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ENVIRONMENTAL IMPACT STUDY (EIA-RIMA)

LD Celulose S/A

Dissolving pulp mill in Indianópolis and Araguari cities, at Minas Gerais State

VOLUME II – ENVIRONMENTAL DIAGNOSIS

TOMO I – PHISICAL ENVIRONMENT

Content

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LD Celulose E
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Orig.	19/10/18 –hbo	19/10/18 – bvv	19/10/18 – hfw	19/10/18 – hfw	Para informação
Rev.	Data/Autor	Data/Verificado	Data/Aprovado	Data/Autorizado	Observações

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7 AREAS OF INFLUENCE DEMARCATION

In this item there are presented the geographical boundaries of the areas that will directly and/or indirectly be affected by impacts of the enterprise, named the area of influence of the project.

The limits include the incidence areas of the cumulative and synergistic impacts, covering the different environmental contours for the several variables focused in this study.

Following there are presented the justifications for the definition of each area of influence which incide the impacts, with their respectively maps.

7.1 Directly Affected Area (ADA)

The Directly Affected Area comprises the L.D Celulose inter region property, where exactly the works and erection of the industrial unit will be held, in addition to the areas of the water intake pipeline, terrestrial effluent pipeline construction.

7.2 Direct Area of Influence (AID)

The Direct Area of Influence, for the physical and biotic environments, was defined from a radius of 3 km around the enterprise area, in particular due to the atmospheric emissions dispersion study of the future dissolving pulp mill, and 100 m on each side of the water intake pipeline and terrestrial effluent pipeline path.

The Direct Area of Influence for the socioeconomic environment is composed by the Indianópolis-MG and Araguari-MG municipalities.

7.3 Indirect Area of Influence (AII)

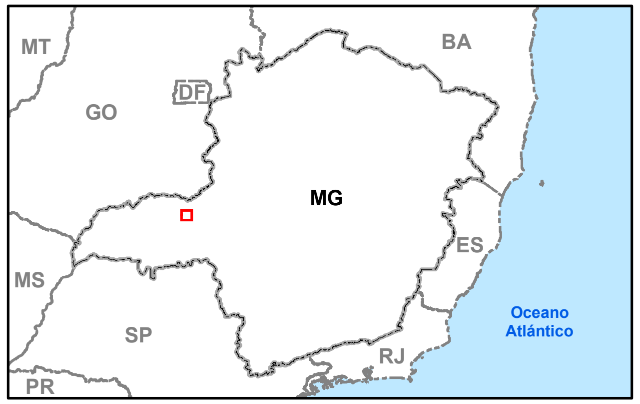
The Indirect Area of Influence for the physical and biotic environments comprises the sub basin set from Water Planning Units (UPH) of Araguari and Dourados Rivers.

The Direct Area of Influence for the socioeconomic environment is composed by the Uberlândia – MG and Estrela do Sul – MG municipalities.

The following figures present the maps of the project areas of influence (ADA, AID and AII) for the physical, biotic and socioeconomic environments.

Figure 1 – Directly Affected Area Map (ADA).

LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

Área Diretamente Afetada - ADA

Área do Empreendimento

Duto 22,8 km

Limite Municipal

ESCALA GRÁFICA: 0 1 2 4 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografias (IBGE, 2015);
- Imagem de Satelite (Esri/Digital Globe, 07/06/2015

PÖYRY

PROJETO AMADEUS

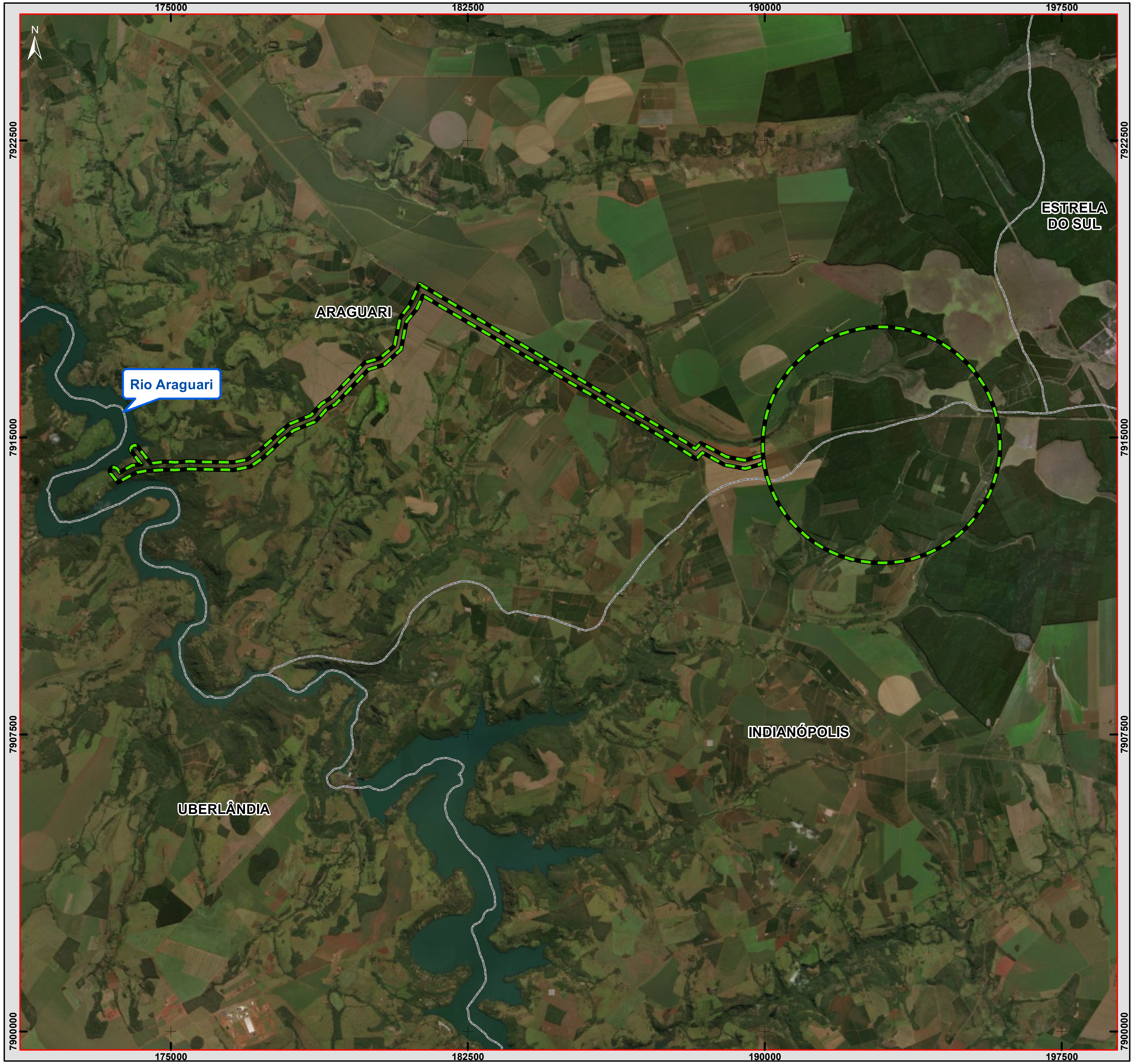
ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

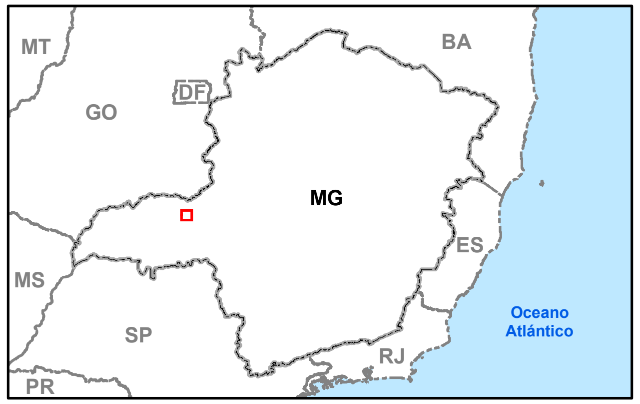
ÁREA DIRETAMENTE AFFETADA (ADA)

ESCALA:	1:100.000	DATA:	Outubro/2018		
DESENHO Nº	XXX	FOLHA:	1/1	TAMANHO:	A3
RESP. TÉCNICO:		ASSINATURA:		REV:	0

Figure 2 – Direct Area of Influence Map (AID) for the physical and biotic environments.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

Área de Influência Direta - AID

Limite Municipal

ESCALA GRÁFICA:

0 1 2 4 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografias (IBGE, 2015);
- Imagem de Satelite (Esri/Digital Globe, 07/06/2015

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

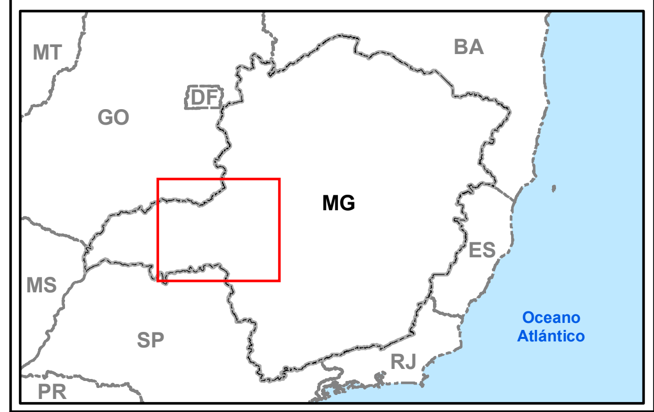
UPH - RIO ARAGUARI/UPH - RIO DOURADOS

ÁREA DE INFLUÊNCIA DIRETA (AID)

ESCALA: 1:100.000		DATA: Outubro/2018	
DESENHO Nº XXX	FOLHA: 1/1	TAMANHO: A3	
RESP. TÉCNICO:	ASSINATURA:	REV: 0	

Figure 3 – Indirect Area of Influence Map (AII) for the physical and biotic environments.

LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UPGRH (IGAM, 2017)
- Solos (EMBRAPA, 2006)

PÖYRY

PROJETO AMADEUS

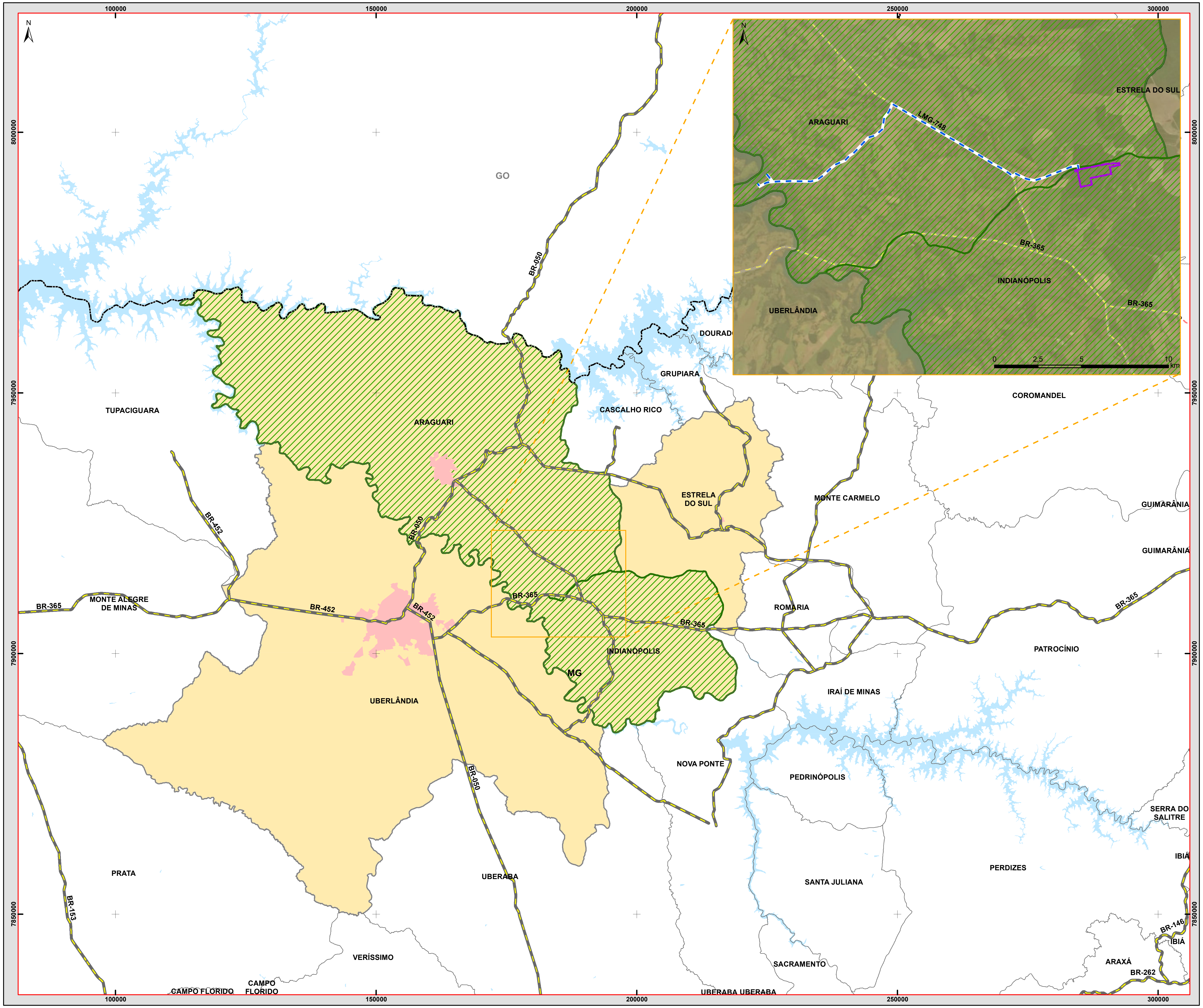
ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

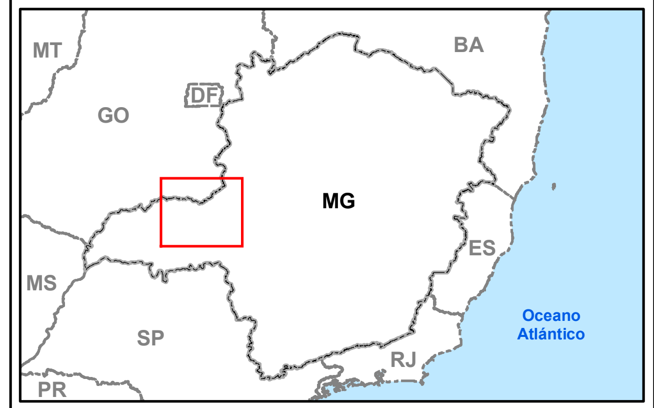
AII PARA OS MEIOS FÍSICO E BIOTICO

ESCALA: 1:750.000		DATA: Junho/2018	
DESENHO Nº XXX	FOLHA: 1/1	TAMANHO: A2	
RESP. TÉCNICO:	ASSINATURA:		REV: 0

Figure 4 – Direct and Indirect Area of Influence Map (AID e AII) for the socioeconomic environment.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Linha de Transmissão
- Tubulação 22 km
- Rodovia de Acesso - 5 km
- AID para o Meio Socioeconômico - Municípios de Araguari e Indianópolis
- AII para o Meio Socioeconômico - Municípios de Araguari, Indianópolis, Estrela do Sul e Uberlândia
- Via Pavimentada
- Área Urbana
- Corpo D'água
- Limite Municipal
- Limite Estadual

ESCALA GRÁFICA:
0 5 10 20 30 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografia (IBGE, 2015);
- Área Urbana (IBGE, 2005)
- Vias (DENIT, 2017)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

ARAGUARI, ESTRELA DO SUL, INDIANÓPOLIS E UBERLÂNDIA

AII E AID - SOCIOECONÔMICO

ESCALA: 1:500.000	DATA: Outubro/2018	
DESENHO Nº XXX	FOLHA: 1/1	TAMANHO: A2
RESP. TÉCNICO:	ASSINATURA:	REV.: 0

8 ENVIRONMENTAL DIAGNOSIS

8.1 Physical Environment

The physical environment diagnosis allows to be observed the current climate and meteorology state, the air quality, noise, geology, geomorphology, pedology, caving and hydrology (surface and underground water resources) of the studied area and thus, to be obtained an appropriate environmental impact assessment related to the implementation and operation of the enterprise.

For the primary and secondary data collection it was considered the areas of influence, namely:

- AII – sub basin set from Water Planning Units (UPH) of Araguari and Dourados Rivers;
- AID – radius of 3 km around the enterprise area, in particular due to the atmospheric emissions dispersion study of the future dissolving pulp mill, and 100 m on each side of the water intake pipeline and terrestrial effluent pipeline path;
- ADA –the inter region of L.D Celulose property, where exactly the works and erection of the industrial unit will be held, in addition to the areas of the water intake pipeline, terrestrial effluent pipeline construction.

8.1.1 Climate and Meteorology

8.1.1.1 Introduction

The climate of the Triângulo Mineiro region, on which the project will be inserted according to the Köppen classification, is of Aw type, i.e. it has a dry winter and a rainy summer, predominantly dominated by intertropicais and polar systems (MENDES, 2001). The region is hit by air masses from the South as the Antarctic Polar front (FPA) and the Polar Mass (MP), East (East waves) and West (tropical instability). It also suffers the influence of the South Atlantic Convergence Zone (ZCAS), which are responsible for the heavy and prolonged rains. The FPA influences the ZCAS funneling moisture from the Amazon to the Southeast Brazilian region.

The project will be held mainly in the Indianapolis city (mill site) and also in Araguari city (water intake and treted effluent disposal pipelines), but at these cities there are no historical data to climate and meteorology. Thus, it was found that the Uberlândia municipality, which is approximately 37 km from the enterprise has a weather station with a good historical data series. Therefore, to characterize the climate of the region, it was used the data of meteorological station at Uberlândia.

According to the macroclimas of Brazil classification, the Uberlândia city, situated near the project, as mentioned, is located in a region of subhot climate, variety of CWa (with thermal averages) ranging from 19° C to 27° C and average rainfall around 1500 mm/year.

Ribeiro et al (2000) notes that in the Uberlândia city there are clear the problems related to the low relative moisture presented in the afternoons of the dry season days, when there are not rare moisture level below 20%.

The atmospheric dynamics is important to the climate of the region. In the summer time, these are represented by the Continental Tropical and Continental Equatorial air masses, producing high thermal amplitudes. With the arrival of the front system and the Polar mass, the atmospheric systems tend to homogenize the temperature and moisture.

Del Grossi comments that the atmospheric dynamics in Uberlândia is under control, mainly, of intertropicais systems, which participation in the course of the year is more than 50%, completed with the action of polar systems, which participation is a little more than 25%.

Mendes (2001) studied the structural rain genesis in the city of Uberlândia, noting that the atmospheric systems presents a certain balance, being the most active the front Polar system-FP (35.8%) and the pre Frontal System-IT (26.1%) as instability formers and the Tropical Atlantic Continental System-TAc (27.6%) as producer of stability.

8.1.1.2 Methodology

The climate characterization of the region in which the project will be inserted considered the following parameters: rainfall, temperature, relative moisture, insolation and radiation, winds direction and speed and hydric balance.

There are presented and handled the data obtained from the records produced series by the monitoring network of the National Institute of Meteorology (INMET, 2018) in Uberlândia. There were also used data from the work carried out by SILVA and ASSUNÇÃO (2004), with weather data for the period from 1981 to 2003.

The following table presents the hydro metheorology station that was used for this present study with its respective coordinates, the institute responsible for it and the used meteorological parameters. The following figure displays the location of the used climatological station in relation to the project area.

Table 1 – Hydro metheorology station used in the study

Posto Hidrometeorológico	Coordenadas UTM WGS84	Cidade	Instituto Responsável	Parâmetros Meteorológicos	Intervalo de dados	Distância em relação à ADA (km)
A507 - Uberlândia	22K 789.072 / 7.906.102	Uberlândia	INMET	Precipitação, Temperatura do Ar, Umidade, Insolação, Ventos e Balanço Hídrico.	2002 a 2017	37,0

Source: INMET, 2018.

Figure 5 – Location of weather station used in the study.

8.1.1.3 Rainfall

According to SILVA and ASSUNÇÃO (2004), the rainfall regime in Uberlândia is well characterized: the rains are concentrated from October to March, representing 86.7 percent of the total annual precipitation. The month with the highest rainfall average is on December (318.9 mm), followed by January (311.6 mm). The months with lower rainfall averages are June and August, with 15.3 mm, and July with 8.7 mm.

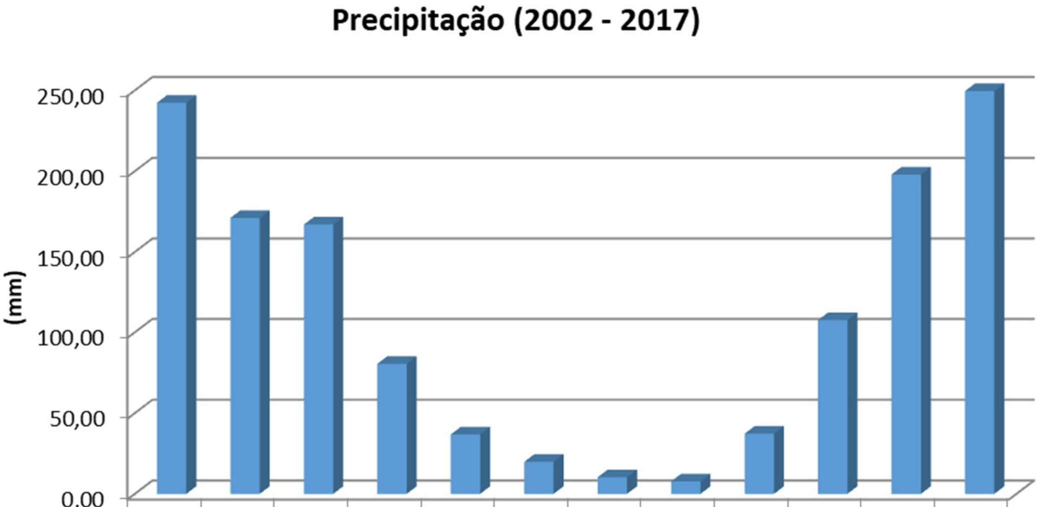
The average annual rainfall totals in the period (1981-2003) was of 1583.6 mm, the largest occurrence (2220.1 mm) was recorded in 1982 and the smallest occurrence (1012.6 mm) in 1990. The rains from the Decade of 1990 were more constant than in the previous decade.

Still according to SILVA and ASSUNÇÃO (2004), when a rainfall precipitation is concentrated in a short period of time and according to the physical conditions of the sites, large impacts are recorded, because the installed infrastructure often don't support the runoff as a result of the rains. The greatest 24-hour rainfall records between 1981 and 2003 occurred in January of 1986 (157.8 mm) and December of 2002 (147.0 mm).

The average rainy days in Uberlândia, according to SILVA and ASSUNÇÃO (2004), is 120 days; being the biggest record occurred in 1983 (149 days) and the lowest in 1999 (93 days). The month with the highest number of rainy days is December with 20 days on average, followed by January (19 days). The months with the lowest raining averages are June and July, with 1 day on average; and on August with 2 days of raining average.

The highest occurrence of rainfall precipitation days in the month of January was in 1982, with 26 raining days. In 1997 was the year in which occurred the greatest amount of rainy days in the winter time, 6 days, in which 56 mm of rain was recorded in July 1997.

According to INMET precipitation data in Uberlândia in the period of 2002-2017, the annual rain average was 1327.68 mm, being the months of December and January the wetterst, with 249.53 mm and 242.30 mm of rainfall, respectively. The least rainy months were July and August with 10.31 mm and 7.73 mm of rainfall, respectively (as shown in the following figure).



	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
Prec. (mm)	242,30	171,04	166,95	80,46	36,77	19,86	10,31	7,73	37,23	107,54	197,96	249,53

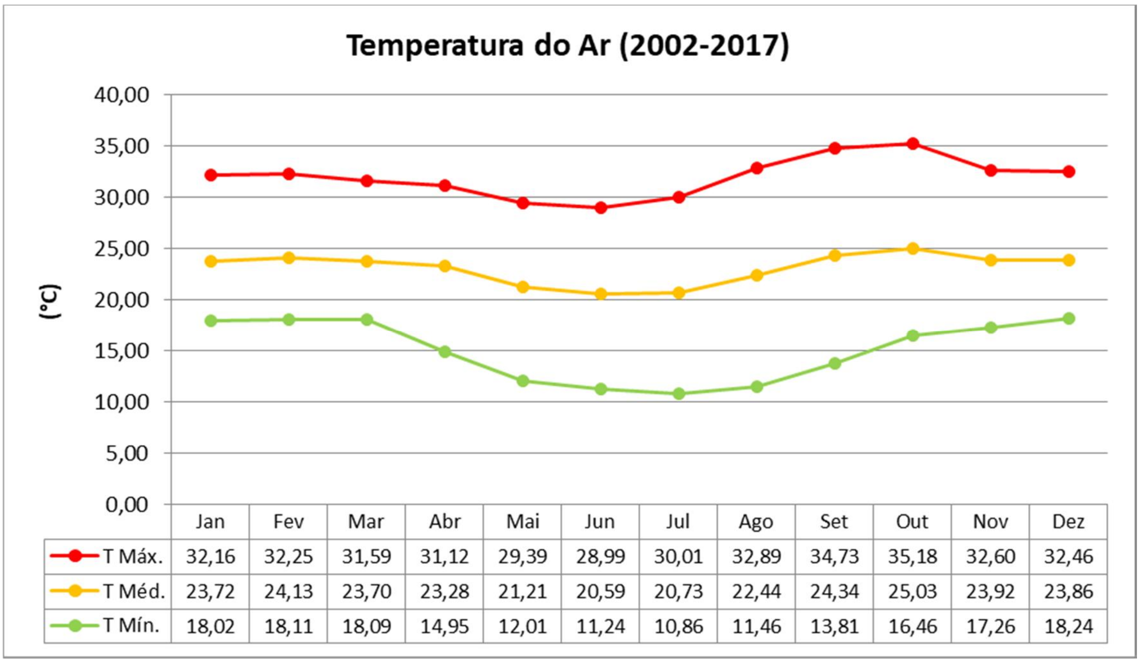
Figure 6 – Rainfall precipitation at Uberlândia station (2002-2017). Source: INMET, 2018.

8.1.1.4 Air temperature

According to SILVA and ASSUNÇÃO (2004), the average temperature in the city of Uberlândia, between 1981 and 2003, was 22.3°C. These values, over the months, present few variations, being the lowest average registered in the month of June (19.3°C) and highest average in the month of October (23.9°C). Analyzing the averages per each weather station, it turns out that the average temperature of the summer was 23.5°C; of the fall was 20.9°C; of the winter was 21.0°C; and of the spring was 23.6°C.

The absolute maximum temperature, between 1991 and 2003, had the largest averages in the months of July and August, which showed an average of 30.3°C and 33.1°C, respectively. The absolute minimum monthly averages temperature remained constant during the summer time, with averages of 18.4°C in the months of January and February; the lowest average temperature occurred in the month of July with 11.1° C.

INMET data for the period from 2002-2017, shown in the following figure, pointed out that the average air temperature was 23.08° C over the period, with the lowest average presented in the month of June (20.59° C) and the highest in the month of October (25.03° C). The highest absolute maximum averages occurred on October and September (35.18 and 34.73° C, respectively) and the lowest on June and May (28.99 and29.39° C, respectively). The absolute minimum averages exhibited a behavior similar to that illustrated by SILVA and ASSUNÇÃO (2004): the smallest minimum averages occurred on June (11.24° C) and July (10.86° C) and the highest minimum averages occurred on February (18.11° C), and March (18.09° C).



	Jan	Fev	Mar	Abr	Mai	Jun	Jul	Ago	Set	Out	Nov	Dez
T Máx.	32,16	32,25	31,59	31,12	29,39	28,99	30,01	32,89	34,73	35,18	32,60	32,46
T Méd.	23,72	24,13	23,70	23,28	21,21	20,59	20,73	22,44	24,34	25,03	23,92	23,86
T Mín.	18,02	18,11	18,09	14,95	12,01	11,24	10,86	11,46	13,81	16,46	17,26	18,24

Figure 7 – Air temperature at Uberlândia station (2002-2017). Source: INMET, 2018.

8.1.1.5 Relative air moisture

The average relative air moisture was 71% for the period of 1981-2003 (SILVA and ASSUNÇÃO, 2004), and the variation between the highest and the lowest average annual range was 21%. However, this value does not reflect the variations in the afternoon, when indexes are under 30%. The lowest average registered during this period occurred in the month of August with 58% and the highest in the months of January and December (80%). For seven months (rainy season) the relative air moisture varied between 73 and 80%.

The INMET data for the period of 2002-2017, shown in the following figure, presented indexes lower than those presented by SILVA and ASSUNÇÃO, 2004. The annual air moisture average for the period was 61%. The lowest monthly average occurred in August (43.0%) and the highest monthly average occurred in the months of January and March (72.37 and 71.78%).

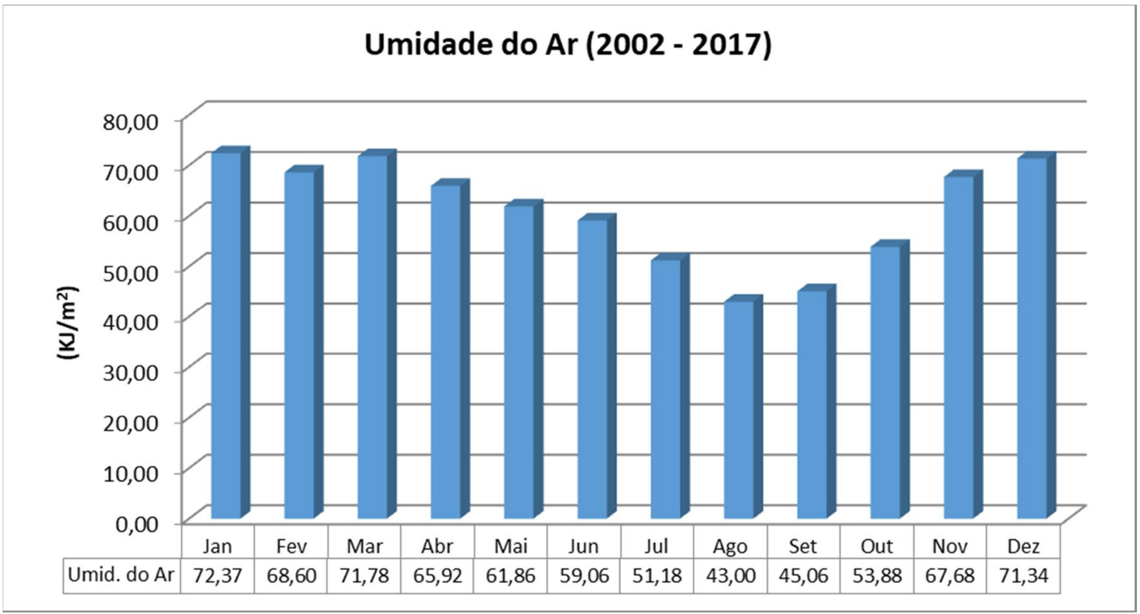


Figure 8 – Air moisture at Uberlândia station (2002-2017). Source: INMET, 2018.

8.1.1.6 Insolation and Global Radiation

The data submitted by SILVA and ASSUNÇÃO (2004) are presented as total insolation (hours/day) while the data obtained on INMET (2018) are presented in the form of global solar radiation (KJ/m2).

The data from SILVA and ASSUNÇÃO (2004), for the period from 1981 to 2003, obtained as average insolation 2491.2 hours; the highest monthly average occurred on July (253.4 hours) and the lowest on December (160.5 hours). The months of April to October showed an insolation that ranged in 50.4 hours, remaining above 200 hours of average insolation.

The data from INMET (2018), for the period from 2002 to 2017, presented the global average solar radiation as 1609.36 KJ/m2, being the lowest value registered on June (1448.6 KJ/m2) and the highest on September (1785.79 KJ/m2) (as the following figure).

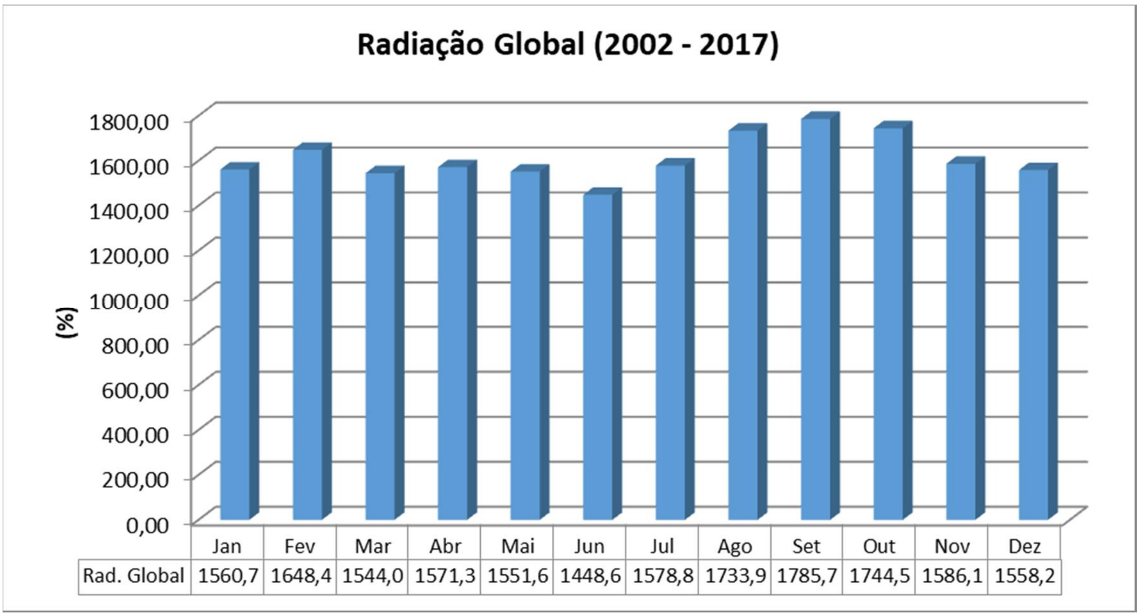


Figure 9 – Global solar radiation at Uberlândia station (2002-2017). Source: INMET, 2018.

8.1.1.7 Winds Direction and Speed

The average wind speed at Uberlândia station (INMET, 2018) in period from 2002-2017 was 1.92 m/s (as the following figure), being highest averages presented in August (2.16 m/s) and September (2.28 m/s); while that lowest averages values occurred in the months of February (1.73 m/s) and March (1.71 m/s).

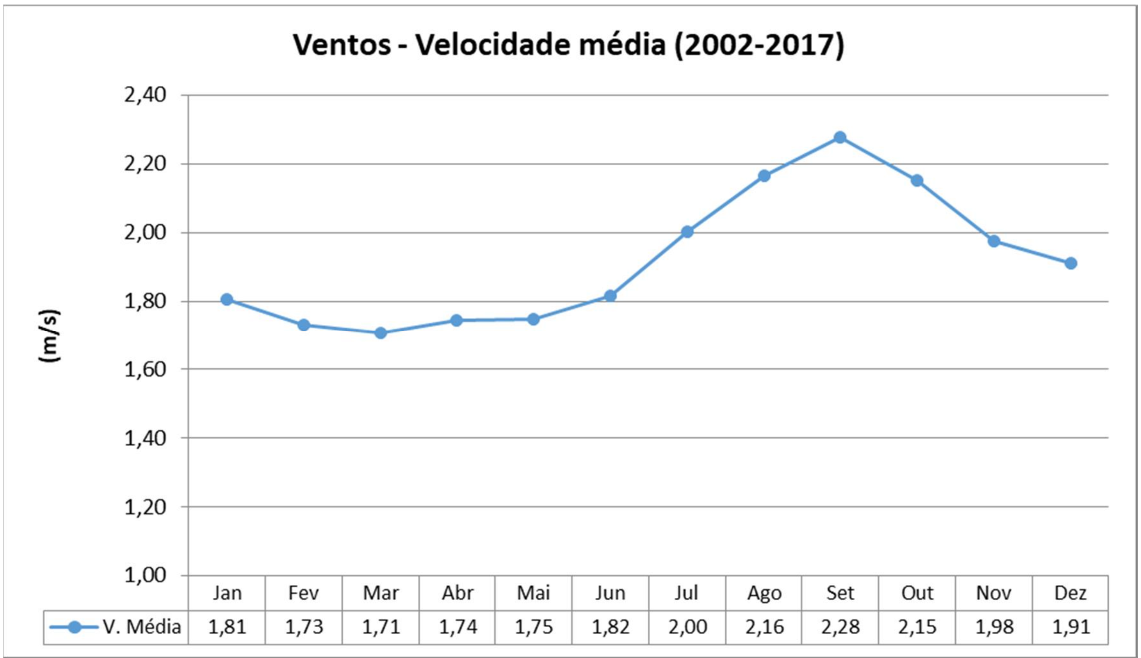


Figure 10 – Average wind speed at Uberlândia station (2002-2017). Source: INMET, 2018.

The gusts of winds at the period from 2002 to 2017 (INMET, 2018), showed highest rates on November (15.71 m/s) and December (16.05 m/s); the lowest rates occurred in the months of April (12.19 m/s) and July (12.67 m/s) (as shown in the following figure).

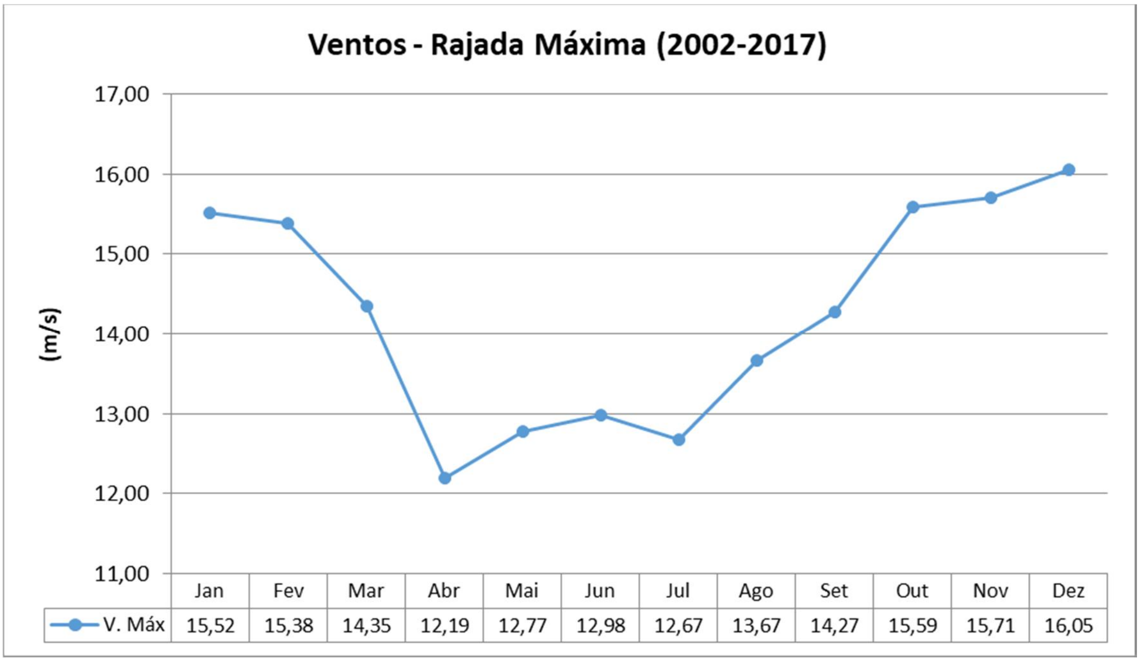


Figure 11 – Maximum gusts of winds at Uberlândia station (2002-2017). Source: INMET, 2018.

In relation to the preferred winds direction, at Uberlândia station, they presented to prefer the direction E/NE (East and Northeast), with secondary components to N (North) during the year (as noted in the following figures).

