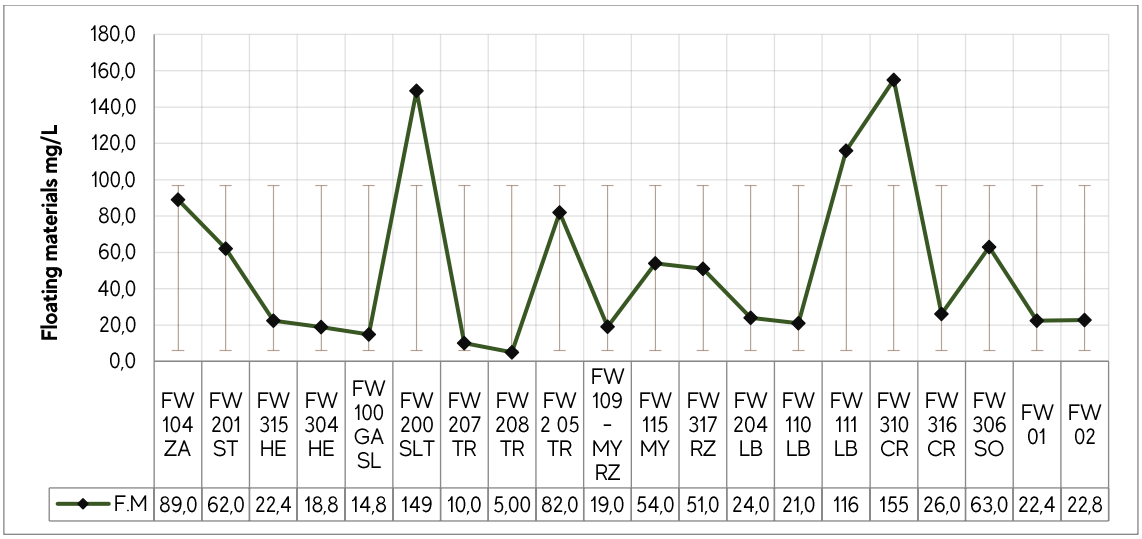
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Turbidity	84,0	61,6	35,0	25,6	8,48	489	47,4	40,3	777	46,6	83,6	96,4	54,7	46,2	357	355	18,6	90,8	41,2	44,6
Limit	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Figure 5. Comparative analysis of turbidity at different monitoring points

The maximum value established in Regulation 222/02 for Class 2 watercourse's NTU is 100. The results of the points FW200-SLTR, FW205-TR, FW111-LB and FW316-CR exceed the permissible limit.

The presence of chlorophyll and sediments may influence high turbidity values; the average value measured for this parameter in the first campaign is 140,154 NTU.

3.2.6 Floating materials



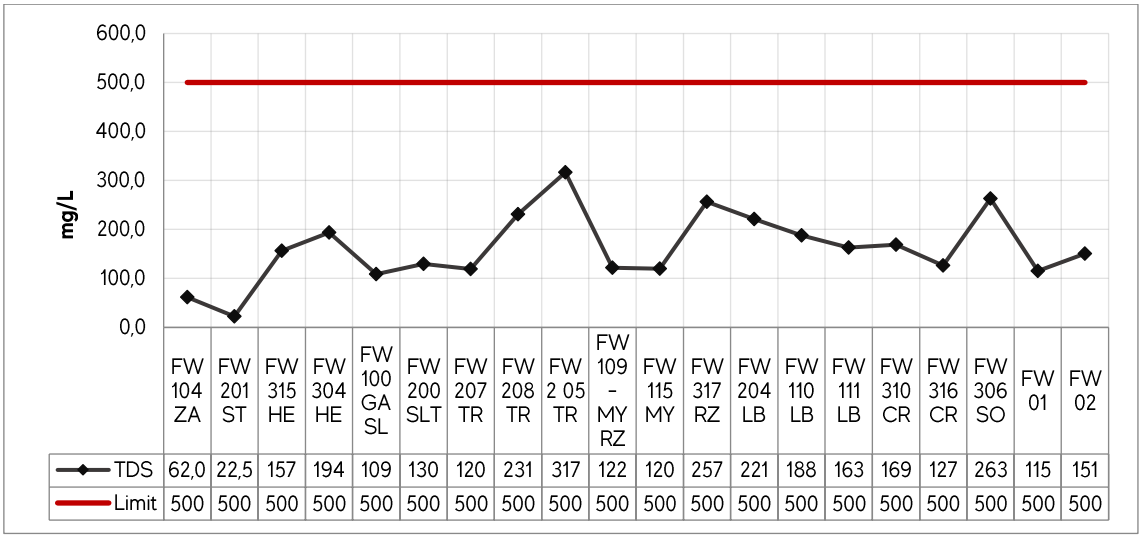
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
F.M	89,0	62,0	22,4	18,8	14,8	149	10,0	5,00	82,0	19,0	54,0	51,0	24,0	21,0	116	155	26,0	63,0	22,4	22,8

Figure 6. Comparative analysis of the presence of floating materials at different monitoring points

The national Regulation 222/02 does not set limits for this parameter but indicates that it should be virtually absent.

According to the results, the parameter's average is 51,36 mg/l. The points FW200 SL-TR, FW111-LB and FW310-CR show values higher than the mean's standard deviation even without established limits. The presence of floating material may be influence by the principal livestock activity in the area.

3.2.7 Total dissolved solids

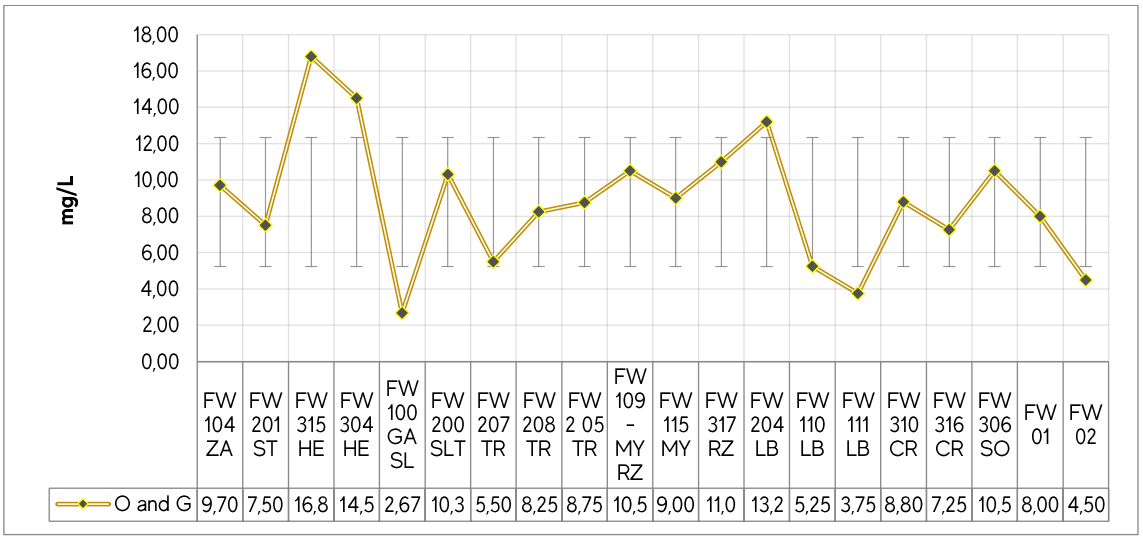


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
TDS	62,0	22,5	157	194	109	130	120	231	317	122	120	257	221	188	163	169	127	263	115	151
Limit	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500	500

Figure 7. Comparative analysis of total dissolved solids (TDS) at different monitoring points

The permissible limit established in the national regulation is 500 mg/l which none monitoring point exceeded in this campaign. The average TDS value is 161,7 mg/l.

3.2.8 Oil and grease



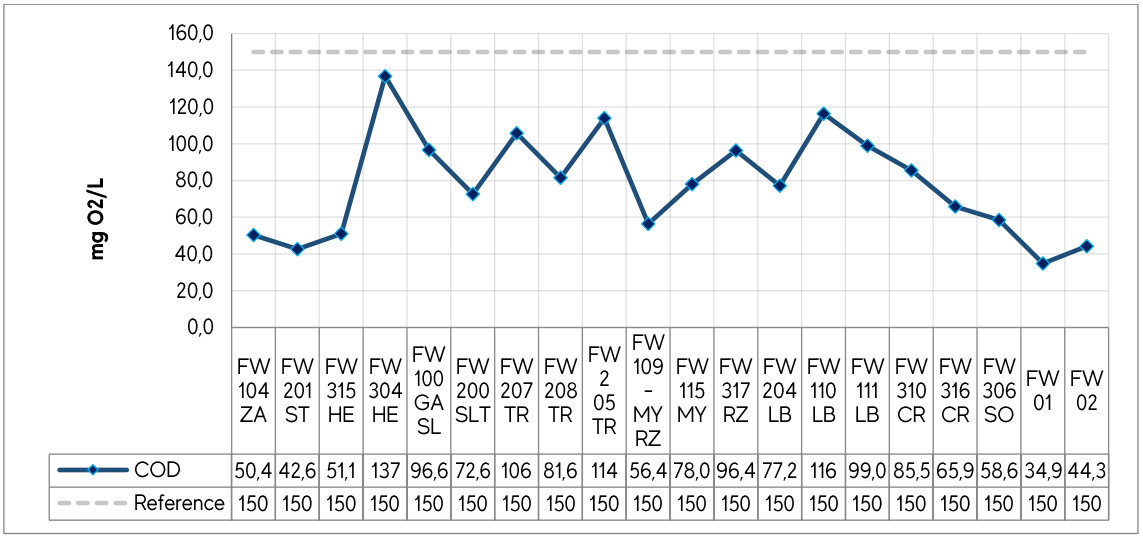
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
O and G	9,70	7,50	16,8	14,5	2,67	10,3	5,50	8,25	8,75	10,5	9,00	11,0	13,2	5,25	3,75	8,80	7,25	10,5	8,00	4,50

Figure 8. Comparative analysis of oil and grease at different monitoring points

For waters Class 2, the national regulation does not establish a limit; it only indicates that it must be virtually absent. For effluent discharges to water bodies, the maximum limits are 20 mg/l for mineral oils and grease and 50 mg/l for animal or vegetable oils and grease.

The average parameter in the first campaign is 8,7 mg/l. The value indicated in FW315-HE is the maximum value measured with 16.8 mg/l. This point's location is close to the departmental route D001 which can be related the higher value.

3.2.9 Chemical oxygen demand

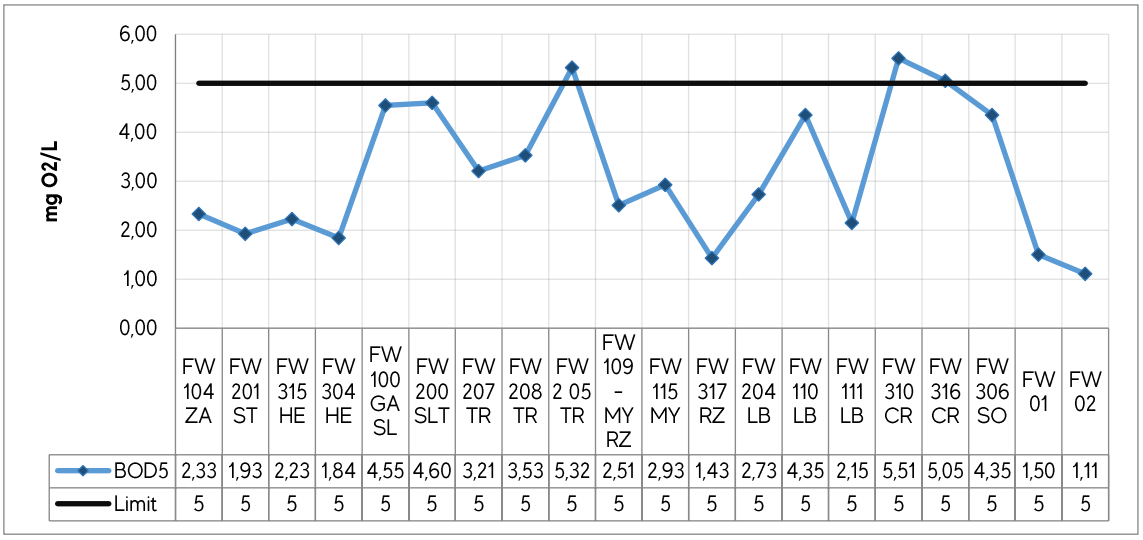


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
COD	50,4	42,6	51,1	137	96,6	72,6	106	81,6	114	56,4	78,0	96,4	77,2	116	99,0	85,5	65,9	58,6	34,9	44,3
Reference	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150

Figure 9. Comparative analysis of COD at different monitoring points

Regulation 222/02 does not establish a permissible limit for water classified as Class 2. It is only defined in Art. 7 a maximum value of 150 mg O_2/l for effluents discharge in water bodies. The average COD measured is equivalent to 78,19 mg O_2/l.

3.2.10 Biological oxygen demand

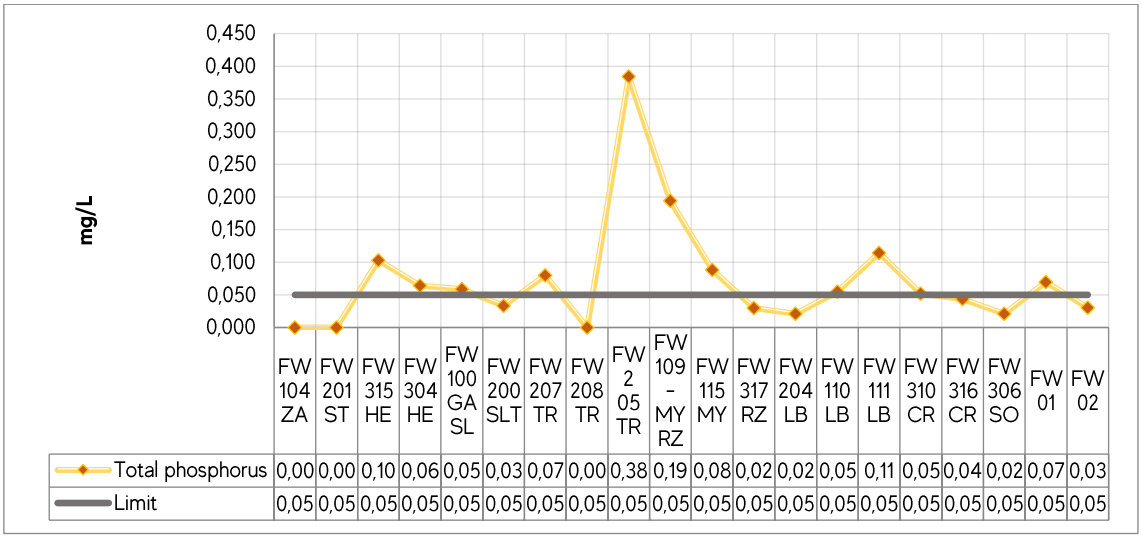


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
BOD5	2,33	1,93	2,23	1,84	4,55	4,60	3,21	3,53	5,32	2,51	2,93	1,43	2,73	4,35	2,15	5,51	5,05	4,35	1,50	1,11
Limit	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

Figure 10. Comparative analysis of BOD5 at different monitoring points

Regulation 222/02 sets a maximum of 5 mg O_2/l for the BOD5 parameter. A percentage of 84 of the monitored points comply with the limits, and the 3 points that slightly exceed it are FW205-TR, FW310-CR and FW316-CR. The BOD5 average in the first campaign is 3,158 mg O_2/l.

3.2.11 Total phosphorus



	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Total phosphorus	0,00	0,00	0,10	0,06	0,05	0,03	0,07	0,00	0,38	0,19	0,08	0,02	0,02	0,05	0,11	0,05	0,04	0,02	0,07	0,03
Limit	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

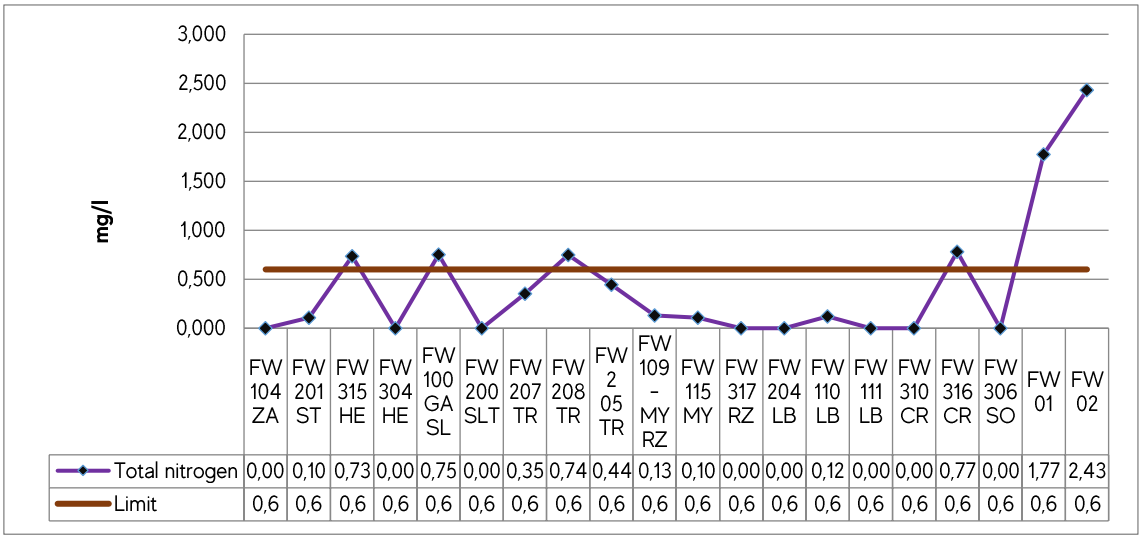
Figure 11. Comparative analysis of total phosphorus at different monitoring points

The presence of phosphorus in water is usually related to the use of organic or synthetic fertilisers. When excesses in the application of fertilisers or agrochemicals happen, it is usual that a fraction that the vegetation doesn't absorb infiltrates into the soil, reaching groundwater and surface water.

The legislation of reference establishes the presence of phosphorus in water to a maximum of 0.05 mg/L.

As shown in figure 11, this parameter's levels exceeded the limit at points FW 315-HE, FW 304-HE, FW 207-TR, FW 205-TR, FW 109-MYRZ, FW 115-MY, FW 110-LB, FW11-LB, FW 310-CR and FW01.

3.2.12 Total nitrogen



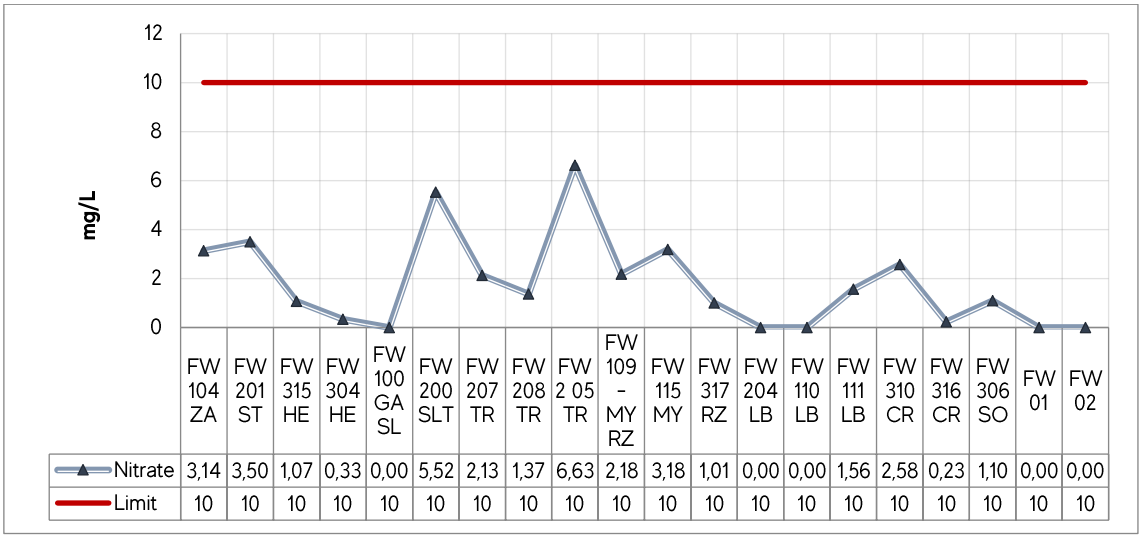
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Total nitrogen	0,00	0,10	0,73	0,00	0,75	0,00	0,35	0,74	0,44	0,13	0,10	0,00	0,00	0,12	0,00	0,00	0,77	0,00	1,77	2,43
Limit	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6

Figure 12. Comparative analysis of total nitrogen at different monitoring points

The limit set by the national water standard for total nitrogen is 0.6 mg/l; the points exceeding the maximum are FW 315-HE, FW 100-GASL, FW 208-TR and FW 316-CR.

The median for this parameter is 0.7 mg/L. A percentage of 70% of the monitoring points shows values under the range.

3.2.13 Nitrate



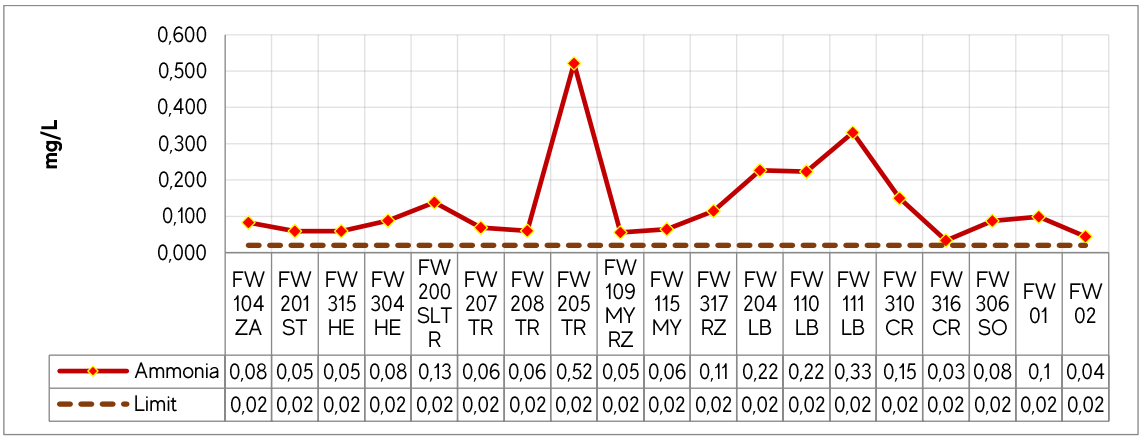
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Nitrate	3,14	3,50	1,07	0,33	0,00	5,52	2,13	1,37	6,63	2,18	3,18	1,01	0,00	0,00	1,56	2,58	0,23	1,10	0,00	0,00
Limit	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Figure 13. Comparative analysis of nitrate levels at different monitoring points

The legislation established a maximum of 10 mg/l for nitrates. None of the points exceeds this value except for point FW205-TR that reaches the maximum result with 6.63 mg/l.

The nitrate's results average is 2.7 mg/l, far below the limit.

3.2.14 Ammonia



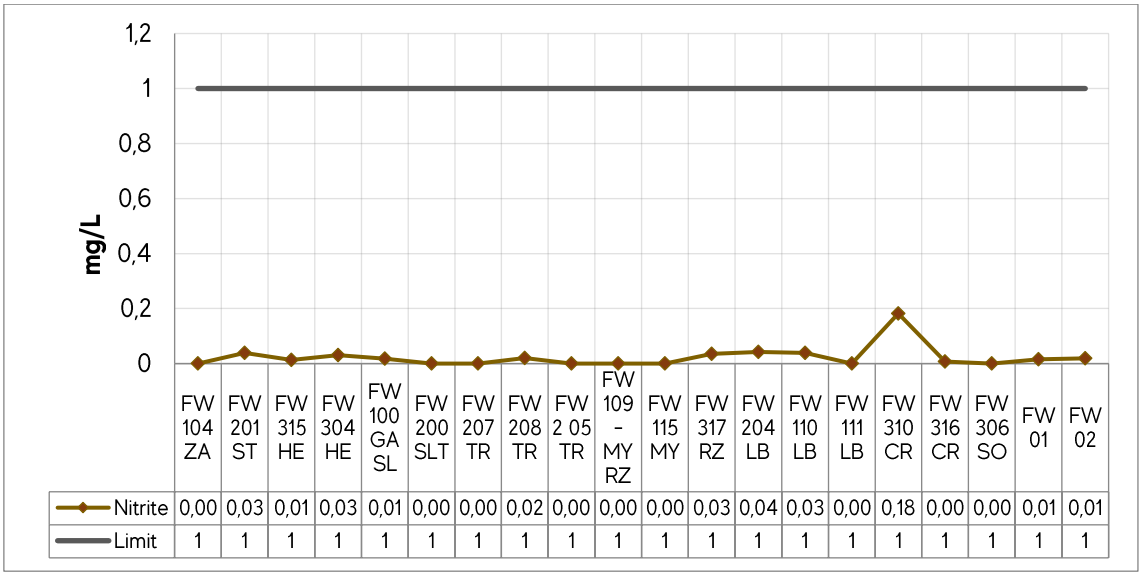
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 200 SLT R	FW 207 TR	FW 208 TR	FW 205 TR	FW 109 MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Ammonia	0,08	0,05	0,05	0,08	0,13	0,06	0,06	0,52	0,05	0,06	0,11	0,22	0,22	0,33	0,15	0,03	0,08	0,1	0,04
Limit	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02

Figure 14. Comparative analysis of ammonia levels at monitoring points

The ammonia levels exceed at all the points with an average value of 0.12 mg/l, which is five times higher than the maximum reference value.

In water bodies that don't receive industrial effluents and are in agro livestock's areas, the primary source of ammonia comes from the degradation of organic matter, specifically the decomposition of faecal matter which can explain the values obtained.

3.2.15 Nitrite

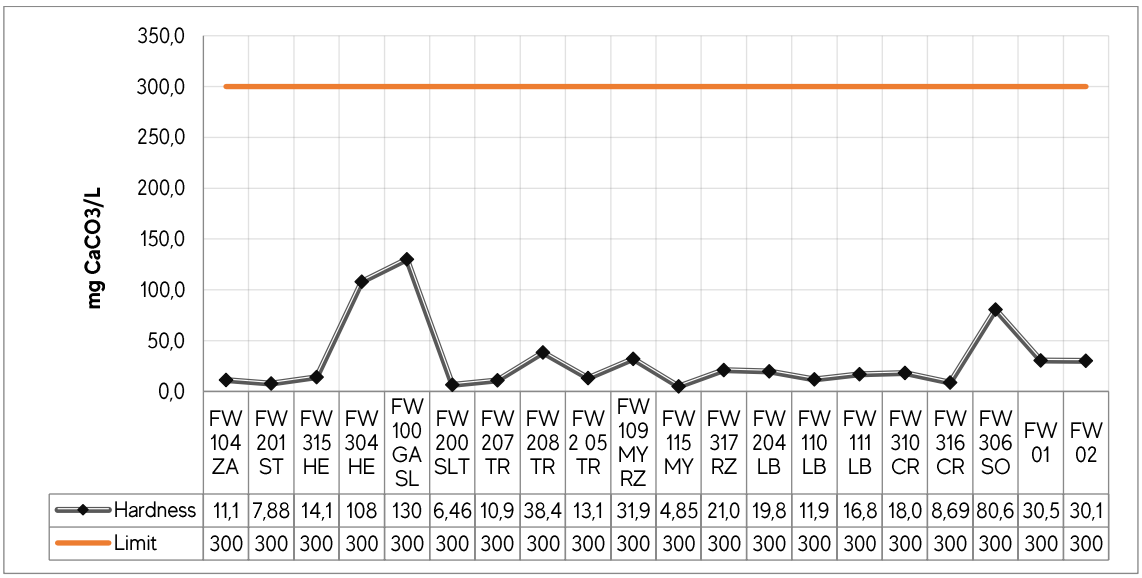


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Nitrite	0,00	0,03	0,01	0,03	0,01	0,00	0,00	0,02	0,00	0,00	0,00	0,03	0,04	0,03	0,00	0,18	0,00	0,00	0,01	0,01
Limit	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Figure 15. Comparative analysis of nitrite levels at monitoring points

For nitrate levels, the maximum established by Regulation 222/02 is 1 mg/l. All monitored points comply with the permissible limit with an average result of 0.024 mg/l.

3.2.16 Hardness

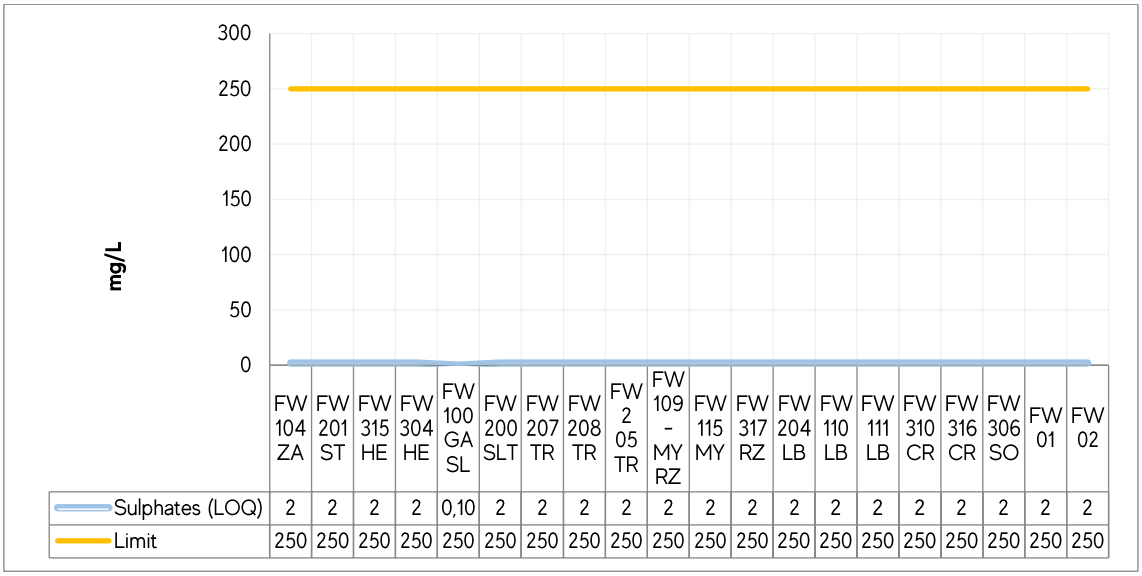


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Hardness	11,1	7,88	14,1	108	130	6,46	10,9	38,4	13,1	31,9	4,85	21,0	19,8	11,9	16,8	18,0	8,69	80,6	30,5	30,1
Limit	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

Figure 16. Comparative analysis of hardness levels at monitoring points

Hardness is a water quality parameter mainly influence by the geological formations of the hydrological area in which a given watercourse is located. Regulation 222/02 stipulates a maximum level of 300 mg/l for this parameter; none result yielded a value higher than limits. The average result in the first campaign is 30.7 mg $CaCO_3$/l.

3.2.17 Sulphates

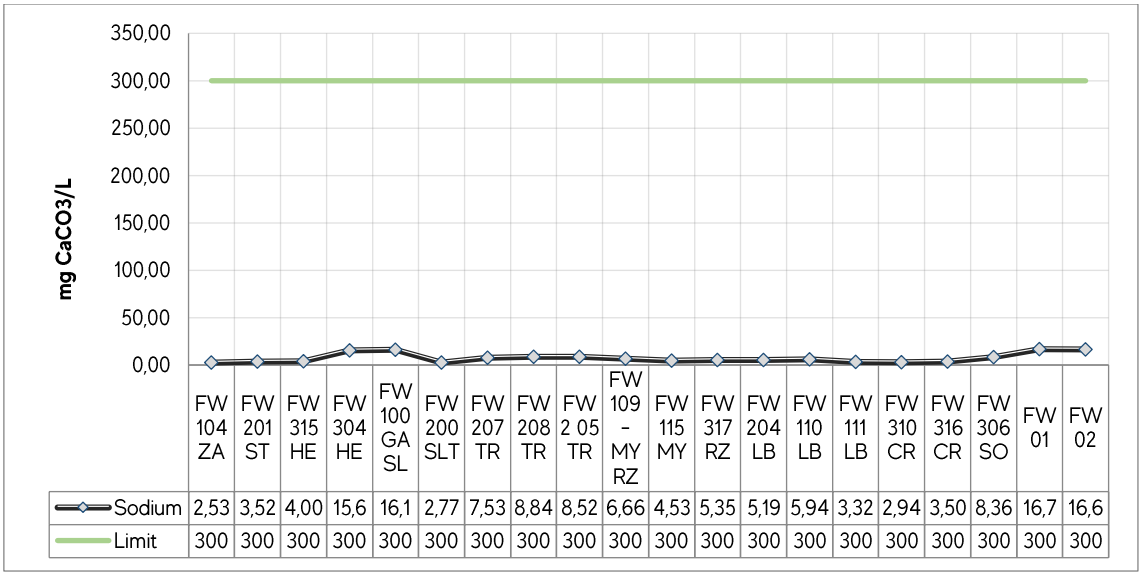


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Sulphates (LOQ)	2	2	2	2	0,10	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Limit	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250	250

Figure 17. Comparative analysis of sulphates levels at monitoring points

All the 19 samples were below the detection limit of the turbidimetric method SM-4500, equal to 2 mg/l. Figure 17 shows a flat line with no points exceeding the permissible limit defined in Regulation 222/02, up to 250 mg/l.

3.2.18 Sodium



	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Sodium	2,53	3,52	4,00	15,6	16,1	2,77	7,53	8,84	8,52	6,66	4,53	5,35	5,19	5,94	3,32	2,94	3,50	8,36	16,7	16,6
Limit	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300

Figure 18. Comparative analysis of sodium levels at monitoring points

The highest values of sodium are measured at FW 304-HE ("Hermosa" stream), FW 100-GASL ("Trementina stream") and at the points of the Paraguay River (FW01 and FW02). Even the points with the highest concentrations are less than the limit established by Regulation 222/02.

3.2.19 Aluminium

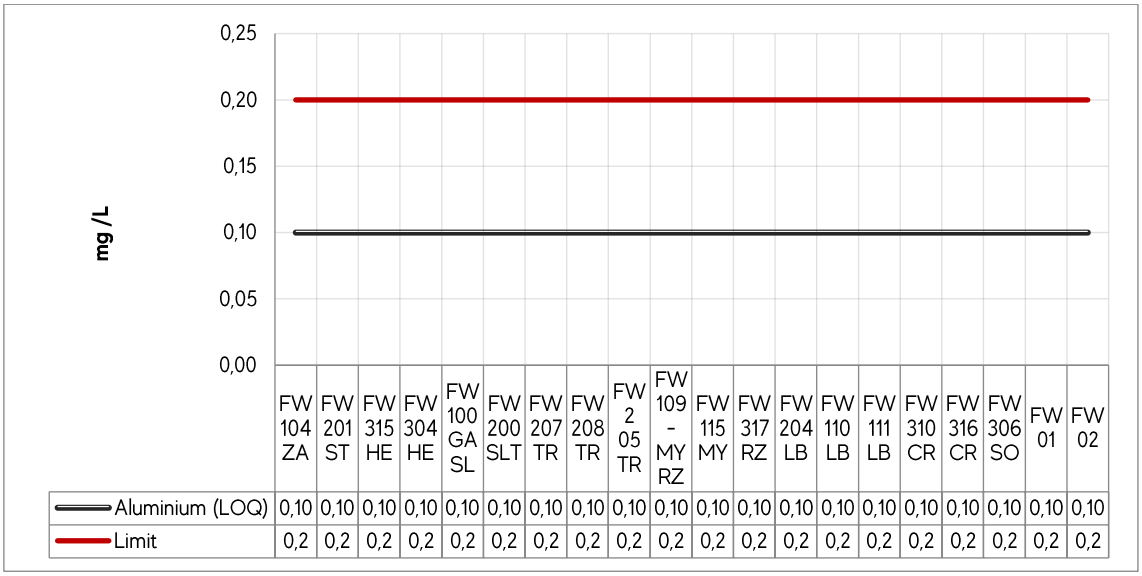


Figure 19. Comparative analysis of aluminium levels at monitoring points

Aluminium levels was measured with AAS-GFA method (SM-3113). The limit of quantification (LOQ) of this method is 0.2 mg/l. According to Regulation 222/02 the permissible limits of aluminium in surface water is 0.1 mg/l.

Figure 19 shows that at all monitoring points the aluminium levels are below the LOQ. In conclusion, all the points comply with the water standard limits for this parameter.

3.2.20 Cadmium

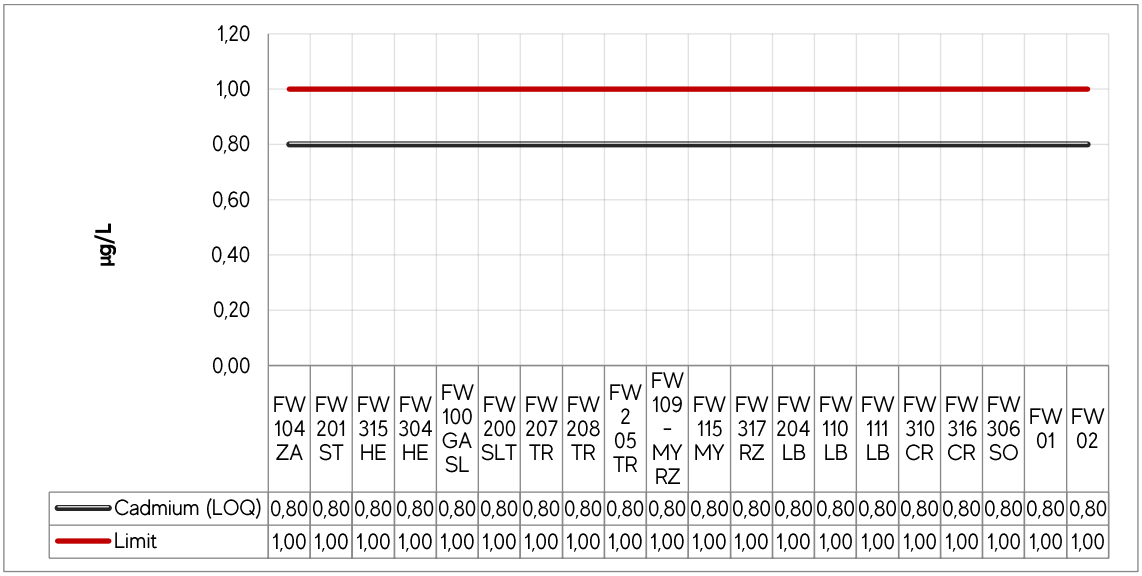
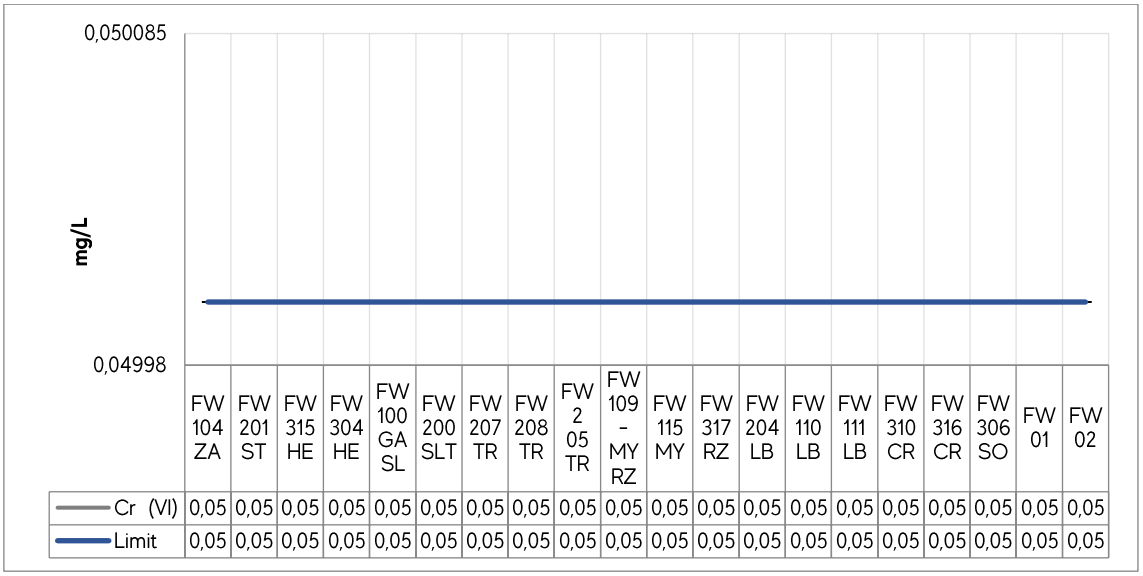


Figure 20. Comparative analysis of cadmium levels at monitoring points

Cadmium levels was measured with AAS-GFA method (SM-3113). The limit of quantification (LOQ) of this method is 0.8 µg/ for cadmium. According to Regulation 222/02 the permissible limits of aluminium in surface water is 1 µg/L

All monitoring points have levels of aluminium below the LOQ. In conclusion, all the points comply with the water standard limits for this parameter.

3.2.21 Hexavalent chromium



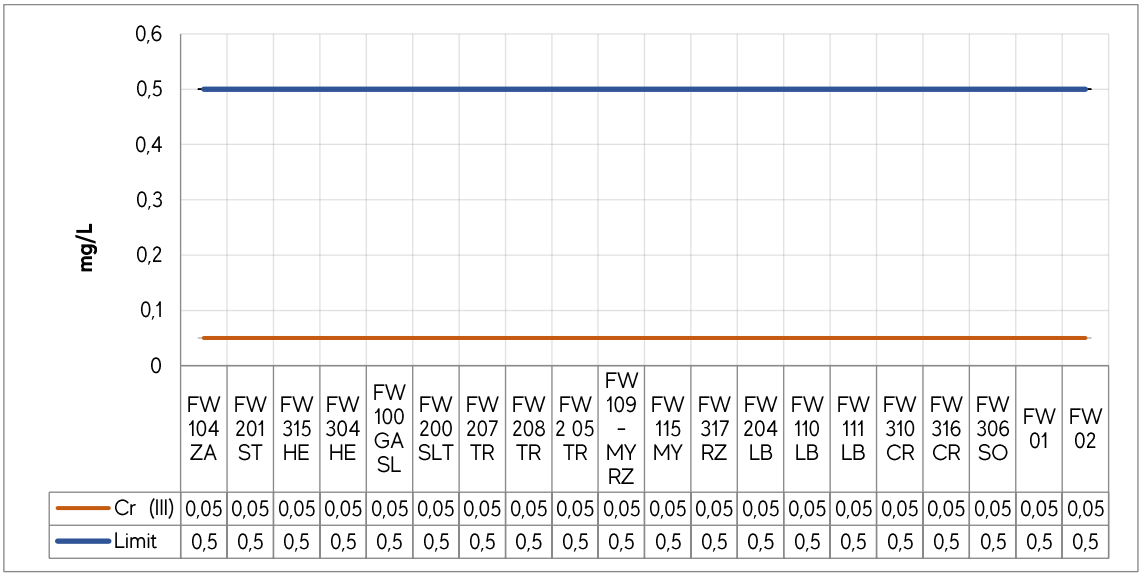
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Cr (VI)	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Limit	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

Figure 21. Comparative analysis of hexavalent chromium levels at monitoring points

The colorimetric method (SM-3500-Cr B) was used to determine the levels of this parameter. The limit of quantification (LOQ) in aqueous matrix is 0.05 mg/l. The hexavalent chromium at all sampling points was below the LOQ.

Under those circumstances, all the points are in accordance with the water standard limits for this parameter.

3.2.22 Trivalent chromium



	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Cr (III)	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05
Limit	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5	0,5

Figure 22. Comparative analysis of trivalent chromium levels at monitoring points

For this determination, the calculation method (Total Chromium - Hexavalent Chromium) was used. The limit of quantification (LOQ) is 0.05 mg/l. The flat line on the graph shows that the 20 points analysed are below the LOQ.

It is important to note that the maximum permissible value according to the national water standard is 10 times higher than the limit of quantification.

3.2.23 Copper

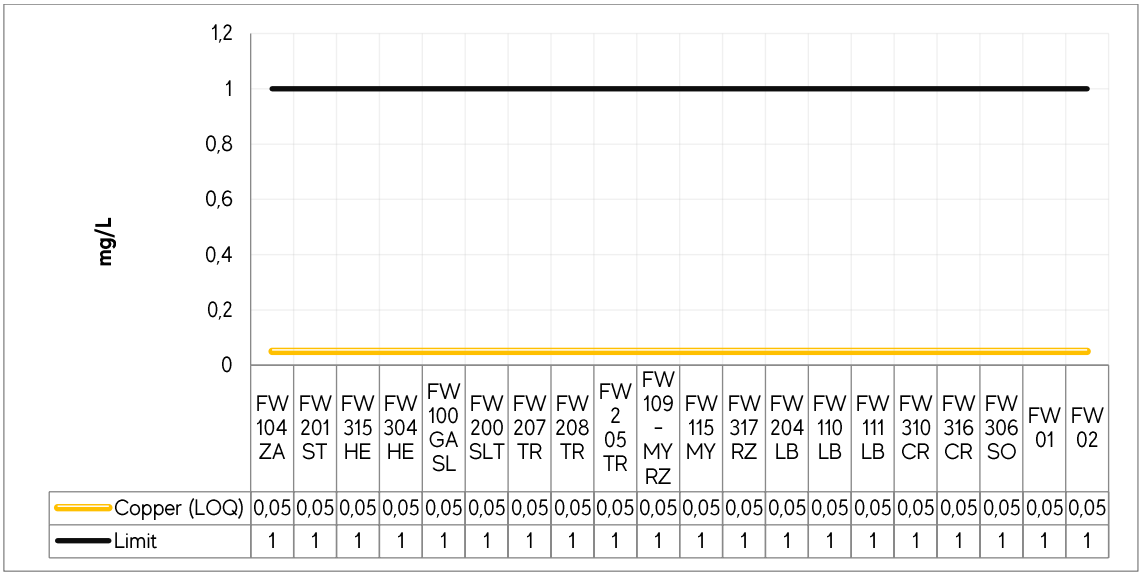


Figure 23. Comparative analysis of copper levels at monitoring points

The copper determinations method is AAS-Air-Acetylene Flame (SM-3111-B)/GFA (SM-3113), which has a sensitivity or limit of quantification in the water of 0.05 mg/l. For this parameter, there are no detectable and quantifiable copper concentrations in any of the 20 samples.

