

# DRAFT Environmental and Social Impact Assessment Report

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## INO: Riau Natural Gas Power Project ESIA Vol.5\_Technical Appendices Part H

Prepared by ESC for the Asian Development Bank

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# APPENDIX

**Appendix 1.1.tr-p** Relative Frequency, Relative Domination, Relative Density, Important Value Index, Diversity Index, and Evenness Index Type of identified tree for plot TR1 on site of power plant development plan at Tenayan Industrial Village, Tenayan Raya District, Pekanbaru City

**N 00°32'28"; E 101°31'11" (0,2 ha).**

No.	Species	FN	DN	KN	INP	H'	E
		(%)	(%)	(%)	(%)	(-pilogpi)	H'/logS
1	<i>Elaeis guineensis</i>	95.2	99.7	97.5	292.5	0.011	0.036
2	<i>Nephelium lappaceum</i>	4.8	0.3	2.5	7.5	0.040	0.133
<b>Total</b>		<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>300.0</b>	<b>0.051</b>	<b>0.169</b>

**Appendix 1.2.tr-p** Relative Frequency, Domination Relative, Relative Density, Important Value Index, Diversity Index, and Evenness Index Type of identified tree for plot TR2 on the site of power plant development plan in Tenaya ndustri village, Tenayan Raya sub-district, Pekanbaru city

**N 00°32'20,7"; E 101°31'18,5" (0,2 ha).**

No.	Species	FN	DN	KN	INP	H'	E
		(%)	(%)	(%)	(%)	(-pilogpi)	H'/logS
1	<i>Elaeis guineensis</i>	90.9	95.8	92.1	278.8	0.033	0.069
2	<i>Archidendron jiringa</i>	4.5	3.4	5.3	13.2	0.067	0.141
3	<i>Acacia mangium</i>	4.5	0.8	2.6	8.0	0.042	0.087
<b>Total</b>		<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>300.0</b>	<b>0.142</b>	<b>0.297</b>

**Appendix 1.3.tr-p** Relative Frequency, Relative Domination, Relative Density, Important Value Index, Diversity Index, and Evenness Index Type of identified tree for plot TR3 on site of power plant development plan at Tenayan Industrial Village, Tenayan Raya Sub-district, Pekanbaru City

**N 00°32'25,2"; E 101°31'10,1" (0,2 ha).**

No.	Species	FN	DN	KN	INP	H'	E
		(%)	(%)	(%)	(%)	(-pilogpi)	H'/logS
1	<i>Elaeis guineensis</i>	54.5	95.9	60.0	210.5	0.133	0.190
2	<i>Acacia mangium</i>	18.2	2.4	20.0	40.6	0.140	0.200
3	<i>Artocarpus elasticus</i>	9.1	0.7	6.7	16.5	0.078	0.112
4	<i>Alstonia angustiloba</i>	9.1	0.5	6.7	16.2	0.078	0.112
<b>Total</b>		<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>300.0</b>	<b>0.508</b>	<b>0.727</b>

**Appendix 1.3.tr-ap** Relative Frequency, Relative Domination, Relative Density, Important Value Index, Diversity Index, and Evenness Index Type of identified sapling for TR3 plot at

the site of power plant development plan at Tenayan Industrial Village, Tenayan Raya Sub-district, Pekanbaru City

**N 00°32'25,2"; E 101°31'10,1" (0,05 ha).**

No.	Species	FN	DN	KN	INP	H'	E
		(%)	(%)	(%)	(%)	(-pilogpi)	H'/logS
1	<i>Artocarpus elasticus</i>	7.6	15.8	8.3	31.6	0.089	0.059
2	<i>Artocarpus integer</i>	6.5	8.7	11.7	26.9	0.109	0.072
3	<i>Alstonia angustiloba</i>	8.7	7.3	10.7	26.6	0.104	0.068
4	<i>Archidendron ellipticum</i>	10.9	7.1	3.4	21.4	0.050	0.033
5	<i>Paropsia vareciformis</i>	2.2	9.4	9.7	21.3	0.098	0.065
6	<i>Acacia mangium</i>	5.4	7.2	4.4	17.0	0.059	0.039
7	<i>Artocarpus dadak</i>	4.3	6.4	4.4	15.1	0.059	0.039
8	<i>Ficus variegata</i>	6.5	3.0	5.3	14.8	0.068	0.045
9	<i>Nephelium rubescens</i>	5.4	4.2	3.9	13.5	0.055	0.036
10	<i>Aporosa arborea</i>	2.2	3.1	6.3	11.6	0.076	0.050
11	<i>Ficus grossularioides</i>	4.3	1.9	3.9	10.1	0.055	0.036
12	<i>Barringtonia lanceolata</i>	3.3	2.6	3.4	9.2	0.050	0.033
13	<i>Dillenia eximia</i>	3.3	2.6	2.4	8.3	0.039	0.026
14	<i>Nephelium lappaceum</i>	3.3	1.5	3.4	8.2	0.050	0.033
15	<i>Garcinia parvifolia</i>	3.3	0.7	2.9	6.9	0.045	0.029
16	<i>Endospermum diadenum</i>	2.2	2.7	1.5	6.3	0.027	0.018
17	<i>Hevea brasiliensis</i>	2.2	2.2	1.0	5.3	0.020	0.013
18	<i>Baccaurea motleyana</i>	1.1	0.9	1.9	3.9	0.033	0.022
19	<i>Ilex macrophylla</i> Blume	1.1	1.9	0.5	3.5	0.011	0.007
20	<i>Horsfieldia polyspherula</i>	1.1	0.7	1.5	3.2	0.027	0.018
21	<i>Glochidion superbum</i>	1.1	1.6	0.5	3.2	0.011	0.007
22	<i>Mallotus paniculatus</i>	1.1	0.7	1.0	2.8	0.020	0.013
23	<i>Litsea grandis</i>	1.1	0.6	0.5	2.2	0.011	0.007
24	<i>Litsea noronhae</i>	1.1	0.6	0.5	2.2	0.011	0.007
25	<i>Ixonanthes petiolaris</i>	1.1	0.2	0.5	1.8	0.011	0.007
26	<i>Sarcothea macrophylla</i>	1.1	0.1	0.5	1.7	0.011	0.007
<b>Total</b>		<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>300.0</b>	<b>1.391</b>	<b>0.916</b>

**Appendix 2.1** Family, genus and species wealth were identified for each plot on the site of a power plant construction plan site at Industri Tenayan Village, Tenayan Raya Sub-district, Pekanbaru City

No.	Species	Tree			Sapling		
		TR-1	TR-2	TR-3	TR-1	TR-2	TR-3
	<b>Apocynaceae</b>						
1	<i>Alstonia angustiloba</i> Miq.	-	-	+	-	-	+
	<b>Aquifoliaceae</b>						
2	<i>Ilex macrophylla</i> Blume	-	-	-	-	-	+
	<b>Clusiaceae</b>						

No.	Species	Tree			Sapling		
		TR-1	TR-2	TR-3	TR-1	TR-2	TR-3
3	<i>Garcinia parvifolia</i> (Miq.) Miq.	-	-	-	-	-	+
	<b>Dilleniaceae</b>						
4	<i>Dillenia eximia</i> Miq.	-	-	-	-	-	+
	<b>Euphorbiaceae</b>						
5	<i>Hevea brasiliensis</i> Muell.Ag.	-	-	-	-	-	+
6	<i>Endospermum diadenum</i> (Miq.) Airy Shaw	-	-	-	-	-	+
7	<i>Mallotus paniculatus</i> Muell.Arg.	-	-	-	-	-	+
	<b>Ixonanthaceae</b>						
8	<i>Ixonanthes petiolaris</i> Blume	-	-	-	-	-	+
	<b>Lauraceae</b>						
9	<i>Litsea grandis</i> (Nees) Hook.f.	-	-	-	-	-	+
10	<i>Litsea noronhae</i> Blume	-	-	-	-	-	+
	<b>Lecythidaceae</b>						
11	<i>Barringtonia lanceolata</i> (Ridl.) Payens	-	-	-	-	-	+
	<b>Leguminosae</b>						
12	<i>Acacia mangium</i> Wild.	-	+	+	-	-	+
13	<i>Archidendron ellipticum</i> (Blume) I. Nielsen	-	-	-	-	-	+
14	<i>Archidendron jiringa</i> (Jack) I.C. Nielsen	-	+	-	-	-	-
15	<b>Moraceae</b>						
16	<i>Artocarpus dadak</i> Miq.	-	-	-	-	-	+
17	<i>Artocarpus elasticus</i> Reinw. Ex Bl.	-	-	+	-	-	-
18	<i>Artocarpus elasticus</i> Reinw. Ex Bl.	-	-	-	-	-	+
19	<i>Artocarpus integer</i> (Thunb.) Merr.	-	-	-	-	-	+
20	<i>Ficus grossularioides</i> Burm.f.	-	-	-	-	-	+
21	<i>Ficus variegata</i> Blume.	-	-	-	-	-	+
	<b>Myristicaceae</b>						
22	<i>Horsfieldia polyspherula</i> (Hook.f.ex King) J. Sinclair	-	-	-	-	-	+
	<b>Oxalidaceae</b>						
23	<i>Sarcothea macrophylla</i> Blume	-	-	-	-	-	+
	<b>Palmae</b>						
24	<i>Elaeis guineensis</i> Jack.	+	+	+	-	-	-
	<b>Passifloraceae</b>						
25	<i>Paropsia vareciformis</i> (Griff.) Mast.	-	-	-	-	-	+
	<b>Phyllanthaceae</b>						
26	<i>Aporosa arborea</i> (Blume) Mull. Arg.	-	-	-	-	-	+
27	<i>Baccaurea motleyana</i> (Mull. Arg.) Mull. Arg.	-	-	-	-	-	+
28	<i>Glochidion superbum</i> Baill. ex Muell. Arg.	-	-	-	-	-	+
	<b>Sapindaceae</b>						
29	<i>Nephelium lappaceum</i> L.	+	-	-	-	-	+
30	<i>Nephelium rubescens</i> Hiern.	-	-	-	-	-	+

## **Appendix O. NBC Wet Season Baseline Survey**

# RIAU 275 MW CCGT WET SEASON ENVIRONMENTAL AND SOCIAL BASELINE STUDY REPORT

Prepared for PT Jacobs Group Indonesia



*December 2017*

# **RIAU 275 MW CCGT WET SEASON ENVIRONMENTAL AND SOCIAL BASELINE STUDY REPORT**

**Prepared for PT Jacobs Group Indonesia**

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## GLOSSARY

ESIA	: Environmental and Social Impact Assessment.
KAN	: Indonesian National Accreditation Committee.
APHA	: Standard Methods for the Examination of Water and Wastewater 21st Edition 2005.
CCGT-PP	: Combine-Cycle Gas Turbine Power Plant.
LIPI	: Indonesian Institute of Sciences.
UNESCO	: United Nations Educational, Scientific and Cultural Organization
EPA	: The United State Environmental Protection Agency.
NRC	: The National Research Council.
IUCN	: International Union for Conservation of Nature
MSL	: Mean Sea Level.
BPS	: Central Bureau of Statistics.
Dinas ESDM	: Regional Energy and Mineral Resources Agency. Responsible for formulating government policy in the field of mining and energy areas. In accordance with the law of 23/2014 which is valid from October 2016 then at present the existence of the institution is in the provincial government.
RT	: The composition of the number of neighborhoods (the lowest administrative division of Indonesia)
RW	: The association of RT (under the Village or Kelurahan)
PVC	: The casing pipe is a poly vinyl chloride pipe.
USDA	: The United States Department of Agriculture.
AMDAL	: Environmental Impact Assessment.
SLF	: Sustainable Livelihood Framework.
UMR	: Minimum Regional Wage.
Puskesmas	: Community Health Centres (The government-mandated community health clinics)

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VOC	: Dutch East India Company (Dutch: Verenigde Oost-Indische Compagnie abbreviated to VOC). Was founded in 1602 and became defunct in 1799.
KB	: Indonesian National Program to establish a healthy and prosperous family by limiting births (Keluarga Berencana).
KIT	: Tenayan Industrial Estate (Kawasan Industri Tenayan).
Pemko	: The City Government (Pekanbaru).
RUTR	: General Plan of Spatial Planning.
RTRW	: Spatial Planning
ADHK	: Constant Prices.
BPN	: Badan Pertahanan Nasional.
SHM	: Certificate of land Property (Sertifikat hak milik).
IKNR	: Family Association of Nias who migrated to Riau (Ikatan Keluarga Nias Riau)
IKRANIS	: Family Association of South of Nias who migrated to Riau (Ikatan Keluarga Riau Asal Nias Selatan)
IKJR	: Family Association of Java Riau (Ikatan Keluarga Jawa Riau)
LPM	: Institute of Community Empowerment. Institutions formed on the initiative of the community as partners of the Village Government and Lurah in accommodating and realizing the aspirations and needs of the community in the field of development. The basic rules used are Regulation of the Indonesian Minister of State Number 5 Year 2007 and Regional Regulation.
LAM	: Malay Customary Institution (Lembaga Adat Melayu)
KTP	: Indonesian Resident Identity Card (Kartu Tanda Penduduk). The card is issued by government upon reaching the age of 17 or upon marriage.
KK	: Family Register/ household register. Is a Family Identity Card which contains data on the arrangement, relationships and number of family members.
AMAN	: The National Indigenous Peoples Alliance (Aliansi Masyarakat Adat Nusantara). Is an independent social organization with a vision to realize a just and prosperous life for all Indigenous Peoples in Indonesia. AMAN works locally, nationally and internationally to represent and advocate for Indigenous Peoples issues. Was first

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declared in 1999 during the initial Kongres Masyarakat Adat Nusantara (KMAN I) in Jakarta.

- PKK : Indonesian National Program for Family Welfare Development (Pendidikan Kesejahteraan Keluarga). Is a community organization that empowers women to participate in the development of Indonesia. PKK is famous for its "10 main programs". Based on The Decree Of The Minister Of Forests And The Autonomy Of The Republic Of Indonesia Number 53 YEAR 2000
- Posyandu : Services among other things are weighing children, child nutrition, and vitamins for pregnant women from Puskesmas (Pos Pelayanan Terpadu). Based on Joint Decree between the Indonesian Minister of Home Affairs No. 23 Year 1885, Indonesian Minister of Health No. 21/Men.Kes/Inst.B./IV Year 1985 and Indonesian Head of National Family Planning Coordinating Board (BKKBN) No. 112/HK-011/A/1985 and proclaimed in about 1986.
- PDAM : Water Supplier Company (Perusahaan Daerah Air Minum). It is one of the regional owned business units, which is engaged in the distribution of clean water for the general public. PDAMs exist in every province, district, and municipality throughout Indonesia. PDAM is a regional company as a means of providing clean water that is supervised and monitored by the apparatus of the executive and local legislative branches.
- Gotong Royong : Mutual Cooperation Activity. Is an Indonesian term to work together to achieve a desired outcome. The term is derived from “gotong” meaning "to work", and “royong” means "together". Together with Deliberation, Pancasila, Customary Law, Deity and Kinship
- BPJS : Social Security Agency (Badan Penyelenggara Jaminan Sosial). Is an institution established to organize social security programs in Indonesia according to Law Number 40 Year 2004 and Law Number 24 Year 2011. Based on Law No. 24 of 2011, BPJS will replace a number of social security institutions in Indonesia, namely health insurance insurance PT Askes Indonesia into BPJS Health and social security agencies PT Jamsostek labor into BPJS Employment.
- Jamkesmas/Jamkesda : Regional Health Insurance (Jaminan Kesehatan Masyarakat). It is a health insurance program for Indonesians who provide social protection in the health sector to ensure the poor and underprivileged whose contributions are paid by the government so that their basic health needs can be met. The program is run by the Ministry of Health since 2008.

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Participants guaranteed in the Jamkesmas program include: (1) The poor and the underprivileged that have been determined by the decision of the Regional Head. (2) Homeless, beggars, children and displaced people, poor people who have no identity. (3) Participants of Family Hope Program (PKH) who do not have Jamkesmas card. (4) The poor defined by the Decree of the Indonesian Minister of Health No. 1185 / Menkes / SK / XII / 2009.

CSR : Corporate social responsibility

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## 1 PREFACE

In order to meet the national electricity demand, especially in Riau Province, Medco Ratch Power Riau (MRPR) plan to construct a Combine-Cycle Gas Turbine Power Plant (CCGT-PP) Riau 275 MW. The facilities construction plan becomes a necessity to meet the needs of electric power in Pekanbaru and surrounding areas.

The result of this study is expected to facilitate the project proponent to recognize environmental and social conditions of construction site plan and surrounding area, as baseline data in order to prepare the Environmental Impact Assessment (AMDAL), Environmental Sosial Impact Assesment (ESIA) document preparation and basis of decision-making during project implementation.

## 2 GENERAL INFORMATION

### 2.1 Study Area

Baseline area study in this report cover Combine-Cycle Gas Turbine Power Plant (CCGT-PP) construction plan site which is administratively located in the Industri Tenayan village of Tenayan Raya district of Pekanbaru city. The area of Power Plant site plan area will cover area of 9 hectares.

Industri Tenayan Village is an administrative area development of Sail Village of Tenayan Raya Sub-district, Pekanbaru City since January 2017. Based on the Regional Regulation of Pekanbaru City No.16 Year 2016, Sail Village was split into 5 villages namely Industri Tenayan, Melebung, Bencah Lesung, Sialang Sati, and Tuah Negeri Village.

### 2.2 Climate

The description of climatic conditions at the study sites obtained from the average rainfall and the monthly rainy day for 33 years (1980-2013) is presented in Figure 1. The monthly data do not show dry months (rainfall <60 mm) and tend to be wet throughout the year (rainfall >100 mm), the Q value of 0.079 belong to type A - very wet, according to the classification of Schmidt Ferguson (Kartasapoetra, 1988).

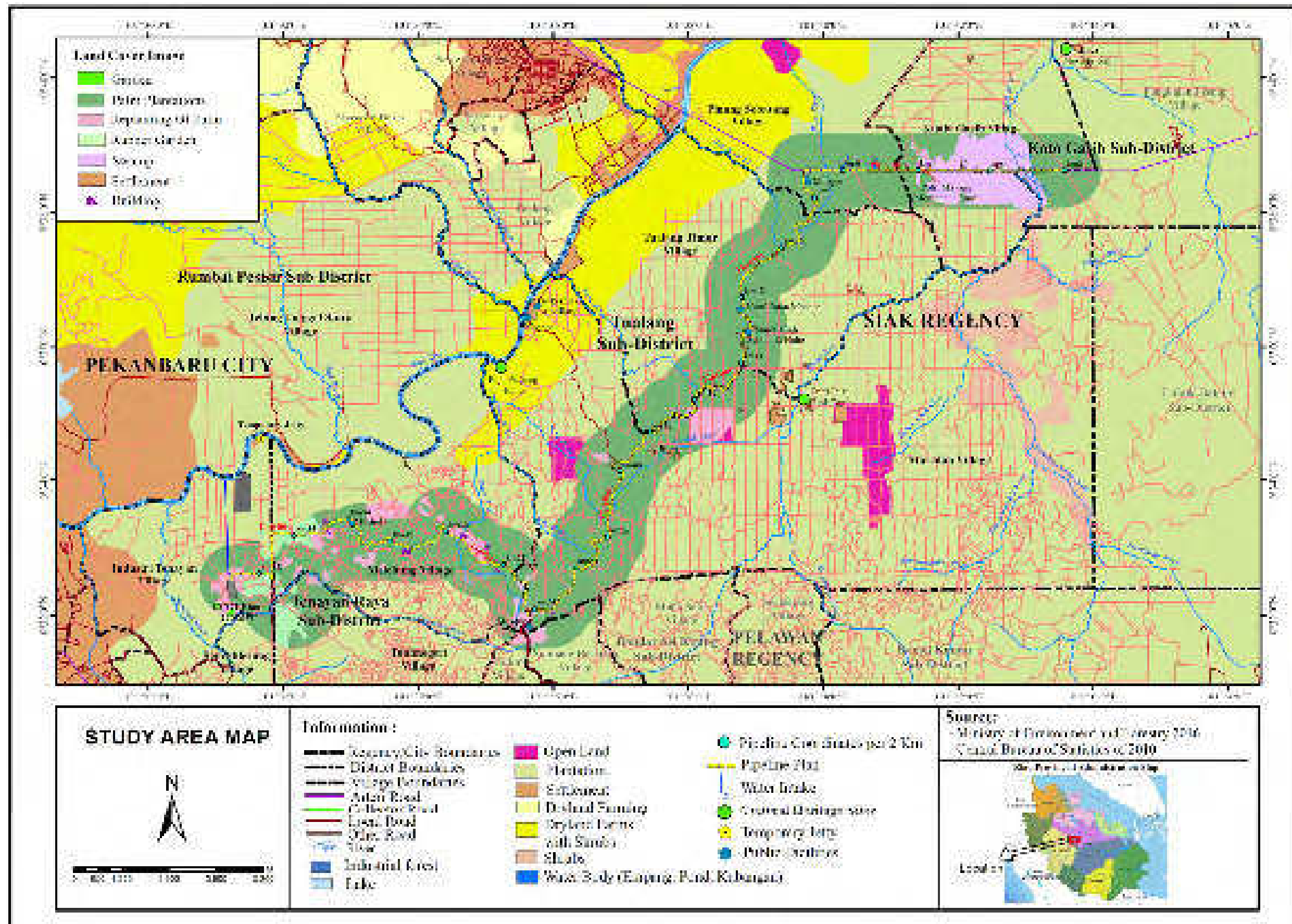
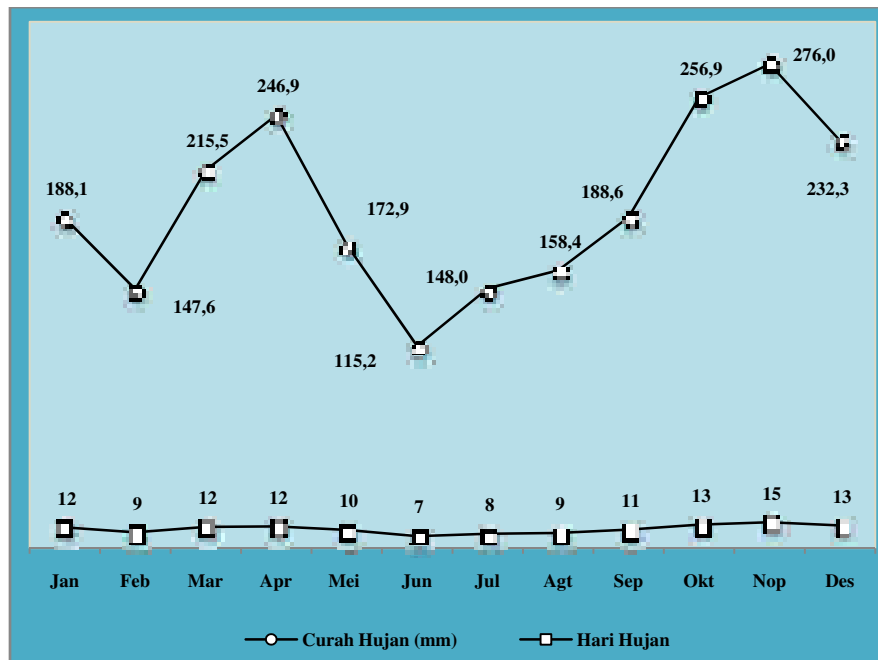


Figure 2-1. Administration Map Of Construction Site Plan.

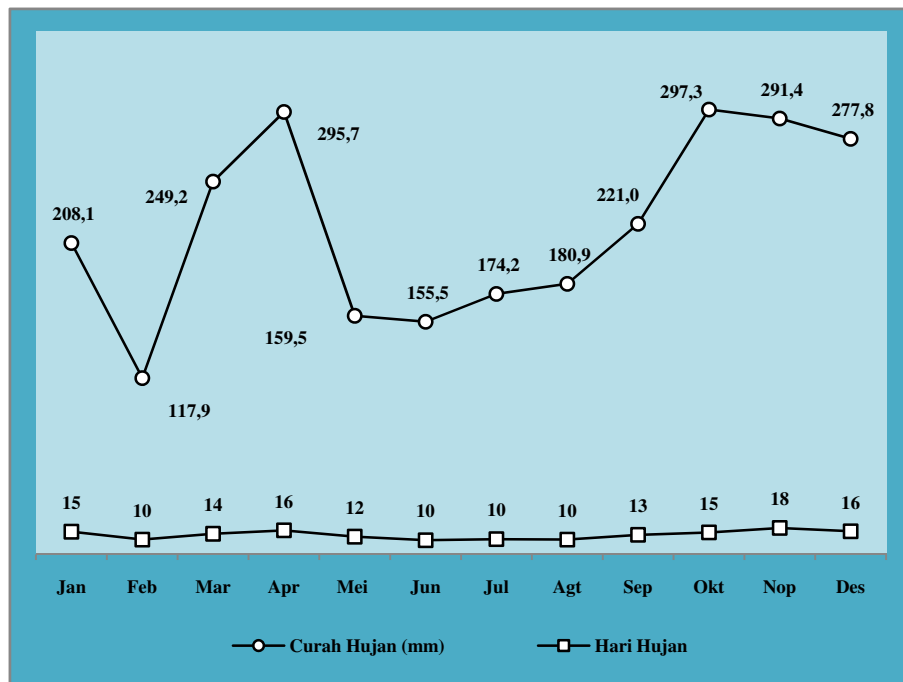


Source: Hidrology Public Work Office, Senapelan District, Pekanbaru City

**Figure 2-2, Average rainfall (mm) and average monthly rainy day in study location (1980-2013)**

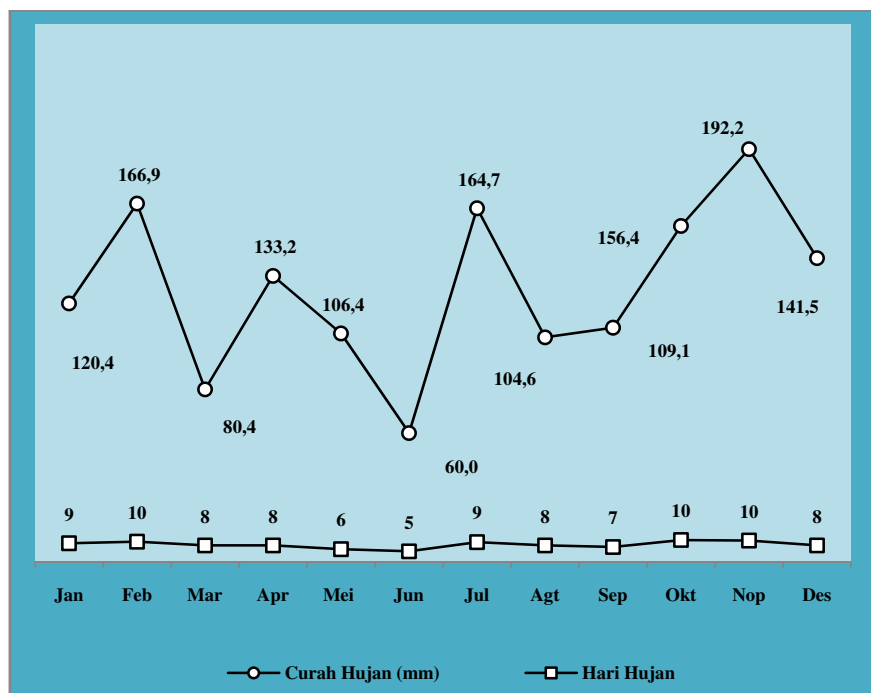
The highest average rainfall occurred in October and November (256.9 and 276.0 mm) and the lowest was in June (115.2 mm), while the rainfall was at the highest in three consecutive months, namely October, November, and December. If we shortened the time span of the 33 years data available into four different time ranges, it is: three ten-year ranges (1980-1989, 1990-1999, and 2000-2009) and four years (2010-2013), Q values for the three ranges ten-year time ranges from 0.037 to 0.074 and is classified as type A-very wet. The trend of Q value shift is seen in the four-year timeframe 2010-2013 of 0.435 and is classified as type C- mildly wet by the classification of Schmidt Ferguson (Kartasapoetra, 1988).

Data shortening into four time ranges, the average rainfall and monthly rainy day tend to be high throughout the year in the ten-year period 2000-2009, while the average rainfall and the monthly rainy day tended to fall much lower throughout the year in the four-year period of 2010 -2013 (Figures 2-3 and 2-4). The occurrence of the trend of shifting the amount of rainfall and rainy days need to be observed, but can not be used as a reference because the time span of data used is very short-only four years, regarding this symptom at least the required data of rainfall measurement is 30 years.



Source: Hidrology Public Work Office, Senapelan District, Pekanbaru City

**Figure 2-3.** Average monthly rainfall (mm) and average monthly rainy day in study location (2000-2009)



Source: Hidrology Public Work Office, Senapelan District, Pekanbaru City.