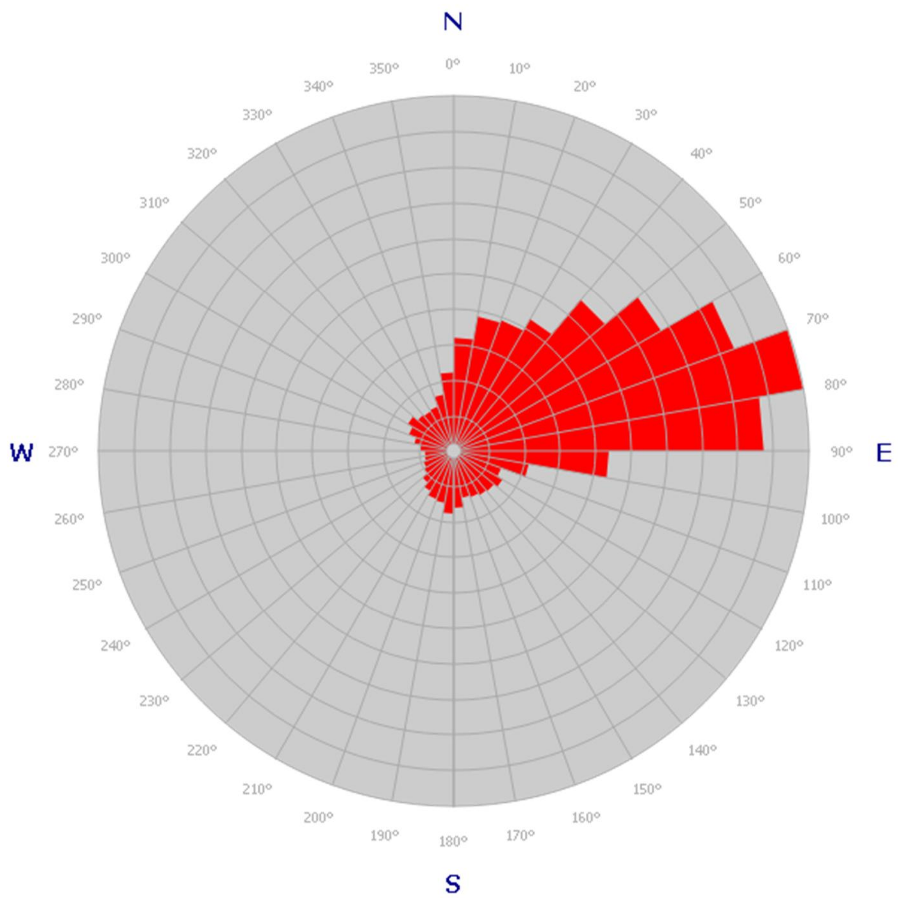


Figure 12 – Wind Compass for the period from 2002-2017. Source: INMET, 2018.

8.1.1.8 Hydric Balance

The hydric balance calculation was performed for the period from 1981 to 2003, including the total annual and the monthly averages of all the studied period (SILVA and ASSUNÇÃO, 2004) (as shown in the following figure).

In the months of January to March, the rain precipitation exceeds the soil evapotranspiration and from April until August, the rainfall is reduced or even non-existent. The hydro replacement begins on September, extending through the month of December.

The average rainfall for the period in question was 1583.6 mm; the average ETR (real evapotranspiration) at the studied period was 919.7 mm; the hydro deficit is therefore 170.5 mm and the hydro surplus is 627.4 mm. The average hydro replacement capacity is only normalized in the month of December.

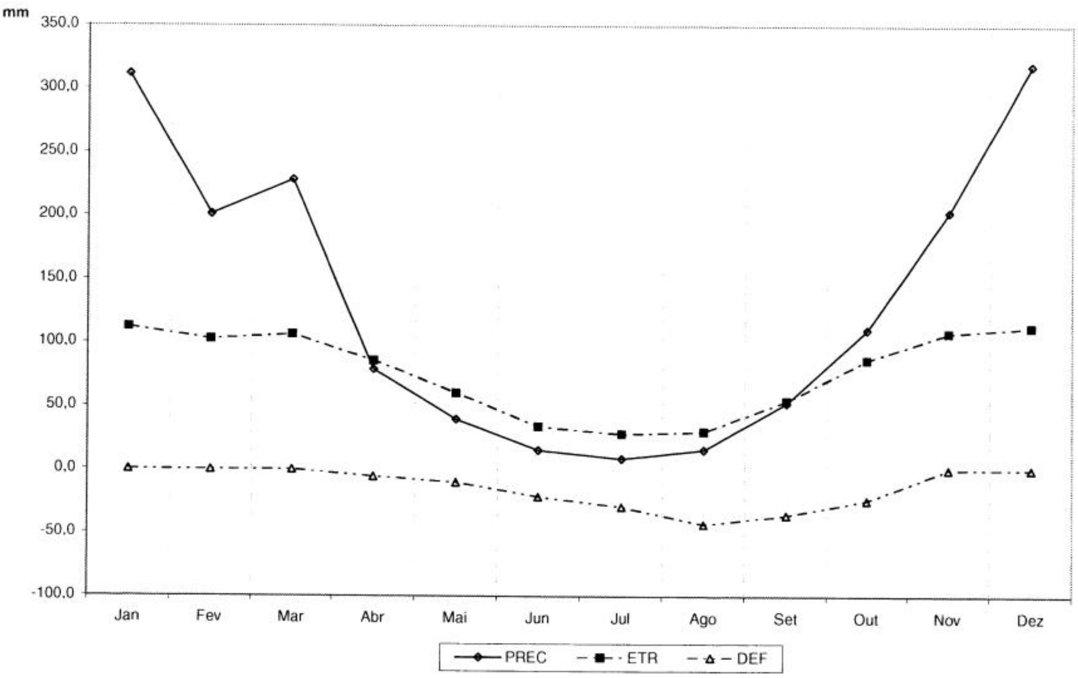


Figure 13 – Hydric Balance (1981-2003). Source: SILVA and ASSUNÇÃO, 2004.

8.1.2 Air Quality

8.1.2.1 Introduction

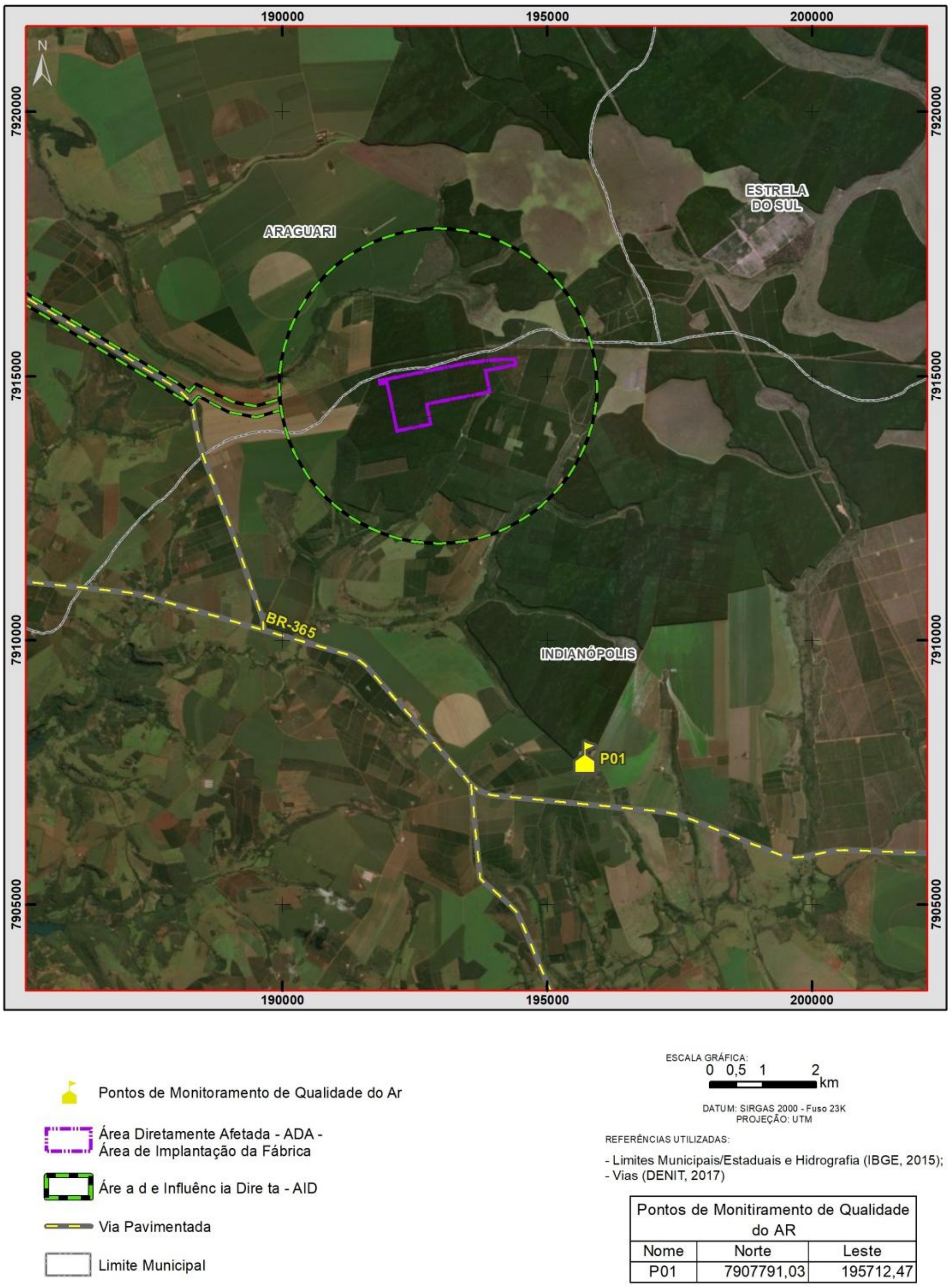
To monitor the air quality at the State of Minas Gerais, FEAM operates air quality monitoring network consisting of 10 automatic stations located at RMBH (Metropolitan region of Belo Horizonte), as well as other 19 automatic stations installed in other 6 municipalities. The referred automatic monitoring network covers the following cities: Belo Horizonte, Betim, Contagem, Ibirité, Ipatinga, Itabira, Paracatu, São José da Lapa, Timóteo. These stations are too far apart from the area focused on this job, not being representative the air quality of the studied area. For this reason, these data were not presented.

Thus, for the environment air quality assessment, there were held two monitoring campaigns near the highway BR-365 at 574 km in the municipality of Estrela do Sul, MG. In this chapter there is presented a summary of the monitoring point location, the monitoring period, the analyzed parameters, the equipment and standards methodology used, and the results of the two campaigns.

The complete and detailed reports of the two air monitoring campaigns are presented in Volume IV of this Environmental Impact Assessment (EIA).

8.1.2.2 Monitoring point location

The following figure shows the point location designated to monitor the air quality, in yellow, being Uberlândia city at left of the figure; from which linear distance is 20 km.



Pontos de Monitiramento de Qualidade do AR		
Nome	Norte	Leste
P01	7907791,03	195712,47

Figure 14 – Air quality sampling point location.

The selected point followed the criteria of region and surroundings representativeness, respecting logistics, environmental and infrastructure aspects, which were:

- Relatively easy to access during daytime operation, every week day;
- Availability of near and reliable electrical power source.

In the following figure there are showed the equipment used during sampling campaigns.

Figure 15 – Overall vision of the equipment at the sampling point.

8.1.2.3 Monitoring period

The first monitoring campaign occurred in the rainy season, from 26/03/2018 to 03/04/2018, and the second campaign in the dry period from 27/04/2018 to 03/05/2018. Both campaigns have been carried out for 7 consecutive days and lasting 24 hours/day.

8.1.2.4 Analyzed parameters, equipment and methodology standards used

The following table summarises the analyzed parameters, the equipment and the methodology standards used in both the campaigns of air quality monitoring.

Table 2 – Analyzed parameters, equipment and methodology

Parâmetro	Sigla	Equipamento	Metodologias	Duração das Coletas	Duração da Campanha
Partículas Totais em Suspensão	PTS	AGV[1] PTS	NBR 9547/1997	24h/dia	7 dias consecutivos
Partículas Inaláveis	MP10	AGV[1] MP10	NBR 13.412/1995		
Ozônio	O3	2B Technologies	US EPA 901-O3 Model 202		
Dióxido de Nitrogênio	NO2	APV[2] Trigás	US EPA EQN-1277-026		
Dióxido de Enxofre	SO2		NBR 12.979		
Sulfeto de Hidrogênio	H2S		Met. CETESB L9.223		
Compostos Reduzidos de Enxofre	ERT		Standard Methods SM22 3120B	3h/dia	
Monóxido de Carbono	CO	GfG460	ISO 17025	1h/dia	

1 - AGV – High-volume sampler, 2 - APV – Low-volume sampler

8.1.2.5 Results

The air quality monitoring was conducted to determine the pollutants concentrations of the universally parameters known as air quality indicators. They are:

- PTS – Total suspended particles,
- PI – Inhalable Particles, referred by MP_{10} – particulate matter with diameter less than 10µm
- SO_2 - Sulphur dioxide (SO_2),
- NO_2 - Nitrogen dioxide (NO_2),
- CO - Carbon monoxide (CO),
- O_3 – Ozone
- ERT – Total reduced sulphur
- H_2S – Hydrogen sulfide.

In Brazil, the air quality standards were stablished by the National Environmental Council (CONAMA), through Resolution nº 03/90, adopted also in Minas Gerais. Among the pollutants presented above, the ones stablished at the referred Resolution are: PTS, PI, SO2, NO2, CO, O3.

8.1.2.5.1 First campaign results

The first campaign was held from 26/03/2018 to 03/04/2018 during 7 consecutive days, 24 hours/day, whose results are presented in the following tables.

Table 3 – PTS concentration registered at the sampling campaign.

Date	Mass (g)	Uncertainty (g)	Volume (m^3)	Uncertainty (m^3)	Concentration ($\mu g/m^3$)	Uncertainty ($\mu g/m^3$)
26/03/2018	0.2448	0.0004	1938.6	54.0	126.3	3.5
27/03/2018	0.3008	0.0037	1905.9	55.3	157.8	5.0
28/03/2018	0.2984	0.0003	1807.8	59.5	165.0	5.4
29/03/2018	0.3288	0.0004	1890.4	62.1	174.0	5.7
30/03/2018	0.4161	0.0004	1911.3	57.7	217.7	6.6
31/03/2018	0.1419	0.0005	1888.7	42.1	75.1	1.7
Domingo 01/04/2018	0.0441	0.0004	1973.6	59.1	22.4	0.7
CONAMA Resolution nº 03/1990						
Primary Standard = 240 $\mu g/m^3$			Secondary Standard = 150 $\mu g/m^3$			

Obs.(1) LI = limite inferior de quantificação igual a 2,0 µg/m³; LS = limite superior de quantificação igual a 750,0 µg/m³. A Incerteza é obtida através do método analítico descrito em "*Joint Committee for Guides in Metrology (JCGM/WG1). Evaluation of measurement data — Guide to the expression of uncertainty in measurement*. http://www.iso.org/sites/JCGM/JCGM-introduction.htm"

Table 4 – MP_{10} concentration registered at the sampling campaign.

Date	Mass (g)	Uncertainty (g)	Volume (m^3)	Uncertainty (m^3)	Concentration ($\mu g/m^3$)	Uncertainty ($\mu g/m^3$)
26/03/2018	0.0143	0.0004	246.0	5.1	CANCELADA[4]	---
27/03/2018	0.0534	0.0004	207.6	5.0	CANCELADA[4]	---
28/03/2018	0.1124	0.0003	0.0	119.8	CANCELADA[4]	---
29/03/2018	0.0896	0.0005	1465.2	5.5	61.2	0.4
30/03/2018	0.1065	0.0004	1498.4	5.1	71.1	0.4
31/03/2018	0.0501	0.0004	1546.2	5.0	32.4	0.3
Domingo 01/04/2018	0.0119	0.0004	1533.8	5.1	7.8	0.2
CONAMA Resolution nº 03/1990						
Primary Standard = 150 $\mu g/m^3$			Secondary Standard = 150 $\mu g/m^3$			

Obs.(1) LI = limite inferior de quantificação igual a 2,0 $\mu g/m^3$; LS = limite superior de quantificação igual a 750,0 $\mu g/m^3$. A Incerteza é obtida através do método analítico descrito em "*Joint Committee for Guides in Metrology (JCGM/WG1). Evaluation of measurement data — Guide to the expression of uncertainty in measurement*. http://www.iso.org/sites/JCGM/JCGM-introduction.htm". (4) Coleta inválida devido ao tempo de coleta <23h (NBR 13.412) e/ou oscilação excessiva na energia elétrica.

Table 5 – SO_2, NO_2 and ERT concentration registered at the air during the sampling campaign period.

Período das coletas de 24h	Concentração, tempo amostral e unidade.			
	SO2 – 24 h ($\mu g/m^3$)	NO2 – 1h ($\mu g/m^3$)	ERT – 3 h ($\mu g/m^3$)	H2S – 24 h ($\mu g/m^3$)
26/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
27/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
28/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
29/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
30/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
31/03/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
01/04/2018	<L.Q.	<L.Q.	<L.Q.	<L.Q.
Resolução CONAMA nº 03/1990				
Padrão Primário ($\mu g/m^3$)	365	320	Padrão Não Definido	Padrão Não Definido Odor Perceptível 6,36
Padrão Secundário ($\mu g/m^3$)	100	190		

Obs1. L.Q. – Limite de quantificação do método analítico utilizado.

Table 6 – O_3 and CO maximum hourly concentration at the air during the sampling campaign period.

Período das coletas de 24h	Concentração máxima diária	
	O3 – 1h (μg/m^3)	CO – 1h (ppm)
26/03/2018	58	<L.Q.
27/03/2018	54	<L.Q.
28/03/2018	57	<L.Q.
29/03/2018	42	<L.Q.
30/03/2018	64	<L.Q.
31/03/2018	75	<L.Q.
01/04/2018	67	<L.Q.
Resolução CONAMA n° 03/1990		
Padrão Primário (μg/m^3)	160	35
Padrão Secundário (μg/m^3)	160	35

Obs. As concentrações de ozônio são referentes às máximas concentrações médias de 1h obtidas durante cada dia.

Final Considerations – 1st Campaign

- Gaseous Pollutants

With regard to pollutants sampled whose air quality standards are established by CONAMA Resolution n° 03/1990, the results presented attendance for both primary as for the secondary standards, to the parameters: SO_2, NO_2, O_3 and CO. In the case of SO_2, NO_2 and CO concentrations they were so low that the respective limits of quantification (L.Q.) of the methods used were not reached.

There is no current legislation of air quality standard established for H_2S or ERT parameters, however, the concentrations are so low that the detection limit of the analytical methods applied were not reached.

- Particulates

With regard the sampled particulate pollutants, PTS and MP_{10}, whose air quality standards are established by CONAMA Resolutions n° 03/1990, the results presented show attendance for both parameters.

8.1.2.5.2 Second campaign results

The second campaign was held from 27/04/2018 to 03/05/2018 during 7 consecutive days, 24 hours/day, whose results are presented in the following tables.

Table 7 – PTS concentration registered at the sampling campaign.

Data	Massa (g)	Incerteza (g)	Volume (m^3)	Incerteza (m^3)	Concentração (µg/m^3)	Incerteza (µg/m^3)
27/04/2018	0,1963	0,0003	1986,4	65,7	98,8	3,3
28/04/2018	0,1933	0,0004	1747,4	75,4	110,6	4,8
29/04/2018	0,2934	0,0004	1994,4	71,0	147,1	5,2
30/04/2018	0,3151	0,0004	1978,9	65,7	159,2	5,3
01/05/2018	0,2778	0,0003	1930,2	65,1	143,9	4,9
02/05/2018	0,2956	0,0004	1996,7	78,1	148,1	5,8
03/05/2018	0,2126	0,0003	1974,9	65,9	107,7	3,6
Resolução CONAMA n^o 03/1990						
Padrão Primário = 240 µg/m^3			Padrão Secundário = 150 µg/m^3			

Obs. (1) LI = limite inferior de quantificação igual a 2,0 µg/m^3; (2) LS = limite superior de quantificação igual a 750,0 µg/m^3. (3) A Incerteza é obtida através do método analítico descrito em "*Joint Committee for Guides in Metrology (JCGM/WG1). Evaluation of measurement data — Guide to the expression of uncertainty in measurement*. http://www.iso.org/sites/JCGM/JCGM-introduction.htm "

Table 8 – MP_{10} concentration registered at the sampling campaign.

Data	Massa (g)	Incerteza (g)	Volume (m^3)	Incerteza (m^3)	Concentração (µg/m^3)	Incerteza (µg/m^3)
27/04/2018	0,0568	0,0004	1474,4	5,6	38,5	0,3
28/04/2018	0,0732	0,0003	1492,2	5,0	49,1	0,3
29/04/2018	0,0775	0,0004	1497,0	5,1	51,8	0,3
30/04/2018	0,1353	0,0003	1497,9	5,1	90,3	0,4
01/05/2018	0,1103	0,0004	1455,5	6,0	75,8	0,4
02/05/2018	0,1019	0,0005	1508,8	5,5	67,5	0,4
03/05/2018	0,0828	0,0003	1486,7	5,2	55,7	0,3
Resolução CONAMA n^o 03/1990						
Padrão Primário = 150 µg/m^3			Padrão Secundário = 150 µg/m^3			

Obs. (1) LI = limite inferior de quantificação igual a 2,0 µg/m^3; (2) LS = limite superior de quantificação igual a 750,0 µg/m^3. (3) A Incerteza é obtida através do método analítico descrito em "*Joint Committee for Guides in Metrology (JCGM/WG1). Evaluation of measurement data — Guide to the expression of uncertainty in measurement*. http://www.iso.org/sites/JCGM/JCGM-introduction.htm "

Table 9 – SO_2, NO_2 and ERT concentration registered at the air during the sampling campaign period.

Período das coletas de 24h	Concentração, tempo amostral e unidade			
	SO_2 – 24 h (µg/m³)	NO_2 – 1h (µg/m³)	ERT – 3 h (µg/m³)	H_2S– 24 h (µg/m³)
27/04/2018	7,8	<L.Q.	<L.Q.	<L.Q.
28/04/2018	17,6	<L.Q.	2006,9	<L.Q.
29/04/2018	21,3	<L.Q.	<L.Q.	<L.Q.
30/04/2018	27,1	<L.Q.	1505,2	<L.Q.
01/05/2018	22,1	<L.Q.	<L.Q.	<L.Q.
02/05/2018	25,3	<L.Q.	1447,5	<L.Q.
03/05/2018	30,1	<L.Q.	1046.2	<L.Q.
Resolução CONAMA nº 03/1990				
Padrão Primário (µg/m³)	365	320	Padrão Não Definido	Padrão Não Definido Odor Perceptível 6,36
Padrão Secundário (µg/m³)	100	190		

Obs1. L.Q. – Limite de quantificação do método analítico utilizado.

Table 10 – O_3 and CO maximum hourly concentration at the air during the sampling campaign period.

Período das coletas de 24h	Concentração máxima diária	
	O_3 – 1h (µg/m³)	CO – 1h (ppm)
27/04/2018	52,7	<L.Q.
28/04/2018	52,6	<L.Q.
29/04/2018	42,1	<L.Q.
30/04/2018	37,7	<L.Q.
01/05/2018	52,0	<L.Q.
02/05/2018	35.9	<L.Q.
03/05/2018	27,8	<L.Q.
Resolução CONAMA nº 03/1990		
Padrão Primário (µg/m³)	160	35
Padrão Secundário (µg/m³)	160	35

Obs. As concentrações de ozônio são referentes às máximas concentrações médias de 1h obtidas durante cada dia.

Final Considerations – 2nd Campaign

- Gaseous Pollutants

With regard to sampled pollutants whose air quality standards are established by CONAMA Resolution nº 03/1990, the results presented show attendance for both the primary as for the secondary standards, to the parameters: SO_2, NO_2, O_3 and CO. In the case of NO_2 and CO the concentrations were so low that the respective limits of quantification (L.Q.) of the methods used were not reached.

There is no current legislation of air quality standard established for H_2S, however, the concentrations are so low that the detection limit of the analytical method applied was not reached.

- ERT

There is no current legislation of air quality standard established for ERT parameter, however, three, among seven average concentrations of 3 hours were so low that the detection limit of the analytical method applied was not reached. There were four significant values and supposedly high. Analyzing these concentrations together to H_2S, there is an inconsistency because at the same sampling dates the H_2S concentrations were below the limit of quantification. Additionally, it is noted that the ERT analytical results come from the lab review analysis, which was drawn up by the laboratory after the initial reports were questioned by consulting firm, for being apparently inconsistent. Finally, it can assumed that these results are false-positives, which in the case of the ERT, although rare, can occur.

- Particulates

With regard to sampled particulate pollutants, PTS and MP10, whose air quality standards are established by CONAMA Resolutions n° 03/1990, the results presented attendance for both parameters.

8.1.3 Noise

8.1.3.1 Introduction

It was held one noise monitoring campaign at the surrounding of the future dissolving pulp mill implementation area in Indianapolis, as well as in Araguari cities, MG, which aimed to check the environment sound pressure level presented in the area, prior to the enterprise operation (as background).

The fieldwork for the environment sound pressure levels measurement was carried out by the Pöyry Tecnologia team on April 03rd 2018. The environment sound pressure levels were measured in 8 different points during the day and night time, totalling 16 measurements.

8.1.3.2 Measurement locations

To define the noise measurement locations it was considered the planned area for dissolving pulp mill implementation, prior to its operation (as background).

In total there were defined 08 (eight) different points for measuring the environment sound pressure level in daytime and nighttime periods, totalling 16 measurements, as described in the following table.

Table 11 – Environment sound pressure level measurement locations description.

Point	Location
P01	Next to the eucalyptus farm fence
P02	Next to the eucalyptus farm fence
P03	Next to the railway line
P04	Next to the railway line
P05	Next to the railway line
P06	In the middle of eucalyptus plantation
P07	In the middle of eucalyptus plantation
P08	Near native vegetation

In the following figure there is the location of the 8 measurement points, while on the other figures there are shown photos of each location.

Pontos de Monitoramento de Ruido

Área Diretamente Afetada - ADA - Área de Implantação da Fábrica

Áre a d e Influênc ia Dire ta - AID

Via Pavimentada

Limite Municipal

ESCALA GRÁFICA:
0 0,5 1 2 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografia (IBGE, 2015);
- Vias (DENIT, 2017)

Pontos de Monitoramento de Ruido		
Ponto	Norte	Leste
P01	7915197,944	191662,954
P02	7914145,486	191498,648
P03	7915369,452	192677,553
P04	7915547,247	193534,696
P05	7915542,019	194098,584
P06	7914323,109	192771,532
P07	7914501,933	194104,473
P08	7914480,557	193626,322

Figure 16 – Location of noise measuring points.

Figure 17 – Point P01. Source: Pöyry Tecnologia (2018).

Figure 18 – Point P02. Source: Pöyry Tecnologia (2018).

Figure 19 – Point P03. Source: Pöyry Tecnologia (2018).

Figure 20 – Point P04. Source: Pöyry Tecnologia (2018).

Figure 21 – Point P05. Source: Pöyry Tecnologia (2018).

Figure 22 – Point P06. Source: Pöyry Tecnologia (2018).

Figure 23 – Point P07. Source: Pöyry Tecnologia (2018).

Figure 24 – Point P08. Source: Pöyry Tecnologia (2018).

8.1.3.3 Methodology

The noise measurement methodology used was based on instructions from NBR 10,151/2000, this standard is regulated by CONAMA Resolution nº 01/1990. In addition, there were also observed the instructions of the State Law nº. 10,100/1990.

The noise assessment method involved of the sound pressure level equivalent (LAeq) measurements in decibels weighted on the "A", commonly called the dB (A), as stated in item 1.3 of the NBR 10,151/2000 standard.

The measurements were carried out in points away to about 1.2 m from the floor and at least 2 m from the boundary of the property and any other reflective surface object such as walls, etc.

The environment sound pressure level measurement time was 2 minutes for each sampled point.

During the measurements it was used wind shield on the microphone.

The sound pressure assessment was performed within 2 periods according to recommendations by NBR 10,151/2000 standard, that is, the day and the night times.

8.1.3.4 Equipment

The sonometer characteristics used in this monitoring campaign is presented below.

Sonometer Characteristics

- Model: Decibel meter DT-8852
- Standard complied with: IEC 61672-1 Classe 2
- Accuracy: ± 1,4 dB
- Frequency range: 31.5 Hz ~ 8 KHz
- Dynamic range: 50 dB
- Memory: 32.700 dados
- Scale levels:

- Lo: 30 dB ~ 80 dB
- Med: 50d B ~ 100 dB
- Hi: 80 dB ~ 130 dB
- Auto: 30 dB ~ 130 dB

– Frequency weighting: A/C
– Time weighting: fast (125 ms) and slow (1s)
– Microphone: 1/2 inch with electret condenser
– Resolution: 0,1dB

8.1.3.5 Results

The environment sound pressure level measurements results are presented in the following table and figure.

Table 12 – Environment sound pressure level measurements results

Point	Place description	Period	Time	Climatic characteristics	Results LAeq
P01	Next to the eucalyptus farm fence	Daytime	10:39	Sunny day and weak wind	38,2 dB(A)
		Nightime	19:54	No wind and sound of insects	43,9 dB(A)
P02	Next to the eucalyptus farm fence	Daytime	10:30	Sunny day and weak wind	40,1 dB(A)
		Nightime	20:05	No wind	40,9 dB(A)
P03	Next to the railway line	Daytime	11:19	No sun and no wind	34,4 dB(A)
		Nightime	19:47	No wind and sound of insects	44,6 dB(A)
P04	Next to the railway line	Daytime	11:39	No sun and no wind	34,7 dB(A)
		Nightime	19:34	No wind and sound of insects	45,8 dB(A)
P05	Next to the railway line	Daytime	11:48	No sun nor wind and sound of birds	34,4 dB(A)
		Nightime	19:20	No wind and sound of insects	41,8 dB(A)
P06	In the middle of eucalyptus plantation	Daytime	12:31	No sun and no wind	35,1 dB(A)
		Nightime	20:19	No wind and sound of insects	45,1 dB(A)
P07	In the middle of eucalyptus plantation	Daytime	12:59	No sun nor wind and sound of birds	34,8 dB(A)
		Nightime	21:13	No wind and sound of insects	44,2 dB(A)
P08	Near native vegetation	Daytime	12:44	No sun and no wind	36,2 dB(A)
		Nightime	20:52	No wind and sound of insects	46,6 dB(A)

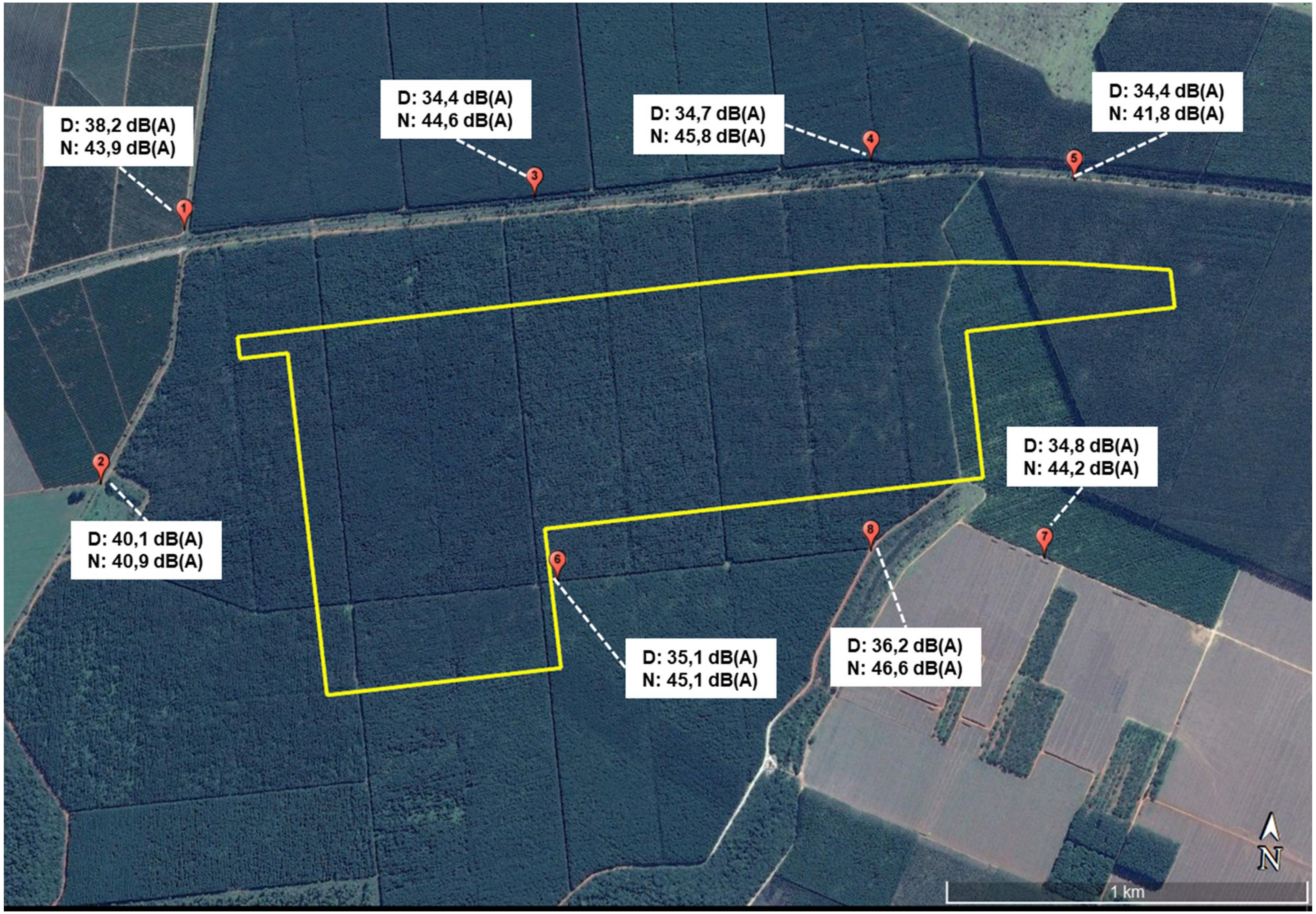


Figure 25 – Noise measurements results for daytime (D) and nightime (N) periods. Source: Adapted from Google Earth (2018).

The environment sound pressure level measurement results in the area around the planned dissolving pulp mill implementation area, ranged from 34.4 dB(A) and 40.1 dB(A) during the daytime, and ranged from 40.9 dB(A) and 46.6 dB(A) at nightime.

The highest results at night occurred in function, primarily, due to sounds of insects.

8.1.3.6 Conclusion

It was measured the environment sound pressure level during day and night periods in 8 different points around area of the LD Celulose dissolving pulp mill in Indianópolis, Minas Gerais.

All environment sound pressure levels measured are below the standard for the predominantly industrial area stablished by NBR 10151/2000 (being 70 dBA for daytime and 60 dBA for nightime) and they are also below the standard stablished by State Law 10.100 / 1990 (70 dBA for daytime and 60 dBA for nightime).

However, regarding the environment sound pressure levels according to standard for farms areas (40 dBA for daytime and 35 dBA for nightime), there is 1 measurement at daytime period and there are 8 measurements at nightime period above that stablished value. In this case, according to NBR 10.151/2000, when the environment sound pressure levels are above the stablished value with no enterprise installed, the sound pressure levels obtained in the field measurement are maintained as the background for noise change evaluation criterion after the enterprise is installed.

8.1.4 Geology

8.1.4.1 Introduction

The State of Minas Gerais has great geological diversity, occurring in this studied area the fanerozoica Archean ages sequences, in tectonic and metamorphic contexts of the most varied types. The main geological units hidden in the Minas territory are thus divided by: (i) the São Francisco Craton; (ii) Brasilia Track; (iii) Orógeno Araçuaí/Ribeira; (iv) Paraná basin; (v) Colluvium-Alluvial and Eluvial coverages. In this context, there are presented the geological units hidden in the studied influence areas.

8.1.4.2 Methodology

The geological description uses the secondary data for the AII characterization, mainly based on existing geological maps, such as: geological map of the State of Minas Gerais (CPRM/CODEMIG, 2014) and the Geodiversity Map of the Minas Gerais State (CPRM, 2010), Water Resource Plan of Paranaíba River Basin (COBRAPE/ANA, 2011), in conjunction with the reports available on the electronic site of the Hydrographics Basins Committee from UPGRN-PN1 (high Parnaíba River) and UPGRN-PN2 (Araguari River).

8.1.4.3 Regional Characterization (AII)

Regionally, in the studied Indirect Influence Area (AII), there are three major structural provinces in terms of partitioning of the geological structure, with origins and behaviors distincts, and conditioning differentiated responses to interventions and evaluations in each of them. These units are named: Tocantins Province, Sanfranciscan Basin and Paraná Province.

The Tocantins Province demonstrates preferential direction from North to South, coming to reach 2,000 km extension long and up to 800 km wide in some areas. It covers the tracks folded by Araguaia and Paraguay, located in the western portion and where it was built on the Amazonian Craton bank; besides Brasilia Track which is located on the São Francisco Craton bank, there is the Magmatic Goiás Arc. The Tocantins Province can be subdivided into two Litho-structurals sub-provinces: the first comprising the crystalline, which is composed by rocks of complex structuring and predominantly with ductile behaviour, particularly granitic-gneissic. The second Litho-structural sub-province corresponds to sequences supracrustal, which usually consist of classical metassedimentary rocks and those are found with little deformation. With respect to the Paranaíba River basin, the area of occurrence of this Province corresponds to its East-Central portion.

The Paraná Province comprises the limits of tectonic basin of Paraná, which is characterized for being a intracratonic structure, with about of 1,750 km length and width of approximately 900 km, covering the southern part of Brazil, the eastern half of Paraguay and part of Argentina and Uruguay, totaling 1.6 million km². It can also be divided into two Litho-structurals sub-provinces: the first corresponds to the clastics sedimentary sequences, with almost exclusively lithological contacts and sub-horizontal stratification; the second sub-province is formed by São Bento Group basalts (Fm. Serra Geral), which are characterized as magmatic rocks from lava spills, being intensely fractured, sometimes diaclased, origing the so called lateritic detrimental coverage. With respect to the Paranaíba River basin, its area is restricted to the western part.

Sanfranciscan basin occurs in a small portion of the basin where the tributaries of the high Paranaíba river is located.

- Tocantins Province

Structural Tocantins Province is located between São Francisco and Amazon Cratons, and it is recognized in it three geotectonics units in its central and North portions, that are represented by the Goiás Massif and by Magmatic Arc through the Araguaia Track and Brasília Track. It is highlighted that within its domain, only the Brasilia track is present in the area of the Paranaíba River basin.

The Goiás Massif contains in addition to granite-greenstone arqueanos terrains, the orthognathic neoproterozoic rocks, being classified as a crustal fragment complex (FÜCK, PIMENTEL and SILVA, 1994), due to having been involved by the Brasiliana orogeny.

The magmatic arc of Western Goiás (PIMENTEL and FÜCK, 1992) is consisted by a juvenile neoproterozoic crust, being composed by volcano sediments and orthogneisses sequences. Its relationship with the Goiás Massif tectonic is still little known.

The Brasília track is made up of supracrustal rocks of the Meso and Neoproterozoic period, whose metamorphism and deformation occurred during the Brasiliano Cycle. Ib should be highlighted that the Brasiliano Cycle occurred during the Neoproterozoic period (850-500 million years ago), and allowed the formation of the supercontinent Gondwana, which has resulted in parts of the South American and African continents.

Finally, the Araguaia Track, located in the Northwest portion of the Tocantins Province, demonstrates the increase in metamorphic grade of the sedimentary coverages being stratigraphically composed by migmatitos (basement), schists and amphibolites and granites, which were covered tectonically by metassedimentaries rocks.

- Paraná Province

The Paraná sedimentary basin is constituted in a geological intracranial structure, located in East-Central of South America, and covers a total area of more than 1.6 million km^2. In Brazil that basin occupies about 1 million km^2, comprising part of the States of Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Minas Gerais, Mato Grosso do Sul, Goiás and Mato Grosso.

It consists of a sedimentary rocks sequence and basaltic lavas spills, registering in its interior thicknesses greater than 5,000 meters, which represents, therefore, a wide paleotopography depression, filled during successive geological periods.

Its main structural and lithological features are linked to an association of various geological phenomena, such as volcanism, subsidence, failures, epirogenesis and sedimentation, which occurred inside the basin in an isolated form or not, during the course of geological time and they were directly responsible for its generation and modeling.

In general, the dip of the layers has an inclination of 2° to 3° towards the center of the basin, and the most significant structural features are aligned with the axis of the main watercourses that drain to its interior.

On the edge of the Paraná basin, where the subsidence process was much slower compared to the center, the erosionais processes linked to the crustal uplift events were stronger, causing the sedimentary record of geological time being less complete that in its center portion, resulting in stratigraphic discontinuous layers and less thick when compared to those presented in the interior of the basin.

- Sanfranciscan Basin

The Sanfransciscana Basin is fanozoic coverage of the San Francisco Craton that occurs in an elongated track, following from the North to South direction, with about 150,000 km^2 of which extends from the Triângulo Mineiro area until the State of Maranhão. Its main feature is that this geological structure forms the watershed of the Paraná and San Francisco basins, however, it is not being detailed in this work, neigher its description in the geological map, since it occurs within a small portion of

Paranaíba river basin, with respect to all other geological groups in the studied area linked to the Tocantins and Parana Provinces.

8.1.4.3.1 Geological Structure

- Tocantins Province

The Tocantins Province is a geological unit generated during Brasiliano Cycle, in Neoproterozoic period, resulting from the collision of Amazon, São Francisco and Parapanema Cratons, which comprises three orogenic belts: the Brasilia, Araguaia and Paraguay Tracks.

In addition to the Tracks, the Province still has the granite-greenstone terrains, the intracontinental Rift, the Goiás Magmatic Arc and the neoproterozoic craton coverages.

The Paranaíba basin region is inserted in the geological context of the Brasília Track, which corresponds to a Neoproterozoic mobile belt located in Eastern portion of Tocantins Province, following from a N to S direction.

The Brasilia Track compartments, involved in the orogeny occurred during the Brasiliano Cycle feature a progressive deformation, culminating in the system of works, jerks and imbricamentos with typical for San Francisco Craton vergence (FONSECA, DARDENE and UHLEIN, 1995).