The fact that all samples were below the detection limit explains the flat line in figure 23; 100% of the monitored points are within the range for this parameter.

3.2.24 Tin

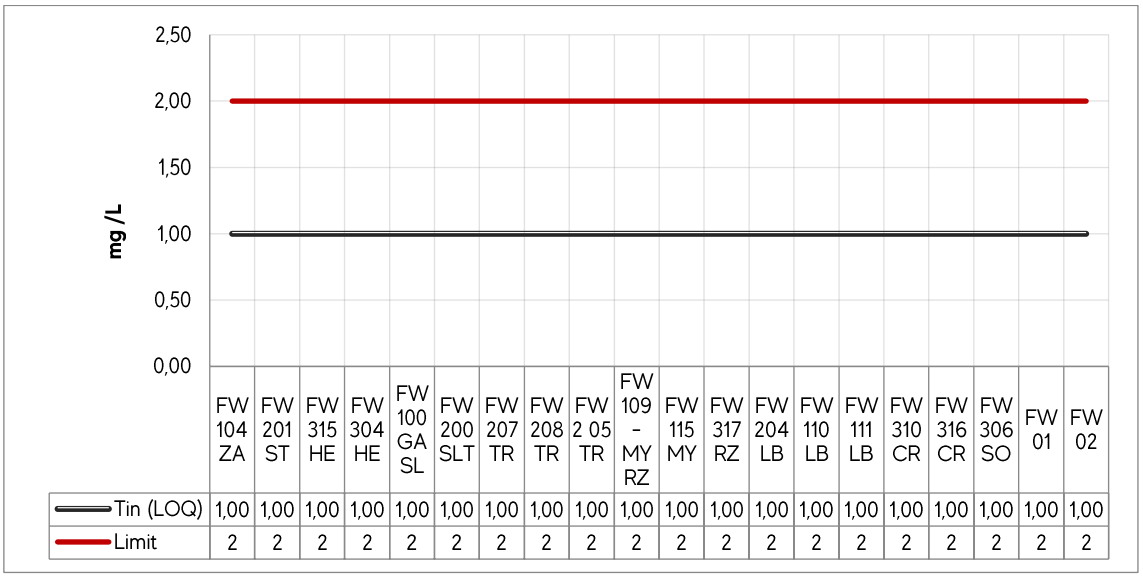
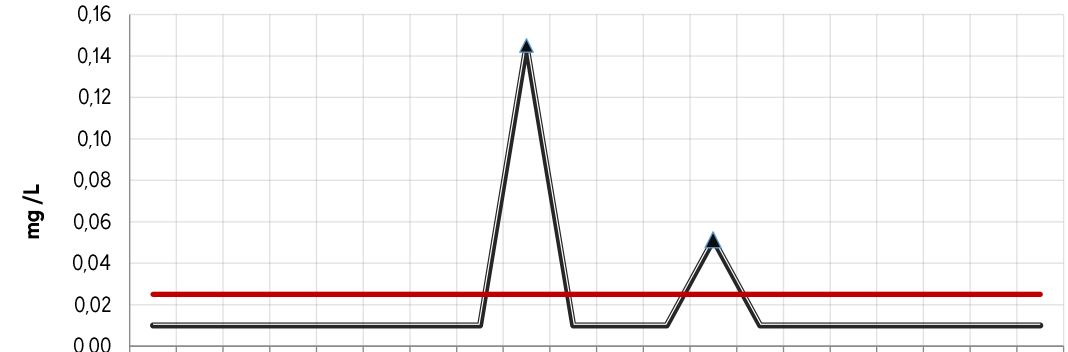


Figure 24. Comparative analysis of tin levels at monitoring points

At all points the concentrations of tin were below the limit of quantification. Since the LOQ (1 mg/l) is lower than the maximum allowed by the water standard regulation (2 mg/l), it is deducted that all the monitoring points comply with the regulation's limits.

3.2.25 Nickel

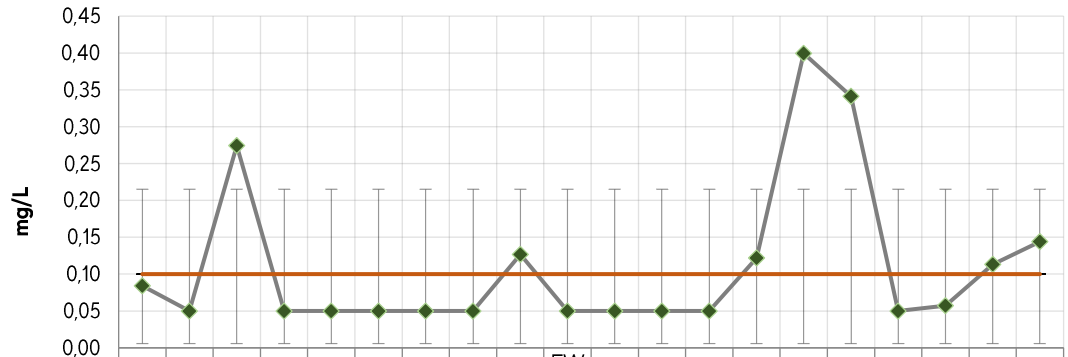


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Nickel	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,15	0,01	0,01	0,01	0,05	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Limit	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02

Figure 25. Comparative analysis of nickel levels at monitoring points

The results of nickel at 18 monitoring points are below the limit of quantification (LOQ= 0.01 mg/L). However, in FW 208-TR and FW 204-LB the values are higher than the limit established by the water standard regulation, which is 0.025 mg/L.

3.2.26 Manganese

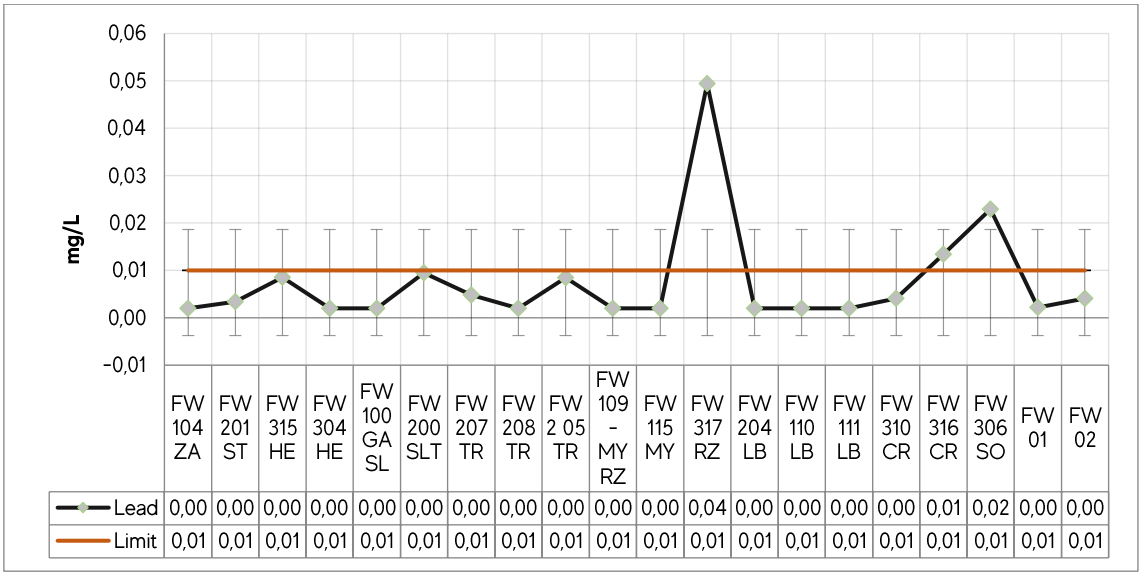


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Mn	0,08	0,05	0,27	0,05	0,05	0,05	0,05	0,05	0,12	0,05	0,05	0,05	0,05	0,12	0,40	0,34	0,05	0,05	0,11	0,14
Limit	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1	0,1

Figure 26. Comparative analysis of manganese levels at monitoring points

The graph shows that points FW 315-HE, FW 205-TR, FW 110 LB, FW 111 LB, FW 310 CR and the two points on the Paraguay River (FW 01 and FW 02) have higher values than the maximum established for waters classify as Class II by the Regulation. The maximum permissible value for this element is 0.1 mg/L and the limit of quantification (LOQ) of the method used to measure is 0.05 mg/L.

3.2.27 Lead

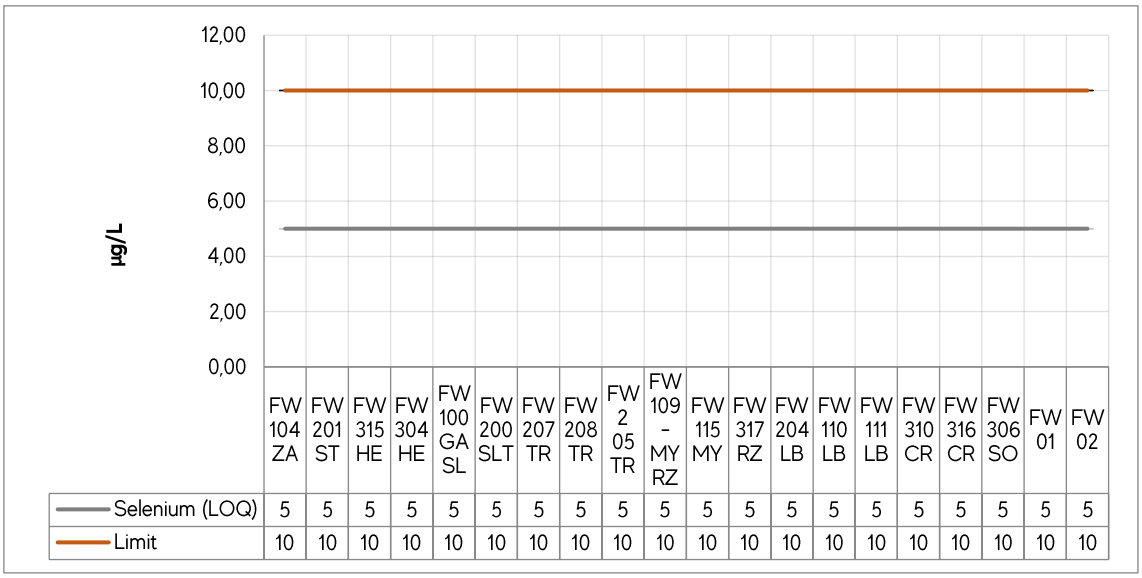


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Lead	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,04	0,00	0,00	0,00	0,00	0,01	0,02	0,00	0,00
Limit	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01

Figure 27. Comparative analysis of lead levels at monitoring points

The method used to determine lead levels is AAS-GFA (SM-3113). The limit of quantification (LOQ) is 0.002 mg/l. The figure 27 reveals that in 9 points the levels were below the LOQ but in 3 points with quantifiable values, the values exceed the water standard limits (0.01 mg/L).

3.2.28 Selenium

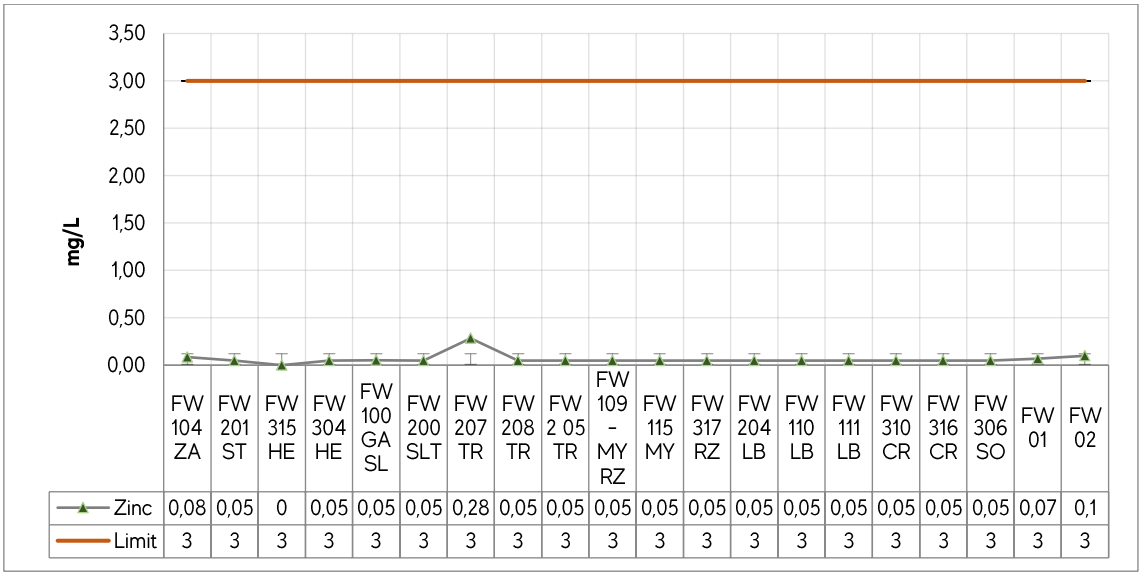


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Selenium (LOQ)	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Limit	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

Figure 28. Comparative analysis of selenium levels at monitoring points

At all sampling points selenium concentrations were below the limit of quantification (LOQ= 5 µg/L). According to Regulation 222/02 the maximum permissible level is 10 µg/L. Therefore, it can be deduced that all points are in accordance with the reference legislation.

3.2.29 Zinc

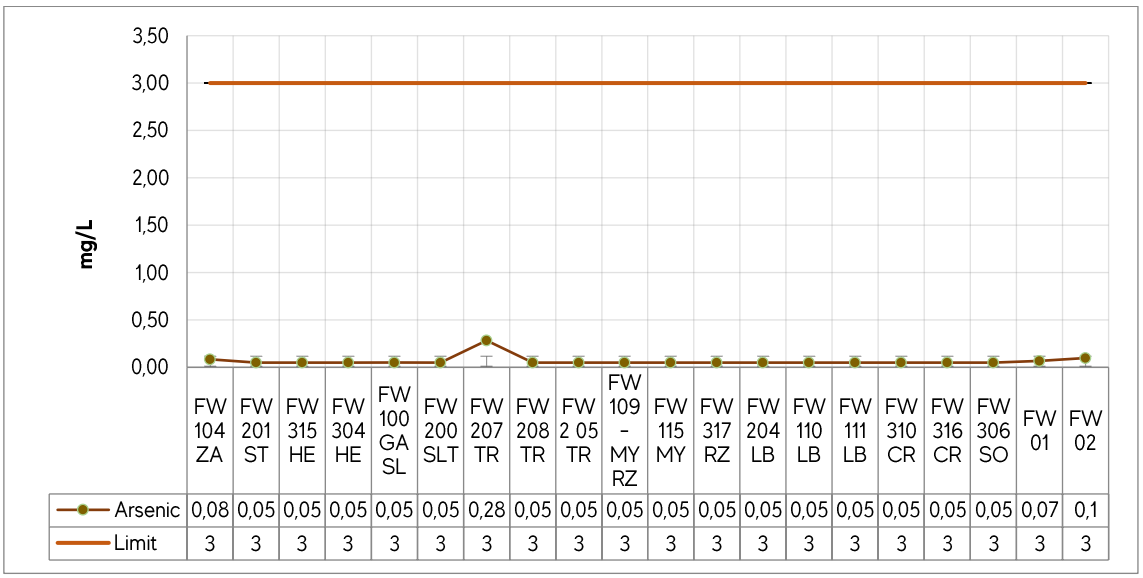


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Zinc	0,08	0,05	0	0,05	0,05	0,05	0,28	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,1
Limit	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Figure 29. Comparative analysis of zinc levels at monitoring points

Zinc concentrations are below the maximum limit established in the water regulation at all points. Even in 75% of the sampled points the zinc levels were under the limit of quantification (LOQ=0.05).

3.2.30 Arsenic

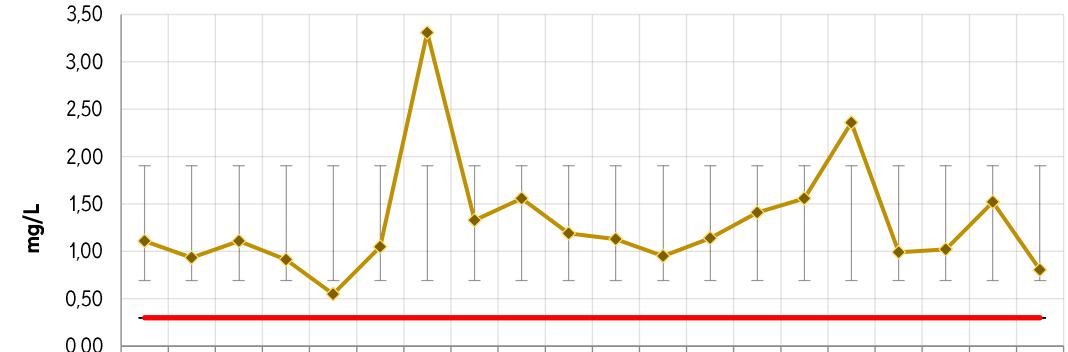


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Arsenic	0,08	0,05	0,05	0,05	0,05	0,05	0,28	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,07	0,1
Limit	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Figure 30. Comparative analysis of zinc levels at monitoring points

As figure 30 illustrates, the arsenic concentrations in all the points are below the maximum defined by the national regulation. In 85% of them, the values are not detectable by the method used to measure; which is LOQ=0.05.

3.2.31 Soluble iron



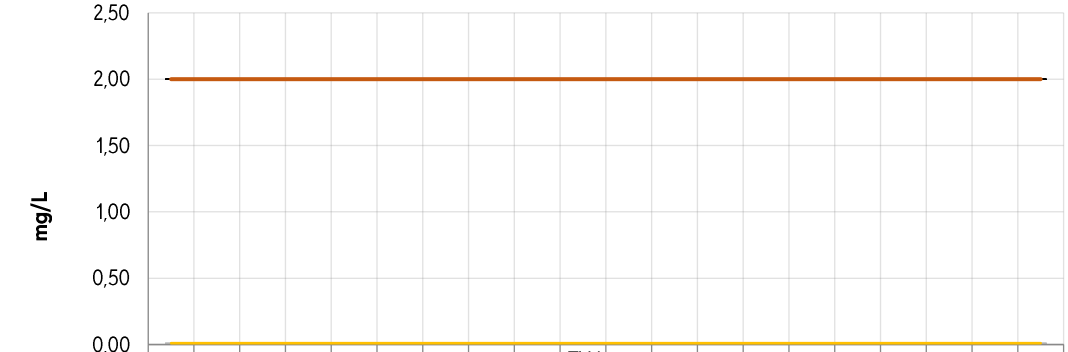
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Fe++	1,11	0,93	1,11	0,91	0,55	1,05	3,31	1,33	1,56	1,19	1,13	0,95	1,14	1,41	1,56	2,36	0,99	1,02	1,52	0,8
Limit	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3	0,3

Figure 31. Comparative analysis of soluble iron levels at monitoring points

The geological formations of a river basin determine the presence of iron in the water. Regulation 222/02 determines a maximum level of 0.3 mg/l for this element.

In the first monitoring campaign, all 20 points reach levels higher than the maximum permissible for waters classify as Class 2 according to the regulation. The average value is up to 1.3 mg/l which is four times higher than the limit.

3.2.32 Total mercury

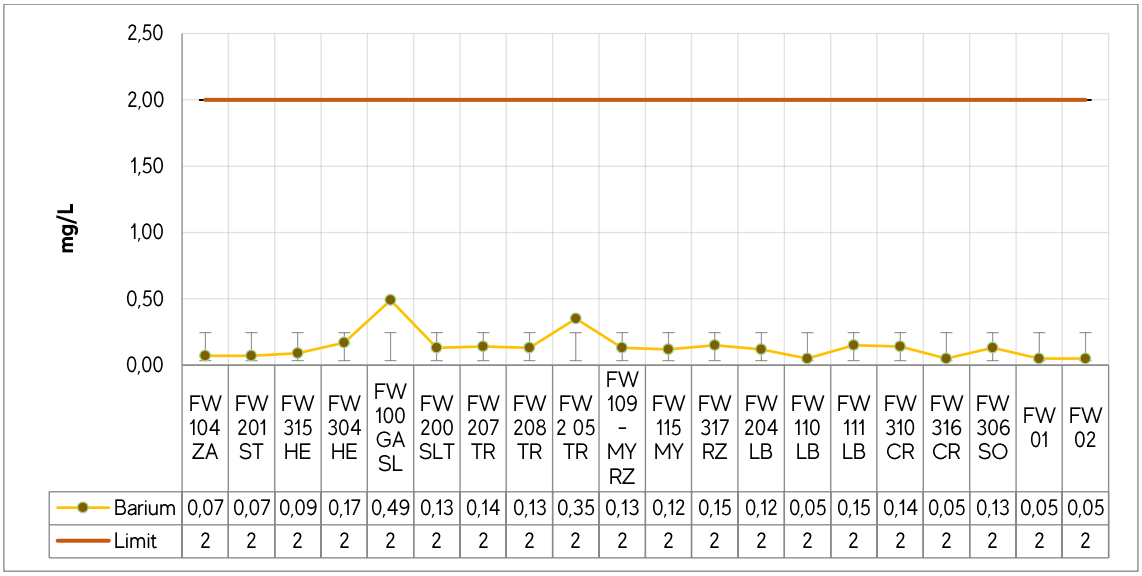


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Mercury	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01	0,01
Limit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Figure 32. Comparative analysis of total mercury levels at monitoring points

Levels of mercury were not detected at any of the 20 points. The national water regulation establishes a limit of 2 mg/l for this parameter. Regarding to the limit of quantification for the method used to analyse the samples is 0.01 mg/l.

3.2.33 Barium

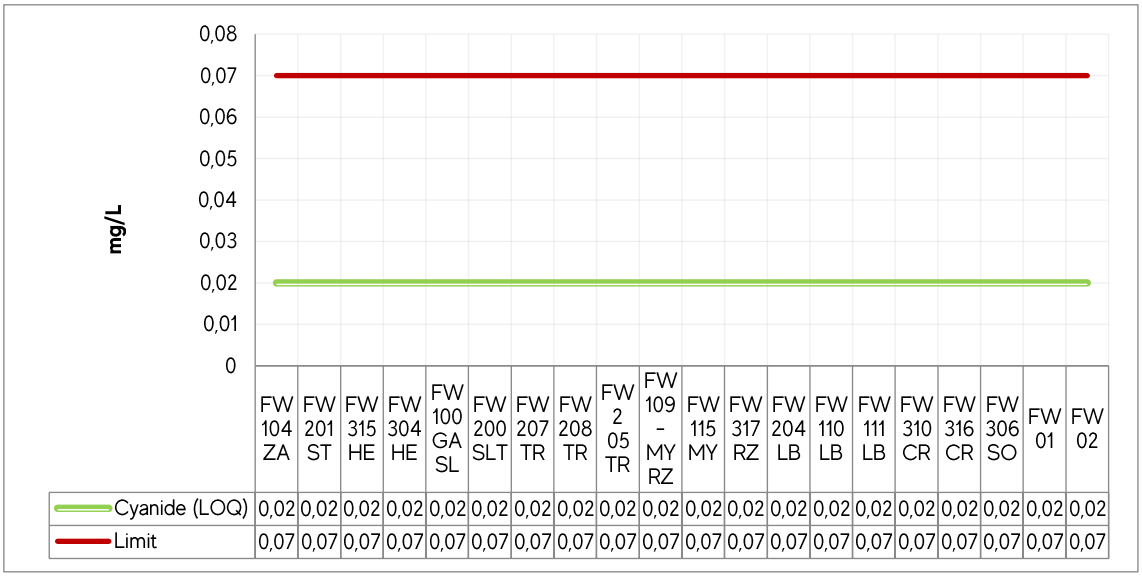


	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Barium	0,07	0,07	0,09	0,17	0,49	0,13	0,14	0,13	0,35	0,13	0,12	0,15	0,12	0,05	0,15	0,14	0,05	0,13	0,05	0,05
Limit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Figure 33. Comparative analysis of barium levels at monitoring points

All the values measured are within the permissible limit established by the Regulation 222/02. The highest value recorded belongs to the point FW 100 GASL and it is approximately 4 times lower than the maximum defined by the mentioned legislation.

3.2.34 Cyanide



	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT	FW 207 TR	FW 208 TR	FW 2 05 TR	FW 109 - MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Cyanide (LOQ)	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02	0,02
Limit	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07	0,07

Figure 34. Comparative analysis of cyanides levels at monitoring points

The SM 4500 CN E method used for cyanides determinations has a limit of quantification (LOQ) equal to 0.02 mg/l, which was not detected in all the sampling points. The regulation establishes a limit 3.5 times higher than LOQ; therefore, it is inferred that the 20 samples comply with the reference regulation.

3.2.35 Glyphosate

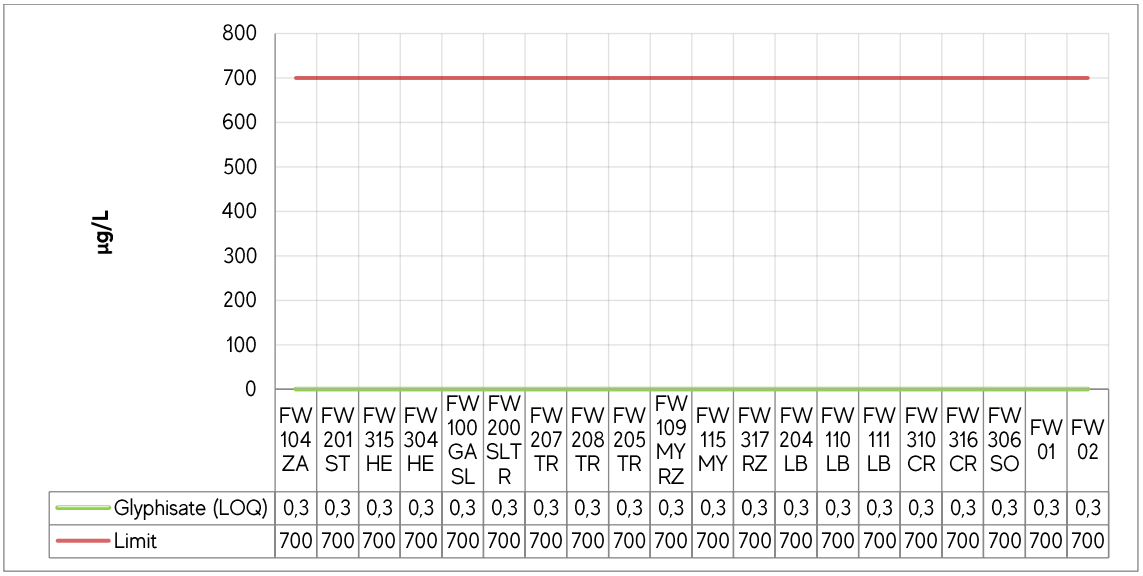


Figure 35. Comparative analysis of glyphosate levels at monitoring points

Glyphosate is a systemic herbicide ($C_3H_8NO_6P$) marketed under the name Round-up, widely used in agricultural and forestry activities.

The water regulation establishes a limit up to 700 µg/l for this substance. The limit of quantification in aqueous matrix is 0.3 µg/l which is not detected in any of the surface water sampling points.

3.2.36 AMPA

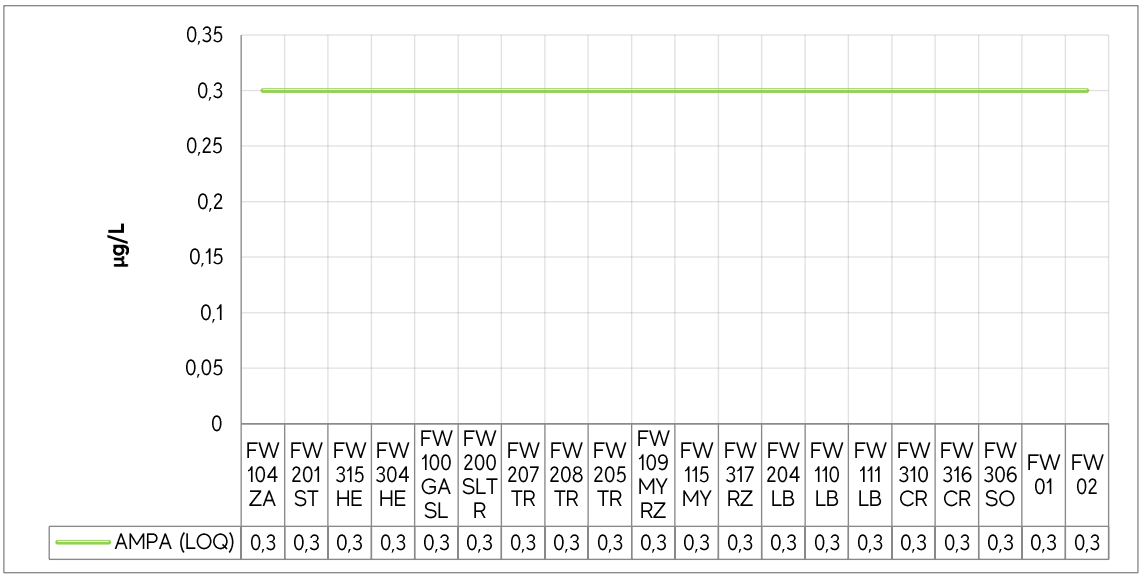


Figure 36. Comparative analysis of AMPA levels at monitoring points

The main metabolite of glyphosate is AMPA (amino-methyl phosphoric acid), which, due to its high solubility, can contaminate surface water.

The national water regulation does not establish limits for this substance.

The limit of quantification of the method used to determine this parameter is 0.3 µg/l. In any of the sampling points were detected levels of AMPA during the first campaign.

3.2.37 Aldrin

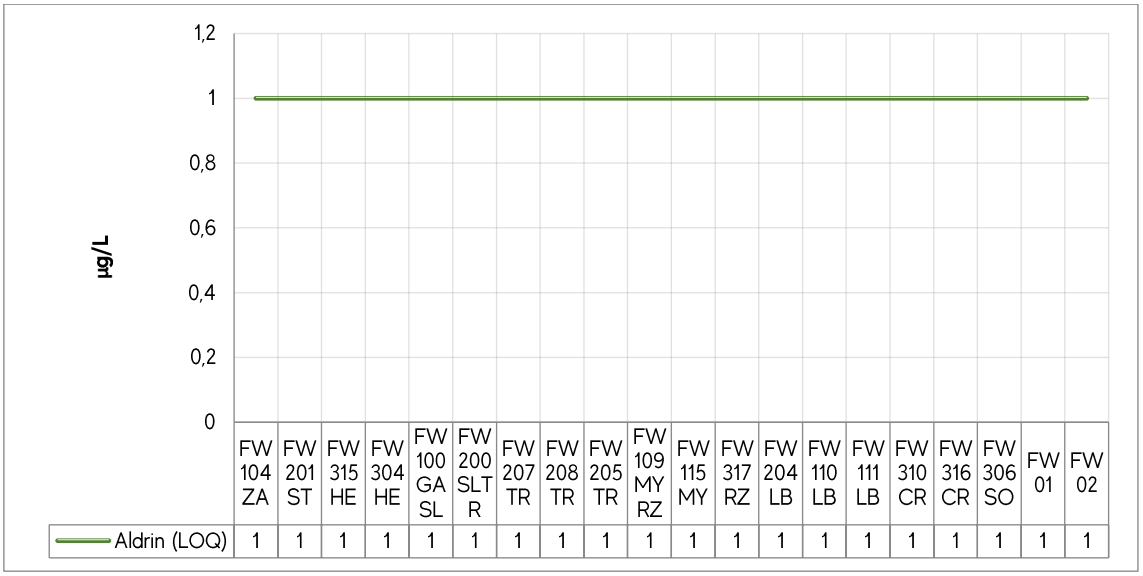


Figure 37. Comparative analysis of Aldrin levels at monitoring points

Aldrin is a non-systemic insecticide which has no maximum limit established by the national water regulation. At none of the samples were was detected levels of this substance. The limit of quantification of the method used to measure this parameter is 1 µg/L.

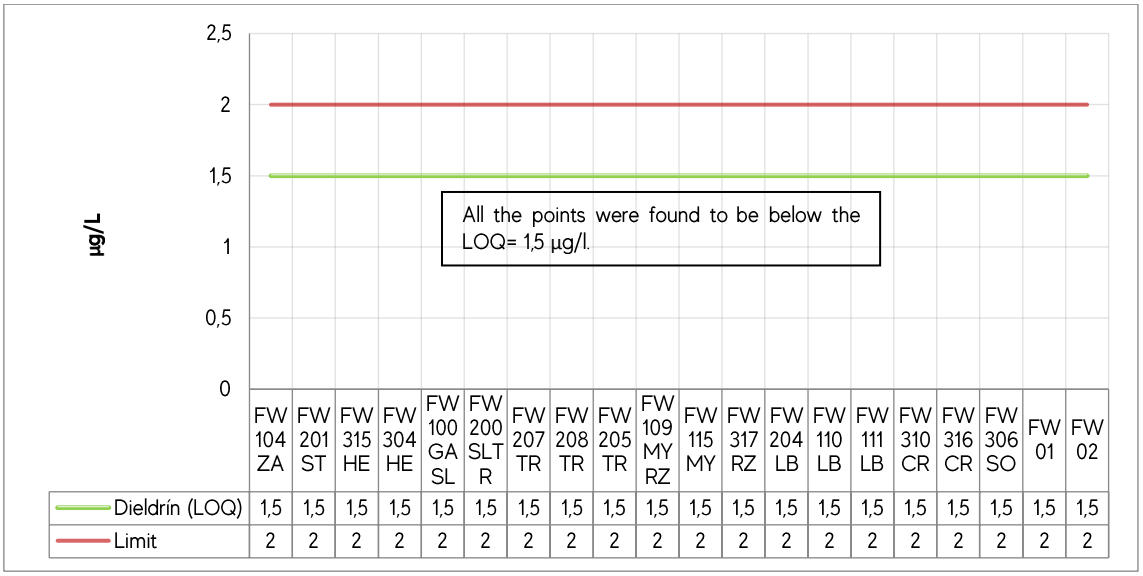
3.2.38 Endrin

Figure 38. Comparative analysis of Endrin levels at monitoring points

Endrin (C12H8Cl6O) is an insecticide and rodenticide. Regulation 222/02 establishes a maximum admissible value for waters Class II up to 2 µg/L. The limit of quantification of the method used to measure this parameter is 1.25 µg/L.

There were not detected levels of Endrin in the samples analysed.

3.2.39 Dieldrin



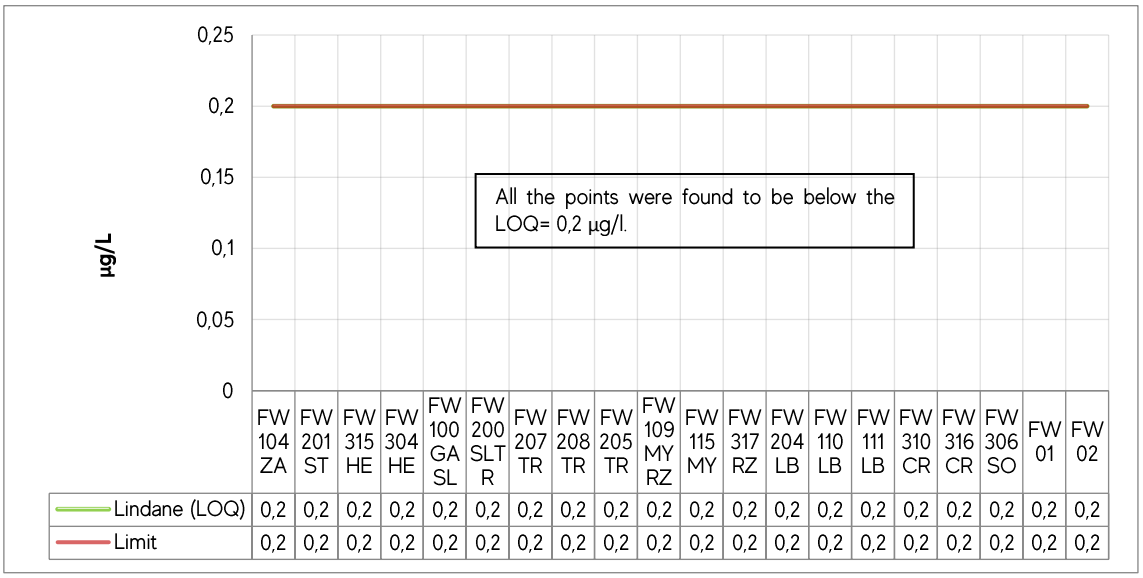
	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT R	FW 207 TR	FW 208 TR	FW 205 TR	FW 109 MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Dieldrín (LOQ)	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5
Limit	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

Figure 39. Comparative analysis of Dieldrin levels at monitoring points

Dieldrin (C12H8Cl6O) is an insecticide. The national water regulation sets a maximum limit for this substance of 2 µg/l.

The method's limit of quantification is 1.5 µg/L. It was not detected this agrochemical at any of the sampling points.

3.2.40 Lindane



	FW 104 ZA	FW 201 ST	FW 315 HE	FW 304 HE	FW 100 GA SL	FW 200 SLT R	FW 207 TR	FW 208 TR	FW 205 TR	FW 109 MY RZ	FW 115 MY	FW 317 RZ	FW 204 LB	FW 110 LB	FW 111 LB	FW 310 CR	FW 316 CR	FW 306 SO	FW 01	FW 02
Lindane (LOQ)	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2
Limit	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2	0,2

Figure 40. Comparative analysis of Lindane levels at monitoring points

Lindane (C6H6CL6) is an insecticide distributed under the trade name Gamexane. Both the permissible limit established by the water regulation and method's LOQ sets a value of 0.2 µg/l. Lindane was not detected at the sampling points.

3.2.41 Chlordane

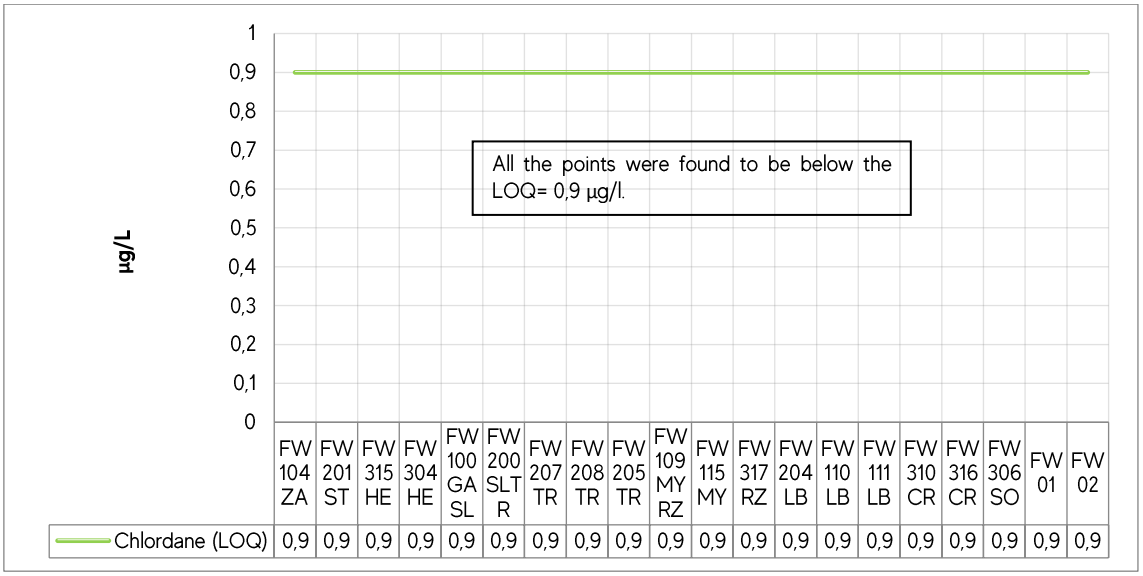


Figure 41. Comparative analysis of chlordane levels at monitoring points

Chlordane ($C_{10}H_6Cl_8$) is an insecticide with no limit established in the national water regulation. The limit of quantification of this parameter is 0.9 µg/L. At all sampling points, chlordane levels was below the LOQ.

3.2.42 DDT

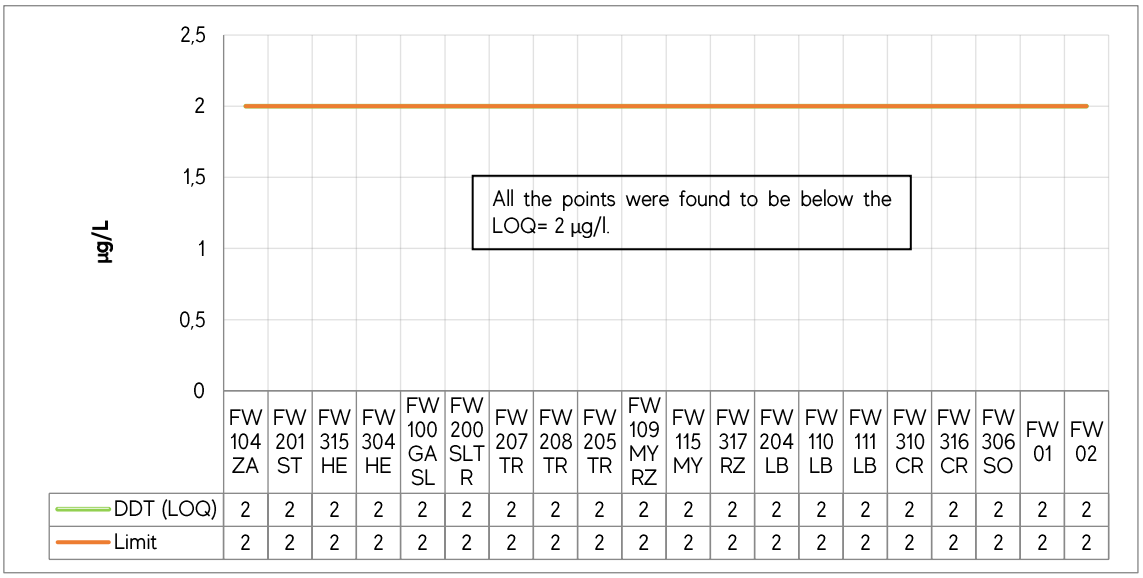


Figure 42. Comparative analysis of DDT levels at monitoring points

DDT ($C_{14}H_9Cl_5$) is an insecticide. According to the national water regulation, the maximum permissible concentration in Class II surface water is 2 µg/L.

The limit of quantification of this parameter is 2 µg/L. DDT levels were below LOQ at all the 20 monitoring points.

3.2.43 DDE

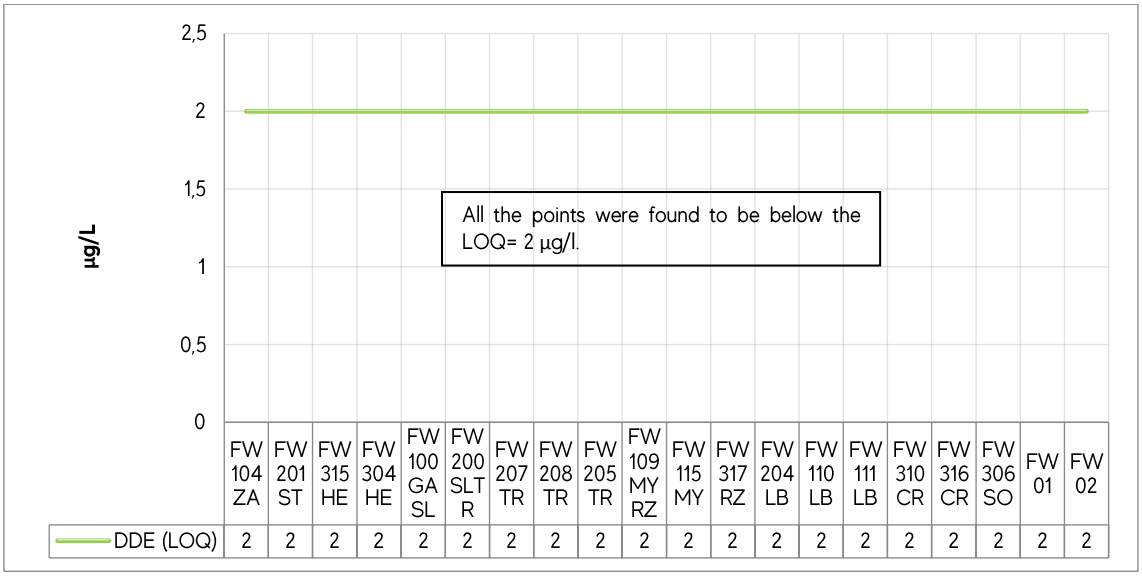


Figure 43. Comparative analysis of DDE levels at monitoring points

Likewise, other pesticides, no evidence of DDE was found in surface water. In all cases the DDE concentrations were below the method's limit of quantification which is LOQ= 2 µg/l.

The national water regulation does not establish maximum limits for this substance.