**Figure 2-4.** Average monthly rainfall (mm) and average monthly rainy day in study location (2000-2013)

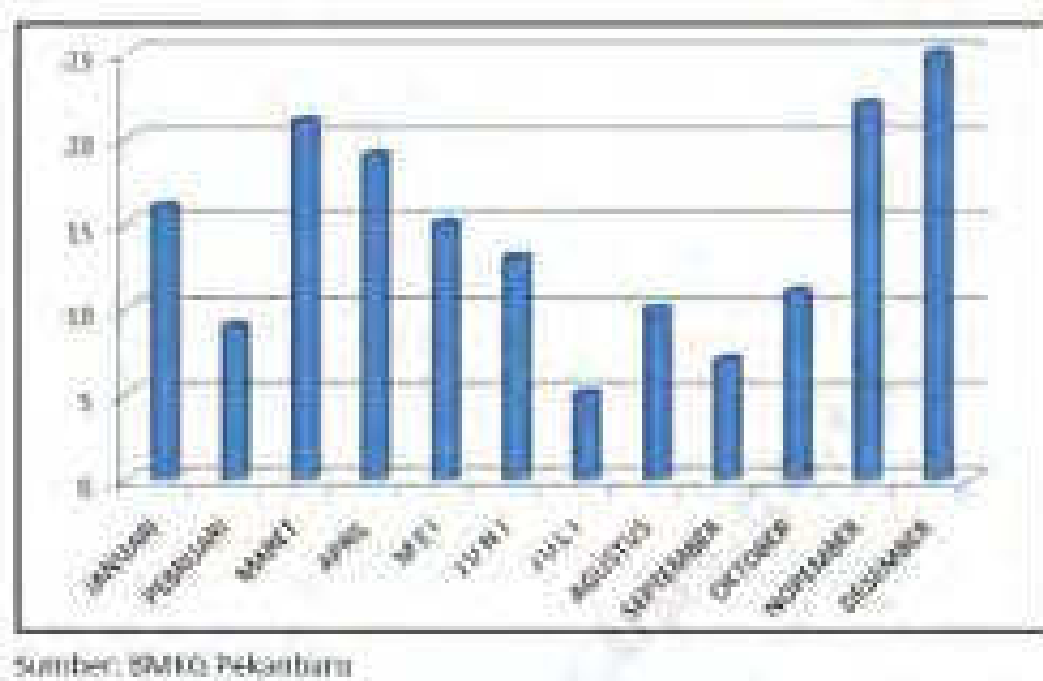
Based on 2015 data t obtained from BPS Pekanbaru, the rainy day and rainfall fluctuated significantly during the year 2015. The maximum of rainy days occurred in December which has 25 days of rain

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day per month, while the minimum of rainy days occurred in July which has 5 days of rain day per month. The highest rainfall occurred in the month of November.

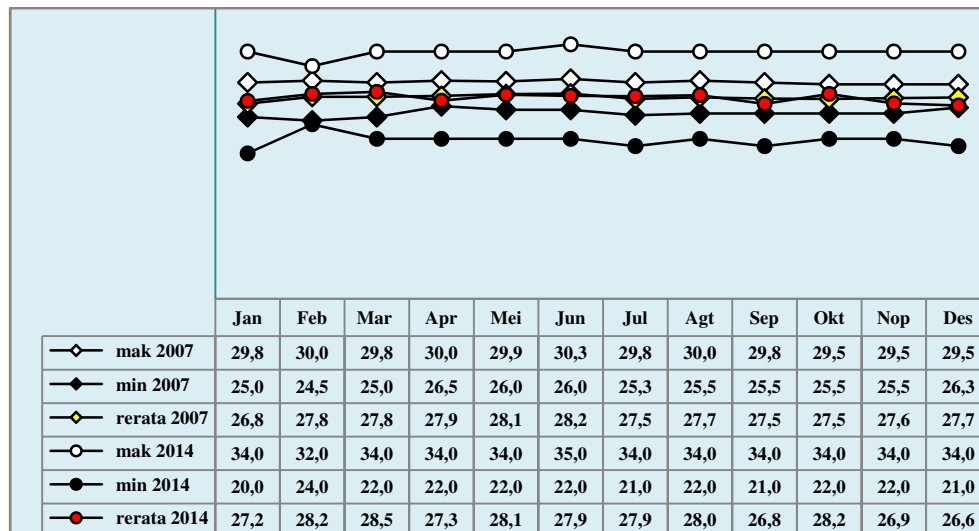
The wet months (rainfall above 200 mm/month) occurred between October and January with an average rainfall of 254 mm/month, while dry months occurred between June and August with monthly average rainfall of 166 mm (BMKG, 2015).

The total mean annual rainfall intensity throughout the year 2015 is between 2,148 - 1,741 mm/year, and the annual average intensity during the last 5 years is 2,472 mm/yr.



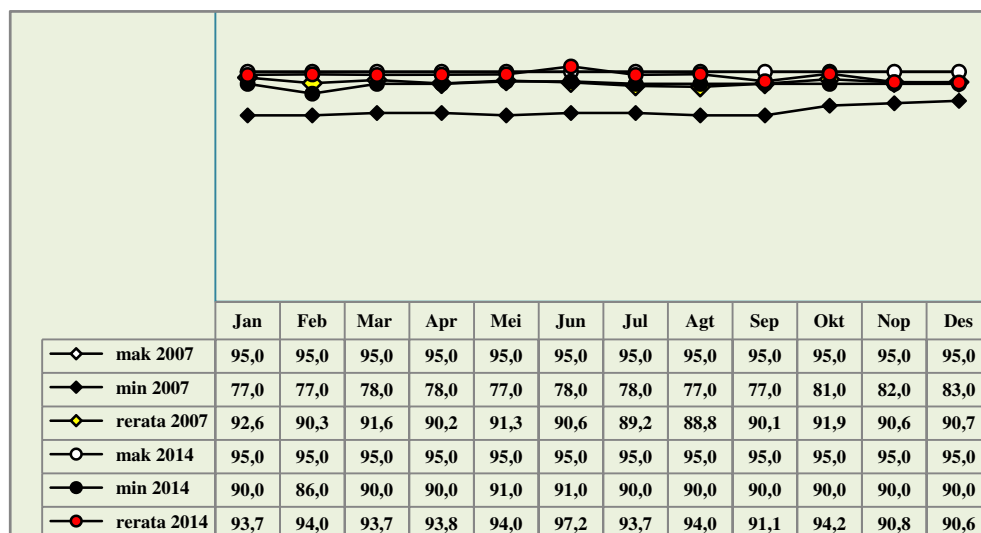
**Figure 2-5.** Rainy day distribution of Pekanbaru and its surrounding during the year 2015

**Figure2-5** shows the measurements of air temperature (°C) in two different years of measurement with seven-year range, which were in 2007 and 2014. Within the time difference it is seen that in 2014 the average monthly minimum temperature range was recorded lower and the average monthly maximum temperature range recorded higher than seven years earlier record. In 2014 the average monthly minimum temperature range is recorded at 20-24 °C and a maximum of 34-35 °C. Seven years ago in 2007 it was seen that the monthly minimum average temperature range was 25-26 °C and maximum 29-30 °C. This symptom shows that the monthly temperature swing in 2014 is wider (the difference in average monthly maximum and minimum temperature is 12.2 °C), in the preceding year recorded 4.3° C.



Source: Artificial station, Koto Gasib Sub District, Siak District

**Figure 2-6.** Maximum, minimum, and average monthly temperature in study location year 2007 and 2014

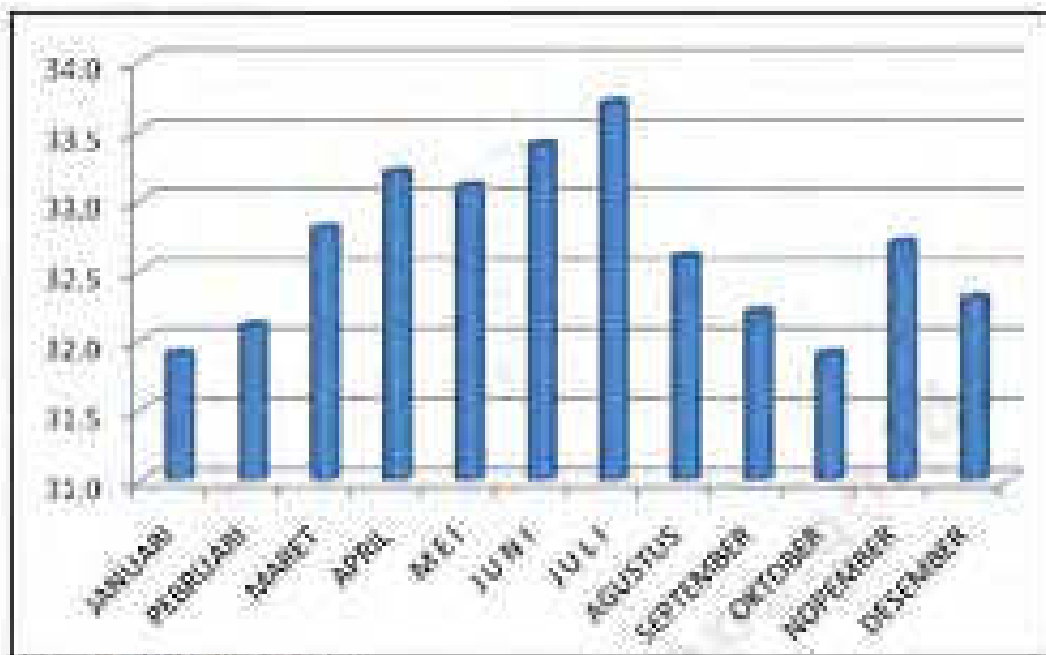


Source: Artificial station, Koto Gasib Sub District, Siak District

**Figure 2-7.** Maximum, minimum, and average monthly humidity in study location year 2007 and 2014

Based on the air temperature data for 2015, the maximum average air temperature occurred in the month of July of 33.6°C and the minimum average air temperature occurred in the month of October of 31.9°C.

The average monthly temperature during 2015 is 32.59°C.



Sumber: BMKG Pekanbaru

**Figure 2-8.** Air temperature distribution of Pekanbaru and its surrounding for 2015.

The condition of the air humidity at the study sites is shown in Figure2-7, covering two years of measurement ie 2007 and 2014. In Figure2-7 it is seen that the average monthly maximum humidity on the two-year measurement tend to be the same which was 95 percent, while the average monthly minimum humidity range of 2007 is measured lower which was 77-83 percent and in 2014 it was ranged from 86-91 percent. The range between the average monthly maximum and minimum in 2014 is very short at 5.2 percent, while in the previous seven years it has a range of 16.4 percent. This symptom is worth noting because the average monthly air humidity during 2014 is very high at above 85 percent, the degree of humidity conducive to the growth of plant diseases, such as the fungus see Kartasapoetra (1988).

### 3 FRESHWATER AQUATIC SURVEY, INCLUDING WATER QUALITY

#### 3.1 Surface Water quality

This section details the water resources of the proposed Power Plant project area. Surface and ground water resources have been summarized in field observation and data collection (ESIA field survey).

Water quality data was analyzed by PT. Organo Science Laboratory on July 2017 accredited by KAN (certified by Indonesian Government). During the survey, four surface water samples were collected and analysed. The data covers water quality including, temperature, total suspended solid (TSS), pH, metals, and major ions, and microbiology sampling. Samples are presented according to the requirements specified in Government Regulation No. 82 Year 2001 regarding Water Quality Management and Pollution Control Class II (as minimum). The sampling followed Indonesian standards set in APHA: Standard Methods for the Examination of Water and Wastewater 21<sup>st</sup> Edition

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2005. The data provides an adequate baseline against which to monitor and assess impacts on water quality.

### **3.1.1 Physical and Chemical properties of surface water**

Surface water quality samples was conducted in the waters around the Power Plant site plan, and in Pipe Line area have been collected at six locations, 3 (three) location at Siak River and 3 (three) location at Gasip River (upstream and downstream). Sampling locations are shown in Figure 3-1.

The results meet standard national effluent limits, except for pH and oil & grease respectively at Gasip River and Siak River. The test result is presented in the Table 3-1 below. Parameters that exceed the quality standard are shown in yellow in the Table. 3-1.

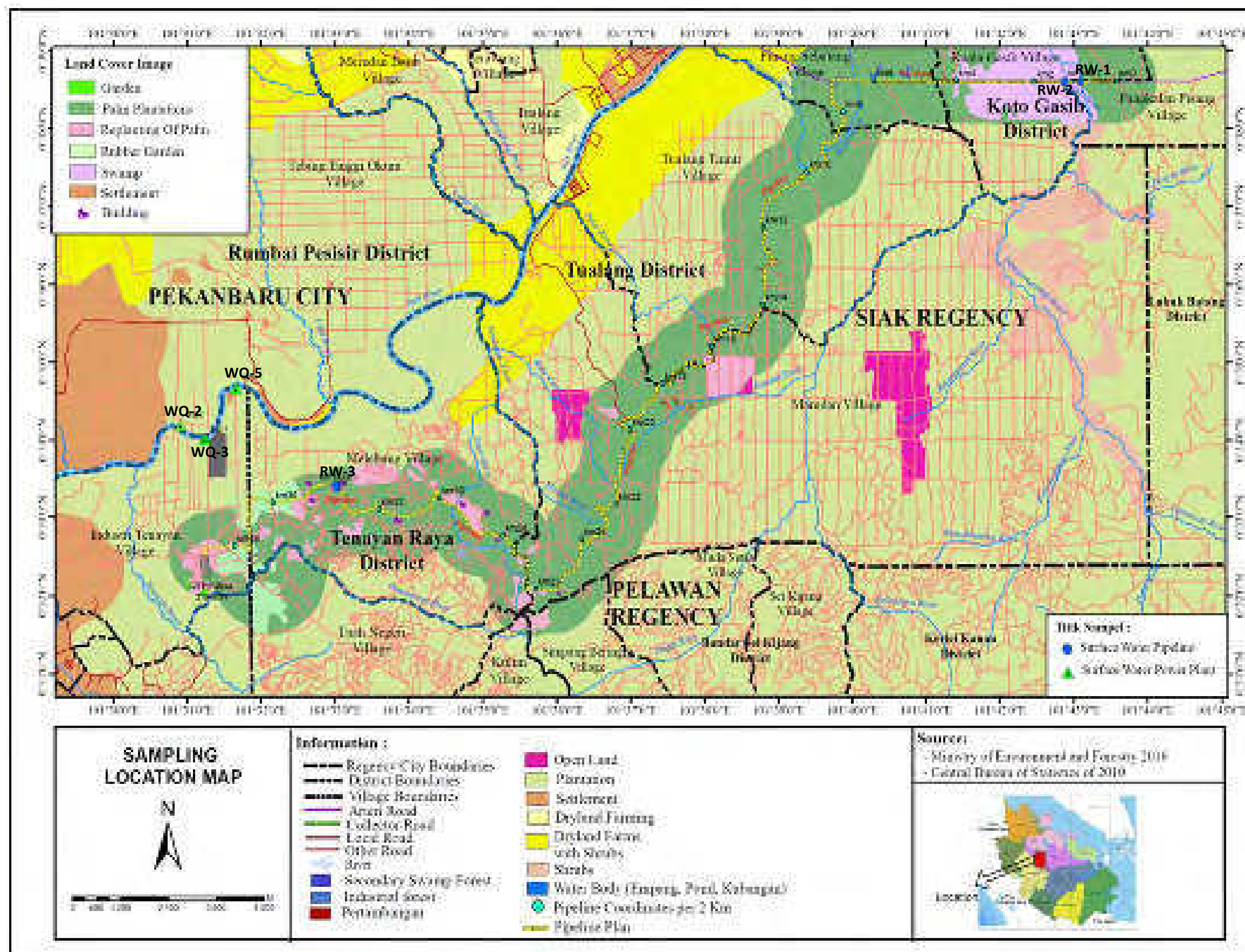


Figure 3-1. Sampling location on power plant area

**Table 3-1. Surface Water Quality Test Report (Power Plant Site)**

No	Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Result		
					WQ 2 PP	WQ 3 PP	WQ 5 PP
					Location reference key at bottom of table		
1	pH	-	-	6 – 9	5,77	5,54	5,67
2	Total Suspended Solids (TSS)	mg/L	1	50	11	15	25
3	Biochemical Oxygen Demand (BOD)	mg/L	2	3	<2	<2	<2
4	Chemical Oxygen Demand (COD)	mg/L	3	25	<5	8,6	18
2	Oil and Grease	µg/L	1000	1000	3800	<1000	2400
3	Total Arsenic (As)	mg/L	0.005	NA <sup>3</sup>	<0,0005	<0,0005	<0,0005
4	Total Boron (B)	mg/L	0.04	NA <sup>3</sup>	<0,04	<0,04	<0,04
5	Total Cadmium (Cd) <sup>2</sup>	mg/L	0.002	NA <sup>3</sup>	<0,002	<0,002	<0,002
6	Total Chromium (Cr)	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
7	Total Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	NA <sup>3</sup>	<0,004	<0,004	<0,004
8	Total Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
9	Total Iron (Fe)	mg/L	0.09	NA <sup>3</sup>	0,64	0,58	0,65
10	Total Lead (Pb) <sup>2</sup>	mg/L	0.005	NA <sup>3</sup>	<0,005	<0,005	<0,005
11	Total Mercury (Hg)	mg/L	0.0005	NA <sup>3</sup>	<0,0005	<0,0005	<0,0005
12	Total Manganese (Mn)	mg/L	0.01	NA <sup>3</sup>	0,06	0,09	0,03
13	Total Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
14	Total Zinc (Zn)	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
15	Ammonia (as NH <sub>3</sub> -N)	mg/L	0.07	(-)	0,17	0,16	0,39
16	Fluoride (F)	mg/L	0.1	1.5	<0,1	0,2	<0,1
17	Total Nitrogen	mg/L	0.06	NA <sup>3</sup>	1,12	1,16	2,63
18	Nitrate (NO <sub>3</sub> )	mg/L	0.003	10	0,10	0,12	0,103

No	Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Result		
					WQ 2 PP	WQ 3 PP	WQ 5 PP
					Location reference key at bottom of table		
19	Nitrite (NO <sub>2</sub> )	mg/L	0.005	0.06	0,015	0,016	0,012
20	Phosphorus (P)	mg/L	0.03	0.2	<0,03	<0,03	<0,03
21	Temperature	°C	-	±3	28,5	27,2	27,4
22	Conductivity	µs/cm	1	NA <sup>3</sup>	27	28	30
23	Turbidity	NTU	0.5	NA <sup>3</sup>	12,4	14,3	14,6
24	Dissolved Oxygen (DO)	mg/L	-	4	6,2	3,8	4,0
25	Dissolved Arsenic (As)	mg/L	0.005	1	<0,0005	<0,0005	<0,0005
26	Dissolved Boron (B)	mg/L	0.04	1	<0,04	<0,04	<0,04
27	Dissolved Cadmium (Cd) <sup>2</sup>	mg/L	0.002	0.01	<0,002	<0,002	<0,002
28	Dissolved Chromium	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
29	Dissolved Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	0.05	<0,004	<0,004	<0,004
30	Dissolved Copper (Cu)	mg/L	0.01	0.02	<0,01	<0,01	<0,01
31	Dissolved Iron (Fe)	mg/L	0.09	(-)	0,46	0,41	0,43
32	Dissolved Lead (Pb) <sup>2</sup>	mg/L	0.005	0.03	<0,005	<0,005	<0,005
33	Dissolved Mercury (Hg)	mg/L	0.0005	0.002	<0,0005	<0,0005	<0,0005
34	Dissolved Manganese (Mn)	mg/L	0.01	(-)	<0,01	<0,01	<0,01
35	Dissolved Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
36	Dissolved Zinc (Zn)	mg/L	0.02	0.05	<0,02	<0,02	<0,02
37	Total Coliform	colony/100mL	-	5000	6.1	110	220

Note(s):

<sup>2</sup> This parameter (in the described matrix) has not been accredited by KAN

<sup>3</sup> Not Applicable or Not Available

WQ 2 PP: Upstream Siak River; Coordinate: N= 00°34'10,1" E= 101°30'47,0"

WQ 3 PP: Downstream Siak River; Coordinate: N= 00°34'01,1" E= 101°31'16,4"

WQ 5 PP: Siak River; Coordinate: N= 00°34'40.14" E= 101°31'39.28"

**Table 3-2. Surface Water Quality Test Report (Pipe Line)**

No	Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Result		
					RW 01 PL	RW 02 PL	RW 03 PL
					Location reference key at bottom of table		
1	pH	-	-	6 – 9	4,98	5,51	5,65
2	Total Suspended Solids (TSS)	mg/L	1	50	16	13	10
3	Biochemical Oxygen Demand (BOD)	mg/L	2	3	<2	<2	<2
4	Chemical Oxygen Demand (COD)	mg/L	3	25	60	51	40
2	Oil and Grease	µg/L	1000	1000	2600	1800	6200
3	Total Arsenic (As)	mg/L	0.005	NA <sup>3</sup>	0,0007	0,0011	<0,0005
4	Total Boron (B)	mg/L	0.04	NA <sup>3</sup>	<0,04	<0,04	<0,04
5	Total Cadmium (Cd) <sup>2</sup>	mg/L	0.002	NA <sup>3</sup>	<0,002	<0,002	<0,002
6	Total Chromium (Cr)	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
7	Total Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	NA <sup>3</sup>	<0,004	<0,004	<0,01
8	Total Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
9	Total Iron (Fe)	mg/L	0.09	NA <sup>3</sup>	3,18	3,26	1,09
10	Total Lead (Pb) <sup>2</sup>	mg/L	0.005	NA <sup>3</sup>	<0,005	<0,05	<0,005
11	Total Mercury (Hg)	mg/L	0.0005	NA <sup>3</sup>	0,012	<0,0005	<0,0005
12	Total Manganese (Mn)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
13	Total Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
14	Total Zinc (Zn)	mg/L	0.02	NA <sup>3</sup>	0,09	0,02	0,02
15	Ammonia (as NH <sub>3</sub> -N)	mg/L	0.07	(-)	0,22	0,13	<0,07

No	Parameter	Unit	Detection Limit	Regulation Limit (PP 82/2001 class II)	Result		
					RW 01 PL	RW 02 PL	RW 03 PL
					Location reference key at bottom of table		
16	Fluoride (F)	mg/L	0.1	1.5	<0,1	0,1	<0,1
17	Total Nitrogen	mg/L	0.06	NA <sup>3</sup>	0,51	1,20	0,87
18	Nitrate (NO <sub>3</sub> )	mg/L	0.003	10	<0,003	0,005	0,01
19	Nitrite (NO <sub>2</sub> )	mg/L	0.005	0.06	0,015	0,007	<0,005
20	Phosphorus (P)	mg/L	0.03	0.2	<0,03	<0,03	<0,03
21	Temperature	°C	-	±3	30,0	28,9	27,7
22	Conductivity	µs/cm	1	NA <sup>3</sup>	40	20	25,6
23	Turbidity	NTU	0.5	NA <sup>3</sup>	4,39	7,66	2,56
24	Dissolved Oxygen (DO)	mg/L	-	4	4,1	5,1	4,7
25	Dissolved Arsenic (As)	mg/L	0.005	1	<0,0005	<0,0005	<0,0005
26	Dissolved Boron (B)	mg/L	0.04	1	<0,04	<0,04	1,62
27	Dissolved Cadmium (Cd) <sup>2</sup>	mg/L	0.002	0.01	<0,002	<0,002	<0,002
28	Dissolved Chromium	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
29	Dissolved Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	0.05	<0,004	<0,004	<0,004
30	Dissolved Copper (Cu)	mg/L	0.01	0.02	<0,01	<0,01	<0,01
31	Dissolved Iron (Fe)	mg/L	0.09	(-)	0,61	0,64	0,24
32	Dissolved Lead (Pb) <sup>2</sup>	mg/L	0.005	0.03	<0,005	<0,005	<0,005
33	Dissolved Mercury (Hg)	mg/L	0.0005	0.002	<0,0005	<0,0005	<0,0005
34	Dissolved Manganese (Mn)	mg/L	0.01	(-)	<0,01	<0,01	<0,01
35	Dissolved Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,02
36	Dissolved Zinc (Zn)	mg/L	0.02	0.05	<0,02	<0,02	<0,02
37	Total Coliform	colony/100mL	-	5000	4,5	1,8	<1,8

Note(s):

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<sup>2</sup> *This parameter (in the described matrix) has not been accredited by KAN*

<sup>3</sup> *Not Applicable or Not Available*

*RW 01 PL : River Gasip; Coordinate: N= 00°38'36.37" E= 101°43'05.34"*

*RW 02 PL : River Gasip; Coordinate: N= 00°38'35.49" E= 101°42'28.40"*

*RW 03 PL : River Gasip; Coordinate: N= 00°33'23.96" E= 101°33'01.55"*



**Figure 3-2.** *Siak River Sampling location*



**Figure 3-3.** *Gasip River Sampling location*

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### 3.1.2 Gasib River Physical Photograph & Properties



***Figure 3-4. Gasip River RW 1***



***Figure 3-5. Gasip River RW 2***

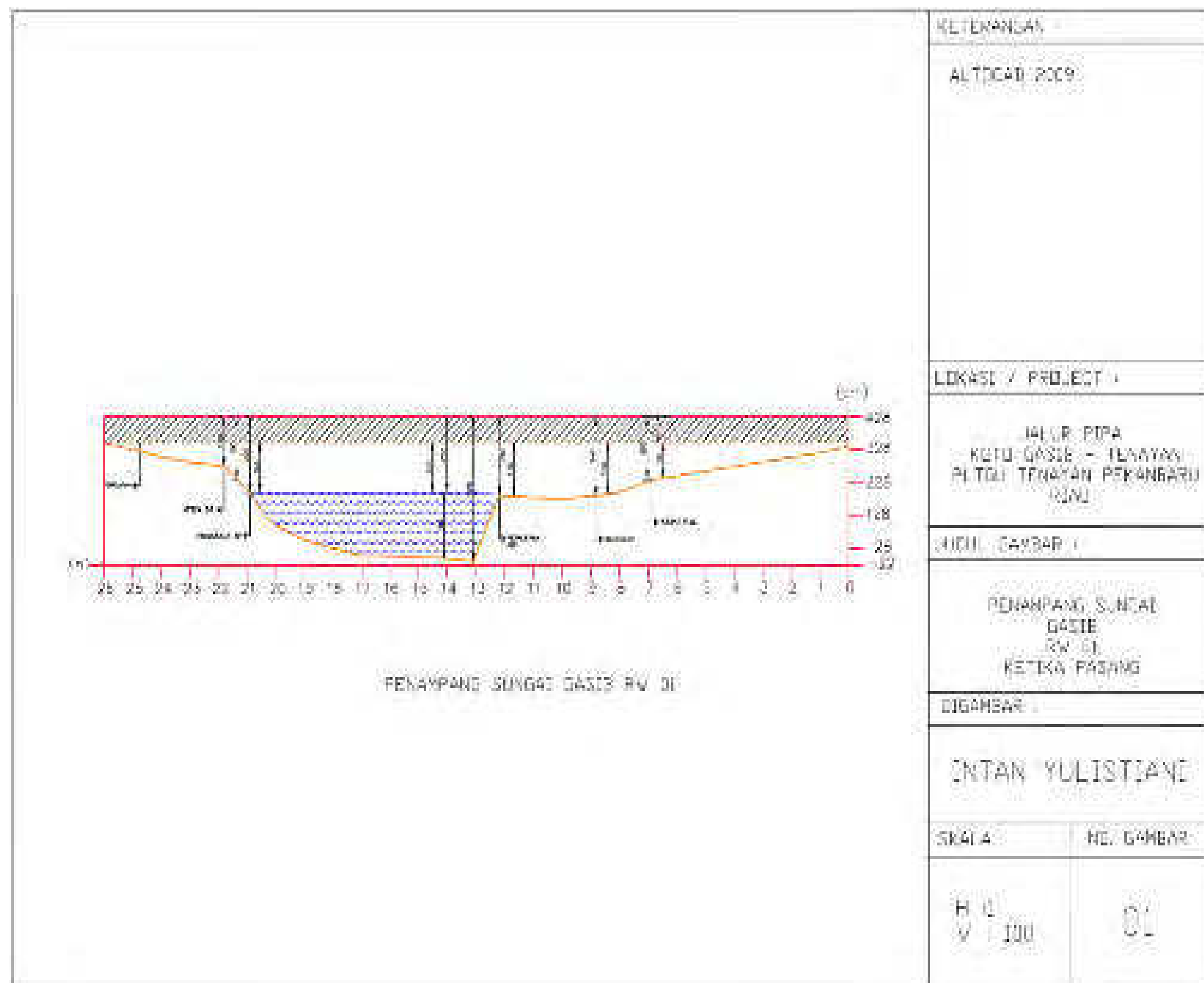


Figure 3-6. Cross-Section Gasip River RW 1

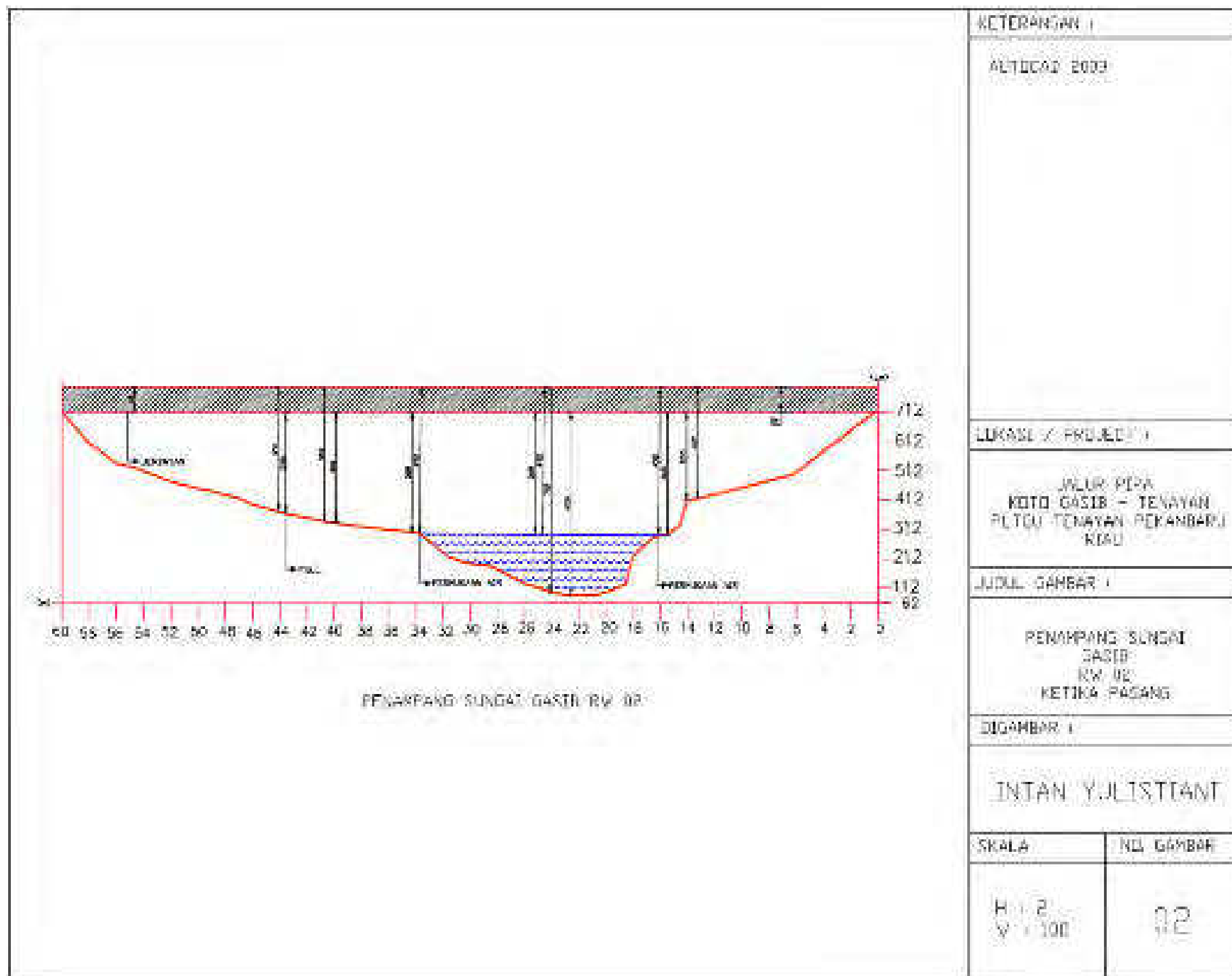


Figure 3-7. Cross-Section Gasip River RW 2

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### 3.1.3 Freshwater Ecological Sampling

#### 3.1.3.1 *Micro-invertebrata Sampling*

Macro-invertebrate Sampling was conducted in the waters around the Power Plant site plan and pipe line area, sampling was conducted in the waters of Siak River, Gasip River and creek in the around location plan activities. Sediment samples are extracted from three location in transect, using the grab or corer box method. The seven sample units are then composited, to extract the benthic fauna and then sent to the laboratory of the Scientific Authority for determination. Samples will be taken from seven sampling points (Table 3-3) and will be merged as composite sampling.