The basement of the track is made up of craton nuclei of Archean and paleoproterozoic ages. In addition to the infrastructure terrain, the Brasilia track comprises the supracrustal rocks of the Meso and Neoproterozoic periods, whose deformation and metamorphism occurred during the Brasiliano Cycle (FONSECA, DARDENE and UHLEIN, 1995).

In the central portion of the mobile track there are the features with extensive ductile shear, dextral and megatongs zones, that cut the track into two parts with different tectonic-structural developments. In the northern portion occurs folds and bestride systems, with N-S direction, and associated with these features, there are smaller transcurrent systems. In the Southern portion, the truncations and imbrications are characterized by the presence of push N-S failures, with the formation of nappes to the San Francisco Craton direction, in addition to Sinister and Dextral Shear Systems.

- Paraná Province

The structural framework of the Paraná Sedimentary Basin is characterized by demonstrating large lineament and arches, with directions varing from NW-SE, E-W and NE-SW. On its land located in Brazil, two-thirds are composed by sandstones and basaltic mesozoic lavas. The other third of the basin involves a wide track of outcrops that surround the lava coverage area, where there are various Paleozoics sedimentary sequence which are filled.

It has mainly a stretched format in the direction NNE-SSW. In its eastern border it can be observed the so-called Ponta Grossa Arc - associated with crustal uplift resulting from the South Atlantic rift - and it is characterized as an Anticline which depicts ancient and deep structures such as faliures for example. The West border is bounded by the Assunção Arc, related to the Andean belt flexure. Its other borders (North and South) delimit areas where the strata overlap the Pre-Cambrian bedrock rocks, or crystalline rocks of craton provinces.

The Paraná basin origin is controversial and relates somehow to the end of the Brasiliano Cycle - during which the geological terrains surrounding the basin were developed - until the Neo-Ordovician period. In this sense, it is important to highlight that its structure inherited from the basement was the main driver of most of its tectonic and stratigraphic evolution.

The tectonic lineaments existing on it, can be grouped into three main directions: NW-SE, NE-SW and E-W. According to (ZALAN, WOLFF, et al., 1990), the structures of NW-SE direction formed large failures areas which during the tectonics reactivation began the supercontinent Gondwana break, promoted the intrusion of thousands of igneous bodies, as sills and dikes.

Throughout the NE-SW lineaments the transcurrent movement is more outstanding (ZALAN, WOLFF, et al., 1990), with a strong relationship with the tectonic framework of the mobile Ribeira and Dom Feliciano Tracks, that border the Paraná Sedimentary Basin to the East, besides the own framework foundation, under laid the basin.

According to (ZALAN, WOLFF, et al., 1990), the E-W lineaments group is the least understood, stating that its development began in Triassic period and its parallelism with oceanic fracture zones may suggest a close connection with the South Atlantic development.

The regional failures, which occurred in the normal direction of the sedimentation phase, were reactivated in a second compressive phase, generating inverse longidutinais faults with high angle, usually with NS and NE axys. During the tectonics reactivation Post-Cretaceous, occasion where subsidence and uplift movements prevailed, there were extensive fractures in the crust, allowing access to the surface of a very large volume of basaltic lavas from the mantle, which spread and filled the Paraná basin.

These failures denote significant transversal alignments to the main axis of the basin, guided under the direction NW and NW-W, and with variable width (between 20 to 100 Km) and hundreds of kilometers long. These tracks match the fractured zones in which basic dikes intruded, often associated with the failures, whose main alignments often coincide with the major tributaries of the Paraná River.

- Sanfranciscan Basin

The Sanfranciscan Basin corresponds to the Phanerozoic coverage of São Francisco Craton. In general, it has elongated direction North-South, regionally showing parallelism with the Recôncavo-Toucan-Jatobá aulacogen, suggestive of a relationship with the evolution of continental Brazilian margin.

The tectonics is little pronounced, and the basement of the basin is represented by the Bambuí Group, sedimentary Paleozoic rocks of Parana basin and metasedimentary rocks of Araxá and Canasta groups.

According to (CAMPOS and DARDENNE, 1997), the origin of the basin was marked by an evolution which involved small deformation rates. The subsidence generated from depositional gutter occurred in response to isostatic rebalances, extension and crustal compression, connected to the Supercontinent Gondwana rupture, although there is no perfect correlation between the evolution of the Brazilian continental margin and the basin.

8.1.4.3.2 Lithostratigraphy

The lithostratigraphy units existing in the AII - based on the geological map data - there are described below, being classified in accordance to the following hierarchy: Group, Subgroup, Formation, Complex, Suite, and Sequence. The lithostratigraphy and lithodemic columns and the geological map are presented in the following tables and the figure, constituting a distribution of these units over the geological time.

Table 13 – Lithostratigraphy column for the studied AII

EÓN	ERA	PERÍODO	UNIDADES LITOESTRATIGRÁFICAS	SÍMBOLO	LITOLOGIA
FANEROZOICO	CENOZOICO	NEÓGENO	*Depósito aluvial*	*Q2a*	*Sedimentos clásticos inconsolidados*
		PALEOÓGENO	*Cobertura Superficial indiferenciada*	*ENdl*	*Sedimentos clásticos e lateríticos ferruginosos*
	MESOZOICO	CRETÁCEO	**BACIAS SEDIMENTARES FANEROZÓICAS PRÉ-CENOZOICAS E MAGMATISMO ASSOCIADO**		
			Suíte Intrusiva Alcalina, Complexo Alcalino Barreiro	*K2λb*	*Rochas ultramáficas alcalinas e associadas em complexos plutônicos*
			Suíte Intrusiva Alcalina, Complexo Alcalino Serra Negra	*K2λsn*	*Rochas ultramáficas alcalinas e associadas em complexos plutônicos*
			Suíte Intrusiva Alcalina, Complexo Alcalino Serra do Salitre	*K2λss*	*Rochas ultramáficas alcalinas e associadas em complexos plutônicos*
			Suíte Intrusiva Alcalina, Complexo Alcalino Tapira	*K2λt*	*Rochas ultramáficas alcalinas e associadas em complexos plutônicos*
			BACIA DO PARANÁ		
			GRUPO BAURU		
			Formação Marília	*K2bm*	*Arenito, argilito arenoso*
			GRUPO SÃO BENTO		
			Formação Serra Geral	*K1δsg*	*Basalto*
			BACIA SANFRANCISCANA		
			Grupo Mata da Corda	*K2mc*	*Arenito, lapili tufo, vulcânicas básicas kamafugíticas; conglomerado*
			Grupo Areado	*K1a*	*Folhelho, arenito feldspático, arenito lítico, arenito conglomerático, conglomerado polimítico, Siltito*
PROTEROZOICO	NEOPROTEROZOICO	EDIACARIANO	**BACIAS SEDIMENTARES PROTEROZOICAS - CAMBRIANAS**		
			PROVÍNCIA TOCANTINS		
			Faixa Brasília Meridional		
			GRUPO IBIÁ		

EÓN	ERA	PERÍODO	UNIDADES LITOESTRATIGRÁFICAS	SÍMBOLO	LITOLOGIA
PROTEROZOICO	NEOPROTEROZOICO	EDIACARIANO	*Formação Rio Verde*	*NP3irv*	*Clorita-muscovita-quartzo xisto, diamictito*
			Formação Cubatão	*NP3icb*	*Calcixisto*
			PROVÍNCIA SÃO FRANCISCO		
			Bacia do São Francisco		
			Supergrupo São Francisco, Grupo Bambuí		
			SUBGRUPO PARAOPEBA		
			Formação Serra da Saudade	*NP3bss*	*Siltito e arenito fino predominantes, folhelho, lentes carbonáticas*
			Formação Lagoa Formosa, litofácies diamictito	*NP3blfd*	*Diamictito e pelito*
			Formação Serra de Santa Helena	*NP3bsh*	*Argilito e siltito ardosianos, marga, lentes de calcário*
			Formação Serra de Santa Helena, litofácies fosfático	*NP3bshP*	*Pelito e fosforito*
		CRIOGENIANO	**BACIAS SEDIMENTARES PROTEROZOICAS - CAMBRIANAS**		
			PROVÍNCIA TOCANTINS		
			Faixa Brasília Meridional		
			COMPLEXO ABADIA DOS DOURADOS		
			Litofácies anfibolítica	*NP2adaf*	*Filito carbonoso, filito sericitico, quartzito e lentes de silexito ferruginoso; metavulcânica ácida xistificada; anfibolito, dependendo do fácies*
			Litofácies filítica	*NP2adf*	*Filito carbonoso, filito sericitico, quartzito e lentes de silexito ferruginoso; metavulcânica ácida xistificada; anfibolito, dependendo do fácies*
			Litofácies metavulcânica ácida	*NP2adva*	*Filito carbonoso, filito sericitico, quartzito e lentes de silexito ferruginoso; metavulcânica ácida xistificada; anfibolito, dependendo do fácies*
			GRUPO ARAXÁ		
			Litofácies Micaxisto	*NP1amx*	*Clorita xisto, granada-biotita xisto, grafita xisto, talco-xisto, quartzito micáceo, quartzito ferruginoso, paragnaisse, anfibolito, turmalinito*

EÓN	ERA	PERÍODO	UNIDADES LITOESTRATIGRÁFICAS	SÍMBOLO	LITOLOGIA
PROTEROZOICO	NEOPROTEROZOICO	TONIANO	**BACIAS SEDIMENTARES PROTEROZOICAS - CAMBRIANAS**		
			PROVÍNCIA TOCANTINS		
			Faixa Brasília Meridional		
			GRUPO CANASTRA		
			Formação Chapada dos Pilões		
			Litofácies filito predominante	*NP1cpf*	*Filito predominante; subordinado quartzito micáceo*
			Litofácies formação ferrífera	*NP1cpff*	*Formação ferrífera bandada em associação com quartzito*
			Membro Hidroelétrica da Batalha	*NP1cphb*	*Quartzito micáceo*
			Formação Paracatu		
		TONIANO	*Formação Paracatu indivisa*	*NP1cpa*	*Filito sericítico e muscovita-clorita-quartzo xisto predominantes*
			Membro Serra da Anta	*NP1cpasa*	*Filito sericítico, quartzito fino*
			Membro Morro do Ouro	*NP1cpamo*	*Filito carbonoso com lentes de quartzo*
			GRUPO VAZANTE		
			Formação Serra da Lapa	*NP1vsl*	*Arenito, Argilito, Calcário, Filito, Siltito, Silexito, Marga*
			Formação Serra do Poço Verde		
			Membro Pamplona inferior	*NP1vspvpi*	*Metapelitos*
			Formação Garrote		
			Membro Serra do Andrequicé	*NP1vsgsa*	*Arenitos predominantes*
	MESOPROTEROZOICO	ECTASIANO	**EMBASAMENTO DAS PROVÍNCIAS NEOPROTEROZOICAS TOCANTINS, SÃO FRANCISCO E MANTIQUEIRA, EM PARTE RETRABALHADA**		
			Ortognaisse Nova Aurora	*MP2γna*	*Ortognaisse calcialcalino*

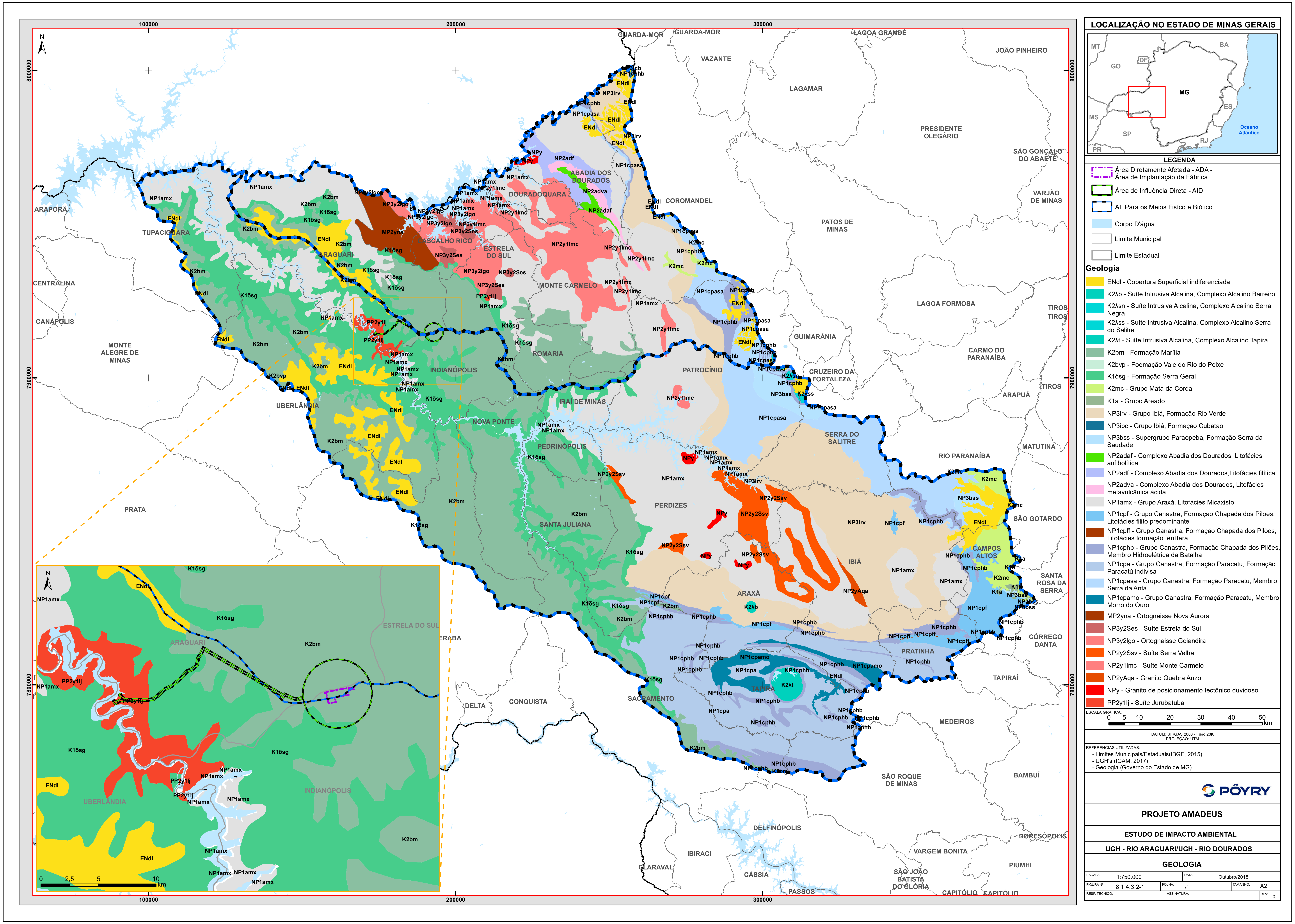
Source: (CPRM/CODEMIG, 2014).

Table 14 – Lithodemic colum for the studied AII

EÓN	ERA	PERÍODO	UNIDADES LITODÊMICAS	SÍMBOLO	LITOLOGIA
PROTEROZOICO	NEOPROTEROZOICO	EDIACARIANO / CRIOGENIANO	**PROVÍNCIA TOCANTINS**		
			Faixa Brasília Meridional		
			GRANITOS SINCOLISIONAIS TIPO S		
			Suíte Estrela do Sul	*NP3γ2Ses*	*Granito, sienogranito, granito a duas micas*
			Suíte Serra Velha	*NP2γ2Ssv*	*Granito, sienogranito, granito a duas micas*
			GRANITOS PRÉ A SINCOLISIONAIS TIPOS I E A		
			Ortognaisse Goiandira	*NP3γ2Igo*	*Associação ortognáissica – anfibolítica*
			Suíte Monte Carmelo	*NP2γ1Imc*	*Biotita tonalito, biotita granito porfirítico*
			Granito Quebra Anzol	*NP2γAqa*	*Granito alcalino*
		CRIOGENIANO	*Granito de posicionamento tectônico duvidoso*	*NPγ*	*Granitos de quimismo e posicionamento tectônico duvidoso*
	PALEOPROTEROZOICO	RIACIANO	**EMBASAMENTO DAS PROVÍNCIAS TOCANTINS, MANTIQUEIRA E SÃO FRANCISCO**		
			GRANITO PRÉ-COLISIONAL		
			Suíte Jurubatuba	*PP2γ1Ij*	*Ortognaisse de composição granítica, granodiorítica e tonalítica*

Source: (CPRM/CODEMIG, 2014).

Figure 26 – Geology Map


LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS
LEGENDA
Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
Área de Influência Direta - AID
AII Para os Meios Físico e Biótico
Corpo D'água
Limite Municipal
Limite Estadual
Geologia
ENdl - Cobertura Superficial indiferenciada
K2λb - Suíte Intrusiva Alcalina, Complexo Alcalino Barreiro
K2λsn - Suíte Intrusiva Alcalina, Complexo Alcalino Serra Negra
K2λss - Suíte Intrusiva Alcalina, Complexo Alcalino Serra do Salitre
K2λt - Suíte Intrusiva Alcalina, Complexo Alcalino Tapira
K2bm - Formação Marília
K2bvp - Foemação Vale do Rio do Peixe
K1δsg - Formação Serra Geral
K2mc - Grupo Mata da Corda
K1a - Grupo Areado
NP3irv - Grupo Ibiá, Formação Rio Verde
NP3ibc - Grupo Ibiá, Formação Cubatão
NP3bss - Supergrupo Paraopeba, Formação Serra da Saudade
NP2adaf - Complexo Abadia dos Dourados, Litofácies anfibolítica
NP2adf - Complexo Abadia dos Dourados,Litofácies fillitica
NP2adva - Complexo Abadia dos Dourados, Litofácies metavulcânica ácida
NP1amx - Grupo Araxá, Litofácies Micaxisto
NP1cpf - Grupo Canastra, Formação Chapada dos Pilões, Litofácies filito predominante
NP1cpff - Grupo Canastra, Formação Chapada dos Pilões, Litofácies formação ferrífera
NP1cphb - Grupo Canastra, Formação Chapada dos Pilões, Membro Hidroelétrica da Batalha
NP1cpa - Grupo Canastra, Formação Paracatu, Formação Paracatú indivisa
NP1cpasa - Grupo Canastra, Formação Paracatu, Membro Serra da Anta
NP1cpamo - Grupo Canastra, Formação Paracatu, Membro Morro do Ouro
MP2yna - Ortognaisse Nova Aurora
NP3y2Ses - Suíte Estrela do Sul
NP3y2lgo - Ortognaisse Goiandira
NP2y2Ssv - Suíte Serra Velha
NP2y1lmc - Suíte Monte Carmelo
NP2yAqa - Granito Quebra Anzol
NPy - Granito de posicionamento tectônico duvidoso
PP2y1lj - Suíte Jurubatuba
ESCALA GRÁFICA:
0 5 10 20 30 40 50 km
DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM
REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UGH's (IGAM, 2017)
- Geologia (Governo do Estado de MG)
PÖYRY
PROJETO AMADEUS
ESTUDO DE IMPACTO AMBIENTAL
UGH - RIO ARAGUARI/UGH - RIO DOURADOS
GEOLOGIA
ESCALA: 1:750.000
DATA: Outubro/2018
FIGURA Nº 8.1.4.3.2-1
FOLHA: 1/1
TAMANHO: A2
RESP. TÉCNICO:
ASSINATURA:
REV.: 0

Tocantins Province

Granulite Complex

This complex consists of high-grade gneisses that arise in NE-SW track limited with the gneiss granite terrains by extensive shear zones. Paleoproterozoic date (1,600 M.a).

Canastra Group

Canastra Indiviso Group

This Group gathers the Canasta Group rocks, from areas where it was not possible to fit them into a set formation. The litho type dominant is the chlorite-sericite-quartz shale, with intercalations of sericite shales, quartz-Muscovite shale and shale graffiti lenses, quartzite, Slate, marble, limestones and chlorite chalcoxist. Mesoproterozoic date (1,000 M.a).

Chapada dos Pilões Formation

The Chapada dos Pilões formation was divided into members, with emphasis on the Serra Hidroelétrica Batalha, at the top and composed by orthoquartzites, with intercalations of subordinate phyllites. Mesoproterozoic date (1,000 M.a).

Paracatu Formation

Paracatu formation is predominantly pelitic, represented by shales with association of subsidiary limestones and quartzites. Mesoproterozoic date (1,000 M).

Araxá Group

The Araxá Group rocks consist of epidote-amphibolite facies of metamorphites, consisting mainly of mycoxist and quartzites with intercalations of amphibolite, being these subordinated. These rocks are under laid by a basement composed of gneisses and granites. Neoproterozoic date (540 M.a).

Vazante Group

The Vazante Group represents a debris carbonate sequence composed primarily by quartzites, slates, conglomerates, siltites and stromatolytic dolostone. The Vazante Group formations provide age patterns belonging to the Neoproterozoic period (540 M.a).

Ibiá Group

Rio Verde Formation

This formation of Neoproterozoic age (540 M.a) is composed lithology by calcines or calcixis phyllites with quartzite laminations and intercalations of thin quartzite and gray phyllite locally with coal mining.

Bambuí Group - Paraopeba Indiviso Subgroup

The Paraopeba Subgroup consists of siltites and greenish-grey to reddish clayey, sometimes with calcines, besides thin gray limestone and intercalations of quartzite lenses. Neoproterozoic date (540 M.a).

Granite

At Neoproterozoic age (540 M.a), they are found grouped under the title "granite", with various categories of plutonic rocks, including Granites sin-tectonic varying from alkali-feldspar granites, biotite-muscovite granites, biotite granites, granodiorites, monzogranites and deformed granites. There are also later tectonic granites ranging from porphyritic to granodiorites Granites, tonalities, monzogranites, sienogranites, quartz-monzonites and syenites.

Paraná Province

São Bento Group

Serra Geral Formation

This unit consists of a thick package of volcanic rocks which occur in the Paraná basin, formed by an extensive series of spills. At Juror-Cretaceous age (64-140 M.a), this formation consists of tololitics basalts, resulting from the intense volcanism that occurred during the Mesozoic era (64-250 M.a). They are massive rocks, brownish colored, dark grey to black when healthful and reddish grey when altered, with aphanitic texture and amygdaloidal at the top.

Interleaved in these spills they occur in sparse sandstones form and lenses form and/or thin layers, plenty of silicified. They are also found in dikes and sills of diabasa granular, dark grey to green.

The occurrence of these rocks along the gutters of main rivers and their tributaries is marked by frequent stretches with structural lineaments controls of NW direction, besides the presence of columnar disjunctions indicating thicker spills, resulting almost always in small leaps and rapids in the course of these rivers. Because of this, the presence of the basalts in the river bed, with its topographical gaps is a geological factor that determines the hydroelectric potential to be exploited, directly supporting most of the hydropower projects.

Bauru Group

Marília Formation

These sediments of Cretaceous age (64.4 M.a) were deposited in sub aqueous and semi-arid climate environments. They are dominated by sandstones, from thin to coarse, clayey and redish and whitish siltites, commonly limonitized, arranged in massive packages and generally silicified and with cross-stratification of small and medium-sizes.

Cretaceous alkaline intrusions

The Alkaline Intrusive rocks of Eocretacea age are described here because they are "Chrono" and "stratigraphically" arranged between the geological materials belonging to the Tocantins Province (oldest) and Paraná Province (newest).

It should be highlighted, however, that these alkaline bodies, characterized as products of ultrapotassic magmatism that affected the region, are found intruded in the midst of the geological materials of the Tocantins Province.

Sanfranciscan Basin

Areado Group

This group is composed by conglomerates, sandstones with variable granulation and shales. It has a restricted occurrence, with ages of Superior Cretaceous (64.4 M.a).

Mata da Corda Group

This group is consisted by conglomerates and volcanic sandstone cemented by carbonates. It shows gray and green colors and features cross-ribbed stratification and geometry in wedges. It occurs near the volcanic facies and represents deposits of alluvial fans, raised on the slopes of volcanic edifices. Date from the Superior Cretaceous (64.4 M.a).

Superficial Formations

Covering locally the older geological materials, there are found the so-called "Superficial Formations", which are characterized as recent materials sediments (Quaternary, 1.6 M.a), and they can be of detrital-lateritic or alluvial origin, as described below.

Detrital-Lateritic Coverages

The covered sediment of Quaternary age (1.6 M.a), are made up of gravel and Sandy-clayey material, little consistent, partially and/or totally lateralized. These deposits can reach tens of meters thick; they occur sparse and along the major drainages.

Alluvial Deposits

Alluvial deposits also from Quaternary age (1.6 M.a) consist of sedimentary deposits from recent ages and occurres occupying narrow discontinuous areas along the rivers. In general they are small deposits, little thick, predominantly fine granulometry, represented by gravels, Sands, silts and unconsolidated clays in plains or fluvial terraces.

8.1.4.4 Local Characterization (AID and ADA)

As shown on the geological map, the AID and ADA feature as geological framework basaltic rocks of the Serra Geral formation, which outcrop in a small portion of the AID being superimposed on the Marília formation rocks, being described below.

8.1.4.4.1 São Bento Group

Serra Geral Formation (K1δsg)

The Serra Geral Formation is characterized by rocks of volcanic nature, which are inserted in Gondwana III sequence, of the Paraná basin. In the Triângulo Mineiro region, they are directly overlaid on the crystalline basement of Brasília track and under laid the sedimentary rocks of the Bauru basin and the unconsolidated sedimentary deposits of Cenozoic age. The observed volcanic rocks show color dark gray to greenish, deposited in layers from 10 to 15 cm thick, forming small abrupt walls over the valleys talvegues.

8.1.4.4.2 Bauru Group

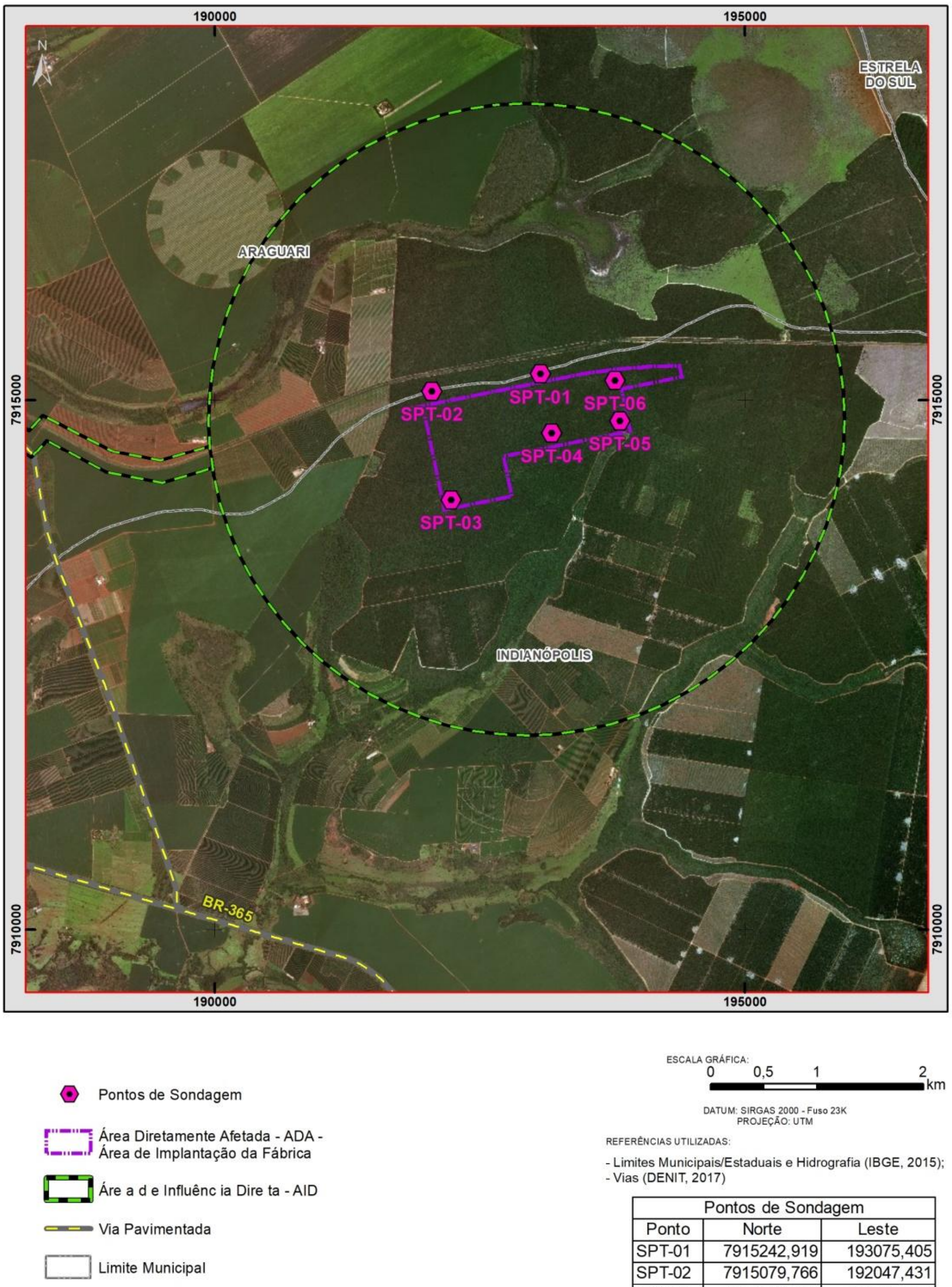
Marília Formation (K2bm)

It is widely distributed in the Western region of Minas Gerais, consisting of white lacustrinos limestone, with sandstone and clayey fragments, and calcareous concretions at the base, and by sandstones and conglomerates calcines at the top. The thicknesses are on the order of 200 m and its exhibition areas present terrain with steep slopes and well outlined. The deposition of this unit relates to a continental lacustrine system, under the influence of semi-arid climate, with formation of detrital paving with carbonate cementation type caliche.

8.1.4.5 SPT Soil Samples

According to the soil survey report conducted in the studied area, there were executed 06 (six) sample holes, as current standards for soil resistance, both percussion with water circulation and default dynamic penetration test standard (SPT) totaling:

- Percussion: 182,70 (182 meters and 70 centimeters)



Pontos de Sondagem		
Ponto	Norte	Leste
SPT-01	7915242,919	193075,405
SPT-02	7915079,766	192047,431
SPT-03	7914052,439	192231,031
SPT-04	7914684,050	193180,578
SPT-05	7914800,949	193823,197
SPT-06	7915181,269	193774,770

Figure 27 – Soil Samples holes location.

8.1.4.5.1 Executive Methodology

In developing the soil survey to percussion there are distinguished three basic steps: drilling, penetration resistance measurement and sampling.

- Drilling: drilling technique, in order to enable the penetration resistance measurement, is made in accordance with the groundwater level.
- Drilling above groundwater level-performed with Auger;
- Drilling below the groundwater level – performed by washing with water circulation with the help of the wash trephine, being also used when the Auger is inoperative.

Sampling:

The removal of subsurface samples, deformed type can be made while drilling through the Auger, the washing with water circulation, or when measuring the penetration resistance by the standardized RAYMONND or S.P.T. sampler.

Penetration Resistance Measurement:

The penetration resistance is represented by resistance to penetration index, N (S.P.T), which is the sum of the number of blows from a standardized hammer weighing 65 kgf, in free fall from a height of 75 cm, necessary for the penetration of 30 cm end of the standardized S.P.T sampler.

The States of compactness and consistency are estimated as a function of the penetration resistance index (Spot).

The terms employed for the classification of the compactness of the sands refer to the deformability and resistance of these soils from the point of view of foundations and should not be confused with the same names used for the designation of compactness relative to the sands or to the situation of the critical empties index defined by soil mechanics.

Groundwater level:

The determination of groundwater level is done when water level is reached during execution of a survey. At this time, the drilling operation stops and the stability and water lowering is observed, this procedure was performed on this sample, in N.A EXISTENTE parameters of the current regulations. At the elevation of the water level in the hole there are made readings every 5 minutes during the minimum period of 15 minutes, to see its stabilization is also held a second reading, after a minimum of 12 hours after the sample closurel.

In some cases there are variations between the water level noted in the survey and the water level effectively found when the infrastructure works starts.

Displacement:

It happens when the drilling does not reach the depth of 8.00 metres set by standard law, thus it starts with 1 meter angle to form a triangular shape from the initial hole.

8.1.4.5.2 Results

Following there are presented the profiles for the 06 (six) conducted survey holes.

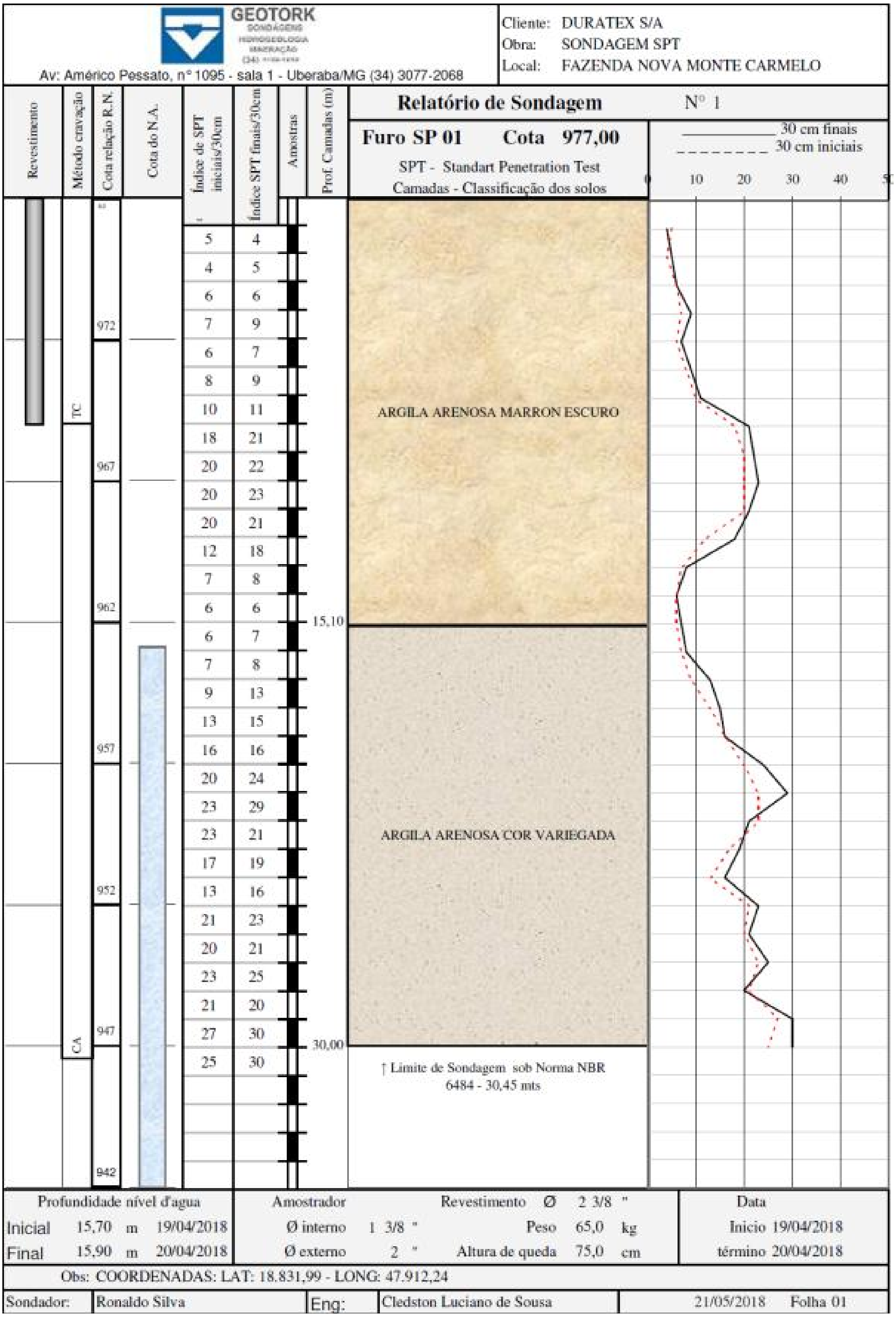


Figure 28 – Profile of the survey hole SP01. Source: GEOTORK, 2018.

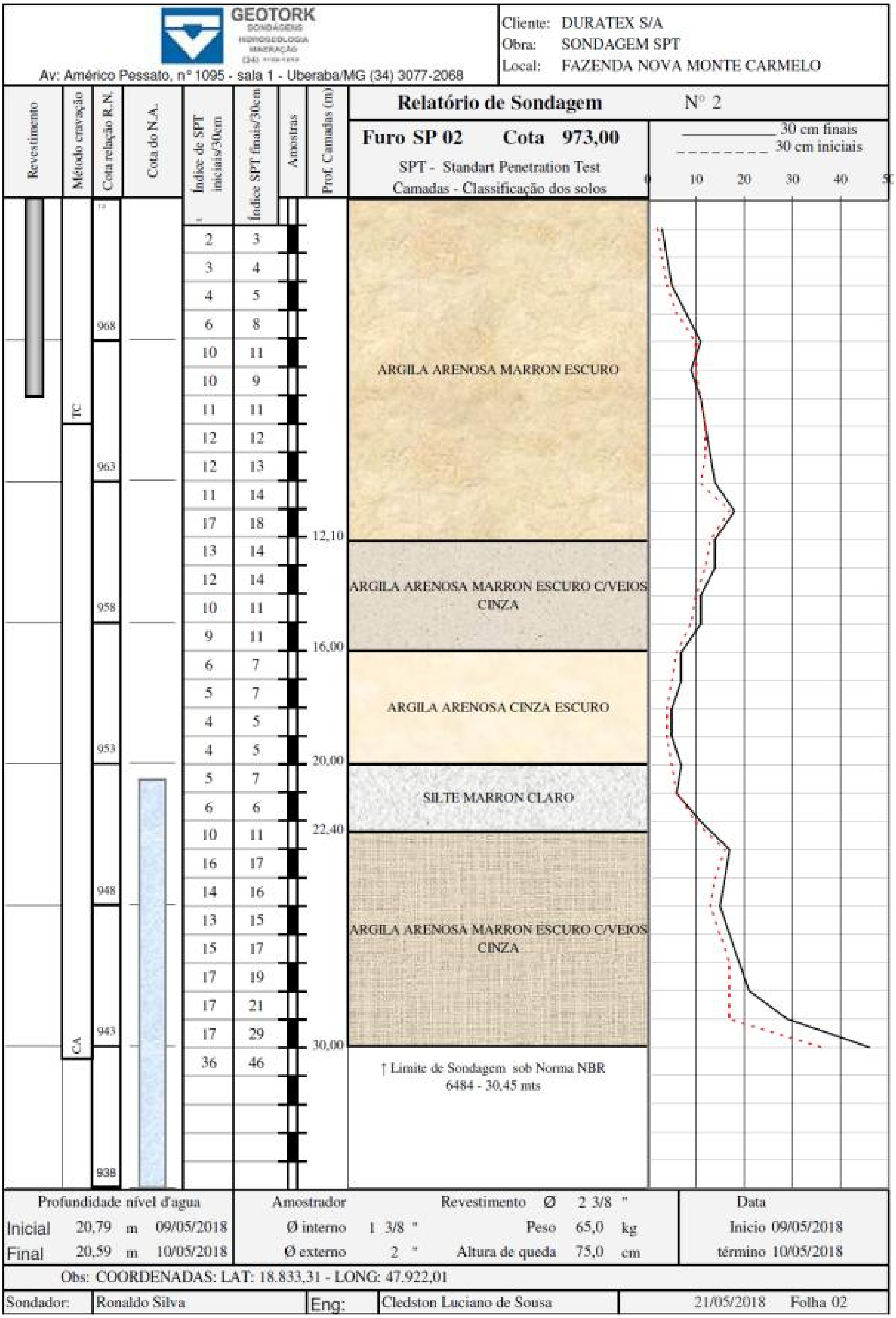


Figure 29 – Profile of the survey hole SP02. Source: GEOTORK, 2018.