3.2.44 DDD

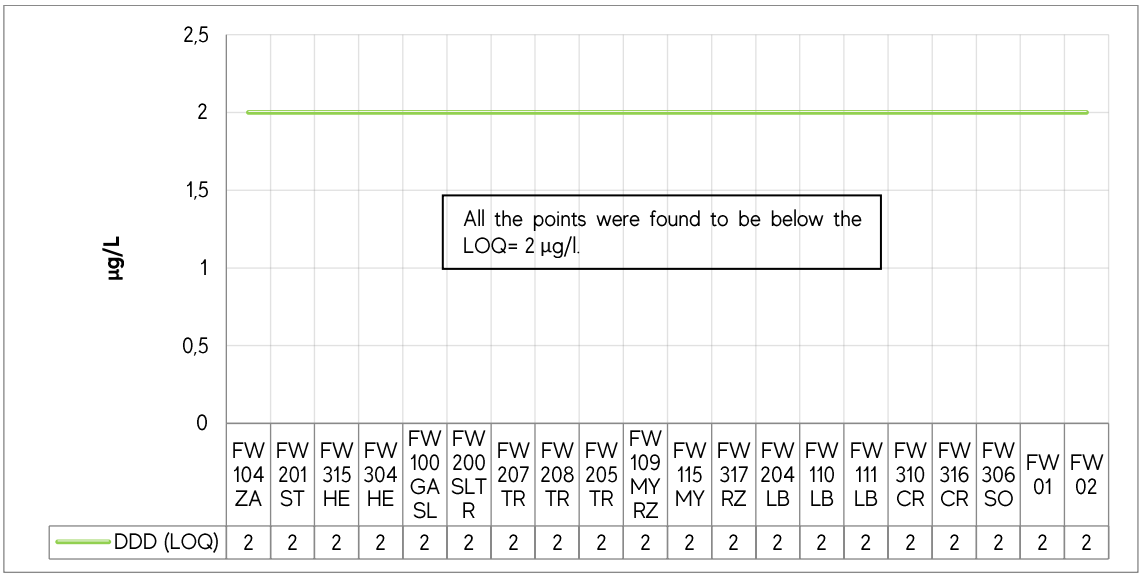


Figure 44. Comparative analysis of DDD levels at monitoring points

DDD is a metabolite resulting from the degradation of the insecticide DDT. The national water regulation does not establish a maximum limit for this parameter.

There is no evidence of DDD in the samples analysed during the first campaign. The method's limit of quantification is 2 µg/ which is not exceeded at any sampling point.

3.2.45 Atrazine

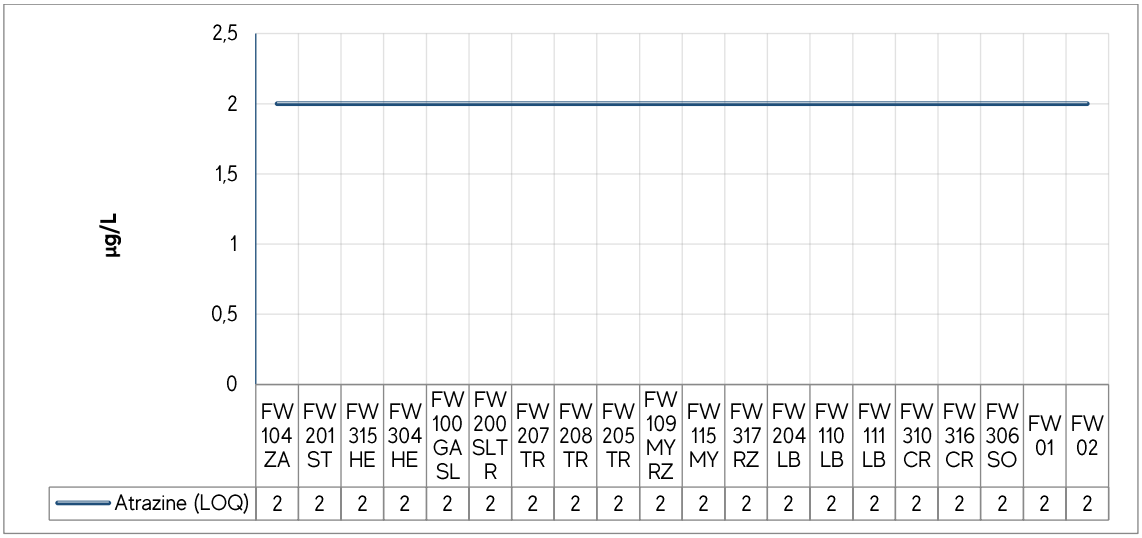


Figure 45. Comparative analysis of atrazine levels at monitoring points

Atrazine ($C_8H_{14}ClN_5$) is an herbicide distributed under the trade names Atramyl or Atraplex. The water standard regulation does not establish limits for this substance.

During the first monitoring campaign, there was no evidence of atrazine in surface waters. The limit of quantification is LOQ= 2 µg/L. None of the 20 samples exceeded this value.

3.2.47 Simazine

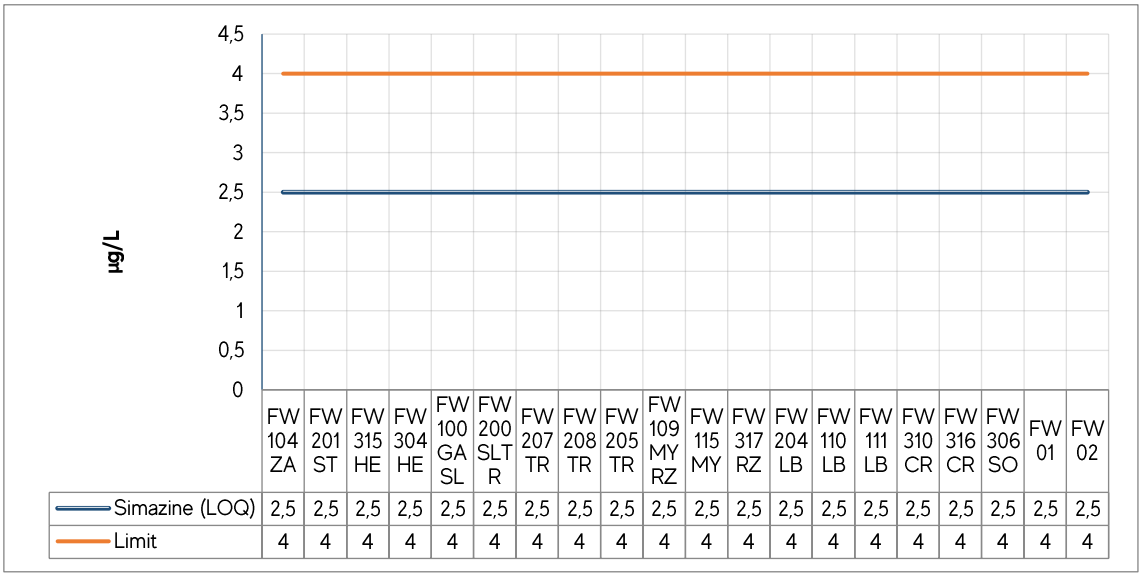


Figure 46. Comparative analysis of simazine levels at monitoring points

Simazine ($C_7H_{12}ClN_5$) is an herbicide distributed under the trade name SIMAPLEX. Regulation 222/02 establishes a maximum of 4 µg/l for this substance.

The analytical method used has a limit of quantification equal to 2.5 µg/l which none of the samples reached. All the monitoring points comply with the established limits.

3.2.48 Carbaryl

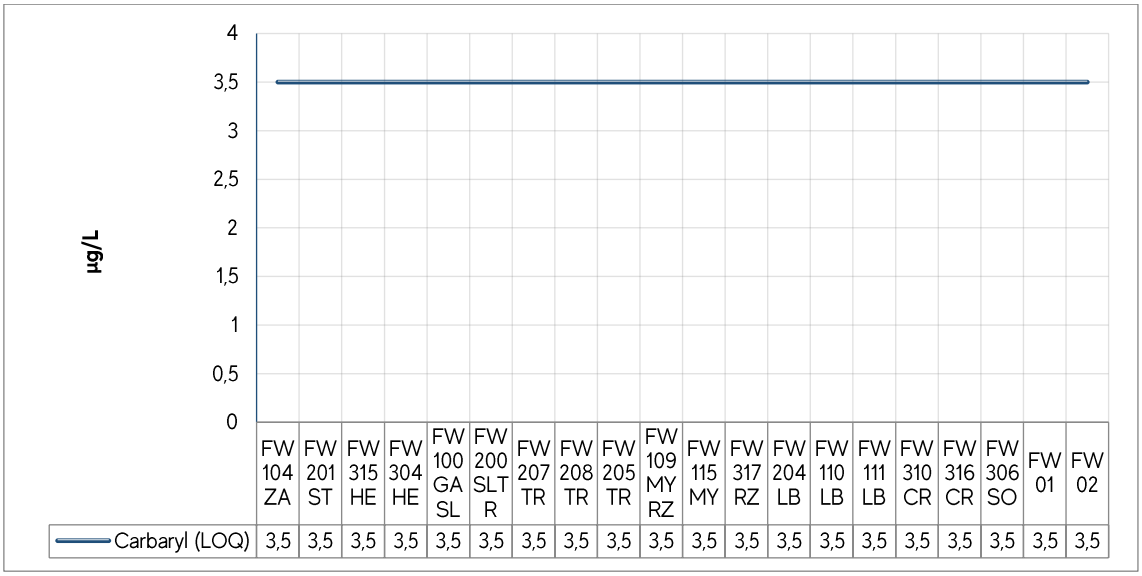


Figure 47. Comparative analysis of Carbaryl levels at monitoring points

Carbaryl ($C_{12}H_{11}NO_2$) is an insecticide used to control insects and ectoparasites. It is distributed under the trade names HORTEVI and CARBARYL.

The analytical method used has a limit of quantification equal to 3.5 µg/L. It was not detected quantifiable levels at any of the points.

3.2.49 Heptachlor

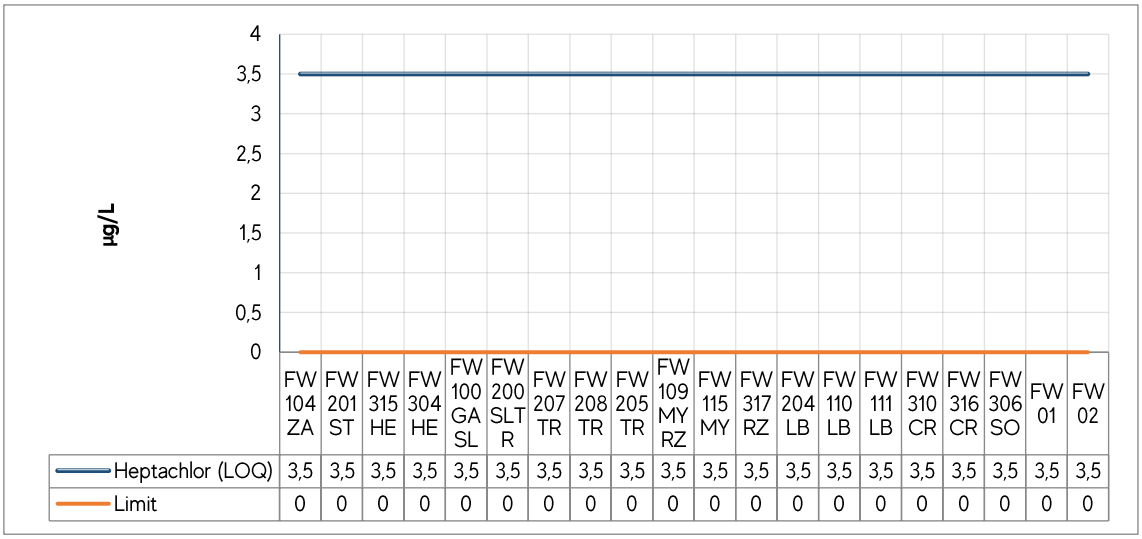


Figure 48. Comparative analysis of heptachlor levels at monitoring points

Heptachlor ($C_{10}H_5Cl_7$) is an insecticide used to control ants and termites. The national water regulation establishes that the concentration of this substance in the aqueous matrix must be 0 µg/L (zero).

The limit of quantification is higher than the maximum permissible by the water regulation (LOQ = 3.5 µg / L), which is why none of the points are within the limits but it is not detected quantifiable values of Heptachlor.

3.2.50 Methomyl

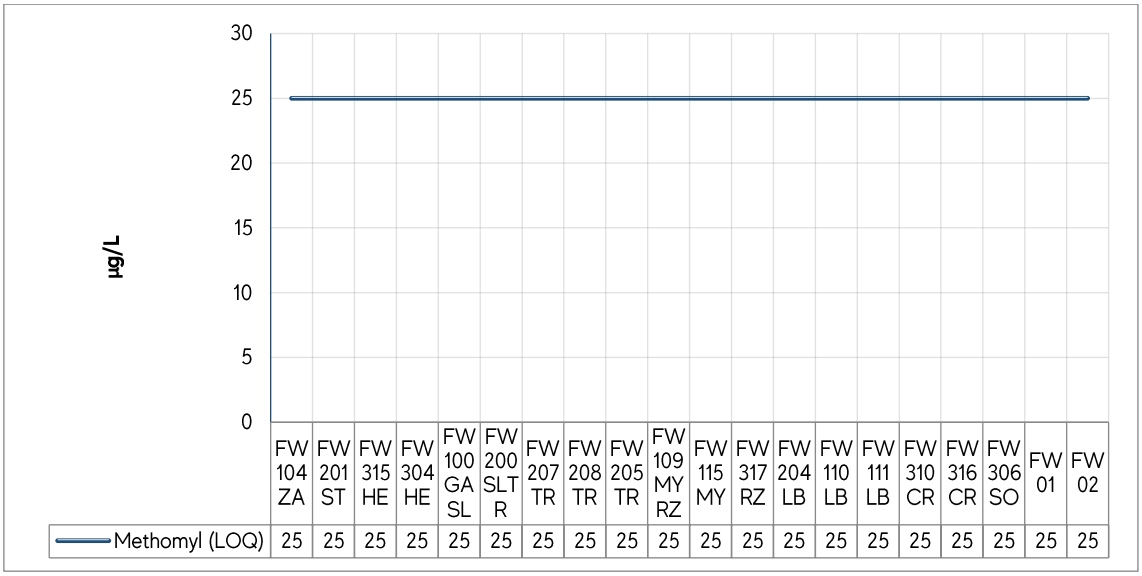


Figure 49. Comparative analysis of Methomyl levels at monitoring points

Methomyl ($C_5H_{10}N_2O_2S$) is an insecticide marketed under the name Lannate®BR. The national water regulation does not establish limits for this pesticide.

The limit of quantification is 25 µg/L and none of the samples exceeded this value.

3.2.51 2,4 D

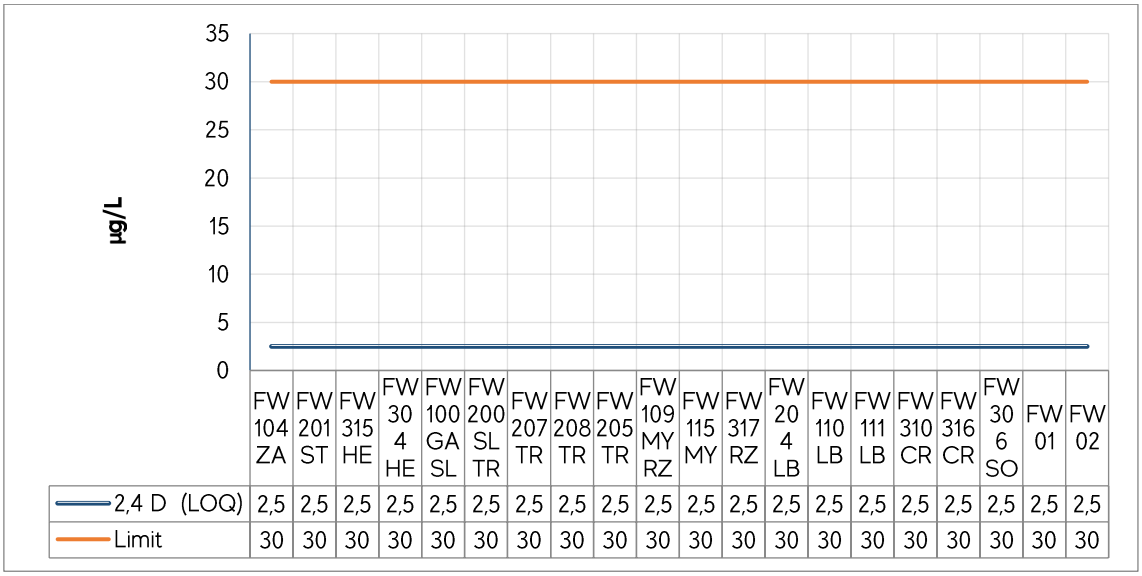


Figure 50. Comparative analysis of 2,4 D levels at monitoring points

2,4 D ($C_8H_6Cl_2O_3$) is an herbicide distributed under the trade names DMA® 6 and Cleanspray (among others). According to Regulation 222/02, the concentration of this herbicide in surface water must not exceed 30 µg/L.

The analytical method used has a limit of quantification of 2.5 µg/L None of the samples exceeds this threshold; therefore, all samples are within the limit established by the water regulation.

3.2.52 Cypermethrin

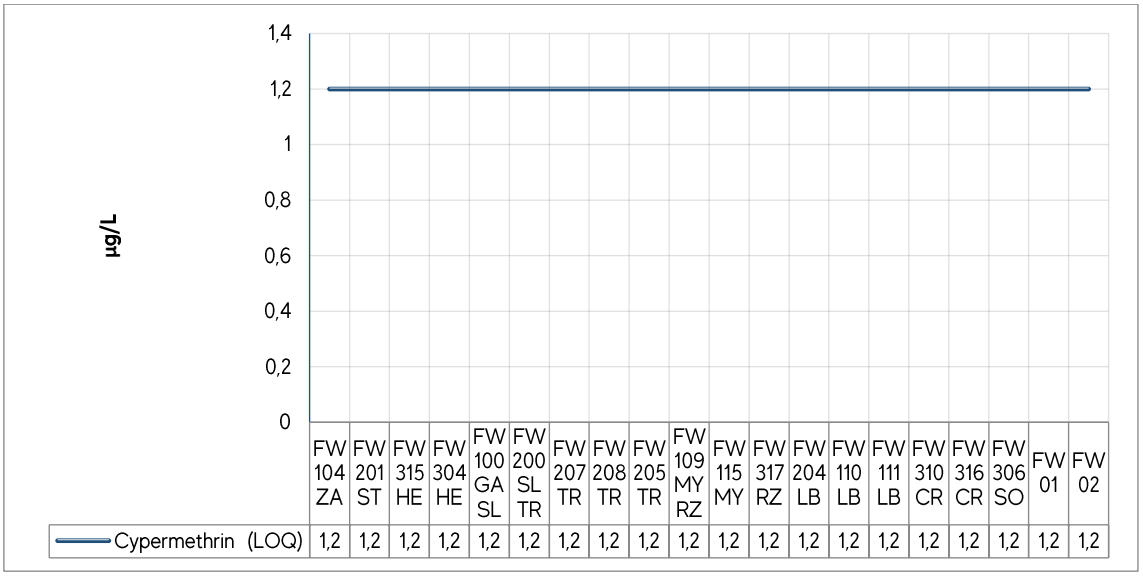


Figure 51. Comparative analysis of Cypermethrin levels at monitoring points

Cypermethrin ($C_{22}H_{19}Cl_2NO_3$) is an insecticide and acaricide distributed in the market under the trade names Trine-aktra and SUPERMYL among others. The water regulation does not establish limits for this pesticide.

As for the analytical results obtained, no quantifiable levels of Cypermethrin were detected in any sample. The limit of quantification is 1.2 µg/L.

3.2.53 Chlorpyrifos

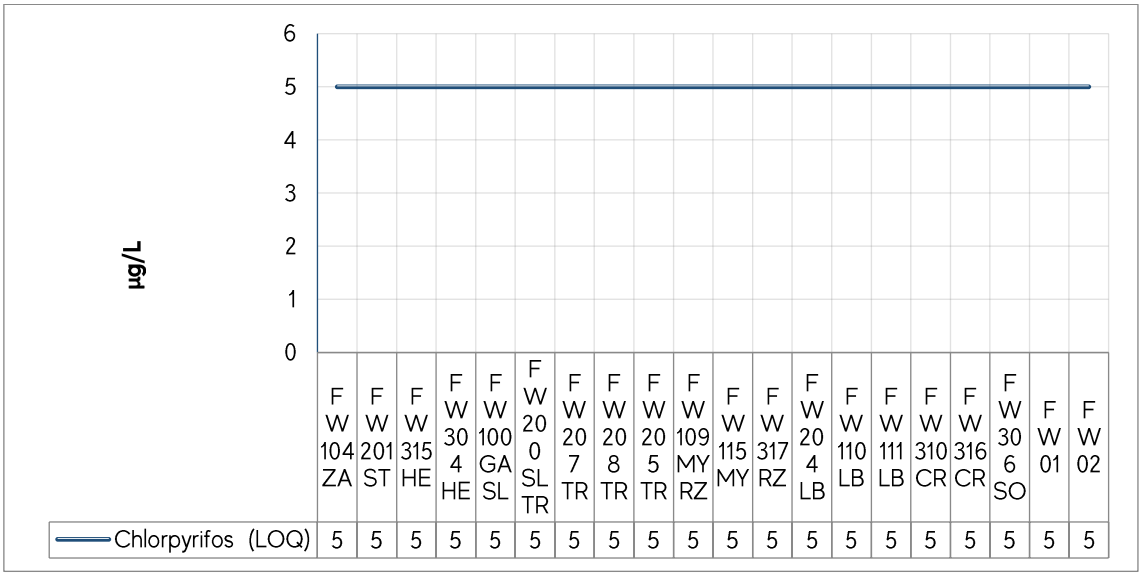


Figure 52. Comparative analysis of Chlorpyrifos levels at monitoring points

Chlorpyrifos ($C_9H_{11}Cl_3NO_3PS$) is an insecticide commonly called CLORFOS and BRONCO®. The national water regulation does not establish a limit for this pesticide.

In none of the samples taken during the first campaign are quantifiable levels of Chlorpyrifos. The limit of quantification of the method used to analyse is 5 µg/L.

3.2.54 Dichlorvos

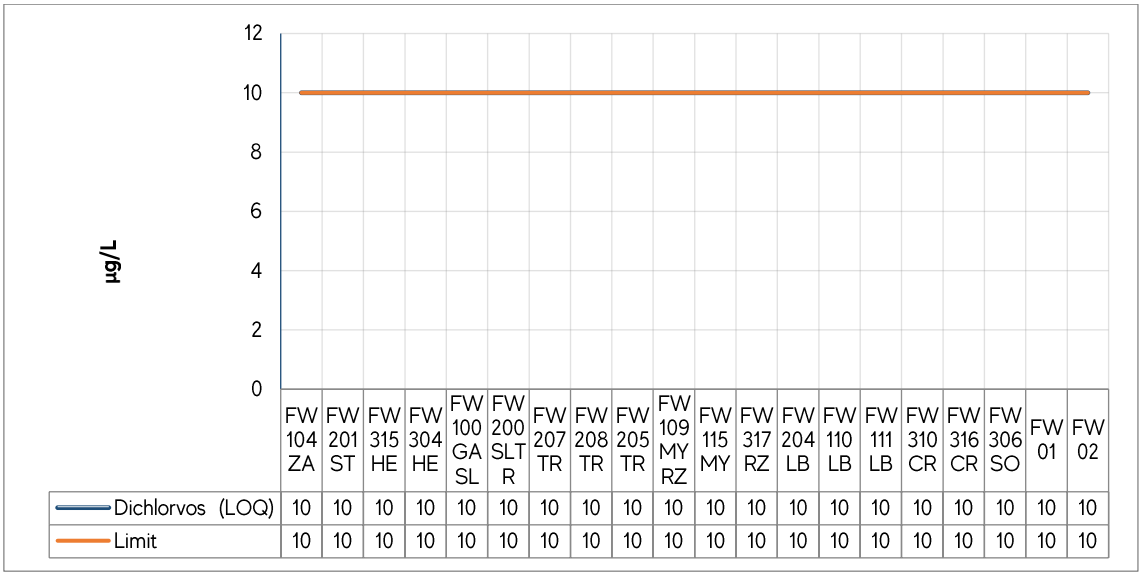


Figure 53. Comparative analysis of Dichlorvos levels at monitoring points

Dichlorvos ($C_4H_7Cl_2O_4P$) is an insecticide and arachnicide trade under commercial names such as Diclovan. According to the national surface water regulation, the maximum concentration allowed for this pesticide is 10 µg/L.

The limit of quantification of the method used to analyse the samples is 10 µg/L (equal to the maximum permissible). No quantifiable levels of Dichlorvos are detected in any sample.

3.2.55 Methamidophos

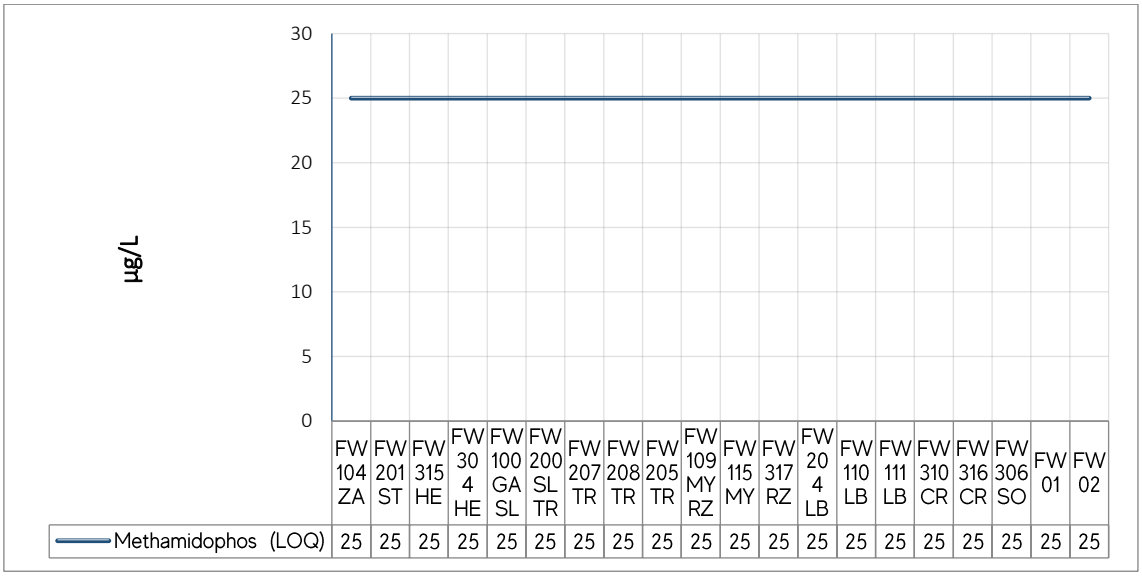


Figure 54. Comparative analysis of Methamidophos levels at monitoring points

Methamidophos ($C_2H_8NO_2PS$) is an insecticide and acaricide. This pesticide does not have limits established in the national water regulation.

The method's limit of quantification is 25 µg/L and none of the samples exceeds this value.

3.2.56 Tebuconazole

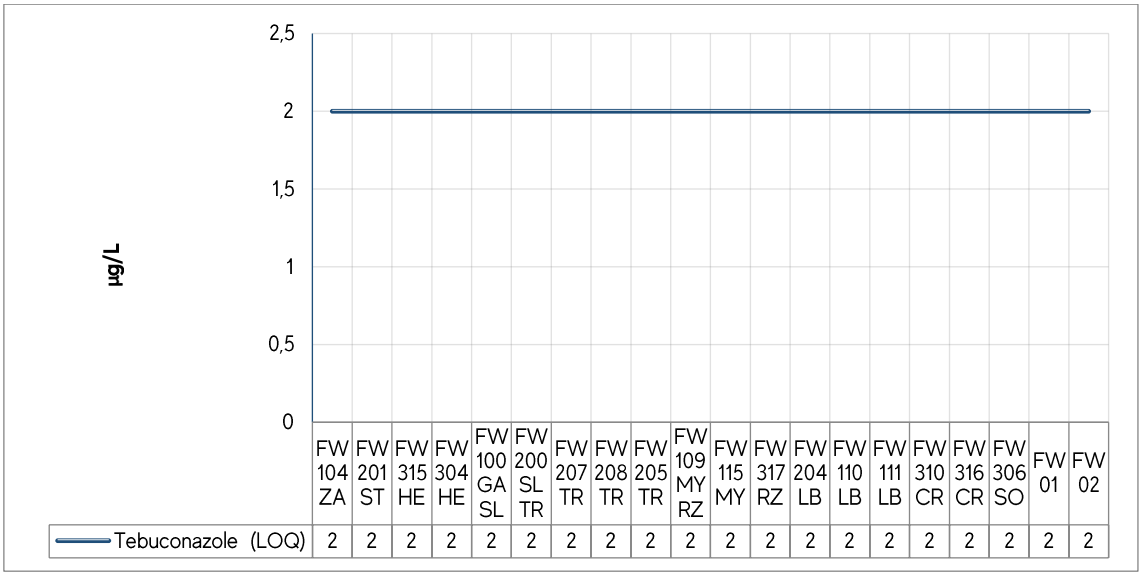


Figure 55. Comparative analysis of Tebuconazole levels at monitoring points

Tebuconazole ($C_{16}H_{22}ClN_3O$) is a fungicide trade under the name Folitra Max among others. It is use mainly in the prevention and eradication of fungi that attack horticultural crops. The water standard regulation does not establish a limit for this parameter.

As for the results, there is no evidence of Tebuconazole in surface waters of the area of study. The limit of quantification is 2 µg/L which no sample exceeds.

3.2.57 Imidacloprid

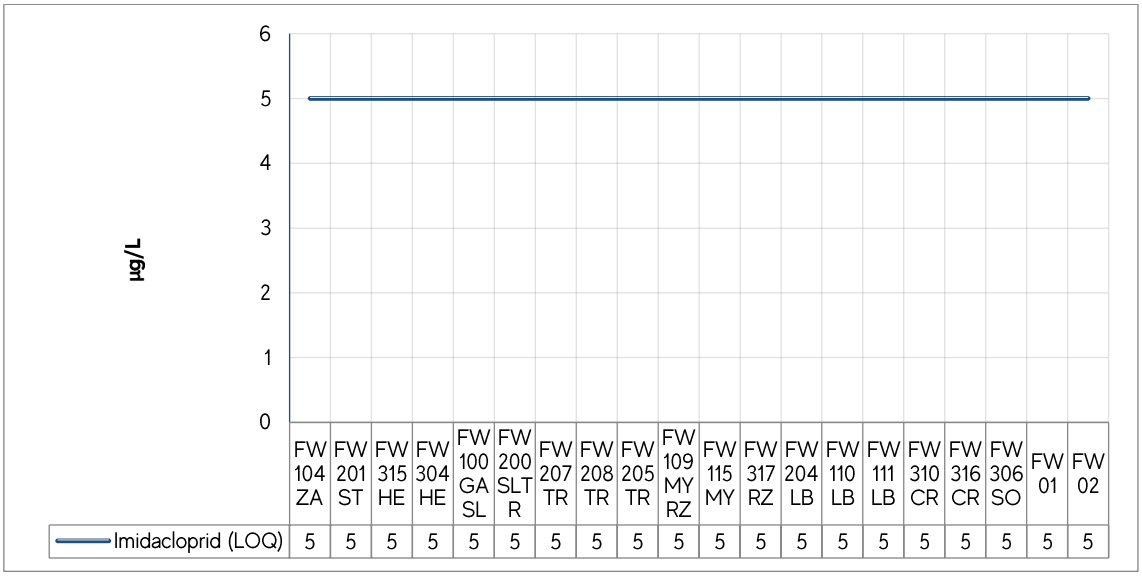


Figure 56. Comparative analysis of Imidacloprid levels at monitoring points

Imidacloprid ($C_9H_{10}ClN_5O_2$) is a systemic insecticide used to control insects, aphids and thrips in various crops. Its commercial name is Dagger or Hephaestus among others.

This pesticide is not detected in any of the points. The limit of quantification is 5 µg/L, and the national regulation does not establish a maximum permissible level for this parameter.

3.2.58 Methyl paraoxon

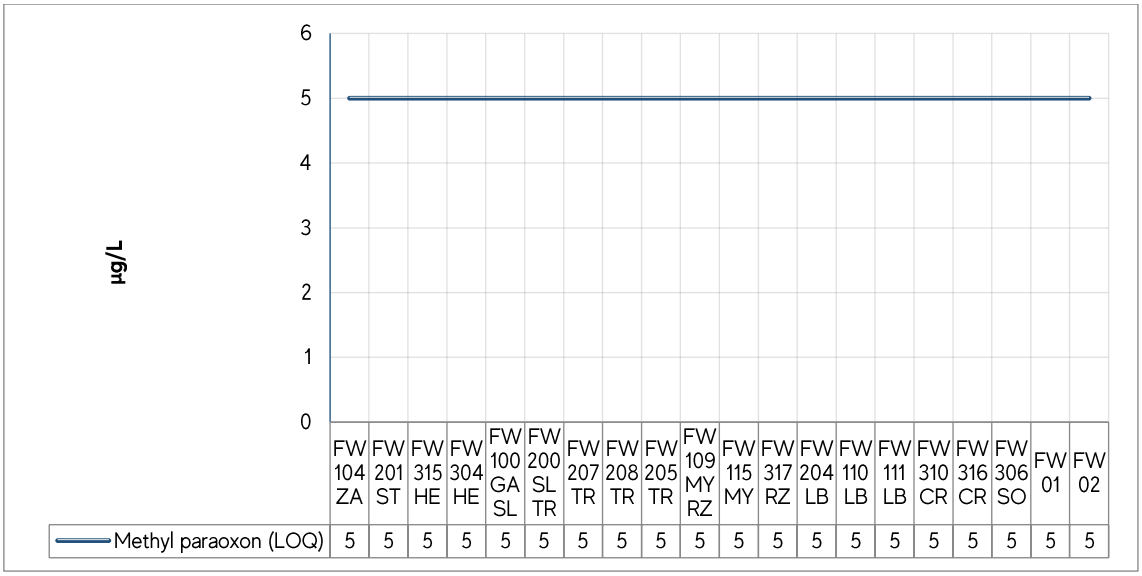


Figure 57. Comparative analysis of methyl paraoxon levels at monitoring points

Methyl Paraoxon ($C_8H_{10}NO_6P$) is a non-systemic and broad-spectrum insecticide. The national water regulation does not establish limits for this pesticide.

No quantifiable levels of this substance is found in any sample. The limit of quantification of the method used is 5 µg/L.

3.2.58 Fipronil

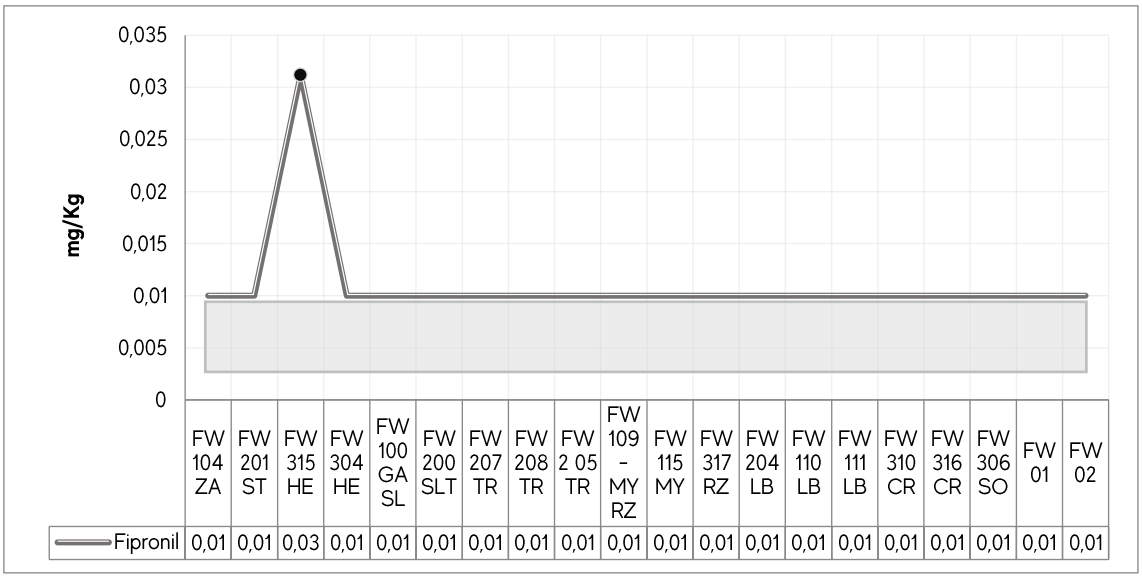


Figure 58. Comparative analysis of Fipronil levels at monitoring points

Regulation 222/02 does not establish a limit for Fipronil concentrations in surface water. The method used to determine Fipronil has a limit of quantification (LOQ) up to 0.01 mg/kg that is not detected in any sample points but FW 315-HE with 0.03113 mg/kg.

3.2.59 Faecal coliforms

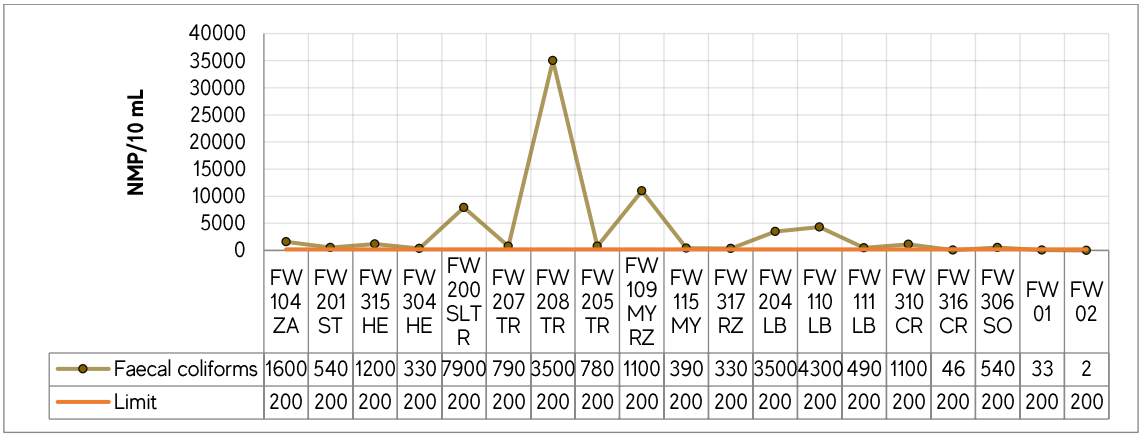


Figure 59. Comparative analysis of faecal coliforms levels at monitoring points

According to the water regulation, in those classify as Class 2, the presence of faecal coliforms must be less than 200 NMP/100ml.

All samples values are beyond the established limits except from the Paraguay River monitoring points (FW01 and FW02) and FW316-CR ("Laguna Penayo" stream).

A percentage of 84% of the samples have values above the maximum permissible. The average for this parameter is 3677 NMP/100ml.

3.2.60 Total coliforms

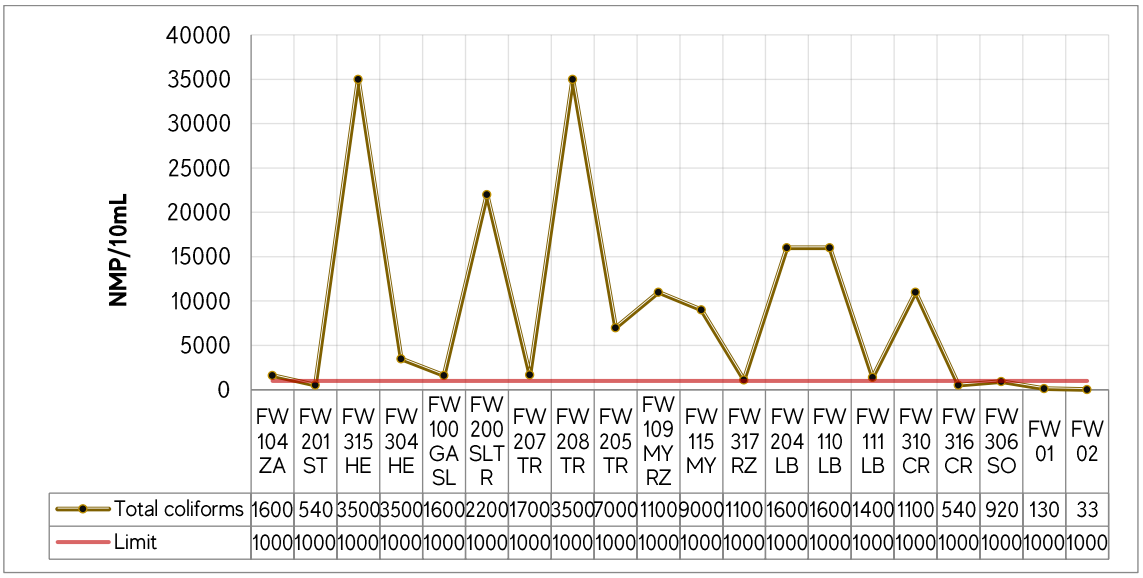
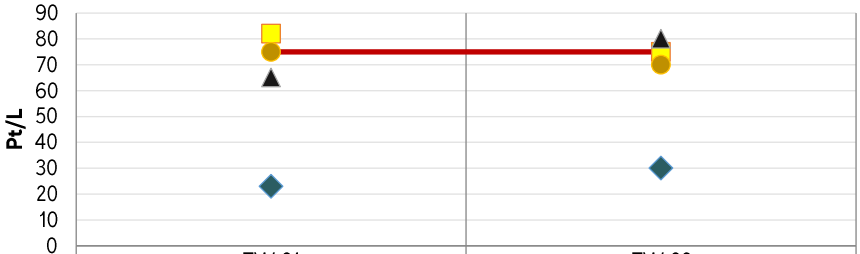


Figure 60. Comparative analysis of total coliforms levels at monitoring points

According to the water regulation, the permissible limit for this parameter is 1000 NMP/ml. Figure 60 shows that only 5 points are under this value while 75% of the points exceeds.

3.2.61 Colour



	FW 01	FW 02
Colour	23	30
3º campaign PYORY	82	75
2º campaign PYORY	65	80
1º campaign PYORY	75	70
Limit	75	75

Figure 61. Comparative analysis of colour at two points of the Paraguay River and three previous monitoring campaigns

Comparing to the values obtained in previous campaigns performed by POYRY (2020) for the project's environmental impact assessment, in the current campaign, the colour is within the range recommended by Regulation 222/02; in comparison with the background results that were close to or exceeded the limit of 75Pt/l.

The colour variations depend on the flow and sediment dragging variations, which relates to climate's conditions. In this case, the values are representative of the rainy season.

3.2.62 Phenols index

	TABLE 10. COMPARATIVE ANALYSIS OF PHENOLS INDEX AT DIFFERENT SAMPLING POINTS	
	PHENOLS INDEX (mg/L)	
	FW01	**FW02**
Current campaign	<0,0005 ND	<0,0005 ND
3° Campaign PYORY	<0,024 ND	<0,024 ND
2° Campaign PYORY	<0,024 ND	<0,024 ND
1° Campaign PYORY	<0,024 ND	<0,024 ND

In all campaigns, phenol at both points is below the limit of quantification (LOQ) therefore not detected. It is essential to mention that the current method is more sensitive than the ones used by POYRY.

The maximum value established by the national water regulation is 0.05 mg/L. None of the 2 points nor the 4 monitoring campaigns exceeds this limit.

3.2.63 PCBs

	TABLE 11. COMPARATIVE ANALYSIS OF PCBs INDEX AT DIFFERENT SAMPLING POINTS	
	PCB (µg/L /L)	
	FW01	**FW02**
Current campaign	<10 µg/L ND	<10µg/L ND
3° Campaign PYORY	<0,2 µg/L ND	<0,2 µg/L ND
2° Campaign PYORY	<0,2 µg/LND	<0,2 µg/L ND
1° Campaign PYORY	<0,2 µg/L ND	<0,2 µg/L ND

The method used during the first, second and third campaigns is more sensitive than the current one. Nevertheless, in all campaigns, PCB levels is below the limit of quantification (LOQ) and so, not detected.

According to Regulation 222/02, the presence of PCBs in waters classified as Class 2 should be zero.

3.3 General performance of groundwater parameters

Table 12 summarises the results obtained for each parameter analysed in groundwater; it also highlights the points that are beyond the established limits and the percentage of monitoring points that comply with regulations.

Regulation 222/02 "Establishing the water quality standard in the national territory" and NP 2400180 established the limits of the analysed parameters and were used to compare the results.

Nº	PARAMETER	AVERAGE	WITHIN THE LIMITS		BEYOND THE LIMITS	
			Nº	%	Nº	%
1	Temperature	23,58 ºC				
2	pH	6,72	15	79%	**4**	**21%**
3	Electrical conductivity	640,1 µS/.cm	17	89%	**2**	**11%**
4	Dissolved solids	422,31 mg/L	16	84%	**3**	**16%**
5	Organic matter	1,7 mg O_2/L				
6	Hardness	100.5 mg $CaCO_3$/L	14	73%	**5**	**27%**
7	Total phosphorus	0,908 mg/L	4	21%	**15**	**79%**
8	Total nitrogen	1,335 mg/L	16	84%	**3**	**26%**
9	Nitrates	37,2 mg/L	15	79%	**4**	**21%**
10	Chlorides	60,82 mg/L	17	89%	**2**	**11%**
11	Alkalinity	109.12 mg $CaCO_3$/L	16	84%	**3**	**16%**
12	Bicarbonates	53,17 mg $CaCO_3$/L				
13	Carbonates	0 mg $CaCO_3$/L				
14	Sulphates	44,53 mg/L	18	94%	**1**	**6%**
15	Sodium	67,9 mg/L	17	89%	**2**	**11%**
16	Potassium	3,66 mg/L	18	94%	**1**	**6%**
17	Calcium	26,3 mg/L	18	94%	**1**	**6%**
18	Magnesium	10,1 mg/L	18	94%	**1**	**6%**
19	Fluorine	0,52 mg/L				
20	Boron	1,84 mg/L	19	100%	**0**	**0%**
21	Faecal coliforms	15,9 NMP/100mL	1	7%	**13**	**93%**
22	Total coliforms	>21 NMP/10mL	2	10%	**17**	**90%**
23	*E Coli*		14	73%	**5**	**27%**

3.4 Comparative analysis of the groundwater's parameters

The following graphs provide each parameter's results determined in the 19 wells sampled on the first monitoring campaign.