TABLE 3-3. BENTHIC ANALYSIS REPORT

No	Familia	Species	LOCATION													
			RW.01		RW.02		RW.03		RW.03B		WQ-02		WQ-03		WQ-05	
			Abundance (Individu/m <sup>2</sup> )	Abundance Relatif (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)	Abundance (Individu/m <sup>2</sup> )	Abundance Relatively (%)
1	Baetidae	Baetissp.	25	11,36	-	-	-	-	88	20,19	-	-	-	-	-	-
2	Glossosomatidae	Glossosoma sp.	5	2,27	-	-	-	-	4	0,96	-	-	-	-	-	-
3	Rhyacophilidae	Rhyacophila sp.	-	-	-	-	-	-	-	-	-	-	-	-	10	100
4	Dytiscidae	Cybister sp.	5	2,27	-	-	-	-	-	-	-	-	-	-	-	-
5	Corixidae	Micronecta sp.	15	6,82	20	17			152	34,62	-	-	-	-	-	-
6		Synptonecta sp.	10	4,55	5	4	-	-	46	10,58	-	-	-	-	-	-
7	Aphelocheiridae	Aphelocheirus sp.	25	11,36	-	-	-	-	4	0,96	-	-	-	-	-	-
8	Nepidae	Ranatra sp.	5	2,27	-	-	-	-	-	-	-	-	-	-	-	-
9	Macroveliidae	Macrovelia sp.	-	-	-	-			13	2,88	-	-	-	-	-	-
10	Coenagrionidae	Enallagma sp.	-	-	-	-	-	-	13	2,88	-	-	-	-	-	-
11	Libellulidae	Leuchorrhinia sp.	20	9,09	5	4			8	1,92	-	-	-	-	-	-
12	Chironomidae	Cricotopus sp.	15	6,82	-	-	-	-	-	-	-	-	-	-	-	-
13		Parachironomus sp.	74	34,09	-	-	-	-	-	-	-	-	-	-	-	-
14		Dicrotendipes sp.	-	-	74	63	-	-	-	-	-	-	-	-	-	-
15		Chironomus sp.	-	-	-	-	8622	99,66	-	-	-	-	-	-	-	-
16		Polypedilum sp.	-	-	-	-	-	-	109	25,00	5	12,50	84	39	-	-
17	Tipulidae	Tipula sp.	5	2,27	-	-	-	-	-	-	-	-	-	-	-	-
18	Scathopagidae	Scathopaga sp.	-	-	-	-	15	0,17	-	-	-	-	-	-	-	-
19	Pachychilidae	Sulcospira sp.	-	-	-	-	15	0,17	-	-	-	-	-	-	-	-
20	Mytilidae	Limnoperna sp.	-	-	-	-	-	-	-	-	-	-	133	61	-	-
21	Tubificidae	Limnodrilus sp.	15	6,82	10	8	-	-	-	-	30	75,00	-	-	-	-
22		Branchiura sp.	-	-			-	-	-	-	5	12,50	-	-	-	-
23	Naididae	Stylaria sp.	-	-	5	4	-	-	-	-	-	-	-	-	-	-
Abundance of macrobenthic-fauna /m <sup>2</sup>			217	100	119	100	8652	100	438	100	40	100	217	100	10	100
Shanon-Wiener Diversity Index (H')			2,11		1,20		0,03		1,64		0,74		0,67		0	
Equitability Index			0,85		0,67		0,02		0,75		0,67		0,96		0	

Table 3-4. Zooplankton Analysis Report

NO	Pylum	Spesies	WQ-02 PP		WQ-03 PP		WQ-04 PP		WQ-05 PP		Middle Stream Tenayan		Upstream Tenayan	
			Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)
	Arthtropoda													
1		Cyclops sp (Naupli)	1	100	1	33,33	1	50	1	100	1	100	2	50
2		Diaptomus sp	-	-	1	33,33	-	-	-	-	-	-	-	-
3		Diaphanosoma sp	-	-	-	-	-	-	-	-	-	-	1	25
4		Moina sp	-	-	-	-	-	-	-	-	-	-	-	-
	Protozoa													
5		Gymnodinium sp	-	-	-	-	-	-	-	-	-	-	-	-
	Rotifera													
6		Asplanchna sp	-	-	-	-	-	-	-	-	-	-	-	-
7		Brachionus sp	-	-	-	-	-	-	-	-	-	-	-	-
8		Conochilus sp	-	-	-	-	-	-	-	-	-	-	1	25
9		Filinia sp	-	-	1	33,33	-	-	-	-	-	-	-	-
10		Monommata sp	-	-	-	-	1	50	-	-	-	-	-	-
11		Trichocerca sp	-	-	-	-	-	-	-	-	-	-	-	-
Total Individu			1	100	3	100	2	100	1	100	1	100	4	100
Total Spesies			1		3		2		1		1		3	
Diversity Index (H')			0		1,099		0,347		0		0		1,040	
Evenness Index (E)			0		1,0		0,50		0		0		0,946	

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
	Arthtropoda									
1		Cyclops sp (Naupli)	3	50	5	55,56	-	-	-	-
2		Diaptomus sp	-	-	-	-	-	-	-	-
3		Diaphanosoma sp	-	-	-	-	-	-	-	-
4		Moina sp	-	-	-	-	-	-	1	50
	Protozoa									
5		Gymnodinium sp	-	-	-	-	1	33,33	1	50
	Rotifera									
6		Asplanchna sp	1	16,67	1	11,11	1	33,33	-	-
7		Brachionus sp	-	-	2	22,22	-	-	-	-
8		Conochilus sp	-	-	-	-	-	-	-	-
9		Filinia sp	-	-	1	11,11	-	-	-	-
10		Monommata sp	-	-	-	-	-	-	-	-
11		Trichocerca sp	2	33,33	-	-	1	33,33	-	-

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
									-	-
Total Individu			6	100	9	100	3	100	2	100
Total Spesies			3		4		3		2	2
Diversity Index (H')			1,011		1,149		1,099		0,693	
Evenness Index (E)			0,921		0,829		1,0		1,0	

**Table 3-5. Fitoplankton Analysis Report**

NO	Pylum	Spesies	WQ-02 PP		WQ-03 PP		WQ-04 PP		WQ-05 PP		Middle Stream Tenayan		Upstream Tenayan	
			Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)
	<b>Bacillariophyta</b>													
1		<i>Actinocyclus sp.</i>	1	6,25	-	-	-	-	1	7,14	-	-	-	-
2		<i>Aulacoseira spp</i>	-	-	2	5,88	-	-	1	7,14	-	-	-	-
3		<i>Cosinodiscus sp</i>	-	-	6	17,65	5	13,89	-	-	-	-	-	-
4		<i>Cyclotella sp</i>	-	-	-	-	3	8,33	-	-	1	4,17	-	-
5		<i>Cyclostephanus sp</i>	-	-	2	5,88	-	-	-	-	-	-	-	-
6		<i>Cymbela sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
7		<i>Diatoma vulgare</i>	-	-	-	-	3	8,33	-	-	5	20,83	2	2,15
8		<i>Diatoma elongatum</i>	-	-	-	-	-	-	-	-	-	-	-	-
9		<i>Denticula sp.</i>	-	-	-	-	-	-	-	-	-	-	-	-
10		<i>Fragilaria crotonensis</i>	-	-	-	-	-	-	-	-	-	-	5	5,38
11		<i>Fragilaria intermedia</i>	-	-	-	-	-	-	-	-	-	-	-	-
12		<i>Fragilaria spp.</i>	2	12,5	-	-	-	-	1	7,14	-	-	-	-
13		<i>Frustulia sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
14		<i>Eunotia spp.</i>	1	6,25	6	17,65	1	2,78	2	14,29	-	-	-	-
15		<i>Hyalodiscus sp</i>	1	6,25	-	-	-	-	1	7,14	-	-	-	-
16		<i>Navicla rhincocephala</i>	-	-	-	-	-	-	-	-	-	-	-	-
17		<i>Navicula subtilissima</i>	-	-	-	-	-	-	-	-	-	-	3	3,23
18		<i>Navicula pupula</i>	-	-	-	-	-	-	-	-	-	-	-	-
19		<i>Navicula sp</i>	1	6,25	-	-	1	2,78	1	7,14	1	4,17	5	5,38
20		<i>Nitzscia acicularis</i>	-	-	-	-	-	-	-	-	-	-	-	-
21		<i>Nitzscihia sigma</i>	-	-	-	-	-	-	-	-	-	-	3	3,23
22		<i>Nitzscia spectabilis</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
23		<i>Nitzscia linearis</i>	-	-	2	5,88	1	2,78	-	-	-	-	-	-
24		<i>Nitzscia spp</i>	-	-	-	-	1	2,78	-	-	-	-	2	2,15
25		<i>Pinnularia sp</i>	2	12,5	-	-	-	-	-	-	-	-	2	2,15
26		<i>Stephanodiscus sp</i>	-	-	6	17,65	3	8,33	2	14,29	1	4,17	-	-
27		<i>Stauroneis sp</i>	-	-	-	-	-	-	-	-	1	4,17	-	-
28		<i>Surirella robusta var splendida</i>	1	6,25	3	8,82	3	8,33	2	14,29	3	12,50	12	12,90
29		<i>Surirella beseriata</i>	-	-	-	-	1	2,78	-	-	-	-	2	2,15
30		<i>Surirella fenera</i>	1	6,25	-	-	1	2,78	1	7,14	-	-	-	-

NO	Pylum	Spesies	WQ-02 PP		WQ-03 PP		WQ-04 PP		WQ-05 PP		Middle Stream Tenayan		Upstream Tenayan	
			Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)
31		<i>Surirela befrons</i>	-	-	-	-	1	2,78	-	-	1	4,17	-	-
32		<i>Surirella liniaris</i>	1	6,25	-	-	-	-	-	-	1	4,17	-	-
33		<i>Synedra ulna</i>	1	6,25	2	5,88	2	5,56	1	7,14	1	4,17	2	2,15
34		<i>Tabellaria sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
														-
	Chlorophyta		-	-	-	-	-	-	-	-	-	-	-	-
35		<i>Actinastrum Hantzschii</i>	-	-	-	-	-	-	-	-	1	4,17	-	-
36		<i>Ankistrodesmus falcatus</i>	-	-	-	-	-	-	-	-	-	-	6	6,45
37		<i>Ankistrodesmus sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
38		<i>Closterium gracile</i>	-	-	-	-	-	-	-	-	-	-	-	-
39		<i>Closterium lineatum</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
40		<i>Closterium ehrenbergii</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
41		<i>Closterium rafsii</i>	-	-	-	-	-	-	-	-	-	-	-	-
42		<i>Closterium lineatum</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
43		<i>Closterium turgidum</i>	-	-	-	-	-	-	-	-	-	-	-	-
44		<i>Closterium tumidum</i>	-	-	-	-	-	-	-	-	-	-	-	-
45		<i>Closterium rectimarginatum</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
46		<i>Coelastrum cambricum</i>	-	-	-	-	-	-	-	-	-	-	-	-
47		<i>Coelastrum sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
48		<i>Cosmarium spp</i>	-	-	-	-	-	-	-	-	-	-	5	5,38
49		<i>Cosmarium identatum</i>	-	-	-	-	-	-	-	-	-	-	-	-
50		<i>Cosmarium pseudoconnatum</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
51		<i>Crucigenia truncata</i>	-	-	-	-	-	-	-	-	1	4,17	-	-
52		<i>Crucigeia quadrata</i>	-	-	-	-	-	-	-	-	-	-	3	3,23
53		<i>Crucigenia spp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
54		<i>Chlamodomonas sphagnicola</i>	-	-	-	-	-	-	-	-	-	-	-	-
55		<i>Desmidium sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
56		<i>Dictyosphaerium</i>	-	-	-	-	-	-	-	-	1	4,17	2	2,15
57		<i>Eudorina</i>	-	-	-	-	-	-	-	-	-	-	-	-
58		<i>Euastrum anastum</i>	-	-	-	-	-	-	-	-	-	-	-	-
59		<i>Euastrum sinosum</i>	-	-	-	-	-	-	-	-	-	-	-	-
60		<i>Euastrum sublobatum</i>	-	-	-	-	-	-	-	-	-	-	-	-
61		<i>Euastrum ausatum</i>	-	-	-	-	-	-	-	-	-	-	-	-
62		<i>Gloeocystis sp</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
63		<i>Lagehermia sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
64		<i>Kircneriella sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
65		<i>Meugeotia sp</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
66		<i>Monoraphidium sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
67		<i>Nephrocytium sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
68		<i>Oocystis sp</i>	-	-	-	-	-	-	-	-	-	-	3	3,23

NO	Pylum	Spesies	WQ-02 PP		WQ-03 PP		WQ-04 PP		WQ-05 PP		Middle Stream Tenayan		Upstream Tenayan	
			Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)
69		<i>Oedogonium sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
70		<i>Pandorina sp</i>	-	-	-	-	-	-	-	-	-	-	5	5,38
71		<i>Pediastrum duplex</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
72		<i>Penium sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
73		<i>Pleurotaenium trabecula</i>	-	-	-	-	-	-	-	-	-	-	-	-
74		<i>Pleurotaenium baculoides</i>	-	-	-	-	-	-	-	-	-	-	-	-
75		<i>Rhizoclonium sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
76		<i>Scenedesmus sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
77		<i>Scenedesmus bijuga</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
78		<i>Selenastrum sp</i>	-	-	-	-	-	-	-	-	-	-	2	2,15
79		<i>Spirogyra sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
80		<i>Sphaerocystis sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
81		<i>Sphaeroplea annulia</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
82		<i>Tetraedron sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
83		<i>Ulothrix sp</i>	-	-	-	-	-	-	-	-	-	-	-	-
	<b>Cyanophyta</b>													
84		<i>Anabaena bergii</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
85		<i>Anabaena affinis</i>	-	-	-	-	-	-	-	-	-	-	-	-
86		<i>Pseudoanabaena</i>	-	-	-	-	-	-	-	-	-	-	-	-
87		<i>Oscillatoria tenuis</i>	-	-	-	-	-	-	-	-	-	-	-	-
88		<i>Oscillatoria sp</i>	-	-	-	-	-	-	-	-	1	4,17	-	-
89		<i>Phormidium tenue</i>	-	-	-	-	-	-	-	-	-	-	-	-
90		<i>Phormidium sp</i>	1	6,25	-	-	-	-	-	-	-	-	-	-
91		<i>Planktothrix sp</i>	1	6,25	3	8,82	1	2,78	1	7,14	-	-	-	-
92		<i>Dactilococcopsis Smithii</i>	-	-	2	5,88	1	2,78	-	-	-	-	-	-
	<b>Dinophyta</b>													
93		<i>Ceratium hirudinella</i>	1	6,25	-	-	-	-	-	-	-	-	-	-
94		<i>Peridinium cinctum</i>	-	-	-	-	-	-	-	-	-	-	-	-
95		<i>Peridinium inospicuum</i>	-	-	-	-	-	-	-	-	-	-	-	-
	<b>Cryptophyta</b>													
96		<i>Rhodomonas sp</i>	-	-	-	-	-	-	-	-	-	-	1	1,08
97		<i>Cryptomonas sp</i>	-	-	-	-	-	-	-	-	1	4,17	3	3,23
	<b>Euglenophyta</b>		-	-	-	-	-	-	-	-	-	-	-	-
98		<i>Euglena texta</i>	-	-	-	-	-	-	-	-	-	-	-	-
99		<i>Euglena acus</i>	1	6,25	-	-	-	-	-	-	1	4,17	-	-
100		<i>Euglena proxima</i>	-	-	-	-	-	-	-	-	-	-	-	-
101		<i>Euglena gracilis</i>	-	-	-	-	-	-	-	-	-	-	1	1,08
102		<i>Euglena oxyuris</i>	-	-	-	-	-	-	-	-	1	4,17	-	-

NO	Pylum	Spesies	WQ-02 PP		WQ-03 PP		WQ-04 PP		WQ-05 PP		Middle Stream Tenayan		Upstream Tenayan	
			Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)	Abundance (Individu/m2)	Abundance Relatively (%)
103		<i>Phacus orbicularis</i>	-	-	-	-	-	-	-	-	-	-	-	-
104		<i>Phacus spp</i>	-	-	-	-	-	-	-	-	-	-	-	-
105		<i>Strombomonas</i>	-	-	-	-	-	-	-	-	1	4,17	-	-
106		<i>Trachelomonas horrida</i>	-	-	-	-	-	-	-	-	0	0,00	-	-
107		<i>Trachelomonas charkowiensis</i>	-	-	-	-	-	-	-	-	1	4,17	2	2,15
108		<i>Trachelomonas superba</i>	-	-	-	-	-	-	-	-	-	-	-	-
109		<i>Trachelomonas scabra var. longicolis</i>	-	-	-	-	1	2,78	-	-	-	-	-	-
110		<i>Trachelomonas voconica</i>	-	-	-	-	-	-	-	-	-	-	-	-
111		<i>Trachelomnas spp</i>	-	-	-	-	-	-	-	-	-	-	-	-
Total Individu			16	100	34	100	36	100	14	100	24	100	93	100
Total Spesies			14	14	10	10	23	23	11		19	19	32	32
Diversity Index (H')			2,599		2,180		2,955			2,342	2,705		3,290	
Evenness Index (E)			0,985		0,947		0,943			0,977	0,903		0,925	

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
	<b>Bacillariophyta</b>									
1		<i>Actinocyclus sp.</i>	-	-	-	-	-	-	-	-
2		<i>Aulacoseira spp</i>	2	0,86	20	9,57	-	-	-	-
3		<i>Cosinodiscus sp</i>	-	-	-	-	-	-	-	-
4		<i>Cyclotella sp</i>	-	-	-	-	-	-	-	-
5		<i>Cyclostephanus sp</i>	-	-	-	-	-	-	-	-
6		<i>Cymbela sp</i>	11	4,72	-	-	-	-	-	-
7		<i>Diatoma vulgare</i>	11	4,72	3	1,44	2	4,08	4	3,64
8		<i>Diatoma elongatum</i>	2	0,86	-	-	-	-	-	-
9		<i>Denticula sp.</i>	-	-	3	1,44	-	-	-	-
10		<i>Fragilaria crotonensis</i>	-	-	-	-	-	-	1	0,91
11		<i>Fragilaria intermedia</i>	2	0,86	-	-	-	-	-	-
12		<i>Fragilaria spp.</i>	40	17,17	-	-	1	2,04	1	0,91
13		<i>Frustulia sp</i>	2	0,86	-	-	-	-	-	-
14		<i>Eunotia spp.</i>	15	6,44	-	-	-	-	1	0,91
15		<i>Hyalodiscus sp</i>	-	-	-	-	2	4,08	-	-
16		<i>Navicla rhincocephala</i>	4	1,72	-	-		0,00	-	-
17		<i>Navicula subtilissima</i>	7	3,00	3	1,44	18	36,73	-	-
18		<i>Navicula pupula</i>	2	0,86	-	-	-	-	-	-
19		<i>Navicula sp</i>	-	-	6	2,87	-	-	1	0,91
20		<i>Nitzscia acicularis</i>	-	-	-	-	-	-	-	-
21		<i>Nitzscihia sigma</i>	-	-	-	-	-	-	-	-
22		<i>Nitzscia spectabilis</i>	2	0,86	-	-	-	-	-	-

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
23		<i>Nitzscia linearis</i>	2	0,86	-	-	-	-	-	-
24		<i>Nitzscia spp</i>	-	-	-	-	-	-	-	-
25		<i>Pinnularia sp</i>	2	0,86	6	2,87	-	-	-	-
26		<i>Stephanodiscus sp</i>	-	-	-	-	-	-	-	-
27		<i>Stauroneis sp</i>	-	-	3	1,44	-	-	-	-
28		<i>Surirella robusta var splendida</i>	-	-	-	-	-	-	-	-
29		<i>Surirella beseriata</i>	-	-	-	-	-	-	-	-
30		<i>Surirella fenera</i>	-	-	-	-	-	-	-	-
31		<i>Surirela befrons</i>	-	-	-	-	-	-	-	-
32		<i>Surirella liniaris</i>	-	-	-	-	-	-	-	-
33		<i>Synedra ulna</i>	23	9,87	3	1,44	-	-	1	0,91
34		<i>Tabellaria sp</i>	9	3,86	-	-	-	-	-	-
	<b>Chlorophyta</b>		-	-	-	-	-	-	-	-
35		<i>Actinastrum Hantzschii</i>	-	-	-	-	-	-	-	-
36		<i>Ankistrodesmus falcatus</i>	-	-	-	-	-	-	-	-
37		<i>Ankistrodesmus sp</i>	-	-	3	1,44	-	-	-	-
38		<i>Closterium gracile</i>	2	0,86	-	-	-	-	-	-
39		<i>Closterium lineatum</i>	-	-	-	-	-	-	-	-
40		<i>Closterium ehrenbergii</i>	-	-	-	-	-	-	-	-
41		<i>Closterium rafsii</i>	-	-	3	1,44	-	-	-	-
42		<i>Closterium lineatum</i>	-	-	-	-	-	-	-	-
43		<i>Closterium turgidum</i>	2	0,86	-	-	-	-	1	0,91
44		<i>Closterium tumidum</i>	-	-	-	-	-	-	-	-
45		<i>Closterium rectimarginatum</i>	-	-	-	-	-	-	-	-
46		<i>Coelastrum cambricum</i>	-	-	-	-	-	-	-	-
47		<i>Coelastrum sp</i>	-	-	3	1,44	-	-	-	-
48		<i>Cosmarium spp</i>	-	-	-	-	-	-	1	0,91
49		<i>Cosmarium identatum</i>	2	0,86	-	-	-	-	-	-
50		<i>Cosmarium pseudoconnatum</i>	-	-	-	-	-	-	-	-
51		<i>Crucigenia truncata</i>	-	-	-	-	-	-	-	-
52		<i>Crucigeia quadrata</i>	-	-	-	-	-	-	-	-
53		<i>Crucigenia spp</i>	-	-	3	1,44	-	-	1	0,91
54		<i>Chlamodomonas sphagnicola</i>	-	-	-	-	-	-	3	2,73
55		<i>Desmidium sp</i>	40	17,17	58	27,75	-	-	-	-
56		<i>Dictyosphaerium</i>	-	-	-	-	-	-	1	0,91
57		<i>Eudorina</i>	-	-	3	1,44	-	-	1	0,91
58		<i>Euastrum anastum</i>	-	-	-	-	-	-	-	-
59		<i>Euastrum sinusum</i>	2	0,86	-	-	-	-	-	-
60		<i>Euastrum sublobatum</i>	-	-	-	-	1	2,04	-	-
61		<i>Euastrum ausatum</i>	-	-	3	1,44	-	-	-	-
62		<i>Gloeocystis sp</i>	-	-	-	-	-	-	-	-
63		<i>Lagehermia sp</i>	-	-	15	7,18	-	-	-	-

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
64		<i>Kircneriella sp</i>	2	0,86	-	-	-	-	-	-
65		<i>Meugeotia sp</i>	6	2,58	-	-	1	2,04	-	-
66		<i>Monoraphidium sp</i>	-	-	-	-	-	-	-	-
67		<i>Nephrocytium sp</i>	-	-	-	-	1	2,04	-	-
68		<i>Oocystis sp</i>	-	-	-	-	-	-	-	-
69		<i>Oedogonium sp</i>	2	0,86	-	-	-	-	-	-
70		<i>Pandorina sp</i>	2	0,86	-	-	-	-	1	0,91
71		<i>Pediastrum duplex</i>	-	-	-	-	-	-	-	-
72		<i>Penium sp</i>	-	-	-	-	-	-	-	-
73		<i>Pleurotaenium trabecula</i>	-	-	-	-	1	2,04	-	-
74		<i>Pleurotaenium baculoides</i>	2	0,86	-	-	-	-	-	-
75		<i>Rhizoclonium sp</i>	6	2,58	-	-	3	6,12	-	-
76		<i>Scenedesmus sp</i>	-	-	-	-	-	-	-	-
77		<i>Scenedesmus bijuga</i>	-	-	-	-	-	-	-	-
78		<i>Selenastrum sp</i>	-	-	-	-	-	-	-	-
79		<i>Spirogyra sp</i>	-	-	-	-	17	34,69	-	-
80		<i>Sphaerocystis sp</i>	-	-	3	1,44	-	-	-	-
81		<i>Sphaeroplea annulia</i>	2	0,86	6	2,87	-	-	-	-
82		<i>Tetraedron sp</i>	-	-	-	-	-	-	-	-
83		<i>Ulothrix sp</i>	2	0,86	-	-	-	-	-	-
					-	-	-	-		
	<b>Cyanophyta</b>									
84		<i>Anabaena bergii</i>	-	-	3	1,44	-	-	-	-
85		<i>Anabaena affinis</i>	-	-	-	-	1	2,04	14	12,73
86		<i>Pseudoanabaena</i>	2	0,86	-	-	-	-	-	-
87		<i>Oscillatoria tenuis</i>	-	-	-	-	-	-	11	10,00
88		<i>Oscillatoria sp</i>	11	4,72	-	-	1	2,04	-	-
89		<i>Phormidium tenue</i>	-	-	-	-	-	-	4	3,64
90		<i>Phormidium sp</i>	-	-	-	-	-	-	-	-
91		<i>Planktothrix sp</i>	-	-	20	9,57	-	-	-	-
92		<i>Dactilococcopsis Smithii</i>	-	-	-	-	-	-	-	-
							-	-		
	<b>Dinophyta</b>									
93		<i>Ceratium hirudinella</i>	-	-	-	-	-	-	-	-
94		<i>Peridinium cinctum</i>	3	1,29	-	-	-	-	1	0,91
95		<i>Peridinium incospicuum</i>	-	-	3	1,44	-	-	-	-
							-	-		
	<b>Cryptophyta</b>									
96		<i>Rhodomonas sp</i>	-	-	-	-	-	-	-	-
97		<i>Cryptomonas sp</i>	-	-	3	1,44	-	-	1	0,91
	<b>Euglenophyta</b>		-	-	-	-	-	-	-	-

NO	Pylum	Spesies	RW.01 PL		RW.02 PL		RW.03 PL		RW.03B	
			Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)	Abundance (Individu/L)	Abundance Relatif (%)
98		<i>Euglena texta</i>	-	-	-	-	-	-	49	44,55
99		<i>Euglena acus</i>	-	-	3	1,44	-	-	-	-
100		<i>Euglena proxima</i>	2	0,86	3	1,44	-	-	1	0,91
101		<i>Euglena gracilis</i>	-	-	-	-	-	-	-	-
102		<i>Euglena oxyuris</i>	-	-	-	-	-	-	-	-
103		<i>Phacus orbicularis</i>	2	0,86	-	-	-	-	-	-
104		<i>Phacus spp</i>	2	-	3	1,44	-	-	1	0,91
105		<i>Strombomonas</i>	-	-	-	-	-	-	-	-
106		<i>Trachelomonas horrida</i>	3	1,29	9	4,31	-	-	-	-
107		<i>Trachelomonas charkowiensis</i>	-	-	-	-	-	-	-	-
108		<i>Trachelomonas superba</i>	-	-	3	1,44	-	-	-	-
109		<i>Trachelomonas scabra var. longicolis</i>	-	-	-	-	-	-	-	-
110		<i>Trachelomonas voconica</i>	-	-	3	1,44	-	-	-	-
111		<i>Trachelomnas spp</i>	-	-	9	4,31	-	-	10	9,09
Total Individu			233	99,1416309	209	100	49	100	110	100
Total Spesies			36	35	29	29	12	13	22	22
Diversity Index (H')			2,942		2,789		1,644		2,051	
Evenness Index (E)			0,821		0,828		0,662		0,664	

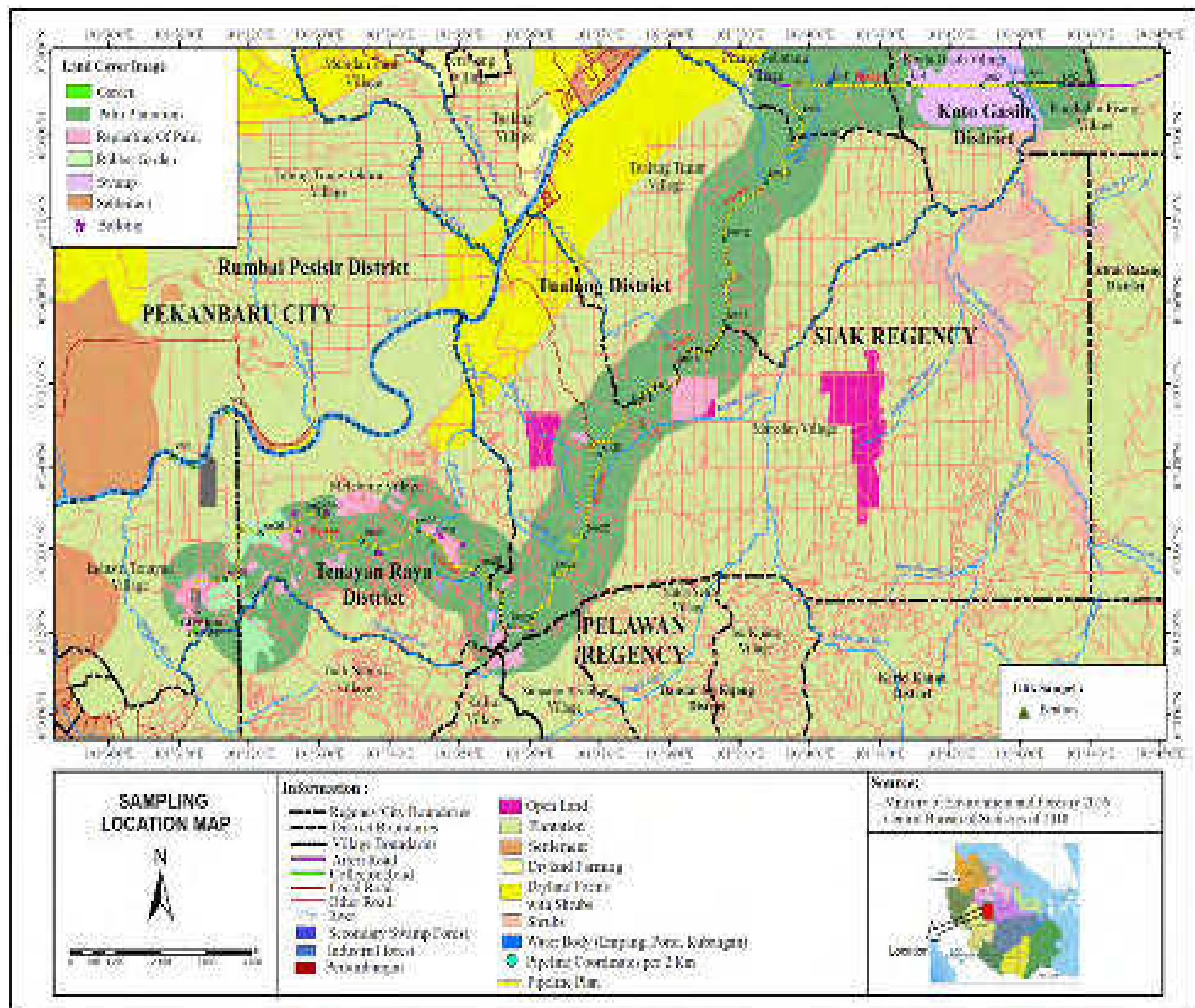


Figure 3-8. **Benthic Sampling Location**

The sediment test results shown in Table 3-6 are not indicating excessive metal content, exceeding the DIV threshold, except cooper which shows that the waters are contaminated lightly.