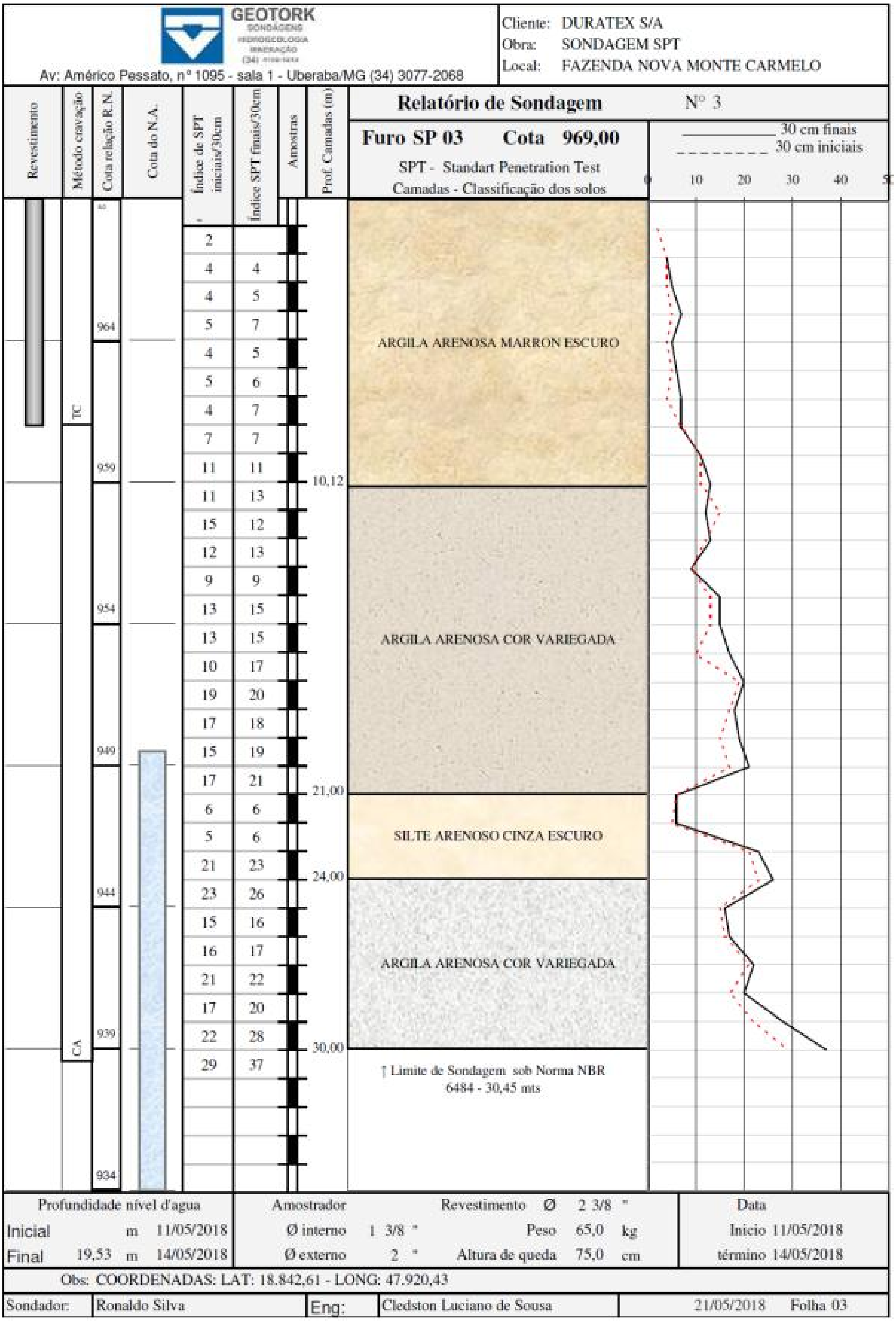


Figure 30 – Profile of the survey hole SP03. Source: GEOTORK, 2018.

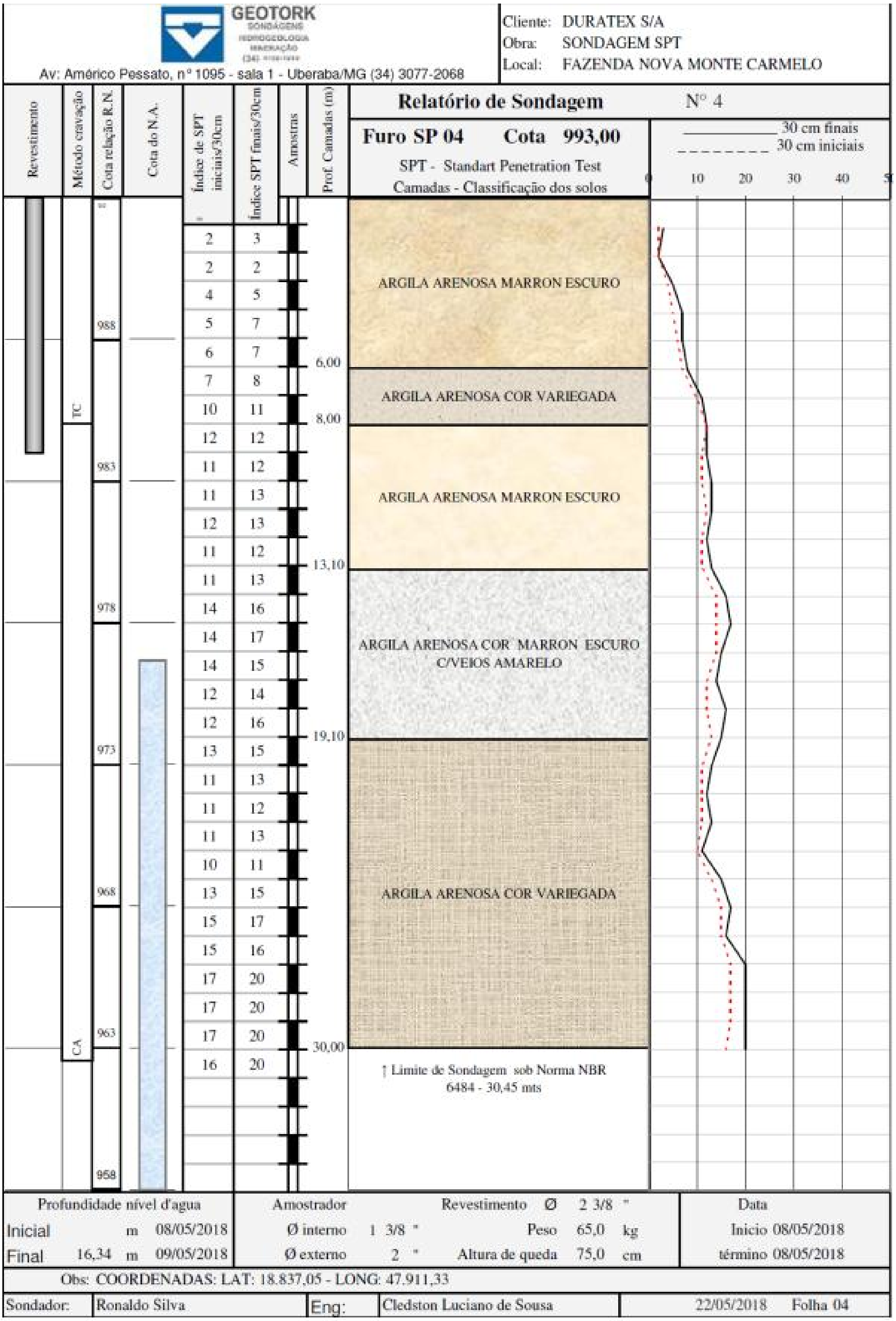
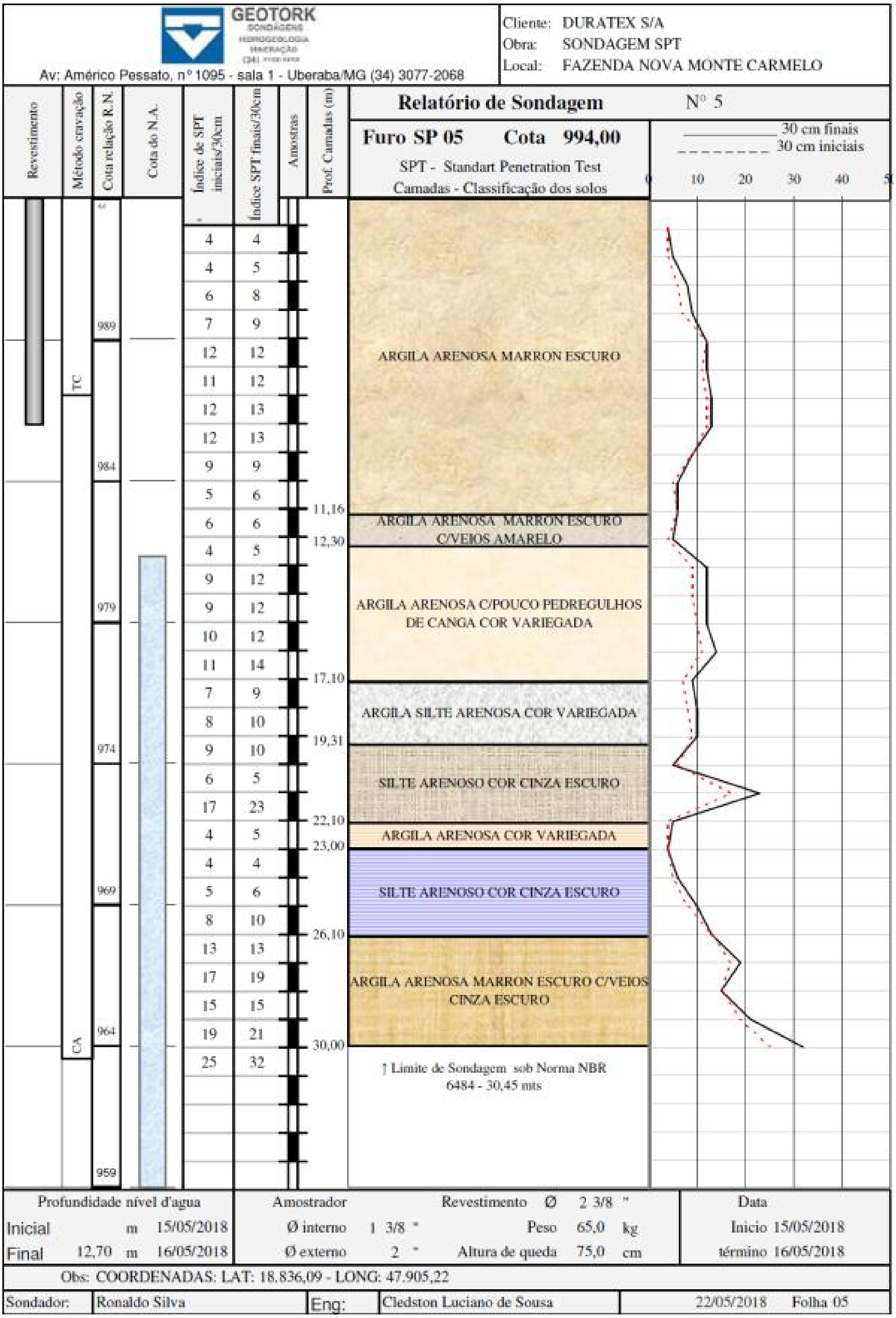


Figure 31 – Profile of the survey hole SP04. Source: GEOTORK, 2018.



Índice de SPT iniciais/30cm	Índice SPT finais/30cm
4	4
4	5
6	8
7	9
12	12
11	12
12	13
12	13
9	9
5	6
6	6
4	5
9	12
9	12
10	12
11	14
7	9
8	10
9	10
6	5
17	23
4	5
4	4
5	6
8	10
13	13
17	19
15	15
19	21
25	32

Figure 32 – Profile of the survey hole SP05. Source: GEOTORK, 2018.

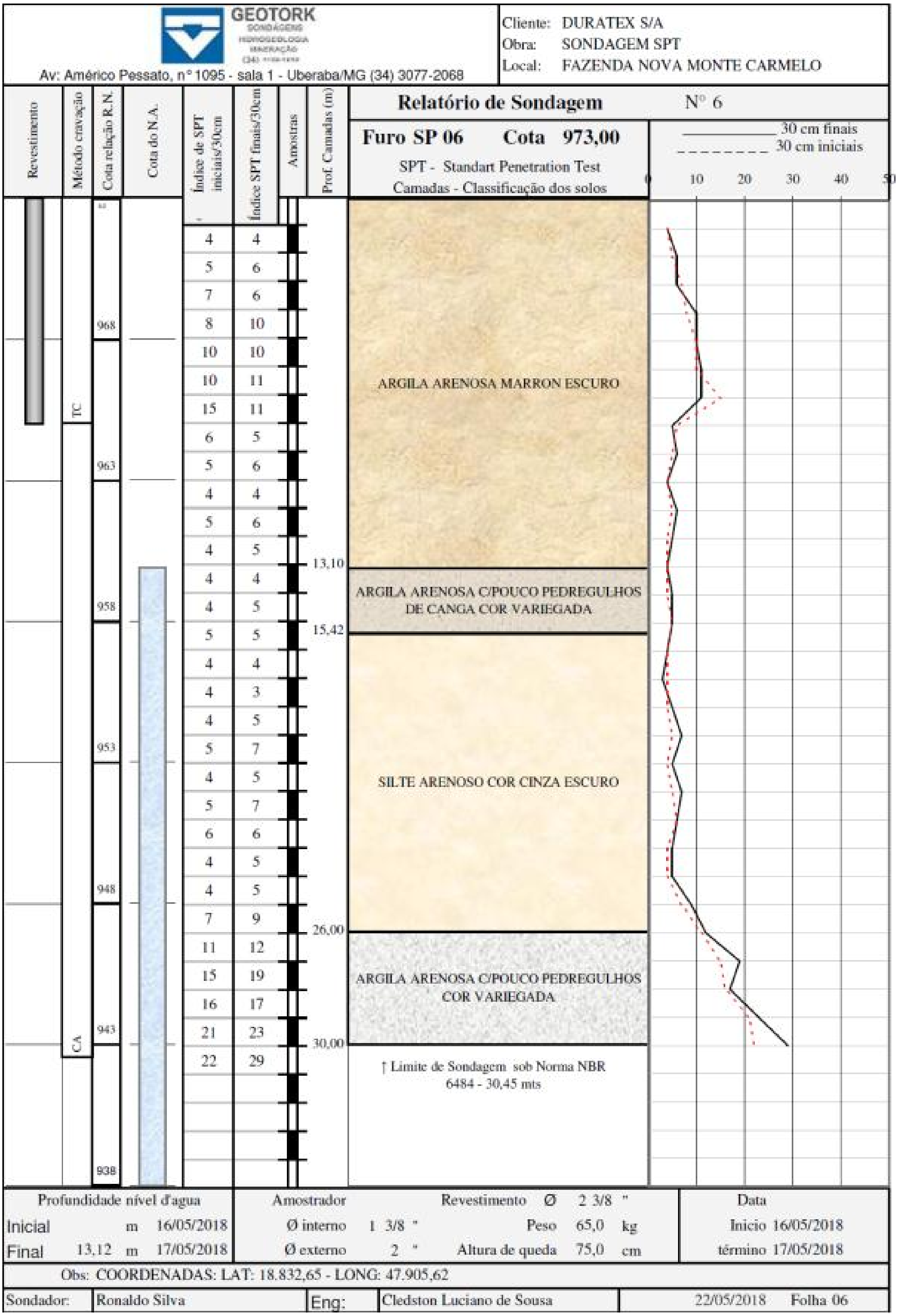


Figure 33 – Profile of the survey hole SP06. Source: GEOTORK, 2018.

Figure 34 – SP01 Drilling hole. Source: GEOTORK, 2018.

Figure 35 – SP02 Drilling hole. Source: GEOTORK, 2018.

Figure 36 – SP03 Drilling hole. Source: GEOTORK, 2018.

Figure 37 – SP04 Drilling hole. Source: GEOTORK, 2018.

Figure 38 – SP05 Drilling hole. Source: GEOTORK, 2018.

Figure 39 – SP06 Drilling hole. Source: GEOTORK, 2018.

8.1.4.5.3 Conclusions

From the surveys carried out in the area of the project, it can b observed that the initial layer of soil is characterized by a dark brown sandy clay, at depths ranging from 6.0 (P4) to 15.10 metres (P1). It is also noted that after this first layer, in all profiles, the layers are dominated by clay-sandy compositions and, occasionally, sandy-silt-clay.

It should be highlighted that all the surveys reached the limit stipulated by the standard NBR 6484 (30 metres) and the groundwater level was delimited in depths ranging between 12.7 (P5) and 20.59 (P2).

8.1.5 Geomorphology

8.1.5.1 Introduction

According to (CPRM, 2010), Minas Gerais presents a terrain that differs from other regions of the country by the diversity of morphological aspects presented in it. Such diversity is a result of the complex tectonic activity in constituent of Brazilian shield rocks from the Mesozoic era: arching, crashing and fracturing such rocks.

According to (SAADI, 1991), the terrain of a region is the result of the processes set, associated to the internal and external dynamics activities on the surface over the geological time. Therefore, the morphological aspect of an area is derived from the tectonic evolution added to actions in climatic order at the referred to the region.

Within the Geodiversity of Minas Gerais framework study, (CPRM, 2010) adopted a partitioning of the territory into five major geomorphological domains areas (Compartments), based on the active processes (gratification or denudation) and the lithotypes, which are segmented into 17 terrains patterns.

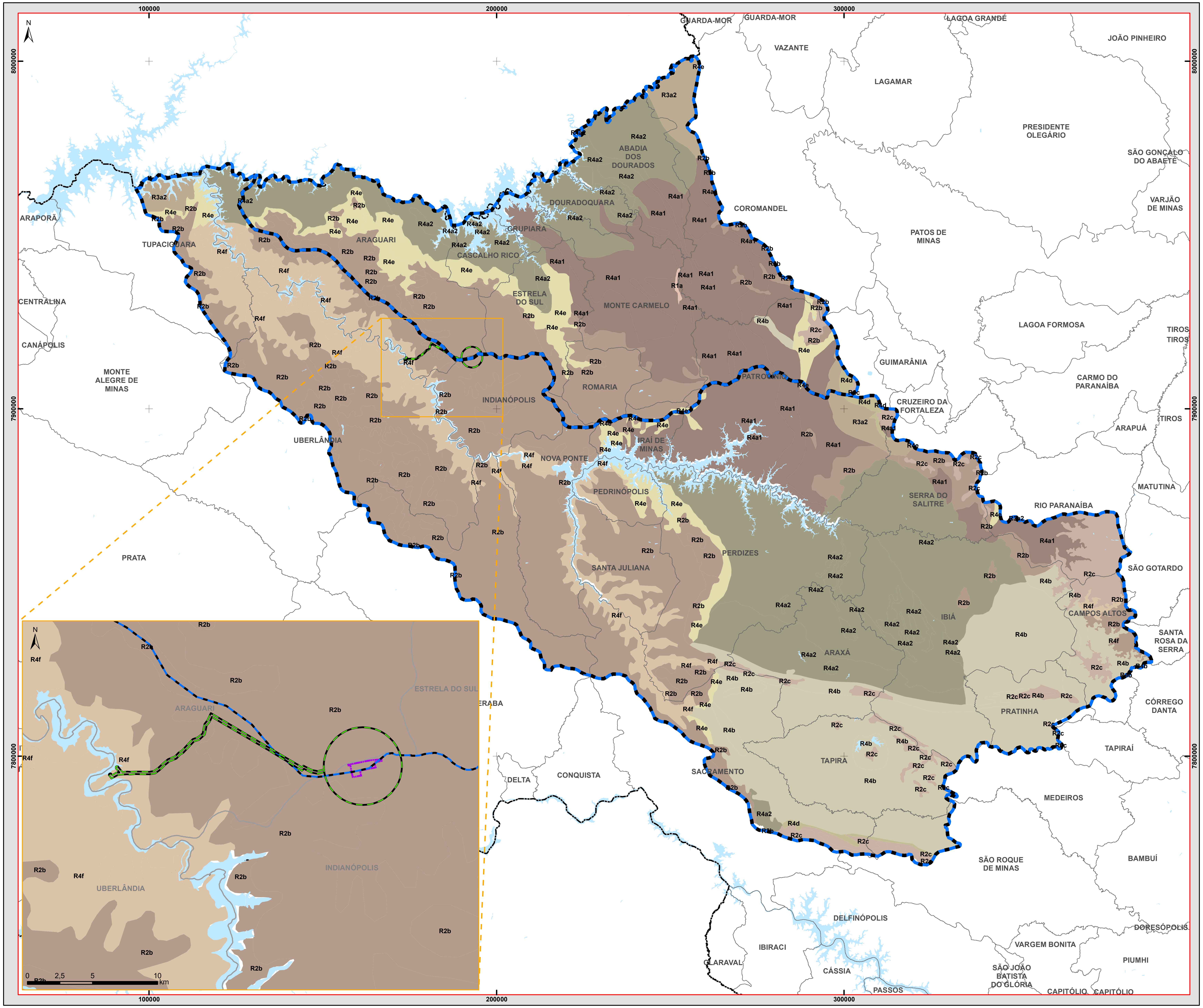
8.1.5.2 Methodology

The Terrains Compartments of the studied area were described from the Geodiversity Map of the Minas Gerais State (CPRM, 2010). It's worth pointing out that in this publication, the individualization of the various terrains compartments was obtained based on analysis and interpretation of SRTM images (Shuttle Radar Topography Mission), with a resolution of 90 m, and the images GeoCover being the terrain units grouped according to texture and roughness characterization of the images.

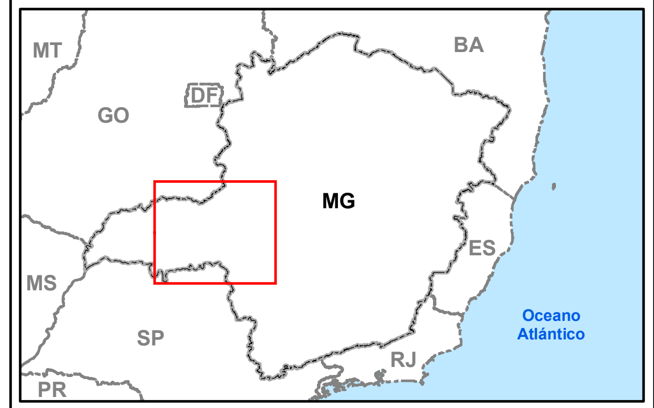
8.1.5.3 Regional Characterization (AII)

Based on the type of active process (gratification or denudation) and the lithological types presented in the area, Minas territory was partioned into five main geomorphological domain areas and 17 terrains patterns. As a result, there will be described the 10 units presented in the direct influence area of the project and that are illustrated in the Geomorphological Map, on Digital Terrain Model and on Declivities Map, presented in the following figures.

Figure 40 – Geomorphological Map.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

Geomorfologia

- R2c - Chapadas e Platôs
- R4e - Degraus Estruturais e Rebordos Erosivos
- R4a1 - Domínio de Colinas Amplas e Suaves
- R4a2 - Domínio de Colinas Dissecadas e Morros Baixos
- R4b - Domínio de Morros e de Serras Baixas
- R4d - Escarpas Serranas
- R2b - Planaltos e Baixos Platôs
- R1a - Planícies Fluviais ou flúvio-lacustres
- R3a2 - Superfícies Aplainadas Degradadas
- R4f - Vales Encaixados

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UGH's (IGAM, 2017)
- Geomorfologia (CPRM, 2007)

PÖYRY

PROJETO AMADEUS

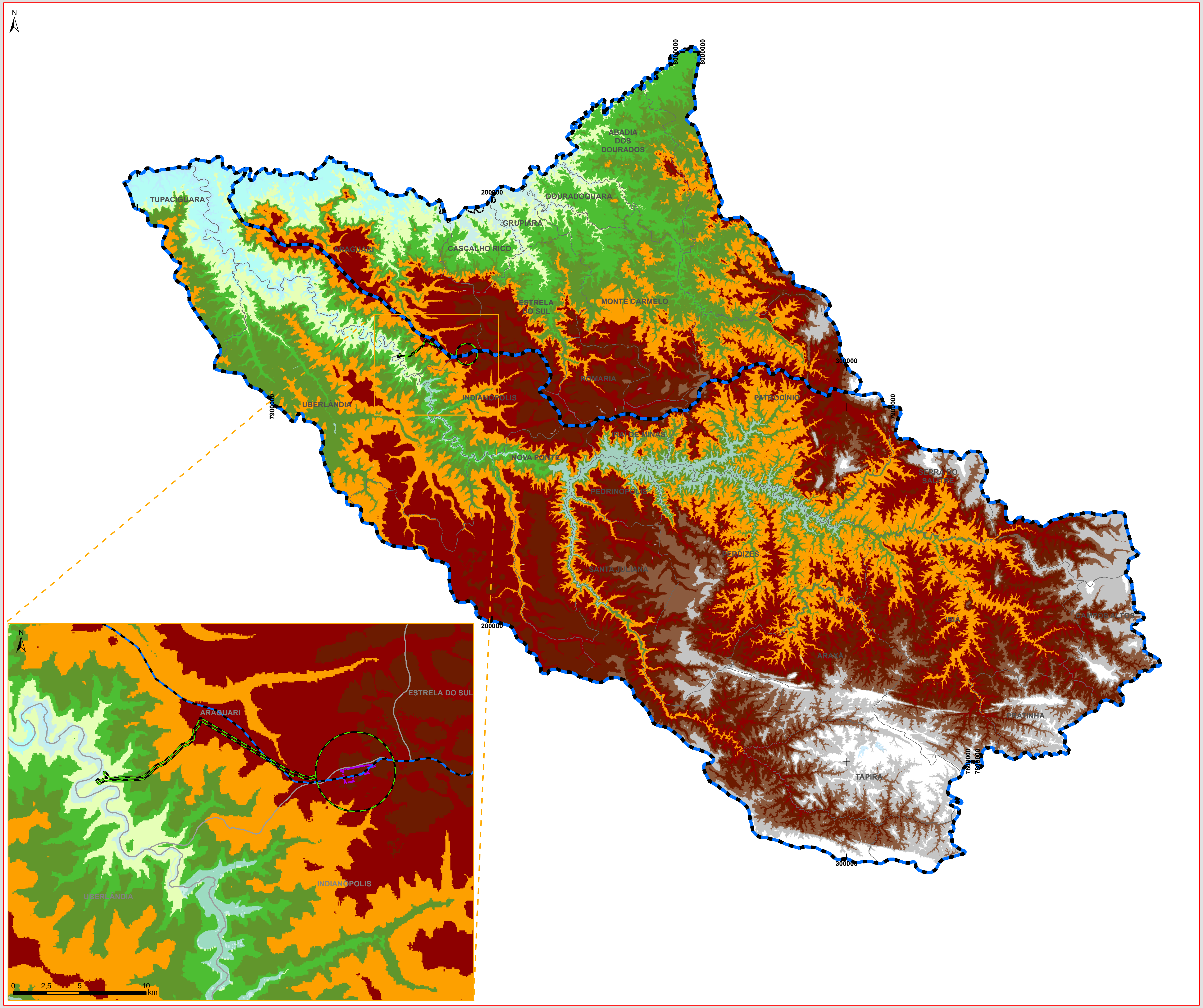
ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

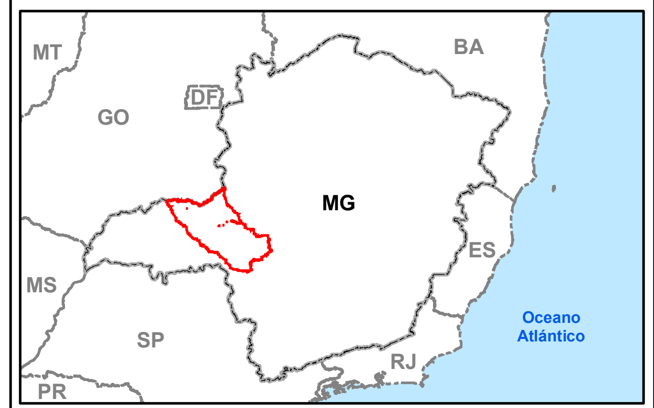
GEOMORFOLOGIA

ESCALA: 1:750.000		DATA: Outubro/2018	
FIGURA Nº 8.1.5.3-1	FOLHA: 1/1	TAMANHO: A2	
RESP. TÉCNICO:	ASSINATURA:		REV: 0

Figure 41 – Digital Terrain Model (MDT).



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

Elevação (em metros)

- 349 - 599
- 600 - 700
- 701 - 788
- 789 - 864
- 865 - 926
- 927 - 984
- 985 - 1.046
- 1.047 - 1.114
- 1.115 - 1.201
- 2.202 - 1.394

ESCALA GRÁFICA:
0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UPGRH (IGAM, 2017)
- MDT (IBGE)

PÖYRY

PROJETO AMADEUS

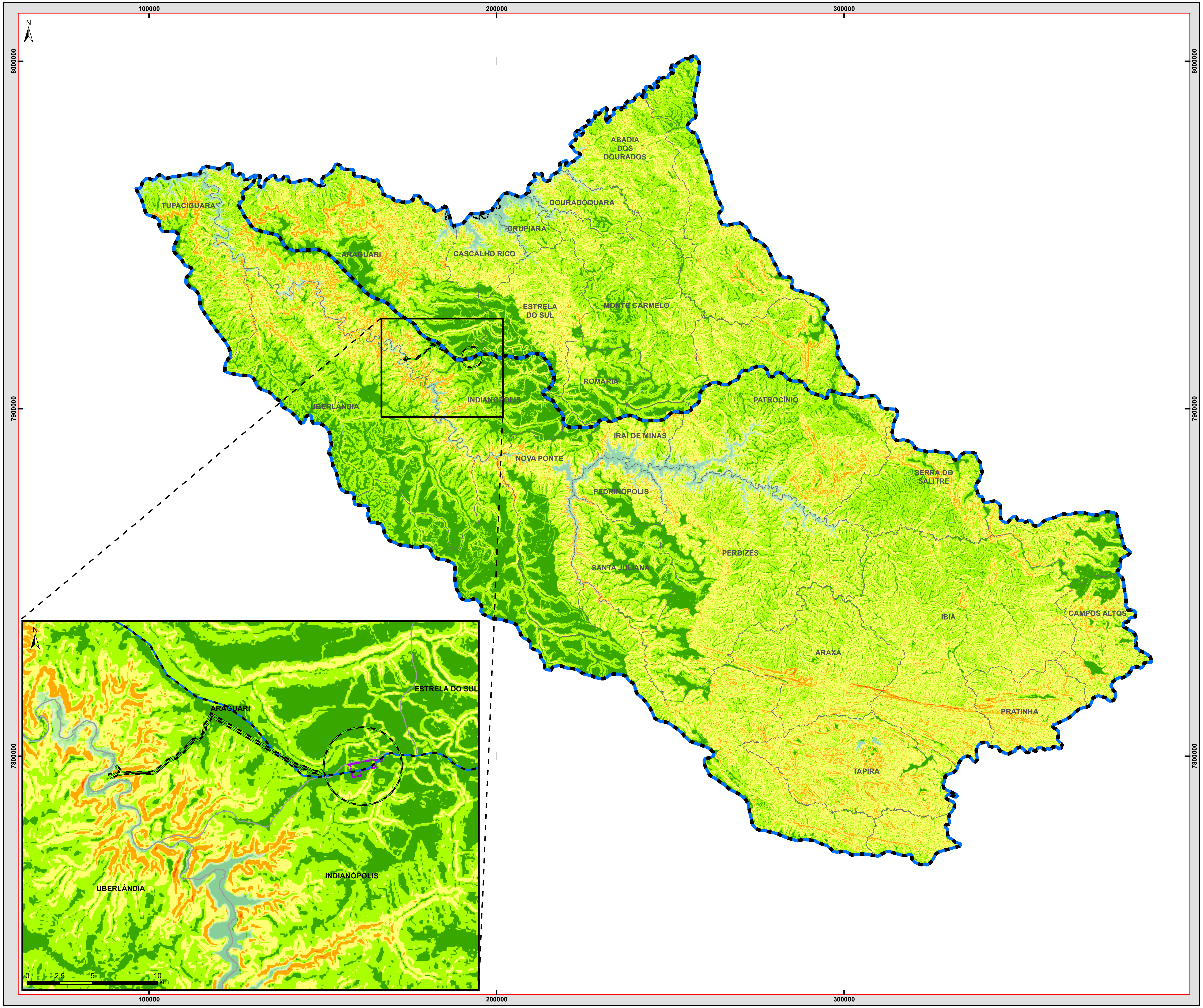
ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

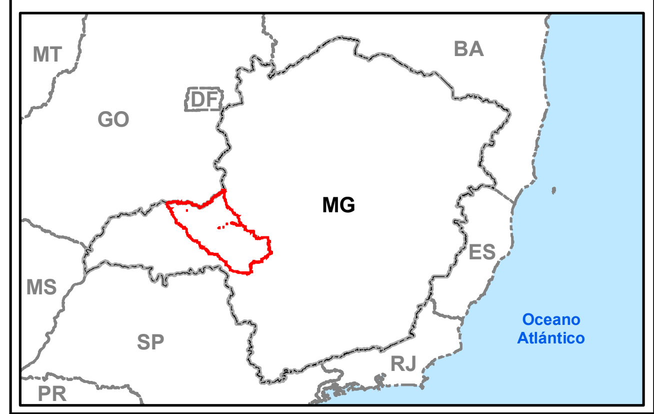
MODELO DIGITAL DO TERRENO - MDT

ESCALA: 1:750.000		DATA: Outubro/2018	
FIGURA Nº 8.1.5.3-2	FOLHA: 1/1		TAMANHO: A2
RESP. TÉCNICO:	ASSINATURA:		REV: 0

Figure 42 – Declivities Map.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

Declividade

- Plano 0 a 3%
- Suave Ondulado 3 a 8%
- Ondulado 8 a 20%
- Forte Ondulado 20 a 45%
- Montanhoso 45 a 75%
- Escarpado > 75%

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UPGRH (IGAM, 2017)
- Declividade (CPRM, 2010)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

DECLIVIDADE

ESCALA: 1:750.000		DATA: Outubro/2018	
FIGURA Nº 8.1.5.3-3	FOLHA: 1/1		TAMANHO: A2
RESP. TÉCNICO:	ASSINATURA:		REV: 0

8.1.5.3.1 Domain of Gratefule Units

The Domain is composed by terrains patterns that correspond to areas of actual and subactual accumulation.

Fluvial plains or fluviolacustres (R1a)

They are flood and lowlands flooded plains. They constitute of actual accumulation zones, sub-horizontals, composed by argillaceous sand and argiloarenoses deposits. They feature extremely smooth gradients and converging towards the main watercourses direction. They are periodically flooded, poorly drained land in flood plains and well drained on the terraces. They display a terrain range of null (zero) and steepness of slopes ranging between 0-3°.

8.1.5.3.2 Domain of Denudacionales Units in sedimentary lithified rocks

The Domain is composed by terrains patterns that correspond to degradation terrains in sedimentary rocks.

High Plateaus and Low Plateaus (R2b)

They consist of surfaces slightly higher than the surrounding lands. They are tabular forms or too broad hills, slightly dissected, with the main drainage system in clear notching and deposition of restricted alluvial plains or in closed valleys. They feature an amplitude terrain between 0 and 50 m, inclination of slopes ranging between 2-5° and top plan to gently wavy.

Tablelands and Plateaus (R2c)

They constitute tabular strap surfaces, or lifted terrains. They are flat or flattened shapes, or not incipiently little dissected. They display edges positioned in high elevations, delimited by the steep rugged slopes. They feature an amplitude terrain that ranges from 0 to 20 m and flat tops. In these forms of terrains, there's clear predominance of pedogenesis processes, with frequent performance of lateralization processes and sporadic occurrences of laminar erosion processes or accelerated linear (ravines and gullies).

8.1.5.3.3 Domain of Flattened Terrains

The Domain is composed by terrains patterns that correspond to flattened terrains.

Degraded Flattened Surfaces (R3a2)

They are flat surfaces lightly wavy, generated by general razing process of land. They are forms that present significant amplitude terrain between 0 and 10 m and inclination of slopes ranging from 0-5°. This form of terrain is characterised by a soft wavy extensive and monotonous terrain. However, they do not constitute a hilly environment, due to very low terrain amplitudes and long ramps with very low gradient.

8.1.5.3.4 Domain of Denudacionales Units in sedimentary or crystalline rocks

The Domain is composed by terrains patterns that correspond to denudacionales terrains. The forms of this domain are characterized as degradated in any lithology terrain patterns, except for embedded valleys patterns and large and smooth hills, in which degradation is predominantly in the sedimentary rock.

Large and Smooth Hills (R4a1)

They constitute of little dissected forms, with convex slopes and large tops, of tabular or elongated morphology. They present the main drainage system with deposition of alluvial plains relatively large. They display terrain amplitude that varies from 20 to 50 m and strands inclination between 3-10°. There is a predominance of pedogenesis processes, with restricted laminar erosion processes occurrence or linear accelerated (ravines and gullies). There may occur generation of colluvium ramps at low slopes.

Dissected Hills and Low Mountains (R4a2)

They are dissected hills, with convex-concave slopes and rounded or sharp tops. The main drainage system with deposition of restricted alluvial plains or in closed valleys. They display range of terrain amplitude that varies from 30 to 80 m and inclination of strands from 5-20°. There is balance between pedogenesis and Morphogenesis processes (formation of thick and well drained soils). There are frequent occurances of laminar erosion processes and sporadic occurrence of linear erosion accelerated processes (ridges, ravines and gullies). There may occur generation of colluvium ramps at low slopes.

Hills and Low Mountains (R4b)

They correspond to convex-concave dissected hills with rounded or sharp tops. They are also included in the top tabular hills unit (characteristic of intensely dissected plateaus) and flat tops. This terrain pattern presents the main drainage system with restricted alluvial plains. They display terrain amplitude that varies from 80 to 200 m and strands inclination between 15-35°.

Within this terrain pattern there is a predominance of morphogenesis processes (formation of little thick soils on slope lands), in addition to frequent performance of laminar erosion and accelerated linear processes (ridges and ravines), with sporadic occurrence of mass movements processes. There may occur generation of colluvium and, subordinately, talus deposits on low strands.

Mountain Slopes (R4c)

They correspond to a mountainous terrain, very rugged, with predominantly rectilinear to concave slopes, sheds, as well as tops of steep lined ridges, lightly rounded or pointed, with sedimentation of colluvium and talus deposits. They present the main drainage system in notching process, amplitudes above 300 m and inclination of strands between 25-45°, with occurrence of rocky subvertical walls (60-90°).

There is a predominance of morphogenesis process (formation of shallow soils on very rough lands), with frequent occurrence of laminar erosion processes and mass movements. There may occur generation of talus deposits and colluvium in low strands.

Structural Steps and Ledges Erosion (R4e)

They are rugged forms, consisting of predominantly rectilinear to concave sheds, sloping and slightly rounded tops, with colluvium sedimentation and talus deposits. They display the main drainage system in notching process, terrain amplitude between 50 and 200 m and inclination of sheds between 10-25°, with occurrence of very inclined slopes (up to 45°).

Within this terrain pattern there is a predominance of morphogenesis processes hogenesis (formation of shallow soils), with frequent performance of laminar erosion processes and mass movements. The talus deposits and colluvium can be generated at low strands. The R4d and R4e patterns feature transition terrains between two distinct surfaces lifts to different dimensions altimetric data.

Embedded Valleys (R4f)

They consist of heavily carved terrain through the vertical drainage incision forming embedded valleys and on plateaus and canyons. They are forms made up of predominantly rectilinear to concave sheds, heavily grooved, sloping, with colluvium sedimentation and talus deposits. They present the main drainage system in notching process, amplitudes between 100 and 300 m and inclination of 10-25° sheds, with possible occurrences of very inclined slopes (up to 45°).

In general, these landforms indicate a recently resumption in the erosive process readjusted at the regional base level. There is a predominance of morphogenesis processes (formation of shallow soils), with frequent performance of laminar erosion processes and mass movements.

8.1.5.4 Local Characterization (AID and ADA)

At the AID and ADA of the enterprise, from the presented Geomorphological Map, it is possible to conclude that predominate terrains relating to the Domain of Plateaus and Low Plateaus (R2b).

As described previously, this unit comprises a degradation terrain in sedimentary rocks and, in some cases, in crystalline rocks. It features surfaces slightly higher than the surrounding terrain, little dissected and tabular forms. The main drainage system displays weak notching.

Pedogenesis processes predominate in the area (formation of thick and well drained soils, generally with low to moderate susceptibility to erosion) and eventual performance of lateralization processes. It is characterised by flat surfaces display modest altitudes in ancient sedimentary basins. There are sporadic occurrences, restricted to processes, of accelerated erosion linear or laminar (ravines and gullies).

In the case of Low Plateaus, the terrain amplitude may vary from 0 to 20 meters and the inclination of the sheds features flat top gently rolled (2-5°). At the Highlands, the terrain amplitude ranges from 20 to 50 metres and the inclination of the sheds features flat top gently rolled (2-5°), except for the axes of the river valleys.

8.1.6 Pedology (Soils)

8.1.6.1 Introduction

The pedogenesis or soil formation is studied at Pedology, where the fundamental concepts have been defined in 1877 by the Russian scientist Dokuchaev. Until that time, it prevailed the geological vision that considered the soil just as a blanket of fragment rocks and of changed products, which reflects only the composition of the rock that gave rise to it. With the finding of the existence of different soils developed from the same source rock, the conception about what is the soil had a more genetics connotation, where the soil is identified as a material that evolves in time, under the action of natural actived factors on the Earth's surface. In 1898, Dokuchaev consolidated the conception that the soil properties are resulted from the soil formation factors that worked and still work on it, namely: source material, climate, organisms, topography (terrain) and time.

Thus, the climate and organisms, controlled by the terrain, acting on a source material, over time, generate a situation of imbalance resulting in weathering and soil formation (pedogenesis).

Among the factors of soil formation, the source material and the time are considered passive factors, climate and organisms are active factors, and the terrain is a controller factor. The passive factor of soil formation is the one that does not add and does not export material neigher generates energy that can accelerate the weathering and pedogenesis processes. The active factors provise energy and chemical compounds that promote the processes of soil formation.