3.4.1 Temperature

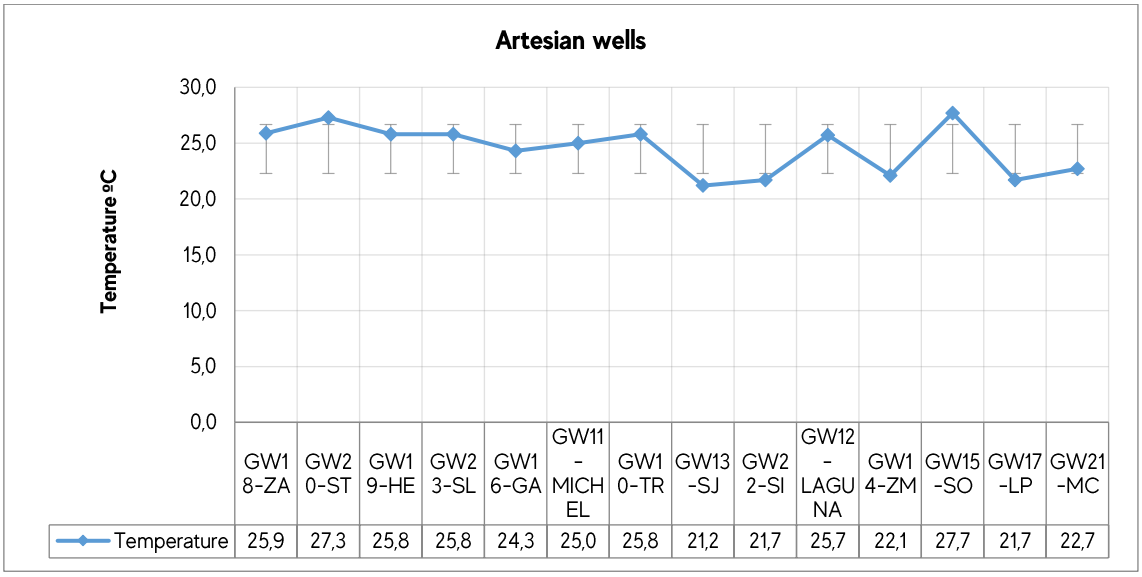


Figure 62. Comparative analysis of temperature measured in artesian wells at the forest plantation area

The artesian wells that provide drinking water to the local population of the "Farm zone" are the monitored points in which the average temperature is 24.5 ºC. The regulations do not establish a limit to analyse this parameter.

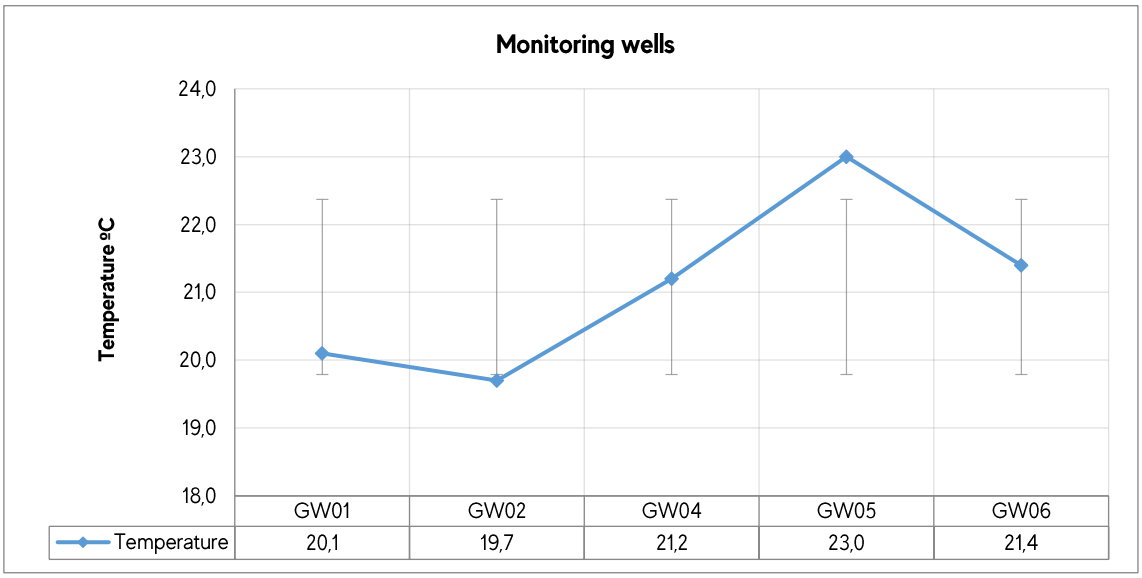
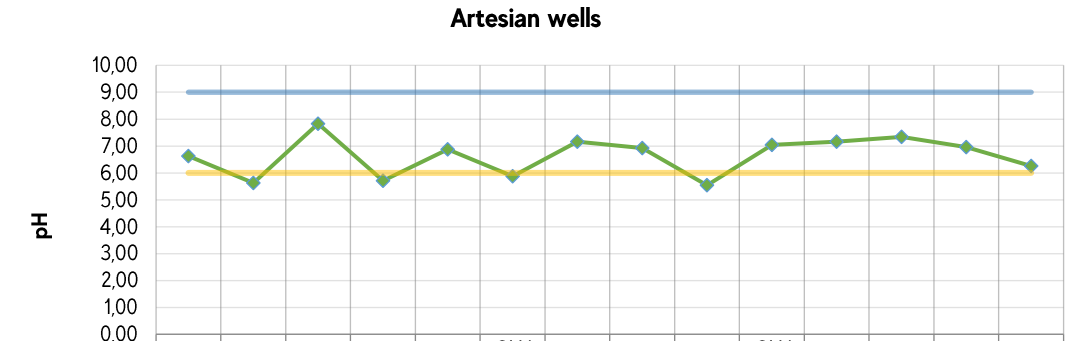


Figure 63. Comparative analysis of temperature measured in monitoring wells at the DAI

The average temperature of the water extracted from the monitoring wells located in the AID of the future industrial plant is 21.08 ºC.

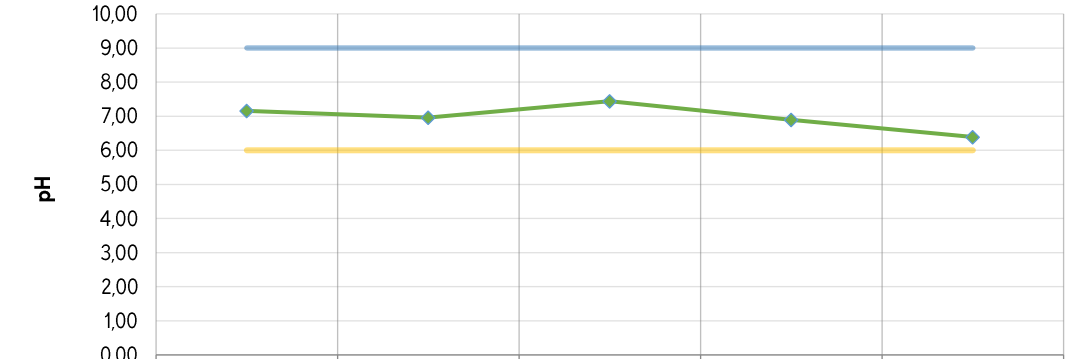
3.4.2 Hydrogen potential



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
pH	6,63	5,63	7,83	5,71	6,87	5,87	7,16	6,92	5,54	7,04	7,16	7,34	6,96	6,26
Limit inf	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Limit sup	9	9	9	9	9	9	9	9	9	9	9	9	9	9

Figure 64. Comparative analysis of pH measured in artesian wells at the forest plantation area

The pH parameter was measured in situ. Regulation 222/02 establishes a limit of range between 6 and 9. Figure 64 shows that none of the points exceeds the upper limit; as for the lower limit, GW20-ST, GW23-SL, GW11-MICHEL and GW22-SILVA show slightly acid pH values.

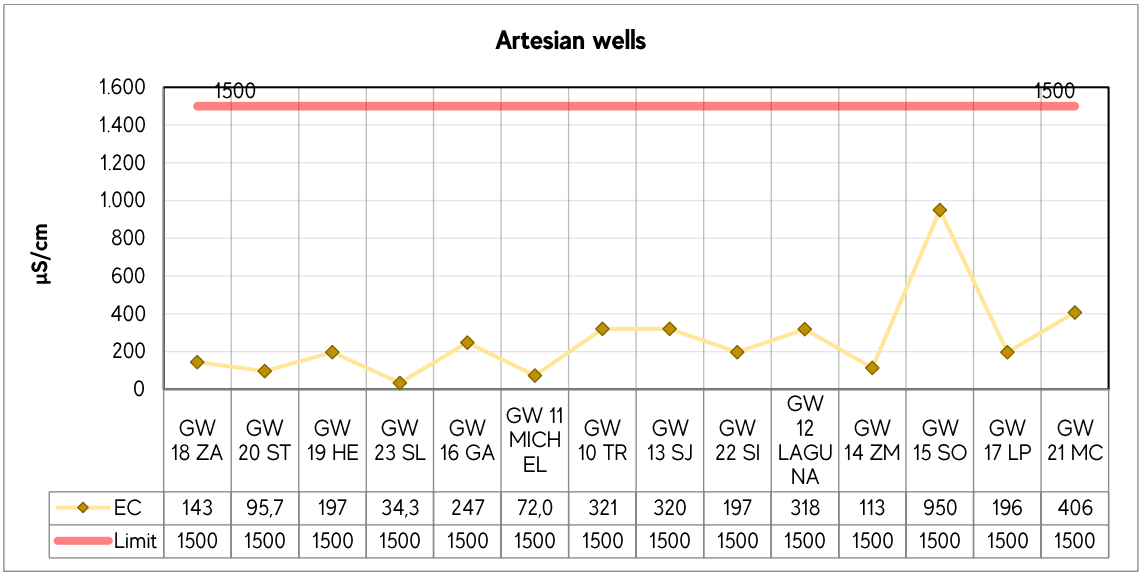


	GW 01	GW 02	GW 04	GW 05	GW 06
pH	7,16	6,96	7,44	6,89	6,39
Limit inf	6	6	6	6	6
Limit sup	9	9	9	9	9

Figure 65. Comparative analysis of pH measured in monitoring wells at the DAI

In the DAI's monitoring wells, all pH values are within the range established in the water regulation.

3.4.3 Electrical conductivity

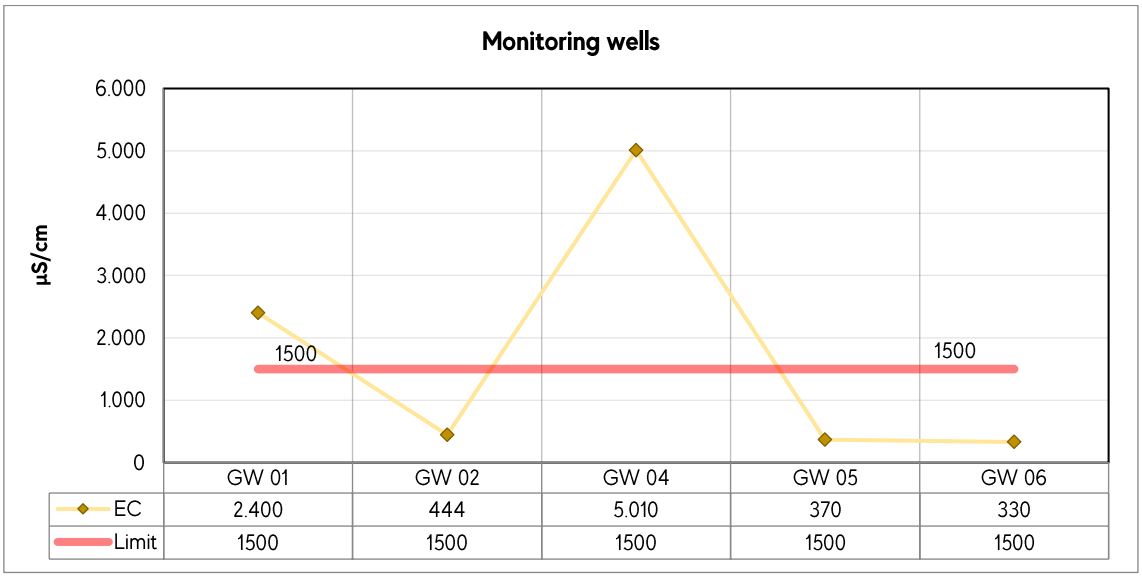


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICH EL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGU NA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
EC	143	95,7	197	34,3	247	72,0	321	320	197	318	113	950	196	406
Limit	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Figure 66. Comparative analysis of EC measured in artesian wells at the forest plantation area

For Class 2 water, Regulation 222/02 does not set any limit for the electrical conductivity. The limit of 1500 µS/.cm established in NP 2400180 "General Requirements for drinking water" is taken as a reference. None determination carried out exceeds the limit mentioned.

The average value is 257.8 µS/cm for the forestry area. The maximum value measured belongs to GW15-SW which represents to the farm "Soledad".

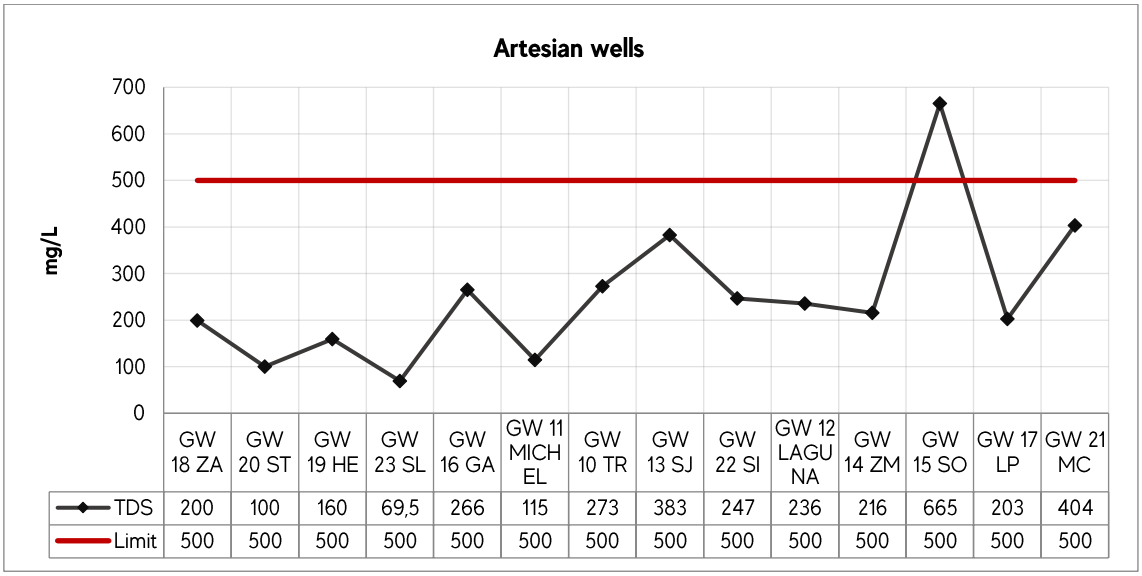


	GW 01	GW 02	GW 04	GW 05	GW 06
EC	2.400	444	5.010	370	330
Limit	1500	1500	1500	1500	1500

Figure 67. Comparative analysis of EC measured in monitoring wells at the DAI

Compared to the forest plantation zone, higher electrical conductivity values are recorded in the DAI zone. The average EC value from the monitoring wells is 1710 µS/cm and the points GW01 and GW04 exceed the maximum values.

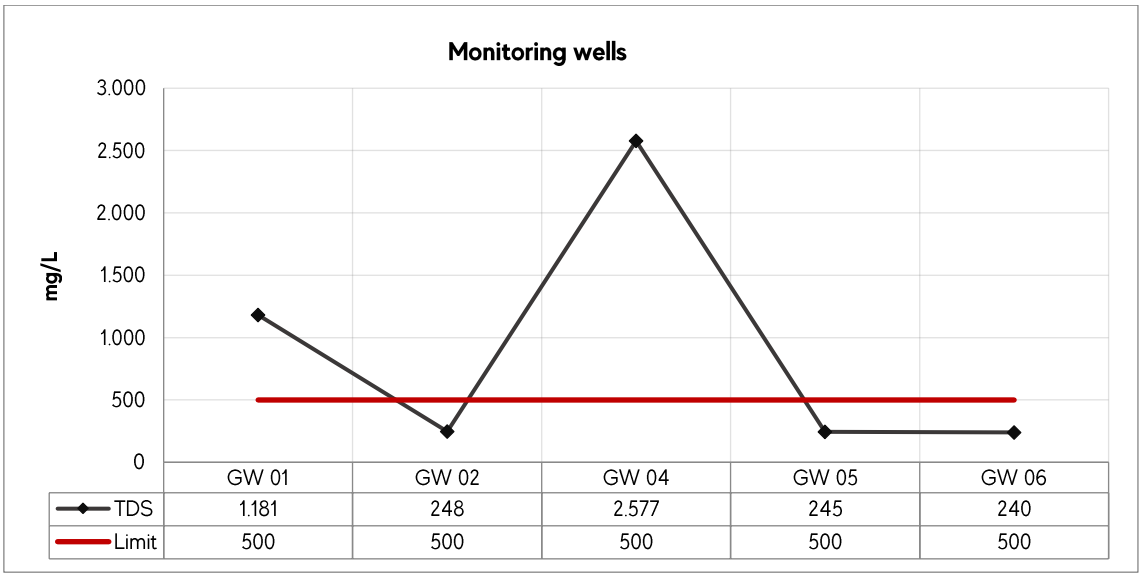
3.4.4 Total dissolved solids (TDS)



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
TDS	200	100	160	69,5	266	115	273	383	247	236	216	665	203	404
Limit	500	500	500	500	500	500	500	500	500	500	500	500	500	500

Figure 68. Comparative analysis of TDS measured in artesian wells at the forest plantation area

The national water regulation establishes a limit of 500 mg/l for this parameter. In the first monitoring campaign, the average TDS value is 252.4 mg/l where only GW 15-SW exceeds the limit.



	GW 01	GW 02	GW 04	GW 05	GW 06
TDS	1.181	248	2.577	245	240
Limit	500	500	500	500	500

Figure 69. Comparative analysis of TDS measured in monitoring wells at the DAI

The average TDS value is 898.2 mg/l in the DAI zone, which is considerably higher compared to the TDS in the forest plantation area.

3.4.5 Organic matter

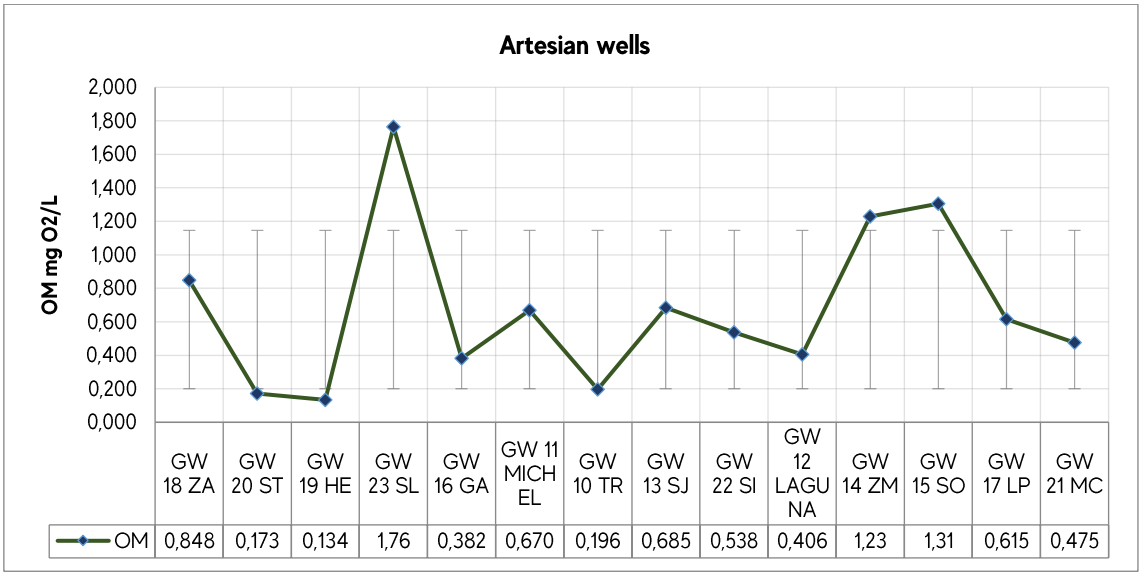


Figure 70. Comparative analysis of OM measured in artesian wells at the forest plantation area

Regulation 222/02 does not determine a maximum concentration for organic matter. The average result is 0.7 mg O_2/l. But, GW23-SL, GW14-ZM and GW15-SO shows values above the standard deviation.

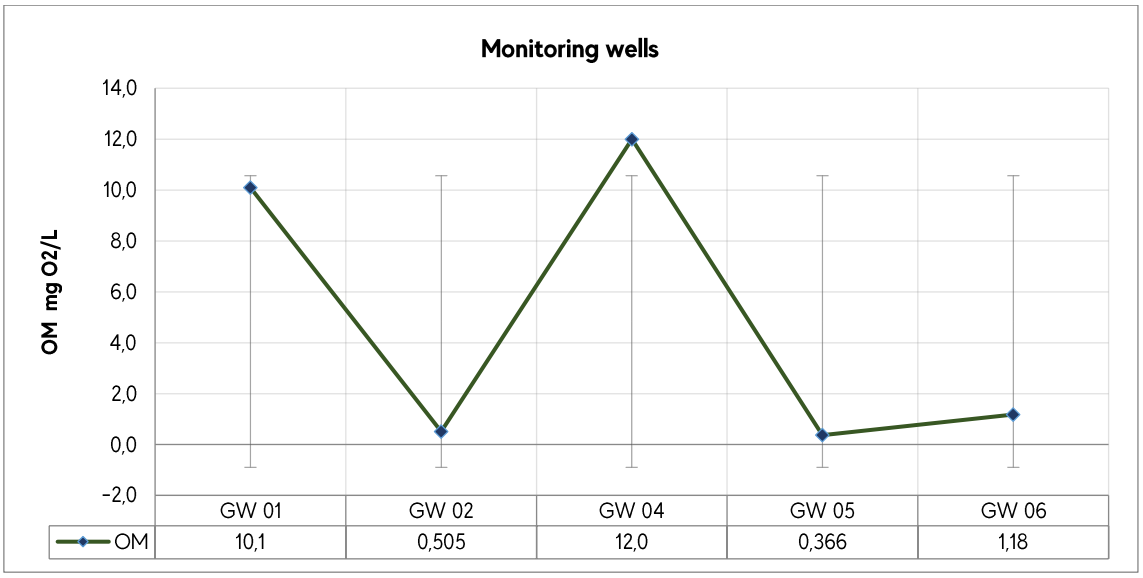
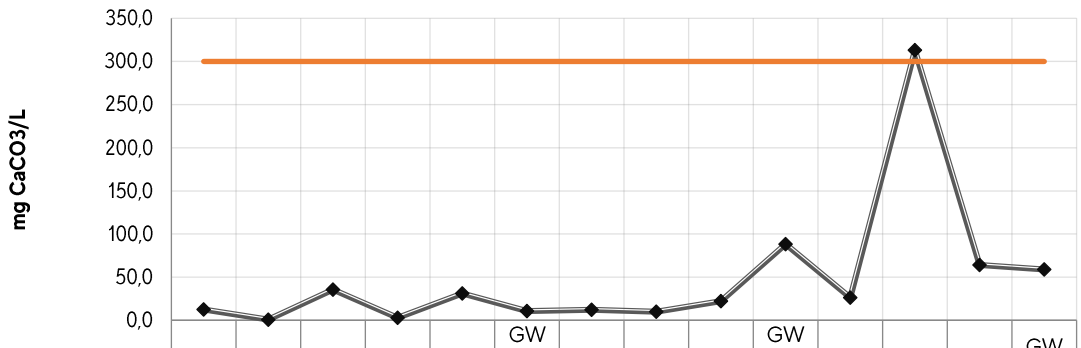


Figure 71. Comparative analysis of OM measured in monitoring wells at the DAI

The average value of OM at the DAI area is 4.8 mg O2/l, which is significantly higher than the average obtained in the forest plantation zone.

3.4.6 Hardness

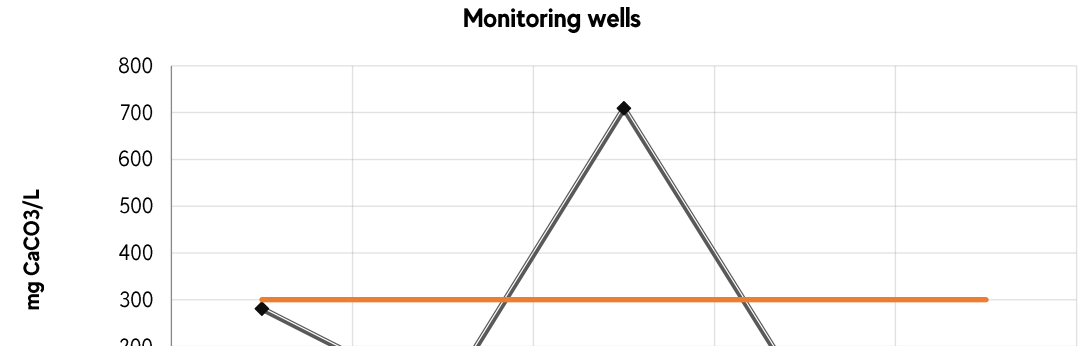


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Hardness	12,5	0,808	35,6	3,03	30,9	10,5	12,3	9,90	22,0	88,1	26,3	313	64,0	58,8
Limit	300	300	300	300	300	300	300	300	300	300	300	300	300	300

Figure 72. Comparative analysis of hardness levels measured in artesian wells at the forest plantation area

Hardness is a water quality parameter influenced by the hydrological area's geological formations in which a well is located. Regulation 222/02 stipulates a maximum of 300 mg/l for this parameter.

The average hardness value in this first campaign is 49.1 mg $CaCO_3$/l. In the forest plantation area, only GW15-SO has a higher result than the permissible limit.

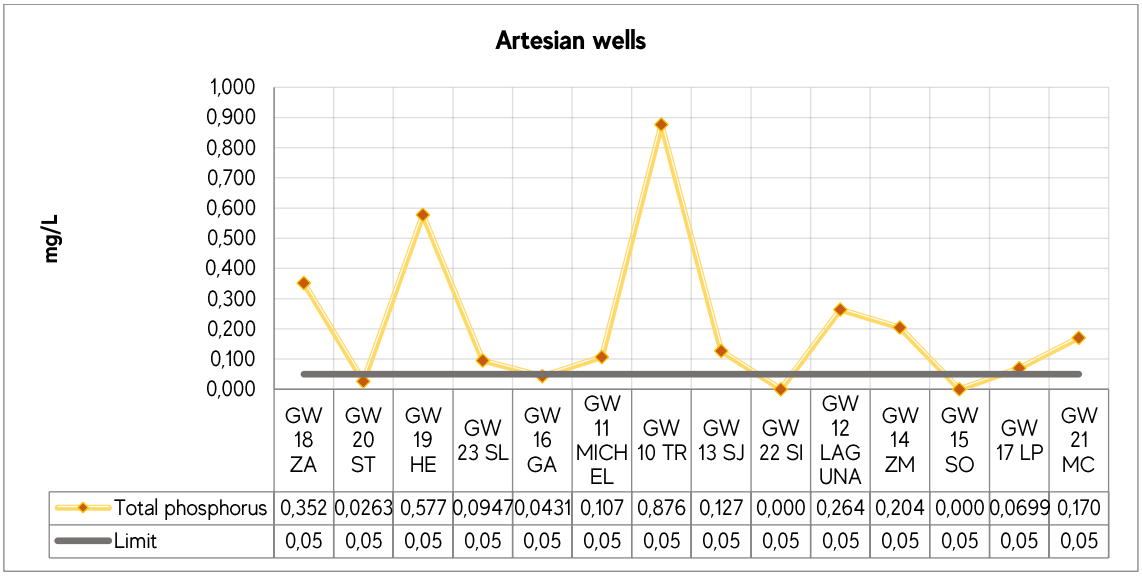


	GW 01	GW 02	GW 04	GW 05	GW 06
Hardness	281	84	709	88,1	60
Limit	300	300	300	300	300

Figure 73. Comparative analysis of hardness levels measured in monitoring wells at the DAI

In the DAI zone, the average hardness value is 244.46 mg CaCO3/l. Only the value measured at the monitoring well GW04 is above the limit.

3.4.7 Total phosphorus

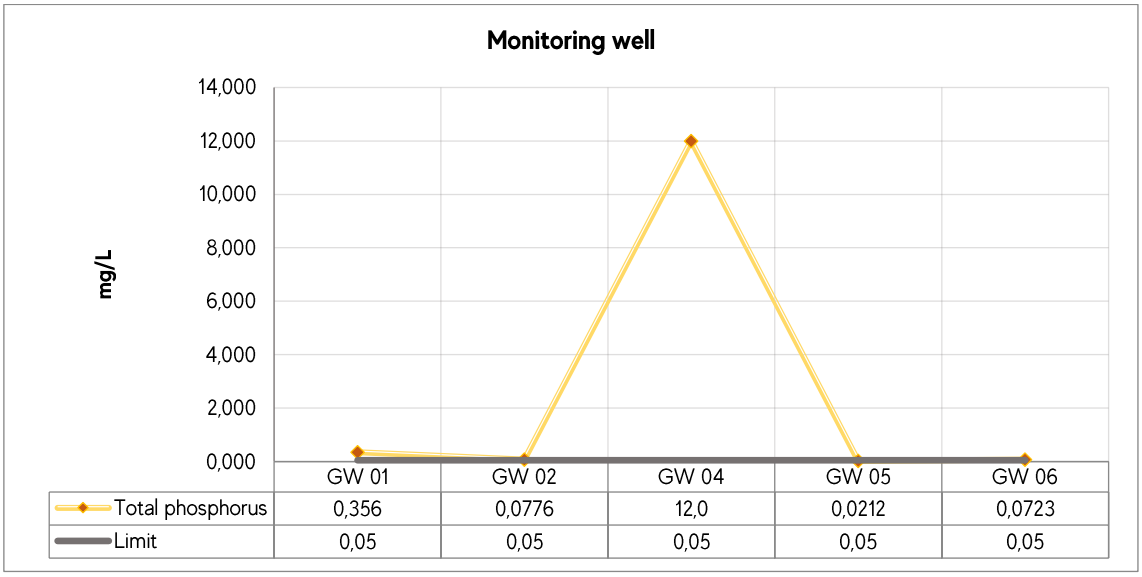


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Total phosphorus	0,352	0,0263	0,577	0,0947	0,0431	0,107	0,876	0,127	0,000	0,264	0,204	0,000	0,0699	0,170
Limit	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05	0,05

Figure 74. Comparative analysis of total phosphorus levels measured in artesian wells at the forest plantation area

Over-fertilisation causes that a fraction of phosphorus not assimilated by the vegetation to infiltrate into the soils and reach groundwater or surface water, which can explain the high phosphorus concentrations.

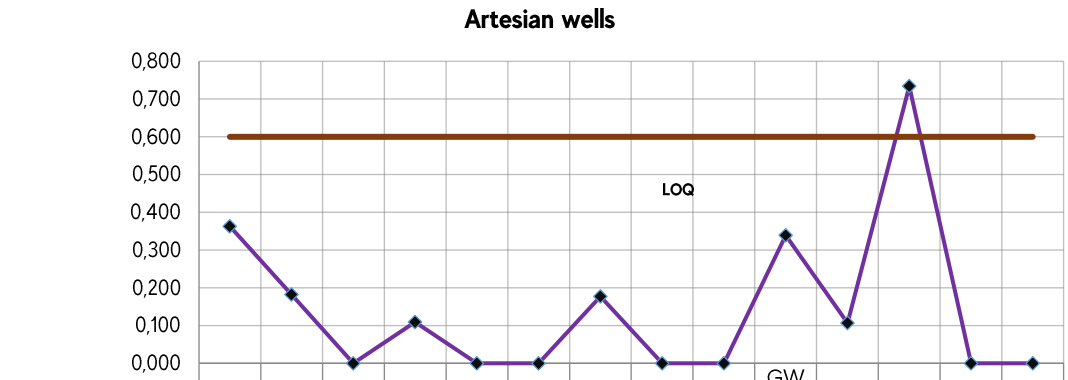
Figure 74 shows that only 4 wells of the forestry area comply with the regulation's established limit. In the remaining 10 wells, the limits exceed up to 17 times the maximum recommended by the national water regulation (0.05 mg/L).



	GW 01	GW 02	GW 04	GW 05	GW 06
Total phosphorus	0,356	0,0776	12,0	0,0212	0,0723
Limit	0,05	0,05	0,05	0,05	0,05

Figure 75. Comparative analysis of total phosphorus levels measured in monitoring wells at the DAI

3.4.8 Total nitrogen

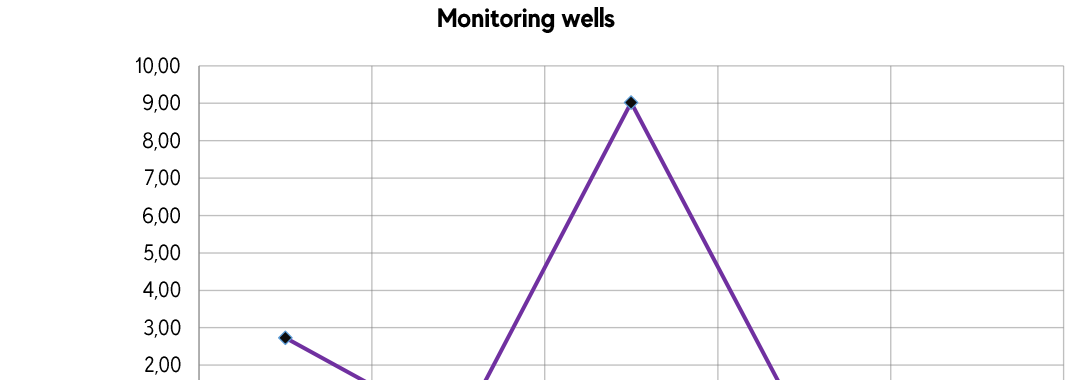


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Total nitrogen	0,363	0,182	0,000	0,109	0,000	0,000	0,177	0,000	0,000	0,339	0,107	0,734	0,000	0,000
Limit	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6	0,6

Figure 76. Comparative analysis of total nitrogen levels measured in artesian wells at the forest plantation area

Figure 76 shows that the limit of quantification (LOQ) for total nitrogen equals 1 mg/l. At points, GW 19-HE, GW 16-GA, GW 11-MICHEL, GW 13-SAN JUAN, GW 22-SILVA, GW 14-ZM, GW 17-LP and GW 21-MC, the concentrations of total nitrogen are lower than the LOQ.

GW 15-SO is the only point that exceeds LOQ with a value of 0.734 mg/l.



	GW 01	GW 02	GW 04	GW 05	GW 06
Total nitrogen	2,73	0,196	9,02	0,245	0,483
Limit	0,6	0,6	0,6	0,6	0,6

Figure 77. Comparative analysis of total nitrogen levels measured in monitoring wells at the DAI

GW01 and are the two monitoring wells in the DAI with values above the limit. The average value of nitrogen in groundwater future industrial plant zone is 2.5 mg/L.

3.4.9 Nitrates

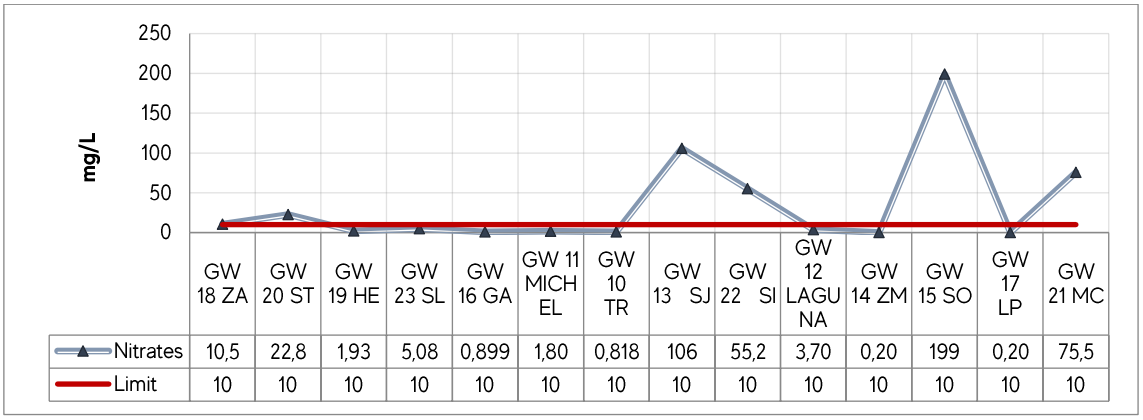


Figure 78. Comparative analysis of nitrate levels measured in artesian wells at the forest plantation area

For nitrates, the maximum level established by the legislation is 10 mg/l. GW 18-ZA. GW 20-ST, GW-13 San Juan, GW 22-Silva, GW 15-SO and GW 21- MC exceed the maximum limit.

Statistically, 79% of wells are within the range while 21% are beyond the limits. The average value of nitrates is 37.2 mg/l.

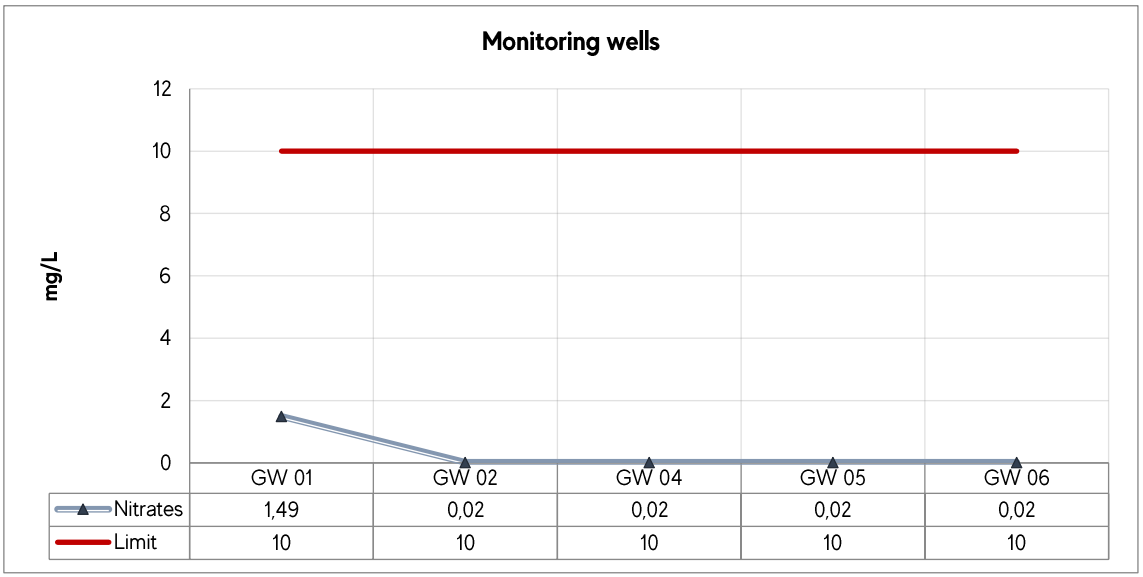
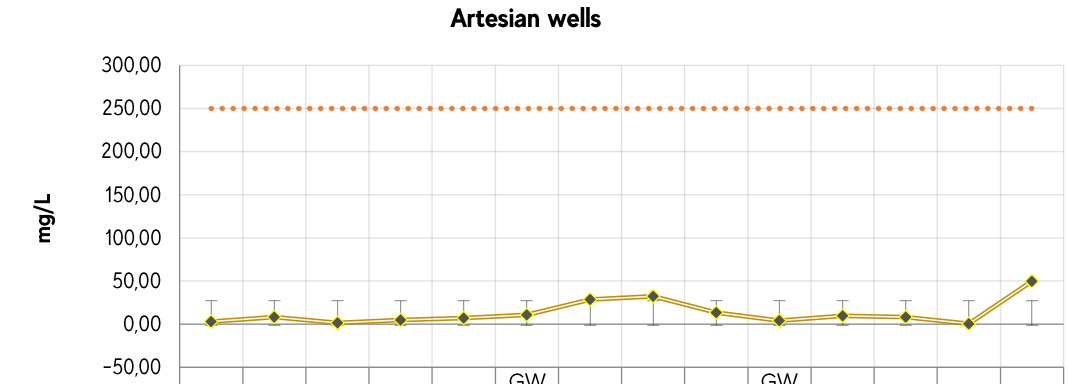


Figure 79. Comparative analysis of nitrate levels measured in monitoring wells at the DAI

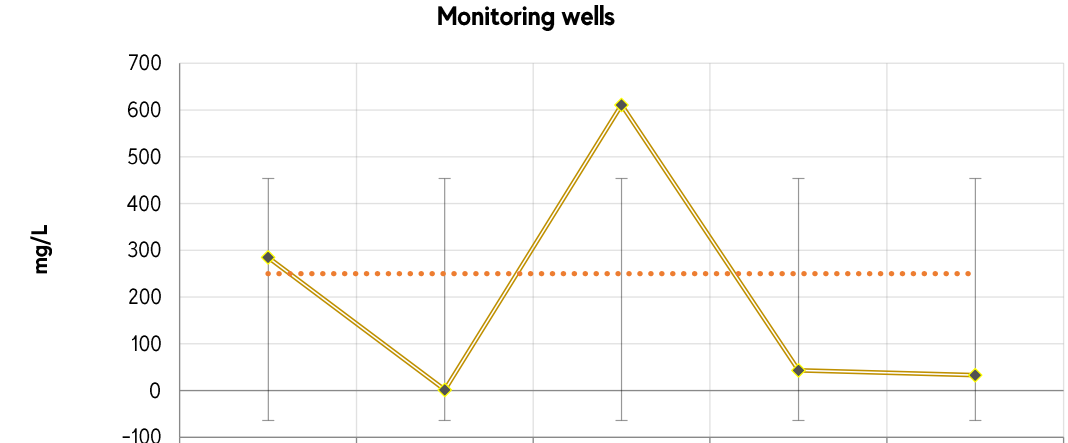
3.4.8 Chlorides



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Chlorides	3,09	8,08	1,43	4,75	6,89	10,9	28,5	32,3	13,3	4,28	9,50	8,31	0,475	49,9
Limit	250	250	250	250	250	250	250	250	250	250	250	250	250	250

Figure 80. Comparative analysis of chloride levels measured in artesian wells at the forest plantation area

According to Law 1614/2000, Chloride's permissible limit is 250 mg/l. None well exceeds this maximum limit. The average chloride value is 12.9 mg/l.

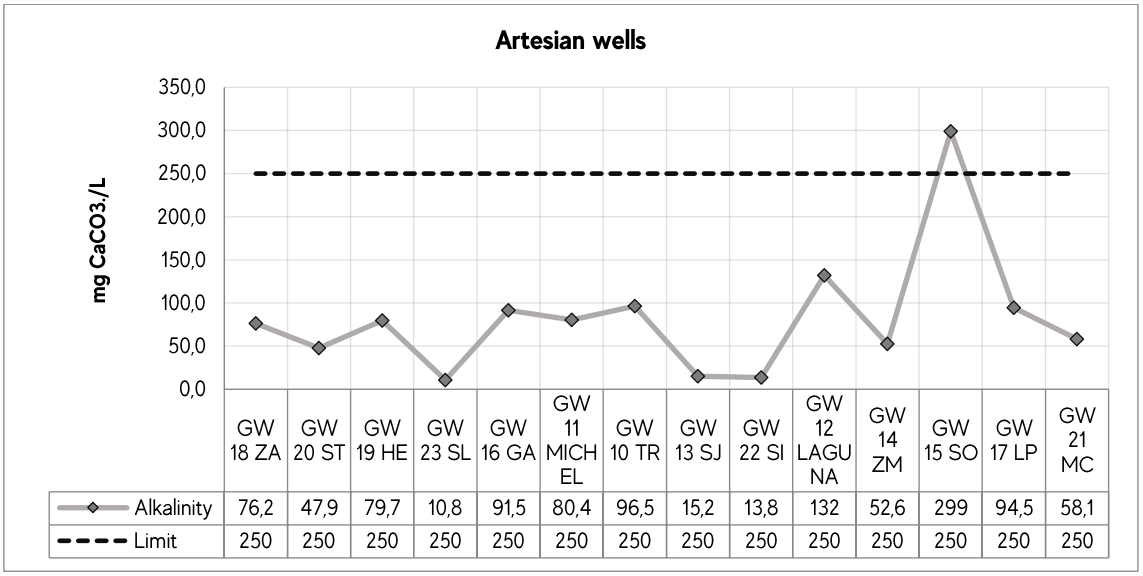


	GW 01	GW 02	GW 04	GW 05	GW 06
Chlorides	285	1,59	611	43,1	33,3
Limit	250	250	250	250	250

Figure 81. Comparative analysis of chloride levels measured in monitoring wells at the DAI

In the DAI, the monitoring wells GW01 and GW04 show values above the established limit. The average result of the parameter is 194.7 mg/l.