**Table 3-6. Sediment Analysis result (Power Plant Site)**

No	Parameter	Unit	Detection Limit	DIV Threshold	Analysis Result				Methode
					WQ 2 PP	WQ 3 PP	WQ 4 PP	WQ 5 PP	
A.	Heavy Metals								
1.	Mercury	mg/Kg	0.05	0.5	0,05	0.06	0.14	<0,05	APHA 3112 B
2.	Arsenic	mg/Kg	1	55	4.98	7.01	4.93	1,67	APHA 3112 B
3.	Boron	mg/Kg	5	-	<5.00	<5.00	<5.00	<5,00	APHA 3112 B
4.	Cadmium	mg/Kg	1	2	<1.00	<1.00	<1.00	<1,00	APHA 3120 B
5.	Chromium	mg/Kg	1	380	9.15	9.54	12.1	10,8	APHA 3120 B
6.	Copper	mg/Kg	1	35	3.31	3.41	4.00	5,43	APHA 3120 B
7.	Iron	mg/Kg	5	-	14500	15900	9250	6460	APHA 3120 B
8.	Lead	mg/Kg	1	530	14.9	15.5	10.5	8,74	APHA 3120 B
9.	Manganese	mg/Kg	1	-	265	269	64.4	46,2	APHA 3120 B
10.	Nickel	mg/Kg	1	35	4.98	5.23	4.00	3,76	APHA 3120 B
11.	Zinc	mg/Kg	5	480	26.5	27.4	25.6	42	APHA 3120 B
B.	Organic								
12.	Polynuclear Aromatic Hydrocarbon	mg/Kg	1		<1,0	<1,0	<1,0	<1,0	USEPA 8270C
13.	Polychlorinated BiPhenyls	mg/Kg	0.25		<0.25	<0.25	<0.25	<0.25	USEPA 8270C
14.	Chlordane	mg/Kg	0.5		<0,5	<0,5	<0,5	<0,5	USEPA 8270C
15.	Endosulfan	mg/Kg	0.5		<0,5	<0,5	<0,5	<0,5	USEPA 8270C
16.	Diedrin	mg/Kg	0.5		<0,5	<0,5	<0,5	<0,5	USEPA 8270C
17.	DDT	mg/Kg	1		<1,0	<1,0	<1,0	<1,0	USEPA 8270C
18.	Mirex	mg/Kg	-		-	-	-	<0.001	USEPA 8270C

WQ 2 PP: Upstream Siak Rievr; Coordinate: N= 00°34'10,1" E= 101°30'47,0"

WQ 3 PP: Downstream Siak River; Coordinate: N= 00°34'01,1" E= 101°31'16,4"

WQ 4 PP: Siak River; Coordinate: N= 00°33'37,7" E= 101°30'19,6"

WQ 5 PP: Siak River; Coordinate: N= 00°34'40.14" E= 101°31'39.28"

**Table 3-7. Sediment Analysis result (Pipe Line)**

No	Parameter	Unit	Detection Limit	DIV Threshold	Analysis Result		Methode
					RW 01 PL	RW 02 PL	
A.	Heavy Metals						
1.	Mercury	mg/Kg	0.05	0.5	0.10	0.12	APHA 3112 B
2.	Arsenic	mg/Kg	1	55	1.80	3.13	APHA 3120 B
3.	Boron	mg/Kg	5	-	<5.00	<5.00	APHA 3120 B
4.	Cadmium	mg/Kg	1	2	<1.00	<1.00	APHA 3120 B
5.	Chromium	mg/Kg	1	380	18.4	24.7	APHA 3120 B
6.	Copper	mg/Kg	1	35	2.34	2.44	APHA 3120 B
7.	Iron	mg/Kg	5	-	16900	14600	APHA 3120 B

No	Parameter	Unit	Detection Limit	DIV Threshold	Analysis Result		Methode
					RW 01 PL	RW 02 PL	
8.	Lead	mg/Kg	1	530	5.09	6.14	APHA 3120 B
9.	Manganese	mg/Kg	1	-	17.8	11.4	APHA 3120 B
10.	Nickel	mg/Kg	1	35	1.86	2.51	APHA 3120 B
11.	Zinc	mg/Kg	5	480	12.7	11.7	APHA 3120 B
<b>B.</b>	<b>Organic</b>						
12.	Polynuclear Aromatic Hydrocarbon	mg/Kg	1		<1,0	<1,0	USEPA 8270C
13.	Polychlorinated BiPhenyls	mg/Kg	0.25		<0.25	<0.25	USEPA 8270C
14.	Chlordane	mg/Kg	0.5		<0,5	<0,5	USEPA 8270C
15.	Endosulfan	mg/Kg	0.5		<0,5	<0,5	USEPA 8270C
16.	Dieldrin	mg/Kg	0.5		<0,5	<0,5	USEPA 8270C
17.	DDT	mg/Kg	1		<1,0	<1,0	USEPA 8270C
18.	Mirex	mg/Kg	-		<0.001	<0.001	USEPA 8270C

RW 01 PL : River Gasip; Coordinate: N= 00°38'36.37" E= 101°43'05.34"

RW 02 PL : River Gasip; Coordinate: N= 00°38'35.49" E= 101°42'28.40"

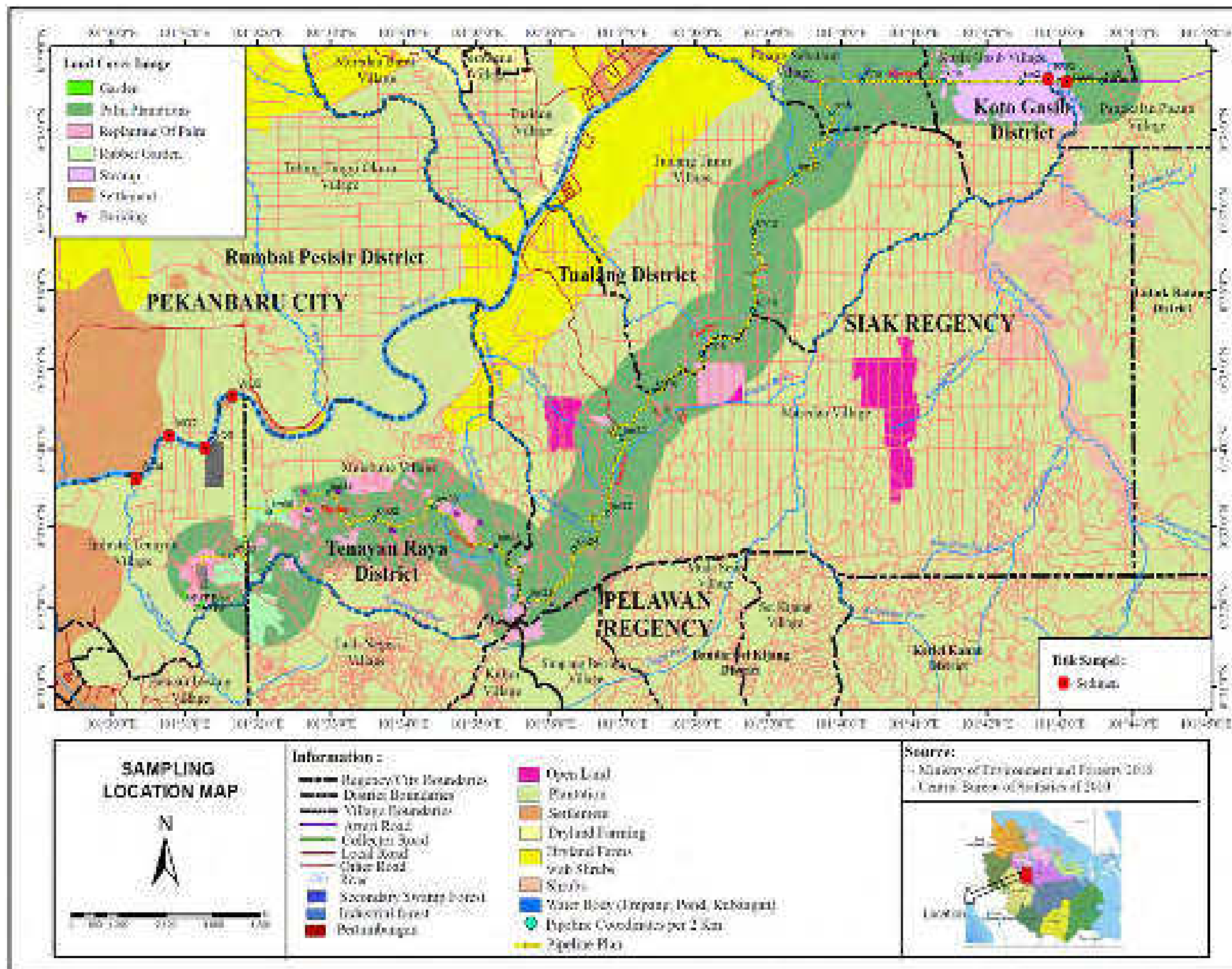


Figure 3-9. Sediment Sampling Location

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### 3.1.3.2 Net Fishing

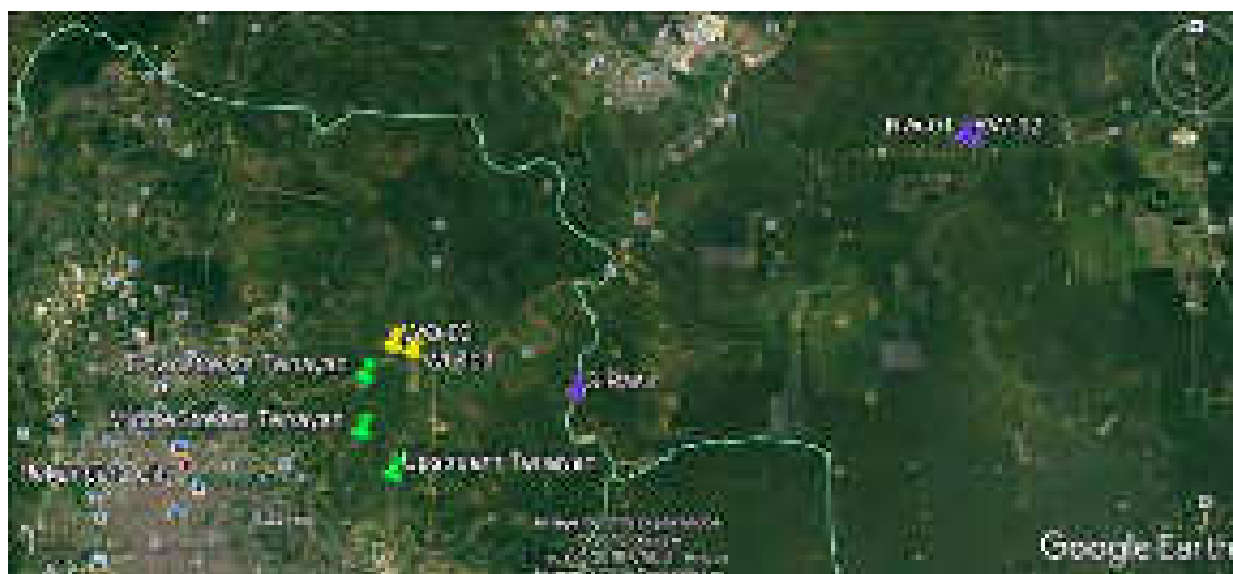
Fish community plays an important role in the life of aquatic organism and as a supporter of biodiversity in the ecosystem. The fish community is part of the food chain in a natural ecosystem having an important ecological function as the life cycle of the biological interaction processes present in the ecosystem. Fish for human life has a very important. The fish can be as a source of protein, medicine activities aquaculture activities, and has a function as recreational value as a sport fishing, ornamental fish trade. For its life, fish depends on the condition of the water habitat suitable for its life. Presently the water quality and habitat conditions, have suffered extensive water damage due to various human activities, and over exploitation is a major issue in maintaining the sustainability of fish resources.

Siak River is located in Riau Province has known as habitat of various types of fish. According to Aryani (2015) there are 260 species of fish in inland waters in Riau Province, where on Siak River recorded 36 species, Kampar Kiri river 86 species, Kampar Kanan river 58 species. The existence of fish communities in several rivers are reported to have decreased. According to Aryani (2015) She states some of the main issues causing the decline of fish biodiversity in Riau province are: extensification and intensification of oil palm plantations which have a negative impact on water quality of the river, waste from anthropogenic activities, sand mining, river damming, and non-selective fishing, also fish cage culture and invasive alien species.

Baseline fish community study in Siak River, Tenayan River and Pipe Line Area at Gasip Distrik is one of the efforts to find out the condition of fish communities that exist presently. The result of study can be basic information in determining the policy of development management around the study area. With this study we hope we can provide basic information about fish communities, such as, number of fish species, fish family, the fish diversity index, Evenness index and Dominance index.

## MATERIALS AND METHODS

Fish were collected at 6-10 and 22-24 February 2018 as represented of wet season. The sampling location followed the aim of research as well as to provide of baseline study about fish community in PLTU-Tenayan. The sampling location are 2 site on Siak River (WQ-02, WQ-03) and, 3 sites on Tenayan River (Downstream, Middle stream and Upstream of Tenayan river) and 3 sites on pipe line area at Gasip Distrik (RW-01, RW-02 and S.Pasir). The coordinate position and sampling maps can see on Figure 1 and Table 1.



**Figure 3-10.** Location of sampling fish in Siak River, Tenayan River and Pipe Line Area at Gasip Distrik, Pekanbaru

**Table 3-8.** GPS Coordinate of sampling location in Siak River, Tenayan River and Pipe Line Area at Gasip Distrik, Pekanbaru

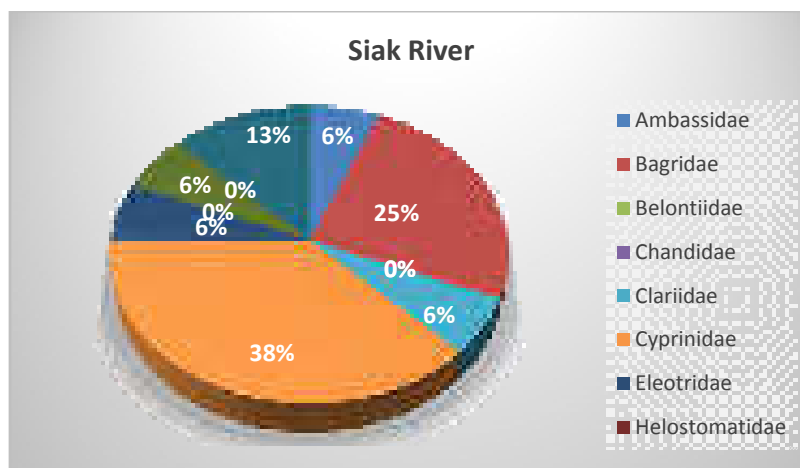
No	Sampling Location	Coordinate	
		Latitude	Longitude
Siak River			
1	Upstream (WQ-02)	N: 0°34'10.14"	E: 101°30'46.99"
2	Downstream (WQ-03)	N: 0°34'01.11"	E: 101°31'16.42"E
Tenayan River			
1	Upstream	N: 0°31'33.07"	E: 101°30'56.05"
2	Middle stream	N: 0°32'23.54"	E: 101°30'16.12"
3	Downstream	N: 0°33'31.58"	E: 101°30'17.75"
Pipe Line Area			
1	RW-01	N: 0°38'36.46"	E: 101°43'06.31"
2	RW-02	N: 0°38'36.42"	E: 101°42'51.95"
3	Sungai Pasir	N: 0°33'10.03"	E: 101°34'36.97"

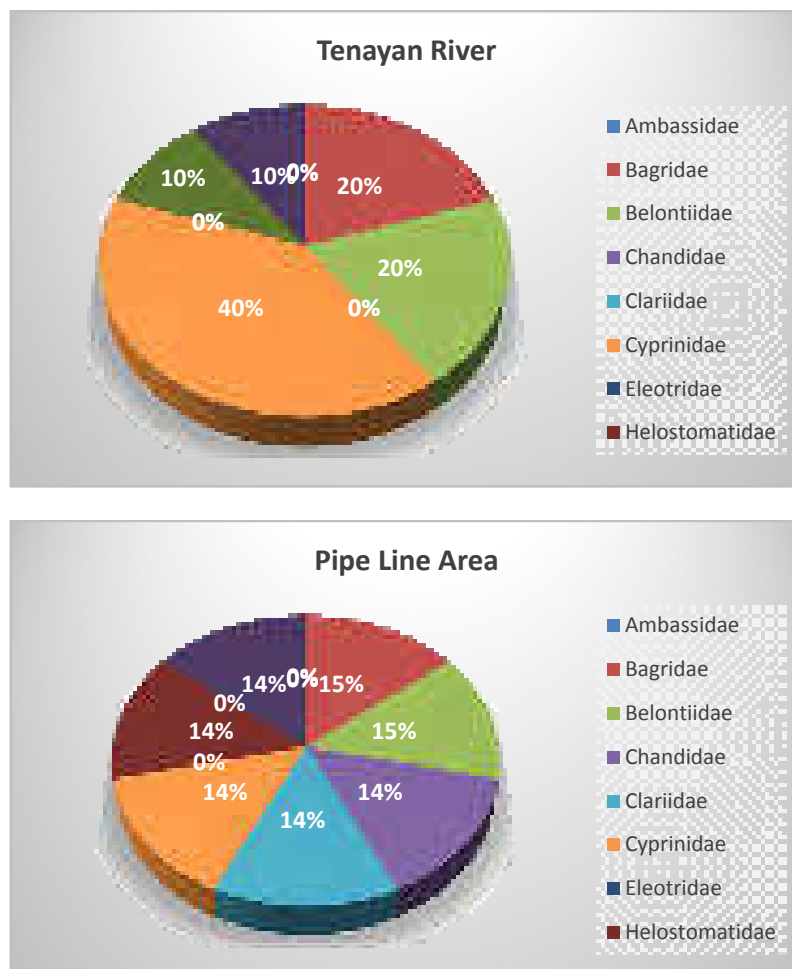
All fishes were captured by using several fishing gear such as experimental gill nets, cast net, hand net and fish net trap. The experimental gill nets have mesh size 1 inch, 2 inch and 3 inch with approximately 35 m of length and 2 m wide. Fish net trap has dimension 0.3 x 0.5 x 7 m with mesh size of nets is 0.5 inch. The gill nets were installed at littoral zone of the river during a day and stay approximately up to 2-3 hours. Cash net and hand net operated also during a day to catch the fishes at surrounding places at each sampling location. While the fish net trap installed at evening-morning as a represented of fish that has activities at the night. All captured fishes were labelled accordingly and placed in a cool box. Each fish

were then measured for its total length and weight, and have been carefully preserved with formalin 10%. Several individual fish from each species were kept as specimens for identification at Laboratory in Research Center for Limnology, LIPI Bogor West Java. The identification based on standard taxonomy key using several guidelines and references (Weber & Beaufort, 1913,1916,1922; Kottelat et al. 1993; Petrus et al. 2008; Iqbal 2011; Pulungan 2011; Aryani 2015; Purnama & Yolanda. 2016; and [www.fishbase.org](http://www.fishbase.org)). Data analyzing for knowing the fish community condition were using diversity index-Shannon-Wiener (Odum 1971 in Suprpto 2014), dominance index and the evenness index (Pielou 1976 in Suprpto 2014).

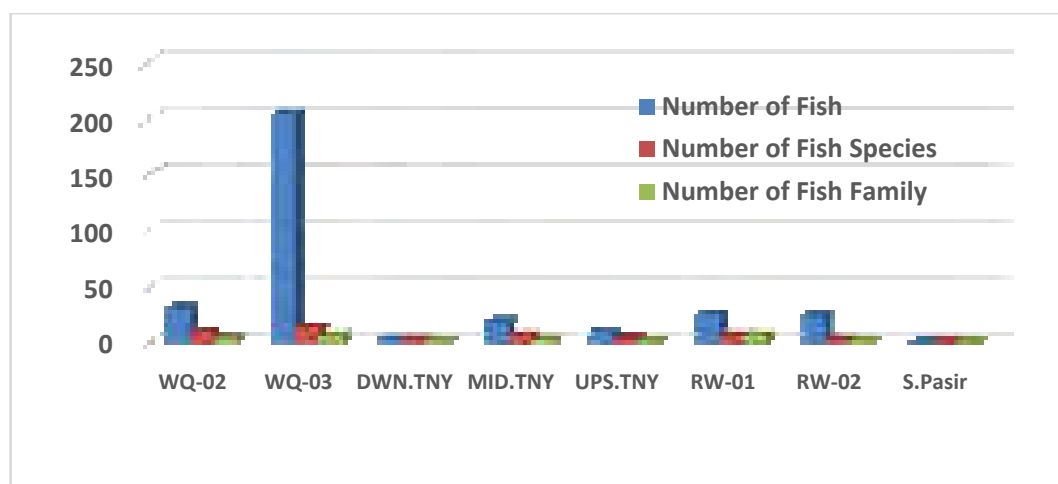
## RESULTS AND DISCUSSIONS

Number of fishes collected during the study were 318 fishes, which comprises of 11 families and 26 species. Cyprinidae was the dominant fish family with 9 species, followed by Bagridae with 4 species and Belontiidae with 3 species. The other families were represented by one to two species only such as Ambassidae, Chandidae, Elotridae, Helostomatidae, Pangasiidae, Pristolepididae, Clariidae and Siluridae. WQ-03 as a downstream of Siak River has the highest number of fish with total fish caught 204 fishes, with comprises of 7 families and 14 fish species. At Tenayan River, downstream sampling location has the lowest number of fish, with total fish caught 3 fishes with comprises of 2 families and 3 fish species. Based on fish family composition (Figure 2), At Siak river Cyprinidae was (38%), Bagridae 25%, Siluridae 13%, Elotridae 6%, Ambassidae 6%, and Pangasiidae 6%. At Tenayan river Cyprinidae was 40%, Bagridae 20%, Belontiidae 20%,Pangasiidae and Pristolepididae respectively 10%. At Pipe Line area fish family presentation respectively equal, Bagridae (14%), Belontiidae (14%) Chandidae (14%), Clariidae (14%), Cyprinidae (14%), Helostomatidae (14%) and Pristolepididae (14%). During the study no fish can found in the Sungai Pasir. Comparison of number of fish, fish species and fish family at each sampling location are shown in figure 3 and figure 4 are shown a composition of fish family.

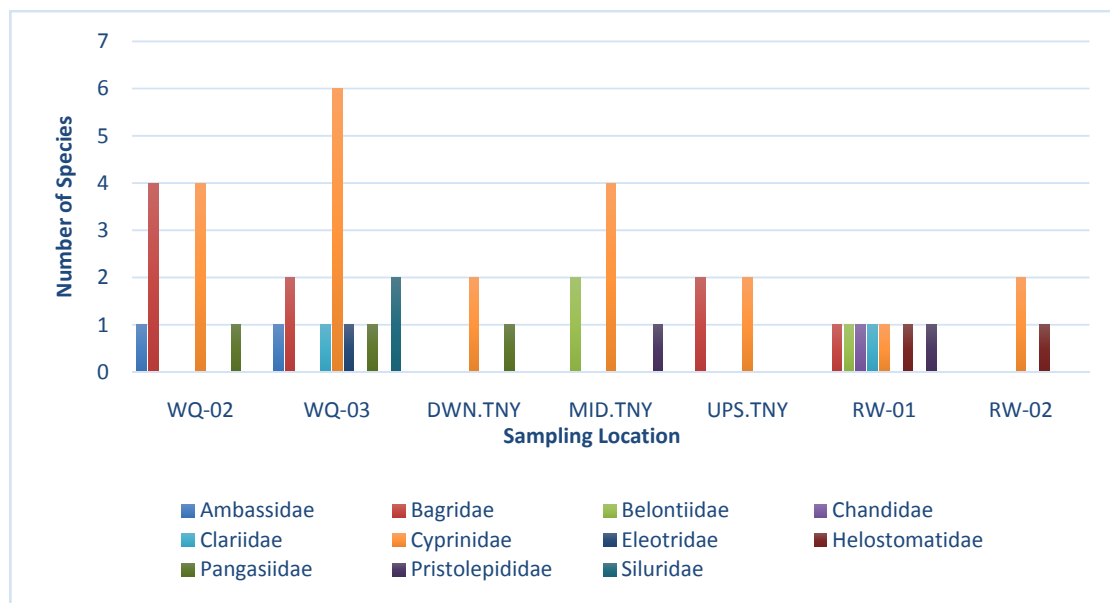




**Figure 3-11.** Presentation of fish family based on number of fish species at each mainly sampling location



**Figure 3-12.** Comparison of number of fish, fish species and fish family at each sampling location



**Figure 3-13.** Fish family assemblage composition at each sampling location

The assemblage family of Cyprinidae are Amblyrhynchichthys truncates, Barbodes schwanenfeldii, Cyclocheilichthys apogon, Hampala macrolepidota, Osteochilus hasseltii, Oxygaster anomalura, Puntius gemellus and Rasbora argyroteaenia. In Siak River Amblyrhynchichthys truncates, Rasbora argyroteaenia and Hampala macrolepidota were found abundant (Table 2). In Tenayan River especially on middle stream location, Cyclocheilichthys apogon, Osteochilus hasseltii and Hampala macrolepidota were found abundant (Table 3). In Pipe line area especially on RW-02 Puntius gemellus was found most abundant (92%) (Table 4)

The assemblage family of Bagridae are Bagrichthys macracanthus, Hemibagrus nemurus, Mystus nigriceps and Mystus singaringan. In Siak river especially on upstream (WQ-02) Hemibagrus nemurus was found most abundant (19.35%). In Tenayan river, upstream location Hemibagrus nemurus was found also abundant (30%). While in Pipe line area (RW-01) Mystus singaringan was found abundant (7.69%).