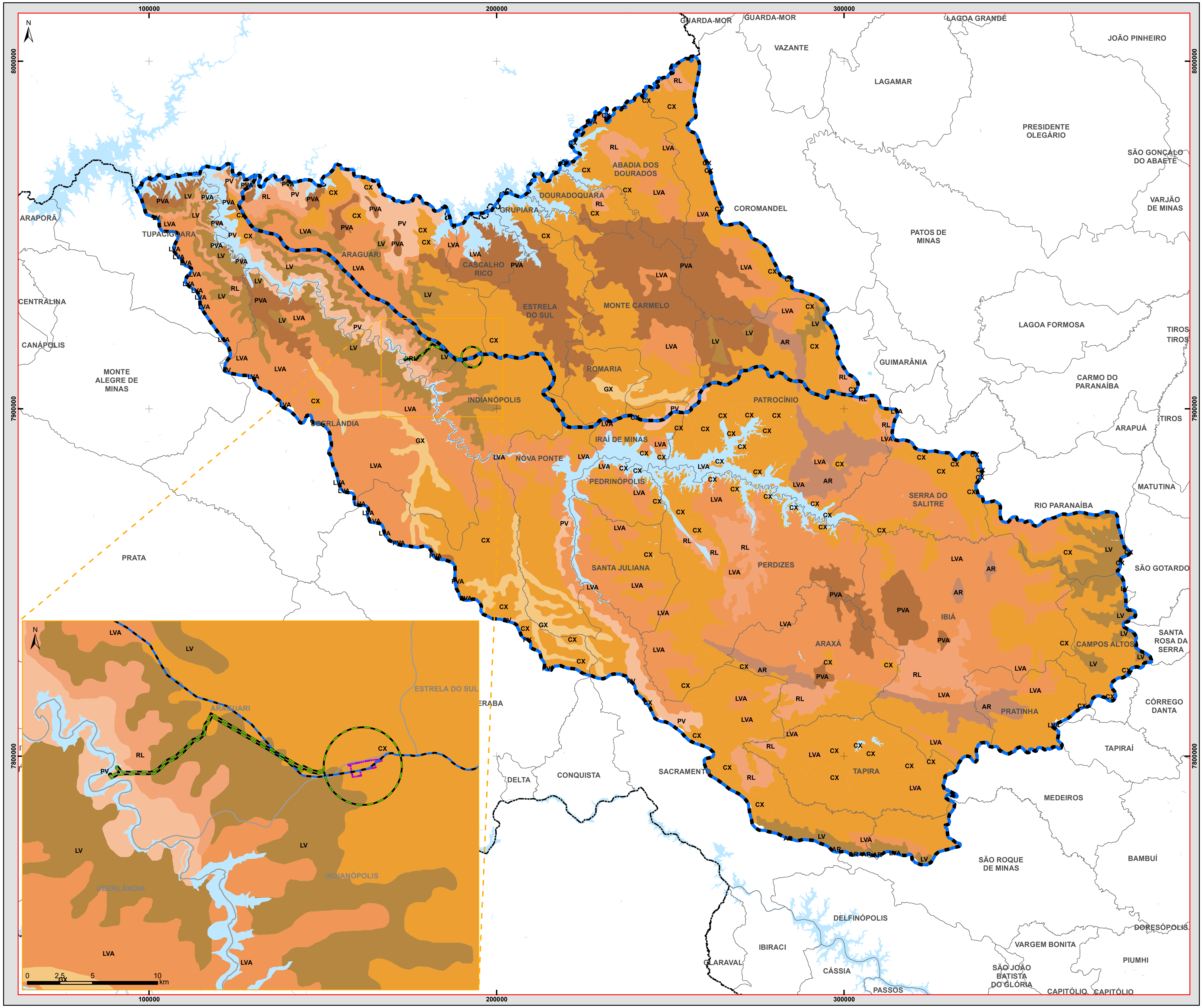
8.1.6.2 Methodology

The pedological characterization was based on secondary data, highlighting the Soil Map of the Minas Gerais State (UFV/UFLA, 2010) and the Water Resources Plan of Rio Paranaíba basin (COBRAPE/ANA, 2011). The pedological map was drawn up in accordance with the Embrapa Soils Classification System (EMBRAPA, 2006).

8.1.6.3 Regional Characterization (AII)

According to the Soils Map of the Minas Gerais State (UFV/UFLA, 2010) shown below, it was possible to identify in the AII the following soil types: Argissolos, Cambissolos, Gleissolos, Latossolos and Neossolos.

Figure 43 –Pedological Map.



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

Pedologia

- Afloramento de Rocha
- CX - Cambissolo Háplico
- GX - Gleissolo Háplico
- LV - Latossolo Vermelho
- LVA - Latossolo Vermelho-Amarelo
- PV - Argissolo Vermelho
- PVA - Argissolo Vermelho-Amarelo
- RL - Neossolo Litólico

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UPGRH (IGAM, 2017)
- Solos (EMBRAPA, 2006)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

PEDOLOGIA

ESCALA: 1:750.000		DATA: Outubro/2018	
FIGURA Nº 8.1.6.3-1	FOLHA: 1/1	TAMANHO: A2	
RESP. TÉCNICO:	ASSINATURA:		REV.: 0

8.1.6.3.1 Argissolos

According to (EMBRAPA, 2006), Argissolos consistitute of mineral material soils, which features the presence of textural B horizon clay with low activity as a differential, or high coupled with low saturated bases or alitiate character. The textural B horizon (Bt) lies immediately below any type of superficial horizon, except the hystic, without, however, presenting the established requirements to be included in the classes of Luvissolos, Planossolos, Plintossolos or Gleissolos.

Most of this class soils presents an obvious increase in clay content at the superficial horizon to horizon B, with or without decrease in the underlying horizons. The transition between the horizons A and Bt is usually clear, abrupt or gradual.

These soils have variable depths, from strong to imperfectly drained, reddish or yellowish colors, and more rarely, bronzed or grayish. The texture ranges from sandy to clay on the horizon A and from medium to very clayish on the horizon Bt, always having an increase of clay from horizon A to Bt.

They are strong to moderately acid, with saturation by high or low bases, predominantly kaolinites and with Ki molecular relationship in general ranging from 1.0 to 3.3.

Still according to (EMBRAPA, 2006) they are soils consisting of mineral material with high or low combined clay activity with low bases saturation or alitiate character and textural B horizon immediately below horizon A or E, and showing the following requirements:

- Horizon plinth, if present, is not above nor coincidental with the superficial part of the B horizon textural;
- Horizon glei, if present, is not above nor coincidental with the superficial part of the B horizon textural.

Within this class are included soils that were previously classified as red-yellow Podzolic clay of high or low activity, small part of structured “Terra Roxa”, similar structured “Terra Roxa”, structured “Terra Bruna” and similar structured “Terra Bruna”, most with textural gradient necessary for B textural, in any case, Eutrophic, Dystrophic or Alicos, Gray Bruno-Podzolic, dark red Podzolic, yellow Podzolic, Gray Podzolic and more recently soils which have been classified as Alissolos with B textural.

Red Argissolos

Soils with 2,5 yr hue or redder or 5 yr hues and values and cromas equal or smaller than 4, mostly at the first 100 cm of the B horizon.

Yellow-Red Argissolos

Other soils of red-yellow and reddish-yellow colors that do not fit in any of the previous classes.

8.1.6.3.2 Cambissolos

According to (EMBRAPA, 2006), Cambissolos include soils consisting of mineral material, with horizon B incipient underpinning any type of superficial horizon, since in any case do not meet the requirements to be included in the classes of Vertissolos, Chernossolos, Plintossolos, Organossolos. They have sequence of horizons A or histic, Bi, C, with or without R.

Due to the heterogeneity of the source material, the terrain forms and the climate conditions, the characteristics of these soils vary a lot from from one location to another.

Thus, the class behaves from soils heavily to imperfectly drained, from shallow to deep, bruna color or bruno-yellowish till even dark red, and from high to low saturation by bases and chemical activity of clay fraction.

The B horizon incipient (Bi) has texture franco-sandy or more clay, and the solum, generally, presents uniform levels of clay, may occuring slight decrease or a little increment of the clay from A to Bi. It allows a marked difference of granulometry from A to the Bi, in cases of developed soils from alluvial sediments or other cases in which there is lithological discontinuity or stratification of the source material.

The structure of the Bi horizon can be in blocks, granular or prismatic, there are also cases of soils with absence of aggregates, with simple grain or massive structure.

The horizon with presence of plinthite or gleation may be present in soils of this class, since they do not meet the established requirements to be included in the classes of Plintossolos or Gleissolos.

Some soils in this class have morphological characteristics similar to those of the Latossolos class soils, but they are distinguished from these by submitting, in the B horizon, one or more of the below specified features, not compatible with very developed soil:

- Cation exchange capacity, without carbon correction, 17 cmolc/kg of clay; and/or;
- 4% or more of primary changeable minerals or 6% or more of Muscovite, determined on sand fraction, but referred to the TFSA;
- Molar ratio SiO_2/Al_2O_3 (Ki), determioned on or corresponding to the clay fraction and/or, greater than 2.2; and/or
- silt/clay ratio equal to or greater than 0.7 when the texture is medium, being equal to or greater than 0.6 when it is clay or it is very clay; this criterion is applied to soils whose source material is related to the crystalline, as the granitic and gneiss rocks; and/or
- 5% or more of the soil volume presents the structure of the original rock, as thin laminates, or saprolite, or fragments of semi or not weathered rock.

Also according to (EMBRAPA, 2006), the soils are composed by mineral material, presenting the horizon A or histic with insufficient thickness to define the class of Organossolos, followed by B horizon incipient and satisfying the following requirements:

- B incipient not coincident with glei horizon within 50 cm of the soil surface;
- B incipient not coincident with plinth horizon;
- B incipient not coincident with vertic horizon within 100 cm of the soil surface; and
- Not presenting the combination of the chernozemic A horizon and B horizon incipient with high saturation by bases and high clay activity.

This class includes the previously classified soils as Cambissolos, including those developed in alluvial sediments. There are excluded from this class the soils with chernozemic A horizon and horizon B incipient with high saturation by bases and high clay activity.

Cambissolos Háplicos

Other soils that do not fit in the previous classes (soils with humic A horizon or soils with flavic character within 120 cm from the soil surface).

8.1.6.3.3 Gleissolos

According to (EMBRAPA, 2006) Gleissolos comprises hydromorphic soils consisting by mineral material, which present glei horizon within 150 cm from the soil surface, immediately below the horizons A or E (with or without gleation), or histic horizon with insufficient thickness to define the class of Organossolos; not presenting exclusively sand or simple sandy texture in all horizons within the first 150 cm of the soil surface or even till a lithic contact, either vertic horizon, or B horizon textural with abrupt textural change above or coincident with glei horizon or any other type of B horizon diagnosis above the glei horizon. Plinth horizon, if present, must be the depth of more than 200 cm of the soil surface.

Soils from this class are permanently or periodically saturated by water, unless artificially drained. The water remains stagnant internally, or the saturation is by lateral flow in the soil. In any circumstance, the water at the soil can rise by capillary rise, reaching the surface.

They are characterized by strong gleation, as a result of reducing environment, virtually free of dissolved oxygen, because of saturation by water throughout the year, or at least for an extended period, associated with the demand for oxygen by biological activity.

The gleation process implies the manifestation of gray colors, bluish or greenish, due to the reduction and solubilization of iron, allowing the expression of the neutral colors of the clay minerals, or the precipitation of ferrous compounds.

They are poorly or very poorly drained soils, under natural conditions, which have sequence horizons of A-Cg, A-Big-Cg, A-Btg-Cg, A-E-Btg-Cg, A-Eg-Bt-Cg, Ag-Cg, HCg, having the superficial horizon colors from gray to black, usually between 10 and 50 mm thickness cm and average to high levels of organic carbon.

The glei horizon, which can be C, B, E or A horizon, has dominantly colors bluer than 10Y, quite low cromas, close to neutral.

They are soils which occasionally may have sandy texture (sand or single sand) only in superficial horizons, being followed by glei horizon with single sandy texture or thinner.

Besides the horizons A, H or E presence, in the C horizon, the structure is generally massive, it can presents cracks and looks similar to the prismatic structure when dry or after having the wall of the trench exposed for a few days. In the B horizon, when it occurs, the structure is in blocks or compound prismatic or not angular and sub-angular blocks. It may include sulphuric horizon, calcic, sodium property, sodium, salicylic character, or plintita in quantity or position not diagnostized to fit in the class of Plintossolos.

They are soils formed mostly from sediments, stratified or not, and subject to constant or periodic excess of water, which can occur in several situations.

Commonly, these soils developed from recent sediments in the vicinity of watercourses and colluvium-alluvial materials susceptible to hydromorphy conditions, and may also be formed in areas of plan terrains of river terraces, laky or marine, as well as in waste materials in depleted and depressions areas. They are eventually formed in sloping areas under the influence of groundwater upwelling (sprung).

They are soils that occur under hydrophilic vegetation or hygrophyll herbaceous, shrubby or arboreal.

Still according to (EMBRAPA, 2006), the Gleissolos are soils consisting of mineral material, with glei horizon within the first 150 cm of the surface, immediately below A or E horizon, or H horizon (histic) with insufficient thickness to fit the Organossolos class, satisfying also the following requirements:

- Absence of any type of B horizon diagnosed above the glei horizon;
- Absence of vertic horizon, plinth, or B textural with abrupt textural change, coinciding with the glei horizon;
- Absence of plinth horizon within 200 cm from the soil surface.

As for comprehensiveness, this class encompasses soils that were previously classified as Glei Little Humic, Glei Humic, part of the Grey Hydromorphic (no textural abrupt change), Glei Tiomorphic and Solonchak with glei horizon.

<u>Gleissolos Háplicos</u>

Other soils that do not fit in the previous classes (Tiomorphic-soils with sulfuric horizon and/or sulfurics materials, within 100 cm from the surface; Salic-soils with salicylic character (EC $\geq$ 7dS/m, 25° C) in one or more horizons, within 100 cm from the surface; Melanic-soils with H horizon histic with less than 40 cm thick, or A horizon humic, prominent or chernozemic.

8.1.6.3.4 Latossolos

Latossolos comprise soils consisting of mineral material, with B horizon latosolic immediately below any one of the types of surface diagnosed horizon, except histic (EMBRAPA, 2006).

They are soils in an advanced stage of weathering, very developed, as a result of energetic constitutive material transformations. The soils are virtually devoid of primary or secondary minerals less resistant to weathering, and are capable of exchanging cations from the low clay fraction, less than 17cmolc/kg of clay without carbon correction, with variations from predominantly kaolinites soils, with higher Ki values, around 2.0, admitting a maximum of 2.2, up to oxidic soils of Ki extremely low.

They vary strongly in well drained, although occurring soils which have pale colors, to moderate drained or even imperfectly drained, indicative of current or past conditions, with a certain degree of gleation.

They are usually very deep, and the thickness of the solum is rarely less than one meter. They have sequence of Horizons A, B, C, with little differentiation from sub-horizons, and transitions usually diffuse or gradual. In distinction to the darker colors of A, the B horizon has brighter colors, varying from yellow or even bruno-grauish to dark red-grey, in shades 2,5 yr to 10 yr, depending on the nature, form and amount of the mineral constituents - mainly of iron oxides and hydroxides - according water regime conditioning and soil drainage, the levels of iron in source material and if the Hematite is inherited or not. In the C horizon, comparatively less colorful, the chromatic expression is quite variable, even heterogeneous, given its nature more saprolite. The increment of clay from A to B is little expressive or non-existent and the textural relationship B/A does not satisfy the requirements for B texture.

Overall, the clay fraction levels in the solum increase gradually with depth, or remain constant throughout the profile. The cerosity, if present, is little and weak. Typically, there is low clays mobility in the B horizon, except for atypical behaviors, of soils developed from material with lighter texture, sand-quartz composition, interactions with organic constituents of high activity, or soils with DpH positive or null.

They are, in general, strongly acidic soils, with low saturation by bases, Dystrophic or aluminum. There are, however, soils with average saturation by bases and even high; usually found in areas that present pronounced dry season, semi-arid or not, or by influence of basic or calcareous rocks.

They are typical of equatorial and tropical regions, occurring also in subtropical zones, distributed mainly by large and ancient erosion surfaces, sediments or ancient river terraces, usually in plan and soft wavy terrain, although they may occur in hilly areas, including mountainous. They are originated from the most diverse of rocks species and sediments, under conditions of climate and vegetation types of the most diverse.

Also according to (EMBRAPA, 2006), the Latossolos are soils consisting of mineral material, showing B horizon latosolic, immediately below A horizon of any type within 200 cm of the soil surface or within 300 cm, if A horizon presents more than 150 cm of thickness. There are included in this class all the former named Latossolos, except some modalities previously identified as plinth Latossolos.

Red Latossolos

Soils with 2,5 yr hue or redder in most of the first 100 cm from the B horizon (including BA).

Red-Yellow Latossolos

Other soils of red-yellow colors and yellow-reddish, which do not fit in the previous classes (Brunos or yellows).

8.1.6.3.5 Neossolos

According to (EMBRAPA, 2006), the Neossolos include soils consisting of mineral material, or organic material little thick, which do not exhibit significant changes in relation to material source due to low intensity of pedogenic processes performance, either due to inherent features to the source material itself, as greater resistance to weathering or chemical-mineralogical composition, or by the influence of other formation factors (climate, topography or time), which can prevent or limit the development of soils.

They have the horizon sequence A-R, A-C-R, A-Cr-R, A-Cr, A-C, O-R or H-C without meeting, however, the requirements established to be identified in the classes of Chernossolos, Vertissolos, Plintossolos, Organossolos or Gleissolos. This class admits various types of superficial horizons, including the O horizon with less than 20 cm thick when overlying the rock, or humic A horizon or prominent with over 50 cm when overlying layer, R, C or Cr.

Some soils may still present B horizon, but with insufficient requirements (very small thickness, for example) to characterize any type of B diagnosed horizon. C diagnosed horizons may occur for other classes, but in a position that does not allow framing them in classes of the Gleissolos, Vertissolos or Plintossolos.

They are soils consisting of mineral material, or by organic material with less than 20 cm thick, not showing any type of B diagnosed horizon and satisfying the following requirements:

- Absence of glei horizon below A within 150 cm deep, except in the case of sand or virtually single sand texture soils without primary weatherproof materials;
- Absence of vertic horizon immediately below the A horizon;
- Absence of plinth horizon within 40 cm, or within 150 cm from the surface immediately beneath the horizons, A or E, or preceded by pale coloring horizons, variegated or mottled in abundance quantity;
- Absence of A chernozemic horizon with carbonate character, or in conjunction with C calcium horizon or carbonate character.

Belong to this class soils with A or histic horizon, with less than 20 cm thick, followed by layer (s) with 90% or more (expressed by volume) of rock fragments or the source material, independent of their resistance to weathering.

In the Neossolos class there are included the soils that have been recognized previously as Litossolos and Litólicos Soils, Regossolos, Alluvial Soils and Silica Sands (Dystrophy, Mrines and Hydromorphic). The humic A horizon soils or prominent A, with thickness greater than 50 cm, followed by lytic contact or with sequence of A, C or ACr horizons (EMBRAPA, 2006).

Neossolos Litólicos

Soils with the A or histic horizon, based directly on the rock or under a C or Cr horizon or under a material with 90% (expressed by volume) or more of their mass consisting of rock fragments greater than 2 mm diameter (gravels, pebbles and matations), a typical lithic contact or fragmentary within 50 cm from the soil surface. They admit a B horizon in early formation, whose thickness does not satisfy any type of B diagnosed horizon.

8.1.6.4 Local Characterization (AID and ADA)

In general, it was observed on AID and ADA of the project, the occurrence of Cambisolos Háplico soils, as illustrated in the Pedological Map presented earlier.

These soils generally consist of mineral material, with B horizon. Due to the heterogeneity of the source material, the terrain forms and the climate conditions, the characteristics of these soils vary greatly from one location to another.

They are soils heavily, to even imperfectly, drained, shallow to deep, of bruna color or bruno-yellowish, and from high to low saturation by bases and chemical activity of the colloidal fraction. The B horizon incipient (Bi) has texture franco-sandy or more clay, and the solum, generally, presents uniform levels of clay, there may occur slight decrease or a slight increment of clay from A to Bi horizon. The structure of the B horizon may be in blocks, granular or prismatic, and there are also cases of soils withiout aggregates, with simple or massive grains.

They feature thickness at least median (50-100 cm deep) and without drainage restriction, in slow moved terrain, eutrophic or dystrophic, they feature good agricultural potential. When located in floodplains are susceptible to flood, which if frequent and occurring from medium to a long-term time, is a limit factor to be used for agricultural purpouses.

8.1.6.4.1 Soil quality

In order to know the soil quality of the region where the dissolving pulp mill will be erected, before its operation, it was carried out a campaign of soil collection and quality analysis (as background).

Collection Points

There were defined 6 collection points in the place foreseen for LD Celulose dissolving pulp mill erection, as shown in the following figure.

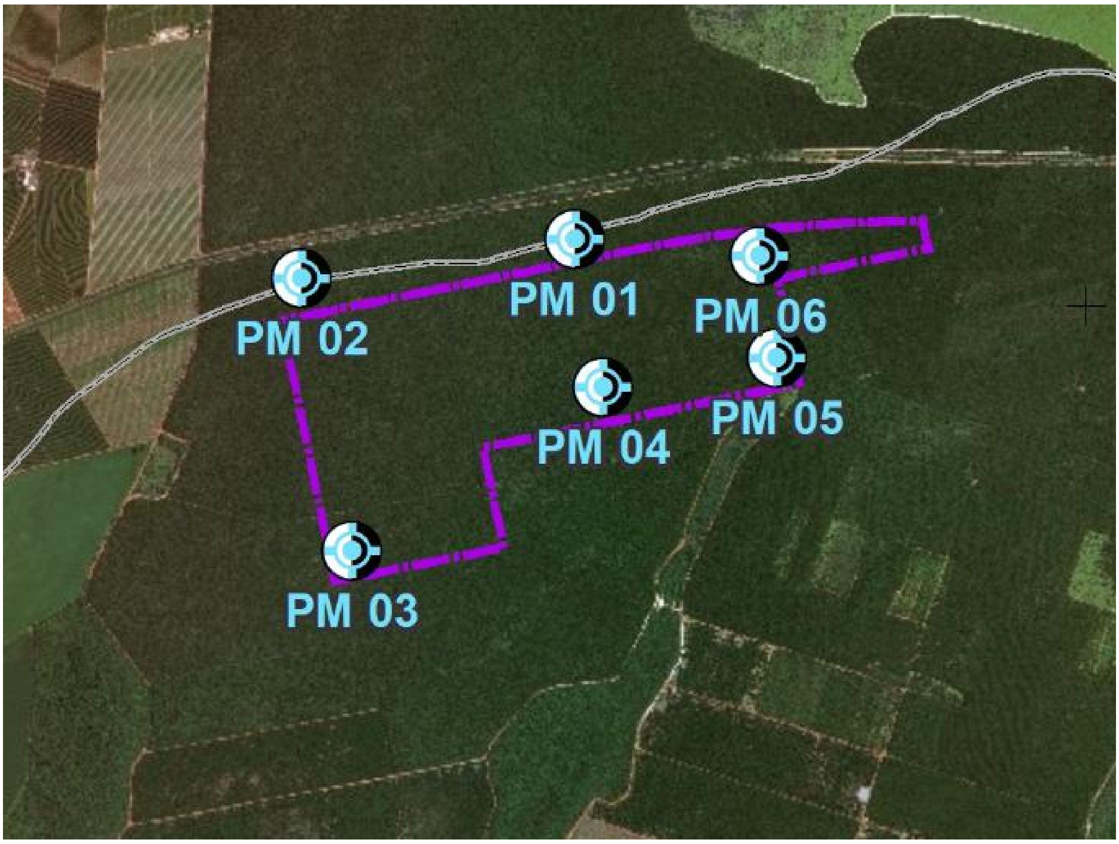


Figure 44 – Location of groundwater and soil monitoring in the future LD Celulose mill area. Source: Pöyry Tecnologia (2018).

Parameters

In order to check the current soil conditions there were analyzed all the parameters listed in the guiding values of CONAMA Resolution nº. 420/2009 and Normative Deliberation COPAM nº 166/2011.

Methodology

The soil collection for quality analysis was performed during the percussion samples with dynamic penetration standardized test (SPT-Standard Penetration Test).

The withdrawal of the sub-soil, warped type was performed in drilling through the auger, washing with circulated water, or when measuring the resistance to penetration by standardized sampler S.P.T.

The works were carried out in accordance with the NBR 6484, NBR 9603 and NBR 6502 Brazilian Standards.

The analyses were performed by the Água e Terra laboratory, which has accreditation on ISSO/IEC 17025.

Below, there are presented some pictures of the collections.

Figure 45 – Soil collections photos. Source: GEOTORK (2017).

Results

In the following table there is presented a summary of the chemical analyses results of the soil collected samples in comparison with the VI values – Research Values established by CONAMA Resolution nº 420/2009 and Normative Deliberation COPAM nº 166/2011 for soils in industrial areas, since this will be a future industrial area.

Table 15 – Soil quality monitoring results

Parameter	Unit	CONAMA Resolution nº 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Alumínio	mg/kg	-	-	93.490	72.740	89.320	89.734	79.044	75.834
Antimônio	mg/kg	25	25	7,87	8,37	8,76	7,44	7,99	6,38
Arsênio	mg/kg	150	150	101,88	80,9	103,78	85,49	80,77	88,25
Bário	mg/kg	750	750	0,83	0,70	0,96	0,55	0,52	0,59
Boro	mg/kg	-	-	<0,4	<0,4	1,5	<0,4	<0,4	<0,4
Cádmio	mg/kg	20	20	3,78	3,61	3,84	3,64	3,25	3,94
Chumbo	mg/kg	900	900	<0,5	<0,5	<0,5	<0,5	<0,5	<0,5
Cobalto	mg/kg	90	90	31,41	1,26	1,11	30,64	31,59	34,50
Cobre	mg/kg	600	600	2,24	0,95	3,44	2,40	2,42	2,10
Cromo	mg/kg	400	400	<0,5	47,24	52,23	<0,5	<0,5	<0,5
Ferro	mg/kg	-	-	41.890	40.349,9	41.889,9	43.542,7	45.832,6	48.143,4
Manganês	mg/kg	-	-	48,9	57,75	36,38	47,44	48,43	47,23
Mercúrio	mg/kg	70	70	<0,05	<0,05	0,06	<0,05	<0,05	<0,05
Molibdênio	mg/kg	120	120	111,55	18,7	8,01	78,98	75,55	77,19
Níquel	mg/kg	130	130	2,72	1,88	2,94	2,90	3,37	3,49
Nitrato (como N)	mg/kg	-	-	1,92	1,60	0,90	1,38	1,03	1,22
Prata	mg/kg	100	100	<0,25	<0,25	<0,250	<0,250	<0,250	<0,250
Selênio	mg/kg	-	-	<0,25	<0,25	<0,250	<0,250	<0,250	<0,250
Vanádio	mg/kg	1000	-	125,5	141,7	128,2	112,4	103,22	101,35
Zinco	mg/kg	2000	2000	12,51	7,78	8,96	11,67	13,73	12,55
Benzeno	mg/kg	0,15	0,15	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Estireno	mg/kg	80	80	<0,010	<0,010	<0,0005	<0,0005	<0,0005	<0,0005
Tolueno	mg/kg	75	75	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Xilenos	mg/kg	70	70	<0,030	<0,030	<0,030	<0,030	<0,030	<0,030

Parameter	Unit	CONAMA Resolution nº 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Antraceno	mg/kg	-	-	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Benzo(a)antraceno	mg/kg	65	65	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Benzo(k)fluoranteno	mg/kg	-	-	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Benzo(g,h,i)perileno	mg/kg	-	-	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
Benzo(a)pireno	mg/kg	3,5	3,5	<0,0015	<0,0015	<0,0015	<0,0015	<0,0015	<0,0015
Criseno	mg/kg	-	-	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Dibenzo(a,h)antraceno	mg/kg	1,3	1,3	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
Fenantreno	mg/kg	95	95	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Indeno(1,2,3,cd)pireno	mg/kg	130	130	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Naftaleno	mg/kg	90	90	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Monoclorobenzeno	mg/kg	120	120	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2-Diclorobenzeno	mg/kg	400	400	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,3-Diclorobenzeno	mg/kg	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,4-Diclorobenzeno	mg/kg	150	150	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2,3-Triclorobenzeno	mg/kg	35	35	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2,4-Triclorobenzeno	mg/kg	40	40	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,3,5-Triclorobenzeno	mg/kg	-	-	<0,008	<0,008	<0,008	<0,008	<0,008	<0,008
1,2,3,4-Tetraclorobenzeno	mg/kg	-	-	<0,010	<0,010	<0,001	<0,001	<0,001	<0,001
1,2,3,5-Tetraclorobenzeno	mg/kg	-	-	<0,010	<0,010	<0,001	<0,001	<0,001	<0,001
1,2,4,5-Tetraclorobenzeno	mg/kg	-	-	<0,010	<0,010	<0,001	<0,001	<0,001	<0,001
Hexaclorobenzeno	mg/kg	1	1	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
1,1-Dicloroetano	mg/kg	25	25	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2-Dicloroetano	mg/kg	0,5	0,5	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
1,1,1-Tricloroetano	mg/kg	25	25	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010

Parameter	Unit	CONAMA Resolution nº 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Cloreto de Vinila	mg/kg	0,008	0,008	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
1,1-Dicloroeteno	mg/kg	8	8	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2-Dicloroeteno (trans)	mg/kg	4 ou 11	4 ou 11	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Tricloroeteno - TCE	mg/kg	22	22	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Tetracloroeteno - PCE	mg/kg	13	13	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Clorofórmio	mg/kg	8,5	8,5	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Tetracloreto de Carbono	mg/kg	1,3	1,3	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
2-Clorofenol	mg/kg	2	2	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
2,4-Diclorofenol	mg/kg	6	6	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
3,4-Diclorofenol	mg/kg	6	6	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
2,4,5-Triclorofenol	mg/kg	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
2,4,6-Triclorofenol	mg/kg	20	20	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
2,3,4,5-Tetraclorofenol	mg/kg	50	50	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
2,3,4,6-Tetraclorofenol	mg/kg	7,5	7,5	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Pentaclorofenol (PCP)	mg/kg	3	3	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Cresóis	mg/kg	19	19	<0,0015	<0,0015	<0,0015	<0,0015	<0,0015	<0,0015
Fenol	mg/kg	15	15	<0,4	<0,4	<0,4	<0,4	<0,4	<0,4
Dietilxil ftalato (DEHP)	mg/kg	10	10	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Dimetil Ftalato	mg/kg	3	3	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Di-n-butil ftalato	mg/kg	-	-	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Aldrin e Dieldrin	mg/kg	0,03 e 1,3	0,03 e 1,3	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
Endrin	mg/kg	2,5	2,5	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
DDT + DDD + DDE	mg/kg	5,7,3	5,7,3	<0,015	<0,015	<0,015	<0,015	<0,015	<0,015
HCH Beta	mg/kg	5	5	<0,00025	<0,00025	<0,00025	<0,00025	<0,00025	<0,00025

Parameter	Unit	CONAMA Resolution nº 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Bifenilas policloradas - PCB´s	mg/kg	0,12	0,12	<0,0075	<0,0075	<0,0075	<0,0075	<0,0075	<0,0075

The aluminum parameter presented values in range of 72,740 to 93,490 mg/kg, these values can be considered within the characteristics of soil quality of the region. It should be added that at the Normative Deliberation COPAM nº 166/2011 and at CONAMA Resolution n° 420/2009 there is no reference standard to soil quality analysis of this parameter.

Regarding the antimony, it presented values in the range of 7.87 to 8.76 mg/kg, which are under the Research Values established by Normative Deliberation COPAM nº 166/2011 and by CONAMA Resolution n° 420/2009 (25 mg/kg).

At all analysed points, the arsenic and barium parameters presented values in the range of concentration of 380.77 to 103.78 mg/kg and 0.52 to 0.96 mg/kg, respectively, which are below the Research Values established by the Normative Deliberation COPAM n°. 166/2011 and CONAMA Resolution n° 420/2009.

At all analysed points, the parameters lead, mercury, silver and selenium are below the quantification limit of the method, i.e. they are way below the Research Values established by Normative Deliberation COPAM nº 166/2011 and CONAMA Resolution n° 420/2009.

The boron parameter presented values in the range of < 0.4 to 1.5 mg/kg, however, it does not have reference value for contamination investigation, as well as the nitrate (as N) that presented values in the range of 0.9 to 1.92 mg/kg, which also has no limit in legislation.

The iron and manganese parameters had the analysed values presented in the range of 40349.9 to 48143.4 mg/kg and from 36.4 to 57.75 mg/kg, respectively. The high values of iron are within the characteristics of soil quality in the region and does not characterize contamination, in addition, the Normative Deliberation COPAM nº 166/2011 and CONAMA Resolution n° 420/2009 do not establish reference values for iron and manganese in the soil.

At all sampled points, the cobalt, copper, chromium, molybdenum, nickel, vanadium and zinc presented values below the limits of investigation established by the Normative Deliberation COPAM nº 166/2011 and CONAMA Resolution n° 420/2009.

In relation to organic compounds analyzed, all points presented values below the limit of quantitation of the method.

<u>Conclusion</u>

With the goal to define the soil quality of the dissolving pulp mill region before its operation, being considered as background and reference for future monitoring studies, there were carried out collection and analyses of soil samples, through a campaign conducted in June and July 2018.

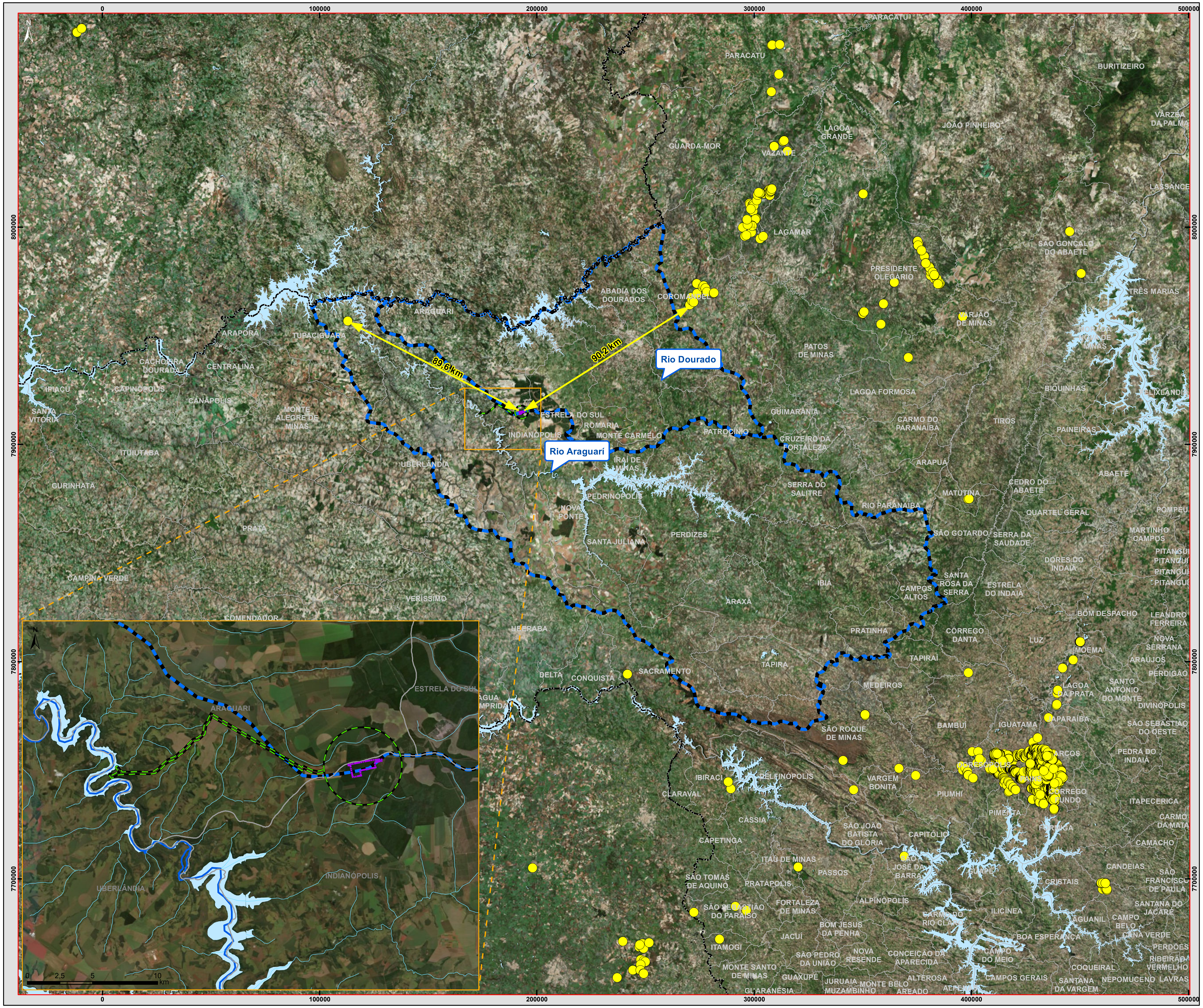
The analysis encompassed all parameters listed in the Quality Reference Values of Normative Deliberation COPAM nº 166/2011 and CONAMA Resolution n° 420/2009.

It can be concluded that there was not found any changes in the soil that would indicate contamination at the evaluated points, once all the results presented Research Values below the limits established at the Normative Deliberation COPAM n° 166/2011 and at CONAMA Resolution n° 420/2009.

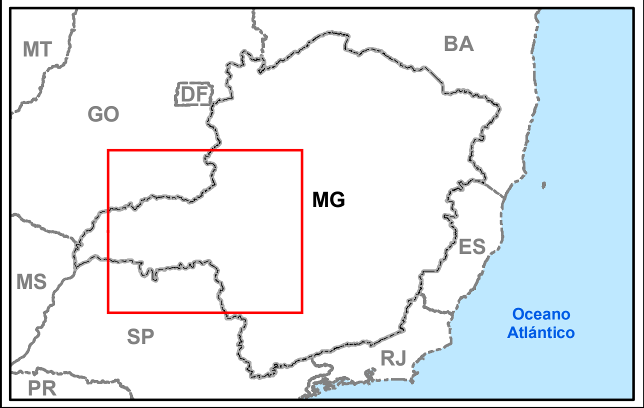
8.1.7 Speleology

The methodology used for speleology consisted in the survey at the National Centre of Studies, Caves Protection and Management (CECAV, 2018), linked to ICMBio. According to this database (with last update on 15/12/2017), in AII, AID and ADA there were not observed the occurrence of underground cavities. The nearest occurrence of underground cavities areas, according to the Speleological map shown below, are located: Northwest (89.6 km from AID), in the municipality of Tupaciguara; and the Northeast (90.2 km from AID), in the municipality of Coromandel.

Figure 46 – Speleological Map.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Cavidade Natural
- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Corpo D'água
- Limite Municipal
- Limite Estadual

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais(IBGE, 2015);
- UPGRH (IGAM, 2017)
- Espepeologia (CECAV, 2017)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

ESPELEOLOGIA

ESCALA: 1:1.200.000		DATA: Outubro/2018	
FIGURA Nº 8.1.7-1	FOLHA: 1/1		TAMANHO: A2
RESP. TÉCNICO:	ASSINATURA:		REV: 0

8.1.8 Hydrology

8.1.8.1 Surface Water Resources

8.1.8.1.1 Introduction

The studied area is located in the rio Paranaíba hydrographic basin, this being the second largest unit of the Paraná Hydrographic Region, occupying 25.4% of its area, including the States of Goiás (63.3%), Mato Grosso do Sul (3.4%) and Minas Gerais (31.7%), in addition to Federal District (1.6%). The basin passes through 197 municipalities, besides the Federal District.

In the State of Minas Gerais, the Paranaíba River basin was divided into three Water Management Units (UGHs): Afluentes Mineiros do Alto Paranaíba (PN1), Rio Araguari (PN2) and Afluentes Mineiros do Baixo Paranaíba (PN3) (according to the following figure). For purposes of planning and data systematization there were also defined Water Planning Units - UPHs along the major rivers. The UPHs correspond to important basins and sub-basins in the context of the basin, defined according to hydrographic factors (main rivers and tributaries), hydrological (presence of fluviometric stations or of dams that alter the river dynamics) and the water uses (presence of large urban centres or of intense irrigation). From the 20 UPHs existing at Paranaíba River basin in the State of Minas Gerais, the studied area includes two of them: Rio Dourados (02) and Rio Araguari (03), which will have their main characteristics described in the following itens.