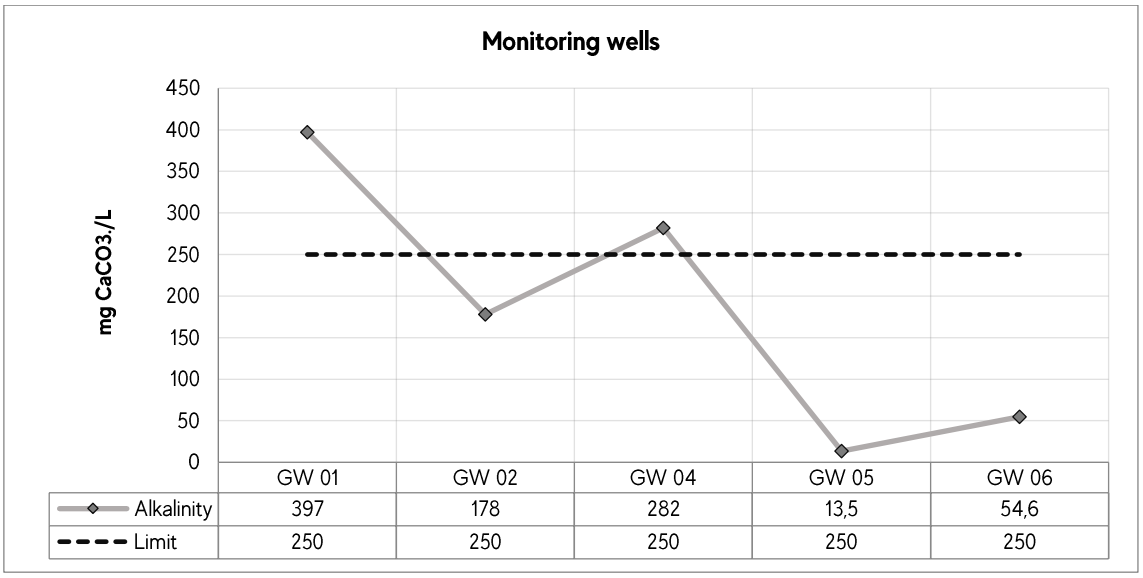
3.4.9 Alkalinity



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Alkalinity	76,2	47,9	79,7	10,8	91,5	80,4	96,5	15,2	13,8	132	52,6	299	94,5	58,1
Limit	250	250	250	250	250	250	250	250	250	250	250	250	250	250

Figure 82. Comparative analysis of alkalinity levels measured in artesian wells at the forest plantation area

The Law 1614/2000 establishes a maximum value of 250 mg $CaCO_3$/l. Figure 82 shows that only well GW15-SO exceeds the limit. The average alkalinity concentration is 82 mg $CaCO_3$/l.



	GW 01	GW 02	GW 04	GW 05	GW 06
Alkalinity	397	178	282	13,5	54,6
Limit	250	250	250	250	250

Figure 83. Comparative analysis of alkalinity levels measured in monitoring wells at the DAI

In the DAI, monitoring wells GW01 and GW04 have concentrations above the limit. The average is 185.02 mg CaCo3/l.

3.4.10 Bicarbonates

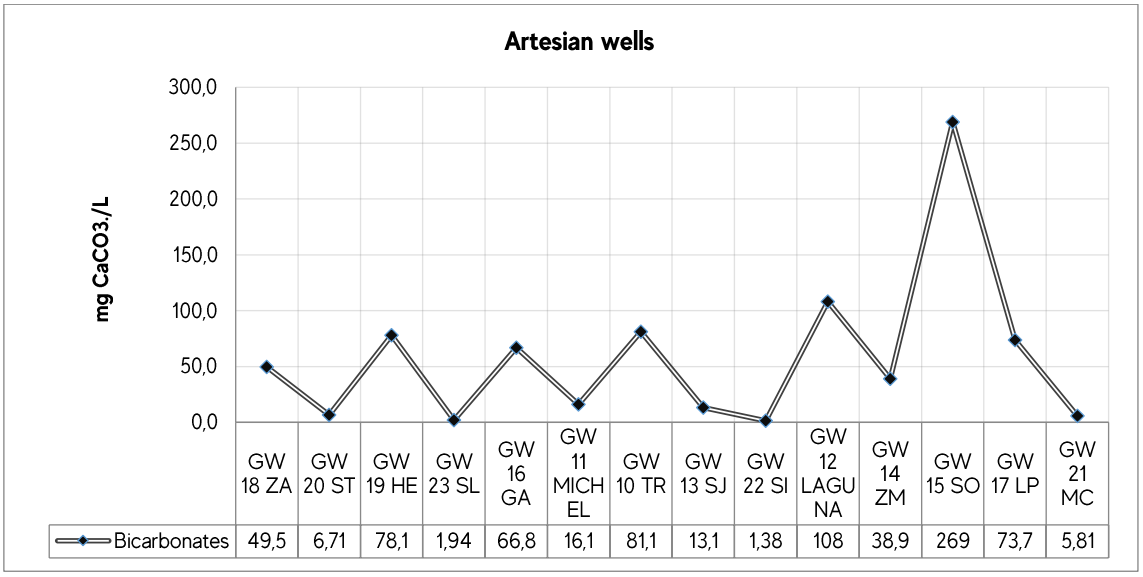


Figure 84. Comparative analysis of bicarbonate levels measured in artesian wells at the forest plantation area

Bicarbonate is a water quality parameter with no set limit. The types of minerals in the geological formation where the wells are, influence the concentrations of this parameter. The average value of bicarbonates is 57.9 mg CaCO3/l.

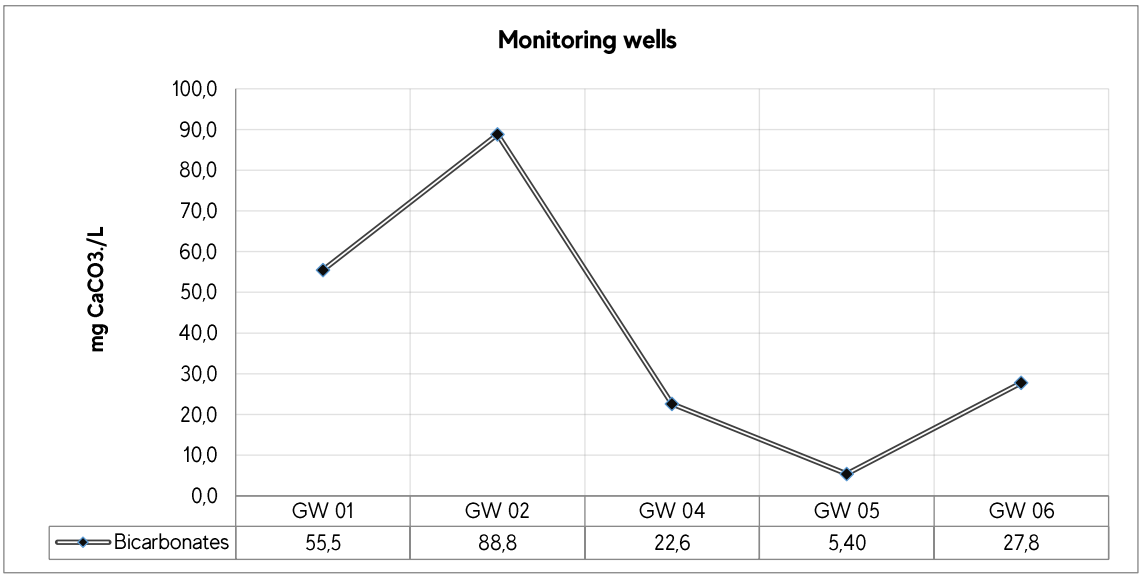


Figure 85. Comparative analysis of bicarbonate levels measured in monitoring wells at the DAI

In the DAI zone, the average bicarbonate concentration is 40.02 mg CaCo3/l.

3.4.11 Carbonates

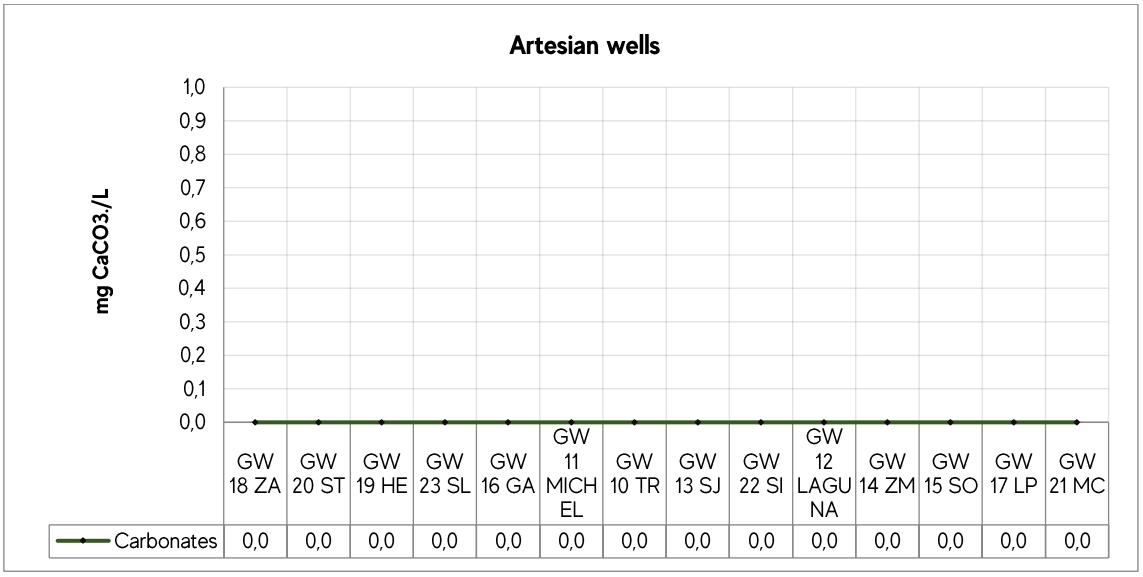


Figure 86. Comparative analysis of carbonate levels measured in artesian wells at the forest plantation area

Carbonate is a water quality parameter with no set limit. According to the laboratory results, there is no presence of this parameter in any sample.

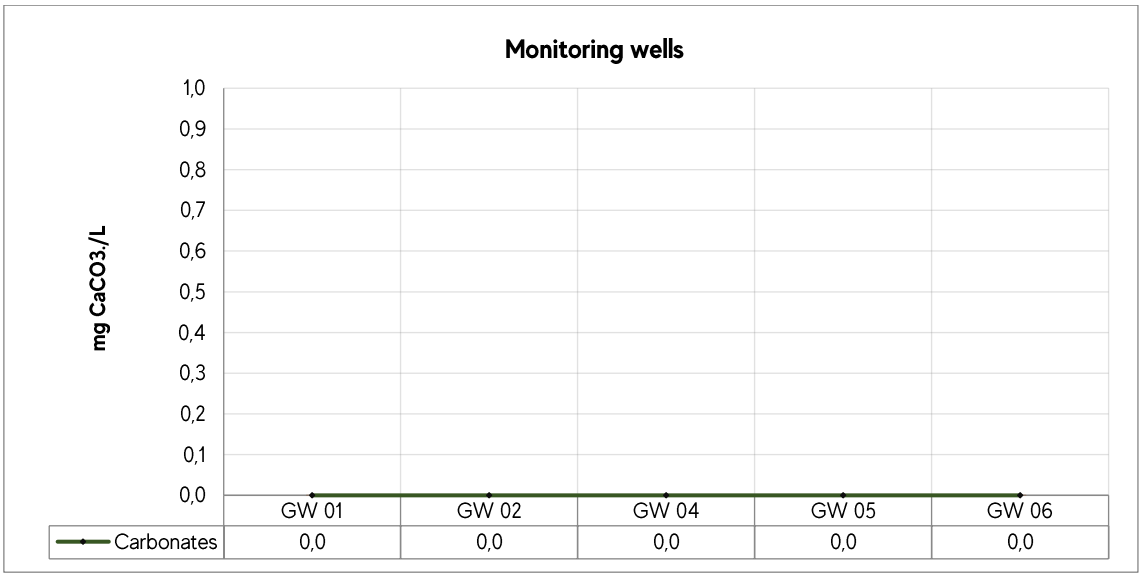
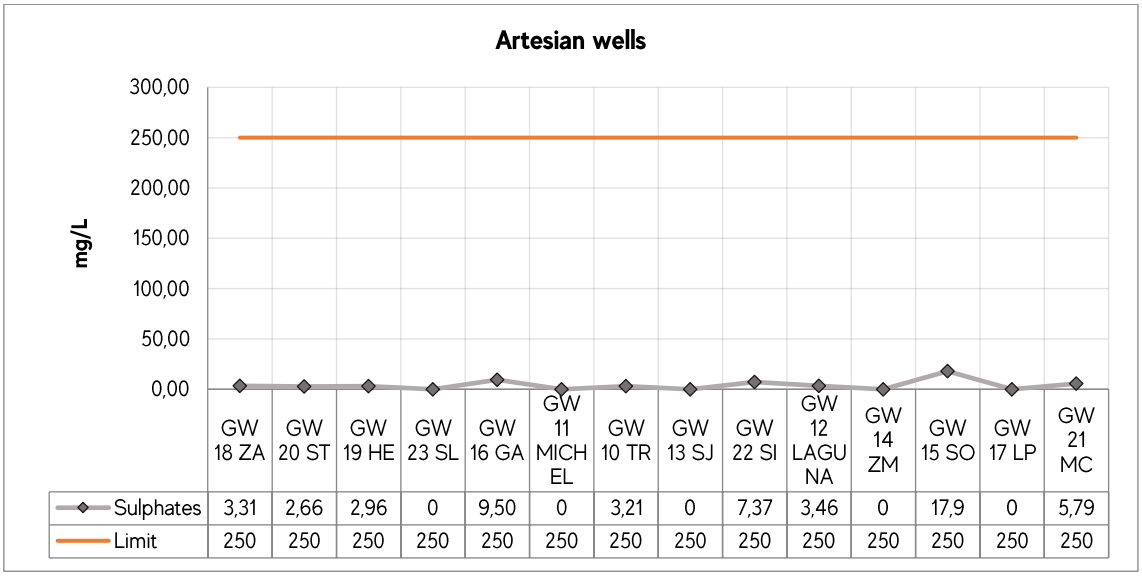


Figure 87. Comparative analysis of carbonate levels measured in monitoring wells at the DAI

As the artesian well's results, the monitoring well's values in the DAI are equal to zero.

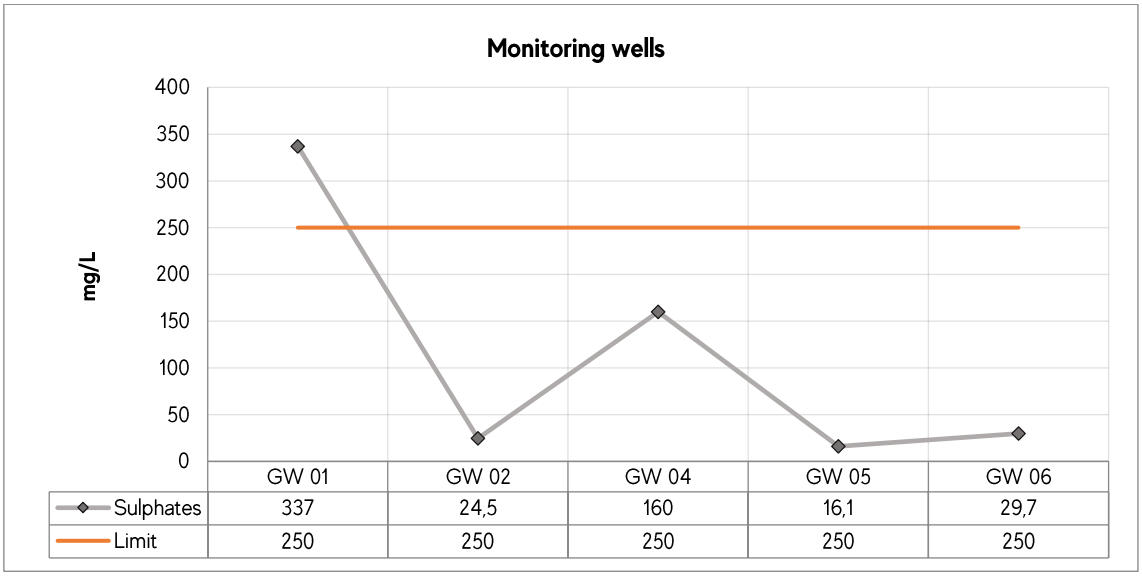
3.4.12 Sulphates



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Sulphates	3,31	2,66	2,96	0	9,50	0	3,21	0	7,37	3,46	0	17,9	0	5,79
Limit	250	250	250	250	250	250	250	250	250	250	250	250	250	250

Figure 88. Comparative analysis of sulphate levels measured in artesian wells at the forest plantation area

In contrast to surface water, all the artesian well's monitored points show sulphate concentrations. Regulation 222/02 defines a maximum of 250 mg/l for this parameter, and the highest determination is 17.9 mg/l at point GW18-SO. All the samples are within the range, and the average sulphate value is 4 mg/l.

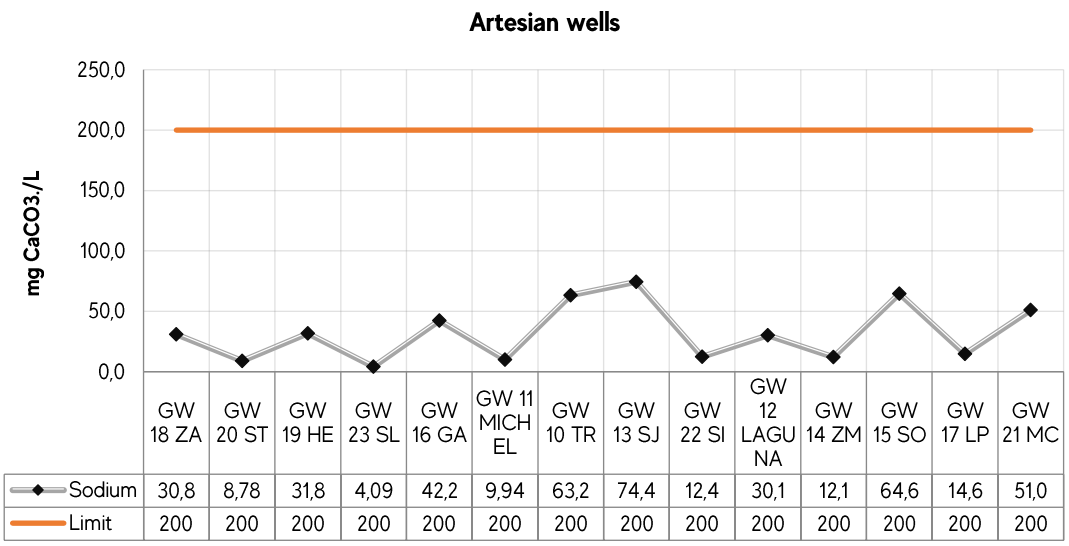


	GW 01	GW 02	GW 04	GW 05	GW 06
Sulphates	337	24,5	160	16,1	29,7
Limit	250	250	250	250	250

Figure 89. Comparative analysis of sulphate levels measured in monitoring wells at the DAI

In the DAI zone, the only well that exceeds the limit is GW01 with 337 mg/L. The average value of sulphates is 113.46 mg/L.

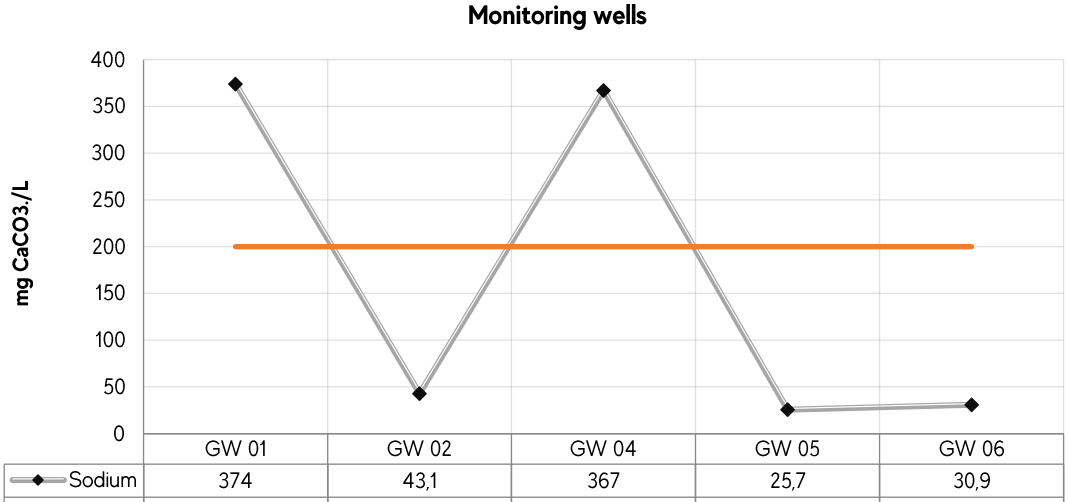
3.4.13 Sodium



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Sodium	30,8	8,78	31,8	4,09	42,2	9,94	63,2	74,4	12,4	30,1	12,1	64,6	14,6	51,0
Limit	200	200	200	200	200	200	200	200	200	200	200	200	200	200

Figure 90. Comparative analysis of sodium levels measured in artesian wells at the forest plantation area

In all the sampled wells, the sodium concentrations are lower than the maximum levels established in Regulation 222/02. Statistically, the average sodium concentration in groundwater is 32.14 mg/L.

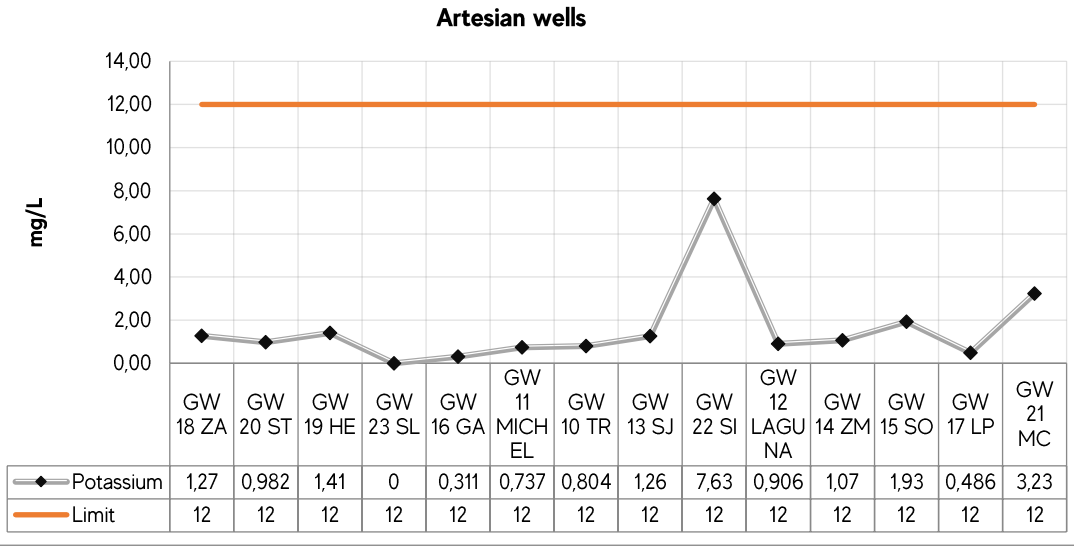


	GW 01	GW 02	GW 04	GW 05	GW 06
Sodium	374	43,1	367	25,7	30,9
Limit	200	200	200	200	200

Figure 91. Comparative analysis of sodium levels measured in monitoring wells at the DAI

In the DAI zone the average sodium concentration is 168.14 mg/l. Only wells GW01 and GW04 have values above the limit.

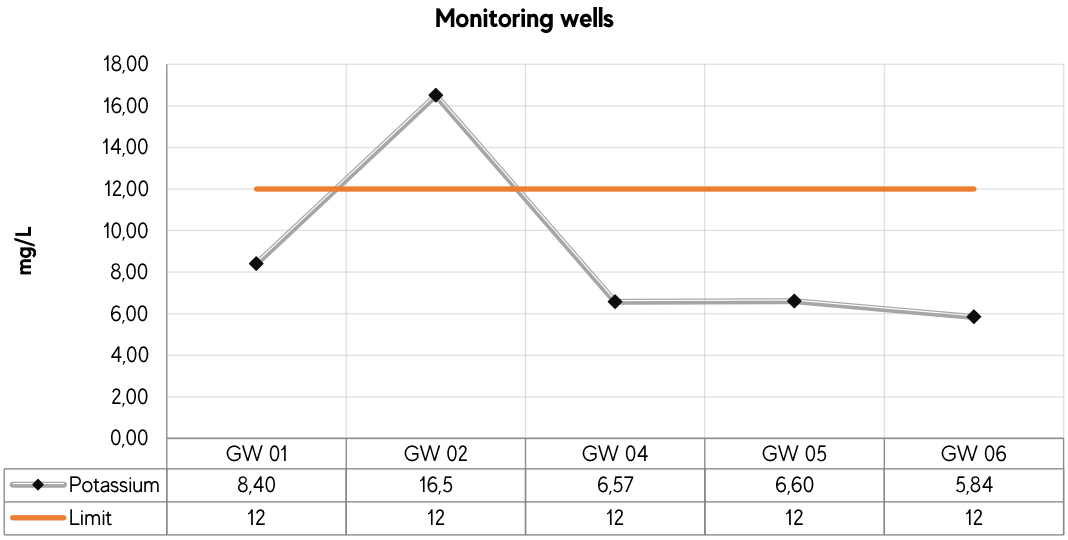
3.4.13 Potassium



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Potassium	1,27	0,982	1,41	0	0,311	0,737	0,804	1,26	7,63	0,906	1,07	1,93	0,486	3,23
Limit	12	12	12	12	12	12	12	12	12	12	12	12	12	12

Figure 92. Comparative analysis of potassium levels measured in artesian wells at the forest plantation area

The recommended sodium limits, in Law 1614/2000, is less than 12 mg/L. All the artesian well's results are within this range.

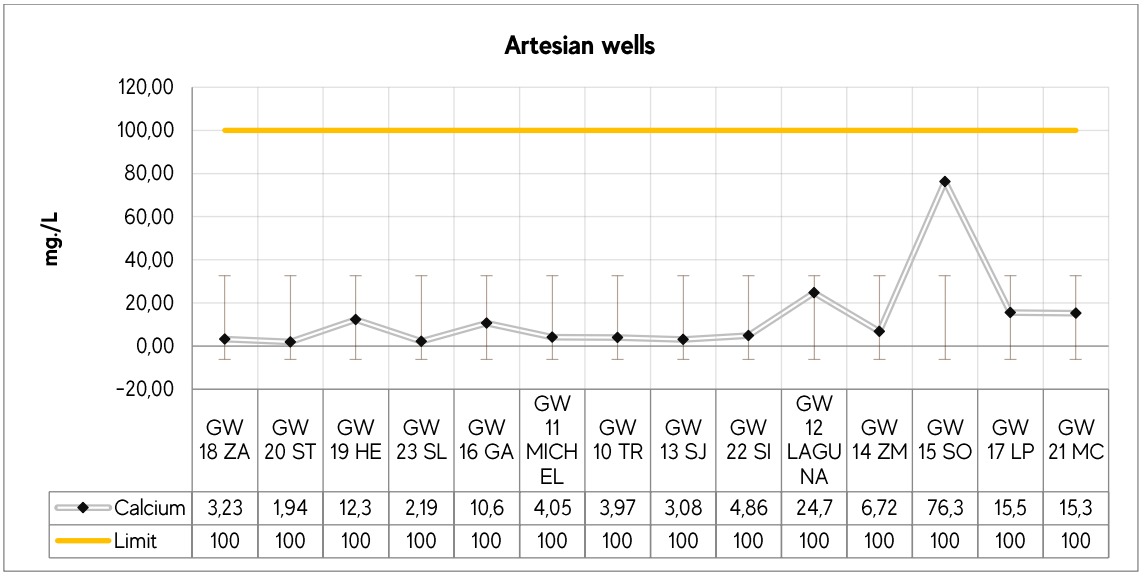


	GW 01	GW 02	GW 04	GW 05	GW 06
Potassium	8,40	16,5	6,57	6,60	5,84
Limit	12	12	12	12	12

Figure 93. Comparative analysis of potassium levels measured in monitoring wells at the DAI

In the DAI zone, monitoring well GW02 exceeds the value established in the reference regulation, the average potassium concentration in groundwater at the future industrial plant zone is 8.7 mg/l.

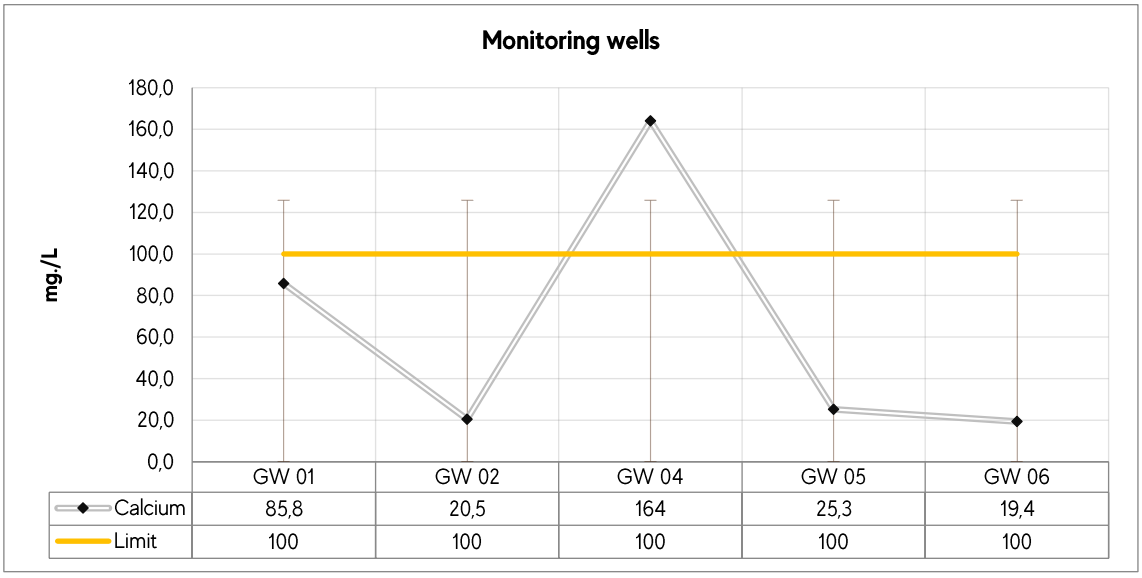
3.4.14 Calcium



	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Calcium	3,23	1,94	12,3	2,19	10,6	4,05	3,97	3,08	4,86	24,7	6,72	76,3	15,5	15,3
Limit	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Figure 94. Comparative analysis of calcium levels measured in artesian wells at the forest plantation area

Regulation 222/02 does not establish a maximum value for this parameter; therefore, the limit value considered is 100 mg/l which is set by Law 1614/2000. Figure 94 shows that none points exceed this value. The average result is 13,19 mg/l.

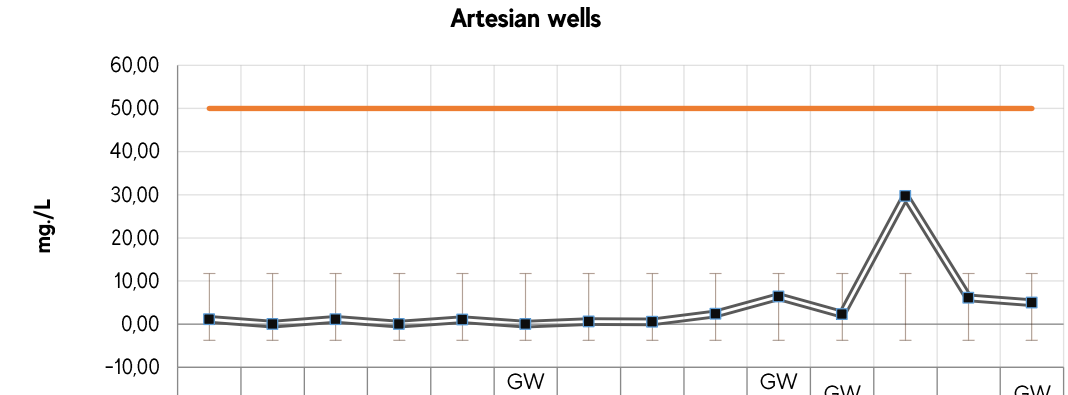


	GW 01	GW 02	GW 04	GW 05	GW 06
Calcium	85,8	20,5	164	25,3	19,4
Limit	100	100	100	100	100

Figure 95. Comparative analysis of calcium levels measured in monitoring wells at the DAI

Figure 95 illustrates that the highest concentrations are recorded in the DAI monitoring wells. GW04 is the only point that exceeds the established limit. The average calcium value in this area is 63 mg/l.

3.4.14 Magnesium

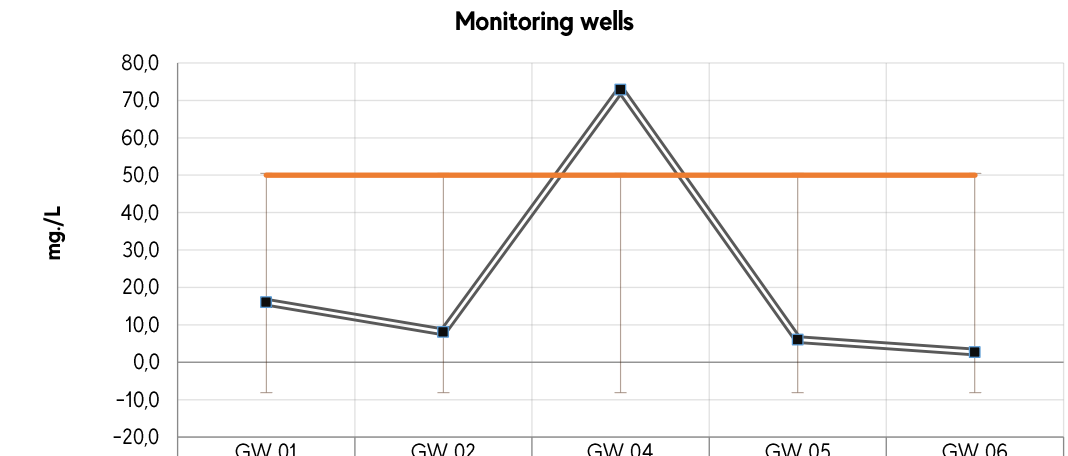


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Magnesium	1,08	0,000	1,15	0,000	1,07	0,000	0,578	0,536	2,41	6,410	2,30	29,7	6,11	4,98
Limit	50	50	50	50	50	50	50	50	50	50	50	50	50	50

Figure 96. Comparative analysis of magnesium levels measured in artesian wells at the forest plantation area

The water standard for the national territory does not establish a maximum level for this parameter; thus, Law 1614/2000 is used as a reference and it establishes 50 mg/l for magnesium level.

None point exceeds the reference value in the forest plantation area. The average magnesium value at all points is 5.1 mg/l.

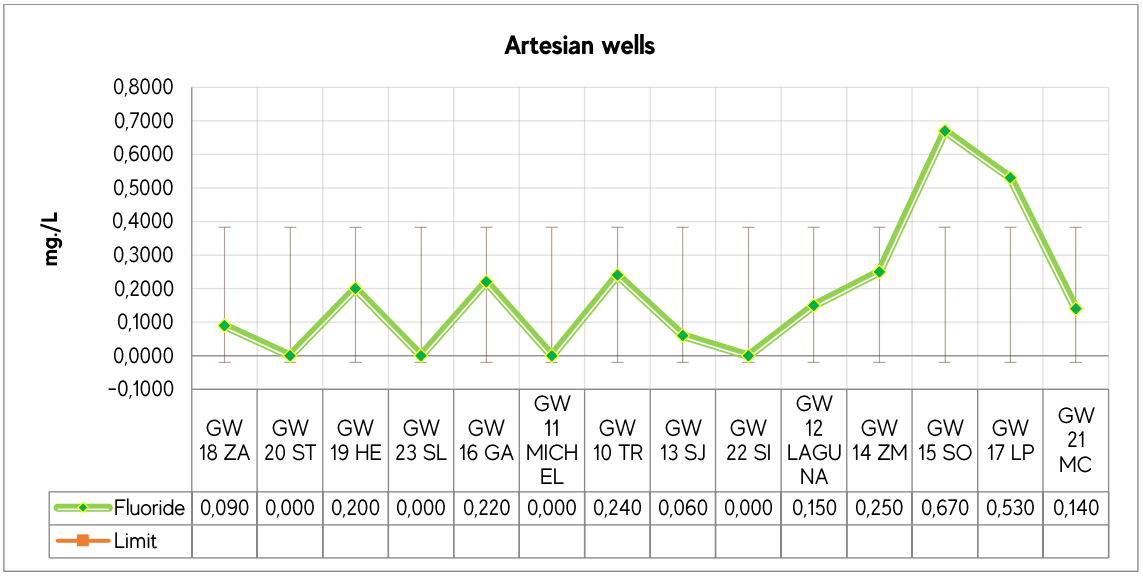


	GW 01	GW 02	GW 04	GW 05	GW 06
Magnesium	16,1	8,07	72,9	6,06	2,73
Limit	50	50	50	50	50

Figure 97. Comparative analysis of magnesium levels measured in monitoring wells at the DAI

In the DAI zone, point GW04 exceeds the limit value established by Law 1614/2000. The average magnesium value in this zone is 21.17 mg/l.

3.4.15 Fluoride

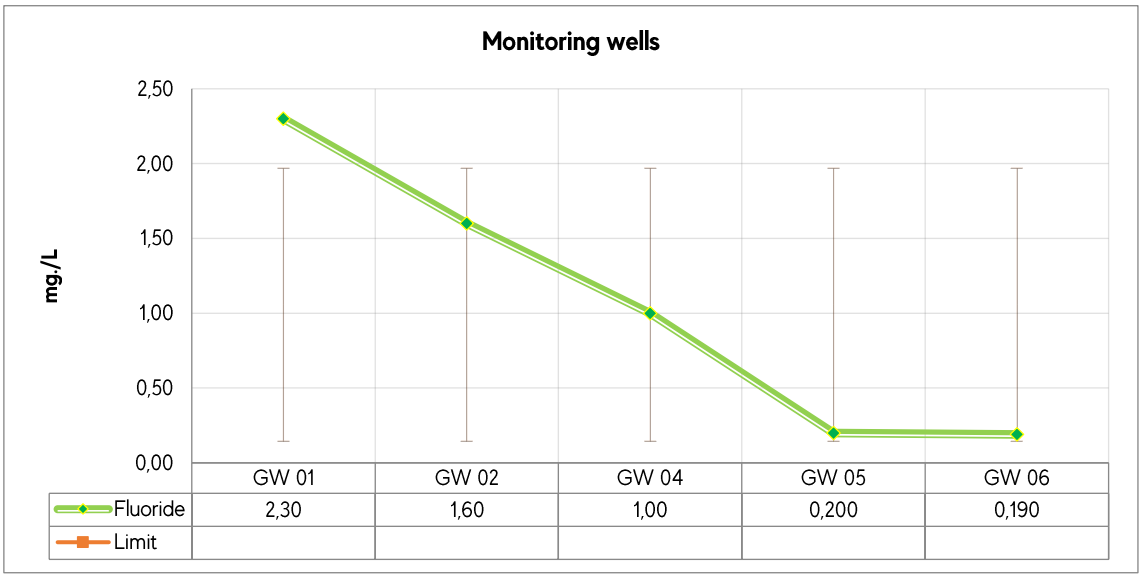


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Fluoride	0,090	0,000	0,200	0,000	0,220	0,000	0,240	0,060	0,000	0,150	0,250	0,670	0,530	0,140
Limit														

Figure 98. Comparative analysis of fluoride levels measured in artesian wells at the forest plantation area

Fluoride is a parameter with no established limits by the legislation.

The average fluoride value, in the forest plantation area, is 0.2 mg/l.



	GW 01	GW 02	GW 04	GW 05	GW 06
Fluoride	2,30	1,60	1,00	0,200	0,190
Limit					

Figure 99. Comparative analysis of fluoride levels measured in monitoring wells at the DAI

In the DAI zone, fluoride has an average concentration of 1.05 mg/l. The highest determination recorded is in well GW01.

3.4.16 Boron

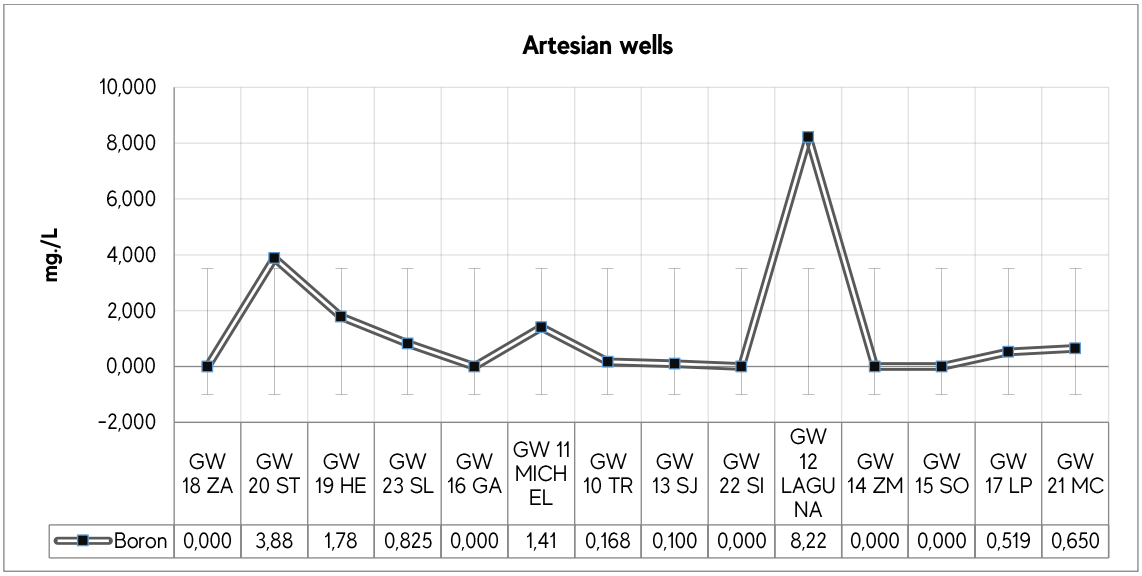


Figure 100. Comparative analysis of boron levels measured in artesian wells at the forest plantation area

In GW 18-ZA, GW 16-GA, GW 13-SJ, GW 22-SI, GW 14-ZM and GW 15-SO, the concentrations of boron are not detectable considering the analytical method's limit of quantification in the water which is 1 mg/L.

The highest result is in well GW 12-LAGUNA; however, this parameter does not have established limits. Statistically, the average boron value is 2 mg/l.

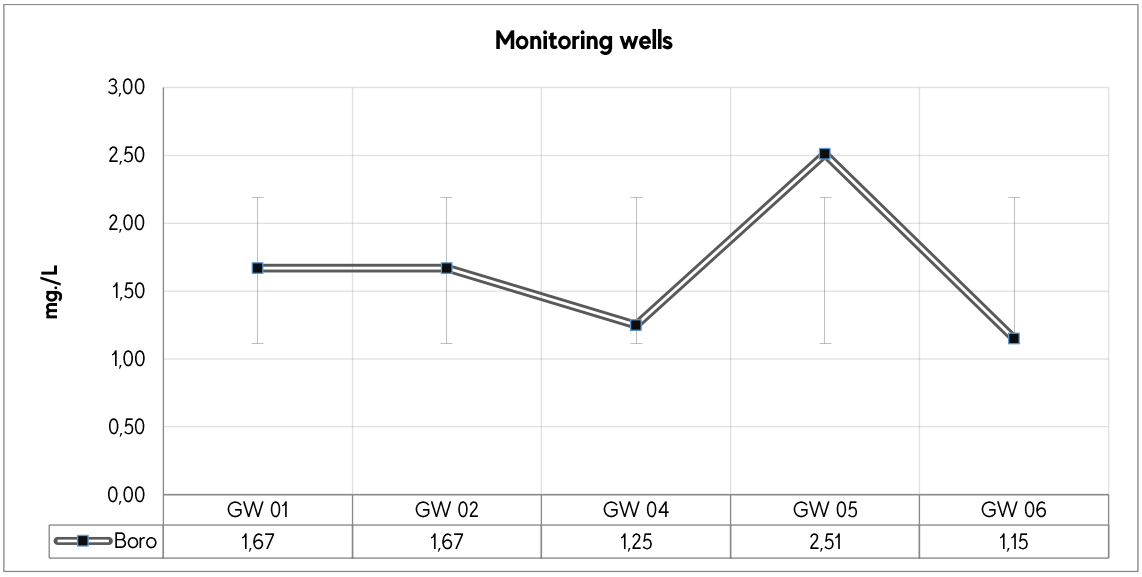
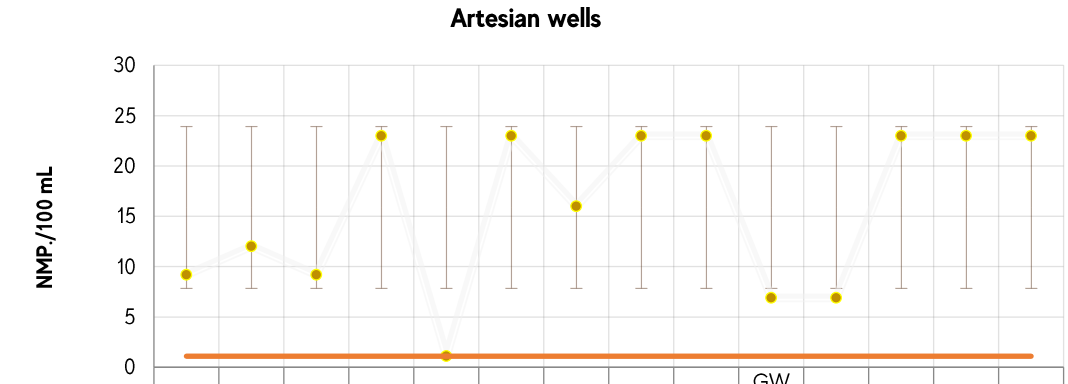


Figure 101. Comparative analysis of boron levels measured in monitoring wells at the DAI

In the DAI zone, Boron values obtained from the samples of the monitoring wells has an average value of 1.65 mg/L.