Pangasius polyranodon from family Pangasiidae known as local name Juaro was most abundant in Siak River (WQ-03 and WQ-02). The abundance relative the fish are 77.45% and 12.90% (Table 2). The fish that found in the least of fish number are Bagrichthys macracanthus, Puntius gemellus, Kryptopterus minor, Trichogaster pectoralis, Trichogaster trichopterus, and Oxyeleotris marmorata. The fishes that can caught only one fish each location with relative abundance 0.49-33%.

The fish diversity index in Siak River was ranged from 1.031-2.097, Tenayan River was ranged from 1.099-1.663 and Pipe Line Area was ranged from 0.334-1.809. While from Evenness Index in Siak River was ranged from 0.391-0.911, Tenayan River was ranged from 0.843-1.00 and Pipe Line Area was ranged from 0.304-0.930 Otherwise the dominance index Siak River was ranged from 0.138-0.607, Tenayan River was ranged from 0.224-0.360 and Pipe Line Area was ranged from 0.186-0.850 (Figure 4). The fish diversity condition in Siak River and Tenayan River were moderate. However the fish diversity condition in Pipe Line Area are low-moderate. According to Krebs (1989) fish communities in these waters are in a diversity category

"Moderate", since the value of H' is in the range of 1-3, Low diversity with the value of H' <1, and High diversity with the value of H' >3. According to Hatauruk et al. 2016, as a comparison in a similar study in Sibam River Pekanbaru Riau value index of fish diversity (H') fish found during the study ranged from 2.709-3.853, Evenness index value (E) fish ranged from 0.719-0.844 and fish dominance index value (C) ranged from 0.096-0.183

If we see the Evenness index value of Siak River illustrates the nature of the spread among the species of fish in the waters is medium, and in Tenayan River was high, while in Pipe Line Area was low. The Evenness index also has correlation to the Dominance index, whereas if the Evenness index is high, the Dominance index will has low value, its mean there are no fish species that dominate the other fish species that live in these waters. Actually we can see at the sampling location with high dominance index such as RW-02 (Pipe Line Area) and WQ-03 (Downstream Siak River) there are fish with abundance relative was higher such as *Pangasius polyranodon* (77.45%) in WQ-03 and *Puntius gemellus* (92%) in RW-02.

**Table 3-9.** List of fish species in Siak River during Wet Season on February 2018

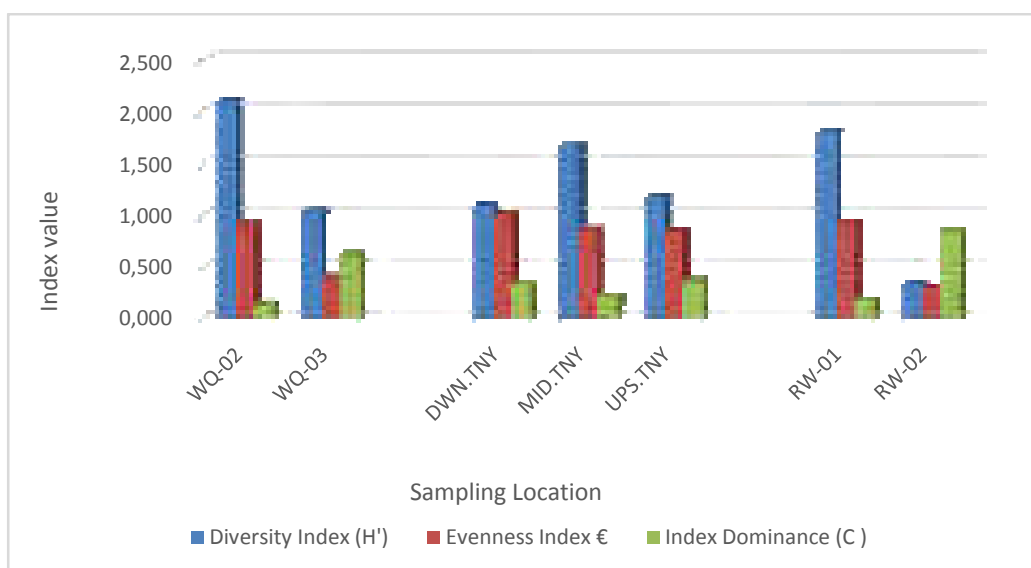
No	Family	Species	Local Name	Siak River			
				WQ-02	Relative Abundance (%)	WQ-03	Relative Abundance (%)
1	Ambassidae	<i>Parambassis siamensis</i>	Sepongkah	4	12.90	13	6.37
2	Bagridae	<i>Bagrichthys macracanthus</i>	Pampang Lahung	1	3.23	-	-
3		<i>Hemibagrus nemurus</i>	Baung duri,tageh	6	19.35	3	1.47
4		<i>Mystus nigriceps</i>	Baung sangiring	1	3.23	-	-
5		<i>Mystus singaringan</i>	Baung Tunggik	1	3.23	1	0.49
6	Belontiidae	<i>Trichogaster trichopterus</i>	Sepat rawa	-	-	-	-
7		<i>Trichogaster pectoralis</i>	Sepat siam	-	-	-	-
8		<i>Trichopsis vittata</i>	Cupang,tampelo	-	-	-	-
9	Chandidae	<i>Channa micropeltes</i>	Toman	-	-	-	-
10	Clariidae	<i>Clarias batrachus</i>	Lele	-	-	1	0.49
11		<i>Clarias leiacanthus</i>	Limbati	-	-	-	-
12	Cyprinidae	<i>Amblyrhynchichthys truncatus</i>	Betet, Kedukul	6	19.35	5	2.45
13		<i>Barbodes schwanenfeldii</i>	Kapiek	3	9.68	2	0.98
14		<i>Cyclocheilichthys apogon</i>	Siban	-	-	2	0.98
15		<i>Hampala macrolepidota</i>	Barau	-	-	4	1.96
16		<i>Osteochilus hasseltii</i>	Paweh	-	-	-	-
17		<i>Oxygaster anomalura</i>	Pimpiang	-	-	1	0.49
18		<i>Puntioplites bulu</i>	Tabingalan	1	3.23	-	-
19		<i>Puntius gemellus</i>	Kemuringan	-	-	-	-
20		<i>Rasbora argyrotaenia</i>	Bada	4	12.90	5	2.45
21	Eleotridae	<i>Oxyeleotris marmorata</i>	Betutu	-	-	1	0.49
22	Helostomatidae	<i>Helostoma temminckii</i>	Tambakang	-	-	-	-
23	Pangasiidae	<i>Pangasius polyranodon</i>	Juaro	4	12.90	158	77.45
24	Pristolepididae	<i>Pristolepis grooti</i>	Katung	-	-	-	-
25	Siluridae	<i>Kryptopterus lais</i>	Lais	-	-	7	3.43
26		<i>Kryptopterus minor</i>	Lais	-	-	1	0.49
Total fishes				31	100	204	100
Number of Species				10		14	

**Table 3-10.** List of fish species in Tenayan River during Wet Season on February 2018

No	Family	Species	Local Name	Tenayan River					
				DWN.TNY	Relative Abundance (%)	MID.TNY	Relative Abundance (%)	UPS.TNY	Relative Abundance (%)
1	Ambassidae	<i>Parambassis siamensis</i>	Sepongkah	-	-	-	-	-	-
2	Bagridae	<i>Bagrichthys macracanthus</i>	Pampang Lahung	-	-	-	-	-	-
3		<i>Hemibagrus nemurus</i>	Baung duri,tageh	-	-	-	-	3	30.00
4		<i>Mystus nigriceps</i>	Baung sangiring	-	-	-	-	-	-
5		<i>Mystus singaringan</i>	Baung Tunggak	-	-	-	-	1	10.00
6	Belontiidae	<i>Trichogaster trichopterus</i>	Sepat rawa	-	-	1	5.26	-	-
7		<i>Trichogaster pectoralis</i>	Sepat siam	-	-	1	5.26	-	-
8		<i>Trichopsis vittata</i>	Cupang,tampelo	-	-	-	-	-	-
9	Chandidae	<i>Channa micropeltes</i>	Toman	-	-	-	-	-	-
10	Clariidae	<i>Clarias batrachus</i>	Lele	-	-	-	-	-	-
11		<i>Clarias leiacanthus</i>	Limbati	-	-	-	-	-	-
12	Cyprinidae	<i>Amblyrhynchichthys truncatus</i>	Betet, Kedukul	-	-	-	-	-	-
13		<i>Barbodes schwanenfeldii</i>	Kapiek	-	-	-	-	-	-
14		<i>Cyclocheilichthys apogon</i>	Siban	-	-	6	31.58	1	10.00
15		<i>Hampala macrolepidota</i>	Barau	-	-	4	21.05	-	-
16		<i>Osteochilus hasseltii</i>	Paweh	1	33.33	5	26.32	5	50.00
17		<i>Oxygaster anomalura</i>	Pimpiang	-	-	-	-	-	-
18		<i>Puntioplites bulu</i>	Tabingalan	-	-	-	-	-	-
19		<i>Puntius gemellus</i>	Kemuringan	-	-	-	-	-	-
20		<i>Rasbora argyrotaenia</i>	Bada	1	33.33	1	5.26	-	-
21	Eleotridae	<i>Oxyeleotris marmorata</i>	Betutu	-	-	-	-	-	-
22	Helostomatidae	<i>Helostoma temminckii</i>	Tambakang	-	-	-	-	-	-
23	Pangasiidae	<i>Pangasius polyranodon</i>	Juaro	1	33.33	-	-	-	-
24	Pristolepididae	<i>Pristolepis grooti</i>	Katung	-	-	1	5.26	-	-
25	Siluridae	<i>Kryptopterus lais</i>	Lais	-	-	-	-	-	-
26		<i>Kryptopterus minor</i>	Lais	-	-	-	-	-	-
<b>Total fishes</b>				3	100	19	100	10	100
<b>Number of Species</b>				3		7		4	

**Table 3-11.** List of fish species in Gas Pipe Area during Wet Season on February 2018

No	Family	Species	Local Name	Pipe Line Area					
				RW-01	Relative Abundance (%)	RW-02	Relative Abundance (%)	Sand River (S.Pasir)	Relative Abundance (%)
1	Ambassidae	<i>Parambassis siamensis</i>	Sepongkah	-	-	-	-	-	-
2	Bagridae	<i>Bagrichthys macracanthus</i>	Pampang Lahung	-	-	-	-	-	-
3		<i>Hemibagrus nemurus</i>	Baung duri,tageh	-	-	-	-	-	-
4		<i>Mystus nigriceps</i>	Baung sangiring	-	-	-	-	-	-
5		<i>Mystus singaringan</i>	Baung Tunggik	2	7.69	-	-	-	-
6	Belontiidae	<i>Trichogaster trichopterus</i>	Sepat rawa	-	-	-	-	-	-
7		<i>Trichogaster pectoralis</i>	Sepat siam	-	-	-	-	-	-
8		<i>Trichopsis vittata</i>	Cupang,tampelo	2	7.69	-	-	-	-
9	Chandidae	<i>Channa micropeltes</i>	Toman	2	7.69	-	-	-	-
10	Clariidae	<i>Clarias batrachus</i>	Lele	-	-	-	-	-	-
11		<i>Clarias leiacanthus</i>	Limbat	3	11.54	-	-	-	-
12	Cyprinidae	<i>Amblyrhynchichthys truncatus</i>	Betet, Kedukul	-	-	-	-	-	-
13		<i>Barbodes schwanenfeldii</i>	Kapiek	-	-	-	-	-	-
14		<i>Cyclocheilichthys apogon</i>	Siban	-	-	-	-	-	-
15		<i>Hampala macrolepidota</i>	Barau	-	-	-	-	-	-
16		<i>Osteochilus hasseltii</i>	Paweh	-	-	-	-	-	-
17		<i>Oxygaster anomalura</i>	Pimpiang	-	-	1	4.00	-	-
18		<i>Puntioplites bulu</i>	Tabingalan	-	-	-	-	-	-
19		<i>Puntius gemellus</i>	Kemuringan	8	30.77	23	92.00	-	-
20		<i>Rasbora argyrotaenia</i>	Bada	-	-	-	-	-	-
21	Eleotridae	<i>Oxyeleotris marmorata</i>	Betutu	-	-	-	-	-	-
22	Helostomatidae	<i>Helostoma temminckii</i>	Tambakang	5	19.23	1	4.00	-	-
23	Pangasiidae	<i>Pangasius polyranodon</i>	Juaro	-	-	-	-	-	-
24	Pristolepididae	<i>Pristolepis grooti</i>	Katung	4	15.38	-	-	-	-
25	Siluridae	<i>Kryptopterus lais</i>	Lais	-	-	-	-	-	-
26		<i>Kryptopterus minor</i>	Lais	-	-	-	-	-	-
<b>Total fishes</b>				26	100	25	100	0	0
<b>Number of Species</b>				7		3		0	



**Figure 3-14.** Comparison of diversity index ( $H'$ ), evenness index ( $E$ ), and dominance index ( $C$ ) according to sampling sites.

**Table 3-12.** The value of diversity index ( $H'$ ), evenness index ( $E$ ), and dominance index ( $C$ ) according to sampling sites.

Sampling Location	Diversity Index ( $H'$ )	Evenness Index ( $E$ )	Index of Dominance ( $C$ )
<b>Siak River</b>			
Upstream (WQ-02)	2.097	0.911	0.138
Downstream (WQ-03)	1.031	0.391	0.607
<b>Tenayan River</b>			
Downstream (DWN.TNY)	1.099	1.000	0.333
Middle stream (MID.TNY)	1.663	0.855	0.224
Upstream (UPS.TNY)	1.168	0.843	0.360
<b>Pipe Line Area</b>			
RW-01	1.809	0.930	0.186
RW-02	0.334	0.304	0.850

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## CONCLUSIONS

Fish community in Siak River at wet season consists of 16 fish species, and 7 families. Fish diversity index in Siak River ranged from 1.031-2.097, Evenness index ranged from 0.391-0.911, and dominance index ranged from 0.138-0.607. Fish community in Tenayan River at wet season consists of 10 fish species, and 5 families. Fish diversity index in Tenayan River ranged from 1.099-1.663, Evenness index ranged from 0.391-0.911, and dominance index ranged from 0.224-0.360. Fish community in Pipe Line at wet season consists of 7 fish species, and 7 families. Fish diversity index in Pipe Line area ranged from 0.334-1.809, Evenness index ranged from 0.304-0.930, and dominance index ranged from 0.186-0.850. Cyprinidae is a dominant fish family with 9 species, while Juaro (*Pangasius polyranodon*) is a fish species that has high abundance in Siak river.



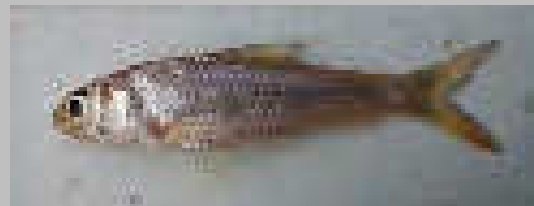
*Cyclocheilichthys apogon*, 110 mm TL



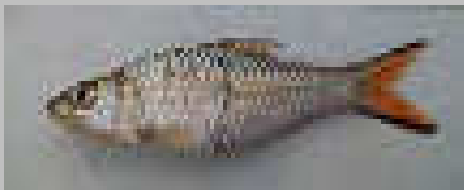
*Osteochilus hasseltii*, 143 mm TL



*Oxygaster anomalura*, 58 mm TL



*Amblyrhynchichthys truncates*, 110 mm TL



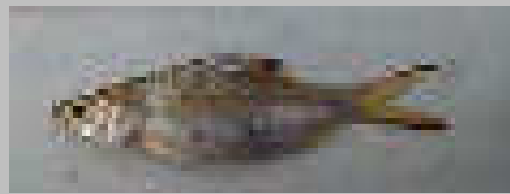
*Hampala macrolepidota*, 130 mm TL



*Parambassis siamensis*, 95 mm TL



*Rasbora argyrotaenia*, 150 mm TL



*Barbodes schwanenfeldii*, 80 mm TL



*Puntius gemellus*, 82 mm TL



*Puntioplites bulu*, 80 mm TL



*Kryptopterus lais*, 115 mm TL



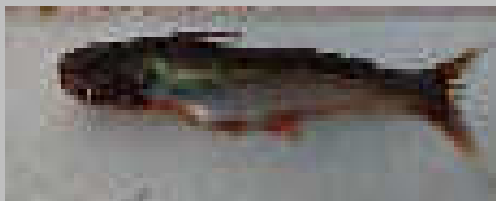
*Kryptopterus minor*



*Trichogaster pectoralis*, 155 mm TL



*Trichogaster trichopterus*, 78 mm TL



*Pangasius polyranodon*, 150 mm TL



*Oxyeleotris marmorata*, 220 mm TL



*Pristolepis grooti*, 90 mm TL



*Helostoma temminckii*, 92 mm TL



*Clarias leiacanthus*, 194 mm TL



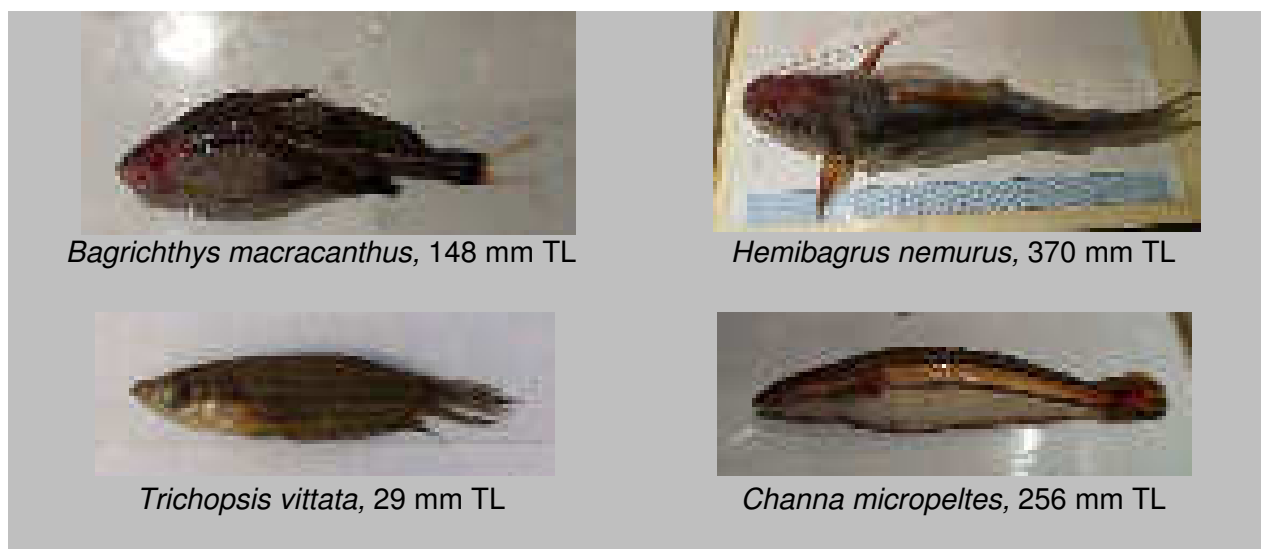
*Clarias batrachus*, 290 mm TL



*Mystus singaringan*, 124 mm TL



*Mystus nigriceps*, 120 mm TL



**Figure 3-15.** Some pictures of fishes from Siak River, Tenayan River and Pipe Line Area in Pekanbaru, Riau Province



**Gill net installation and the habitat condition at Upstream (WQ-02) in Siak River**



**Habitat condition at Downstream (WQ-03) in Siak River**



**Measuring fish (Total Length and Weight) and preparation for documentation**



**Middle Stream at Tenayan River**



**Fish net trap installation in Middle Stream Tenayan River**



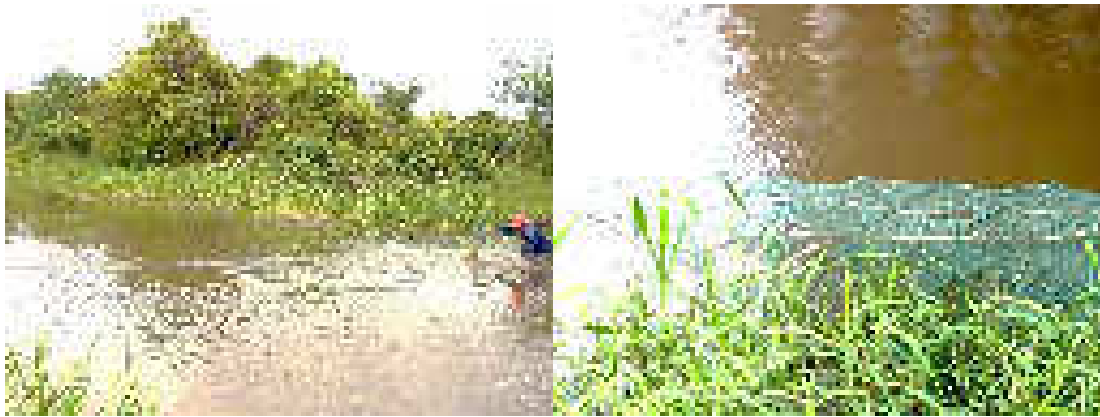
**Upstream Tenayan River and Fishing preparation using fish net trap**



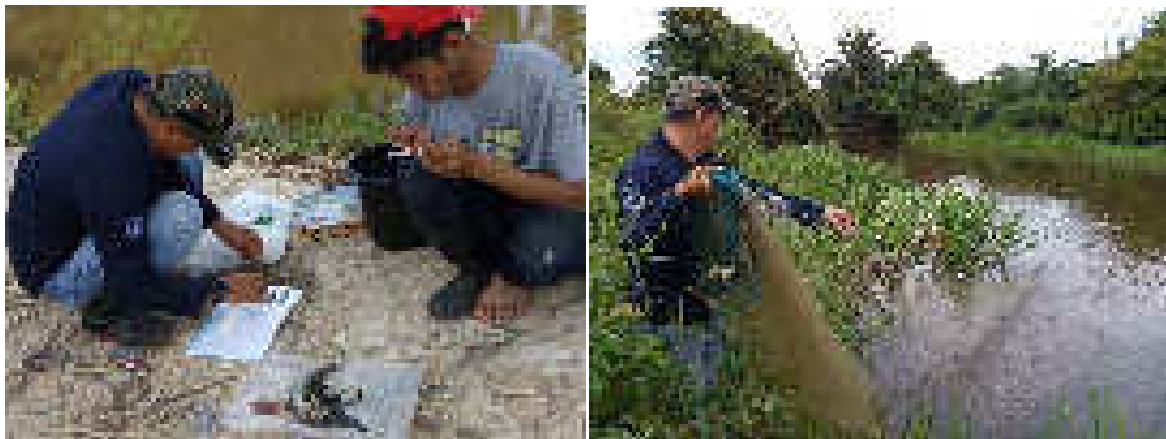
**Water condition of Sampling location at Pipe Line Area (RW-01)**



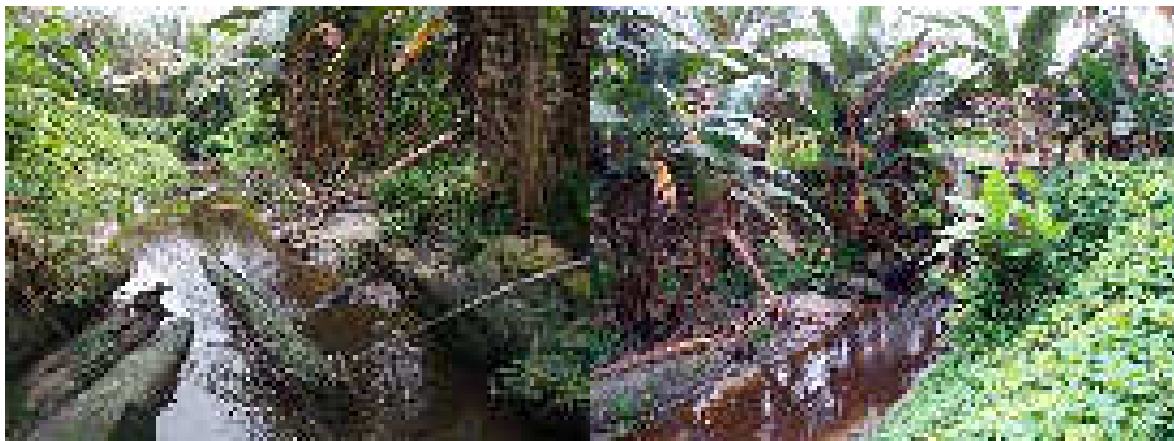
**Fishing operation using cash net in Pipe Line area (RW-01)**



**Fishing operation using gill nets and fish net trap in Pipe Line Area (RW-02)**



**Fish collection, preparation and labelling after fishing using gill nets in Pipe Line Area (RW-02)**



**Condition of Sungai Pasir as known a typical of gambut waters**



**Fishing fish using hand net and small trap in Sungai Pasir**

**Figure 3-16.** *Picture of fish habitat condition at sampling location in Siak River, Tenayan River and Pipe Gas Area in Pekanbaru, Riau Province*

## 4 TERRESTRIAL ECOLOGY

### 4.1 Flora

The procurement of SGPP facilities becomes a necessity to meet the needs of electricity in Pekanbaru and surrounding areas. The plan site is located in Tenayan Industrial Village, Tenayan Raya Sub-district, Pekanbaru City. Gas-fuel needs, for this power plant will be supplied from Taping Point & Gas Start Point in the Kuala Gasib village, Koto Gasib Sub-district, Siak District approximately 40 km from the SGPP construction plan. Gas supply is planned to be channeled through pipes to be built across six village areas, located within three districts and two districts / municipalities.

The construction of PLTGU facilities, water supply channel, and gas pipelines has the potential to change the landscape above it. The SGPP construction plan site, water supply channel and gas pipeline covers the forest area, settlement area, and agricultural cultivation area especially oil palm and rubber plantation.

#### 4.1.1 Work Method

##### 4.1.1.1 Research Location

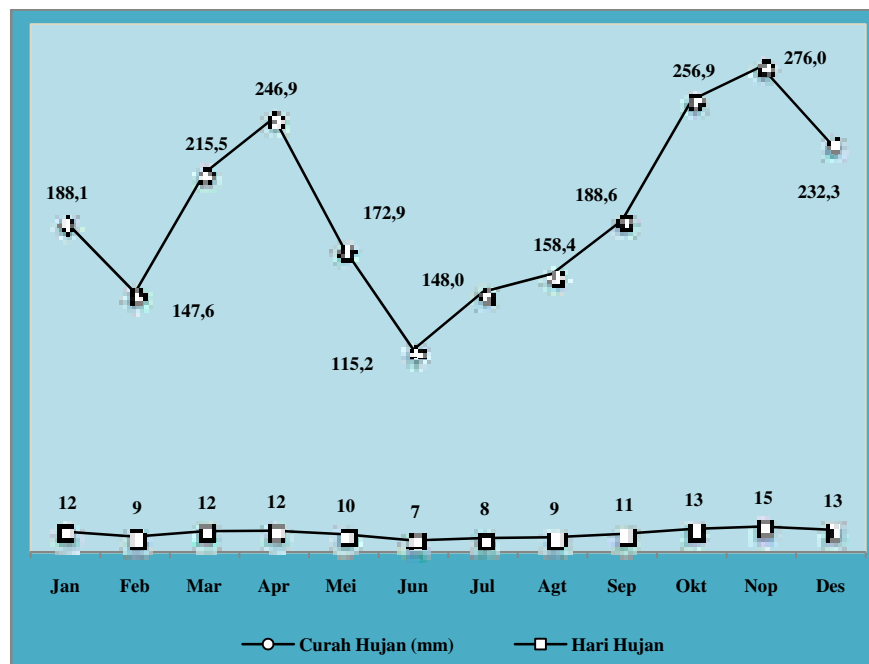
The research sites are: i) Gas pipeline construction plan site crossing Kuala Gasib Village, Koto Gasib Sub-district, Siak District; Pinang Sebatang and Bakal Village, Tualang Sub-district, Siak District; Melebung Village, Tenayan Raya Sub-district, Pekanbaru City; ii) Powerplant (SGPP) construction plan site in Industri Tenayan Village, Tenayan Raya Sub-district, Pekanbaru City; and iii) Water supply channel plan site in Industri Tenayan Village, Tenayan Raya Sub-district, Pekanbaru City.

Koto Gasib Sub-district has an area of 702.7 km<sup>2</sup> and covers 11 villages, among others is Kuala Gasib Village which is covering 12 percent of Sub-district's area (Koto Gasib-KDA, 2016). Tualang Sub-district has an area of 382,97 km<sup>2</sup> and covers nine villages, among others is Pinang Sebatang Village which is covering 11 percent of the sub-district's area (Tualang-KDA, 2016). On the early 2017 there was a village area expansion in Tualang Sub-district area, which was Bakal Village additioning. Tenayan Raya

Sub-district has an area of 171,27 km<sup>2</sup> and covers four villages, among other is Sail Village (now is Industri Tenayan Village) which is covering 58 percent of sub-district's area (Tenayan Raya-KDA,2016).

In general, the mainland's soil type in the research area is red-yellow podsolic, also organosol and glei humus which were formed in swamps and wetlands. Red-yellow podsolic were formed of acidic tufa, sand stone, and sand sediment as parent materials; slightly thick solum; a red to yellow color; various texture, lumpy structure, more to the bottom more solid; its consistency are firm to loose, more to the bottom more firm; pliant webbed aggregate; acidic to very acidic; low nutrient; permeability depends on parent material texture, slow to medium; large erosion sensitivity (Soepraptohardjo, 1978).