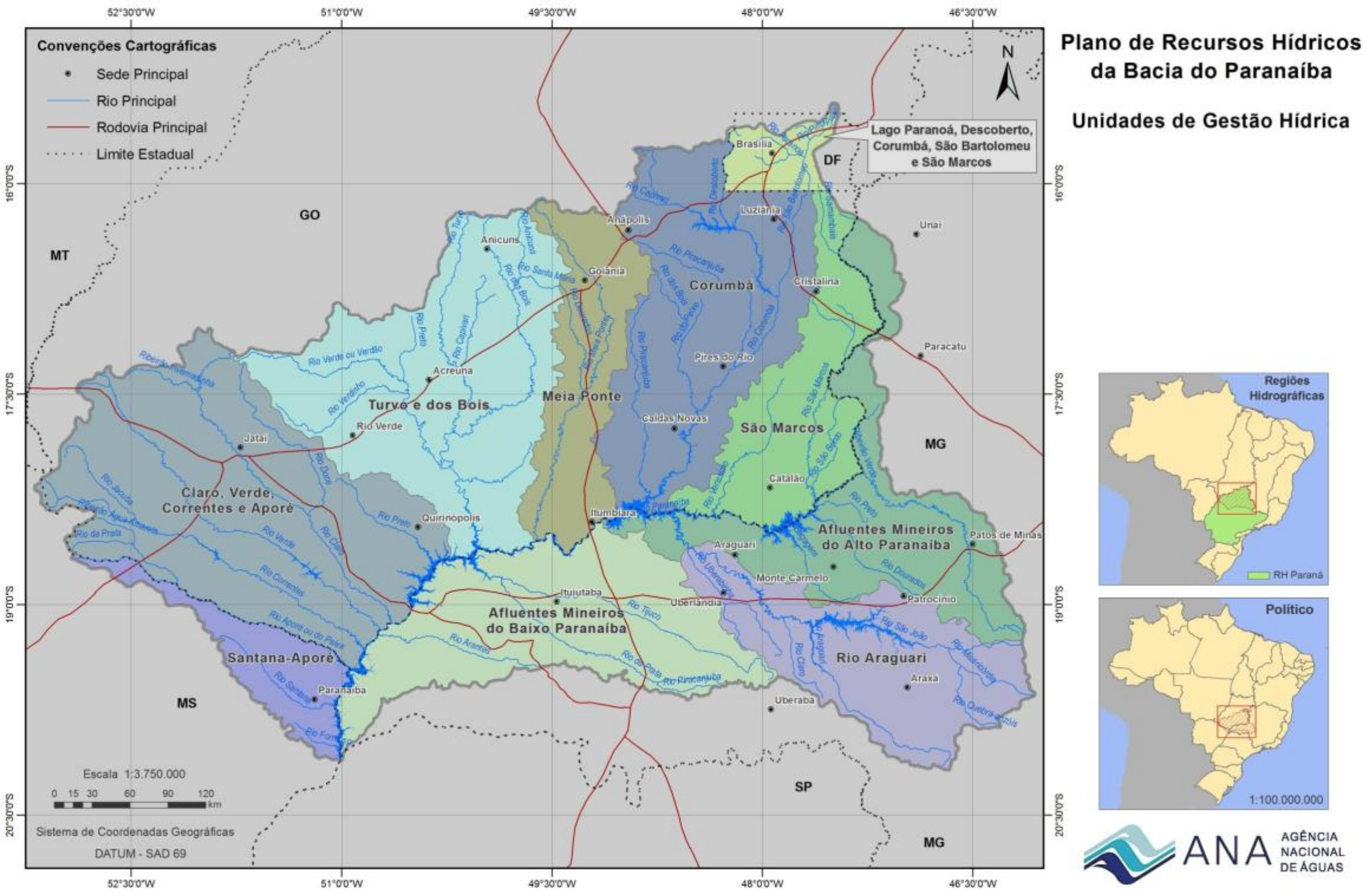


Figure 47 – Water Management Units (UGHs) from rio Paranaíba basin. Source: ANA, 2013.

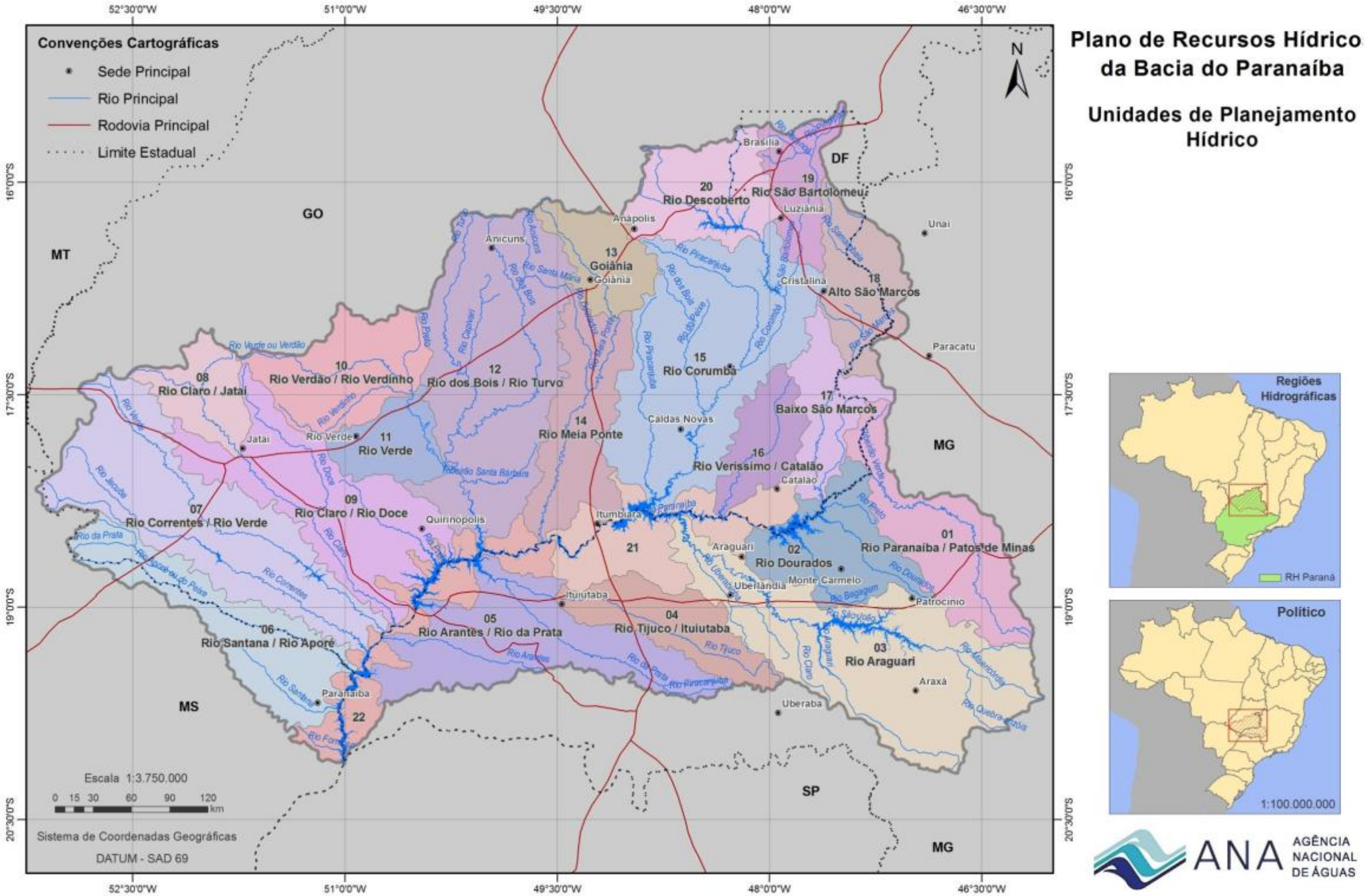


Figure 48 – Water Planning Units (UPHs) from rio Paranaíba basin. Source: ANA, 2013.

8.1.8.1.2 Methodology

The description of the Water Planning Units (UPH) at the areas of influence of the project took place through secondary data survey, mainly through the PARH - Water Resource Plan and the Classification of Surface Water Bodies from Paranaíba River Basin (PN1) (ANA, 2013), the PARH - Action Plan of the Water Resources from Water Management Unit Afluentes Mineiros do Paranaíba (PN1) (CBH AMAP, 2013) and the Rio Araguari (PN2) (COBRAPE, 2013). There are also presented, on Local Characterization, information about the surface water quality campaigns carried out in rio Araguari (PÖYRY, 2018).

8.1.8.1.3 Regional Characterization (AII)

The UGH of the Afluentes Mineiros do Alto Paranaíba Miners (PN1) is located in the meso-regions of Triângulo Mineiro and Alto Paranaíba, having total area of 22,409 km ² (4% of the total State area). This Unit is polarized by the urban areas of Patos de Minas, Monte Carmelo and Araguari. Other important municipalities have part of their areas within this UGH, like Paracatu and Unaí, however their urban centers are out of this basin, being located at the São Francisco River basin.

The UGH of the Rio Araguari (PN2), is located in the western portion of the State, covering the regions of Triângulo Mineiro and Alto Paranaíba. With a total area of 22,091 km ² and a population of 1,163,718 inhabitants, it is divided into 20 municipalities, being its source located in São Roque de Minas municipality, at 1,180 m height and its mouth is on the border of the Araguari and Tupacigura cities, 510 m height.

8.1.8.1.3.1 Water Demands and Uses ´

The activities developed in the basin resulted in an increase demand for water. The demand estimatives have as reference the year of 2010 and the gathered information, such as irrigated areas and the grant records from the water resource managers responsible. The withdrawal flow rates correspond to the water intake from the water bodies, while the consumption flow rates correspond to the water effectively consumed considering the average return coefficient from the different uses (as seen in the following table).

Table 16 – Water return rates according to its uses

Irrigated Agriculture	Livestock	Mining	Industry	Urban Supply	Rural Supply
20%	20%	90%	80%	80%	50%

Source: ANA, 2013.

The water demand (withdrawal flow) to attend various uses presented in the Paranaíba basin is 315.9 m ^{3}/s, while the total consumption flow is 211.1 m ^{3}/s (66.8% of the withdrawn) (according to the following table).

Sectorally, the basin's agricultural activity (irrigated) represents a water demand of 188.9 m³/s, i.e., 89.5% of the total demand at both UGHs. The second largest water demand is the animal watering, representing 4.0% of the total demand at both UGHs, followed by industrial demand (3.5%) and the public supply demand (2.9%). The demands for mining reach 0.2% of the total demand at both UGHs, concentrating its activities on UGH Rio Araguari.

When compared the water consumption demands with the withdrawal, a greater participation of the industrial sector, mining and public supply with respect to irrigation and animal watering sectors is observed, which have lower water return rate (20 %). Therefore, 74.8% of the withdrawal flow is reached by irrigated agriculture sector compared to the various water uses presented in the basin, and 11.6% of the withdrawal flow belongs to industry sector.

Among the biggest demands of the basin, there are the UGHs of Afluentes Mineiros do Alto Paranaíba, Turvo and dos Bois and Rio Araguari with 41.3 m³/s, 39.8 m³/s and 28.1 m³/s, respectively. It is observed in all UGHs that irrigated agriculture is use with more expressive demand, and the demand for human supply is more significant in UGHs Meia Ponte, Corumbá and the Federal District.

Table 17 – Demands (consumption flow) by UGH

UGH	Irrigated Agriculture (m^3/s)	Industry (m^3/s)	Mining (m^3/s)	Animal Watering (m^3/s)	Human Supply (m^3/s)	Total
Afluentes Mineiros do Alto Paranaíba	39,9	0,1	0,03	1,0	0,3	41,3
Rio Araguari	26,4	0,2	0,27	0,7	0,6	28,1
Total Basin	**188,9**	**7,3**	**0,33**	**8,5**	**6,1**	**211,1**

Source: ANA, 2013.

Human Supply

The human supply demands are concentrated in UGHs with more populous political-administrative units, which also have high urbanization rate. From the total intake, the consumption is 0.6 m³/s at the UGH Rio Araguari, 0.3 m³/s at UGH dos Afluentes Mineiros do Alto Paranaíba and 6.1 m³/s of the total basin.

Industry

The industry water demand was based on the National Register of Water Resources Users (CNARH) from ANA and from grant data. According to these sources, the basin demand reaches 36.6 m³/s, with consumption of 0.2 m³/s at UGH Rio Araguari, 0.1 m³/s at UGH dos Afluentes Mineiros do Alto Paranaíba.

Livestock

The total withdrawal demand for animal watering is 10.6 m³/s, with the consumption of 8.5 m³/s, with emphasis at the western sector of the UGHs basin, especially in municipalities of Mato Grosso do Sul State. In the studied area, with consumption with animal watering is 0.7 m³/s at UGH Rio Araguari and 1.0 m ³/s at UGH dos Afluentes Mineiros do Alto Paranaíba.

Irrigated Agriculture

Of the total irrigated area at the Paranaíba basin (608,808.9 ha), the UGHs Turvo and dos Bois and Afluentes Mineiros do Baixo Paranaíba concentrate 23.4% and 17.5%, respectively. The UGHs Afluentes Mineiros do Baixo Paranaíba e Rio Araguari in Minas Gerais State also present significant irrigated areas with 85 and 77000 ha, respectively (accordinf to the table below).

Table 18 – Irrigated area, total and by UGH.

UGH	Irrigated area (ha) – ANA Study	Irrigated area (ha) – Agricultural Census	Total (ha)
Afluentes Mineiros do Alto Paranaíba	95.773,8	10.859,3	106.633,1
Rio Araguari	69.317,8	7.973,7	77.291,5
Total Basin	**501.966,2**	**106.842,7**	**608.808,9**

Source: ANA, 2013.

The irrigation demands considered the water use in the critical months, corresponding to August and September when reached 236.2 m³/s, which correspond to 74.8% of all withdrawal demand at Paranaíba River basin. The consumption of 188.9 m³/s, corresponds to 89.5% of the total basin. The irrigated area was estimated as 608,808.8 ha, having been identified around of 3,500 central pivots of irrigation, occupying a total area of 229,569 ha.

Due to the increased of water use, the agriculture areas of more intensive uses, as in the case of central pivot method, presented the highest demands at the basin. The

UGHs of the studied area present the following demand: Afluentes Mineiros do Alto Paranaíba (49.8 m³/s) and Rio Araguari (33.0 m³/s).

Mining

The water demand for mining, used the same sources for industry sector, in addition to the Portal da Compensação Financeira pela Exploração de Recursos Minerais (DNPM, 2011b) and the Annual Brazilian Mineral (DNPM, 2006), having been identified the demand for withdrawal of 3.3 m ³/s. The activity concentrates on UGH Rio Araguari, in the Triângulo Mineiro region, it is responsible for 82% of the total demand at the Paranaíba River basin. The UGH dos Afluentes Mineiros do Alto Paranaíba is responsable for a consumption of 0.03 m³/s.

8.1.8.1.3.2 Energy generation

According to ANA (2013) data, on the Paranaíba River basin there are 19 hydroelectric plants (UHEs) in operation and 1 in final construction phase (UHE Batalha), in addition there are 14 small hydroelectric plants (PCHs) in operation and 2 in construction phase. The total output power of the hydroelectric plants in operation/construction is 8,362.5 MW, while the PCHs reach a total of 264.5 MW.

There are still being studied other 163 hydroelectric projects (27 hydroelectric plants and 136 PCHs), which demonstrates the great potential of expansion of one of the most important sectors for water resources use in the basin. The additional power that can be achieved is 1,664.4 MW for all UHEs and 1,529.9 MW with all PCHs. Together, 30 rivers of the basin feature hydroelectric plants uses under study, with emphasis on the river São Bartolomeu (05 enterprises), Tijuco (12) , Piracanjuba (12), Doce (13), Claro (13), Verde (15) and Meia Ponte (18).

The UGHs dos Afluentes Mineiros do Baixo Paranaíba and Rio Araguari count with the following hydropower enterprises: Amador Aguiar I and II, Miranda, Nova Ponte, Emborcação, Serra do Facão and Batalha.

8.1.8.1.3.3 Water availability

The analysis of the fluviometric regime of the Paranaíba River basin was conducted from the daily, monthly and annual data of 76 fluviometric stations, plus 21 natural series reconstituted in projects contracted by ONS, totaling 97 historical series.

The parameters selected to represent the water availability of the Paranaíba River basin are the average flow of long period (QmLT), minimum flows of drought of 7 days long and 10 years of recurrence (Q7,10), 95% flow permanence of flow permanence curve (Q95%), maximum daily flows and regularization flows. The flows were used in absolute terms (in m ³/s) and also on specific values (in L/s.km^2) that allow the analysis of the spatial variability availability.

The water availability in the PRH Paranaíba was characterized as the high permanence flow of the reservoir/dam located upstream of the section of interest coupled with incremental flow at the section, obtained from the daily flows data of the power plants and from the fluviometric stations. In the river pathes not influenced by reservoirs, the water availability was set according to the Q95% daily flow or the Q7,10 flow. In the river pathes influenced by reservoirs, high flow permanence was set as the Q95% natural monthly flow, or the Q100% natural monthly flow, obtained on the monthly series of natural flow of the plants in the period from 1931 to 2009. The values obtained for Q95% and Q100% natural monthly flows from the natural series flows at the locations of the hydropower plants (UHEs) located in the studied area are presented in the following table.

Table 19 – Monthly flow rates ($Q_{95\%}$ and $Q_{100\%}$) at UHEs dams located in the studied areas UGHs.

Reservoir	$Q_{95\%}$ monthly (m^3/s)	$Q_{100\%}$ monthly (m^3/s)
Amador Aguiar I	123,00	65,00
Amador Aguiar II	129,00	68,00
Batalha	23,00	23,00
Emborcação	37,00	22,00
Miranda	121,00	64,00
Nova Ponte	97,00	53,00
Serra do Facão	49,00	27,00

Source: ANA, 2013.

Based on these premises, the water availability at the rio Paranaíba basin mouth is 931.8 m^3/s for the reference flow Q7,10 and is 1,251.7 m^3/s for the reference flow Q95%. The specific basin flow reaches 4.05 $L/s.km^2$ (Q7,10) and 5.26 $L/s.km^2$ (Q95%). Considering the average flow of long term period (QmLT), obtained from the arithmetic average of the available series flows, the estimated flow at the mouth of rio Paranaíba is 3,418.4 m^3/s. In the following table there are presented the data for UGHs dos Afluentes Mineiros do Baixo Paranaíba and Araguari River and for the total Paranaíba River basin.

Table 20 – Surface water availability in studied area UGHs.

	UGH Afluentes Mineiros do Alto Paranaíba	UGH Rio Araguari	Total Rio Paranaíba Basin
Area (km^2)	22.408,67	21.063,47	222.593,4
Q_{mLT} (m^3/s)	362,05	392,37	3.418,4
q_{mLT} ($L/s.km^2$)	16,16	17,51	11,0
$Q_{7,10}$ (m^3/s)	71,70	97,68	931,8
$q_{7,10}$ ($L/s.km^2$)	3,20	4,64	4,05
$Q_{95\%}$ (m^3/s)	103,51	135,37	1.251,7
q95% ($L/s.km^2$)	4,62	6,43	5,26
Surface water availability ($Q_{7,10}$ + $Q_{95\%}$ monthly) (m^3/s)	91,25	133,92	1.188,6
Surface water availability ($Q_{95\%}$ daily + $Q_{95\%}$ monthly)	105,19	138,02	1.214,0
Average Annual Precipitation (mm)	1.464	1.552	1.509
Average Annual Evapotranspiration (mm)	954	964	1.016

Source: ANA, 2013.

8.1.8.1.3.4 Surface water quality

The water quality of the Paranaíba River basin suffers the influence of multiple human activities that occur in the territory, from agriculture to urban expansion and occupation. The impacts at this basin are related to processes such as siltation, eutrophication and contamination by domestic and industrial effluents.

The water quality was evaluated by the existing reservoirs monitoring and the monitoring on the water courses conducted by hydroelectric sector of the region, by the public organs and by the water resources managers organs of the federation units (IGAM/MG). The results were related to the classification of the water bodies, according to the prevailing usages, established by CONAMA Resolution n° 357/2005. In addition, it was made an estimation of the loads polluting tributaries to water courses and an analysis of the relationship between pollution sources and water quality.

The main analyzed parameters were BOD, total phosphorus and thermotolerant coliforms. The BOD quantifies the oxygen necessary to oxidize the organic matter through the action of micro-organisms, expressing indirectly the amount of organic matter present in the effluent. The phosphorus presents itself at inorganic form, linked to the use of detergents and other household chemicals, and at organic form, linked to physiological origin compounds. Finally, the thermotolerant coliforms are a group of bacteria from the intestinal of humans and other animals, therefore they also function as contamination indicators by domestic sewage (Von Sperling, 2007).

From the monitoring conducted by the IGAM, it was observed that UGHs Araguari River and Afluentes Mineiros do Alto Paranaíba feature greater number of parameters with concentration values that do not meet the recommended limits for class 2 according to CONAMA Resolution n^{o} 357/05, particularly with respect to thermotolerant coliforms parameter. The proximity to urban centres (Uberlândia and Patos de Minas), the domestic sewage and industrial effluents disposal on the rivers and the existence of farming activities in the surroundings of the cities influence negatively on the water bodies quality at those regions.

The principal source of the BOD and coliforms parameters is the domestic sewage which features regularly disposal and features a punctual pollution. With respect to the total phosphorus parameter, the potential sources involve both domestic effluents as well as farming and mining activities, which are susceptable to runoff, and thus feature a diffuse pollution. This type of pollution does not present regularity on disposal due to topographic and soil characteristics of the terrain, intermittent superficial runoff in the basin and rainfall intensity and frequency.

The basin has a large number of reservoirs, with sizes and varied functions, susceptible to the effects of human activity that intensifies the process of silting and eutrophication. The increase in the supply of nutrients to water courses, in particular phosphorus, enhances the reservoirs eutrophication, compromising the multiple use.

To evaluate the water quality, in addition to the monitoring network, it was held a simulation of the loads pollution from urban domestic sewage, considering the parameters BOD, total phosphorus and thermotolerant coliforms. These loads estimattion at water bodies, adopted separate removal coefficients for three groups of population: population without sewage collection, population with sewage collection and without treatment and population with sewage collection and treatment. In the following table there are presented the data to the UGHs Afluentes Mineiros do Baixo Paranaíba and Rio Araguari and for the total of the Paranaíba River basin.

Table 21 – Loads of domestic origin (generated and remnants) at the studied area UGHs.

		UGH Afluentes Mineiros do Alto Paranaíba	UGH Rio Araguari	Rio Paranaíba Total Basin
BOD	Generated (kg/d)	21.843	44.791	435.611
	Remnant (kg/d)	18.699	19.931	209.116
	Reduction (%)	14,4%	55,5%	52,0%
Total Phosphorus	Generated (kg/d)	405	829	8.067
	Remnant (kg/d)	346	593	4.671
	Reduction (%)	14,4%	28,6%	42,1%
Coliforme Termotolerante	Generated (NMP*/d)	4,0E+13	8,3E+13	8,1E+14
	Remnant (NMP*/d)	3,5E+13	5,0E+13	4,0E+14
	Reduction (%)	14,4%	39,9%	50,4%

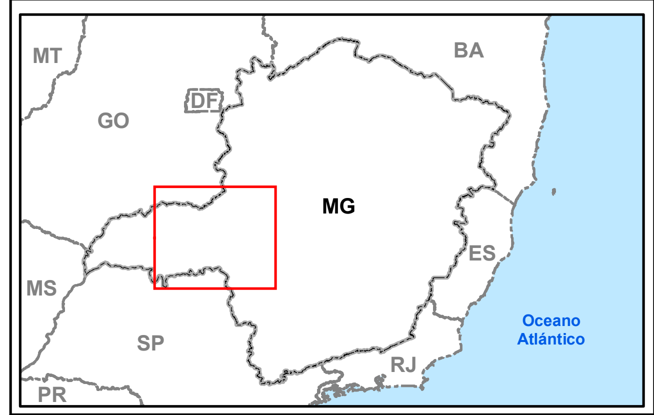
Source: ANA, 2013.

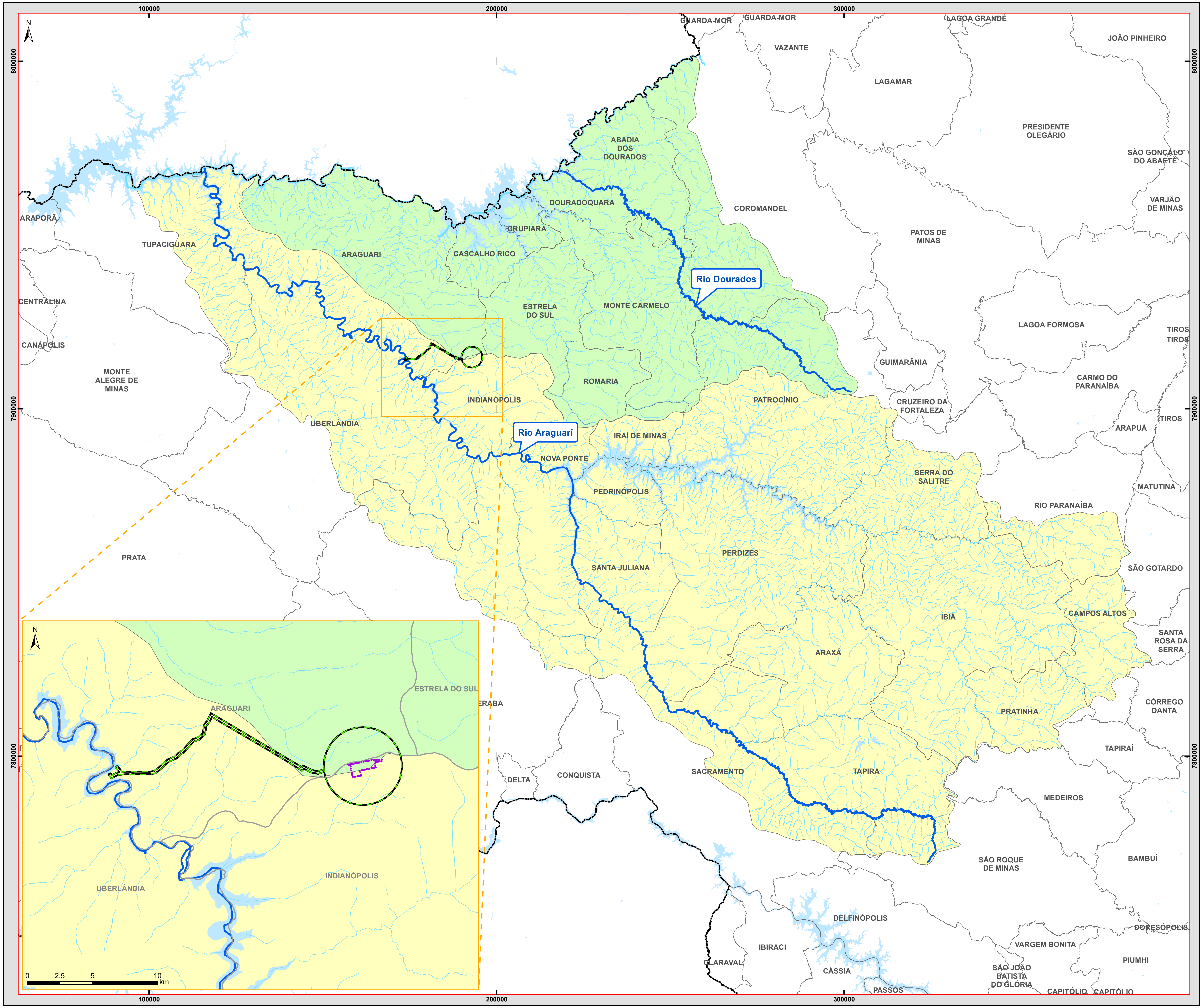
8.1.8.1.4 Local Characterization (AID and ADA)

As described earlier, the AID and ADA of the enterprise are located on the edge of two basin UPHs of the rio Paranaíba: Rio Dourados and Rio Araguari, as illustrated in the following figure.

Figure 49 –Surface water resources Map.

LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS





LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Hidrografia
- Rio Araguari/Rio Dourados
- Corpo D'água
- Limite Municipal
- Limite Estadual

UPGRH - AII - Área de Interferência Indireta

- UGH - Rio Dourados
- UGH - Rio Araguarí

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografia (IBGE, 2015);
- UPGRH (IGAM, 2017)
- Hidrogeologia (CPRM, 2007)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

RECURSOS HÍDRICOS

ESCALA: 1:750.000		DATA: Agosto/2018	
FIGURA Nº 8.1.8.4-1	FOLHA: 1/1	TAMANHO: A2	
RESP. TÉCNICO:		ASSINATURA:	REV.: 0

It should be noted that, in the context of this study, there will be detailed the characteristics of the UPH Araguari River, once the future dissolving pulp mill will have the water intake and the liquid treated effluent disposal on the Araguari River; on the UPH do rio Dourados is where the industrial unit itself will be installed.

8.1.8.1.4.1 Araguari river basin characterization

The Araguari River basin has a large drainage network, which allows its division into internal planning unit. The sub-basins division and the municipalities that reach the river are described below. It should be noted that the enterprise area is located in the Sub-basin of the Ribeirão das Furnas (as showed on the figure and table below).

- Rio Araguari Mouth: stretch between the Amador Aguiar I dam and the rio Araguari mouth;
- Rio Uberabinha: Drainage area of the river Uberabinha;
- AHEs Capim Branco: Section between Miranda and Amador Aguiar I dams;
- Médio Araguari: Drainage area of the rio Araguari tributaries, since Miranda dam till the end of the Nova Ponte reservoir backwater in rio Araguari, except the sub basins of rio Claro, rib. Santa Juliana, rib. Das Furnas and rio Quebra-Anzol;
- Ribeirão das Furnas: Drainage area of the ribeirão das Furnas;
- Rio Claro: Drainage area of the rio Claro;
- Baixo Quebra-Anzol: Drainage area of the tributaries of the rio Quebra-Anzol from the mouth of the rio Quebra-Anzol till the end of the reservoir backwater of Nova Ponte on the rio Quebra-Anzol, except the sub basins of the rib. Santo Antônio, rib. do Salitre, rio Galheiro and Capivara River;
- Ribeirão Santa Juliana: Drainage area of ribeirão Santa Juliana;
- Ribeirão Santo Antônio: Drainage area of ribeirão Santo Antônio;
- Alto Araguari: Drainage area of the tributaries of the rio Araguari since the stretch that runs from the end of the Nova Ponte reservoir backwater in rio Araguari till its source, excepted the sub basin of the ribeirão do Inferno;
- Rio Galheiro: Drainage area of rio Galheiro;
- Rio Capivara: Drainage area of rio Capivara;
- Ribeirão do Salitre: Drainage area of ribeirão do Salitre;
- Ribeirão do Inferno: Drainage area of ribeirão do Inferno;
- Alto Quebra-Anzol: Drainage area of the tributaries of the rio Quebra-Anzol from the end of the reservoir backwater of Nova Ponte on the rio Quebra-Anzol up its source, except the sub basins of the rib. Grande, rio São João and rio Misericórdia;
- Ribeirão Grande: Drainage area of ribeirão Grande;
- Rio São João: Drainage area of rio São João;
- Rio Misericórdia: Drainage area of rio Misericórdia.

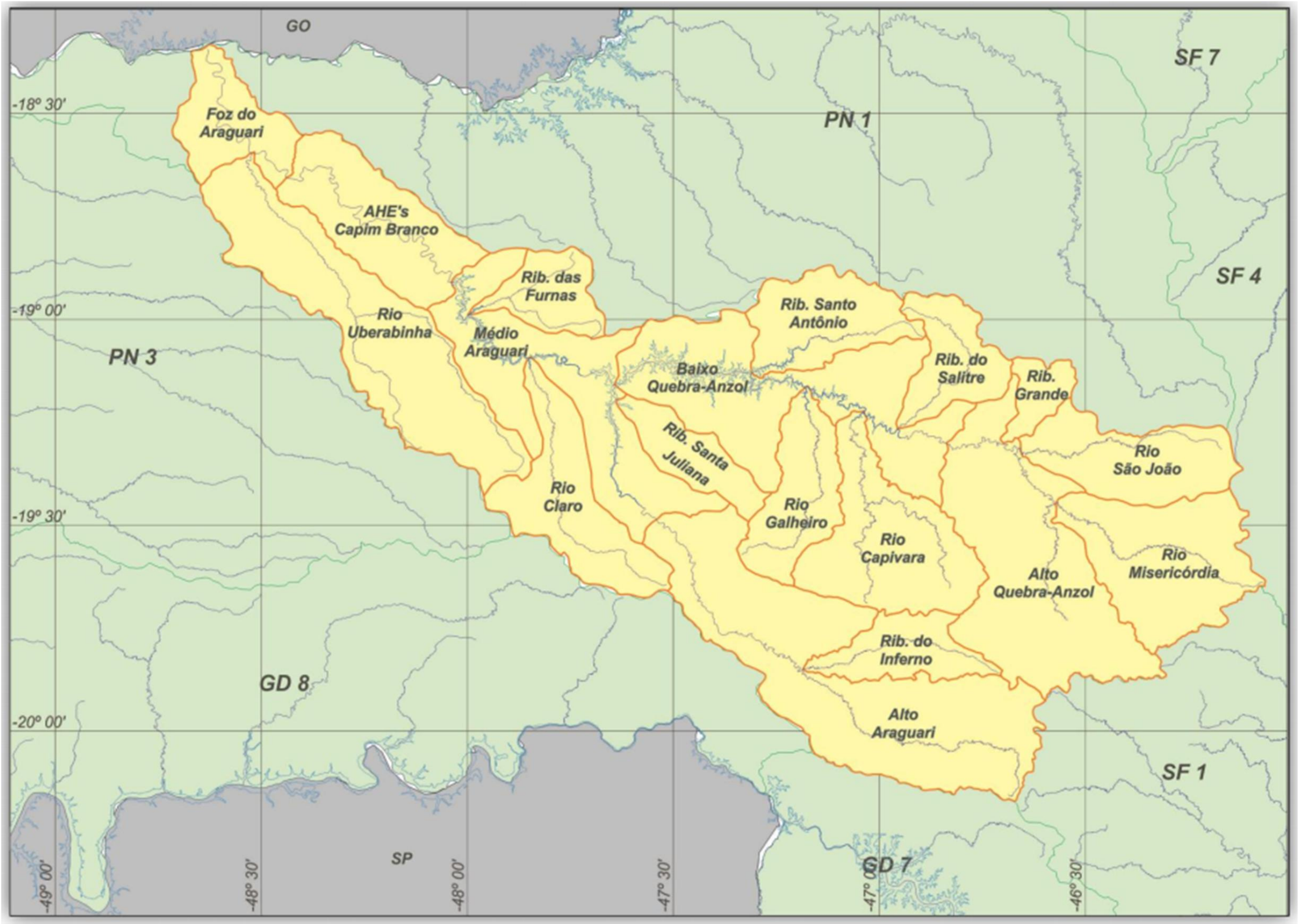


Figure 50 – Distribution of the sub-basins in the basin of Rio Araguari (MONTEPLAN, 2011).

Table 22 – Area of the Sub-basin and municipalities involved, especially the Sub-basin in which it is inserted the studied area.

Title	Total Area	Municipality (ies)
Rio Araguari Mouth	686 Km²	Araguari – 48,54% Tupaciguara – 51,46%
Rio Uberabinha	2.189 Km²	Tupaciguara – 10,32% Uberaba – 20,05% Uberlândia – 69,63%
AHEs Capim Branco	1.179 Km²	Araguari – 46,48% Indianópolis – 00,76% Uberlândia – 52,76%
Médio Araguari	1.745 Km²	Uberlândia – 16,62% Indianópolis – 19,60% Uberaba – 13,75% Nova Ponte – 27,51% Santa Juliana – 19,20% Sacramento – 03,32%
Ribeirão das Furnas	**485 Km²**	**Indianópolis – 100,00%**
Rio Claro	1.106 Km²	Uberaba – 41,32% Nova Ponte – 48,92% Sacramento – 09,76%
Baixo Quebra-Anzol	2.105 Km²	Nova Ponte – 01,62% Irai de Minas – 14,25% Pedrinópolis – 13,59% Perdizes – 39,09% Patrocínio – 26,51% Serra do Salitre – 4,94%
Ribeirão Santa Juliana	485 Km²	Pedrinópolis – 15,46% Santa Juliana – 60,00% Perdizes – 24,54%
Ribeirão Santo Antônio	843 Km²	Patrocínio – 100,00%

Title	Total Area	Municipality (ies)
Alto Araguari	3.029 Km²	Santa Juliana – 03,43% Sacramento – 45,92% Perdizes – 11,89% Araxá – 02,05% Tapira – 28,13% São Roque de Minas – 8,58%
Rio Galheiro	775 Km²	Perdizes – 100,00%
Rio Capivara	1.360 Km²	Perdizes – 27,57% Araxá – 67,28% Ibiá – 05,15%
Ribeirão do Salitre	613 Km²	Patrocínio – 63,46% Serra do Salitre – 36,54%
Ribeirão do Inferno	564 Km²	Araxá – 34,22% Tapira – 59,04% Sacramento – 06,74%
Alto Quebra-Anzol	2.303 Km²	Serra do Salitre – 06,86% Ibiá – 76,77% Pratinha – 16,37%
Ribeirão Grande	250 Km²	Serra do Salitre – 100,00%
Rio São João	962 Km²	Serra do Salitre – 16,01% Rio Paranaíba – 54,05% Ibiá – 29,94%
Rio Misericórdia	1.412 Km²	Ibiá – 41,36% Pratinha – 15,51% Campos Altos – 43,13%

Source: MONTEPLAN, 2011.

8.1.8.1.4.2 Physiographic characteristics

The sub basins physiographic characteristics influences directly on the hydrometeorological behavior and by consequence on the river regime and sedimentological of the main water course.

As instruments that helped in the interpretation of the hydrological studies results are pointed some aspects: area, perimeter, shape, drainage density, river slope, time of concentration, vegetation coverage, use, occupation and terrain.

- **Drainage area**: Projection on a horizontal plane of the surface contained between its topographic dividers;
- **Perimeter**: Linear length of the basin boundary contour;
- **Compactness Coefficient (K_c)**: Relation between the perimeter of the basin and the circle circumference of an area equal to that of the basin;
- **Shape Factor (K_f)**: Relation between the basin area and the square of its axial length;
- **Drainage density (D_d)**: Relation between the length of the watercourses and the basin area;
- **River Slope (S):** Relation between the level variation and the length of the river within the basin;
- **Time of Concentration (t_c)**: Assessment of the required time for precipitation throughout the basin to contribute to the runoff at a particular point.

Following there are presented the main physiographic features and the sub-basin of ribeirão das Furnas (as tables below).

Table 23 – Sub-basin of ribeirão das Furnas features.

Features		Sub-basin of Ribeirão das Furnas
Area (km^2)		484,67
Perimeter (km)		104,47
Length (Km)	Length	254,68
	Main watercourse	35,25
Elevation (m)	Minimum	635,00
	Maximum	1.002,00

Source: MONTEPLAN, 2011.

Table 24 – Sub-basin of ribeirão das Furnas physiographic features.

Features	Sub-basin of Ribeirão das Furnas
Compactness Coefficient (K_c)	1,33
Shape Factor (K_f)	0,39
Drainage density (D_d)	0,53
River Slope (S)	10,41
Time of Concentration (t_c)	5,99

Source: MONTEPLAN, 2011.

8.1.8.1.4.3 Minimum availability of surface water

There is a considerable range of references for determining the minimum flow of a spring, which uses several factors to its evaluation. In the water resources management of the Araguari River basin, it will be used the same reference used by IGAM, developed by HIDROSSISTEMAS Engenharia de Recursos Hídricos Ltda, published by COPASA in 1993, under the material of " Deflúvios Superficiais in the State of Minas Gerais (DSEMG) ".

The application of the methodology contained in this publication and on the Rain-Flow Model of the Araguari River basin was used to determine the reference flow rates in the sub basins, the results are presented in the following table, highlighting the Sub-basin of the Ribeirão de Furnas.

Table 25 – Comparison between the foreseen availabilities for the Sub-basin of ribeirão das Furnas.

Sub-basin	DSEMG $Q_{7.10}$ (L/s)	Simulation model (L/s)		
		$Q_{7,10}$	$Q_{95\%}$	$Q_{100\%}$
Ribeirão das Furnas	2.202,83	2.190,00	3.000,00	3.560,00

Source: MONTEPLAN, 2011.

8.1.8.1.4.4 Demand for Water Use

The use of water for irrigation, for human consumption and for industrial consumption represents the greatest concentration of uses, in amount of granted points and mainly on the consumed volume in Araguari River basin. In the sub-basins, the significance of the three activities, where is concentrated the higher consumption in the basin, is maintained. The following table presents the data reffered on the main consumption and demand trends in the Sub-basin of the Ribeirão das Furnas (from 1991 to 2006); while the subsequent table shows the demand trend for the same sub-basin, for the period from 2006 to 2016.

Table 26 – Representation of the main consumptions in the demand evolution at Ribeirão das Furnas (1991-2006).

	Human Consumption	Irrigation	Industrial Consumption	Total
1991	-	100%	-	100%
1992	-	100%	-	100%
1993	-	100%	-	100%
1994	-	100%	-	100%
1995	-	100%	-	100%
1996	-	100%	-	100%
1997	-	100%	-	100%
1998	-	100%	-	100%
1999	-	100%	-	100%
2000	-	100%	-	100%
2001	-	100%	-	100%
2002	-	99,94%	-	99,94%
2003	-	99,93%	-	99,93%
2004	0,20%	97,52%	-	97,72%
2005	0,23%	97,47%	-	97,70%
2006	0,23%	97,37%	-	97,60%

Source: MONTEPLAN, 2011.