3.4.17 Faecal coliforms

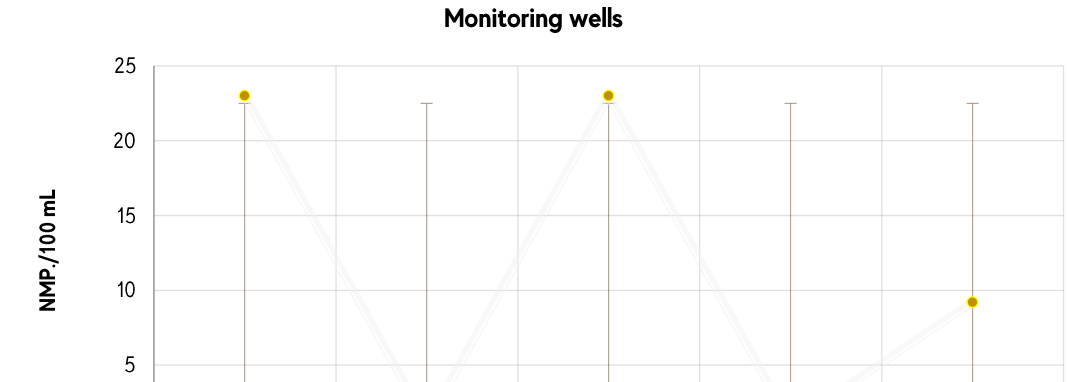


	GW 18 ZA	GW 20 ST	GW 19 HE	GW 23 SL	GW 16 GA	GW 11 MICHEL	GW 10 TR	GW 13 SJ	GW 22 SI	GW 12 LAGUNA	GW 14 ZM	GW 15 SO	GW 17 LP	GW 21 MC
Faecal C	9,2	12	9,2	23	1,1	23	16	23	23	6,9	6,9	23	23	23
Limit	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1	1,1

Figure 102. Comparative analysis of faecal coliforms levels measured in artesian wells at the forest plantation area

Since the water of the artesian wells are for human consumption, the results are compared to the maximum limits set in NP 2400180 norm for faecal coliform.

All the wells located at the forest plantation area have concentrations above the established limit in this campaign. Only GW16-GA does not exceed the maximum value of 1.1 NMP/100ml.



	GW 01	GW 02	GW 04	GW 05	GW 06
Feacal C	23	1,1	23	1,1	9,2
Limit	1,1	1,1	1,1	1,1	1,1

Figure 103. Comparative analysis of faecal coliforms levels measured in monitoring wells at the DAI

In the DAI zone, 3 of the monitoring wells, except GW02 and GW05, have faecal coliform concentrations above the limits.

3.4.17 Total coliforms

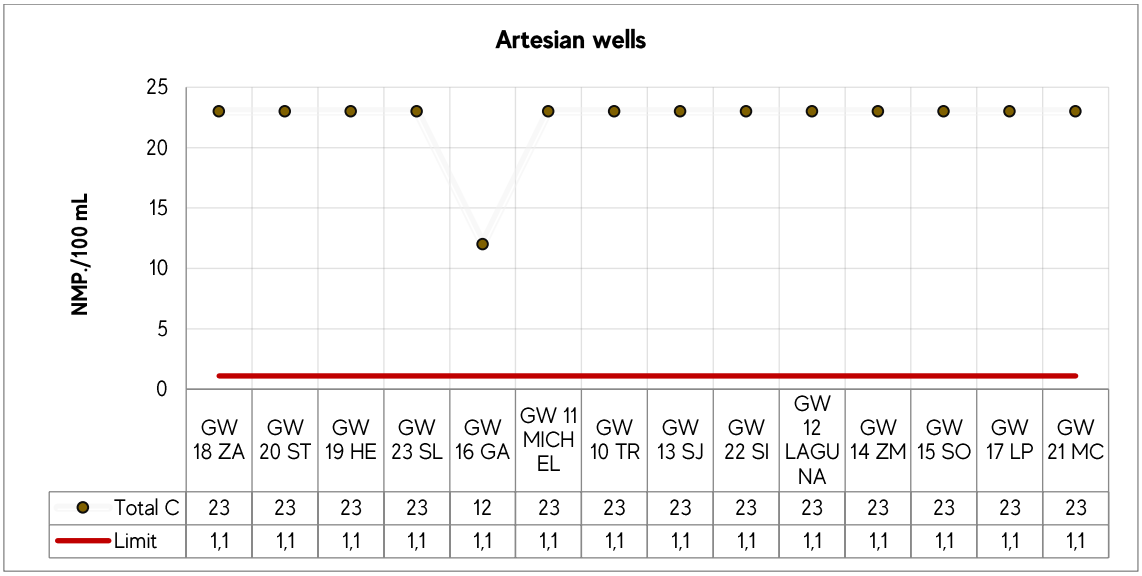


Figure 104. Comparative analysis of total coliforms levels measured in artesian wells at the forest plantation area

Total coliforms values of artesian wells are compared with the limits set by NP 2400180 which establishes a maximum of 1.1 NMP/100ml in water used for human consumption. All the wells art the forest plantation zone exceeds this limit.

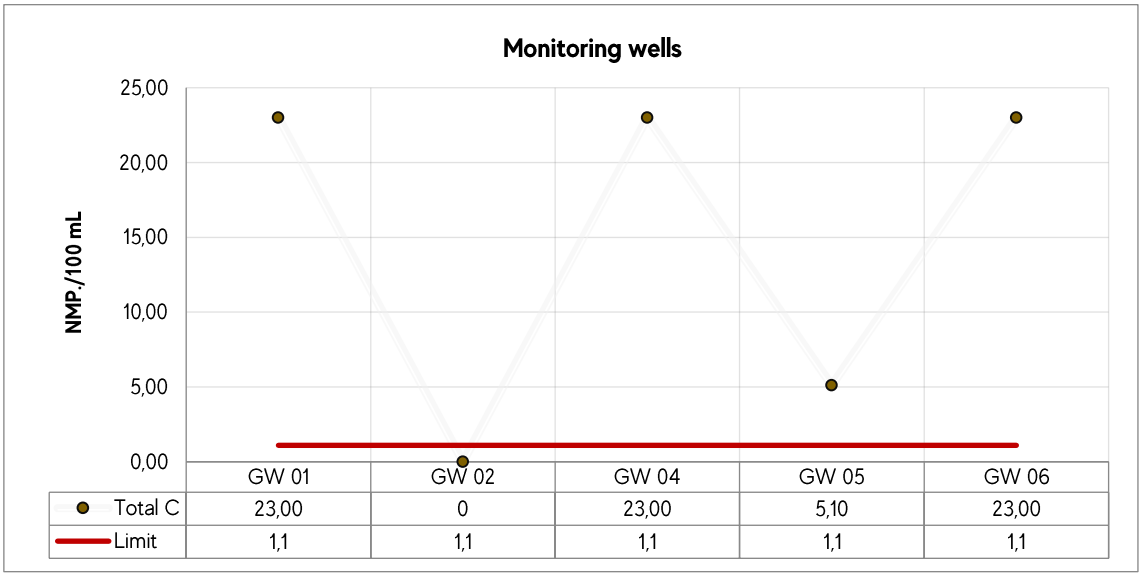


Figure 105. Comparative analysis of total coliforms levels measured in monitoring wells at the DAI

In the DAI zone, all monitoring wells except for GW02 shows concentrations of total coliforms above the established limit.

3.4.18 Escherichia coli

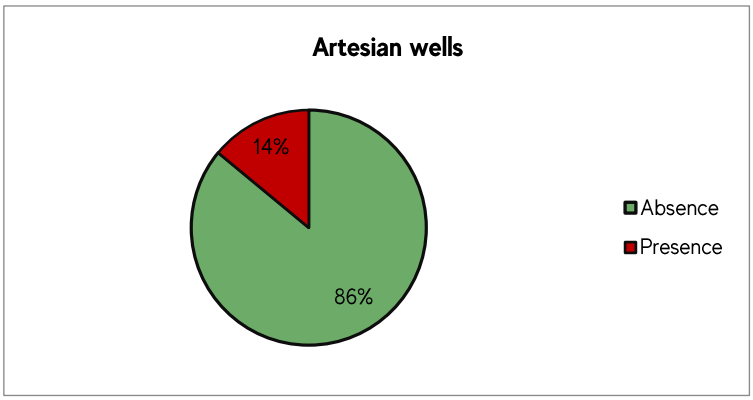


Figure 106. Presence-absence test of *E. coli* in artesian wells at the forest plantation area

According to NP 2400180, *Escherichia coli* bacteria must be absent from water for human consumption. In GW22-SILVA Y GW 23-SL it is found the presence of this bacteria.

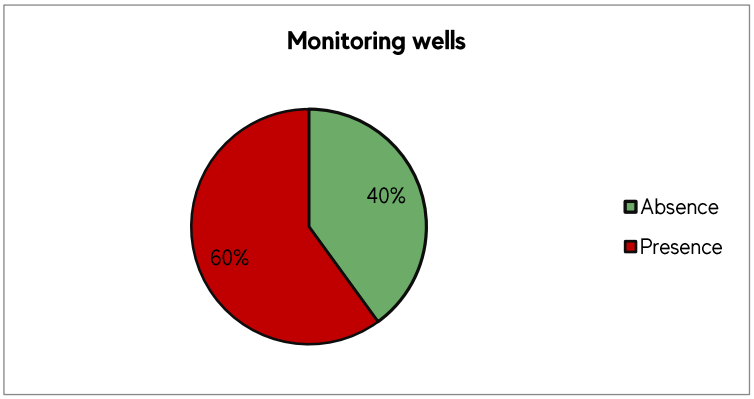


Figure 107. Presence-absence test of *E. coli* in monitoring wells at the DAI

Escherichia coli is found in the following DAI monitoring wells: GW01, GW04, and GW05.

IV. CONCLUSION

This report presents the direct area of influence and indirect area of influence's results of the first water monitoring campaign. According to the consultancy terms, it should be two campaigns to monitor groundwater and surface water quality, one in the rainy season and other in the dry season; the present report corresponds to the first one.

PARACEL provided the coordinates of 40 monitoring points, 20 for surface water and 20 for groundwater. Of the total number, 39 were sampled and analysed and only one monitoring well in the DAI was not sampled since it was not found water (Appendix D. Evidence).

In terms of the parameters defined, a 100% of the parameters for groundwater are reported in this document, as well as 63 of 67 of the parameters established for surface water. Sulfluramide, Bifenthrin, Thiamethoxam y Lambdacyalothrin are the 4 parameters that are not included since these determinations depend on reagents and chemical substances that were not possible to acquire until now due to pandemic (Appendix E. Suppliers note).

According to the terms of reference, Glyphosate, Sulfluramide, Lambdacyhalothrin, Bifenthrin, Thiamethoxam, Carbofuran, Lindane and Fipronil are the parameters to report for the 18 surface water points. However, 22 agrochemicals are included in addition (Table 4).

Laboratories certified by the ONA (National Accreditation Body) are the responsible of the results obtained by analytical determinations. The analysis and evaluation of the results are contrast with the following normative:

- Regulation SEAM Nº 222/02 "BY WHICH THE WATER QUALITY PADRON OF THE NATIONAL TERRITORY IS ESTABLISHED".
- Law 1614/200 - GENERAL LAW ON THE REGULATORY AND TARIFFING FRAMEWORK FOR THE DRINKING WATER AND SANITARY SEWERAGE SERVICE - ANNEX I.
- NP 24 001 80. DRINKING WATER: GENERAL REQUIREMENTS

Regarding the surface water results, the main findings are:

- Of the 63 parameters analysed (physicochemical, agrochemical and bacteriological), 44 have limits established in the regulations while 19 do not.
- Of the 44 parameters with defined limits, 31 (75%) do not show any deviation compared to the regulation's limits and 13 parameters (25%) show values above the maximum allowed in at least one monitoring point.
- During the first monitoring campaign no traces of agrochemicals were found in surface waters. Still, there are pendant determinations as Sulfluramide, Bifenthrin, Thiamethoxam and Lambdacyhalothrin and the only exception is Fipronil at point FW 315-HE.
- The physicochemical parameters that do not have any deviation are (20): floating materials, total dissolved solids (TDS), oils and fats, nitrates, nitrites, hardness, sulphate, sodium, aluminium, cadmium, trivalent chromium, hexavalent chromium, copper, tin, selenium, zinc, arsenic, mercury, barium, cyanide.
- The physicochemical parameters with deviations are (9): pH, Dissolved Oxygen, Turbidity, BOD5, Total Phosphorus, Total Nitrogen, Nickel, Manganese and Lead.

In the case of groundwater, specifically at forest plantation area, the main findings are:

- The 14 artesian wells located in the forest plantation area provides water for human consumption.
- Of the 23 physicochemical and bacteriological parameters evaluated, 18 have limits established in the current regulations, and 5 do not have defined limits.
- Of the 18 parameters with defined limits, 11 (61%) do not show any deviation regarding current regulations and 7 (39%) show values above the maximum permitted in at least one monitoring point.

- The 11 parameters that do not show any deviation in the 14 wells evaluated are electrical conductivity, total dissolved solids, hardness, total nitrogen, chlorides, sulphates, sodium, potassium, calcium, magnesium, fluoride and E coli.
- The parameters deviated from the established limits are pH, total phosphorus, nitrates, alkalinity, faecal coliforms and total coliforms.
- The parameters that most frequently show deviations in the 14 sampled wells are nitrates (42%), total phosphorus (71%), faecal coliforms (92%) and total coliforms (100%).

As for the monitoring wells placed at DAI zone of the future industry, the groundwater main findings are:

- A total of 5 monitoring wells located in the AID were analysed. Unlike the wells in the forest plantation area, these well's purposes are exclusively for monitoring groundwater quality.
- One of the monitoring wells did not have water.
- The parameters results were significantly higher in comparison with the values obtained in the forest plantation zone.

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APPENDIX A:
SURFACE WATER
LABORATORY RESULTS

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A.1 Analytical determinations of point FW104-ZA

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FW 104-ZA			
SAMPLING POINT DATA			
Sampling time:	18:30	Air temperature:	28,5 ºC
Atmospheric conditions:	Cloudy skies, drizzle	Relative humidity:	60%
UTM coordinates:	21K 546639,23 mE; 7513553,82 mS	Elevation:	190 m

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation2 22/02	Alternative reference standards *
1	Water temperature	Tº	ºC	25,2	No limits	
2	Hydrogen potential	pH	---	7,44	6 - 9	
3	Electrical conductivity	σ	µS/cm	62,1	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,88	> 5 mg O_2/L	
5	Turbidity		m	84,0	100 NTU	

TABLE 2. PHYSICOCHEMICAL PARAMETERS – FW 104-ZA						
FW 104-ZA						
PHYSICOCHEMICAL PARAMETER						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
6	Floating materials			**89,0**	Visually absent	
7	Total dissolved solids	TDS	mg/L	62,0	500	
8	Oil and grease		mg/L	**9,70**	Visually absent	
9	Chemical oxygen demand	COD	mg O_2/L	50,4	No limits	[1] <150
10	Biological oxygen demand	BOD5	mg O_2/L	2,33	5	
11	Total phosphorus	P	mg/L	<0,0200	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	3,14	10	
14	Ammonia	NH_3	mg/L	**0,083**	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,0025	1	
16	Hardness		mg $CaCO_3$/L	11,1	300	
17	Sodium	Na	mg/L	2,53	200	
18	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
19	Cyanides		mg/L	<0,02 LOQ	0,2	
20	Copper	Cu	mg/L	<0,0500	1	
21	Soluble iron	Fe^{++}	mg/L	**1,110**	0,3	
22	Aluminium	Al	mg/L	<0,100	0,2	
23	Cadmium	Cd	µg/L	<0,000800	0,001	
24	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
25	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
26	Tin	Sn	mg/L	<1,00	2	
27	Nickel	Ni	mg/L	0,0839	0,025	
28	Manganese	Mn	mg/L	0,0839	0,1	
29	Lead	Pb	mg/L	0,00200	0,01	

30	Selenium	Se	mg/L	0,00500	0,01	
31	Zinc	Zn	mg/L	0,0851	3	
32	Arsenic	As	mg/L	0,0143	0,5	
33	Mercury	Hg	mg/L	0,001	2	
34	Barium	Ba	mg/L	0,07	2	

TABLE 1. TABLE 3. AGROCHEMICAL IN SURFACE WATER – FW 104-ZA							
FW 104-ZA							
AGROCHEMICAL							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atrazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacyalothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLEE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 4. HYDROBIOLOGICAL AND BACTERIOLOGICAL PARAMETERS – FW104-ZA				
FW 104 – ZA – HYDROBIOLOGICAL PARAMETERS				
(Nº 64) PHYTOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
C Y A N O B A C T E R I A **(805)**			**Cylindrospermum sp.**	805
Presence of organic material	+		TOTAL CELLS/mL	805
Presence of sediment	+++		Abundant/dominant organism	Cylindrospermum sp. 100%
Presence of bacteria	+++		Range of risk	Null
Presence of fungal hyphae	X			
CODES				
+(less than half of the field)	**++** (half of the field)		**+++** (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL		Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº 65) ZOOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
Absence of zooplankton.				
Plant remains	No		TOTAL CELLS /mL	Not applicable
Colour	Yellowish		Abundant/dominant organism	Not applicable
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation 222/02**
66	Total coliforms	NMP/100mL	1600	1000 NMP/100mL
67	Faecal coliforms	NMP/100mL	1600	200 NMP/100mL

A2 Analytical determinations of point FW 201-ST

TABLE 5. PARAMETERS MEASURED ON THE SITE – FW 201-ST			
FW 201-ST			
SAMPLING POINT DATA			
Sampling time	13:50	Air temperature	26 ºC
Atmospheric conditions	Cloudy sky, drizzle	Relative humidity	58%
UTM coordinates	21K 543911.54 m E 7497910.60 m S	Elevation	179

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	Tº	ºC	24,4	No limits	
2	Hydrogen potential	pH	---	6,6	6 – 9	
3	Electrical conductivity	σ	µS/cm	40,3	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,21	> 5 mg O_2/L	
5	Turbidity		NTU	61,6	100 NTU	

TABLE 6. PHYSICOCHEMICAL PARAMETERS - FW201-ST						
FW 201-ST						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Alternative reference standards ***
6	Floating materials			62,0	Visually absent	
7	Total dissolved solids	TDS	mg/L	22,5	500	
8	Oil and grease		mg/L	7,50	Visually absent	
9	Chemical oxygen demand	COD	mg O_2/L	42,6	No limits	[1] <150
10	Biological oxygen demand	BOD5	mg O_2/L	1,93	5	
11	Total phosphorus	P	mg/L	<0,0200	0,05	
12	Total nitrogen	N	mg/L	0,108	0,6	
13	Nitrates	NO_3^-	mg/L	3,5	10	
14	Ammonia	NH_3	mg/L	0,0594	0,02	
15	Nitrites	NO_2^-	mg/L	0,0388	1	
16	Hardness		mg $CaCO_3$/L	7,88	300	
17	Sodium	Na	mg/L	2,53	200	
18	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
19	Cyanides		mg/L	<0,02 LOQ	0,2	
20	Copper	Cu	mg/L	<0,0500	1	
21	Soluble iron	Fe^{++}	mg/L	0,935	0,3	
22	Aluminium	Al	mg/L	<0,100	0,2	
23	Cadmium	Cd	µg/L	<0,000800	0,001	
24	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
25	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
26	Tin	Sn	mg/L	<1,00	2	
27	Nickel	Ni	mg/L	<0,01	0,025	
28	Manganese	Mn	mg/L	<0,01	0,1	
29	Lead	Pb	mg/L	0,00337	0,01	

30	Selenium	Se	mg/L	<0,005	0,01	
31	Zinc	Zn	mg/L	<0,0500	3	
32	Arsenic	As	mg/L	0,0132	0,5	
33	Mercury	Hg	mg/L	0,001	2	
34	Barium	Ba	mg/L	0,07	2	

TABLE 7. AGROCHEMICALS IN SURFACE WATER – FW201-ST							
FW 201-ST							
AGROCHEMICAL							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards** *
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atrazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacyalothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLEE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 8. HYDROBIOLOGICAL AND BACTERIOLOGICAL PARAMETERS – FW201-ST

FW 201-ST – HYDROBIOLOGICAL PARAMETERS			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C H L O R O P H Y T A (69)		*Ankistrodesmus sp.*	69
B A C I L L A R I O P H Y T A (46)		*Pennate diatoms*	46
E U G L E N O Z O A (184)		*Euglena sp.*	184
Presence of organic material	+	TOTAL CELLS /mL	**299**
Presence of sediment	+++	Abundant/dominant organism:	*Euglena sp.* 61,5%
Presence of bacteria	+++	Range of risk:	Null
Spicules	X		
CODES			
+(less than half of the field)	**++** (half of the field)	**+++** (whole field)	**X** (se observa en forma esporádica)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº 65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	Not applicable
Colour	Yellowish	Abundant/dominant organism	Not applicable

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	540	200 NMP/100mL
67	Total coliforms	NMP/100mL	540	1000 NMP/100mL

A3 Analytical determinations of point FW 315-HE

TABLE 9. PARAMETERS MEASURED ON THE SITE – FW315-HE			
FW 315-HE			
SAMPLING POINT DATA			
Sampling time	10:30	Air temperature	25 ºC
Atmospheric conditions	Cloudy, rainy all-day	Relative humidity	78%
UTM coordinates	21K 515424,99mE; 7523026,00 mS	Elevation	184

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	Tº	ºC	24,5	No limits	
2	Hydrogen potential	pH	---	6,68	6 - 9	
3	Electrical conductivity	σ	µS/cm	52,1	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,17	> 5 mg O_2/L	
5	Turbidity		NTU	35,0	100 NTU	

TABLE 10. PHYSICOCHEMICAL PARAMETERS - FW 315-HE						
FW 315-HE						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
6	Floating materials			22,4	Visually absent	
7	Total dissolved solids	TDS	mg/L	157	500	
8	Oil and grease		mg/L	16,8	Visually absent	
9	Chemical oxygen demand	COD	mg O_2/L	51,1	No limits	[1] <150
10	Biological oxygen demand	BOD5	mg O_2/L	2,23	5	
11	Total phosphorus	P	mg/L	0,103	0,05	
12	Total nitrogen	N	mg/L	0,734	0,6	
13	Nitrates	NO_{3-}	mg/L	1,07	10	
14	Ammonia	NH_3	mg/L	0,0587	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0136	1	
16	Hardness		mg $CaCO_3$/L	14,1	300	
17	Sodium	Na	mg/L	4	200	
18	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
19	Cyanides		mg/L	<0,02	0,2	
20	Copper	Cu	mg/L	<0,0500	1	
21	Soluble iron	Fe^{++}	mg/L	1,11	0,3	
22	Aluminium	Al	mg/L	<0,1	0,2	
23	Cadmium	Cd	µg/L	<0,0080	0,001	
24	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
25	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
26	Tin	Sn	mg/L	<1,0	2	
27	Nickel	Ni	mg/L	<0,01	0,025	
28	Manganese	Mn	mg/L	0,274	0,1	
29	Lead	Pb	mg/L	0,0085	0,01	
30	Selenium	Se	mg/L	<0,005	0,01	

31	Zinc	Zn	mg/L	<0,0500	3	
32	Arsenic	As	mg/L	<0,0100	0,5	
33	Mercury	Hg	mg/L	0,001	2	
34	Barium	Ba	mg/L	0,09	2	

TABLE 11. AGROCHEMICALS IN SURFACE WATER – FW315-HE							
FW 315-HE							
AGROCHEMICAL							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atrazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacyalothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLEE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	0,03	No limits	

TABLE 12. HYDROBIOLOGICAL AND BACTERIOLOGICAL PARAMETERS – FW 315-HE				
FW 315-HE – HYDROBIOLOGICAL PARAMETERS				
(Nº 64) PHYTOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
C Y A N O B A C T E R I A **(395)**			*Pseudanabaena sp.1*	135
			Pseudanabaena sp.2	180
			Pseudanabaena sp.3	80
B A C I L L A R I O P H Y T A **(20)**			*Pennate diatoms*	20
E U G L E N O Z O A **(10)**			*Euglena sp.*	
Presence of organic material	+		TOTAL CELLS /mL	**425**
Presence of sediment	+++		Abundant/dominant organism	Pseudanabaena sp.2 38,9%
Mushroom spores	x		Range of risk	Null
CODES				
+(less than half of the field)	**++** (half of the field)		**+++** (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL		Alert I – between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº 65) ZOOPLANKTON DIVERSITY				
Type			**Species**	**Measured value (Org/m³)**
COPEPODS			*Harpacticoida sp*	20
Plant remains			TOTAL CELLS /mL	20
Colour			Abundant/dominant organism	*Harpacticoida sp 100%*
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	1200	200 NMP/100mL
67	Total coliforms	NMP/100mL	35000	1000 NMP/100mL

A4 Analytical determinations of point FW304-HE

TABLE 13. PARAMETERS MEASURED ON THE SITE – FW 304-HE.			
FW 304-HE			
SAMPLING POINT DATA			
Sampling time	11:30	Aire temperature	24 ºC
Atmospheric conditions	Cloudy skies, light rain	Relative humidity	76%
UTM coordinates	21K 506172,99 mE; 7509505,00 mS	Elevation	180

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	Tº	ºC	24,4	No limits	
2	Hydrogen potential	pH	---	7,89	6 - 9	
3	Electrical conductivity	σ	µS/cm	294	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	6,76	> 5 mg O_2/L	
5	Turbidity		m	25,6	100 NTU	

TABLE 14. PHYSICOCHEMICAL PARAMETERS – FW304-HE						
FW 304-HE						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
6	Floating materials			18,8	Visually absent	
7	Total dissolved solids	TDS	mg/L	194	500	
8	Oil and grease		mg/L	14,5	Visually absent	
9	Chemical oxygen demand	COD	mg O_2/L	137	No limits	[1] <150
10	Biological oxygen demand	BOD5	mg O_2/L	1,84	5	
11	Total phosphorus	P	mg/L	0,0639	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	0,338	10	
14	Ammonia	NH_3	mg/L	0,0880	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0306	1	
16	Hardness		mg $CaCO_3$/L	108	300	
17	Sodium	Na	mg/L	15,6	200	
18	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
19	Cyanides		mg/L	<0,02	0,2	
20	Copper	Cu	mg/L	<0,0500	1	
21	Soluble iron	Fe^{++}	mg/L	0,913	0,3	
22	Aluminium	Al	mg/L	<0,01	0,2	
23	Cadmium	Cd	µg/L	<0,008	0,001	
24	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
25	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
26	Tin	Sn	mg/L	<1	2	
27	Nickel	Ni	mg/L	<0,01	0,025	
28	Manganese	Mn	mg/L	<0,0500	0,1	
29	Lead	Pb	mg/L	<0,002	0,01	

30	Selenium	Se	mg/L	<0,005	0,01	
31	Zinc	Zn	mg/L	<0,0500	3	
32	Arsenic	As	mg/L	0,0616	0,5	
33	Mercury	Hg	mg/L	0,001	2	
34	Barium	Ba	mg/L	0,17	2	

TABLE 15. AGROCHEMICALS IN SURFACE WATER - FW 304-HE							
FW 304-HE							
AGROCHEMICAL							
GROUP AOX	№	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atrazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacyalothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLEE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 16. HYDROBIOLOGICAL AND BACTERIOLOGICAL PARAMETERS – FW304-HE				
FW 304-HE - HYDROBIOLOGICAL PARAMETERS				
(Nº 64) PHYTOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
C Y A N O B A C T E R I A **(120)**			*Phormidium sp.*	120
B A C I L L A R I O P H Y T A **(15)**			*Gomphonema sp.*	15
E U G L E N O Z O A **(25)**			*Euglena sp.*	25
Presence of organic material	+		TOTAL CELLS /mL	**160**
Presence of sediment	+		Abundant/dominant organism	*Phormidium sp.* 75,0%
			Range of risk	Null
CODES				
+(less than half of the field)	++ (half of the field)		+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL		Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº 65) ZOOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
Absence of zooplankton.				
Plant remains	No		TOTAL CELLS /mL	
Colour	Yellowish		Abundant/dominant organism	
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	330	200 NMP/100mL
67	Total coliforms	NMP/100mL	3500	1000 NMP/100mL

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A.5 Analytical determinations of point FW 100-GASL

TABLE 2. PARAMETERS MEASURED ON THE SITE – FW 100-GASL			
FW 100-GASL			
SAMPLING POINT DATA			
Sampling time		Air temperature	
Atmospheric conditions		Relative humidity	
UTM coordinates		Elevation	

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Alternative reference standards***
1	Water temperature	T_{agua}	ºC	24,9	NO LIMITS	
2	Hydrogen potential	pH	---	7,22	6 - 9	
3	Electrical conductivity	σ	µS/cm	294	NO LIMITS	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	**4,47**	> 5 mg O_2/L	
5	Turbidity		m	8,48	100 NTU	

TABLE 3. PHYSICOCHEMICAL PARAMETERS - FW 100-GASL						
FW 100-GASL						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Alternative reference standards***
6	Floating materials			14,8	Visually absent..	
7	Total dissolved solids	TDS	mg/L	109	500	
8	Oil and grease		mg/L	2,67	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	96,6	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	4,55	5	
11	Total phosphorus	P	mg/L	**0,0586**	0,05	
12	Total nitrogen	N	mg/L	**0,750**	0,6	
13	Nitrates	NO_{3-}	mg/L	<0,0200	10	
14	Ammonia	NH_3	mg/L	**0,0457**	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0179	1	
16	Hardness		mg $CaCO_3$/L	130	300	
17	Sulphates	SO_4^{2-}	mg/L	0,102	250	
18	Sodium	Na	mg/L	16,1	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1	2	
25	Nickel	Ni	mg/L	<0,01	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	0,0518	3	
30	Arsenic	As	mg/L	0,913	0,5	
31	Soluble iron	Fe^{++}	mg/L	**0,550**	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,49	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 4. AGROCHEMICALS IN SURFACE WATER – FW 100-GASL							
AGROCHEMICAL							
GROUP AOX	**Nº**	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLEE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O	µg/L	<0,01	No limits	

TABLE 5. - HYDROBIOLOGICAL PARAMETERS - FW 100-GASL			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Presence of organic material		TOTAL CELLS /mL	
Presence of sediment		Abundant/dominant organism	
		Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton			
Plant remains		TOTAL CELLS /mL	
Colour		Abundant/dominant organism	

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	140	200 NMP/100mL
67	Total coliforms	NMP/100mL	1600	1000 NMP/100mL

A.6 Analytical determinations of point FW 200-SLTR

TABLE 6. PARAMETERS MEASURED ON THE SITE – FW 200-SLTR			
FW 200-SLTR			
SAMPLING POINT DATA			
Sampling time	14:30	Air temperature	28 ºC
Atmospheric conditions	Cloudy, light rain	Relative humidity	83%
UTM coordinates	21K 519072.00 m E; 7494784.00 m S	Elevation	173

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	28,1	NO LIMITS	
2	Hydrogen potential	pH	---	6,01	6 - 9	
3	Electrical conductivity	σ	µS/cm	23,1	NO LIMITS	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	6,73	> 5 mg O_2/L	
5	Turbidity		m	489	100 NTU	

TABLE 7. PHYSICOCHEMICAL PARAMETERS - FW 200-SLTR						
FW 200-SLTR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			149	Visually absent	
7	Total dissolved solids	TDS	mg/L	130	500	
8	Oil and grease		mg/L	10,3	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	72,6	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	4,60	5	
11	Total phosphorus	P	mg/L	0,0334	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	5,52	10	
14	Ammonia	NH_3	mg/L	0,138	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	6,46	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	2,77	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1	2	
25	Nickel	Ni	mg/L	<0,01	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 7. PHYSICOCHEMICAL PARAMETERS - FW 200-SLTR						
FW 200-SLTR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,00947	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0536	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,05	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,13	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 8. AGROCHEMICALS IN SURFACE WATER – FW 200-SLTR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards.***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	

TABLE 8. AGROCHEMICALS IN SURFACE WATER – FW 200-SLTR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 9. HYDROBIOLOGICAL PARAMETERS - FW 200-SLTR			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(276)**		*Pseudanabaena sp.*	276
B A C I L L A R I O P H Y T A **(92)**		Diatomeas pennadas	92
E U G L E N O Z O A **(25)**		*Euglena sp.*	25
Presence of organic material	+	TOTAL CELLS /mL	**393**
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.* 70,2%
		Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton			
Plant remains	No	TOTAL CELLS /mL	n/a
Colour	Yellowish	Abundant/dominant organism	n/a

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	7900	200 NMP/100mL
67	Total coliforms	NMP/100mL	22000	1000 NMP/100mL

A.7 Analytical determinations of point FW 207-TR

TABLE 10. DATOS Y PARAMETERS TOMADOS EN CAMPO FW 207-TR.			
FW 207-TR			
SAMPLING POINT DATA			
Sampling time	15:10	Air temperature	28 ºC
Atmospheric conditions	Cloudy, rainy	Relative humidity	76%
UTM coordinates	21K 518004.00 m E; 7490567.00 m S	Elevation	161

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	26,3	No limits	
2	Hydrogen potential	pH	---	6,56	6 - 9	
3	Electrical conductivity	σ	µS/cm	77,9	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	**2,43**	> 5 mg O_2/L	
5	Turbidity		m	47,4	100 NTU	

TABLE 11. PHYSICOCHEMICAL PARAMETERS - FW 207-TR						
FW 207-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			10,0	Visually absent	
7	Total dissolved solids	TDS	mg/L	120	500	
8	Oil and grease		mg/L	5,50	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	106	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	3,21	5	
11	Total phosphorus	P	mg/L	0,0796	0,05	
12	Total nitrogen	N	mg/L	0,352	0,6	
13	Nitrates	NO_{3-}	mg/L	2,13	10	
14	Ammonia	NH_3	mg/L	0,0687	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	10,9	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	7,53	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 11. PHYSICOCHEMICAL PARAMETERS - FW 207-TR						
FW 207-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0048	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	0,284	3	
30	Arsenic	As	mg/L	0,0190	0,5	
31	Soluble iron	Fe^{++}	mg/L	3,31	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,14	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 12. AGROCHEMICALS IN SURFACE WATER – FW 207-TR							
FW 207 - TR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	

TABLE 12. AGROCHEMICALS IN SURFACE WATER – FW 207-TR							
FW 207 - TR							
AGROCHEMICALS							
GROUP AOX	№	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 13. HYDROBIOLOGICAL PARAMETERS - FW 207-TR			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(1150)**		*Pseudanabaena sp.*	1150
C H L O R O P H Y T A **(322)**		*Chlorococcales coccoides*	322
B A C I L L A R I O P H Y T A **(161)**		*Diatomeas pennadas*	161
C R Y P T O P H Y T A **(23)**		*Cryptomonadales sp*	23
E U G L E N O Z O A **(184)**		*Phacus sp.*	115
		Trachelomonas sp.	69
Presence of organic material	+	TOTAL CELLS /mL	**1840**
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.* 62,5%
		Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(№65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a
Colour	Yellowish	Abundant/dominant organism	n/a

BACTERIOLOGICAL PARAMETERS				
№	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	790	200 NMP/100mL
67	Total coliforms	NMP/100mL	1700	1000 NMP/100mL

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A.8 Analytical determinations of point FW 208-TR

TABLE 14. PARAMETERS MEASURED ON THE SITE - FW 208-TR			
FW 208-TR			
SAMPLING POINT DATA			
Sampling time	7:00	Air temperature	26 ºC
Atmospheric conditions	Sunny with some clouds	Relative humidity	60%
UTM coordinates	21K 514416.00 m E; 7485700.00 m S	Elevation	140

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	21,1	No limits	
2	Hydrogen potential	pH	---	6,88	6 - 9	
3	Electrical conductivity	σ	µS/cm	127	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	**4,30**	> 5 mg O_2/L	
5	Turbidity		m	40,3	100 NTU	

TABLE 15. PHYSICOCHEMICAL PARAMETERS - FW 208-TR						
FW 208-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			5,00	Visually absent..	
7	Total dissolved solids	TDS	mg/L	231	500	
8	Oil and grease		mg/L	8,25	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	81,6	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	3,53	5	
11	Total phosphorus	P	mg/L	<0,0200	0,05	
12	Total nitrogen	N	mg/L	0,748	0,6	
13	Nitrates	NO_{3-}	mg/L	1,37	10	
14	Ammonia	NH_3	mg/L	0,0603	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0203	1	
16	Hardness		mg $CaCO_3$/L	38,4	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	8,84	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	

TABLE 15. PHYSICOCHEMICAL PARAMETERS - FW 208-TR						
FW 208-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
26	Manganese	Mn	mg/L	<0,0500	0,1	
27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0359	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,33	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,13	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 16. AGROCHEMICALS IN SURFACE WATER – FW 208 TR							
FW 208 TR							
AGROCHEMICALS							
AOX GROUP	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limites**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	

	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 17. HYDROBIOLOGICAL PARAMETERS - FW 208-TR			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(135)**		*Pseudanabaena sp.*	135
C H L O R O P H Y T A **(50)**		*Monoraphidium sp.*	50
B A C I L L A R I O P H Y T A **(10)**		*Diatomeas pennadas*	10
C R Y P T O P H Y T A **(5)**		*Cryptomonadales sp*	5
Presence of organic material	+	TOTAL CELLS /mL	**200**
Presence of sediment	+++	Abundant/dominant organism	Pseudanabaena sp. 67,5%
		Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	
Colour	Yellowish	Abundant/dominant organism	

BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	**35000**	200 NMP/100mL
67	Total coliforms	NMP/100mL	**35000**	1000 NMP/100mL

A.9 Analytical determination of point FW205-TR

TABLE 18. PARAMETERS MEASURED ON THE SITE - FW 205-TR.			
FW 205-TR			
SAMPLING POINT DATA			
Sampling time	15:50	Air temperature	26 ºC
Atmospheric conditions	Cloudy, rainy	Relative humidity	80%
UTM coordinates	21K 516574.00 m E; 7482061.00 m S	Elevation	151

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	25,8	No limits	
2	Hydrogen potential	pH	---	7,18	6 - 9	
3	Electrical conductivity	σ	µS/cm	67,9	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,91	> 5 mg O_2/L	
5	Turbidity		m	77,7	100 NTU	

TABLE 19. PHYSICOCHEMICAL PARAMETERS - FW 205-TR						
FW 205-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			82,0	Visually absent	
7	Total dissolved solids	TDS	mg/L	317	500	
8	Oil and grease		mg/L	8,75	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	114	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	5,32	5	
11	Total phosphorus	P	mg/L	0,384	0,05	
12	Total nitrogen	N	mg/L	0,443	0,6	
13	Nitrates	NO_{3-}	mg/L	6,63	10	
14	Ammonia	NH_3	mg/L	0,521	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	13,1	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	8,52	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	0,145	0,025	
26	Manganese	Mn	mg/L	0,127	0,1	

TABLE 19. PHYSICOCHEMICAL PARAMETERS - FW 205-TR						
FW 205-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0085	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0360	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,56	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,35	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 20. AGROCHEMICALS IN SURFACE WATER – FW 205-TR							
FW 205-TR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	

TABLE 20. AGROCHEMICALS IN SURFACE WATER – FW 205-TR							
FW 205-TR							
AGROCHEMICALS							
GROUP AOX	№	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 21. HYDROBIOLOGICAL PARAMETERS - FW 205 TR			
FW 205-TR – HYDROBIOLOGICAL PARAMETERS			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
B A C I L L A R I O P H Y T A **(146)**		*Navicula sp.*	**146**
Presence of organic material	+	TOTAL CELLS /mL	**146**
Presence of sediment	+++	Abundant/dominant organism	*Navicula sp.* 100%
Insect remains	X	Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(№65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
ROTÍFERA **(20)**		*Bdelloidea*	20
Plant remains	No	TOTAL CELLS /mL	**20**
Colour	Yellowish	Abundant/dominant organism	*Bdelloidea* 100%
BACTERIOLOGICAL PARAMETERS			
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	780	200 NMP/100mL
67	Total coliforms	NMP/100mL	7000	1000 NMP/100mL

A.10 Analytical determinations of point FW 109-MYRZ

TABLE 22. PARAMETERS MEASURED ON THE SITE - FW 109-MYRZ			
FW 109-MYRZ			
SAMPLING POINT DATA			
Sampling time	17:45	Air temperature	28ºC
Atmospheric conditions	Cloduy	Relative humidity	68%
UTM coordinates	21K 508110.00 m E; 7475784.00 m S	Elevation	130

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	26,5	NO LIMITS	
2	Hydrogen potential	pH	---	6,52	6 - 9	
3	Electrical conductivity	σ	µS/cm	106	NO LIMITS	[2]<1250
4	Dissolved oxygen	DO	mg O_2/L	**4,58**	> 5 mg O_2/L	
5	Turbidity		m	46,6	100 NTU	

TABLE 23. PHYSICOCHEMICAL PARAMETERS - FW 109-MYRZ						
FW 109-MYRZ						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			19,0	Visually absent..	
7	Total dissolved solids	TDS	mg/L	122	500	
8	Oil and grease		mg/L	10,5	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	56,4	NO LIMITS	[1]<150
10	Biological oxygen demand	DBO_5	mg O_2/L	2,51	5	
11	Total phosphorus	P	mg/L	0,194	0,05	
12	Total nitrogen	N	mg/L	0,132	0,6	
13	Nitrates	NO_{3-}	mg/L	2,18	10	
14	Ammonia	NH_3	mg/L	0,0554	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,0025	1	
16	Hardness		mg $CaCO_3$/L	31,9	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	6,66	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 23. PHYSICOCHEMICAL PARAMETERS - FW 109-MYRZ						
FW 109-MYRZ						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,19	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,13	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 24. AGROCHEMICALS IN SURFACE WATER – FW 109-MYRZ							
FW 109-MYRZ							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	

TABLE 24. AGROCHEMICALS IN SURFACE WATER – FW 109-MYRZ							
FW 109-MYRZ							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 25. HYDROBIOLOGICAL PARAMETERS - FW 109-MYRZ			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(322)**		*Pseudanabaena sp.*	322
C H L O R O P H Y T A **(138)**		*Monoraphidium sp.*	138
B A C I L L A R I O P H Y T A **(184)**		*Diatomeas pennadas*	**184**
Presence of organic material	+	TOTAL CELLS /mL	**644**
Presence of sediment	+	Abundant/dominant organism	*Pseudanabaena sp.* 50,0%
Presence of bacterias	+++	Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Feacal coliforms	NMP/100mL	11000	200 NMP/100mL
67	Total coliforms	NMP/100mL	11000	1000 NMP/100mL

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A.11 Analytical determinations of point FW 115-MY

TABLE 26. PARAMETERS MEASURED ON THE SITE - FW 115-MY			
FW 115-MY			
SAMPLING POINT DATA			
Sampling time	18:40	Air temperature	28,6 ºC
Atmospheric conditions	Cloudy	Relative humidity	70%
UTM coordinates	21K 509155.00 m E; 7467194.00 m S	Eelevation	138

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	26,5	No limits	
2	Hydrogen potential	pH	---	6,94	6 - 9	
3	Electrical conductivity	σ	µS/cm	39,2	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	**4,98**	>5 mg O_2/L	
5	Turbidity		m	83,6	100 NTU	

TABLE 27. PHYSICOCHEMICAL PARAMETERS - FW 115-MY						
FW 115-MY						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
6	Floating materials			54,0	Visually absent	
7	Total dissolved solids	TDS	mg/L	120	500	
8	Oil and grease		mg/L	9,00	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	78,0	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	2,93	5	
11	Total phosphorus	P	mg/L	0,0882	0,05	
12	Total nitrogen	N	mg/L	0,106	0,6	
13	Nitrates	NO_{3-}	mg/L	3,18	10	
14	Ammonia	NH_3	mg/L	0,065	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	4,85	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	4,53	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	

26	Manganese	Mn	mg/L	<0,0500	0,1	
27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,13	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,12	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 28. AGROCHEMICALS IN SURFACE WATER – FW 115-MY

FW 115-MY

AGROCHEMICALS

GROUP AOX	№	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	No limits	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 29. HIDROBIOLÓGICAL PARAMETERS - FW 115-MY			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C H L O R O P H Y T A **(92)**		*Monoraphidium sp.*	92
B A C I L L A R I O P H Y T A (69)		*Diatomeas pennadas*	69
Presence of organic material	+	TOTAL CELLS /mL	**161**
Presence of sediment	+++	Abundant/dominant organism	*Monoraphidium sp.* 57,1%
Insect remain	X	Range of risk	
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit de Medida**	**Determinación**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	390	200 NMP/100mL
67	Total coliforms	NMP/100mL	9000	1000 NMP/100mL

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A.12 Analytical determinations of point FW 317-RZ

TABLE 30. PARAMETERS MEASURED ON THE SITE - FW 317-RZ			
FW 317-RZ			
SAMPLING POINT DATA			
Sampling time	8:20	Air temperature	25,6 ºC
Atmospheric conditions	Partly cloudy	Relative humidity	65%
UTM coordinates	21K 503324.00 m E; 7459243.00 m S	Elevation	116

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	T_{agua}	ºC	21,9	No limits	
2	Hydrogen potential	pH	---	5,67	6 - 9	
3	Electrical conductivity	σ	µS/cm	73,8	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,40	> 5 mg O_2/L	
5	Turbidity		m	96,4	100 NTU	

TABLE 31. PHYSICOCHEMICAL PARAMETERS - FW 317-RZ						
FW 317-RZ						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			51,0	Visually absent..	
7	Total dissolved solids	TDS	mg/L	257	500	
8	Oil and grease		mg/L	11,0	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	96,4	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	1,43	5	
11	Total phosphorus	P	mg/L	0,0299	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	1,01	10	
14	Ammonia	NH_3	mg/L	0,115	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0351	1	
16	Hardness		mg $CaCO_3$/L	21,0	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	5,35	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 31. PHYSICOCHEMICAL PARAMETERS - FW 317-RZ						
FW 317-RZ						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0494	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0132	0,5	
31	Soluble iron	Fe^{++}	mg/L	0,951	0,3	
32	Mercurio	Hg	mg/L	0,001	2	
33	Mercury	Ba	mg/L	0,15	2	
34	Barium	CN^-	mg/L	<0,02	0,07	

TABLE 32. AGROCHEMICALS IN SURFACE WATER – FW 317-RZ							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O	µg/L	<0,01	No limits	