#### 4.1.1.2 Climate

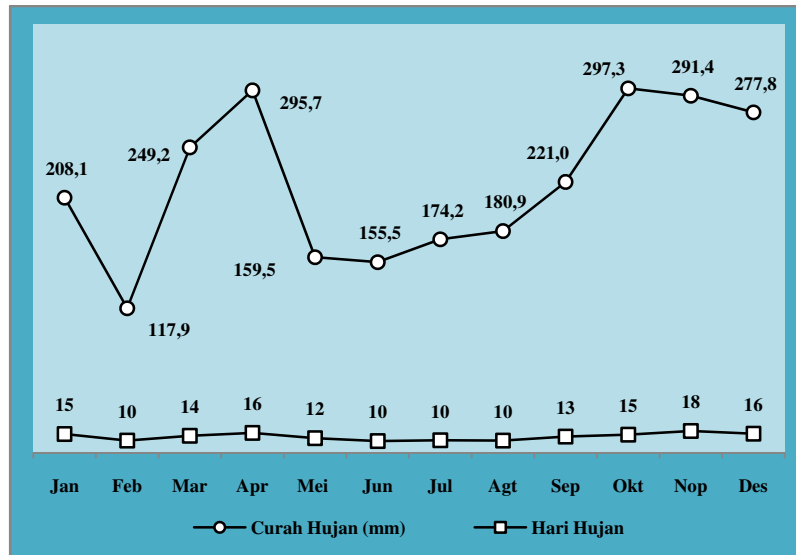


Source: Hydrology PW Office Station, Senapelan Sub-district, Pekanbaru. city

**Figure 4-1. Monthly average rainfall (mm) and monthly average rainy day in research area (1980-2013)**

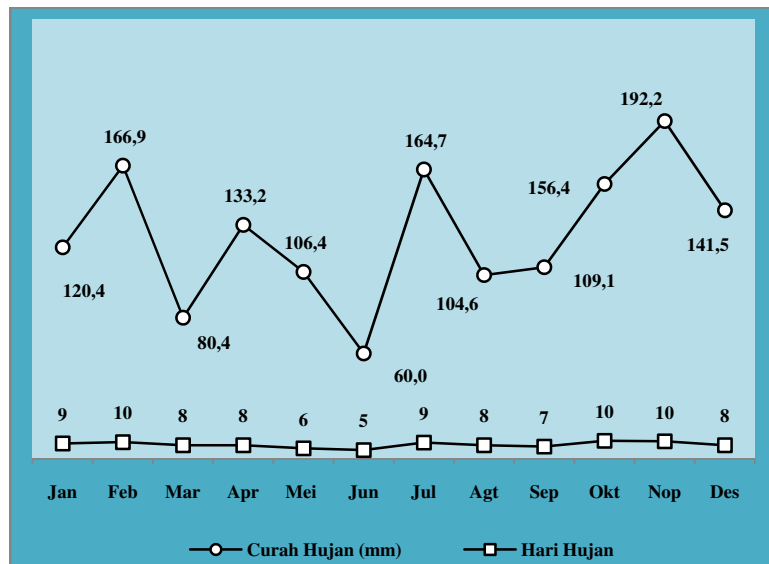
The climate condition depiction in research location obtained from monthly average rainfall and rainy days for 33 years (1980-2013) is presented in Figure 4-1. The monthly average number does not show any dry month (rainfall <60 mm) and tend to wet throughout the year (rainfall >100 mm), Q value of 0.079 which is classified into very wet, according to Schmidt Ferguson classification (Kartasapoetra, 1988). The highest rainfall average happened in October and November months (256,9 and 276,0 mm) and the lowest in June (115,2 mm), while the most average of rainy days happened in three months continuously, namely October, November, and December. Should there is a time spans shortening from the available 33 years data into four difference time spans, namely : three 10-years spans (1980-1989, 1990-1999, and 2000-2009) and four- years span (2010-2013), the Q value for those three 10-years span is around 0,037-0,074 and classified into type A-very wet. The Q value shifting tendency is shown in four-years span (2010-2013) as much 0,435 and classified into type C-lighly wet according to Schmidt Ferguson classification (Kartasapoetra, 1988).

On the data cut that become four time spans, It is found that the monthly average rainfall and rainy days are high throughout the year in the 10-years time span (2000-2009), while monthly average rainfall and rainy days are tend to drop much lower throughout the year of four-years span (2010-2013) (Figure 4-2 and 4-3). The occurrence of shifting tendency on rainfall and rainy days numebrs is need to be observed, but it can not be used as reference because the data's time span used is very short-only four years. Because of this symptom, at least 30 years of rainfall measurement is needed.



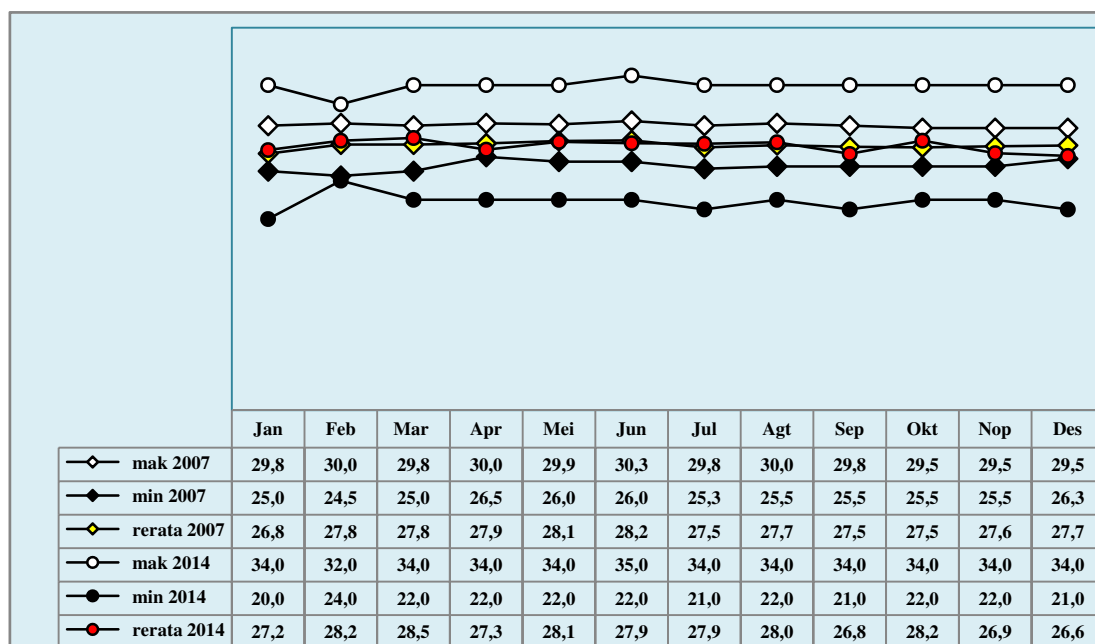
Source: Hydrology PW Office Station, Senapelan Sub-district, Pekanbaru city.

**Figure 4-2. Monthly average rainfall (mm) and monthly average rainy day in research area (2000-2009)**



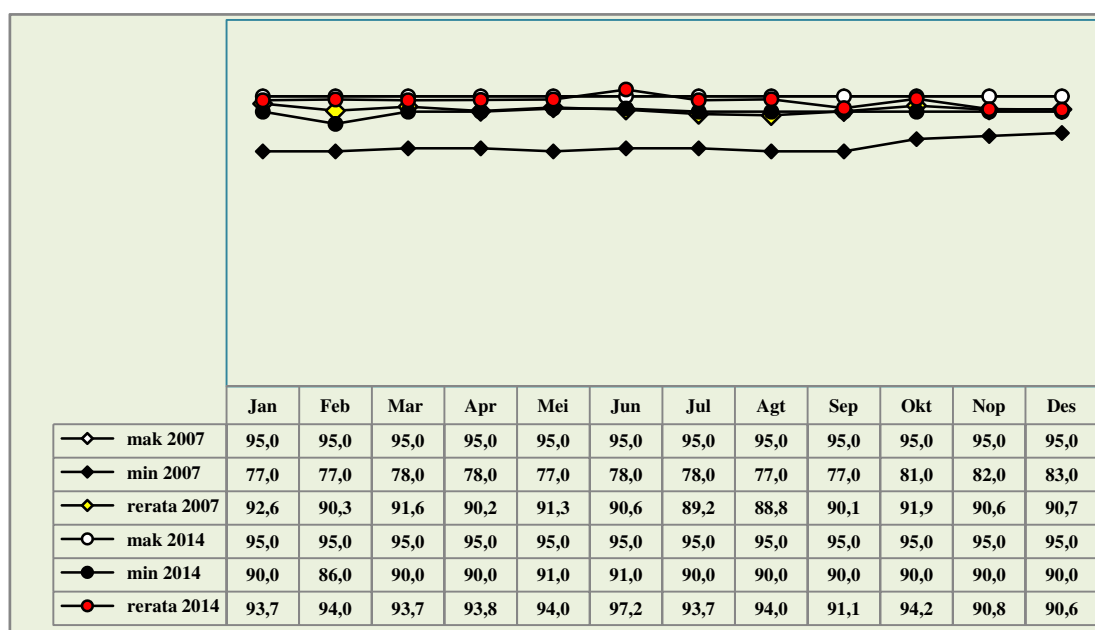
Source: Hydrology PW Office Station, Senapelan Sub-district, Pekanbaru. city

**Figure 4-3. Monthly average rainfall (mm) and monthly average rainy day in research area (2000-2013)**



Source: Makeshift Station, Koto Gasib Sub-district, Siak District

**Figure 4-4. Monthly average, maximum, and minimum temperature in research location year 2007 and 2014**



Source: Makeshift Station, Koto Gasib Sub-district, Siak District

**Figure 4-5. Monthly average, maximum, and minimum humidity in research location year 2007 and 2014**

Figure 4-4 shows the result of air temperature measurement (oC) on two measurement years with seven-years span, ie 2007 and 2014. In those span difference it was shown that in year 2014 the average monthly minimum temperature recorded is 20-24 oC and maximum is 34-35 oC. Seven years prior, in 2007, it was recorded that the monthly average minimum temperature was 25-26 oC and

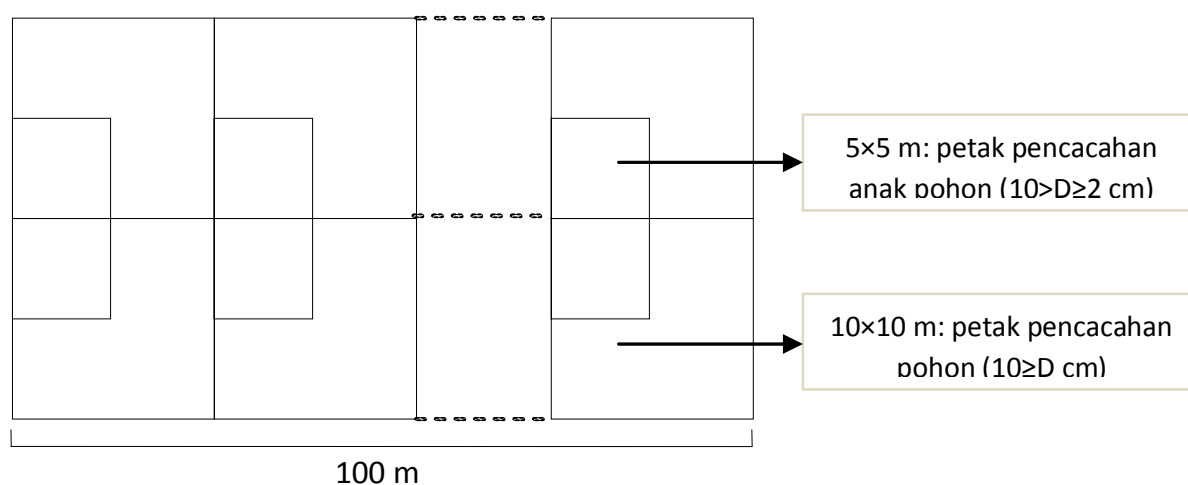
maximum 29-30 °C. This symptom shows that the monthly temperature swing in 2014 was wider (the monthly average difference between maximum and minimum temperature is 12.2 °C), in the previous seven years recorded 4.3 °C.

The condition of the air humidity at the study sites is shown in Figure 2b, covering two years of measurement ie 2007 and 2014. In Figure 4-5 it is seen that the monthly average on maximum humidity on the two-year measurement tends to be the same ie 95 percent, while the monthly average on minimum humidity of 2007 is measured lower ie 77-83 percent and in 2014 ranged from 86-91 percent. The difference gap of monthly average on maximum and minimum humidity in 2014 recorded was very short at 5.2 percent, while in the previous seven years it has a range of 16.4 percent. This symptom is worth noting because the monthly average on humidity during 2014 was very high at above 85 percent, the degree of humidity conducive to the growth of plant diseases, such as the fungus see Kartasapoetra (1988).

#### 4.1.2 Sampling Plot and Vegetation Data Analysis

##### 4.1.2.1 Sampling Plot

Sampling was conducted by placing 19 plots, covered i) 13 plots in pipeline construction plan site; ii) four plots on the SGPP construction and transmission line plan sites; and iii) two plots on water supply channel construction plan site. Each plot size was 20x100m, on that plot was made: i) 20 subplots of 10x10m for tree enumeration and ii) 20 subplots of 5x5m for saplings enumeration (Picture 3a). All the trees in the subplot were enumerated, breast height stem diameter was measured, and the height of free branches and crown height were measured. For the saplings, the diameter is measured as high as 30 cm above ground level. Lower plants or herbs are observed qualitatively. For information enrichment, qualitative observation was conducted around the sampling plot. A voucher specimen was taken from each measured tree and sapling for the sake of identification. Identification was done by comparing the evidence specimen with the herbarium collection by Ismail Rahman, Plant Taxonomy Expert who is affiliated with Herbarium Bogoriense, LIPI Bogor. The placement of the sampling plot takes into account the representation of the built and natural ecosystems, detailed placement of the sample plot shown in Picture 3b and Table 1. Nomenclature refers to The Plant List (2013).



**Figure 4-6. Vegetation Sampling Plot**

**Table 4-1. Sampling location, tabulation, and administration area of vegetation sampling plot placement in Siak District and Pekanbaru City**

Sampling Location	Tabulation	Administration Area	Remark
<b>1 Pipe Line Site</b>			
1.1 Main Road Side			
1 Segment 1 (Km 1-5)	1.1.1a	Kuala Gasib Vil., Koto Gasib Sub-dist., Siak District	Swamps
	1.1.1b	Kuala Gasib Vil., Koto Gasib Sub-dist., Siak District	Swamps
2 Segment 2 (Km 6-10)	1.1.2a	Pinang Sebatang Vil., Tualang Sub-dist., Siak District	Shrubs
	1.1.2b	Pinang Sebatang Vil., Tualang Sub-dist., Siak District	Rubber and Oil Plam Plantations mixed with natural types
3 Segment 3 (Km 11-15)	1.1.3	Pinang Sebatang Vil., Tualang Sub-dist., Siak District	Secondary forest mixed with rubber
4 Segment 4 (Km 16-20)	1.1.4	Bakal Vil., Tualang Sub-dist., Siak District	Rubber Plantation
5 Segment 5 (Km 21-25)	1.1.5	Bakal Vil., Tualang Sub-dist., Siak District	Oil Plam Plantation and Secondary forest
1.2 Plantation Road Side			
1 Segment 1 (Km 1-5)	1.2.1a	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Rubber Plantation
	1.2.1b	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Jabon (burflower-tree) plantation
2 Segment 2 (Km 6-10)	1.2.2a	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Oil Palm Plantation
	1.2.2b	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Oil Palm Plantation
3 Segment 3 (Km 11-15)	1.2.3a	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Jabon (burflower-tree) and oil palm plantations
	1.2.3b	Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City	Oil Palm Plantation
<b>2 SGPP Site and Transmission Line</b>			
2.1 SGPP Site			
1 SGPP Site	2.1a	Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City	Oil Palm Plantation

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Sampling Location	Tabulation	Administration Area	Remark
2 SGPP Site	2.1b	Industri Tenayan Vil., Tenayan Raya Sub-dist, Pekanbaru City	Oil Palm Plantation
3 SGPP Site	2.c	Industri Tenayan Vil., Tenayan Raya Sub-dist, Pekanbaru City	Oil Palm Plantation
2.2 Transmission Line	2.2	Industri Tenayan Vil., Tenayan Raya Sub-dist, Pekanbaru City	Shrubs
<b>3 Water Supply Channel</b>			
3.1 Water supply channel side1	3.1	Industri Tenayan Vil., Tenayan Raya Sub-dist, Pekanbaru City	Shrubs
3.2 Water supply channel side2	3.2	Industri Tenayan Vil., Tenayan Raya Sub-dist, Pekanbaru City	Shrubs, acasia (pure stands)

#### **4.1.2.2 Vegetation Data Analysis**

From the tree and sapling enumeration, the relative frequency (FN), relative dominance (DN), relative density (KN), and important value index (INP) were calculated by using Curtis 1959 method (see Dombois-Ellenber 1974). Trees and saplings INP were obtained from the sum of FN, DN, and KN. The species diversity index ( $H'$ ) and the species evenness index (E) in the plot were calculated by Shannon method (see Magurran, 1988).

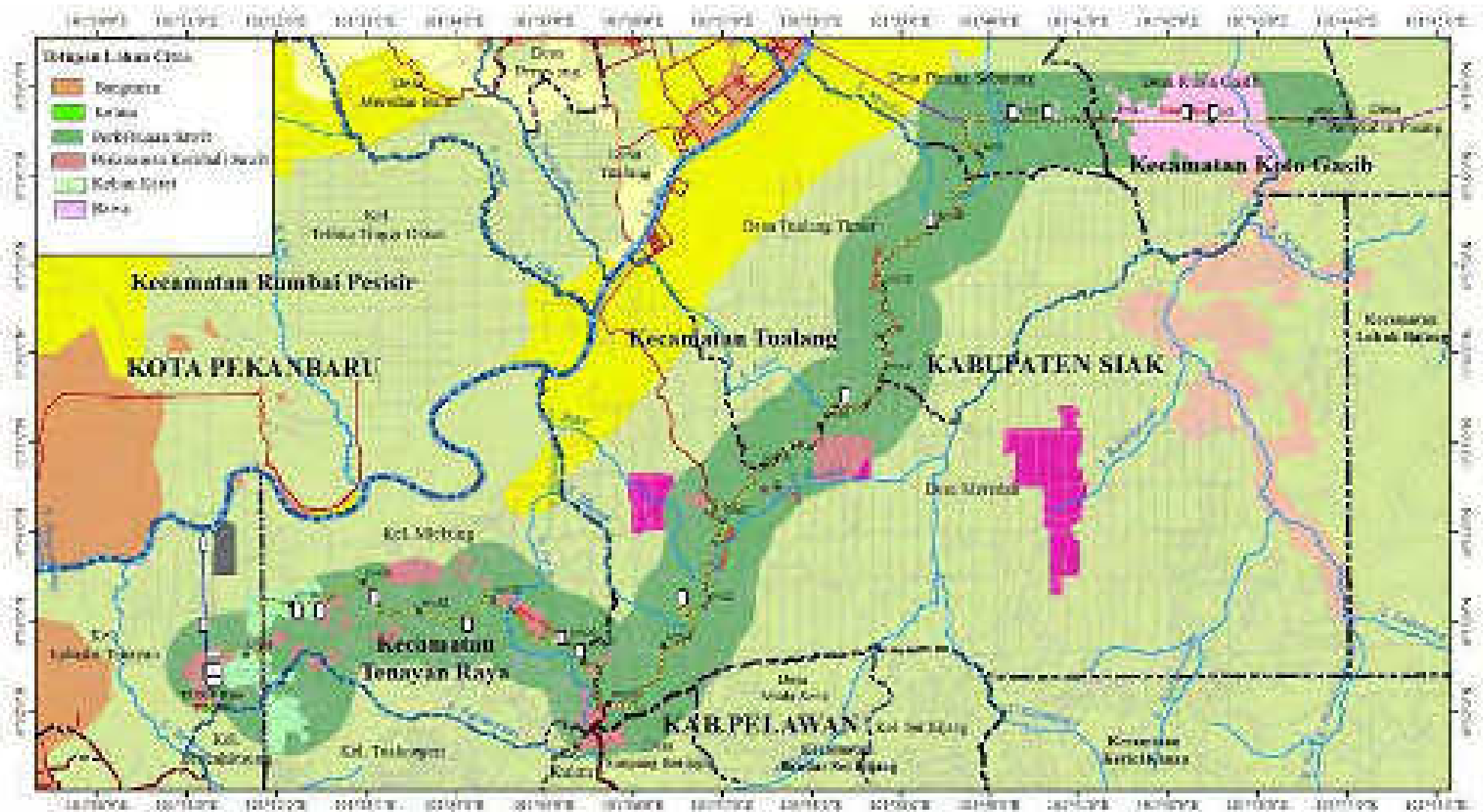


Figure 4-7. Vegetation Sampling Location

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### 4.1.3 Vegetation Condition At Pipe Gas, Sgpp, And Water Supply Channel Construction Plan Site

From the field survey conducted in January and February 2018, it was seen that human activities interference on the local ecology system was very big. Currently, land coverage was dominated by plantation especially oil palm, natural stands were still found scattered in a much damaged condition. Table 4-2 below shows the area's width and ownership of oil palm plantation in the research location

**Table 4-2. Area's width and percentage of people's plantation, state's plantation, private plantation, and total area of oil palm plantation in Pekanbaru and Siak**

District/ Municipal	People's Plantation		State's Plantation		Private Plantation		Total
	Area's width	Percentage	Area's width	Percentage	Area's width	Percentage	
Pekanbaru	710	9,5	0	0	6.745	90,5	7.455
Siak	101.369	58,1	9.473	5,43	63.730	36.5	174.572

As much as 19 sampling plots were placed within the research area, covered: 13 plots on the side of pipeline construction plan site; four plots were on SGPP and transmission line construction plan sites; and two plots were on the water supply channel construction plan site, see Table 4-1 and Figure 4-7.

### 4.1.4 Vegetation Composition and Structure on Pipeline Construction Plan Site

#### 4.1.4.1 Main Road Segment

Seven sampling plots on the side of the pipeline construction plan site were on the Kuala Gasib-Melebung main road segment, covering: swamp forests (1.1.1a and 1.1.1b); Shrubs (1.1.2a); rubber and oil palm plantations, mixed with natural types (1.1.2b); secondary forest mixed with rubber trees (1.1.3); rubber plantation (1.1.4); and oil palm plantation and secondary forest (1.1.5).

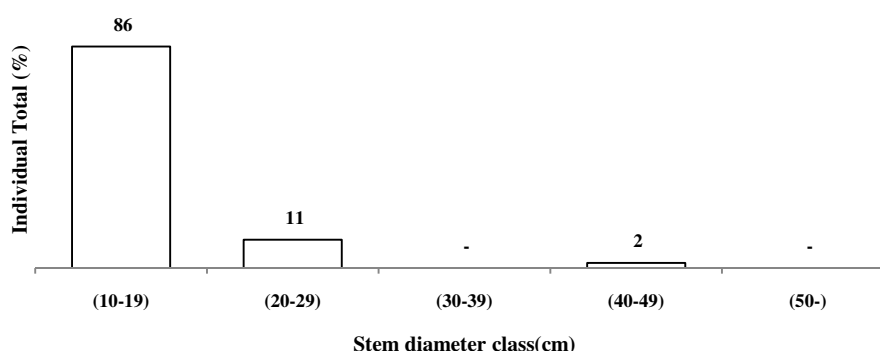
From those seven plots, the first two plots were swamps' stands which exist on Gasib River border. This swamp stands were remnants of stands that much damaged even started being re-used for oil palm planting. From the outside view, the swamps were composed by saplings and small trees. On open places it was seen overgrown by lianas, ferns, and swamp grass. The recorded tree density was 160 and 220 individual/ hectare, for saplings density it was recorded 3.660 and 760 individual/ hectare. Compiler trees' size were very small, the average LBD/ individual was only 104 and 194 cm<sup>2</sup> (Table 4-1). Using crown strata division according to Richards, 1962 (E 5-9 m, D 10-19 m, C 20-29 m, B 30-39 m, and A ≥40 m), one of the swamp's stand structure form in Kuala Gasib can be seen on Figure 4-8 and 4-9, whereas 86 percent the compiler trees has a diameter of 10-19cm, and 77 percent of the compiler tree has crown height of less than 10 meters. Suratmin (2018, private communication) conveyed that this area is known as dry swamp. Generally flood happens in September until January, the highest flood happens in the end of December until early January.

The high level of disturbance on the swamp forest is affecting to the impoverishment on this stands. The detail of families, genus, and species wealth or index numbers of species variant and spreads is presented in Table 4-4. On Tables 4-5 and 4-6 the main tree and sapling type was shown

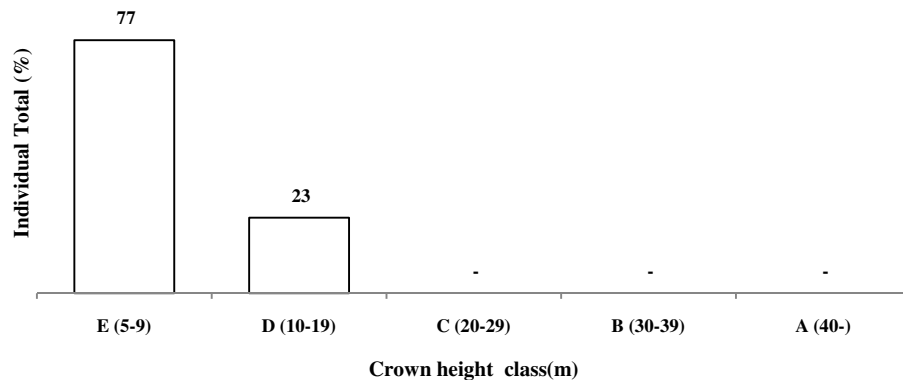
with INP  $\geq 10\%$ . On the first plot (1.1.1a) it was recorded that there were three main tree types, namely: *Planchonia valida*, *Psychotria* sp., *Syzygium* sp.1 and three main sapling types, namely: *Alstonia spatulata*, *Glochidion rubrum*, dan *Planchonia valida*. The *Planchonia valida* and *Glochidion rubrum* are the main tree and sapling with height domination, in the future *Planchonia valida* is thought to be still dominating this area. On the swamp forest's second plot (1.1.1b), the existence of the main tree type were much more available, recorded 11 types of main tree in this stand, such as: *Artocarpus integer*, *Artocarpus rigidus*, *Claoxylon longifolium*, *Diospyros maingayi*, *Glochidion rubrum*, *Mesua ferruginea*, *Syzygium cymosum*, *Syzygium incarnatum*, *Syzygium occlusum*, *Syzygium* sp.3, and *Vatica pauciflora*. For the main sapling there were nine species recorded, covers : *Claoxylon longifolium*, *Elaeocarpus petiolatus*, *Glochidion rubrum*, *Maranthes corymbosa*, *Nephelium maingayi*, *Symplocos lucida*, *Syzygium cymosum*, *Syzygium incarnatum*, and *Syzygium occlusum*. The INP detail on each species in every sampling plot was presented in Appendix 1.1.1a-p until 1.1.1b-ap. For lower plants species which tends to thicken on open spaces among others are liana kait-kait/ cat's claw (*Uncaria* sp.), rumput sayat/ grass (*Scleria purpurascens*), paku resam/ forked fern (*Dicranopteris linearis*), and paku hurang (*Stenochlaena palustris*).