Table 27 – Ribeirão das Furnas surface waters demand trend (2006-2016)

	Demand Trend (L/s)
2006	2.306
2007	2.456
2008	2.605
2009	2.605
2010	2.904
2011	3.053
2012	3.202
2013	3.351
2014	3.500
2015	3.649
2016	3.798

Source: MONTEPLAN, 2011.

8.1.8.1.4.5 Surface water quality

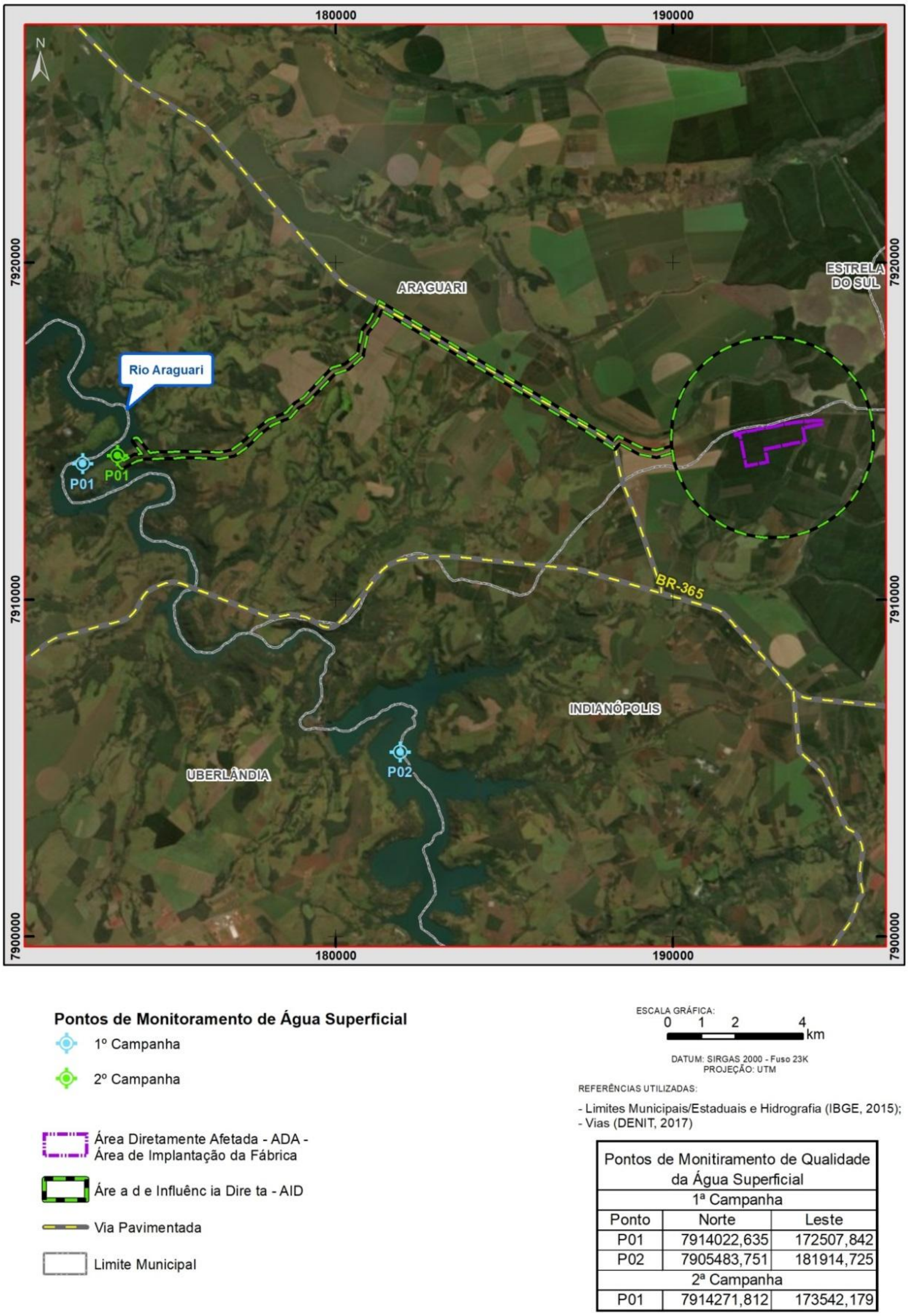
To check the surface water quality of the rio Araguari, at the place foressen for raw water intake and for treated liquid effluent disposal from L.D Celulose dissolving pulp mill, two monitoring campaigns were carried out with the objective of check the water quality of the rio Araguari, prior to the mill operation (as a background value).

The surface water collection samples was carried out in two campaigns, being the first on 12 non-consecutive days in the period of 18/07/2017 to 11/08/2017 (dry season) and the second comprised 11 non-consecutive days in the period of 03/04/2018 to 26/04/2018 (rainy season).

Collection points

The collection points were defined in order to meet the surface water quality in the region where the dissolving pulp mill will be erected before its operation, therefore, being considered as a background value, that will be used as a reference to future monitoring studies. The definition of the sampling points was in function of the water intake point and treated effluent disposal point from the future mill, located in the rio Araguari.

In the first campaign (dry season) of surface water monitoring, the location of water intake and effluents disposal had not been defined, so there were set 2 (two) points in rio Araguari: 1 (one) point upstream near the Miranda dam and 1 (one) point in the effluents disposal region in Capim Branco reservoir. The second monitoring campaign (rainy season) of surface water sample was held in 1 (one) point in the region of water intake and treated effluents disposal from the future dissolving pulp mill, once those points were already set.



Pontos de Monitiramento de Qualidade da Água Superficial		
1ª Campanha		
Ponto	Norte	Leste
P01	7914022,635	172507,842
P02	7905483,751	181914,725
2ª Campanha		
P01	7914271,812	173542,179

Figure 51 – Surface water quality monitoring points.

Figure 52 – Point P01 referred to 1st campaign. Source: Bioagri (2017).

Figure 53 – Point P02 referred to 1st campaign. Source: Bioagri (2017).

Figure 54 – Point P01 referred to 2nd campaign. Source: TASQA (2018).

Parameters

To check the current conditions of the surface water of the Araguari River there were analyzed the main control parameters for rivers 2 Class, defined in the Normative Deliberation COPAM nº 01/2008 and CONAMA Resolution n° 357/2005. In addition, in each of the campaigns it was also carried out an analysis of all the parameters listed for class 2 River defined in CONAMA Resolution n° 357/2005.

Methodology

The surface water sampling was carried out in accordance with the rules and procedures of the "Handbook of collection and preservation of samples from CETESB", as within the standards described by ABNT and Standard Methods for the Examination of Water and Wastewater from EPA/USA. The preservation of samples follows the rules and procedures of the "Handbook of collection and preservation of samples from CETESB". The sample type was simple (punctual), i.e. the surface water sample in sufficient quantity for analysis. In relation to physical-chemical analysis, it was used a specific analytical method for each examined parameter.

Results

1st campaign

The first campaign was held during a period of 12 non-consecutive days, between 18/07/2017 to 11/08/2017, for P01 and P02 points, amount and in the region of the future treated effluents disposal.

In the following table there is a summary of the results of surface water analysis in the first campaign, including the standards established for Class 2 waters by Normative Deliberation COPAM n° 01/2008 and by CONAMA Resolution nº 357/2005, for comparison.

Table 28 – First surface water monitoring campaign results for P01.

Parameter	Unit	CONAMA Resolution n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
BOD	mg/L	≤ 5	< 3	< 3	3,4	3,7	< 3	< 3	< 3	< 3	< 3	**5,2**	< 3	< 3
COD	mg/L	---	11,8	< 5	11,7	16,4	< 5	< 5	12,5	10,2	8,6	16,4	< 5	6,9
Turbidity	UNT	100	1,6	1,87	2,35	2,89	1,48	0,87	0,76	0,33	0,65	0,73	0,57	0,51
True Color	CU	75	9,5	25,4	< 5	< 5	6,6	25,5	13,9	< 5	9,9	< 5	< 5	11
pH (25ºC)		6 – 9	7,24	7,75	7,24	7,62	7,25	7,35	7,25	6,69	6,81	6,77	6,21	**5,7**
Dissolved Aluminum	mg/L	0,1	0,0146	0,0114	0,0196	0,00536	0,00465	0,00613	0,0254	0,0395	0,0166	0,0246	0,0185	0,00634
Barium	mg/L	0,7	0,0126	0,0137	0,0149	0,0293	0,0205	0,0299	0,0185	0,0172	0,018	0,0159	0,0126	0,0111
Boron	mg/L	0,5	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	0,0047	0,049
Cadmium	mg/L	0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Lead	mg/L	0,01	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Dissolved copper	mg/L	0,009	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Chrome	mg/L	0,05	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Dissolved Iron	mg/L	0,3	0,0106	0,0192	0,00654	0,0228	0,129	0,0406	0,0482	0,0398	0,0771	0,016	0,00409	0,0137
Fluoride	mg/L	1,4	0,06	0,05	0,07	0,05	0,06	0,06	0,07	0,07	0,06	0,08	0,09	0,07
Total phosphorus	mg/L	0,03	**0,07**	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	0,01	< 0,01	0,01
Lithium	mg/L	2,5	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Manganese	mg/L	0,1	0,0186	0,0254	0,0865	**0,438**	**0,44**	**0,394**	**0,206**	**0,179**	**0,282**	**0,135**	0,0512	0,0518
Mercury	mg/L	0,0002	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001
Nickel	mg/L	0,025	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Nitrate (as N)	mg/L	10	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Sulfate	mg/L	250	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	0,63	< 0,5	< 0,5
Vanadium	mg/L	0,1	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Zinc	mg/L	0,18	0,00604	0,00216	0,00316	0,00595	0,0042	0,00118	0,00432	0,00184	0,0135	0,00472	0,00729	0,00231
Nitrite (as N)	mg/L	1	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Calcium	mg/L	---	1,04	1,04	1,21	1,25	1,18	1,85	1,42	1,31	2,01	1,06	1,4	1,95

Parameter	Unit	CONAMA Resolution n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
Iron	mg/L	---	0,0192	0,0416	0,0381	0,141	0,157	0,149	0,104	0,117	0,143	0,137	0,0282	0,0332
Arsenic	mg/L	0,01	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Magnesium	mg/L	---	0,687	0,685	0,85	0,916	0,592	1,01	0,929	0,884	0,954	0,841	0,858	1,27
Molybdenum	mg/L	---	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Potassium	mg/L	---	0,701	0,791	0,655	1,06	0,881	1,29	1,06	1,01	1,14	1,05	1,16	1,46
Silica	mg/L	---	6,01	6,72	6,64	7,69	5,19	8,69	8,85	8,36	8,26	6,88	6,67	7,24
Strontium	mg/L	---	0,0136	0,016	0,0151	0,021	0,0153	0,0219	0,0198	0,0192	0,0169	0,0168	0,0172	0,00799
Sodium	mg/L	---	0,981	1,04	0,976	1,28	1,56	1,51	1,34	1,29	1,57	1,32	1,47	1,99
Silicon	mg/L	---	2,81	3,14	3,1	3,59	2,43	4,06	4,13	3,91	3,86	3,21	3,11	3,38
Total Chlorine	mg/L	---	< 0,01	0,07	0,03	0,02	< 0,01	< 0,01	0,1	0,06	0,05	0,02	0,09	0,1
Bromide	mg/L	---	< 0,005	< 0,005	< 0,005	< 0,005	0,01	0,01	< 0,005	< 0,005	< 0,005	< 0,005	< 0,005	< 0,005
Carbonate (as $CaCO_3$)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate (as $CaCO_3$)	mg/L	---	9,67	10,3	10,3	12,5	11,9	9,5	10,8	10,7	10,7	10,6	23,3	10
Conductivity	µS/cm	---	21,9	22,5	24	26,1	25,3	24,8	26,7	26,2	26,3	26,3	24	23,5
Alkalinity Bicarbonates	mg/L	---	9,67	10,3	10,3	12,5	11,9	9,5	10,8	10,7	10,7	10,6	23,3	10
Alkalinity Carbonates	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate (as P)	mg/L	---	0,02	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	0,05	< 0,01	< 0,01	0,01	< 0,01	< 0,01
Phosphate (as PO_4)	mg/L	---	0,06	< 0,03	< 0,03	< 0,03	< 0,03	< 0,03	0,16	< 0,03	< 0,03	0,03	< 0,03	< 0,03
Total Organic Carbon	mg/L	---	3,6	1,9	2,1	2,1	1,7	< 1	1,9	18	1,1	2,8	2,8	< 1
Ammonium (as NH_4)	mg/L	---	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13
Total Suspended Solids	mg/L	---	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Total hardness	mg/L	---	5,42	5,42	6,52	6,89	5,39	8,78	7,38	6,91	8,95	6,11	7,04	10,1
Dissolved Organic Carbon	mg/L	---	2,3	1,7	1,9	1,8	1,1	< 1	1	14,2	< 1	1,8	1,9	< 1
Total Inorganic Carbon	mg/L	---	1,7	< 0,5	1,7	2,1	0,9	1,6	1,3	1,5	1,9	2,1	< 0,5	3,5

Parameter	Unit	CONAMA Resolution n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
Total Dissolved Solids	mg/L	500	16	16	18	19	19	18	20	19	20	19	23	17

Table 29 – First surface water monitoring campaign results for P02.

Parameter	Unit	Resolução CONAMA n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
BOD	mg/L	≤5	< 3	< 3	3,4	< 3	< 3	< 3	< 3	< 3	< 3	4,8	< 3	< 3
COD	mg/L	---	8,1	< 5	13,7	11,8	< 5	< 5	8,5	6,5	9,8	14	< 5	10,9
Turbidity	UNT	100	1,94	2,87	2,64	2,32	2,6	1,59	0,76	< 0,1	0,8	0,65	0,89	1,24
True Color	CU	75	6,9	7,6	< 5	< 5	13,6	12,2	13,3	< 5	< 5	< 5	< 5	< 5
pH (25ºC)		6 - 9	6,71	7,49	7,26	7,13	7,63	7,45	6,52	6,7	6,37	6,3	6,08	6,5
Dissolved Aluminum	mg/L	0,1	0,00877	0,0139	< 0,001	0,00361	0,00217	< 0,001	0,031	0,0203	0,0152	0,0157	0,0102	0,00956
Barium	mg/L	0,7	0,0169	0,0232	0,0304	0,0249	0,0252	0,031	0,0247	0,019	0,0174	0,0157	0,0137	0,0145
Boron	mg/L	0,5	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	0,00291	< 0,001	< 0,001	< 0,001	0,00508	0,0052
Cadmium	mg/L	0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Lead	mg/L	0,01	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Dissolved copper	mg/L	0,009	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Chrome	mg/L	0,05	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Dissolved Iron	mg/L	0,3	0,0264	0,212	0,285	0,0112	0,017	0,0304	0,123	0,0589	0,0478	0,0175	0,00869	0,00836
Fluoride	mg/L	1,4	0,06	0,05	0,07	0,06	0,06	0,07	0,05	0,07	0,07	0,06	0,08	0,08
Total phosphorus	mg/L	0,03	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	0,01	< 0,01	< 0,01
Lithium	mg/L	2,5	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Manganese	mg/L	0,1	**0,28**	**0,421**	**0,671**	**0,343**	**0,368**	**0,386**	**0,247**	**0,208**	**0,23**	**0,14**	0,0826	0,0855
Mercury	mg/L	0,0002	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001	< 0,0001
Nickel	mg/L	0,025	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Nitrate (as N)	mg/L	10	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5
Sulfate	mg/L	250	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	< 0,5	0,52	< 0,5	< 0,5	< 0,5	< 0,5
Vanadium	mg/L	0,1	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Zinc	mg/L	0,18	0,0083	0,00294	< 0,001	0,00614	0,00638	0,00103	0,00317	0,00213	0,0156	0,00472	0,00842	0,00895
Nitrite (as N)	mg/L	1	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02	< 0,02
Calcium	mg/L	---	1,03	1,37	1,47	1,24	1,64	1,87	1,6	1,33	1,81	1,15	1,35	1,34

Parameter	Unit	Resolução CONAMA n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
Iron	mg/L	---	0,0443	0,259	0,317	0,175	0,186	0,264	0,173	0,158	0,106	0,101	0,0193	0,0237
Arsenic	mg/L	0,01	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Magnesium	mg/L	---	0,644	0,702	1,03	0,834	0,977	1,02	1,02	0,939	0,915	0,906	0,818	0,906
Molybdenum	mg/L	---	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001	< 0,001
Potassium	mg/L	---	0,674	0,825	1,19	0,951	1,16	1,27	1,19	1,09	1,11	1,11	1,06	1,15
Silica	mg/L	---	5,63	6,87	9,1	6,95	8,71	8,83	9,67	8,87	8	7,33	6,32	6,83
Strontium	mg/L	---	0,0133	0,0169	0,022	0,019	0,017	0,022	0,0242	0,0198	0,0164	0,0178	0,0165	0,0188
Sodium	mg/L	---	0,939	1,04	1,44	1,21	1,59	1,56	1,57	1,38	1,55	1,46	1,36	1,61
Silicon	mg/L	---	2,63	3,21	4,25	3,25	4,07	4,13	4,52	4,15	3,74	3,43	2,96	3,19
Total Chlorine	mg/L	---	0,12	0,06	0,03	0,03	0,02	0,03	0,11	0,06	0,09	0,08	0,14	0,12
Bromide	mg/L	---	< 0,005	0,01	< 0,005	< 0,005	< 0,005	0,01	0,01	< 0,005	0,01	< 0,005	< 0,005	< 0,005
Carbonate (as $CaCO_3$)	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0
Bicarbonate (as $CaCO_3$)	mg/L	---	11,5	12,5	10,6	11,4	11,4	0	10,9	9,18	9,49	10,3	9,63	10,9
Conductivity	µS/cm	---	23,4	24,1	26	24,4	24	23,9	27,4	27,1	26,1	26,5	23	23
Alkalinity Bicarbonates	mg/L	---	11,5	12,5	10,6	11,4	11,4	0	10,9	9,18	9,49	10,3	9,63	10,9
Alkalinity Carbonates	mg/L	---	0	0	0	0	0	0	0	0	0	0	0	0
Phosphate (as P)	mg/L	---	0,09	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01	0,01	< 0,01	< 0,01	< 0,01	< 0,01	< 0,01
Phosphate (as PO_4)	mg/L	---	0,26	< 0,03	< 0,03	< 0,03	< 0,03	< 0,03	0,03	< 0,03	< 0,03	< 0,03	< 0,03	< 0,03
Total Organic Carbon	mg/L	---	2	2,5	2,3	1,7	1,8	< 1	1,8	7,4	1,4	2,4	< 1	1,2
Ammonium (as NH_4)	mg/L	---	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13	< 0,13
Total Suspended Solids	mg/L	---	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Total hardness	mg/L	---	5,23	6,3	7,9	6,52	8,13	8,85	8,22	7,18	8,3	6,61	6,75	7,08
Dissolved Organic Carbon	mg/L	---	1,7	2,1	1,9	1,3	1,3	< 1	1,8	6,5	1,1	1,5	< 1	1
Total Inorganic Carbon	mg/L	---	< 0,5	< 0,5	2	2,2	0,6	1	0,5	1,8	2,6	1,1	3,8	1,8

Parameter	Unit	Resolução CONAMA n°357/2005 and Deliberação COPAM 01/2008	18/07/17	19/07/17	20/07/17	25/07/17	26/07/17	27/07/17	01/08/17	02/08/17	03/08/17	07/08/17	10/08/17	11/08/17
Total Dissolved Solids	mg/L	500	17	18	19	19	18	11	20	20	22	19	< 5	< 5

Regarding the results of the analyzes in point P01 all parameters are in accordance with CONAMA Resolution 357/2005 and COPAM Resolution 01/2008, except for total phosphorus on 07/18/17, BOD on 07/08/17 and pH on 08/11/17, which presented values of 0.07 mg/L, 5.2 mg/L and 5.7 mg/L, respectively. The manganese parameter was also in disagreement with those legislations.

Considering the analyzes results of point P02, all parameters are in accordance with CONAMA Resolution No. 357/2005 and COPAM Resolution No. 01/2008, except manganese that presented values above 0.1 mg/L .

The results of the first campaign presented that most of analyzed parameters, are within the conditions required for Class 2 water bodies, in accordance with current legislation, and it can be stated that the Rio Araguari presents homogeneity and good condition of quality.

It is important to note that, except for manganese, the other parameters in disagreement (total phosphorus, BOD and pH) were identified in only one (1) sampling within the period, that is, occasional case that may have been due to a problem in the collection or analysis of the parameter, and therefore, must be considered in the next monitorings.

According to IGAM (2014), manganese is an important constituent of the substrate layer of soils in the state of Minas Gerais and it can be considered natural from surface waters, as well as iron, which was also presented in surface water.

In addition to the results above, a complete analysis was performed at points P01 and P02 on 07/19/17, with all parameters of CONAMA Resolution 357/2005 and COPAM Resolution 01/2008, the results are shown in the following table.

Table 30 – 1st campaign complete sampling results of surface water monitoring.

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1	Point 2
			19/07/2017	19/07/2017
Floating Materials	---	Absent	Absent	Absent
Visible Oils and Greases	---	Absent	Absent	Absent
Substances that Communicate Odor	---	Not objectionable (*)	Absent	Absent
Artificial Dyes	---	Absent	Absent	Absent
Solid Waste	---	Absent	Absent	Absent
Total Coliforms	NMP/100 m L	---	97	228
Thermotolerant Coliforms (E. coli)	NMP/100 m L	1000	< 10	< 10
BOD	mg/L	5	< 3	< 3
COD	mg/L	---	11,4	< 5
Dissolved Oxygen	mg/L	≥ 5	7,3	**4,7**
Turbity	UNT	100	1,81	3,92
Color	CU	75	14,4	22,8
pH (a 25°C)	---	6 - 9	7,75	7,49

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1	Point 2
			19/07/2017	19/07/2017
Chlorophyll A	µg/L	30	< 3	< 3
Cyanobacteria Count	ceL/m L	50000	741	1644
Total Dissolved Solids	mg/L	500	28	41
Dissolved Aluminum	mg/L	0,1	0,0124	0,0112
Antimony	mg/L	0,005	< 0,001	< 0,001
Arsenic	mg/L	0,01	< 0,001	< 0,001
Barium	mg/L	0,7	0,0163	0,0229
Beryllium	mg/L	0,04	< 0,001	< 0,001
Boron	mg/L	0,5	< 0,001	< 0,001
Cadmium	mg/L	0,001	< 0,001	< 0,001
Lead	mg/L	0,01	< 0,001	< 0,001
Free Cyanide	mg/L	0,005	< 0,001	< 0,001
Chloride	mg/L	250	0,76	0,78
Cobalt	mg/L	0,05	< 0,001	< 0,001
Dissolved Copper	mg/L	0,009	< 0,001	< 0,001
Chrome	mg/L	0,05	< 0,001	< 0,001
Dissolved Iron	mg/L	0,3	0,0224	0,18
Fluoride	mg/L	1,4	0,07	0,07
Total Phosphor	mg/L	0,03	< 0,01	< 0,01
Lithium	mg/L	2,5	< 0,001	< 0,001
Manganese	mg/L	0,1	0,0335	**0,414**
Mercury	mg/L	0,0002	< 0,0001	< 0,0001
Nickel	mg/L	0,025	< 0,001	< 0,001
Nitrate (with N)	mg/L	10	< 0,5	< 0,5
Nitrite (with N))	mg/L	1	< 0,02	< 0,02
Ammonia Nitrogen	mg/L	Obs (1)	< 0,1	< 0,1
Silver	mg/L	0,01	< 0,001	< 0,001
Selenium	mg/L	0,01	< 0,001	< 0,001
Sulfate	mg/L	250	< 0,5	< 0,5
Sulfides (as undissociated H2S)	mg/L	0,002	< 0,002	< 0,002
Temperature	°C	---	21,2	21,1
Uranium	mg/L	0,02	< 0,001	< 0,001
Vanadium	mg/L	0,1	< 0,001	< 0,001
Zinc	mg/L	0,18	0,00201	0,00304
Acrylamide	µg/L	0,5	< 0,1	< 0,1
Alaclor	µg/L	20	< 0,005	< 0,005
Aldrin + Dieldrin	µg/L	0,005	< 0,003	< 0,003
Atrazine	µg/L	2	0,02	< 0,01
Benzene	mg/L	0,005	< 0,001	< 0,001

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1 19/07/2017	Point 2 19/07/2017
Benzo (a) anthracene	µg/L	0,05	< 0,01	< 0,01
Benzo (a) pyrene	µg/L	0,05	< 0,01	< 0,01
Benzo (b) fluoranthene	µg/L	0,05	< 0,01	< 0,01
Benzo (k) fluoranthene	µg/L	0,05	< 0,01	< 0,01
Carbaryl	µg/L	0,02	< 0,02	< 0,02
Chlordane (cis and trans)	µg/L	0,04	< 0,003	< 0,003
2-Chlorophenol	µg/L	0,1	< 0,005	< 0,005
Criseno	µg/L	0,05	< 0,01	< 0,01
2,4-D	µg/L	4	< 0,1	< 0,1
Demeton (Demeton-O e Demeton-S)	µg/L	0,1	< 0,03	< 0,03
Dibenzo (a, h) anthracene	µg/L	0,05	< 0,01	< 0,01
1,2- Dichloroethane	mg/L	0,01	< 0,001	< 0,001
1,1- Dichloroethene	mg/L	0,003	< 0,001	< 0,001
2,4- Dichlorophenol	µg/L	0,3	< 0,1	< 0,1
Dichloromethane	mg/L	0,02	< 0,001	< 0,001
p,p'-DDT + p,p'-DDD + p,p'-DDE	µg/L	0,002	< 0,002	< 0,002
Dodecachloropentacyclodecane	µg/L	0,001	< 0,001	< 0,001
Endossulfan (a, b e sulfate)	µg/L	0,056	< 0,009	< 0,009
Endrin	µg/L	0,004	< 0,003	< 0,003
Styrene	mg/L	0,02	< 0,001	< 0,001
Ethylbenzene	µg/L	90	< 1	< 1
Phenols Index	mg/L	0,003	< 0,001	< 0,001
Glyphosate	µg/L	65	< 5	< 5
Gution	µg/L	0,005	< 0,004	< 0,004
Heptachlor and Heptachlor Epoxide	µg/L	0,01	< 0,003	< 0,003
Indene (1,2,3, cd) pyrene	µg/L	0,05	< 0,01	< 0,01
Lindane (g-HCH)	µg/L	0,02	< 0,003	< 0,003
Malation	µg/L	0,1	< 0,01	< 0,01
Metolachlor	µg/L	10	< 0,05	< 0,05
Methoxychlor	µg/L	0,03	< 0,01	< 0,01
Paration	µg/L	0,04	< 0,04	< 0,04
PCBs - Polychlorinated Biphenyls	µg/L	0,001	< 0,001	< 0,001
Pentachlorophenol	mg/L	0,009	< 0,00001	< 0,00001
Simazine	µg/L	2	< 0,05	< 0,05
Surfactants (like LAS)	mg/L	0,5	0,25	0,35
2,4,5-T	µg/L	2	< 0,005	< 0,005
Carbon tetrachloride	mg/L	0,002	< 0,001	< 0,001

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1	Point 2
			19/07/2017	19/07/2017
Tetrachloroethene	mg/L	0,01	< 0,001	< 0,001
Toluene	µg/L	2	< 1	< 1
Toxaphene	µg/L	0,01	< 0,01	< 0,01
2,4,5-TP	µg/L	10	< 0,005	< 0,005
Trichlorobenzenes	mg/L	0,02	< 0,003	< 0,003
Trichloroethene	mg/L	0,03	< 0,001	< 0,001
2,4,6- Trichlorophenol	mg/L	0,01	< 0,00005	< 0,00005
Trifluralin	µg/L	0,2	< 0,05	< 0,05
Xylenes	µg/L	300	< 3	< 3
Hexachlorobenzene	µg/L	0,0065	< 0,005	< 0,005
Tributyltin	µg/L	0,063	< 0,005	< 0,005
Benzidine	µg/L	0,001	< 0,0001	< 0,0001

Obs (1): 3,7mg/L N, para pH ≤ 7,5 2,0 mg/L N, para 7,5 < pH ≤ 8,0 1,0 mg/L N, para 8,0 < pH ≤ 8,5 0,5 mg/L N, para pH > 8,5

At point P01, all parameters are in accordance with CONAMA Resolution 357/2005 and COPAM Resolution No. 01/2008.

For P02, some parameters presented values above the values established for River Class 2, which are: dissolved oxygen (DO) and manganese.

It is important to highlight that the OD parameter was identified over the limit in only 1 (one) sampling within the period, ie, being an occasional case that may have been due to some problem in the collection or analysis of the parameter, and therefore, should be considered at the next monitorings.

2nd campaign

The second campaign was carried out during a period of 11 non-consecutive days between 04/03/18 to 04/26/18, only within point P01, near the site of the future treated effluents disposal from LD Celulose.

The following table presents a summary of the results of the surface water analysis at the 2nd campaign, including the standards established for Class 2 waters by COPAM Normative Resolution nº 01/2008 and CONAMA Resolution nº 357/2005, for comparison.

Table 31 – 2nd campaign P01 collections results.

Parameter	Unit	Resolução CONAMA n°357/2005 and Deliberação COPAM 01/2008	03/04/18	05/04/18	06/04/18	09/04/18	11/04/18	16/04/18	17/04/18	18/04/18	23/04/18	25/04/18	26/04/18
Total alkalinity	mg/L	-	12,9	11,3	10,3	13,4	11,3	10,3	12,4	10,3	10,3	11,3	11,3
Dissolved Aluminum	mg/L	0,1	0,014	0,016	0,024	0,019	0,029	<0,0050	<0,0050	0,016	<0,0050	0,033	0,016
Total Arsenic	mg/L	0,01	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050
Total Barium	mg/L	0,7	0,01	0,0082	0,0082	<0,0050	0,013	0,019	0,0092	0,0098	0,016	0,014	0,014
Cadmium	mg/L	0,001	<0,0050	<0,0050	<0,0050	<0,0050	0,005	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050
Lead	mg/L	0,01	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	0,0053	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050
Chloride	mg/L	250	1,01	0,93	0,92	0,96	1,18	0,9	0,91	0,89	0,99	1,03	1,13
Dissolved Copper	mg/L	0,009	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050
Conductivity	µS/cm	---	21,3	21,4	21,5	21,4	22,9	21,6	20,8	20,8	21,4	23,1	23,6
Color	mg/L	75	<5	9	8	5	<5	<5	<5	<5	<5	9,00	<5
Total Chrome	mg/L	0,05	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	0,021	<0,0050	<0,0050	<0,0050
BOD	mg/L	≤ 5	<3,00	<3,00	<3,00	4,13	<3,0	3,91	<3,0	<3,0	<3,0	<3,00	<3,00
COD	mg/L	---	42	58	38	38	12	39	11	15,0	<5,00	26,0	10,0
Total Hardness	mg/L	---	6,05	6,33	6,57	6,21	6,61	7,04	6,35	6,14	6,14	6,65	6,61
Dissolved Iron	mg/L	0,3	0,01	0,22	0,024	0,02	0,022	0,011	0,02	0,039	0,012	0,017	0,011
Total fluoride	mg/L	1,4	<0,05	0,056	0,053	0,051	0,059	0,058	0,053	0,054	0,069	0,068	0,061
Total Phosphorus	mg/L	0,03	<0,0050	0,019	**0,076**	**0,043**	**0,087**	**0,11**	**0,033**	0,017	**0,083**	0,029	<0,0050
Dissolved Manganese	mg/L	0,1	0,0051	0,0072	0,007	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	0,012	<0,0050
Floating Materials	-	Virtually absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
Mercury	mg/L	0,0002	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017	<0,00017
Total Nickel	mg/L	0,025	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050
Nitrate (as N)	mg/L	10	0,27	<0,1	<0,1	0,26	0,14	0,31	0,17	0,23	0,46	0,2	0,28
Nitrite (as N)N)	mg/L	1	0,0057	0,014	0,015	0,0067	0,0025	0,0057	0,0086	0,0096	0,014	0,0077	0,031
Ammonia Nitrogen	mg/L	Obs (1)	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06	<0,06

Parameter	Unit	Resolução CONAMA n°357/2005 and Deliberação COPAM 01/2008	03/04/18	05/04/18	06/04/18	09/04/18	11/04/18	16/04/18	17/04/18	18/04/18	23/04/18	25/04/18	26/04/18
Organic Nitrogen	mg/L	-	1,38	1,8	1,8	0,85	0,94	0,25	0,33	1,38	1,2	3,54	0,48
Odor	-	Virtually absent	ausente	1	1	1	1	1	1	1	1	1	1
Dissolved oxygen	mg/L	≥ 5	6,3	6,36	6,42	6,43	6,36	6,2	6,41	6,36	6,42	6,36	6,32
pH (25ºC)	-	6 - 9	7,62	7,61	7,56	7,52	7,56	7,67	7,41	7,39	7,39	7,52	7,56
Total Dissolved Solids	mg/L	500	20	42	110	79	45	-	62	30,0	30	61,0	23
Total Suspended Solids	mg/L	---	7	<1,0	<1,0	<1,0	<1,0	<1,0	133	24,0	4	10,0	3
Sulfate	mg/L	250	<1,00	<1,00	<1,00	-	1	<1,0	2,19	2,04	3,63	<1,0	1,04
Sulfide	mg/L	0,002	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001	**1,96**
Temperature	°C	-	28	27	27	27	26,5	27	26,5	26,5	26	27,0	27
Turbidity	UNT	100	1,11	0,57	0,86	0,97	0,92	<0,4	3,08	4,03	<0,4	0,65	0,75
Total Vanadium	mg/L	0,1	<0,0050	<0,0050	<0,0054	<0,0050	0,011	0,0074	0,0056	<0,0050	0,0098	<0,0050	<0,0050
Total zinc	mg/L	0,18	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	<0,0050	0,17	0,16
Thermotolerant coliforms	UFC/100 mL	1000	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	1,0 x 10^2	1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2
Total coliforms	UFC/100 mL	-	<1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	1,0 x 10^2	<1,0 x 10^2	<1,0 x 10^2	7,0 x 10^2	5,0x10^2	3,0 x 10^03	<1,4 x 10^3	<1,0 x 10^2
Chlorophyll a	µg/L	30	-	-	-	<10,00	<5,00	<5,00	<5,00	<5,00	<5,00	5,87	5,34
Fioflina a		-	-	-	-	<13,00	<6,50	<6,50	<6,50	<6,50	<6,50	<2,60	<3,25
Density cyanobacteria	cel/mL	50.000	1.210	953	783	<3	1.167	1.210	1.201	1.257	1.654	1.100	1.155
Phosphate	mg/L	-	<0,02	<0,02	<0,02	<0,02	<0,02	0,1	<0,02	<0,02	<0,02	<0,02	<0,02
Oils and greases	-	Virtually absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent
Solid Waste	-	Virtually absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent	absent

Obs (1): 3,7mg/L N, para pH ≤ 7,5 2,0 mg/L N, para 7,5 < pH ≤ 8,0 1,0 mg/L N, para 8,0 < pH ≤ 8,5 0,5 mg/L N, para pH > 8,5

According to the results of the 2nd campaign, it can be verified that most of the parameters are in accordance with CONAMA Resolution 357/2005 and COPAM Resolution 01/2008, except for the sulfide and total phosphorus parameters.

Regarding the sulfide parameter, a value of above the established (1.96 mg / L) was found on 04/26/18, with the limit of the legislation being 0.002 mg / L. It should be noted that it was identified in disagreement in only one (1) sampling within the period, that is, a one-off event that may have been due to some problem in the collection or analysis of the parameter, and therefore, must be followed up in the next monitoring.

The parameter phosphorus presented values above the limit established for lentic environments (0.03 mg/L) of river Class 2 according to CONAMA Resolution 357/2005 and COPAM Resolution 01/2008.

Phosphorus is a nutrient, originated naturally from the dissolution of compounds present in the soil and the decomposition of organic matter. Its presence in surface water may probably be related to the contribution of diffuse loads due to the use of fertilizers, and to a lesser extent related to the contribution of sanitary sewage and industrial effluents.

Differentiating values of two samples were determined in relation to the sulphate and total dissolved solids parameters (of sulphate in the sample on 04/14/18 and the total dissolved solid parameter in the sample of 04/16/18). This discrepancy was confirmed with the TASQA laboratory, which prepared a letter justifying the deviation that occurred. Therefore, the results of these parameters will not be presented in the reports of the mentioned days.

In addition to the above results, it was performed with a sample for analysis, with all the parameters of CONAMA Resolution 357/2005 and COPAM Resolution 01/2008, and the results are presented in the table below.

Table 32 – Results of the complete sampling of the 2nd campaign of surface water monitoring.

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1
			03/04/2018
Floating Materials	---	Absent	Absent
Visible Oils and Greases	---	Absent	Absent
Artificial Dyes	---	Absent	Absent
Solid Waste	---	Absent	Absent
Thermotolerant Coliforms (E. coli)	NMP/100mL	1000	<1,0 x 10^2
BOD	mg/L	≤5	3,55
COD	mg/L	---	91
Dissolved Oxygen	mg/L	> 5	6,3
Turbity	UNT	100	0,89
Color	CU	75	9
pH (a 25°C)	---	6 - 9	7,62
Chlorophyll A	µg/L	30	<2,50
Cyanobacteria Count	ceL/mL	50000	1210
Feoftina a	µg/L	-	<3,25

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1 03/04/2018
Total Dissolved Solids	mg/L	500	47
Electric conductivit	µS/cm	-	21,3
Dissolved Aluminum	mg/L	0,1	0,02
Antimony	mg/L	0,005	<0,0010
Arsenic	mg/L	0,01	<0,0010
Barium	mg/L	0,7	0,0097
Beryllium	mg/L	0,04	<0,0050
Boron	mg/L	0,5	<0,0050
Cadmium	mg/L	0,001	<0,0002
Lead	mg/L	0,01	<0,002
Free Cyanide	mg/L	0,005	<0,005
Chloride	mg/L	250	0,94
Cobalt	mg/L	0,05	<0,0050
Dissolved Copper	mg/L	0,009	<0,0050
Chrome	mg/L	0,05	<0,0050
Total phenols	mg/L	0,003	<0,001
Dissolved Iron	mg/L	0,3	0,022
Fluoride	mg/L	1,4	<0,05
Total Phosphor	mg/L	0,03	0,016
Tasty	-	Virtually absent	Absent
Lithium	mg/L	2,5	<0,025
Manganese	mg/L	0,1	0,014
Mercury	mg/L	0,0002	<0,00017
Nickel	mg/L	0,025	<0,0050
Nitrate (with N)	mg/L	10	0,23
Nitrite (with N))	mg/L	1	0,0057
Ammonia Nitrogen	mg/L	Obs (1)	<0,05
Odor	-	Virtually absent	Absent
Silver	mg/L	0,01	<0,0050
Selenium	mg/L	0,01	0,0022
Surfactants reacting with methylene blue	-	0,5	<0,03
Sulfate	mg/L	250	<1,00
Sulfide	mg/L	-	<0,005
Sulfides (as undissociated H2S)	mg/L	0,002	<0,001
Temperature	°C	---	28
Uranium	mg/L	0,02	<0,010
Vanadium	mg/L	0,1	<0,0050
Zinc	mg/L	0,18	<0,0050
Acrylamide	µg/L	0,5	<0,5
Alaclor	µg/L	20	<1,0
Aldrin + Dieldrin	µg/L	0,005	<0,001

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1 03/04/2018
Atrazine	µg/L	2	<1,0
Benzene	mg/L	0,005	<2,0
Benzo (a) anthracene	µg/L	0,05	<0,05
Benzo (a) pyrene	µg/L	0,05	<0,01
Benzo (b) fluoranthene	µg/L	0,05	<0,05
Benzo (k) fluoranthene	µg/L	0,05	<0,05
Carbaryl	µg/L	0,02	<0,01
Chlordane (cis and trans)	µg/L	0,04	<0,01
2-Chlorophenol	µg/L	0,1	<0,05
Criseno	µg/L	0,05	<0,05
2,4-D	µg/L	4	<0,5
Demeton (Demeton-O e Demeton-S)	µg/L	0,1	<0,01
Dibenzo (a, h) anthracene	µg/L	0,05	<0,05
1,2- Dichloroethane	mg/L	0,01	<4,0
1,1- Dichloroethene	mg/L	0,003	<2,0
2,4- Dichlorophenol	µg/L	0,3	<0,05
Dichloromethane	mg/L	0,02	<2,0
p,p'-DDT + p,p'-DDD + p,p'-DDE	µg/L	0,002	<0,002
Dodecachloropentacyclodecane	µg/L	0,001	<0,001
Endossulfan (a, b e sulfate)	µg/L	0,056	<0,002
Endrin	µg/L	0,004	<0,002
Styrene	mg/L	0,02	<2,0
Ethylbenzene	µg/L	90	<2,0
Glyphosate	µg/L	65	<60
Gution	µg/L	0,005	<0,005
Heptachlor and Heptachlor Epoxide	µg/L	0,01	<0,01
Indene (1,2,3, cd) pyrene	µg/L	0,05	<0,05
Lindane (g-HCH)	µg/L	0,02	<0,01
Malation	µg/L	0,1	<0,01
Metolachlor	µg/L	10	<1,0
Methoxychlor	µg/L	0,03	<0,01
Paration	µg/L	0,04	<0,01
PCBs - Polychlorinated Biphenyls	µg/L	0,001	<0,001
Pentachlorophenol	mg/L	0,009	<1,0
Simazine	µg/L	2	<1,0
2,4,5-T	µg/L	2	<1,0
Carbon tetrachloride	mg/L	0,002	<2,0
Tetrachloroethene	mg/L	0,01	<2,0
Toluene	µg/L	2	<2,0
Toxaphene	µg/L	0,01	<0,01
2,4,5-TP	µg/L	10	<1,0

Parameter	Unit	Res. CONAMA and DN COPAM	Point 1
			03/04/2018
Trichlorobenzenes	mg/L	0,02	<4,0
Trichloroethene	mg/L	0,03	<4,0
2,4,6- Trichlorophenol	mg/L	0,01	<5,0
Trifluralin	µg/L	0,2	<0,1
Xylenes	µg/L	300	<2,0
Hexachlorobenzene	µg/L	0,0065	<0,002
Tributyltin	µg/L	0,063	<0,01
Benzidine	µg/L	0,001	<0,001

Obs (1): 3,7mg/L N, para pH ≤ 7,5 2,0 mg/L N, para 7,5 < pH ≤ 8,0 1,0 mg/L N, para 8,0 < pH ≤ 8,5 0,5 mg/L N, para pH > 8,5

It can be verified that all parameters analyzed are in accordance with CONAMA Resolution No. 357/2005 and COPAM Resolution No. 01/2008.