TABLE 33. HIDROBIOLÓGICAL PARAMETERS - FW 317-RZ			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(192)**		*Pseudanabaena sp.*	192
Presence of organic material	+	TOTAL CELLS /mL	**192**
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.* 100%
		Rango de riesgo	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	**330**	200 NMP/100mL
67	Total coliforms	NMP/100mL	**1100**	1000 NMP/100mL

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A.13 Analytical determinations of point FW 204-LB

TABLE 34. PARAMETERS MEASURED ON THE SITE - FW 204-LB			
FW 204-LB			
SAMPLING POINT DATA			
Sampling time	9:30	Air temperature	28 ºC
Atmospheric conditions	Parcialmente nublado	Relative humidity	68%
UTM coordinates	21 K 498840.00 m E; 7451514.00 m S	Elevation	104

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	23,0	NO LIMITS	
2	Hydrogen potential	pH	---	7,0	6 - 9	
3	Electrical conductivity	σ	µS/cm	67,3	NO LIMITS	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,46	>5 mg O_2/L	
5	Turbidity		m	54,7	100 NTU	

TABLE 35. PARAMETERS PHYSICOCHEMICAL FW 204-LB						
FW 204-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			24,0	Visually absent	
7	Total dissolved solids	TDS	mg/L	221	500	
8	Oil and grease		mg/L	13,2	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	77,2	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	2,73	5	
11	Total phosphorus	P	mg/L	0,0211	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	<0,0200	10	
14	Ammonia	NH_3	mg/L	0,226	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0420	1	
16	Hardness		mg $CaCO_3$/L	19,8	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	5,19	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	0,0513	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 35. PARAMETERS PHYSICOCHEMICAL FW 204-LB						
FW 204-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0772	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,14	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,12	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 36. AGROCHEMICALS IN SURFACE WATER – FW 204-LB							
FW 204-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	No limits	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	

TABLE 36. AGROCHEMICALS IN SURFACE WATER – FW 204-LB							
FW 204-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 37. HIDROBIOLÓGICAL PARAMETERS - FW 204-LB			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
B A C I L L A R I O P H Y T A **(391)**		*Diatomeas pennadas*	115
		Gomphonema sp.	92
		Navicula sp.	184
E U G L E N O Z O A **(46)**		*Euglena sp.*	
Presence of organic material	+	TOTAL CELLS /mL	**437**
Presence of sediment	+++	Abundant/dominant organism	*Navicula sp.* *42,1%*
Presence of bacteria	+++	Range of risk	Null
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	**3500**	200 NMP/100mL
67	Total coliforms	NMP/100mL	**16000**	1000 NMP/100mL

A.14 Analytical determinations of point FW 110-LB

TABLE 38. PARAMETERS MEASURED ON THE SITE - FW 110-LB			
FW 110-LB			
SAMPLING POINT DATA			
Sampling time	6:50	Air temperature	23,6 ºC
Atmospheric conditions	Partly cloudy	Relative humidity	58%
UTM coordinates	21K 511487.00 m E; 7450940.00 m S	Elevation	122

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	22,3	No limits	
2	Hydrogen potential	pH	---	6,62	6 - 9	
3	Electrical conductivity	σ	µS/cm	67,2	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	2,38	>5 mg O_2/L	
5	Turbidity		m	46,2	100 NTU	

TABLE 39. PHYSICOCHEMICAL PARAMETERS - FW 110-LB						
FW 110-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			21,0	Visually absent..	
7	Total dissolved solids	TDS	mg/L	188	500	
8	Oil and grease		mg/L	5,25	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	116	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	4,35	5	
11	Total phosphorus	P	mg/L	0,0548	0,05	
12	Total nitrogen	N	mg/L	0,121	0,6	
13	Nitrates	NO_{3-}	mg/L	<0,0200	10	
14	Ammonia	NH_3	mg/L	0,224	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0394	1	
16	Hardness		mg $CaCO_3$/L	11,9	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	5,94	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	0,122	0,1	

TABLE 39. PHYSICOCHEMICAL PARAMETERS - FW 110-LB						
FW 110-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L		0,01	
28	Selenium	Se	mg/L		0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,41	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,05	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 40. AGROCHEMICALS IN SURFACE WATER – FW 110-LB							
FW 110-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	

TABLE 40. AGROCHEMICALS IN SURFACE WATER – FW 110-LB							
FW 110-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O	µg/L	<0,01	No limits	

TABLE 41. HIDROBIOLÓGICAL PARAMETERS - FW 110-LB			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(315)**		*Pseudanabaena sp.1*	65
		Pseudanabaena sp.2	250
B A C I L L A R I O P H Y T A **(15)**		*Diatomeas pennadas*	15
C R Y P T O P H Y T A **(15)**		*Cryptomonadales sp*	15
Presence of organic material	+	TOTAL CELLS /mL	350
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.2* 71,4%
Protists	X	Range of risk	Null.
Rizhopods	X		
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	**4300**	200 NMP/100mL
67	Total coliforms	NMP/100mL	**160000**	1000 NMP/100mL

A.15 Analytical determinations of point FW 111-LB

TABLE 42. PARAMETERS MEASURED ON THE SITE - FW 111-LB			
FW 111-LB			
SAMPLING POINT DATA			
Sampling time	6:00	Air temperature	
Atmospheric conditions	Cloudy	Relative humidity	
UTM coordinates	21 K 514185.37 m E; 7447625.56 m S	Elevation	121

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limites**	
					Regulation 222/02	**Alternative reference standards***
1	Water temperature	T_{agua}	ºC	21,9	No limits	
2	Hydrogen potential	pH	---	5,91	6 - 9	
3	Electrical conductivity	σ	µS/cm	60,5	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,91	>5 mg O_2/L	
5	Turbidity		m	35,7	100 NTU	

TABLE 43. PHYSICOCHEMICAL PARAMETERS - FW 111-LB						
FW 111-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Alternative reference standards***
6	Floating materials			116	Visually absent	
7	Total dissolved solids	TDS	mg/L	163	500	
8	Oil and grease		mg/L	3,75	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	99,0	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	2,15	5	
11	Total phosphorus	P	mg/L	0,114	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	1,56	10	
14	Ammonia	NH_3	mg/L	0,331	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	16,8	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	3,32	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	0,400	0,1	

TABLE 43. PHYSICOCHEMICAL PARAMETERS - FW 111-LB						
FW 111-LB						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	<0,002	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,56	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,15	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 44. AGROCHEMICALS IN SURFACE WATER – FW 111-LB							
FW 111-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	No limits	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	

TABLE 44. AGROCHEMICALS IN SURFACE WATER – FW 111-LB							
FW 111-LB							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 45. HIDROBIOLÓGICAL PARAMETERS - FW 111-LB				
(Nº 64) PHYTOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
B A C I L L A R I O P H Y T A (207)			*Diatomeas pennadas*	207
Presence of organic material	+		TOTAL CELLS /mL	**207**
Presence of sediment	+++		Abundant/dominant organism	*Diatomeas pennadas* 100%
			Rango de riesgo	Null
CODES				
+(less than half of the field)	++ (half of the field)		+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL		Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
Absence of zooplankton.				
Plant remains	No		TOTAL CELLS /mL	N/a.
Colour	Yellowish		Abundant/dominant organism	N/a.
BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	490	200 NMP/100mL
67	Total coliforms	NMP/100mL	1400	1000 NMP/100mL

A.16 Analytical determinations of point FW 310-CR

TABLE 46. PARAMETERS MEASURED ON THE SITE - FW 310-CR			
FW 310-CR			
SAMPLING POINT DATA			
Sampling time	18:20	Air temperature	
Atmospheric conditions	Cloudy	Relative humidity	
UTM coordinates	21 K 487444.00 m E; 7449950.00 m S	Elevation	110

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	T_{agua}	ºC	23,7	No limits	
2	Hydrogen potential	pH	---	7,21	6 - 9	
3	Electrical conductivity	σ	µS/cm	559	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,59	> 5 mg O_2/L	
5	Turbidity		m	355	100 NTU	

TABLE 47. PHYSICOCHEMICAL PARAMETERS FW 310-CR						
FW 310-CR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			155	Visually absent	
7	Total dissolved solids	TDS	mg/L	169	500	
8	Oil and grease		mg/L	8,80	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	85,5	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	5,51	5	
11	Total phosphorus	P	mg/L	0,0518	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	2,58	10	
14	Ammonia	NH_3	mg/L	0,150	0,02	
15	Nitrites	NO_{2-}	mg/L	0,182	1	
16	Hardness		mg $CaCO_3$/L	18,0	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	2,94	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,0	2	
25	Nickel	Ni	mg/L	<0,01	0,025	
26	Manganese	Mn	mg/L	0,341	0,1	

TABLE 47. PHYSICOCHEMICAL PARAMETERS FW 310-CR						
FW 310-CR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,00407	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	2,36	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,14	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 48. AGROCHEMICALS IN SURFACE WATER – FW 310-CR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards ***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 49. HYDROBIOLOGICAL PARAMETERS - FW 310-CR				
(Nº 64) PHYTOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
B A C I L L A R I O P H Y T A **(184)**			*Synedra sp.*	184
Presence of organic material	+		TOTAL CELLS /mL	**184**
Presence of sediment	+++		Abundant/dominant organism	*Synedra sp.* 100%
			Range of risk	Null
CODES				
+(less than half of the field)	++ (half of the field)		+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL		Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY				
Type			**Species**	**Measured value**
Absence of zooplankton.				
Plant remains	No		TOTAL CELLS /mL	n/a.
Colour	Yellowish		Abundant/dominant organism	n/a.
BACTERIOLÓGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	11000	200 NMP/100mL
67	Total coliforms	NMP/100mL	11000	1000 NMP/100mL

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A.17 Analytical determinations of point FW 316-CR

TABLE 50. PARAMETERS MEASURED ON THE SITE - FW 316-CR			
FW 316-CR			
SAMPLING POINT DATA			
Sampling time	18:50	Air temperature	
Atmospheric conditions	Rainy	Relative humidity	
UTM coordinates	21K 485341.00 m E; 7442662.00 m S	Topographical elevation	110

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	25,7	No limits	
2	Hydrogen potential	pH	---	6,82	6 - 9	
3	Electrical conductivity	σ	µS/cm	44,8	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	5,08	> 5 mg O_2/L	
5	Turbidity		m	18,6	100 NTU	

TABLE 51. PHYSICOCHEMICAL PARAMETERS - FW 316-CR						
FW 316-CR						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			26,0	Visually absent..	
7	Total dissolved solids	TDS	mg/L	127	500	
8	Oil and grease		mg/L	7,25	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	65,9	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	5,05	5	
11	Total phosphorus	P	mg/L	0,0435	0,05	
12	Total nitrogen	N	mg/L	0,779	0,6	
13	Nitrates	NO_{3-}	mg/L	0,231	10	
14	Ammonia	NH_3	mg/L	0,0331	0,02	
15	Nitrites	NO_{2-}	mg/L	0,00778	1	
16	Hardness		mg $CaCO_3$/L	8,69	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	3,50	200	
19	Aluminum	Al	mg/L	<01,00	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	<0,0500	0,1	

TABLE 51. PHYSICOCHEMICAL PARAMETERS - FW 316-CR						
FW 316-CR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0134	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	0,991	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,05	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 52. AGROCHEMICALS IN SURFACE WATER – FW 316-CR							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 53. HIDROBIOLÓGICAL PARAMETERS - FW 316-CR			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A **(50)**		*Pseudanabaena sp.*	50
C H L O R O P H Y T A **(35)**		*Monoraphidium sp.*	35
B A C I L L A R I O P H Y T A **(10)**		*Diatomeas pennadas*	10
C R Y P T O P H Y T A **(20)**		*Cryptomonadales*	20
Presence of organic material	+	TOTAL CELLS /mL	115
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.* 43,5%
Presence of nematodes	X	Range of risk	Null.
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	n/a.
Colour	Yellowish	Abundant/dominant organism	n/a.

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	46	200 NMP/100mL
67	Total coliforms	NMP/100mL	540	1000 NMP/100mL

A.18 Analytical determinations of point FW 306-SO

TABLE 54. PARAMETERS MEASURED ON THE SITE FW 306-SO			
FW 306-SO			
SAMPLING POINT DATA			
Sampling time	14:30	Air temperature	
Atmospheric conditions	Cloudy	Relative humidity	
UTM coordinates	21K 486496.00 m E, 7493077.00 m S	Elevation	176

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
1	Water temperature	T_{agua}	ºC	23,1	No limits	
2	Hydrogen potential	pH	---	7,81	6 - 9	
3	Electrical conductivity	σ	µS/cm	213	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,47	> 5 mg O_2/L	
5	Turbidity		m	90,8	100 NTU	

TABLE 55. PHYSICOCHEMICAL PARAMETERS - FW 306-SO						
FW 306-SO						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards *
6	Floating materials			63,0	Visually absent..	
7	Total dissolved solids	TDS	mg/L	263	500	
8	Oil and grease		mg/L	10,5	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	58,6	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	4,35	5	
11	Total phosphorus	P	mg/L	0,0208	0,05	
12	Total nitrogen	N	mg/L	<0,100	0,6	
13	Nitrates	NO_{3-}	mg/L	1,10	10	
14	Ammonia	NH_3	mg/L	0,0872	0,02	
15	Nitrites	NO_{2-}	mg/L	<0,00250	1	
16	Hardness		mg $CaCO_3$/L	80,6	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	8,36	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	0,0571	0,1	

TABLE 55. PHYSICOCHEMICAL PARAMETERS - FW 306-SO						
FW 306-SO						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0229	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	<0,0500	3	
30	Arsenic	As	mg/L	0,0539	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,02	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,13	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	

TABLE 56. AGROCHEMICALS IN SURFACE WATER – FW 306-SO							
FW 306-SO							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	35	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	36	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	37	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	38	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	39	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	40	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	41	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	42	DDT	C10H6Cl8	µg/L	<2,00	2	
	43	DDE	--	µg/L	<2,00	No limits	
	44	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	45	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	46	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	47	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	48	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	49	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	50	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	51	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	52	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	53	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	54	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	55	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	56	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	57	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	58	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	59	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	60	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	61	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	

TABLE 56. AGROCHEMICALS IN SURFACE WATER – FW 306-SO							
FW 306-SO							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
FLUORATED	62	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	63	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

TABLE 57. HIDROBIOLÓGICAL PARAMETERS - FW 306-SO			
(Nº 64) PHYTOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
C Y A N O B A C T E R I A (345)		*Pseudanabaena sp.*	345
C H L O R O P H Y T A (184)		*Monoraphidium sp.*	184
B A C I L L A R I O P H Y T A (230)		*Diatomeas pennadas*	230
Presence of organic material	+	TOTAL CELLS /mL	759
Presence of sediment	+++	Abundant/dominant organism	*Pseudanabaena sp.* 45,5%
Fungal spores	X	Range of risk	Null.
CODES			
+(less than half of the field)	++ (half of the field)	+++ (whole field)	**X** (sporadically observed)
Risk level (UNESCO)	Null until 10.000 Cel/mL	Alert I - between 10.000 to 20.000 Cel/mL	Alert II More than 20.000 Cel/mL
(Nº65) ZOOPLANKTON DIVERSITY			
Type		**Species**	**Measured value**
Absence of zooplankton.			
Plant remains	No	TOTAL CELLS /mL	N/a.
Colour	Yellowish	Abundant/dominant organism	N/a.

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
66	Faecal coliforms	NMP/100mL	540	200 NMP/100mL
67	Total coliforms	NMP/100mL	920	1000 NMP/100mL

A.19 Analytical determinations of point FW 01

TABLE 58. PARAMETERS MEASURED ON THE SITE FW 01			
FW 01 - PY			
SAMPLING POINT DATA			
Sampling time	10:20	Air temperature	
Atmospheric conditions	Soleado	Relative humidity	
UTM coordinates	21K 446252.08 m E 7428199.87 m S	Elevation	85

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	26,0	No limits	
2	Hydrogen potential	pH	---	7,26	6 - 9	
3	Electrical conductivity	σ	µS/cm	169	No limits	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,03	>5 mg O_2/L	
5	Turbidity		m	41,2	100 NTU	

TABLE 59. PHYSICOCHEMICAL PARAMETERS FW 01						
FW 01 - PY						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Alternative reference standards***
6	Floating materials			22,4	Visually absent	
7	Total dissolved solids	TDS	mg/L	115	500	
8	Oil and grease		mg/L	8,00	Visually absent	
9	Chemical oxygen demand	DQO	mg O_2/L	34,9	No limits	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	1,50	5	
11	Total phosphorus	P	mg/L	0,0694	0,05	
12	Total nitrogen	N	mg/L	1,77	0,6	
13	Nitrates	NO_{3-}	mg/L	<0,100	10	
14	Ammonia	NH_3	mg/L	0,0989	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0153	1	
16	Hardness		mg $CaCO_3$/L	30,5	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	16,7	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	0,113	0,1	

TABLE 59. PHYSICOCHEMICAL PARAMETERS FW 01						
FW 01 - PY						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,00219	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	0,0694	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	1,52	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,05	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	
ADDITIONAL PARAMETERS DETERMINED IN PARAGUAY RIVER						
35	Colour		Pt/L	23	75	
36	Phenols index		mg/L	<0,00500	0,5	
37	PCBs		mg/L	Not detected.	0	

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
38	Faecal coliforms	NMP/100mL	33	200 NMP/100mL
39	Total coliforms	NMP/100mL	130	1000 NMP/100mL

TABLE 60. AGROCHEMICALS IN SURFACE WATER – FW PY 01							
FW PY 01							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	40	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	41	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	42	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	43	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	44	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	45	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	46	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	47	DDT	C10H6Cl8	µg/L	<2,00	2	
	48	DDE	--	µg/L	<2,00	No limits	
	49	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	50	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	51	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	52	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	53	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	54	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	55	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	56	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	57	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	
	58	Bifenthrin	C23H22	µg/L	--	No limits	

TABLE 60. AGROCHEMICALS IN SURFACE WATER – FW PY 01							
FW PY 01							
AGROCHEMICALS							
GROUP AOX	№	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
			ClF3NO2				
	59	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	60	Chlorpyrifos	C9H11Cl3NO3PS	µg/L	<5,00	No limits	
	61	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	62	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	63	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	64	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	65	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	66	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	67	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	68	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

A.20 Analytical determinations of point FW 02

TABLE 61. PARAMETERS MEASURED ON THE SITE - FW02			
FW 02 - PY			
SAMPLING POINT DATA			
Sampling time	9:30	Air temperature	
Atmospheric conditions	Sunny	Relative humidity	
UTM coordinates	21K 449651.97 m E 7424489.86 m S	Elevation	81

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limites	
					Regulation 222/02	Alternative reference standards*
1	Water temperature	T_{agua}	ºC	25,0	NO LIMITS	
2	Hydrogen potential	pH	---	7,29	6 - 9	
3	Electrical conductivity	σ	µS/cm	172	NO LIMITS	[2] <1500
4	Dissolved oxygen	DO	mg O_2/L	7,26	> 5mg O_2/L	
5	Turbidity		m	44,6	100 NTU	

.

TABLE 62. PHYSICOCHEMICAL PARAMETERS - FW 02						
FW 02 - PY						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Alternative reference standards*
6	Floating materials			22,8	Visually absent..	
7	Total dissolved solids	TDS	mg/L	151	500	
8	Oil and grease		mg/L	4,50	Visually absent.	
9	Chemical oxygen demand	DQO	mg O_2/L	44,3	NO LIMITS	[1] <150
10	Biological oxygen demand	DBO_5	mg O_2/L	1,11	5	
11	Total phosphorus	P	mg/L	0,0305	0,05	
12	Total nitrogen	N	mg/L	2,43	0,6	
13	Nitrates	NO_{3-}	mg/L	<0,100	10	
14	Ammonia	NH_3	mg/L	0,0441	0,02	
15	Nitrites	NO_{2-}	mg/L	0,0186	1	
16	Hardness		mg $CaCO_3$/L	30,1	300	
17	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
18	Sodium	Na	mg/L	16,6	200	
19	Aluminum	Al	mg/L	<0,01	0,2	
20	Cadmium	Cd	mg/L	<0,0008	2	
21	Hexavalent chromium	Cr (VI)	mg/L	<0,0500	0,05	
22	Trivalent chromium	Cr (III)	mg/L	<0,0500	0,5	
23	Copper	Cu	mg/L	<0,0500	1	
24	Tin	Sn	mg/L	<1,00	2	
25	Nickel	Ni	mg/L	<0,001	0,025	
26	Manganese	Mn	mg/L	0,144	0,1	

TABLE 62. PHYSICOCHEMICAL PARAMETERS - FW 02						
FW 02 - PY						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured**	**Limits**	
27	Lead	Pb	mg/L	0,0041	0,01	
28	Selenium	Se	mg/L	<0,005	0,01	
29	Zinc	Zn	mg/L	0,0983	3	
30	Arsenic	As	mg/L	<0,0100	0,5	
31	Soluble iron	Fe^{++}	mg/L	0,804	0,3	
32	Mercury	Hg	mg/L	0,001	2	
33	Barium	Ba	mg/L	0,05	2	
34	Cyanides	CN^-	mg/L	<0,02	0,07	
ADDITIONAL PARAMETERS DETERMINED IN PARAGUAY RIVER						
35	Colour	--	Pt/L	30,0	75	
36	Phenols index	--	mg/L	<0,00500	0,5	
37	PCBs	--	mg/L	Not detected.	0	

BACTERIOLOGICAL PARAMETERS				
Nº	**Parameters**	**Unit**	**Measured value**	**Regulation 222/02**
38	Faecal coliforms	NMP/100mL	2	200 NMP/100mL
39	Total coliforms	NMP/100mL	33	1000 NMP/100mL

TABLE 63. AGROCHEMICALS IN SURFACE WATER – FW 02 - PY							
FW 02 - PY							
AGROCHEMICALS							
GROUP AOX	Nº	**Parameter**	**Chemical formula**	**Unit**	**Measured value**	**Limits**	
						Regulation 222/02	**Alternative reference standards***
PHOSPHOGLYCINE	40	Glyphosate	C3H8NO6P	µg/L	<0,300	0,7	
	41	AMPA	CH6NO3P	µg/L	<0,300	No limits	
CHLORDANE	42	Aldrin	C12H8Cl6	µg/L	<1,00	No limits	
	43	Endrin	C12H8Cl6O	µg/L	<1,25	2	
	44	Dieldrin	C12H8Cl6O	µg/L	<1,50	No limits	
	45	Lindane	C6H6Cl6	µg/L	<0,2	0,2	
	46	Chlordane	C10H6Cl8	µg/L	<0,90	No limits	
	47	DDT	C10H6Cl8	µg/L	<2,00	2	
	48	DDE	--	µg/L	<2,00	No limits	
	49	DDD	--	µg/L	<2,00	No limits	
TRIAZINE	50	Atriazine	C8H14ClN5	µg/L	<2,00	3	
	51	Simazine	C7H12ClN5	µg/L	<2,50	4	
CARBAMATE	52	Carbaryl	C12H11NO2	µg/L	<3,50	No limits	
	53	Carbofuran	C12H15NO3	µg/L	<3,00	4	
	54	Heptachlor	C10H5Cl7	µg/L	<1,50	0	
	55	Methomyl	C5H10N2O2S	µg/L	<25,0	No limits	
ALKYLCHLORO-PHENOXY	56	2,4 D	C8H6Cl2O3	µg/L	<2,50	30	
PYRETHROIDS	57	Lambdacialothrin	$C_{23}H_{19}ClF_3NO_3$	µg/L	--	No limits	

TABLE 63. AGROCHEMICALS IN SURFACE WATER – FW 02 - PY							
FW 02 - PY							
AGROCHEMICALS							
GROUP AOX	№	**Parameter**	**Chemical**	**Unit**	**Measured**	**Limits**	
	58	Bifenthrin	C23H22 ClF3NO2	µg/L	--	No limits	
	59	Cypermethrin	C22H19Cl2NO3	µg/L	<1,20	No limits	
	60	Chlorpyrifos	C9H11Cl3NO3P S	µg/L	<5,00	No limits	
	61	Dichlorvos	C4H7Cl2O4P	µg/L	<10,0	10	
	62	Methamidophos	C2H8NO2PS	µg/L	<25,0	No limits	
TRIAZOLE	63	Tebuconazole	C16H22ClN3O	µg/L	<2,00	1	
NEONICOTINOID	64	Imidacloprid	C9H10ClN5O2	µg/L	<5,00	No limits	
	65	Methylparaoxon	C8H10NO6P	µg/L	<25,0	No limits	
	66	Thiamethoxam	C10H6F17NO2S	µg/L	--	No limits	
FLUORATED	67	Sulfluramide	C10H6F17NO2S	µg/L	--	No limits	
PHENYLPYRAZOLES	68	Fipronil	C12H4Cl2F6N4O.	µg/L	<0,01	No limits	

*Alternative reference standards refers to other national water quality standards, such as Law 1614/200 and NP 24001/80, as well as IFC EHS Guidelines.

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APPENDIX B
GROUNDWATER LABORATORY RESULTS

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B1. Analytical determinations of the sampling point GW 18-ZA

TABLE 1. PARAMETERS MEASURED ON THE SITE - GW 18-ZA			
GW 18-ZA			
SAMPLING POINT DATA			
Sampling time	15:10	Air temperature	25,9 ºC
Atmospheric conditions	Cloudy, drizzle	Relative humidity	80%
UTM coordinates	21K 548201.00 m E; 7512128.00 m S	Elevation	211
Water level	No data	Water table	No data

IN SITU MEASUREMENT						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	25,9	No limits	
2	Hydrogen potential	pH		6,63	6-9	
3	Electrical conductivity	σ	µS/cm	143	-	1250

TABLE 2. PHYSICOCHEMICAL PARAMETERS - GW 18-ZA						
GW 18-ZA						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	200	500	
5	Organic matter	OM	mg O_2/L	0,848	No limits	
6	Hardness	---	mg $CaCO_3$/L	12,5	300	
7	Total phosphorus	P	mg/L	0,352	0,05	
8	Total nitrogen	N	mg/L	0,363	0,6	
9	Nitrates	NO_{3-}	mg/L	10,5	10	
10	Chlorides	Cl-	mg/L	3,09	-	250
11	Alkalinity	---	mg $CaCO_3$./L	76,2	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	49,5	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	3,31	250	
15	Sodium	Na	mg/L	30,8	200	
16	Potasium	K	mg/L	1,27	-	12
17	Calcium	Ca	mg/L	3,23	-	100
18	Magnesium	Mg	mg/L	1,08	-	50
19	Fluorine	F	mg/L	0,09	-	1,5
20	Boron	B	mg/L	<0,100	No limits	

TABLE 3. BACTERIOLOGICAL PARAMETERS				
GW 18-ZA				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	16	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B2. Analytical determinations of sampling point GW20-ST

TABLE 4. PARAMETERS MEASURED ON THE SITE - GW 20-ST			
GW 20-ST			
SAMPLING POINT DATA			
Sampling time	13:00	Air temperature	28,5 ºC
Atmospheric conditions	Nublado	Relative humidity	60%
UTM coordinates	21K 537999.00 m E; 7498476.00 m S	Elevation	186
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	27,3	No limits	
2	Hydrogen potential	pH	--	5,63	6-9	
3	Electrical conductivity	σ	µS/cm	95,7	-	1250

TABLE 5. PHYSICOCHEMICAL PARAMETERS - GW 20-ST						
GW 20-ST						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	100	500	
5	Organic matter	OM	mg O_2/L	0,173	No limits	
6	Hardness	---	mg $CaCO_3$/L	0,808	300	
7	Total phosphorus	P	mg/L	0,0263	0,05	
8	Total nitrogen	N	mg/L	0,182	0,6	
9	Nitrates	NO_{3-}	mg/L	22,8	10	
10	Chlorides	Cl-	mg/L	8,08	-	250
11	Alkalinity	---	mg $CaCO_3$./L	47,9	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	6,71	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	2,66	250	
15	Sodium	Na	mg/L	8,78	200	
16	Potasium	K	mg/L	0,982	-	12
17	Calcium	Ca	mg/L	1,94	-	100
18	Magnesium	Mg	mg/L	<0,243	-	50
19	Fluorine	F	mg/L	<0,05	-	1,5
20	Boron	B	mg/L	3,88	No limits	

TABLE 6. BACTERIOLOGICAL PARAMETERS - GW 20-S				
GW 20-ST				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	12	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B3. Analytical determinations of sampling point GW 19-HE

TABLE 7. PARAMETERS MEASURED ON THE SITE - GW 19-HE			
GW 19-HE			
SAMPLING POINT DATA			
Sampling time	12:20	Air temperature	28 ºC
Atmospheric conditions	Cloudy, drizzle	Relative humidity	76%
UTM coordinates	21K 512695.00 m E; 7515558.00 m S	Elevation	230
Water level	No data	Water table	No data

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
1	Water temperature	Tº	ºC	25,8	No limits	
2	Hydrogen potential	pH		7,83	6-9	
3	Electrical conductivity	σ	µS/cm	197	-	1250

TABLE 8. PHYSICOCHEMICAL PARAMETERS - GW 19-HE						
GW 19-HE						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
4	Total dissolved solids	TDS	mg/L	160	500	
5	Organic matter	OM	mg O_2/L	0,134	No limits	
6	Hardness	---	mg $CaCO_3$/L	35,6	300	
7	Total phosphorus	P	mg/L	0,577	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_3^-	mg/L	1,93	10	
10	Chlorides	Cl-	mg/L	1,43	-	250
11	Alkalinity	---	mg $CaCO_3$./L	79,7	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	78,1	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	2,96	250	
15	Sodium	Na	mg/L	31,8	200	
16	Potasium	K	mg/L	1,41	-	12
17	Calcium	Ca	mg/L	12,3	-	100
18	Magnesium	Mg	mg/L	1,15	-	50
19	Fluorine	F	mg/L	0,20	-	1,5
20	Boron	B	mg/L	1,78	No limits	

TABLE 9. BACTERIOLOGICAL PARAMETERS - GW 19-HE				
BACTERIOLOGICAL PARAMETERS - GW 19-HE				
Nº	Parameter	Unit	Measured value	Regulation NP 2400180 limits
2	Faecal coliforms	NMP/100mL	9,2	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B4. Analytical determinations of sampling point GW 23-SL

TABLE 10. PARAMETERS MEASURED ON THE SITE - GW 23-S			
GW 23-SL			
SAMPLING POINT DATA			
Sampling time	13:00	Air temperature	28 ºC
Atmospheric conditions	Cloudy	Relative humidity	76%
UTM coordinates	21K 516367.00 m E; 7503054.00 m S	Elevation	205
Water level	19	Water table	186

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
1	Water temperature	Tº	ºC	25,8	No limits	
2	Hydrogen potential	pH		5,71	6-9	
3	Electrical conductivity	σ	µS/cm	34,3	-	1250

TABLE 11. PHYSICOCHEMICAL PARAMETERS - GW 23-SL						
GW 23-SL						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
4	Total dissolved solids	TDS	mg/L	69,5	500	
5	Organic matter	OM	mg O_2/L	1,76	No limits	
6	Hardness	---	mg $CaCO_3$/L	3,03	300	
7	Total phosphorus	P	mg/L	0,0947	0,05	
8	Total nitrogen	N	mg/L	0,109	0,6	
9	Nitrates	NO_{3-}	mg/L	5,08	10	
10	Chlorides	Cl-	mg/L	4,75	-	250
11	Alkalinity	---	mg $CaCO_3$./L	10,8	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	1,94	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
15	Sodium	Na	mg/L	4,09	200	
16	Potasium	K	mg/L	<0,250	-	12
17	Calcium	Ca	mg/L	2,19	-	100
18	Magnesium	Mg	mg/L	<0,243	-	50
19	Fluorine	F	mg/L	<0,05	-	1,5
20	Boron	B	mg/L	0,825	NO LIMITS	

TABLE 12. BACTERIOLOGICAL PARAMETERS - GW 23-SL				
GW 23-SL				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B5. Analytical determinations for sampling point GW 16-GA

TABLE 13. PARAMETERS MEASURED ON THE SITE - GW 16-GA			
GW 16-GA			
SAMPLING POINT DATA			
Sampling time	13:00	Air temperature	29,6ºC
Atmospheric conditions	Sunny	Relative humidity	65%
UTM coordinates	21K 505125.00 m E; 7498320.00 m S	Elevation	219
Water level	No data	Water table	No data

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
1	Water temperature	Tº	ºC	24,3	No limits	
2	Hydrogen potential	pH		6,87	6-9	
3	Electrical conductivity	σ	µS/cm	247	-	1250

TABLE 14. PHYSICOCHEMICAL PARAMETERS - GW 16-GA						
GW 16-GA						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
4	Total dissolved solids	TDS	mg/L	266	500	
5	Organic matter	OM	mg O_2/L	0,382	No limits	
6	Hardness	---	mg $CaCO_3$/L	30,9	300	
7	Total phosphorus	P	mg/L	0,0431	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	0,899	10	
10	Chlorides	Cl-	mg/L	6,89	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	91,5	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	66,8	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	9,50	250	
15	Sodium	Na	mg/L	42,2	200	
16	Potasium	K	mg/L	0,311	-	12
17	Calcium	Ca	mg/L	10,6	-	100
18	Magnesium	Mg	mg/L	1,07	-	50
19	Fluorine	F	mg/L	0,22	-	1,5
20	Boron	B	mg/L	<0,100	No limits	

TABLE 15. BACTERIOLOGICAL PARAMETERS – GW 16-GA				
GW 16-GA				
BACTERIOLOGICAL PARAMETERS				
Nº	Parameter	Unit	Measured value	Regulation NP 2400180 limits
21	Faecal coliforms	NMP/100mL	<1,1	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	12	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B6. Analytical determinations for sampling point GW 11-MICHEL

TABLE 16. PHYSICOCHEMICAL PARAMETERS - GW 11-MICHEL			
GW 11-MICHEL			
SAMPLING POINT DATA			
Sampling time	06:50	Air temperature	24,5 ºC
Atmospheric conditions	Cloudy, drizzle	Relative humidity	82%
UTM coordinates	21K 518643.00 m E; 7484801.00 m S	Elevation	182
Water level	No data	Water table	No data

IN SITU MEASUREMENTS

Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
1	Water temperature	Tº	ºC	25,0	No limits	
2	Hydrogen potential	pH		5,87	6-9	
3	Electrical conductivity	σ	µS/cm	72,0	-	1250

TABLE 17. PHYSICOCHEMICAL PARAMETERS - GW 11-MICHEL						
GW 11-MICHEL						
PHYSICOCHEMICAL PARAMETERS						
Nº	Parameter	Symbol	Unit	Measured value	Limits	
					Regulation 222/02	Annexe I Law 1614/2000.
4	Total dissolved solids	TDS	mg/L	115	500	
5	Organic matter	OM	mg O_2/L	0,670	No limits	
6	Hardness	---	mg $CaCO_3$/L	10,5	300	
7	Total phosphorus	P	mg/L	0,107	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	1,80	10	
10	Chlorides	Cl-	mg/L	10,9	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	80,4	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	16,1	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
15	Sodium	Na	mg/L	9,94	200	
16	Potasium	K	mg/L	0,737	-	12
17	Calcium	Ca	mg/L	4,05	-	100
18	Magnesium	Mg	mg/L	<0,243	-	50
19	Fluorine	F	mg/L	<0,05	-	1,5
20	Boron	B	mg/L	1,41	No limits	

TABLE 18. BACTERIOLOGICAL PARAMETERS - GW11-MICHEL				
GW 11-MICHEL				
BACTERIOLOGICAL PARAMETERS				
Nº	Parameter	Unit	Measured value	Regulation NP 2400180 limits
21	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B7. Analytical determinations for sampling point GW 10-TR

TABLE 19. PARAMETERS MEASURED ON THE SITE - GW 10-TR			
GW 10-TR			
SAMPLING POINT DATA			
Sampling time	7:20	Air temperature	25 ºC
Atmospheric conditions	Cloudy	Relative humidity	81%
UTM coordinates	21K 516254.00 m E 7484946.00 m S	Elevation	157
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	25,8	No limits	
2	Hydrogen potential	pH		7,16	6-9	
3	Electrical conductivity	σ	µS/cm	321	-	1500

TABLE 20. PHYSICOCHEMICAL PARAMETERS - GW 10-TR						
GW 10-TR						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	273	500	
5	Organic matter	OM	mg O_2/L	0,196	No limits	
6	Hardness	---	mg $CaCO_3$/L	12,3	300	
7	Total phosphorus	P	mg/L	0,876	0,05	
8	Total nitrogen	N	mg/L	0,177	0,6	
9	Nitrates	NO_{3-}	mg/L	0,818	1	
10	Chlorides	Cl-	mg/L	28,50	-	250
11	Alkalinity	---	mg $CaCO_3$./L	96,5	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	81,1	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	3,21	250	
15	Sodium	Na	mg/L	63,2	200	
16	Potasium	K	mg/L	0,804	-	12
17	Calcium	Ca	mg/L	3,97	-	100
18	Magnesium	Mg	mg/L	0,578	-	50
19	Fluorine	F	mg/L	0,24	-	1,5
20	Boron	B	mg/L	0,168	No limits	

TABLE 21. BACTERIOLOGICAL PARAMETERS - GW 10-TR				
GW 10-TR				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
22	Faecal coliforms	NMP/100mL	10	1,1 NMP/100mL
23	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
24	E. coli	NMP/100mL	Absent	Absent

B8. Analytical determinations for sampling point GW 13-San Juan

TABLE 22. PARAMETERS MEASURED ON THE SITE - GW 13-SAN JUAN			
GW 13-San Juan			
SAMPLING POINT DATA			
Sampling time	8:20	Air temperature	26,5 ºC
Atmospheric conditions	Sunny, disperse clouds	Relative humidity	80%
UTM coordinates	21K 509767.00 m E; 7486076.00 m S	Elevation	184
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	21,2	No limits	
2	Hydrogen potential	pH		6,92	6-9	
3	Electrical conductivity	σ	µS/cm	320	-	1250

TABLE 23. PHYSICOCHEMICAL PARAMETERS - GW 13-SAN JUAN						
GW 13-San Juan						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	383	500	
5	Organic matter	OM	mg O_2/L	0,685	No limits	
6	Hardness	---	mg $CaCO_3$/L	9,90	300	
7	Total phosphorus	P	mg/L	0,127	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	106	10	
10	Chlorides	Cl-	mg/L	32,3	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	15,2	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	13,1	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
15	Sodium	Na	mg/L	74,4	200	
16	Potasium	K	mg/L	1,26	-	12
17	Calcium	Ca	mg/L	3,08	-	100
18	Magnesium	Mg	mg/L	0,536	-	50
19	Fluorine	F	mg/L	0,06	-	1,5
20	Boron	B	mg/L	0,100	No limits	

TABLE 24.BACTERIOLOGICAL PARAMETERS - GW 13-SAN JUAN				
GW 13-San Juan				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
22	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
24	E. coli	NMP/100mL	Absent	Absent

B9. Analytical determinations for sampling point GW 22-Silva

TABLE 25. PARAMETERS MEASURED ON THE SITE - GW22-SILVA			
GW 22-Silva			
SAMPLING POINT DATA			
Sampling time	8:50	Air temperature	27 °C
Atmospheric conditions	Sunny, disperse clouds	Relative humidity	80%
UTM coordinates	21K 509830.00 m E; 7484037.00 m S	Elevation	179
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	21,7	No limits	
2	Hydrogen potential	pH		5,54	6-9	
3	Electrical conductivity	σ	µS/cm	197	-	1250

TABLE 26. PHYSICOCHEMICAL PARAMETERS - GW 22-SILVA						
GW 22-Silva						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	247	500	
5	Organic matter	OM	mg O_2/L	0,538	No limits	
6	Hardness	---	mg $CaCO_3$/L	22,0	300	
7	Total phosphorus	P	mg/L	<0,0200	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	55,2	10	
10	Chlorides	Cl-	mg/L	13,3	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	13,8	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	1,38	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	7,37	250	
15	Sodium	Na	mg/L	12,4	200	
16	Potasium	K	mg/L	7,63	-	12
17	Calcium	Ca	mg/L	4,86	-	100
18	Magnesium	Mg	mg/L	2,41	-	50
19	Fluorine	F	mg/L	<0,05	-	1,5
20	Boron	B	mg/L	<0,100	No limits	

TABLE 27. BACTERIOLOGICAL PARAMETERS - GW 22-SILVA				
GW 22-Silva				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B10. Analytical determinations for sampling point GW 12- Laguna

TABLE 28. PARAMETERS MEASURED ON THE SITE - GW 12-LAGUNA			
GW 12- Laguna			
SAMPLING POINT DATA			
Sampling time	16:30	Air temperature	28,6 ºC
Atmospheric conditions	Cloudy	Relative humidity	79%
UTM coordinates	21K 516419.00 m E; 7478307.00 m S	Elevation	154
Water level	12,3	Water table	183,3

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	25,7	No limits	
2	Hydrogen potential	pH		7,04	6-9	
3	Electrical conductivity	σ	µS/cm	318	-	1250

TABLE 29. PHYSICOCHEMICAL PARAMETERS - GW 12-LAGUNA						
GW 12- Laguna						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	236	500	
5	Organic matter	OM	mg O_2/L	0,406	No limits	
6	Hardness	---	mg $CaCO_3$/L	88,1	300	
7	Total phosphorus	P	mg/L	0,264	0,05	
8	Total nitrogen	N	mg/L	0,339	0,6	
9	Nitrates	NO_{3-}	mg/L	3,70	10	
10	Chlorides	Cl-	mg/L	4,28	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	132	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	108	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	3,46	250	
15	Sodium	Na	mg/L	30,1	200	
16	Potasium	K	mg/L	0,906	-	12
17	Calcium	Ca	mg/L	24,7	-	100
18	Magnesium	Mg	mg/L	6,410	-	50
19	Fluorine	F	mg/L	0,15	-	1,5
20	Boron	B	mg/L	8,22	No limits	

TABLE 30. BACTERIOLOGICAL PARAMETERS - GW 12-LAGUNA				
GW 12- Laguna				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	6,9	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Ausente	Ausencia

B11. Analytical determinations for sampling point GW 14-ZM

TABLE 31. PARAMETERS MEASURED ON THE SITE - GW 14-ZM			
GW 14-ZM			
SAMPLING POINT DATA			
Sampling time	13:40	Air temperature	29,5 º C
Atmospheric conditions	Cloudy, drizzle	Relative humidity	79%
UTM coordinates	21K 493064.00 m E; 7499176.00 m S	Elevation	212
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	22,1	No limits	
2	Hydrogen potential	pH		7,16	6-9	
3	Electrical conductivity	σ	µS/cm	113	-	1250

TABLE 32. PARÁMETROS FISICOQUÍMICOS GW 14-ZM						
GW 14-ZM						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	216	500	
5	Organic matter	OM	mg O_2/L	1,23	No limits	
6	Hardness	---	mg $CaCO_3$/L	26,3	300	
7	Total phosphorus	P	mg/L	0,204	0,05	
8	Total nitrogen	N	mg/L	0,107	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,200	10	
10	Chlorides	Cl-	mg/L	9,50	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	52,6	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	38,9	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
15	Sodium	Na	mg/L	12,1	200	
16	Potasium	K	mg/L	1,07	-	12
17	Calcium	Ca	mg/L	6,72	-	100
18	Magnesium	Mg	mg/L	2,30	-	50
19	Fluorine	F	mg/L	0,25	-	1,5
20	Boron	B	mg/L	<0,100	No limits	

TABLE 33. BACTERIOLOGICAL PARAMETERS - GW 14-ZM				
GW 14-ZM				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
22	Faecal coliforms	NMP/100mL	6,9	1,1 NMP/100mL
23	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
24	E. coli	NMP/100mL	Absent	Absent

B12. Analytical determinations for sampling point GW 15-SO

TABLE 34. PARAMETERS MEASURED ON THE SITE - GW 15-SO			
GW 15-SO			
DATOS DEL PUNTO DE MUESTREO			
Sampling time	12:10	Air temperature	24,8 ºC
Atmospheric conditions	Cloudy, rainy	Relative humidity	60%
UTM coordinates	21K 483316.00 m E, 7497562.00 m S	Elevation	290
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	27,7	No limits	
2	Hydrogen potential	pH		7,34	6-9	
3	Electrical conductivity	σ	µS/cm	950	-	1250

TABLE 35. PHYSICOCHEMICAL PARAMETERS - GW 15-SO						
GW 15-SO						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	665	500	
5	Organic matter	OM	mg O_2/L	1,31	No limits	
6	Hardness	---	mg $CaCO_3$/L	313	300	
7	Total phosphorus	P	mg/L	<0,0200	0,05	
8	Total nitrogen	N	mg/L	0,734	0,6	
9	Nitrates	NO_{3-}	mg/L	199	10	
10	Chlorides	Cl-	mg/L	8,31	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	299	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	269	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	17,9	250	
15	Sodium	Na	mg/L	64,6	200	
16	Potasium	K	mg/L	1,93	-	12
17	Calcium	Ca	mg/L	76,3	-	100
18	Magnesium	Mg	mg/L	29,7	-	50
19	Fluorine	F	mg/L	0,67	-	1,5
20	Boron	B	mg/L	<0,100	No limits	

TABLE 36. BACTERIOLOGICAL PARAMETERS - GW 15-SO				
GW 15-SO				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
22	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
24	E. coli	NMP/100mL	Absent	Absent

B13. Analytical determinations for sampling point GW 17-LP

TABLE 37. PARAMETERS MEASURED ON THE SITE - GW 17-LP			
GW 17-LP			
SAMPLING POINT DATA			
Sampling time	14: 50	Air temperature	26,8 ºC
Atmospheric conditions	Sunny, disperse clouds	Relative humidity	60%
UTM coordinates	21K 489833.00 m E, 7492572.00 m S	Elevation	215
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	Tº	ºC	21,7	No limits	
2	Hydrogen potential	pH		6,96	6-9	
3	Electrical conductivity	σ	µS/cm	196	-	1250