**Table 4-3. Individual Total , LBD per hectare, and LBD per tree and sapling individual for every plot and pipeline construction plan site on main road side segment (1.1) in Siak District**

Tree	Sampling Plot						
	1a	1b	2a	2b	3	4	5
Individual amount	160	220	170	635	690	910	445
LBD (cm <sup>2</sup> ) per ha	16,700	42,738.9	59,576.8	158,341.1	136,101.4	213,812.5	141,821.4
LBD (cm2) per individual	104.4	194.3	350.5	249.4	197.2	235.0	318.7
<b>Sapling</b>							
Individual amount	3,660	760	4,480	2,360	2,640	1,720	1,460
LBD (cm <sup>2</sup> ) per ha	77,281.6	23,995.7	57,537.9	40,240.4	38,012.9	27,142.5	22,691.4
LBD (cm2) per individual	21.1	31.6	12.8	17.1	14.4	15.8	15.5



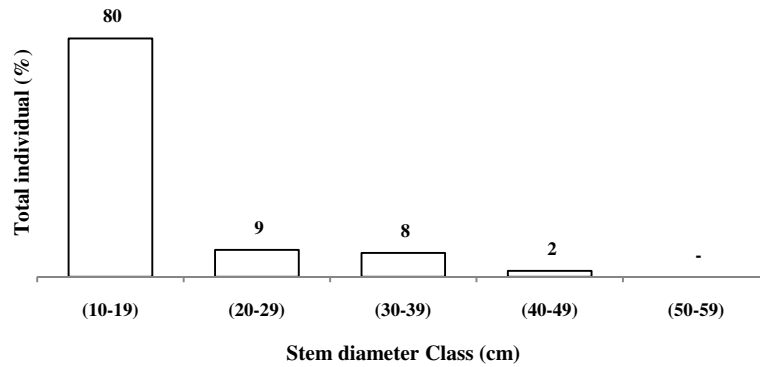
**Figure 4-8. Tree stem diameter spread on secondary swamp forest of main road segment side (1.1b) in Kuala Gasib Vil., Koto Gasib Sub-dist, Siak District**



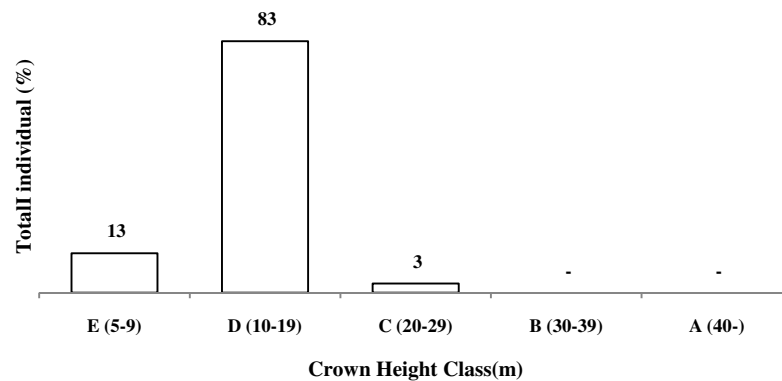
**Figure 4-9. Tree crown height spread on secondary swamp forest of main road segment side (1.1b) in Kuala Gasib Vil., Koto Gasib Sub-dist, Siak District**

On the second segment of main road (km 6-10), there was shrubs stand to be found (1.1.2a) and rubber and oil palm plantations stands mixed with natural stands (1.1.2b). The tree and sapling density on the shrubs stands in the border of Abdullah Lake, Pinang Sebatang Vil. were recorded of 170 and 4.480 individual/ hectare, LBD/individual for tree as big as 351 cm<sup>2</sup> and for sapling of 13 cm<sup>2</sup>, while LBD/hectare was reaching 59.577 cm<sup>2</sup> for tree and 57.538 cm<sup>2</sup> for sapling (Table 4-3). The detail of families, genus, and species wealth or index numbers of species's variant and spreads are presented in Table 4-4. There were five species of main tree recorded (INP  $\geq 10\%$ ) covers *Acacia mangium*, *Archidendron jiringa*, *Cocos nucifera*, *Elaeis guineensis*, and *Hevea brasiliensis*. For the main sapling covers eight species, such as *Acacia mangium*, *Alstonia angustiloba*, *Hevea brasiliensis*, *Ixonanthes petiolaris*, *Mallotus paniculatus*, *Melastoma malabathricum*, *Melicope lunu-akenda*, and *Vitex pinnata* (Tables 4-5 and 4-6). The INP detail on each species in every sampling plot was presented in Appendix 1.1.2a-p and 1.1.2a-ap. The sapling density in this stand is quite high which is possible by the existence of open space. On other open spaces, it was very dense covered by forke fern/paku resam (*Dicranopteris linearis*), and paku hurang (*Stenochlaena palustris*). Outside the sampling plot, at the open lake border, there was forke fern (*Dicranopteris linearis*) cover with kantung semar (*Nepenthes* sp.) insertion and on the outside of the plantation around Abdullah Lake, pinang merah (*Cyrtostachys renda*) can be found.

On the rubber and oil palm plantation stands mixed with natural stands, a better outside look was found. There were bigger and quite high trees. Trees and saplings density in this stand covered 635 and 2.360 individual/hectare, LBD/ individual for tree as big as 249 cm<sup>2</sup> and for sapling 17 cm<sup>2</sup>, LBD/ hectare was reaching 158.341 cm<sup>2</sup> for tree and 40.240 cm<sup>2</sup> for sapling (Table 4-3). This stand structure can be seen in Figure 4-10 and 4-11 which shows the histogram of stem diameter class and crown height class spreadings, whereas the stem diameter spread range is quite wide reaching to class 40-49 cm, with 80 percent of the compiler trees have a diameter of 10-19 cm. Meanwhile, the vertical structure of this stand shows 83 percent of the tree compiler are within the D stratu, (10-19m). There were six species of main tree in this stand covering *Acacia mangium*, *Alstonia angustiloba*, *Artocarpus heterophyllus*, *Garcinia parvifolia*, *Hevea brasiliensis*, dan *Vitex pinnata*. Those main tree species were also the main species for saplings (see Table 4-5 and 4-6). INP details of each species on every sampling plot is presented in Appendix 1.1.2b-p and Appendix 1.1.2b-ap. The rubber and oil palm plants were seem not well managed, on the natural species rubber trees it looked overgrown.



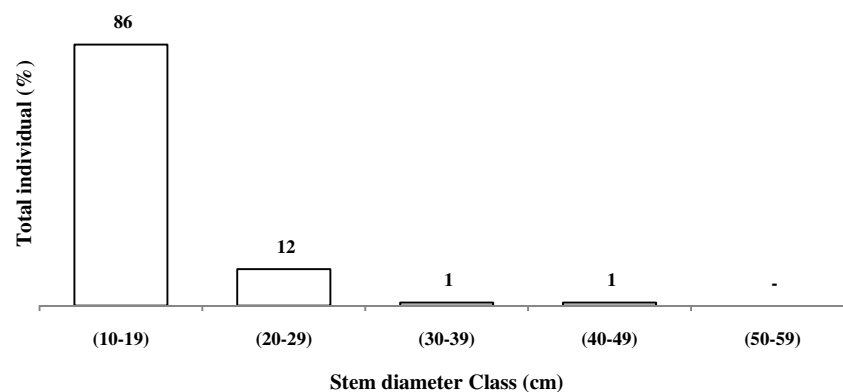
**Figure 4-10. Tree stem diameter spread on mixed-rubber-oil palm plantation plot on main road segment side (1.1.2b) in Pinang Sebatang village, Tualang Sub-district, Siak District**



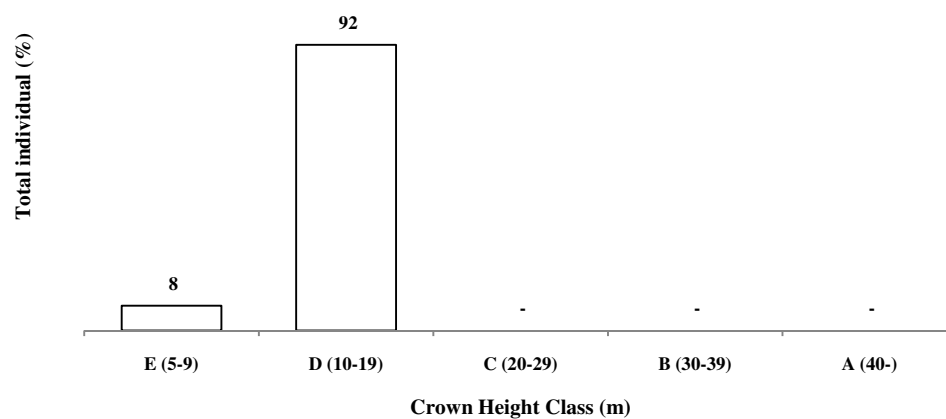
**Figure 4-11. Tree crown height spread on mixed-rubber-oil palm plantation plot on main road segment side (1.1.2b) in Pinang Sebatang village, Tualang Sub-district, Siak District**

Secondary low-land forest stand which is mixed with cultivated rubber species were found grows in the third Segment (km 11-15) on the side of main road in Pinang Sebatang Village, Tualang Sub-district, Siak District. This stand is the remaining stand between plantation land coverage and settlements. The rubber trees were possible growing naturally and never been nicked (tapped for sap). The tree and sapling density on this stand covers 690 and 2.640 individual/hectare, LBD/individual for tree as big as 197 cm<sup>2</sup> and for sapling 14 cm<sup>2</sup>, LBD/hectare was reaching 136.101 cm<sup>2</sup> for tree and 38.013 cm<sup>2</sup> for sapling (Table 4-3). Picture 4.3a and 4.3b shows the histogram of stem diameter class and crown height class spreadings of this secondary low-land forest, whereas the stem diameter spread range is quite wide reaching class 40-49 cm, with 86 percent of the compiler tree have a diameter of 10-19 cm and 12 percent on the rang of 20-29 cm. Meanwhile, the vertical structure of this stand shows that stratum was continously formed on stratum D (10-19 m). The stand condition which is relatively good apparently are still capable to support livelihood for animal –bear. During the field survey there was animal nest found on berangan tree (*Castanopsis costata*). The main species of this stand compliler (see Table 4-5 and 4-6) covers four species of tree, namely : *Archidendron jiringa*, *Artocarpus elasticus*, *Hevea brasiliensis*, and *Vitex pinnata*; also seven species of saplings , covering: *Alstonia angustiloba*, *Artocarpus elasticus*, *Hevea brasiliensis*, *Nephelium ramboutan-ake*, *Rhodamnia cinerea*, *Sloetia*

elongata, and Vitex pinnata. The existence of rambung/rubber (*Hevea brasiliensis*) as the compiler of this stand were possible to be grow naturally and never been nicked (tapped). The INP details of each species on every sampling plot is presented on Appendix 1.1.3-p and 1.1.3-ap.



**Figure 4-12. Tree stem diameter spread on secondary low-land forest of main road segment side (1.1.3) in Pinang Sebatang Vil., Tualang sub-dist., Siak District**



**Figure 4-13. Tree crown height spread on secondary low-land forest of main road segment side (1.1.3) in Pinang Sebatang Vil., Tualang sub-dist., Siak District**

**Table 4-4. The families, genus, and species of tree and sapling wealth for every plot and gas pipeline construction plan site on main road segment side (1.1) in Siak District.**

Tree	Sampling Plot						
	1a	1b	2a	2b	3	4	5
Families	3	9	5	12	12	15	13
Genus	3	11	9	12	20	17	16
Species	3	19	10	13	23	22	17

	Sampling Plot						
H'	0.161	1.190	0.863	0.662	0.978	0.544	1.093
E	0.338	0.930	0.863	0.595	0.718	0.405	0.854
<b>Sapling</b>							
Families	6	7	16	15	19	9	21
Genus	6	7	22	20	28	14	27
Species	6	9	25	22	30	14	30
H'	0.400	0.804	1.030	0.911	1.223	0.750	1.294
E	0.514	0.842	0.737	0.678	0.828	0.638	0.876

Along the Kuala Gasib main road side until Melebung, the rubber plantations were tend to lessen. The community's interest to plant this commodity is tend to decline and changed into planting oil palm. Rubber plantation in segment 4 (km 16-20) of main road side in Bakal village, Tualang Sub-district, Siak District was not seem to be well planned, as seen in the distance between planting distance which was un-organized and stem diameter and crown height spreading were not uniform. The tree and sapling density in this plantation covers 910 and 1.720 individual/ hectare, LBD/ individual for tree as big as 235 cm<sup>2</sup> and for sapling 16 cm<sup>2</sup>, LBD/ hectare reached 213.813 cm<sup>2</sup> for tree and 27.142 cm<sup>2</sup> for sapling (Table 4-3). Several species of natural plants as fruit and lumber producer are still maintained were growing between the rubber stands. This rubber stand become the the exploration area for monkey / beruk (home range and food range), It was possible by the existence of those natural fruit trees. At the time of field survey, duku (*Lansium parasiticum*) is in fruitful season.

On table 4-4 it is shown the detail of families, genus, and species wealth, even the index number of species diversity and evenness on the plots along the main road. Itis shown that the highest families, genus and species wealth for tree and sapling can be found on secondary low-land forest stand plot in Segment 3 (km 11-15), namely : 23 species, 20 genus, and 12 families for trees; also 30 species, 28 genus, and 19 families for saplings. The main compilers of this stand are covering four species of tree, namely : *Artocarpus elasticus*, *Hevea brasiliensis*, *Ixonanthes petiolaris*, and *Nephelium cuspidatum*; also four species of sapling covering: *Alstonia angustiloba*, *Garcinia parvifolia*, *Hevea brasiliensis*, and *Lepionurus sylvestris* (see Table 4-5 and 4-6). The INP deatils for each species on every sampling plot is presented in Appendix 1.1.4-p and 1.1.4-ap. The garden floor were grown by species of ferns, grass or tree seedlings, such as: paku resam (*Dicranopteris linearis*), paku hurang (*Stenochlaena palustris*), rumput sayat (*Scleria purpurascens*), senggani (*Clidemia hirta*), rambung/karet (*Hevea brasiliensis*), and mahang (*Macaranga sp.*).

The secondary low-land forest remaining stand that adjacent to the oil palm plantation can be found growing in Segment 5 (km 11-15) on Main road side in Bakal village, Tualang Sub-district, Siak District. The tree and sapling density on natural stand and oil palm plantation covers 445 and 1.460 individual/hectare, LBD/individual for tree as big as 319 cm<sup>2</sup> and for sapling is 16 cm<sup>2</sup>. The LBD/hectare reached 141.821 cm<sup>2</sup> for tree and 22.691 cm<sup>2</sup> for sapling (Table 4-3). The main species of this stand's compiler covered eight species of tree, namely: *Alstonia angustiloba*, *Artocarpus elasticus*, *Elaeis guineensis*, *Endospermum diadenum*, *Garcinia parvifolia*, *Glochidion rubrum*, *Ixonanthes petiolaris*, and

Rhodamnia cinerea; also seven species of sapling covering: Acacia mangium, Alstonia angustiloba, Dillenia eximia, Endospermum diadenum, Fordia splendidissima, Ixonanthes petiolaris, and Rhodamnia cinerea (see Table 4-5 and 4-6). The INP details of each species on every sampling plot is presented on Appendix 1.1.5-p and 1.1.5-ap.

**Table 4-5. The main tree species names with Value Index (INP) 10% or more for every plot on gas pipeline construction plan site on main road side in Siak District**

No.	Species Name	1.1 Main Road Side Segment						
		1a	1b	2a	2b	3	4	5
1	<i>Acacia mangium</i>	-	-	66.6	19.5	-	-	-
2	<i>Alstonia angustiloba</i>	-	-	-	31.0	-	-	18.9
3	<i>Archidendron jiringa</i>	-	-	22.5	-	16.9	-	-
4	<i>Artocarpus elasticus</i>	-	-	-	-	81.6	10.1	32.0
5	<i>Artocarpus heterophyllus</i>	-	-	-	10.1	-	-	-
6	<i>Artocarpus integer</i>	-	25.2	-	-	-	-	-
7	<i>Artocarpus rigidus</i>	-	14.3	-	-	-	-	-
8	<i>Claoxylon longifolium</i>	-	34.0	-	-	-	-	-
9	<i>Cocos nucifera</i>	-	-	47.9	-	-	-	-
10	<i>Diospyros maingayi</i>	-	13.4	-	-	-	-	-
11	<i>Elaeis guineensis</i>	-	-	83.1	-	-	-	79.6
12	<i>Endospermum diadenum</i>	-	-	-	-	-	-	21.2
13	<i>Garcinia parvifolia</i>	-	-	-	10.5	-	-	13.3
14	<i>Glochidion rubrum</i>	-	18.6	-	-	-	-	11.5
15	<i>Hevea brasiliensis</i>	-	-	37.7	119	81.6	182	-
16	<i>Ixonanthes petiolaris</i>	-	-	-	-	-	13.8	45.5
17	<i>Mesua ferruginea</i>	-	21.7	-	-	-	-	-
18	<i>Nephelium cuspidatum</i>	-	-	-	-	-	10.6	-
19	<i>Planchonia valida</i>	228	-	-	-	-	-	-
20	<i>Psychotria sp.</i>	45.1	-	-	-	-	-	-
21	<i>Rhodamnia cinerea</i>	-	-	-	-	-	-	20.5
22	<i>Syzygium cymosum</i>	-	14.1	-	-	-	-	-
23	<i>Syzygium incarnatum</i>	-	25.8	-	-	-	-	-
24	<i>Syzygium occlusum</i>	-	24.9	-	-	-	-	-
25	<i>Syzygium sp.1</i>	27.1	-	-	-	-	-	-
26	<i>Syzygium sp.3</i>	-	17.5	-	-	-	-	-

No.	Species Name	1.1 Main Road Side Segment						
		1a	1b	2a	2b	3	4	5
27	<i>Vatica pauciflora</i>	-	21.6	-	-	-	-	-
28	<i>Vitex pinnata</i>	-	-	-	31.3	15.4	-	-

**Table 4-6. The main sapling species names with Value Index (INP) 10% or more for every plot on gas pipeline construction plan site on main road side in Siak District**

No.	Species Name	1.1 Main Road Side Segment						
		1a	1b	2a	2b	3	4	5
1	<i>Acacia mangium</i>	-	-	22	20	-	-	14
2	<i>Alstonia angustiloba</i>	-	-	11	31	49	35	45
3	<i>Alstonia spatulata</i>	16	-	-	-	-	-	-
4	<i>Artocarpus elasticus</i>	-	-	-	-	19	-	-
5	<i>Artocarpus heterophyllus</i>	-	-	-	10	-	-	-
6	<i>Claoxylon longifolium</i>	-	13	-	-	-	-	-
7	<i>Dillenia eximia</i>	-	-	-	-	-	-	13
8	<i>Elaeocarpus petiolatus</i>	-	56	-	-	-	-	-
9	<i>Endospermum diadenum</i>	-	-	-	-	-	-	37
10	<i>Fordia splendidissima</i>	-	-	-	-	-	-	11
11	<i>Garcinia parvifolia</i>	-	-	-	10	-	26	-
12	<i>Glochidion rubrum</i>	168	91	-	-	-	-	-
13	<i>Hevea brasiliensis</i>	-	-	82	119	49	162	-
14	<i>Ixonanthes petiolaris</i>	-	-	13	-	-	-	47
15	<i>Lepionurus sylvestris</i>	-	-	-	-	-	16	-
16	<i>Mallotus paniculatus</i>	-	-	12	-	-	-	-
17	<i>Maranthes corymbosa</i>	-	22	-	-	-	-	-
18	<i>Melastoma malabathricum</i>	-	-	12	-	-	-	-
19	<i>Melicope lunu-akenda</i>	-	-	56	-	-	-	-
20	<i>Nephelium maingayi</i>	-	10	-	-	-	-	-
21	<i>Nephelium ramboutan-ake</i>	-	-	-	-	25	-	-
22	<i>Planchonia valida</i>	98	-	-	-	-	-	-
23	<i>Rhodamnia cinerea</i>	-	-	-	-	16	-	13
24	<i>Sloetia elongata</i>	-	-	-	-	12	-	-
25	<i>Symplocos lucida</i>	-	13	-	-	-	-	-

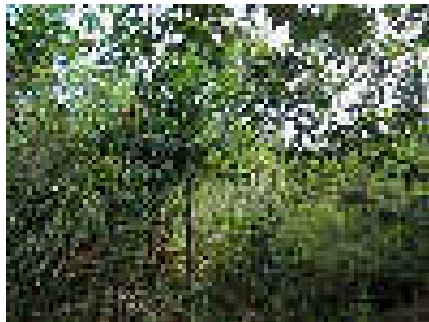
No.	Species Name	1.1 Main Road Side Segment						
		1a	1b	2a	2b	3	4	5
26	<i>Syzygium cymosum</i>	-	21	-	-	-	-	-
27	<i>Syzygium incarnatum</i>	-	33	-	-	-	-	-
28	<i>Syzygium occlusum</i>	-	42	-	-	-	-	-
29	<i>Vitex pinnata</i>	-	-	23	31	17	-	-



Pule (*Alstonia spatulata*) swamp compiler plant on the side of main road in Kuala Gasib Vil., Koto Gasib Sub-district, Siak District (1.1.1b).



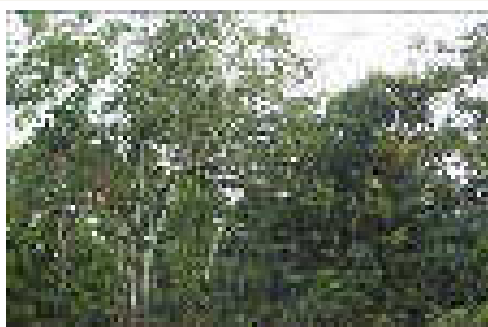
swamp vegetation on the side of main road in Kuala Gasib Vil., Koto Gasib Sub-district, Siak District (1.1.1b).



Shrubs stand around Abdullah Lake on the main road side of Pinang Sebatang Vil., Tualang Sub-district, Siak district (1.1.2a)



Kantung semar (*Nepenthes* sp.) grows in the thickness of ferns on the border of Abdullah Lake on the main road side in Pinang Sebatang Vil., Tualang Sub-district,

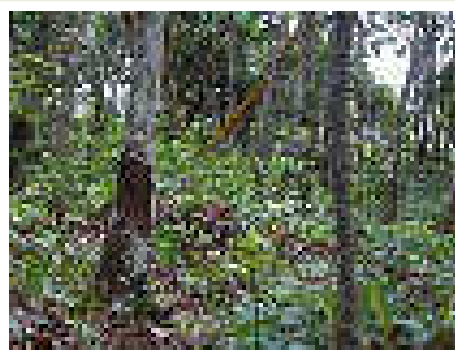


Rubber and oil palm plantation mixed with natural species on the main road side in Pinang Sebatang Vil., Tualang Sub-district, Siak District (1.1.2b).

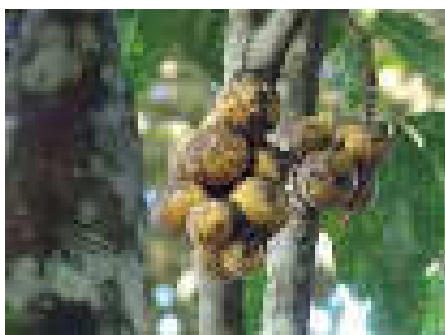


Secondary low-land forest stand mixed with rubber tree on the main road side in Pinang Sebatang Vil., Tualang Sub-district, Siak District (1.1.3).

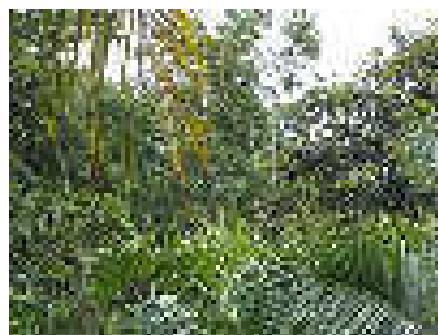
Berangan tree (*Castanopsis costata*) is being used as bear nest in secondary low-land forest stand mixed with rubber



Rubber plantation on the main road side in Bakal Vil., Tualang Sub-district, Siak District (1.1.4).



Duku (*Lansium parasiticum*) grows and fruiting in rubber plantation on main road side in Bakal Vil., Tualang Sub-district, Siak District (1.1.4).



Secondary forest and oil palm plantation on the main road side in Bakal Vil., Tualang Sub-district, Siak District (1.1.5).

#### 4.1.4.2 Plantation Road Segment

Six sampling plots on the gas pipeline construction plan site were on the plantation road segment, which covered : rubber plantation (1.2.1a); jabon plantation (1.2.1b); oil palm plantation (1.2.2a, 1.2.2b, and 1.2.3a); and jabon and oil palm plantation (1.2.3a). Those six plots were within Melebung Village, Tenayan Raya Sub-district, Pekanbaru City area.

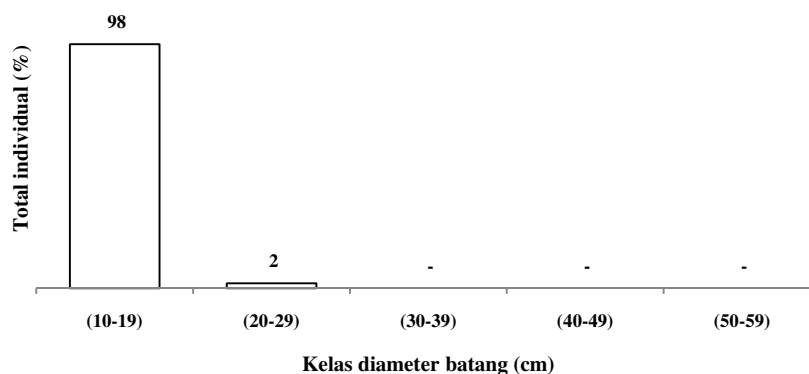
Along the road side of plantation road it was plainly to see dominated by oil palm plantation, only small numbers of other commodities planted on this plantation road segment side, such as rambung/rubber

(*Hevea brasiliensis*) and jabon (*Neonauclea purpurea*). The tree and sapling density on this rubber plantation covered 595 and 200 individual/hectare, LBD/individual for tree as big as 146 cm<sup>2</sup> and for sapling is 40 cm<sup>2</sup>. The LBD/hectare reached 86.825 cm<sup>2</sup> for tree and 7.900 cm<sup>2</sup> for sapling. Meanwhile, the tree and sapling density on jabon plantation covered 320 and 700 individual/hectare, and LBD/individual for tree is as big as 32.646 cm<sup>2</sup> and for sapling is 102 cm<sup>2</sup>. The LBD/hectare reached 32.646 cm<sup>2</sup> for trees and 1.784 cm<sup>2</sup> for sapling (Table 4-7). The rubber plantation seems to be well planned and quite maintained, pests plant on the road side seem to be well managed while those that was far from the road were still thick and overgrown with weeds or natural saplings and seedlings. The jabon plantation seem to be unkept, many trees were shedding and weeds were overgrown. During the time of field survey, hogs were found living in this garden.

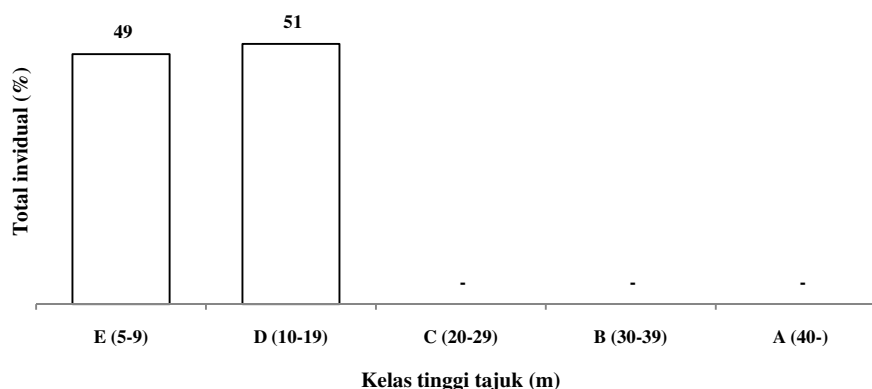
The depiction about the rubber plantation can be seen in Figure 4-14 and 4-15 which shows the histogram of stem diameter class and crown height class spreading, whereas the rubber plantation was composed of small trees, 98 percent of the trees have a diameter of 10-19 cm, with continuous stratum form on stratum E and D (crown height is 5-19 m). The intensity of plantation management was affecting to the impoverishment of composer species variety on every plantation plot. The wealth detail of families, genus, and species or index number of species variety and species evenness is presented in Table 4-8. There is only one species of tree in this plantation plot which is rubber (*Hevea brasiliensis*), for the main sapling, beside rubber there is also the natural species of tempinis (*Artocarpus rigidus*) see Table 4-9 and 4-10. The INP details for each species on every sampling plot are presented on Appendixes 1.1.1a-p and 1.2.1b-ap.

**Table 4-7. Individual Total, LBD per hectare, and LBD per individual, tree and sapling for every plot on gas pipeline construction plan site of plantation road segment side (1.2) in Pekanbaru City**

Tree	Sampling Plot					
	1a	1b	2a	2b	3a	3b
Individual Total	595	320	135	190	140	165
LBD (cm <sup>2</sup> ) per ha	86,825.4	32,646.4	170,598.2	261,422.9	128,788.4	234,193.9
LBD (cm <sup>2</sup> ) per individual	145.9	102.0	1,263.7	1,375.9	919.9	1,419.4
<b>Sapling</b>						
Individual Total	200	700	-	-	200	-
LBD (cm <sup>2</sup> ) per ha	7,900.4	1,783.6	-	-	9,185.0	-
LBD (cm <sup>2</sup> ) per individual	39.5	2.5	-	-	45.9	-

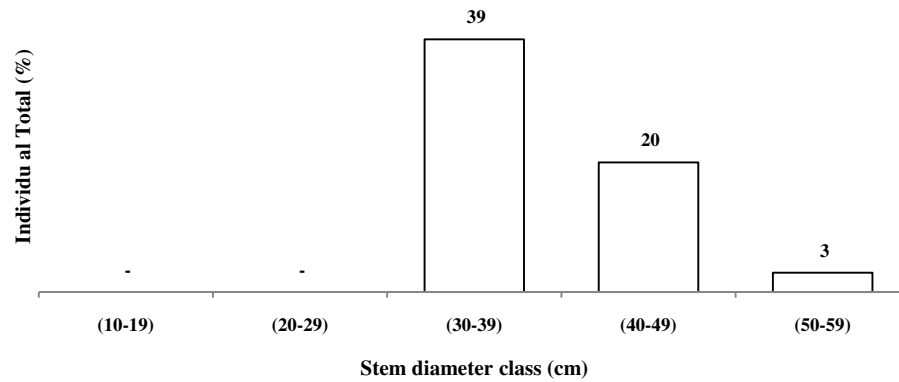


**Figure 4-14. Tree stem diameter spread on rubber plantation plot of plantation road segment side (1.2.1a) in Pekanbaru City**

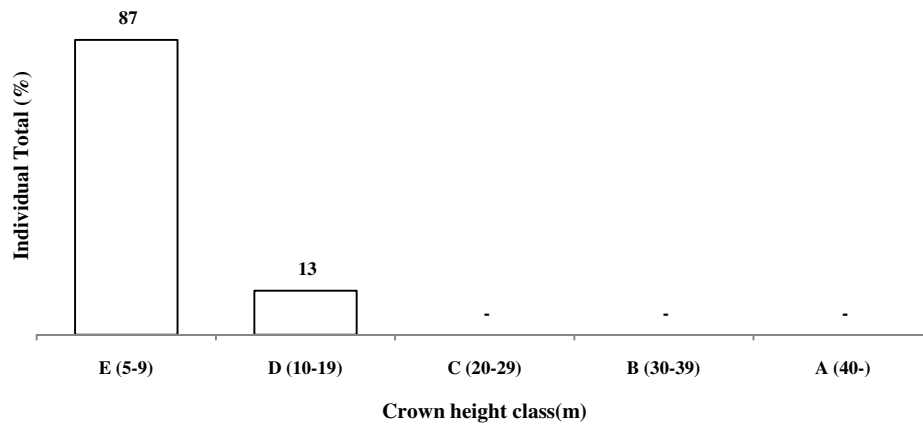


**Figure 4-15. Tree crown height spread on rubber plantation plot of plantation road segment side (1.2.1a) in Pekanbaru City.**

The oil palm plantation was very well planned and well managed (1.2.2a, 1.2.2b, and 1.2.3a), the trees were planted in organized lane and column with certain planting distance, there was no sapling growing under these trees. The depiction of the oil palm structure can be seen in Figure 4-16 and 4-17 which shows the histogram of stem diameter class and crown height class spreadings, whereas the plantation was composed of large trees with diameter of 30-59 cm, the highest crown was less than 10 m. There were only one species of tree in these three plots of oil palm plantation, namely oil palm (*Elaeis guineensis*) see Table 4-8 and 4-9. The intensity of the management is not allowing other species to grow between the oil palm stands. The tree density in these three plantation covering 135, 190, and 165 individual/hectare; LBD/individual was as big as 1.264 cm<sup>2</sup>, 1.376 cm<sup>2</sup>, and 1.419 cm<sup>2</sup>; also LBD/hectare reached 170.598 cm<sup>2</sup>, 261.423 cm<sup>2</sup>, and 234.194 cm<sup>2</sup> (Table 4-7). The INP detail for each species in every oil palm plantation sampling plot is presented in Appendixes 1.2.2a-p, 1.2.2b-p, and 1.2.3b-p. The low plants that grow covering the plantation floor are : *Cyperus* sp., sendudu (*Melastoma malabathricum*), rumput sayat (*Scleria pupurascens*), paku harupat (*Nephrolepis bisserata*), senggani (*Clidemia hirta*), paku resam (*Dicranopteris linearis*), and paku *Pteris* sp.