The results of the 2nd campaign showed that in most of the analyzed parameters, except for phosphorus and sulfide, they are within the conditions required for Class 2 water bodies, in accordance with current legislation, and it can be stated that Rio Araguari presents homogeneity and good condition of quality.

Conclusion

In order to define the surface water quality of the Araguari river before the operation of the dissolving pulp mill, to be considered as background and reference for future monitoring studies, two campaigns were carried out for the collection and analysis of surface water, one during the dry season (18/07/17 to 11/11/17) and one during the rainy season (04/03/18 to 04/26/18).

The analyzes included the main parameters established in COPAM Normative Resolution 01/2008 and CONAMA Resolution no. 357/2005, however there was also a collection in each campaign to analyze all the parameters.

The results showed that most of the analyzed parameters are within the conditions required for Class 2 water bodies, in accordance with current legislation, and it is noted that the Araguari river presents homogeneity and good condition of quality.

Some parameters were in disagreement with the legislations, in the 1st campaign: manganese, BOD, pH, total phosphorus and dissolved oxygen, and in the second campaign: sulfide and phosphorus.

Regarding the results of the analyzes in the 1st campaign, the P01 point presented the pH value of 5.7 mg/L, BOD of 5.2 mg/L, phosphorus of 0.07 mg/L and manganese with values above of 0.1 mg/L. For the P02, dissolved oxygen presented a value of 4.5 mg/L, and the manganese also with values in disagreement with CONAMA Resolution no. 357/2005 and COPAM Resolution no. 01/2008

In the second campaign, the sulfide parameter presented a value of 1.96 mg/L and in some days the total phosphorus presented values above 0.03 mg/L; all in disagreement with CONAMA Resolution No. 357/2005 and COPAM Resolution No. 01/2008.

It is important to highlight that, with the exception of manganese in the 1st campaign and phosphorus in the 2nd campaign, the other parameters in disagreement were identified in only one (1) sampling within the period, that is, occasional cases that may have been due to a problem in the collection or analysis of the parameter, and therefore, must be followed up in the next monitoring.

According to IGAM (2014), manganese is an important constituent of the substrate layer of soils in the state of Minas Gerais and can be considered natural of surface waters. As well as iron, which was also present in surface water.

Phosphorus is a nutrient, originated naturally from the dissolution of compounds present in the soil and the decomposition of organic matter. Its presence in surface water may probably be related to the contribution of diffuse loads due to the use of fertilizers, and to a less extent related to the contribution of sanitary sewage and industrial effluents.

8.1.8.2 Groundwater Resources

8.1.8.2.1 Introduction

The occurrence, the storage and movement of groundwater resources are directly tied to the lithological characteristics and existing geological units' structures, which determine the water potential of a given aquifer. Thus, this item aims to draw up a hydrogeological characterization of the project areas of influence.

8.1.8.2.2 Methodology

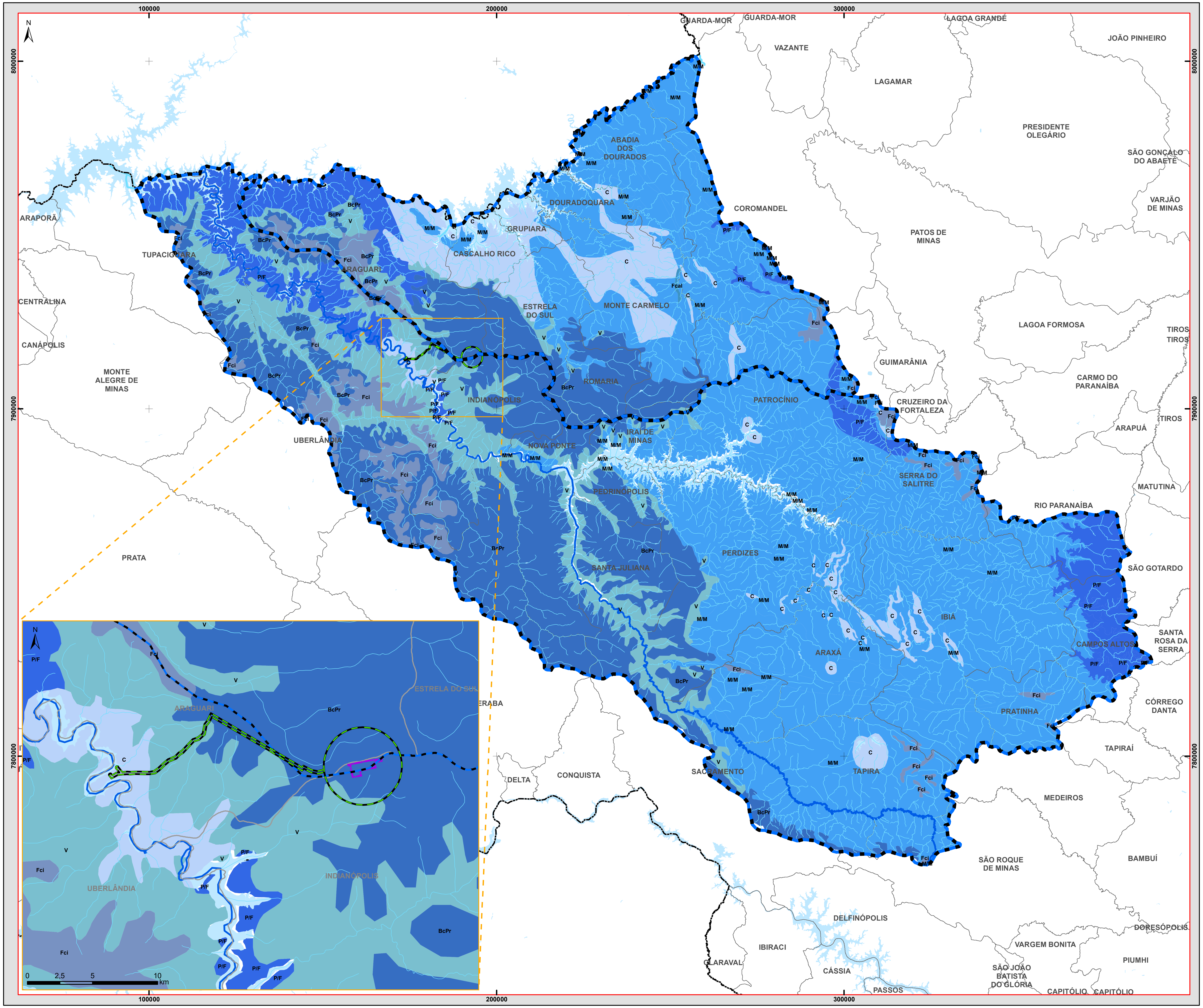
The description of the Hydrogeological Units presented in the areas of influence of the project took place through secondary data, mainly through the PARH-Action Plan of Water Resources from Afluentes Mineiros do Paranaíba Water Management Unit (PN1) (CBH AMAP, 2013) and the Rio Araguari (PN2) (COBRAPE, 2013).

8.1.8.2.3 Regional Characterization (AII)

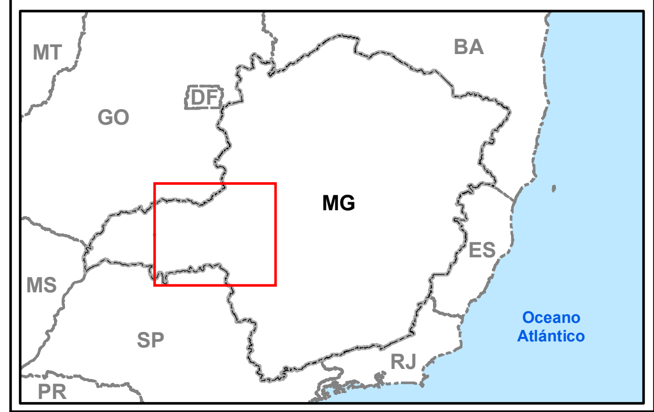
The aquifer systems, depending on the way they store and convey water, are divided into the porous and fractured domains. The porous domain is formed by the rocks that hold water in the spaces between the constituent grains (sandstones and shales, for example). In the fractured domain there are no spaces between the rock's grains. The water occupies the spaces represented by cracks or fractures, joints, faults and, in special cases, vesicles. The water potential is linked to the opening, density and interconnection of these anisotropies, which is significantly influenced by the recent tectonic period (neotectonic). The Hydrogeological Map (as the following figure) illustrates the aquifer systems presented in the AII.

According to (CBH AMAP, 2013) and (COBRAPE, 2013), in UPGRH PN1 (Afluentes Mineiros do Paranaíba) and UPGRH PN2 (Rio Araguari), the domain is porous represented by aquifers Bauru and Mata da Corda and the fractured domain is represented by Crystalline Sudeste de Goiás, Canastra, Araxá, Bambuí, Serra Geral and Paranoá. The characteristic of the UPGRHs tubular wells, by aquifer, is presented in the following tables, according to the available data.

Figure 55 –Groundwater Resources Map.



LOCALIZAÇÃO NO ESTADO DE MINAS GERAIS



LEGENDA

- Área Diretamente Afetada - ADA - Área de Implantação da Fábrica
- Área de Influência Direta - AID
- AII Para os Meios Físico e Biótico
- Hidrografia
- Rio Araguari
- Corpo D'água
- Limite Municipal
- Limite Estadual

Hidrogeologia

- Fcal - Aluviões
- BcPr - Bacia Indiferenciada
- Bci - Bacia do Paraná
- C - Cristalino
- Fci - Formações Cenozóicas Indiferenciadas
- M/M - Metassedimento/Vulcanica
- P/F - Poroso/Fissural
- V - Vulcânica

ESCALA GRÁFICA: 0 5 10 20 30 40 50 km

DATUM: SIRGAS 2000 - Fuso 23K
PROJEÇÃO: UTM

REFERÊNCIAS UTILIZADAS:
- Limites Municipais/Estaduais e Hidrografia (IBGE, 2015);
- UPGRH (IGAM, 2017)
- Hidrogeologia (CPRM, 2007)

PÖYRY

PROJETO AMADEUS

ESTUDO DE IMPACTO AMBIENTAL

UPH - RIO ARAGUARI/UPH - RIO DOURADOS

HIDROGEOLOGIA

ESCALA: 1:750.000		DATA: Outubro/2018	
FIGURA Nº 8.1.9.3-1	FOLHA: 1/1		TAMANHO: A2
RESP. TÉCNICO:	ASSINATURA:		REV: 0

Table 33 – Wells characteristics by aquifer at UPGRH PN1 (Afluentes Mineiros do Paranaíba)

Aquifer N=226 well	Depth (m)				Static Level (m)				Dynamic Level (m)				Flow (m^3/h)					Specific Capacity ($m^3/h/m$)				
	Min	Aver.	Max	N	Min	Aver.	Max	N	Min	Aver.	Max	N	Min	Aver.	Med	Max	N	Min	Aver.	Med	Max	N
Mata da Corda	50,9	78	17	29	0	14	27	24	11	30	53	22	1,62	19,6	14,8	80	22	0,06	2,25	1,40	11,69	21
Bambuí	60	100	306	17	2	8	12	11	28	39	63	10	2,0	11,5	12,1	29	12	0,07	0,43	0,38	0,874	10
Bauru	52	77	101	6	8,6	17	28	6	30	40	50	6	1,4	11,6	9,9	22	6	0,02	0,51	0,35	1,262	6
Araxá	35	70	120	26	0	7	15	22	10	39	87	19	1,0	14,2	11,0	55	23	0,05	0,76	0,31	5,324	19
Canastra	36	72	137	59	0	9	64	53	4,6	28	66	52	3,0	34,0	40,0	82	52	0,07	2,05	2,15	6,278	50
Cristalino Sudeste de Goiás	70	80	96	6	1,8	6	10	5	25	48	71	4	2,7	22,4	15,8	55	4	0,04	0,81	0,64	1,932	4

Source: (CBH AMAP, 2013). N = Number of data; Med = Median.

Table 34 – Wells characteristics by aquifer at UPGRH PN2 (Rio Araguari)

Aquifer N=240 wells	Depth (m)				Static Level (m)				Dynamic Level (m)				Flow (m^3/h)					Specific Capacity ($m^3/h/m$)				
	Min	**Aver.**	**Max**	**N**	**Min**	**Min**	**Aver.**	**Max**	**N**	**Min**	**Min**	**Aver.**	**Max**	**N**	**Min**	**Min**	**Aver.**	**Max**	**N**	**Min**	**Min**	**Aver.**
Mata da Corda	80	93	100	4	10	21	38	4	29	57	70	4	0,5	6,7	4,6	17	4	0,01	0,43	0,31	1,085	4
Bauru	76	79	82	3	0,5	14	42	3	16	36	69	3	1,8	25,7	18,9	57	3	0,07	1,51	0,80	3,65	3
Serra Geral	44	85	120	9	0	21	42	8	6	42	78	8	2,55	22,6	16,2	90	8	0,03	3,36	1,45	15,99	8
Misto Bauru/Serra Geral	72	78	86	3	16,1	17	17	2	35	46	58	2	14,4	15,2	15,2	16	2	0,35	0,62	0,62	0,889	2
Araxá	49	101	150	29	0,85	10	31	23	10	59	99	25	0,54	12,2	6,5	55	27	0,01	1,23	0,13	15,11	24
Canastra	18	91	162	21	2,7	12	25	10	12	53	95	10	0,8	5,9	7,0	14	13	0,03	0,16	0,12	0,441	10
Cristalino Sudeste de Goiás	9	72	140	118	4,6	21	42	14	7	51	94	15	1,94	20,7	10,3	64	15	0,06	1,53	0,75	11,71	15

Source: (COBRAPE, 2013). N = Number of data; Med = Median.

The Bauru aquifer system matches the thick sediment packages composed by fine to medium sandstones, interleaved by layers of siltites and argillites, deposited in two distinct phases on the Serra Geral Formation basalts. They are classified as porous and free aquifer type and may be presented locally confined. When it comes to productivity, the average flow of the wells in Goiás is 10.5 m3/h, in the Paranaíba basin is 12.3 m3/h, at UPGRH PN1 is 11.6 m3/h and at UPGRN PN2 is 22.0 m3/h. The drilled wells in Bauru group display area that also intersect the basalts of the Serra Geral formation in depth have average flow less than 15 m3/h.

The Mata da Corda aquifer system is composed mainly by sandstones of the Capacete formation, as well as alkaline lava and tuffs from Patos formationg, which assigns a feature of aquifer of the mixed type, i.e., a mixture between the Porous and Fractured domains. The outcropping part in the basin was considered only as Porous, since the registered analysis of the wells profile shows that the vast majority of them don't intersect the volcanic rocks from Patos formation. Although not regionally considered it is an aquifer with high productivity, the average flow of the Parnaíba basin wells presented relatively high levels, around 17m3/h and at UPGRH PN1 around 19.5 m3/h and at UPGRH PN2 it is 7 m3/h. This can be related to the interception in depth, in the case of some wells, by sandstone from Areado aquifer, with higher average productivity.

The Crystalline Southeast of Goiás aquifer system is composed by rocks of the Granulite Anápolis-Itauçu Complex, besides gneisses, granites and granitoids of the basement. This is the lowest water availability aquifer in the basin due to the nature of its rocks, where it is low the density and the interconnectivity of faults and fractures, as well as the association with soil covers usually little thick. In the Paranaíba basin, the presented wells have stabilized flow and specific capacity of 7,5 m^3/h and 0.39 $m^3/h/m$, respectively, and there is a high incidence of dry wells or with very low flow rates. Considering the wells of UPGRH PN1, it was obtained an average flow well higher, about 20 m3/h, but that is not considered representative due to the low number of available data (only four wells). In UPGRH PN2 there is no wells data from the fissural portion of the aquifer.

The Canasta aquifer system encompasses the rocks of the Paracatu, Serra do Landim and Chapada dos Pilões formations, in addition to the undivided Canasta groups, Ibiá and Vazante. Locally, the occurrence of Canastra Group marble lenses and limestones of the Vazante Group features a fissure-karst subsystem with very restricted extension, but with high productivity. For the UPGRH PN1, the average wells flow of Canasta fissural aquifer was 34 m3/h, the value is far superior to the average flow obtained on the entire basin of the Parnaíba River, which is 12.8 m^3/h. The higher value is due to the large number of high-flow wells in the municipality of Guarda-Mor, which probably capture water, in depth, at the fissure-karst portion of the aquifer that within the hole basin has average flow of 51m3/h. In UPGRH PN2 the average flow is 6 m3/h, lower than the average value of the Paranaíba basin.

The Araxá aquifer system is formed mainly of shales, rocks with usually clay composition whose fractures tend to close in depth, giving it a low hygeological potential. According to regional data, the average wells flow is 6.9 m3/h, it has a high incidence of dry wells or with very low flow. In the basin, the average wells flow of Araxá is 8.3 m3/h, the specific capacity is 0.42 m3/h/d. In UPGRH PN1, the average flow obtained was 14 m3/h and at UPGRH PN2 was 12.2 m3/h.

The Bambuí aquifer system is located in the extreme southeast portion of the Parnaíba basin, with an area of outcrop of 4,169 Km2, almost entirely located in the UGH Afluentes mineiros do Alto Paranaíba (UPGRH PN1). Regionally, it is subdivided into fractured subsystems, fissure-Karst and Karst, presenting extremely heterogeneous in terms of water availability and productivity at the wells. In the Paranaíba basin it was nor possible to differentiate the subsystems due to the lack of geological and hydrogeological data, because the geological map doesn't differenciate the geological formations of the Bambuí Group and there are few wells with geological profile. The wells presented in that system have stabilized flow and specific capacity averages of 11.5 m3/h and 0.43 m3/h/m, respectively. In UPGRH PN2 there is no wells data from the fissural portion of the aquifer.

The Serra Geral aquifer system corresponds, in geological terms, the Serra Geral Formation of the São Bento group. It is characterized by the absence of spaces between the rock grains and the water occupies the spaces represented by cracks or fractures, joints, faults and, in special cases, vesicles. The water potential is variable and is linked to the opening, density and interconnection of these anisotropies, which is significantly influenced by the recent tectonic moves (neotectonic). The system has secondary permeability associated also to the existing contacts zones between basaltic dikes and rocks incasing systems. In some regions there are restrictions of use due to high concentrations of iron and manganese, probably of non-human origin. The UPGRH PN1 has an oucrop area greatly reduced and there are few registered wells that represent it. In UPGRH PN2 the average well flow is 22.6 m3/h. In the Paranaíba basin the flow is 14.3 m3/h, with specific capacity of 1.25 m^3/h/m.

8.1.8.2.4 Underground Water Availability

The underground water availability was characterized through the base flow calculation observed in the fluviometric stations used in the hydrological study, corresponding to active or regulated reservations, which are renewed annually by the aquifers. Conservatively, there were not considered, therefore, the underground water resources reservations, the permanent reservations in order not to consider the permanent water depletion volume of the aquifers. In terms of Water Resources of the Parnaíba basin Plan, it was considered that 50% of the active reserve would be available to be exploited, corresponding to the underground water availability.

The following tables present the active reserve and water availability in the UPGRHs PN1 and PN2 and in the Control Points (PCs). It turns out that:

- The UPGRH PN1 features active reserve in the order of 110.42 m3/s (4.93L/s.km2) which results in the underground water availability of 55.21 m3/s (2.47 L/s.km2);
- The UPGRH PN2 features active reserve in the order of 144,68 m^3/s (6,87 L/s.km2) which results in the underground water availability of 72,34 m3/s (3,43 L/s.km2).

Table 35 – Active reserve and underground water availability of control points at UPGRH PN1 (Afluentes Mineiros do Paranaíba)

Control point	Control point Description	Area (km^2)	Active reserve		Water Availability	
			(m^3/s)	($L/s.km^2$)	(m^3/s)	($L/s.km^2$)
1	Confluência Rio Samambaia - Rio São Marcos	1.675,83	5,79	3,45	2,90	1,73
2	Estação - 60020000	2.848,95	9,84	3,45	4,92	1,73
3	UHE Batalha	2.183,06	11,93	5,47	5,97	2,74
4	Foz do Rio São Marcos	5.242,56	24,65	4,70	12,33	2,35
5	Estação - 60110000	1.861,63	5,51	2,96	2,76	1,48
6	Estação - 60150000	871,75	5,22	5,98	2,61	2,99
7	Foz do Rio Jordão	949,34	8,88	9,35	4,44	4,68
14	Foz do Rio Araguari	2.563,10	21,96	8,57	10,98	4,29
60	Estação - 60011000	3.814,10	13,29	3,48	6,65	1,74
61	UHE Escada Grande	3.848,16	23,49	6,10	11,75	3,05
62	Confluência Rio Verde MG - Rio Paranaíba	2.012,87	8,42	4,18	4,21	2,09
63	UHE Emborcação	4.609,22	17,64	3,83	8,82	1,92
UPGRH	**-**	**22.408,67**	**110,42**	**4,93**	**55,21**	**2,47**

Source: (CBH AMAP, 2013).

Table 36 – Active reserve and underground water availability of control points at UPGRH PN2 (Rio Araguari)

Control point	Control point Description	Area (km^2)	Active reserve		Water Availability	
			(m^3/s)	($L/s.km^2$)	(m^3/s)	($L/s.km^2$)
10	Confluência rio Misericórdia - rio São João	4.070,8	30,8	7,57	15,4	3,78
11	UHE Nova Ponte	11.100,0	65,08	5,86	32,54	2,93
12	Estação - 60350000	1.894,1	22,44	11,85	11,22	5,92

Control point	Control point Description	Area (km^2)	Active reserve		Water Availability	
			(m^3/s)	($L/s.km^2$)	(m^3/s)	($L/s.km^2$)
13	Confluência rio Uberabinha - rio Araguari	2.048,4	9,25	4,52	4,62	2,26
UPGRH	**-**	**21.063,5**	**144,68**	**6,87**	**72,34**	**3,43**

Source: (COBRAPE, 2013).

8.1.8.2.5 Local Characterization (AID and ADA)

According to the Hydrogeological Map, presented previously, the area of the future enterprise is under areas dominated by porous aquifers, belonging to Bauru Group (Marília formation).

The basal Bauru Aquifer level is represented by a continuous layer of conglomerates, 4 m average thickness, with relative importance in the process of storage and water circulation. Most of the wells with lithological information reveal that they can't reach such aquifer unit, not exploiting this spring.

According to (VELASQUEZ, et al., 2008), the natural recharge of the Bauru Aquifer is associated with direct infiltration of precipitation in sediments Bauru (453.2 km2), as well as silt-sandy soil overlaid with thicknesses of 5 to 10 m. Such pedological unit (569.9 km2) contains coarse levels, colluvium, covering part of the top and almost all of the contact ramps of the sandstone/basalt.

Also according to the study developed by the authors mentioned above, in Araguari/MG, the Bauru Aquifer is predominantly free, showing located sub confinements conditions and with storage coefficients of 0.12, average permeability of 2.3 x 10-3 cm/s (3.0 x 10-3 to 1.63 x 10-3 cm/s) and transmissivity average of 76 m3/h/m (31.04 to 126.85 m3/h/m). The effective porosity value of 0.15 has been more commonly found elsewhere in the Paraná basin.

The most frequent thickness found (from information from the depths of wells) is between 50 and 60 m (average: 54 m), and the average saturated thickness is around 38 m. The average values of flow and specific capacity are of 22 m3/h and 1.0 m3/h/m. The higher frequency of flows found is in the range of 10 to 20 m3/h (on 60 wells, 32%), with exceptional maximum found of 100 m3/h.

The specific capacity, estimated from the average flow (22 m3/h) and average lowering (24 m), is 0.92 m3/h/m, equivalent to the average of the specific capabilities (1,0 m3/h/m). The most common values are between 0.5 and 1.0 m3/h/m, 40.6% of the total wells. The most frequent wells depths are between 50 and 60 m.

The good productivity, little deph and the nature of lithological material facilitate the exploitation of this aquifer at the present time, being elevated the wells density in some areas which, in the long run, can compromise the productivity in these areas.

8.1.8.2.5.1 Groundwater quality

In order to verify the groundwater quality in the vicinity of the future enterprise area, there were held 06 (six) well holes samples SPT and there were installed 06 (six) monitoring wells (as shown in the following figures), according to current regulations to soil resistance, both by percussion sample, with water circulation and standard dynamic penetration test, totaling 180.80 metres of drilling by percussion and 187.08 meters for drilling the monitoring wells.

Sample points

The sample points collection were defined in order to know the groundwater quality of the future dissolving pulp mill area, before its operation, therefore, being considered as background value, that will be used as a reference to future monitoring studies.

The definition of the sampling points was due to the location of the future mill, as shown in the following figure.

Pontos de Monitiramento de Águas Subterrâneas		
Ponto	Norte	Leste
PM 01	7915251,788	193075,787
PM 02	7915101,814	192040,738
PM 03	7914073,506	192232,055
PM 04	7914692,485	193181,495
PM 05	7914801,350	193834,162
PM 06	7915186,134	193774,163

Figure 56 – Groundwater quality monitoring wells.

Figure 57 – Well PM01. Source: GEOTORK, 2018.

Figure 58 – Well PM02. Source: GEOTORK, 2018.

Figure 59 – Well PM03. Source: GEOTORK, 2018.

Figure 60 – Well PM04. Source: GEOTORK, 2018.

Figure 61 – Well PM05. Source: GEOTORK, 2018.

Figure 62 – Well PM06. Source: GEOTORK, 2018.

Parameters

To check the current groundwater conditions there were analyzed all the parameters listed as Reaserch Values of CONAMA Resolution n° 420/2009 and Normative Deliberation COPAM nº 166/2011.

Methodology

The collection procedures followed the guidelines of the Brazilian standard ABNT NBR 15847/2010 "Groundwater sampling in monitoring wells - purging Methods".

Among the Purging Methods described in the mencioned standard, the sampling method recommended for this monitoring was the "purging of low flow". In this method the purge was carried out through reduced pumping rates (between 0.05 L/min and 1.0 L/min), compatible with the monitoring well production capacity, which wouldn't cause excessive lowering water level, avoiding non representative water collection.

While pumping, the purged water underwent a flow cell, attached to electrodes, to monitor the quality indicators parameters (pH, electrical conductivity, temperature, redox potential and dissolved oxygen) until there were found three similar and successive values of each parameter, which indicated that the ideal conditions for sampling was reached. The considered measures ranged within minimum intervals, according to the criteria presented in table bellow.

Table 37 – Stabilization criteria for sampling in low flow.

Parameter	Variation limit (Source: ABNT – NBR 15847/2010)
Temperature	± 0,5 °C
pH	± 0,2 unit
Electric conductivity	± 5,0 % from readings
Dissolved oxygen	± 10,0 % from readings or ± 0,2 mg/L (which is greater)
Redox potential (Eh)	± 20 mV

When reached the ideal sampling conditions, the disposable hoses were immediately uncoupled from the flow cell, and were used to transfer water directly into the bottles provided by the laboratory.

The aliquots of water samples for the dissolved metals analysis were filtered in the field.

The samples were properly identified, listed on the packing sample guide and kept refrigerated (4° C + or-2° C) in coolers until they arrived at the laboratory.

The groundwater samples preservation and analysis procedures followed the guidelines of the standard "Standard Methods for the Examination for Water and Wastewater, 23rd Edition".

The analyses were performed by the Água e Terra laboratory, which has accreditation in ISSO/IEC 17025 standards.

Results

In the following table there is a summary of the groundwater analyses results, including Research Values for groundwater contamination – Annex II of CONAMA Resolution nº 420/2009 and Normative Deliberation COPAM nº 166/2011.

Table 38 – Groundwater monitoring results

Parameter	Unit	CONAMA Resolution 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Aluminum	mg/L	3,5	3,5	0,206	0,204	0,649	0,207	0,249	0,201
Antimony	mg/L	0,005	0,005	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Arsenic	mg/L	0,01	0,01	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Barium	mg/L	0,7	0,7	<0,01	<0,01	<0,010	<0,01	<0,010	<0,010
Boron	mg/L	0,5	0,5	0,376	0,376	<0,100	0,374	0,201	0,374
Cadmium	mg/L	0,005	0,005	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
Lead	mg/L	0,01	0,01	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Cobalt	mg/L	0,07	0,005	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Copper	mg/L	2	2	<0,010	<0,010	0,029	<0,010	<0,010	<0,010
Chromium	mg/L	0,05	0,05	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Iron	mg/L	2,45	2,45	0,135	0,134	1,130	0,132	0,276	0,132
Manganese	mg/L	0,4	0,4	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Mercury	mg/L	0,001	0,001	<0,0002	<0,0002	<0,0002	<0,0002	<0,0002	<0,0002
Molybdenum	mg/L	0,07	0,07	<0,07	<0,07	<0,07	<0,07	<0,07	<0,07
Nickel	mg/L	0,02	0,02	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Nitrate (as N)	mg/L	10	10	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Silver	mg/L	0,05	0,05	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Selenium	mg/L	0,01	0,01	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Vanadium	µg/L	-	-	<10,0	<10,0	<10,0	<10,0	<10,0	<10,0
Zinc	mg/L	1,05	1,05	0,047	0,042	0,011	0,045	0,046	0,043
Benzene	µg/L	5	5	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
Styrene	µg/L	20	20	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
Ethylbenzene	mg/L	0,3	0,3	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Toluene	mg/L	0,7	0,7	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Xylenes	mg/L	0,5	0,5	<0,006	<0,006	<0,006	<0,006	<0,006	<0,006

Parameter	Unit	CONAMA Resolution 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Anthracene	µg/L	-	-	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
Benzo (a) anthracene	µg/L	1,75	1,75	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Benzo (k) fluoranthene	µg/L	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Benzo (g, h, i) perylene	µg/L	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Benzo (a) pyrene	µg/L	0,7	0,7	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Chrysogen	µg/L	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Dibenzo (a, h) anthracene	µg/L	0,18	0,18	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Phenanthrene	µg/L	140	140	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
Indene (1.2 .3, cd) pyrene	µg/L	0,17	0,17	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Naphthalene	µg/L	140	140	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
Monochlorobenzen	mg/L	0,7	0,7	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
1,2- Dichlorobenzene	mg/L	1	1	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004
1,3- Dichlorobenzene	µg/L	-	-	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
1,4- Dichlorobenzene	mg/L	0,3	0,3	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
1,2,3- Trichlorobenzene	µg/L	*	*	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
1,2,4- Trichlorobenzene	µg/L	*	*	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
1,3,5- Trichlorobenzene	µg/L	*	*	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
1,2,3,4- Tetrachlorobenzene	µg/L	-	-	<0,100	<0,100	<0,100	<0,100	<0,100	<0,100
1,2,3,5- Tetrachlorobenzene	µg/L	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
1,2,4,5- Tetrachlorobenzene	µg/L	-	-	<0,010	<0,010	<0,010	<0,010	<0,010	<0,010
Hexachlorobenzene	µg/L	1*	1*	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
1,1- Dichloroethane	µg/L	280	280	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
1,2- Dichloroethane	mg/L	0,01	0,01	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
1,1,1- Trichloroethane	µg/L	280	280	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0

Parameter	Unit	CONAMA Resolution 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Vinyl chloride	µg/L	5	5	<0,500	<0,500	<0,500	<0,500	<0,500	<0,500
1,1- Dichloroethene	mg/L	0,03	0,03	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
1,2- Dichloroethene (cis + trans)	µg/L	0,05	0,05	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
Trichloroethene - TCE	µg/L	70	70	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
Tetrachloroethene - PCE	µg/L	40	40	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
Chloroform	µg/L	200	200	6	4,3	<2,0	4,4	126	4,3
Carbon tetrachloride	mg/L	0,002	0,002	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
2- Chlorophenol	µg/L	10,5	10,5	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
2,4- Dichlorophenol	µg/L	10,5	10,5	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
3,4- Dichlorophenol	µg/L	10,5	10,5	<0,500	<0,500	<0,500	<0,500	<0,500	<0,500
2,4,5- Trichlorophenol	µg/L	10,5	10,5	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
2,4,6- Trichlorophenol	mg/L	0,2	0,2	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005	<0,0005
2,3,4,5- Tetrachlorophenol	µg/L	10,5	10,5	<2,0	<2,0	<2,0	<2,0	<2,0	<2,0
2,3,4,6- Tetrachlorophenol	µg/L	10,5	10,5	<0,050	<0,050	<0,050	<0,050	<0,050	<0,050
Pentachlorophenol (PCP)	mg/L	0,009	0,009	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005
Cresols	µg/L	175	175	<0,15	<0,15	<0,15	<0,15	<0,15	<0,15
Phenol	µg/L	140	140	<1,0	<1,0	<1,0	<1,0	<1,0	<1,0
Dietilxil phthalate (DEHP)	µg/L	8	8	<0,100	<0,100	<0,100	<0,100	<0,100	<0,100
Dimethyl Phthalate	µg/L	14	14	<0,100	<0,100	<0,100	<0,100	<0,100	<0,100
Di-n-butyl phthalate	µg/L	-	-	<,0100	<,0100	<,0100	<,0100	<,0100	<,0100
Aldrin and Dieldrin	µg/L	0,03	0,03	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
Endrin	µg/L	0,6	0,6	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
DDT + DDD + DDE	µg/L	0,002	0,002	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001
HCH Beta	µg/L	0,07	0,07	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005

Parameter	Unit	CONAMA Resolution 420/2009	Normative Deliberation COPAM nº 166/2011	P01	P02	P03	P04	P05	P06
Lindane (g-HCH)	µg/L	2	2	<0,005	<0,005	<0,005	<0,005	<0,005	<0,005
Polychlorinated biphenyls - PCB´s	µg/L	3,5	3,5	<0,001	<0,001	<0,001	<0,001	<0,001	<0,001

* sum of trichlorobenzenes: 20 µg/L

The aluminum parameter presented values in the range of 0.201 to 0.649 mg/L, at all points the values are below the Research Value established by CONAMA Resolution n° 420/2009 and Normative Deliberation nº 166/2011 COPAM (3.5 mg/L).

At all analysed points, the parameters antimony, arsenic, barium, cadmium, lead, cobalt, copper, chromium, manganese, mercury, molybdenum, nickel, nitrate, silver, selenium and vanadium presented values below the limit of quantification of the method, i.e. way under the Research Values established by CONAMA Resolution n° 420/2009 and Normative Deliberation COPAM nº 166/2011.

The boron parameter presented values in the range of < 0.100 to 0.376 mg/L, at all sampled points below the research value established by CONAMA Resolution n° 420/2009 and Normative Deliberation COPAM nº 166/2011 (0.5 mg/L).

At all analysed points, the parameters iron and zinc presented concentration values in the range of 0,132 to 1,130 mg/L for iron and 0,011 to 0,047 mg/L for zinc, being therefore, below the Research Value established by CONAMA Resolution n° 420/2009 and Normative Deliberation COPAM nº 166/2011.

In relation to organic compounds analyzed, at all sampled points presented values below the limit of quantitation of this method. Except for chloroform that presented values in the range of <2.0 to 126 µg/L, however, under the Research Values established by Normative Deliberation COPAM nº 166/2011 and CONAMA resolution n° 420/2009.

Conclusion

With the aim to define the groundwater quality in the future dissolving pulp mill area before its operation, to be considered as background and reference for future monitoring studies, there were held groundwater and soil samples collection and analyses, through a campaign conducted in June and July 2018.

The analysis encompassed all parameters listed as Quality Reference Values of Normative Deliberation COPAM nº 166/2011 and CONAMA Resolution n° 420/2009.

It can be concluded that there was not found any change in the area that would indicate soil contamination at the sampled points, once all results presented reaserch values below the limits established by Normative Deliberation COPAM n° 166/2011 and CONAMA Resolution n° 420/2009.

8.1.8.2.5.2 Groundwater table flow direction

Through the surveys and the monitoring wells installation, it could be observed, initially, the groundwater table flow direction, defined from the observed water level. Thus, it was observed that the groundwater percolates from East to West, in a linear form, as illustrated in the following figure.

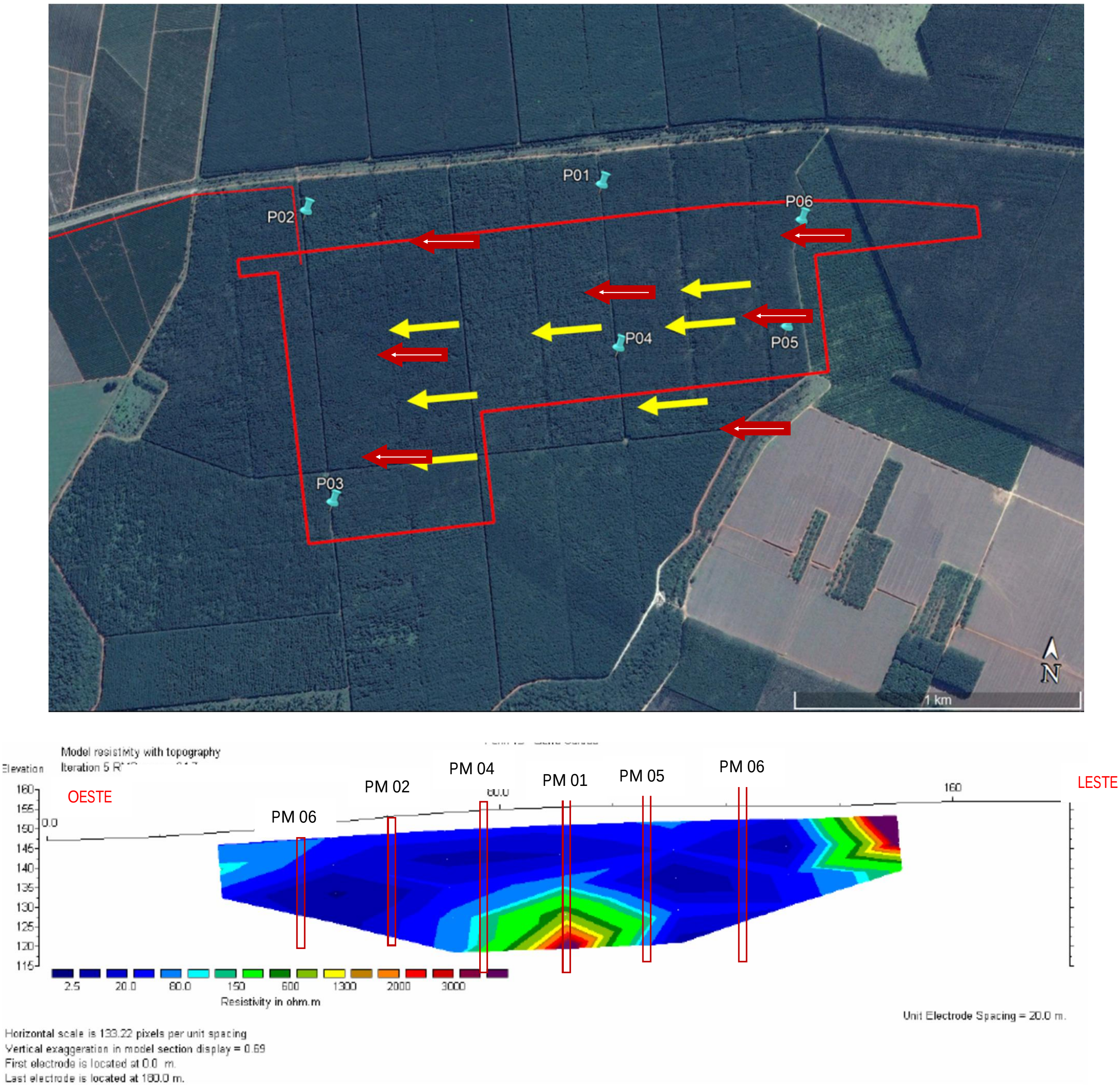


Figure 63 – Groundwater table flow direction from water level observed in the surveys. Source: GEOTORK, 2018.

8.1.9 References

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