TABLE 38. PHYSICOCHEMICAL PARAMETERS - GW 17-LP						
GW 17-LP						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	203	500	
5	Organic matter	OM	mg O_2/L	0,615	No limits	
6	Hardness	---	mg $CaCO_3$/L	64,0	300	
7	Total phosphorus	P	mg/L	0,0699	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,200	10	
10	Chlorides	Cl-	mg/L	0,475	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	94,5	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	73,7	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	<2,00	250	
15	Sodium	Na	mg/L	14,6	200	
16	Potasium	K	mg/L	0,486	-	12
17	Calcium	Ca	mg/L	15,5	-	100
18	Magnesium	Mg	mg/L	6,11	-	50
19	Fluorine	F	mg/L	0,53	-	1,5
20	Boron	B	mg/L	0,519	No limits	

TABLE 39. BACTERIOLOGICAL PARAMETERS - GW 17-LP				
GW 17-LP				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B14. Analytical determinations for sampling point GW 21-MC

TABLE 40. PARAMETERS MEASURED ON THE SITE - GW 21-MC			
GW 21-MC			
SAMPLING POINT DATA			
Sampling time	15:30	Air temperature	26,5 ºC
Atmospheric conditions	Cloudy	Relative humidity	63%
UTM coordinates	21K 495202.00 m E; 7489899.00 m S	Elevation	177
Water level	10,70	Water table	166,3

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	22,7	NO LIMITS	
2	Hydrogen potential	pH		6,26	6-9	
3	Electrical conductivity	σ	µS/cm	406	-	1250

TABLE 41. PHYSICOCHEMICAL PARAMETERS - GW 21-MC						
GW 21-MC						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	404	500	
5	Organic matter	OM	mg O_2/L	0,475	No limits	
6	Hardness	---	mg $CaCO_3$/L	58,8	300	
7	Total phosphorus	P	mg/L	0,170	0,05	
8	Total nitrogen	N	mg/L	<0,100	0,6	
9	Nitrates	NO_{3-}	mg/L	75,5	10	
10	Chlorides	Cl-	mg/L	49,9	-	250
11	Alkalinity	---	mg $CaCO_{3.}$/L	58,1	-	250
12	Bicarbonates	---	mg $CaCO_{3.}$/L	5,81	No limits	
13	Carbonates		mg $CaCO_{3.}$/L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	5,79	250	
15	Sodium	Na	mg/L	51,0	200	
16	Potasium	K	mg/L	3,23	-	12
17	Calcium	Ca	mg/L	15,3	-	100
18	Magnesium	Mg	mg/L	4,98	-	50
19	Fluorine	F	mg/L	0,14	-	1,5
20	Boron	B	mg/L	0,650	No limits	

TABLE 42. BACTERIOLOGICAL PARAMETERS - GW 21-MC				
GW 21-MC				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B15. Analytical determinations for sampling point GW 01

TABLE 43. PARAMETERS MEASURED ON THE SITE - GW 01			
GW 01			
SAMPLING POINT DATA			
Sampling time	11:40	Air temperature	29,7 ºC
Atmospheric conditions	Sunny	Relative humidity	64%
UTM coordinates	21K 449839.00 m E 7430729.00 m S	Elevation	123 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	20,1	NO LIMITS	
2	Hydrogen potential	pH		7,16	6-9	
3	Electrical conductivity	σ	µS/cm	2.400	-	1250

TABLE 44. PHYSICOCHEMICAL PARAMETERS - GW 01						
GW 01						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	1.181	500	
5	Organic matter	OM	mg O_2/L	10,1	No limits	
6	Hardness	---	mg $CaCO_3$/L	281	300	
7	Total phosphorus	P	mg/L	0,356	0,05	
8	Total nitrogen	N	mg/L	2,73	0,6	
9	Nitrates	NO_{3-}	mg/L	1,49	10	
10	Chlorides	Cl-	mg/L	285	-	250
11	Alkalinity	---	mg $CaCO_3$./L	397	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	55,5	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	337	250	
15	Sodium	Na	mg/L	374	200	
16	Potasium	K	mg/L	8,40	-	12
17	Calcium	Ca	mg/L	85,8	-	100
18	Magnesium	Mg	mg/L	16,1	-	50
19	Fluorine	F	mg/L	2,30	-	1,5
20	Boron	B	mg/L	1,67	No limits	

TABLE 45. BACTERIOLOGICAL PARAMETERS - GW 01				
GW 01				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	>23	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	>23	1,1 NMP/100mL
23	E. coli	NMP/100mL	Present	Absent

B16. Analytical determinations for sampling point GW 02

TABLE 46. PARAMETERS MEASURED ON THE SITE - GW 02			
GW 02			
SAMPLING POINT DATA			
Sampling time	9:40	Air temperature	28,5 ºC
Atmospheric conditions	Sunny	Relative humidity	65%
UTM coordinates	21k 450165.00 m E 7430301.00 m S	Elevation	116 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	19,7	NO LIMITS	
2	Hydrogen potential	pH		6,96	6-9	
3	Electrical conductivity	σ	µS/cm	444	-	1250

TABLE 47. PHYSICOCHEMICAL PARAMETERS - GW 02						
GW 02						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	248	500	
5	Organic matter	OM	mg O_2/L	0,505	No limits	
6	Hardness	---	mg $CaCO_3$/L	84	300	
7	Total phosphorus	P	mg/L	0,0776	0,05	
8	Total nitrogen	N	mg/L	0,196	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,0200	10	
10	Chlorides	Cl-	mg/L	1,59	-	250
11	Alkalinity	---	mg $CaCO_3$./L	178	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	88,8	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	24,5	250	
15	Sodium	Na	mg/L	43,1	200	
16	Potasium	K	mg/L	16,5	-	12
17	Calcium	Ca	mg/L	20,5	-	100
18	Magnesium	Mg	mg/L	8,07	-	50
19	Fluorine	F	mg/L	1,60	-	1,5
20	Boron	B	mg/L	1,67	No limits	

TABLE 48. BACTERIOLOGICAL PARAMETERS - GW 02				
GW 02				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	<1,1	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	<1,1	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

B17. Analytical determinations for sampling point GW 03 (NO WATER)

TABLE 49. PARAMETERS MEASURED ON THE SITE - GW 03			
GW 03			
SAMPLING POINT DATA			
Sampling time	13:30	Air temperature	30,4 ºC
Atmospheric conditions	Sunny	Relative humidity	67%
UTM coordinates	21 k 449680.00 m E 7426904.00 m S	Elevation	83 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	-	NO LIMITS	
2	Hydrogen potential	pH		-	6-9	
3	Electrical conductivity	σ	µS/cm	-	-	1250

TABLE 50. PHYSICOCHEMICAL PARAMETERS - GW 03						
GW 03						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	-	500	
5	Organic matter	OM	mg O_2/L	-	No limits	
6	Hardness	---	mg $CaCO_3$/L	-	300	
7	Total phosphorus	P	mg/L	-	0,05	
8	Total nitrogen	N	mg/L	-	0,6	
9	Nitrates	NO_{3-}	mg/L	-	10	
10	Chlorides	Cl-	mg/L	-	-	250
11	Alkalinity	---	mg $CaCO_3$./L	-	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	-	No limits	
13	Carbonates		mg $CaCO_3$./L	-	No limits	
14	Sulphates	SO_4^{2}-	mg/L	-	250	
15	Sodium	Na	mg/L	-	200	
16	Potasium	K	mg/L	-	-	12
17	Calcium	Ca	mg/L	-	-	100
18	Magnesium	Mg	mg/L	-	-	50
19	Fluorine	F	mg/L	-	-	1,5
20	Boron	B	mg/L	-	No limits	

TABLE 51. BACTERIOLOGICAL PARAMETERS - GW 03				
GW 03				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	-	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	-	1,1 NMP/100mL
23	E. coli	NMP/100mL	-	Absent

B18. Analytical determinations for sampling point GW 04

TABLE 52. PARAMETERS MEASURED ON THE SITE - GW 04			
GW 04			
SAMPLING POINT DATA			
Sampling time	10:00	Air temperature	29.7 ºC
Atmospheric conditions	Sunny	Relative humidity	58 %
UTM coordinates	21k 449136.00 m E 7427123.00 m S	Elevation	94 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	21,2	NO LIMITS	
2	Hydrogen potential	pH		7,44	6-9	
3	Electrical conductivity	σ	µS/cm	5.010	-	1250

TABLE 53. PHYSICOCHEMICAL PARAMETERS - GW 04						
GW 04						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	**2.577**	500	
5	Organic matter	OM	mg O_2/L	12,0	No limits	
6	Hardness	---	mg $CaCO_3$/L	**709**	300	
7	Total phosphorus	P	mg/L	12,0	0,05	
8	Total nitrogen	N	mg/L	9,02	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,0200	10	
10	Chlorides	Cl-	mg/L	**611**	-	250
11	Alkalinity	---	mg $CaCO_3$./L	**282**	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	22,6	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	160	250	
15	Sodium	Na	mg/L	**367**	200	
16	Potasium	K	mg/L	6,57	-	12
17	Calcium	Ca	mg/L	**164**	-	100
18	Magnesium	Mg	mg/L	**72,9**	-	50
19	Fluorine	F	mg/L	1,00	-	1,5
20	Boron	B	mg/L	1,25	No limits	

TABLE 54. BACTERIOLOGICAL PARAMETERS - GW 04				
GW 04				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	**>23**	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	**>23**	1,1 NMP/100mL
23	E. coli	NMP/100mL	Present	Absent

B19. Analytical determinations for sampling point GW 05

TABLE 55. PARAMETERS MEASURED ON THE SITE - GW 05			
GW 05			
SAMPLING POINT DATA			
Sampling time	14:50	Air temperature	31,2 ºC
Atmospheric conditions	Sunny	Relative humidity	52 %
UTM coordinates	21K 450803.00 m E 7426714.00 m S	Elevation	91 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	23,0	NO LIMITS	
2	Hydrogen potential	pH		6,89	6-9	
3	Electrical conductivity	σ	µS/cm	370	-	1250

TABLE 56. PHYSICOCHEMICAL PARAMETERS - GW 05						
GW 05						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	245	500	
5	Organic matter	OM	mg O_2/L	0,366	No limits	
6	Hardness	---	mg $CaCO_3$/L	88,1	300	
7	Total phosphorus	P	mg/L	0,0212	0,05	
8	Total nitrogen	N	mg/L	0,245	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,0200	10	
10	Chlorides	Cl-	mg/L	43,1	-	250
11	Alkalinity	---	mg $CaCO_3$./L	13,5	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	5,40	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	16,1	250	
15	Sodium	Na	mg/L	25,7	200	
16	Potasium	K	mg/L	6,60	-	12
17	Calcium	Ca	mg/L	25,3	-	100
18	Magnesium	Mg	mg/L	6,06	-	50
19	Fluorine	F	mg/L	0,200	-	1,5
20	Boron	B	mg/L	2,51	No limits	

TABLE 57. BACTERIOLOGICAL PARAMETERS - GW 05				
GW 05				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	**5,1**	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	**1,1**	1,1 NMP/100mL
23	E. coli	NMP/100mL	Present	Absent

B20. Analytical determinations for sampling point GW 06

TABLE 58. PARAMETERS MEASURED ON THE SITE - GW 06			
GW 06			
SAMPLING POINT DATA			
Sampling time	16:00	Air temperature	30,08 ºC
Atmospheric conditions	Sunny	Relative humidity	57 %
UTM coordinates	21k 451708.00 m E 7427153.00 m S	Elevation	90 m
Water level	No data	Water table	No data

IN SITU MEASUREMENTS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
1	Water temperature	T_{agua}	ºC	21,4	NO LIMITS	
2	Hydrogen potential	pH		6,39	6-9	
3	Electrical conductivity	σ	µS/cm	330	-	1250

TABLE 59. PHYSICOCHEMICAL PARAMETERS - GW 06						
GW 06						
PHYSICOCHEMICAL PARAMETERS						
Nº	**Parameter**	**Symbol**	**Unit**	**Measured value**	**Limits**	
					Regulation 222/02	**Annexe I Law 1614/2000.**
4	Total dissolved solids	TDS	mg/L	240	500	
5	Organic matter	OM	mg O_2/L	1,18	No limits	
6	Hardness	---	mg $CaCO_3$/L	60	300	
7	Total phosphorus	P	mg/L	0,0723	0,05	
8	Total nitrogen	N	mg/L	0,483	0,6	
9	Nitrates	NO_{3-}	mg/L	<0,0200	10	
10	Chlorides	Cl-	mg/L	33,3	-	250
11	Alkalinity	---	mg $CaCO_3$./L	54,6	-	250
12	Bicarbonates	---	mg $CaCO_3$./L	27,8	No limits	
13	Carbonates		mg $CaCO_3$./L	0,00	No limits	
14	Sulphates	SO_4^{2-}	mg/L	29,7	250	
15	Sodium	Na	mg/L	30,9	200	
16	Potasium	K	mg/L	5,84	-	12
17	Calcium	Ca	mg/L	19,4	-	100
18	Magnesium	Mg	mg/L	2,73	-	50
19	Fluorine	F	mg/L	0,190	-	1,5
20	Boron	B	mg/L	1,15	No limits	

TABLE 60. BACTERIOLOGICAL PARAMETERS - GW 06				
GW 06				
BACTERIOLOGICAL PARAMETERS				
Nº	**Parameter**	**Unit**	**Measured value**	**Regulation NP 2400180 limits**
21	Faecal coliforms	NMP/100mL	**>23**	1,1 NMP/100mL
22	Total coliforms	NMP/100mL	**9,2**	1,1 NMP/100mL
23	E. coli	NMP/100mL	Absent	Absent

confidential

APPENDIX C:
ANALYSIS OF THE RESULTS PER POINT

confidential

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C1 FW104-ZA - NEGLA STREAM – UPPER PART OF THE MICRO-WATERSHED

TABLE 1. OUT-OF-RANGE PARAMETERS – FW104-ZA				
COD: FW 104-ZA	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	40	**4**
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Ammonia	0,083 mg/L		0,02 mg/L	
Soluble iron	1,110 mg/L		0,3 mg/L	
Total coliforms	16000 NMP/100mL		1000 NMP/100mL	
Faecal coliforms	16000 NMP/100mL		200 NMP/100mL	

C2 GW18-ZA – HEADQUARTERS OF "ZAPALLLO" FARM – DEEP TUBULAR WELL USED FOR WATER DRINKING SUPPLY

TABLE 2. OUT-OF-RANGE PARAMETERS – GW18-ZA				
COD: GW 18-ZA	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	**4**
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,352 mg/L		0,05	
Nitrates	10,5 mg/L		10	
Faecal coliforms	16 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C3 FW201-ST – NAPAGUE STREAM – UPPER MIDDLE PART OF THE NEGLA STREAM MICRO-WATERSHED

TABLE 3. OUT-OF-RANGE PARAMETERS – FW201-ST				
COD: FW 201-ST	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	41	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Ammonia	0,0594 mg/L		0,02 mg/L	
Soluble iron	0,935 mg/L		0,3 mg/L	
Faecal coliforms	540 NMP/100mL		200 NMP/100mL	

C4 GW 20-ST - HEADQUARTERS OF THE "SANTA TERESA" FARM - DEEP TUBULAR WELL USED FOR DRINKING WATER SUPPLY

TABLE 4. OUT-OF-RANGE PARAMETERS – GW20-ST				
COD: GW 20-ST	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	4

OUT-OF-RANGE PARAMETER	LABORATORY RESULTS	REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS
pH	5,63	6-9
Nitrates	22,8 mg/L	10 mg/L
Faecal coliforms	12 NMP/100mL	1,1 NMP/100mL
Total coliforms	>23 NMP/100mL	1,1 NMP/100mL

C5 FW 315-HE - "HERMOSA" STREAM - UPPER WATERSHED OF THE "HERMOSA" CREEK MICRO-WATERSHED

TABLE 5. OUT-OF-RANGE PARAMETERS – FW315-HE				
COD: FW 315-HE	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	37	7
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Total phosphorus	0,103 mg/L		0,05 mg/L	
Total nitrogen	0,734 mg/L		0,6 mg/L	
Ammonia	0,0587 mg/L		0,02 mg/L	
Manganese	0,274 mg/L		0,1 mg/L	
Soluble iron	1,11 mg/L		0,3 mg/L	
Faecal coliforms	1200		200 NMP/100mL	
Total coliforms	35000		1000 NMP/100mL	

C6 GW 19-HE – HEADQUARTERS OF THE "HERMOSA" FARM - DEEP TUBULAR WELL FOR DRINKING WATER SUPPLY

TABLE 6. OUT-OF-RANGE PARAMETERS – GW19-HE				
COD: GW 19-HE	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	15	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,577 mg/L		0,05 mg/L	
Faecal coliforms	9,2 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C7 GW 304-HE - TREMENTINA STREAM – UPPER WATERSHED OF THE TREMENTINA STREAM MICRO-WATERSHED

TABLE 7. OUT-OF-RANGE PARAMETERS – GW304-HE				
COD: FW 304-HE	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	**5**
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Total phosphorus	0,0639 mg/L		0,05 mg/L	
Ammonia	0,0880 mg/L		0,02 mg/L	
Soluble iron	0,913 mg/L		0,3 mg/L	

Faecal coliforms	330 NMP/100mL	200 NMP/100mL
Total coliforms	3500 NMP/100mL	1000 NMP/100mL

C8 GW 23-SL - HEADQUARTERS OF THE "SAN LIBERATO" FARM - DEEP TUBULAR WELL FOR WATER PROVISION FOR HUMAN CONSUMPTION

TABLE 8. OUT-OF-RANGE PARAMETERS - GW23-SL				
COD: GW 23-SL	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
pH	5,71		6-9	
Total phosphorus	0,0947 mg/L		0,05 mg/L	
Faecal coliforms	23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C9 GW 16-GA - HEADQUARTERS OF THE "SAN GAVILÁN" FARM AT 200 METRES FROM *EUCALYPTUS SP.* PLANTATIONS - DEEP TUBULAR WELL TO PROVIDE WATER FOR HUMAN CONSUMPTION

TABLE 9. OUT-OF-RANGE PARAMETERS - GW16-GA				
COD: GW 16-GA	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	17	1
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total coliforms	12 NMP/100mL		1,1 NMP/100mL	

C10 FW 100-GASL - TREMENTINA STREAM - MIDDLE/UPPER CATCHMENT OF THE TREMENTINA STREAM MICRO-WATERSHED RUNS THROUGH APPROXIMATELY 7 KM OF *EUCALYPTUS SP.* PLANTATIONS

TABLE 10. OUT-OF-RANGE PARAMETERS FW 100-GASL				
COD: FW 100-GASL	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	38	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02**	
Dissolved oxygen	4,47 mg/L		>5 mg/L	
Total phosphorus	0,0586mg/L		0,05 mg/L	
Total Nitrogen	0,750 mg/L		0,6 mg/L	
Ammonia	0,0457 mg/L		0,02 mg/L	
Soluble Iron	0,550 mg/L		0,3 mg/L	

C11 FW 200-SL - TRIBUTARY OF THE TREMENTINA STREAM AT THE SOUTHEAST OF THE HEADQUARTERS OF THE "SAN LIBERATO" FARM – MIDDLE CATCHMENT OF THE TREMENTINA STREAM

TABLE 11. OUT-OF-RANGE PARAMETERS – FW200-SL				
COD: FW 200-SL	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Turbidity	489 NTU		100NTU	
Ammonia	0,138 mg/L		0,02 mg/L	
Soluble iron	1,05 mg/L		0,3 mg/L	
Faecal coliforms	7900 NMP/100mL		200 NMP/100mL	
Total coliforms	22000 NMP/100mL		1000 NMP/100mL	

C12 FW 207-TR - TRIBUTARY OF THE TREMENTINA STREAM, 5 KM AT THE NORTH OF THE HEADQUARTERS OF THE "TREMENTINA" FARM – MIDDLE CATCHMENT OF THE TREMENTINA STREAM

TABLE 12. OUT-OF-RANGE PARAMETERS – FW207-TR				
COD: FW 207-TR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	38	6
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Dissolved oxygen	2,43 mg O_2/L		> 5 mg O_2/L	
Total phosphorus	0,0796 mg/L		0,05 mg/L	
Ammonia	0,0687 mg/L		0,02 mg/L	
Soluble iron	3,31 mg/L		0,3 mg/L	
Faecal coliforms	790 NMP/100mL		200 NMP/100mL	
Total coliforms	1700 NMP/100mL		1000 NMP/100mL	

C13 FW 208-TR - TREMENTINA STREAM, 2 KM NORTHWEST OF THE TREMENTINA FARM'S HEADQUARTERS – MIDDLE CATCHMENT OF THE TREMENTINA STREAM

TABLE 13. OUT-OF-RANGE PARAMETERS – FW208-TR				
COD: FW 208-TR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	38	6
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Dissolved oxygen	4,30 mg O_2/L		> 5 mg O_2/L	
Total nitrogen	0,748 mg/L		0,6 mg/L	
Amoniaco	0,0603 mg/L		0,02 mg/L	
Ammonia	1,33 mg/L		0,3 mg/L	
Soluble iron	35000 NMP/100mL		200 NMP/100mL	
Faecal coliforms	35000 NMP/100mL		1000 NMP/100mL	

C14 GW 11-MICHEL - DEEP TUBULAR WELLS LOCATED IN NEW PLANTATIONS OF *EUCALYPTUS SP* – MIDDLE BASIN OF THE TREMENTINA STREAM

TABLE 14. OUT-OF-RANGE PARAMETERS – GW11-MICHEL				
COD: GW 11-MICHEL	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
pH	5,87		6-9	
Total phosphorus	0,107 mg/L		0,05 mg/L	
Faecal coliforms	>23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C15 GW 10-TR - TREMENTINA FARM HEADQUARTERS –MIDDLE BASIN OF THE TREMENTINA STREAM, DAIRY FARM AND CORRALS WITHIN 200 METRES OF THE AII OF THE WELL, USE FOR DRINKING WATER SUPPLY

TABLE 15. OUT-OF-RANGE PARAMETERS – GW10-TR				
COD: GW 10-TR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	15	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,876 mg/L		0,05	
Faecal coliforms	10 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C16 GW 13-SAN JUAN - "SAN JUAN" FARM, THE MIDDLE BASIN OF THE TREMENTINA STREAM – WELL FOR DRINKING WATER SUPPLY

TABLE 16. OUT-OF-RANGE PARAMETERS – GW13-SAN JUAN				
COD: GW 13-SAN JUAN	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	26	6	16	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 LIMITS**	
Total phosphorus	0,127 mg/L		0,05 mg/L	
Nitrates	106 mg/L		10 mg/L	
Faecal coliforms	>23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C17 GW 22-SILVA - "SILVA" FARM, THE MIDDLE BASIN OF THE TREMENTINA STREAM - WELL FOR DRINKING WATER SUPPLY

TABLE 17. OUT-OF-RANGE PARAMETERS - GW22-SILVA				
COD: GW 22-SILVA	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
pH	5,54		6-9	
Nitrates	55,2 mg/L		10 mg/L	
Faecal coliforms	23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C18 FW 205-TR - TREMENTINA STREAM, 2.7 KM EAST OF THE TREMENTINA FARM HEADQUARTERS, MIDDLE CATCHMENT OF THE TREMENTINA STREAM MICRO-CATCHMENT

TABLE 18. OUT-OF-RANGE PARAMETERS - FW205-TR				
COD: FW 205-TR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	36	8
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
BOD5	5,32 mg O_2/L		5 mg O_2/L	
Total phosphorus	0,384 mg/L		0,05 mg/L	
Ammonia	0,521 mg/L		0,02 mg/L	
Manganese	0,127 mg/L		0,1 mg/L	
Soluble iron	1,56 mg/L		0,3 mg/L	
Faecal coliforms	780 NMP/100mL		200 NMP/100mL	
Total coliforms	7000 NMP/100mL		1000 NMP/100mL	
Nickel	0,145 mg/L		0,025 mg/L	

C19 GW 12-LAGUNA - "LAGUNA" FARM, THE MIDDLE BASIN OF THE TREMENTINA STREAM MICRO-BASIN - WELL FOR DRINKING WATER SUPPLY AND IRRIGATION OF SEEDLINGS, CURRENTLY DEVELOPING A FOREST NURSERY AND PLANTATION OF NEW CROPS OF *EUCALYPTUS SP*

TABLE 19. OUT-OF-RANGE PARAMETERS - GW12-LAGUNA				
COD: GW 12-LAGUNA	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	15	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,264 mg/L		0,05 mg/L	
Faecal coliforms	6,9 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C20 FW 109-MYRZ - TREMENTINA STREAM, POINT LOCATED BETWEEN THE "MANDYJU" AND "RANCHO Z" PROPERTY BOUNDARIES - MIDDLE CATCHMENT OF THE "TREMENTINA" STREAM MICRO-WATERSHED

TABLE 20. OUT-OF-RANGE PARAMETERS – FW109-MYRZ				
COD: FW 109-MYRZ	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	38	6
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Dissolved oxygen	4,58 mg O_2/L		> 5 mg O_2/L	
Total phosphorus	0,194 mg/L		0,05 mg/L	
Ammonia	0,055 mg/L		0,02 mg/L	
Soluble iron	1,19 mg/L		0,3 mg/L	
Faecal coliforms	11000 NMP/100mL		200 NMP/100mL	
Total coliforms	11000 NMP/100mL		1000 NMP/100mL	

C21 FW 115-MANDYJU - TREMENTINA STREAM, A POINT LOCATED 11 KM SOUTHEAST OF THE "RANCHO Z" FOREST PLANTATIONS - MIDDLE CATCHMENT OF THE TREMENTINA STREAM MICRO-WATERSHED

TABLE 21. OUT-OF-RANGE PARAMETERS – FW115-MANDYJU				
COD: FW 115- MANDYJU	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	38	6
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Dissolved oxygen	4,98 mg O_2/L		>5 mg O_2/L	
Total phosphorus	0,0882 mg/L		0,05 mg/L	
Ammonia	0,065 mg/L		0,02 mg/L	
Soluble iron	1,13 mg/L		0,3 mg/L	
Faecal coliforms	390 NMP/100mL		200 NMP/100mL	
Total coliforms	9000 NMP/100mL		1000 NMP/100mL	

C22 FW 317-RZ - TREMENTINA STREAM - LOWER CATCHMENT OF THE TREMENTINA STREAM MICRO-CATCHMENT

TABLE 22. OUT-OF-RANGE PARAMETERS – FW317-RZ				
COD: FW 317-RZ	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Ammonia	0,115 mg/L		0,02 mg/L	
Soluble iron	0,951 mg/L		0,3 mg/L	
Faecal coliforms	330 NMP/100mL		200 NMP/100mL	
Total coliforms	1100 NMP/100mL		1000 NMP/100mL	
Lead	0,0494 mg/L		0,01 mg/L	

C23 FW 204-LB - TREMENTINA STREAM POINT LOCATED 5 KM UPSTREAM OF THE OUTFLOW POINT OF THE TREMENTINA STREAM TO THE AQUIDABÁN RIVER – THE LOWER WATERSHED OF THE "TREMENTINA" STREAM MICRO-WATERSHED

TABLE 23. OUT-OF-RANGE PARAMETERS – FW204-LB				
COD: FW 204-LB	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Ammonia	0,226 mg/L		0,02 mg/L	
Soluble iron	1,14 mg/L		0,3 mg/L	
Faecal coliforms	3500 NMP/100mL		200 NMP/100mL	
Total coliforms	16000 NMP/100mL		1000 NMP/100mL	
Nickel	0,0513 mg/L		0,025 mg/L	

C24 FW 110-LB - UNNAMED STREAM – TRIBUTARY OF THE AQUIDABÁN RIVER

TABLE 24. OUT-OF-RANGE PARAMETERS – FW110-LB				
COD: FW 110-LB	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	37	7
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Dissolved oxygen	2,38 mg O_2/L		>5 mg O_2/L	
Total phosphorus	0,0548 mg/L		0,05 mg/L	
Manganese	0,122 mg/L		0,1 mg/L	
Ammonia	0,224 mg/L		0,02 mg/L	
Soluble iron	1,41 mg/L		0,3 mg/L	
Faecal coliforms	4300 NMP/100mL		200 NMP/100mL	
Total coliforms	160000 NMP/100mL		1000 NMP/100mL	

C25 FW 111-LB - AQUIDABÁN RIVER – LOWER-MIDDLE BASIN OF THE AQUIDABÁN RIVER CATCHMENT

TABLE 25. OUT-OF-RANGE PARAMETERS – FW111-LB				
COD: FW 111-LB	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	37	7
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
pH	5,91		6 - 9	
Total phosphorus	0,114 mg/L		0,05 mg/L	
Ammonia	0,331 mg/L		0,02 mg/L	
Manganese	0,4 mg/L		0,1 mg/L	
Soluble iron	1,56 mg/L		0,3 mg/L	
Faecal coliforms	490 NMP/100mL		200 NMP/100mL	
Total coliforms	1400 NMP/100mL		1000 NMP/100mL	

C26 FW 310-CR - AQUIDABÁN RIVER – LOWER BASIN OF THE AQUIDABÁN RIVER CATCHMENT

TABLE 26. OUT-OF-RANGE PARAMETERS – FW310-CR				
COD: FW 310-CR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	36	8
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Turbidity	355 NTU		100 NTU	
BOD5	5,51 mg O_2/L		5 mg O_2/L	
Total phosphorus	0,0518 mg/L		0,05 mg/L	
Ammonia	0,150 mg/L		0,02 mg/L	
Manganese	0,341 mg/L		0,1 mg/L	
Soluble iron	2,36 mg/L		0,3 mg/L	
Faecal coliforms	11000 NMP/100mL		200 NMP/100mL	
Total coliforms	11000 NMP/100mL		1000 NMP/100mL	

C27 FW 316-CR - "LAGUNA PENAYO" STREAM – LOWER BASIN OF THE AQUIDABÁN RIVER

TABLE 27. OUT-OF-RANGE PARAMETERS – FW316-CR				
COD: FW 316-CR	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
BOD5	5,05 mg O_2/L		5 mg O_2/L	
Total nitrogen	0,779 mg/L		0,6 mg/L	
Ammonia	0,0331 mg/L		0,02 mg/L	
Soluble iron	0,991 mg/L		0,3 mg/L	
Lead	0,0134 mg/L		0,01 mg/L	

C28 GW 14-ZM - HEADQUARTERS OF THE "ZANJA MOROTÎ" FARM - DEEP TUBULAR WELL FOR DRINKING WATER SUPPLY

TABLE 28. OUT-OF-RANGE PARAMETERS – GW14-ZM				
COD: GW 14-ZM	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	15	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,204 mg/L		0,05 mg/L	
Faecal coliforms	6,9 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C29 GW 15-SO - HEADQUARTERS OF THE "SOLEDAD" FARM - DEEP TUBULAR WELL FOR DRINKING WATER SUPPLY

TABLE 29. OUT-OF-RANGE PARAMETERS – GW15-SO				
COD: GW 15-SO	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	11	7
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total dissolved solids	665 mg/L		500 mg/L	
Hardness	313 mg $CaCO_3$/L		300 mg $CaCO_3$/L	
Total nitrogen	0,734 mg/L		0,6 mg/L	
Nitrates	199 mg/L		10 mg/L	
Alkalinity	299 mg $CaCO_3$./L		250 mg $CaCO_3$./L	
Faecal coliforms	>23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C30 FW 306-SO - TRIBUTARY OF THE PITANOHAGA STREAM- UPPER CATCHMENT OF THE PITANOHAGA STREAM MICRO-WATERSHED

TABLE 30. OUT-OF-RANGE PARAMETERS – FW306-SO				
COD: FW 306-SO	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	63	19	39	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Amoniaco	0,0872 mg/L		0,02 mg/L	
Soluble iron	1,02 mg/L		0,3 mg/L	
Faecal coliforms	540 NMP/100mL		200 NMP/100mL	
Total coliforms	920 NMP/100mL		1000 NMP/100mL	
Lead	0,0229 mg/L		0,01 mg/L	

C31 GW 17-LP - HEADQUARTERS OF "LA PARAGUAYA" FARM – DEEP TUBULAR WELL FOR WATER PROVISION FOR HUMAN CONSUMPTION

TABLE 31. OUT-OF-RANGE PARAMETERS – GW17-LP				
COD: GW 17-LP	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	15	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,0699 mg/L		0,05 mg/L	
Faecal coliforms	>23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C32 GW 21-MC - HEADQUARTERS OF THE "MACHUCA-CUE" FARM - DEEP TUBULAR WELL FOR DRINKING WATER SUPPLY

TABLE 32. OUT-OF-RANGE PARAMETERS – GW21-MC				
COD: GW 21-MC	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 LAW 1614/2000 AND NP 24 001 80 LIMITS**	
Total phosphorus	0,170 mg/L		0,05 mg/L	
Nitrates	75,5 mg/L		10 mg/L	
Faecal coliforms	>23 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

C.33 FW01 PARAGUAY RIVER – PROJECT'S ADA – POINT LOCATED 2.5 KM UPSTREAM BEFORE THE EFFLUENT DISCHARGE POINT.

TABLE 33. OUT-OF-RANGE PARAMETERS FW 01 – PARAGUAY RIVER				
COD: FW 01	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	64	15	44	5
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Total phosphorus	0,0694 mg/L		0,05 mg/L	
Ammonia	0,0989 mg/L		0,02 mg/L	
Nitrites	0,01533 mg/L		1 mg/L	
Manganese	0,113 mg/L		0,1 mg/L	
Soluble Iron	1,52 mg/L		0,3 mg/L	

C.34 **FW02 PARAGUAY RIVER – PROJECT'S ADA –POINT LOCATED 2.5 KM DOWNSTREAM OF THE EFFLUENT DISCHARGE POINT**.

TABLA 34. OUT-OF-RANGE PARAMETERS FW 02				
COD: FW 02	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	64	15	46	3
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**REGULATION SEAM 222/02 PERMISSIBLE LIMITS**	
Ammonia	0,0441 mg/L		0,02	
Manganese	0,144 mg/L		0,1 mg/L	
Soluble iron	0,804 mg/L		0,3 mg/L	

C.35 MONITORING WELL GW01 LOCATED IN THE ADA OF THE INDUSTRIAL PLANT

TABLA 35. OUT-OF-RANGE PARAMETERS GW 01	
COD:	PARAMETERS

GW 01	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	23	5	5	13

OUT-OF-RANGE PARAMETER	LABORATORY RESULTS	REGULATION SEAM 222/02 LAW 1614/2000 y NP 24 001 80 PERMISSIBLE LIMITS
Electric conductivity	2400	1250
Total dissolved solids	1.181	500
Hardness	281	300
Total phosphorus	0,356	0,05
Total nitrogen	2,73	0,6
Chlorides	285	250
Alkalinity	397	250
Sulfates	337	250
Sodium	374	200
Fluorine	2,30	1,5
E Coli	Presence	Absent
Fecal coliforms	>23 NMP/100mL	1,1 NMP/100mL
Total coliforms	>23 NMP/100mL	1,1 NMP/100mL

C.36 MONITORING WELL GW02 LOCATED IN THE ADA OF THE INDUSTRIAL PLANT

TABLA 36. OUT-OF-RANGE PARAMETERS GW 02				
COD: GW 02	PARAMETROS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	23	5	14	4

OUT-OF-RANGE PARAMETER	LABORATORY RESULTS	REGULATION SEAM 222/02 LAW 1614/2000 y NP 24 001 80 PERMISSIBLE LIMITS
Hardness	84	300
Total phosphorus	0,0776	0,05
Potassium	16,5	12
Fluorine	1,60	1,5

C.37 MONITORING WELL GW04 LOCATED IN THE ADA OF THE INDUSTRIAL PLANT

TABLA 37. OUT-OF-RANGE PARAMETERS GW 04				
COD: GW 04	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	23	5	5	13

OUT-OF-RANGE PARAMETER	LABORATORY RESULTS	LÍMITS: REGULATION SEAM 222/02 LAW 1614/2000 y NP 24 001 80
Electric Conductivity	5.010	1250
TDS	2.577	500
Hardness	709	300
Total phosphorus	12	0,05
Total nitrogen	9,02	0,6
Chlorides	611	250
Alkalinity	282	250
Sodium	367	200
Calcium	164	100

Magnesium	72,9	50
E Coli	Presence	Absent
Fecal coliforms	>23 NMP/100mL	1,1 NMP/100mL
Total coliforms	>23 NMP/100mL	1,1 NMP/100mL

C.38 MONITORING WELL GW05 LOCATED IN THE ADA OF THE INDUSTRIAL PLANT

TABLA 38. OUT-OF-RANGE PARAMETERS GW 05				
COD: GW 05	PARAMETERS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**LÍMITS REGULATION SEAM 222/02 LAW 1614/2000 y NP 24 001 80**	
Hardness	88,1		300	
E Coli	Presence		Absent	
Fecal coliforms	1,1 NMP/100mL		1,1 NMP/100mL	
Total coliforms	5,1 NMP/100mL		1,1 NMP/100mL	

C.39 MONITORING WELL GW06 LOCATED IN THE ADA OF THE INDUSTRIAL PLANT

TABLA 39. OUT-OF-RANGE PARAMETERS GW 06				
COD: GW 06	PARAMETROS			
	PARAMETER QUANTITY	NO LIMITS	COMPLY WITH THE LIMITS.	BEYOND THE LIMITS
	23	5	14	4
OUT-OF-RANGE PARAMETER	**LABORATORY RESULTS**		**LÍMITS: REGULATION SEAM 222/02 LAW 1614/2000 y NP 24 001 80**	
Total phosphorus	60 mg/L		0,05 mg/L	
Total nitrogen	0,073 mg/L		0,6 mg/L	
Fecal coliforms	9,2 NMP/100mL		1,1 NMP/100mL	
Total coliforms	>23 NMP/100mL		1,1 NMP/100mL	

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APPENDIX D.
PHOTOGRAPHY GALLERY OF THE FIRST MONITORING CAMPAIGN

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FW 104 - ZA

GW 18-ZA

FW 201-ST

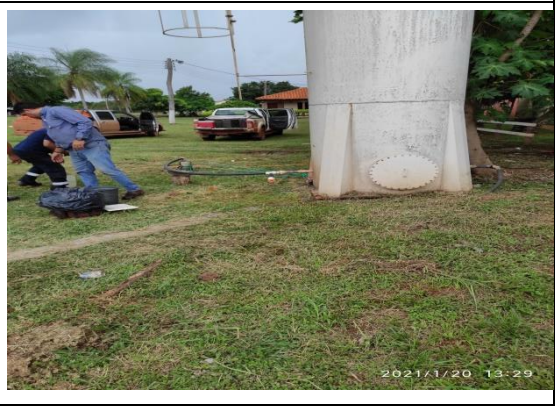
GW 20-ST

FW 315-HE

GW 19-HE

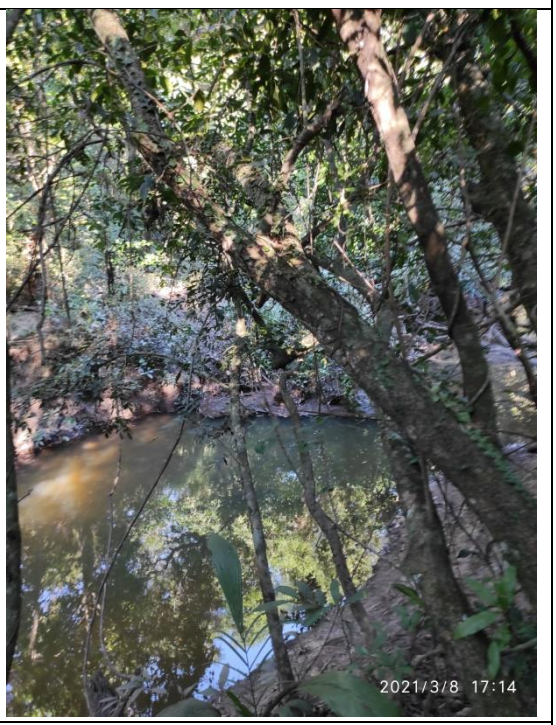
FW 304-HE

GW 23-SL



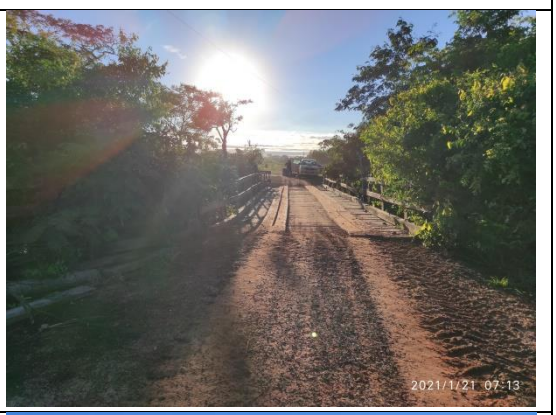
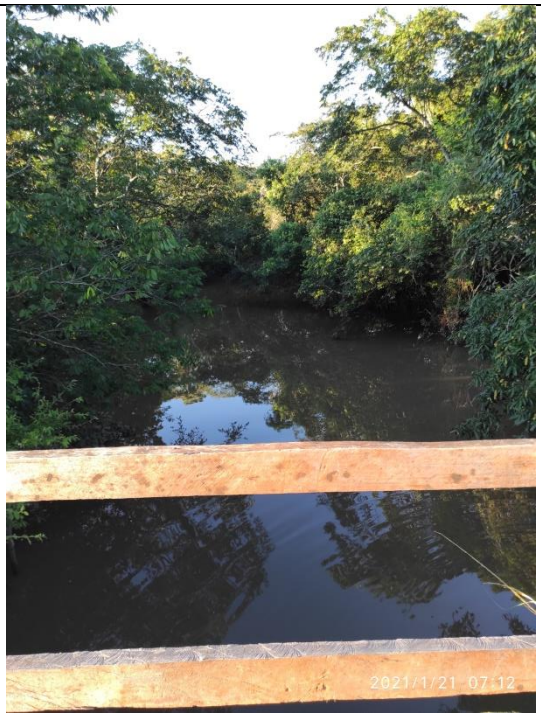
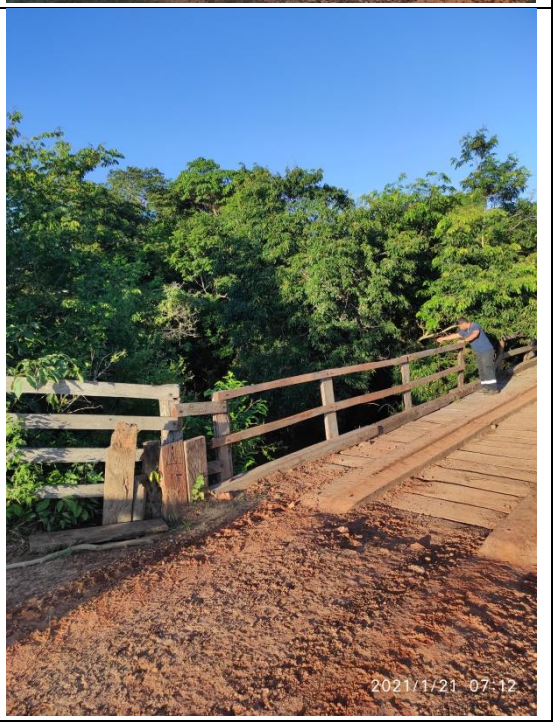
GW 16-GA

FW 100-GASL



FW 200-SL

FW 207-TR	

FW 208-TR	
	
	

GW 11-MICHEL

GW 10-TR

GW 13-SAN JUAN

FW 205-TR

GW 12- Laguna

FW 109-MYRZ

FW 115-MANDYJU

FW 317-RZ

FW 204-LB

FW 110-LB

FW 111-LB

FW 310-CR

FW 316-CR

GW 14-ZM

GW 15-SO

FW 306 -SO

GW 17-LP

GW 21-MC

FW 01

FW 02

GW 01

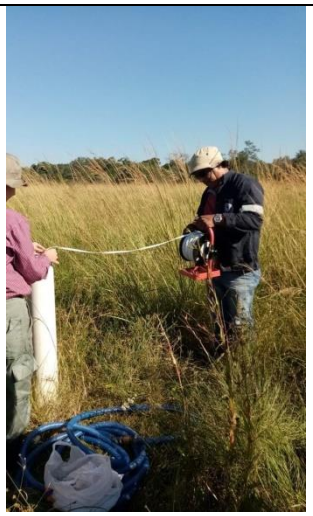
GW 02

GW 03

GW 04

GW 05

GW 06



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APPENDIX E.
SUPPLIERS NOTE

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Lasca

San Lorenzo, 20 de Abril de 2021

Dr. Gilberto Antonio Benitez
CEMIT.-
Presente.-

En relación los productos que fueron cotizados de la cartera ***SIGMA ALDRICH*** y que aún siguen pendientes de entrega, informamos que el motivo de la demora obedece a la crisis sanitaria actual, ya que los vuelos están supeditados a vuelos cargueros no comerciales (como es habitual), por lo que las fechas de embarque dependen exclusivamente de las informaciones que recibimos desde origen USA.

A la fecha seguimos aguardando confirmación de vuelo que estimamos sería dentro de este mes, de igual manera estamos duplicando esfuerzos para que estos tiempos logísticos demoren lo menos posible y podamos cumplir con sus necesidades

De nuestra mayor consideración.-

B.C. Rossana Vallejos.
Productos Químicos y Reactivos
Vicente Scavone & Cía. S.A.E

TRANSLATION

Note: texts between parenthesis and with different fonts are our comments and they describe certain particularities of the document, such as logos, and others.

(*There is a Logo:* **LASCA laboratory**)

San Lorenzo, 20th April, 2021

Dr. Gilberto Antonio López
CEMIT
Present:

Regarding to the products from SIGMA ALDRICH that are still pending delivery, we inform you that the reason for the delay is due to the current health crisis, since the flights depends on non-commercial cargo flights (as usual), so the shipment dates rest exclusively on the information we receive from the USA.

We are still awaiting confirmation of the flight, which we estimate will be within this month. We are also doubling our efforts so that these logistical issues can be solve as soon as possible so we can meet your needs.

Kind regards,

B.C. Rossana Vallejos
Reagents and chemical products
Vicente Scavone & Cía. S.A.E