**Figure 4-16. Tree stem diameter spread on oil palm plantation plot of plantation road segment side (1.2.2b) in Melebung Vil, Tenayan Raya Sub-dist., Pekanbaru City.**



**Table 4-8. Tree crown height spread on rubber plantation plot of plantation road segment side (1.2.2b) in Melebung Vil, Tenayan Raya Sub-dist., Pekanbaru City.**

Tree	Sampling Plot					
	1a	1b	2a	2b	3a	3b
Families	1	2	1	1	2	1
Genus	1	2	1	1	2	1
Species	1	2	1	1	2	1
H'	-	0.082	-	-	0.297	-
E	-	0.273	-	-	0.985	-
<b>Sapling</b>						
Families	2	3	-	-	1	-
Genus	2	3	-	-	1	-
Species	2	3	-	-	1	-

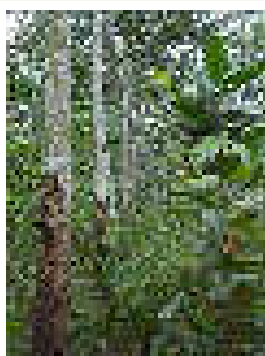
	Sampling Plot					
H'	0.217	0.324	-	-	-	-
E	0.674	0.680	-	-	-	-

**Table 4-9. The main tree species names with Value Index (INP) 10% or more for every plot on gas pipeline construction plan site on plantation road side in Pekanbaru City.**

No.	Species Name	1.2 Plantation Road Side Segment					
		1a	1b	2a	2b	3a	3b
1	<i>Acacia mangium</i>	-	24.2	-	-	-	-
2	<i>Elaeis guineensis</i>	-	-	300	300	179	300
3	<i>Hevea brasiliensis</i>	300	-	-	-	-	-
4	<i>Neonauclea purpurea</i>	-	276	-	-	121	-

**Table 4-10. The main sapling species names with Value Index (INP) 10% or more for every plot on gas pipeline construction plan site on main road side in Pekanbaru City.**

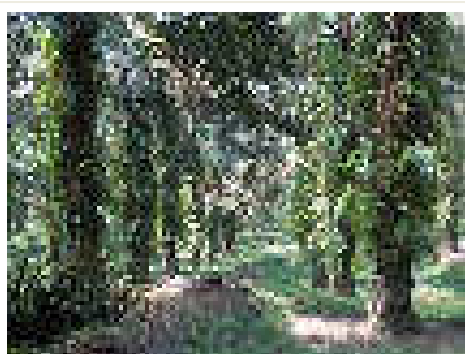
No.	Species Name	1.2 Plantation Road Side Segment					
		1a	1b	2a	2b	3a	3b
1	<i>Acacia mangium</i>	-	44	-	-	-	-
1	<i>Artocarpus rigidus</i>	44	-	-	-	-	-
2	<i>Hevea brasiliensis</i>	256	-	-	-	-	-
4	<i>Mallotus paniculatus</i>	-	43	-	-	-	-
5	<i>Neonauclea purpurea</i>	-	212	-	-	300	-



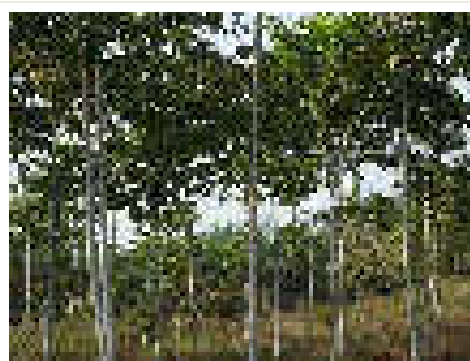
Rubber plantation on the plantation road side in Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City (1.2.1a)



Rubber plantation on the plantation road side in Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City (1.2.1b)



Oil Palm plantation on the plantation road side in Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City (1.2.2a)



Oil Palm and jabon plantation on the plantation road side in Melebung Vil., Tenayan Raya Sub-dist., Pekanbaru City (1.2.3a)

#### 4.1.5 Vegetation Composition and Structure in SGPP Construction and Transmission Network Plan Sites

##### 4.1.5.1 SGPP Construction Plan Site

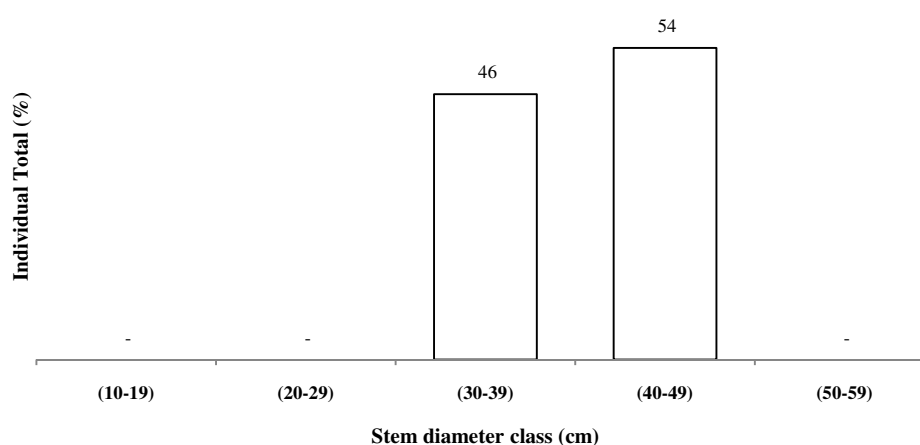
The land coverage on the SGPP plant site located in Tenayan Industrial Village, Tenayan Raya District, Pekanbaru City is in the form of oil palm plantations (2.1a, 2.1b and 2.1c), these oil palm plantations are generally well-maintained, the palm is the only tree constituents of plantation stands and no other species is allowed to grow to disturb the growth of the palm. As commonly encountered in other gardens, monoculture cultivation results in the impoverishment of plant species, Table 4-12 presents the detailed wealth of families, genus, and species and index numbers of species and evenness of species in this oil palm plantation. In the 2.1b plot there was an exception, whereas in addition to the oil palm plantation, other plants were let grow naturally, such as jering (*Archidendron jiringa*) and aren (*Arenga pinnata*) see Table 4-13, the palm oil plantation is not found.

The tree density on these three oil palm plantation covered 175, 175, and 130 individual/hectare; LBD/individual was as big as 1.190 cm<sup>2</sup>, 1.248 cm<sup>2</sup>, and 1.368 cm<sup>2</sup>; also LBD/hectare was reached 208.293 cm<sup>2</sup>, 218.370 cm<sup>2</sup>, and 177.784 cm<sup>2</sup> (Table 4-11). The INP detail for each species on every sampling plot in these three oil palm plantations is presented in Appendixes 2.1a-p, 2.1b-p, and 2.1c-p.

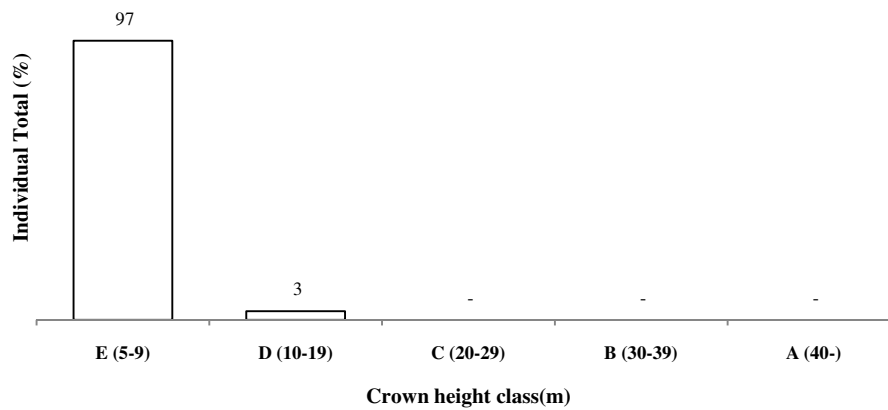
The depiction of this oil palm plantation structure is can be seen in Figure 4-17 and 4-18 which shows the histogram of stem diameter class and crown height class spreading, whereas the oil plam plantation was composed by large tree with a diameter of 30-49 cm, the average of the highest crown are less than 10 m.

**Table 4-11. Individual Total, LBD per hectare, and LBD per individual, tree and sapling for every plot on SGPP construction and transmission network plan sites in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City**

Tree	Sampling Plot			
	2.1a	2.1b	2.1c	2.2
Indiviual Total	175	175	130	210
LBD (cm <sup>2</sup> ) per ha	208,292.9	218,369.6	177,783.6	28,802.3
LBD (cm2) per individual	1,190.2	1,247.8	1,367.6	137.2
<b>Sapling</b>				
Indiviual Total	-	-	-	6,140
LBD (cm <sup>2</sup> ) per ha	-	-	-	87,749.5
LBD (cm2) per individual	-	-	-	14.3



**Figure 4-17. Tree stem diameter spread on oil palm plantation plot of SGPP site (2.1b) in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City.**



**Figure 4-18. Tree crown height spread on oil palm plantation plot of SGPP site (2.1b) in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City**

**Table 4-12. The families, genus, and species of tree and sapling wealth for every plot on SGPP construction plan site in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City**

Tree	Sampling Plot			
	2.1a	2.1b	2.1c	2.2
Families	1	3	1	5
Genus	1	4	1	8
Species	1	4	1	9
H'	-	0.168	-	0.527
E	-	0.279	-	0.553
<b>Sapling</b>				
Families	-	-	-	9
Genus	-	-	-	13
Species	-	-	-	16
H'	-	-	-	0.791
E	-	-	-	0.643

**Table 4-13. The main tree species names with Value Index (INP) 10% or more for every plot on SGPP construction plan site in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City.**

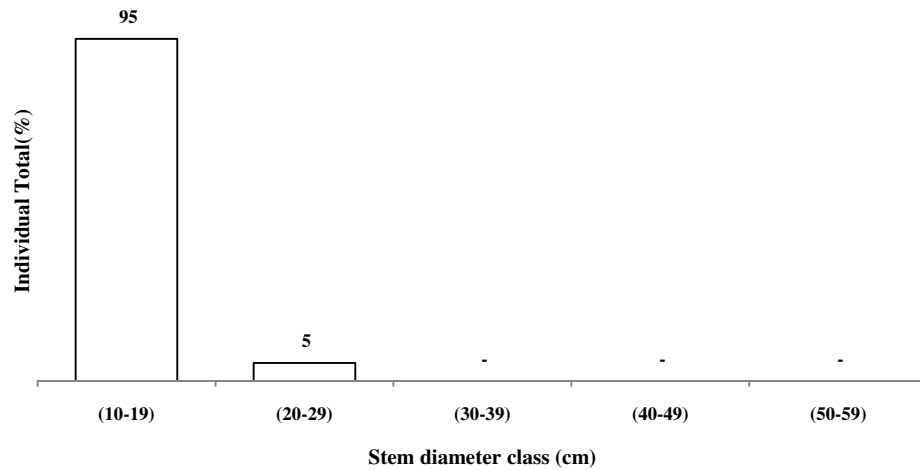
No.	Main Species Name	TREE				SAPLING			
		2.1a	2.1b	2.1c	2.2	2.1a	2.1b	2.1c	2.2
1	<i>Acacia mangium</i>	-	-	-	188.8	-	-	-	108.4

No.	Main Species Name	TREE			SAPPLING				
		2.1a	2.1b	2.1c	2.2	2.1a	2.1b	2.1c	2.2
2	<i>Afzelia rhomboidea</i>	-	-	-	12.8	-	-	-	-
3	<i>Archidendron jiringa</i>	-	10.6	-	-	-	-	-	-
4	<i>Arenga pinnata</i> Merrill.	-	10.1	-	-	-	-	-	-
5	<i>Artocarpus elasticus</i>	-	-	-	33.3	-	-	-	19.7
6	<i>Artocarpus integer</i>	-	-	-	13.4	-	-	-	-
7	<i>Artocarpus rigidus</i>		-	-	-	-	-	-	10.8
8	<i>Bambusa vulgaris</i>		-	-	-	-	-	-	66.0
9	<i>Commersonia bartramia</i>		-	-	-	-	-	-	13.5
10	<i>Elaeis guineensis</i>	300.0	269.7	300	-	-	-	-	-
11	<i>Endospermum diadenum</i>	-	-	-	13.1	-	-	-	-
12	<i>Macaranga gigantea</i>	-	-	-	10.4	-	-	-	-
13	<i>Macaranga trichocarpa</i>		-	-	-	-	-	-	10.7
14	<i>Melicope lunu-akenda</i>		-	-	-	-	-	-	25.9
15	<i>Syzygium palembanicum</i>	-	-	-	10.4	-	-	-	-

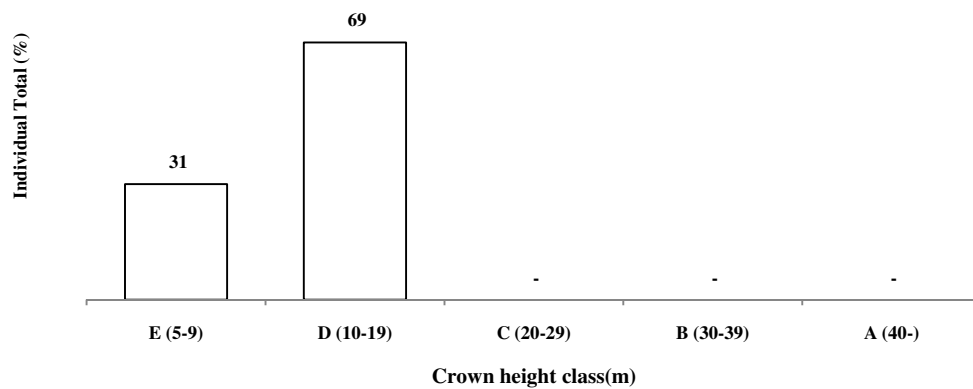
#### 4.1.5.2 Transmission network construction plan site

Outside the SGPP construction plan site, a sampling was conducted on the transmission line construction plan site (2.2). The land coverage on this site is mixed shrubs. The main species composer for the stand are quite vary (Table 4-13), it was recorded that there were 12 species of tree and sapling which mostly were fast growing species, those main species among other were: *Acacia mangium*, *Afzelia rhomboidea*, *Artocarpus elasticus*, *Artocarpus integer*, *Endospermum diadenum*, *Macaranga gigantea*, *Syzygium palembanicum*, *Artocarpus rigidus*, *Bambusa vulgaris*, *Commersonia bartramia*, *Macaranga trichocarpa*, and *Melicope lunu-akenda*. The INP detail dor each species on the mixed shrubs sampling plot is presented in Appendixes 2.2-p, and 2.2-ap.

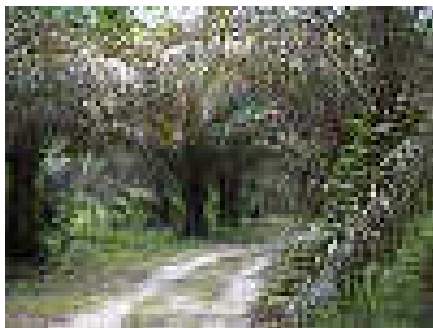
The tree and sapling density of this shrubs plot was covering 210 and 6.140 individual/hectare; LBD/individual was as big as 137 cm<sup>2</sup> and 14 cm<sup>2</sup>; also LBD/hectare were reaching 28.802 cm<sup>2</sup> and 87.750 cm<sup>2</sup> (Table 4-11). Depiction about the mixed shrubs structure can be seen in Figure 4-19 and 4-20 which shows the histogram of stem diameter class and crown height class spreading, whereas this shrubs were 95 percent compiled of small trees with a diameter of 10-19 cm. The stratification was composed of stratum E (5-9 m) and D (10-19 m). Observed from the saplings existence, it was possible the species such as akasia (*Acacia mangium*), terap (*Artocarpus elasticus*), tenggek burung (*Melicope lunu-akenda*), empelu (*Commersonia bartramia*), mahang (*Macaranga trichocarpa*), and tempinis (*Artocarpus rigidus*) will emerge as the main species in the future, also yellow bamboo/ bambu kuning (*Bambusa vulgaris*) will still dominating the limited space such as drainage channel.



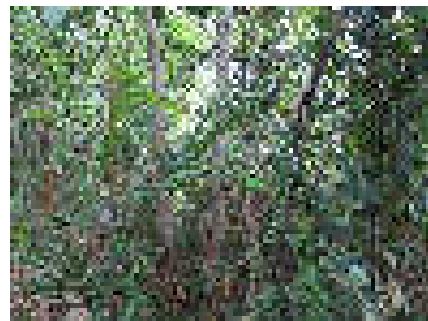
**Figure 4-19. Tree stem diameter spread on shrub plot of SGPP transmission line site (2.2) in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City**



**Figure 4-20. Tree crown height spread on shrub plot of SGPP transmission line site (2.2) in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City**



Oil palm plantation in SGPP construction plan site in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City..



Shrubs condition on SGPP transmission line construction plan site in Industri Tenayan Vil., Tenayan Raya Sub-dist., Pekanbaru City.

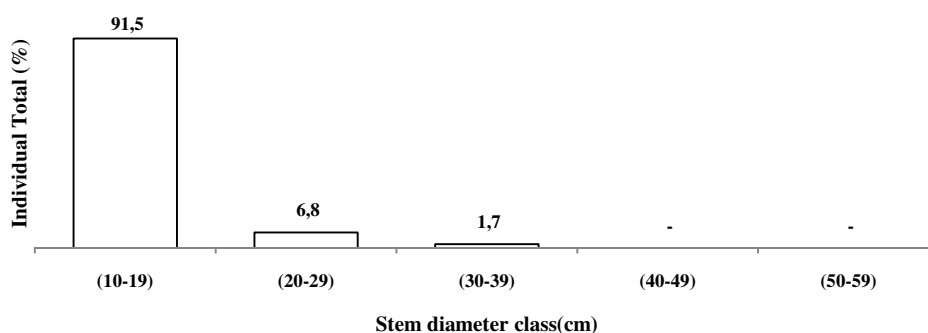
#### 4.1.6 Vegetation Composition and Structure in Water Supply Channel Construction Plan Site

The water supply channel construction plan site is spread from SGPP plan site to the Siak River body, covering wavy dry land and swamps. Two plots sampling was conducted, the first plot was on the starting point of the water supply channel at Siak River border (3.1), and the second plot was at acacia shrubs (3.2).

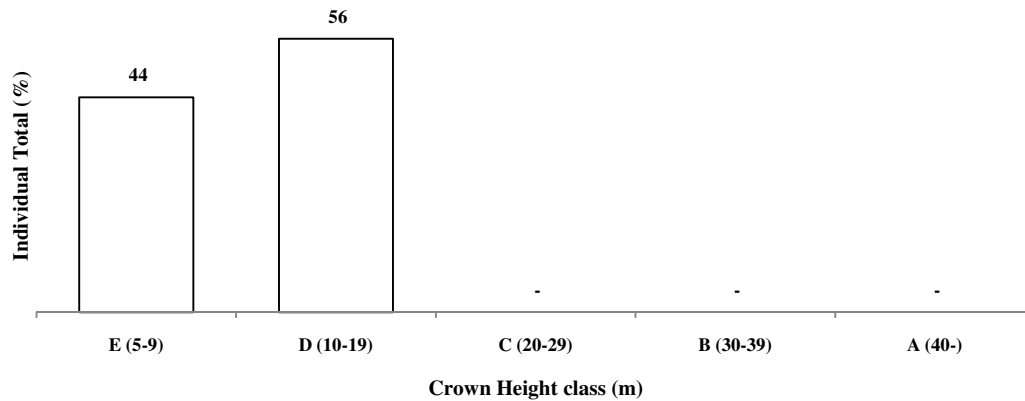
On the first plot, the land coverage were shrubs mixed with rubber (*Hevea brasiliensis*), the density number of tree and spling in this plot are 295 and 5.560 individual/hectare, LBD/individual for tree was as big as 162 cm<sup>2</sup> and for sapling was 13 cm<sup>2</sup>, LBD/hectare reached 47.772 cm<sup>2</sup> for tree and 74.616 cm<sup>2</sup> for sapling (Table 4-14). The depiction of this shrubs structure can be seen in Figures 4-21 dan 4-22 which shows the histogram of stem diameter class and crown height class spread, whereas 91.5 percents of the shrubs were composed of small trees with a diameter of 10-19 cm, the ceown stratification was composed by stratum E (5-19 m) and D (10-19 m). The families, genus, and specieas wealth and the index number of species variant and eveness are presented in Table 4-15. The main species of this shrubs stand is quite vary (Table 4-16), there were seven species main trees recorded, namely: *Artocarpus rigidus*, *Ficus variegata*, *Glochidion rubrum*, *Hevea brasiliensis*, *Macaranga pruinosa*, *Melicope lunu-akenda*, and *Vitex pinnata*; also seven species of saplings, namely: *Acacia mangium*, *Alstonia angustiloba*, *Aporosa arborea*, *Macaranga javanica*, *Melastoma malabathricum*, *Melicope lunu-akenda*, and *Vitex pinnata*. The INP detail for each species on this sampling plot is presented in Appendixes 3.1-p dan 3.1-ap.

**Table 4-14. Individual total, LBD per hectare, and LBD per individual of tree and sapling for every plot on water supply channel construction plan site in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

	Tree		Sapling	
	Sampling Plot		Sampling Plot	
	1	2	1	2
Individual Total	295	305	5,560	4,980
LBD (cm <sup>2</sup> ) per ha	47,772.4	34,365.2	74,616.3	71,363.4
LBD (cm2) per individual	161.9	112.7	13.4	14.3



**Figure 4-21. Tree stem diameter spread on shrub plot of rubber-shrubs plantation plot of water supply channel site (3.1) in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

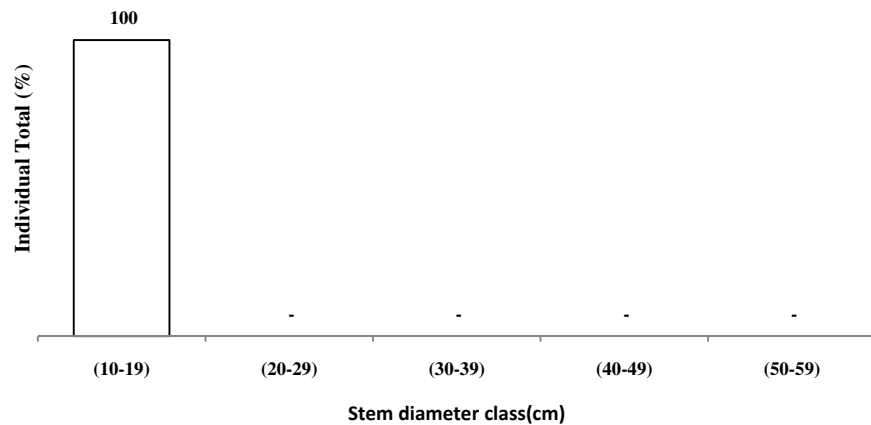


**Figure 4-22. Tree crown height spread on shrub plot of rubber-shrubs plantation plot of water supply channel site (3.1) in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City.**

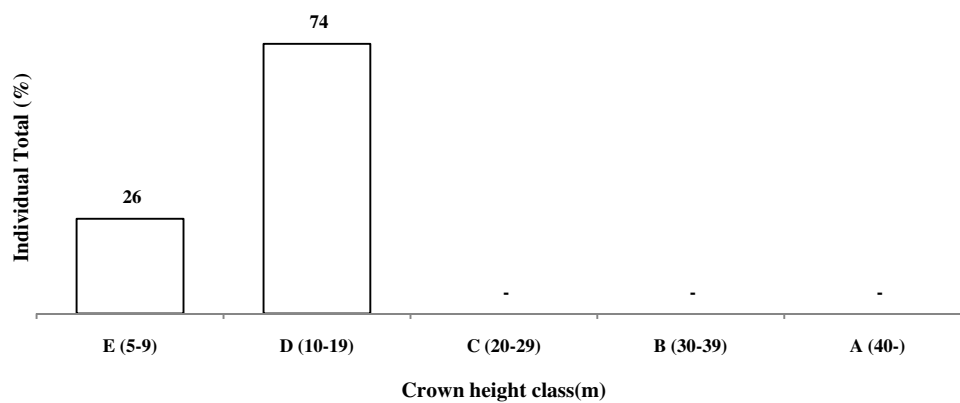
**Table 4-15. The families, genus, and species of tree and sapling wealth for every plot on water supply channel construction plan site (3.1) in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

		Pohon		Anak Pohon	
		Petak Cuplikan			
		1	2	1	2
Families		7	1	18	11
Genus		11	1	24	15
Species		13	1	29	15
H'		0.821	-	0.869	0.430
E		0.737		0.594	0.365

On the second plot, the land coverage was pure acacia/akasia (*Acacia mangium*) stand shrub, the sapling were very dense and tend to be uniformed size, showing simultaneously growth on sapling on this site. The tree and sapling density covered 305 and 4.980 individual/hectare, LBD/individual for tree was as big as 113 cm<sup>2</sup> and for sapling was 14 cm<sup>2</sup>, LBD/hectare reached 34.365 cm<sup>2</sup> for tree and 71.363 cm<sup>2</sup> for sapling (Table 4-14). Depiction about the stand structure is shown in Picture 4-23 and 4-24 which shows the stem diameter class and crown height class spreading, whereas the entire tree censused has small diameter (10-19 cm). The crown stratification was compiled by stratum E (5-19 m) and D (10-19 m). There was only one main compiler tree species which is: acacia/akasia (*Acacia mangium*), also there are six main saplings recorded, namely: *Acacia mangium*, *Alstonia angustiloba*, *Aporosa arborea*, *Macaranga javanica*, *Melastoma malabathricum*, and *Vitex pinnata* (Table 4-16). The INP detail for each species on this sampling plot is presented in Appendixes 3.2-p and 3.2-ap.



**Figure 4-23. Tree stem diameter spread on acacia shrubs plot of water supply channel site (3.2) in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

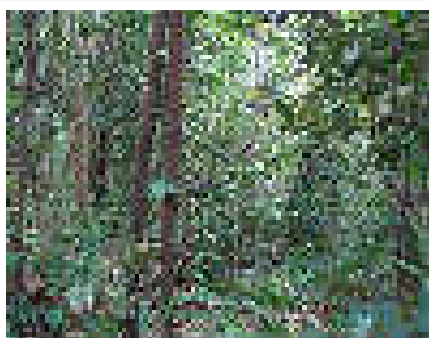


**Figure 4-24. Tree crown height spread on acacia shrubs plot of water supply channel site (3.2) in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

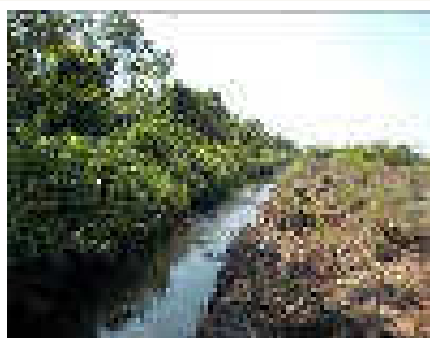
**Table 4-16. The families, genus, and species of tree and sapling wealth for every plot on water supply channel construction plan site in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City**

No.	Species Name	Tree		Sapling	
		1	2	1	2
1	<i>Acacia mangium</i>	-	300	-	123.5
2	<i>Alstonia angustiloba</i>	-	-	-	19.2
3	<i>Aporosa arborea</i>	-	-	-	10.9
4	<i>Artocarpus rigidus</i>	19.3	-	20.6	-
5	<i>Commersonia bartramia</i>	-	-	11.2	-

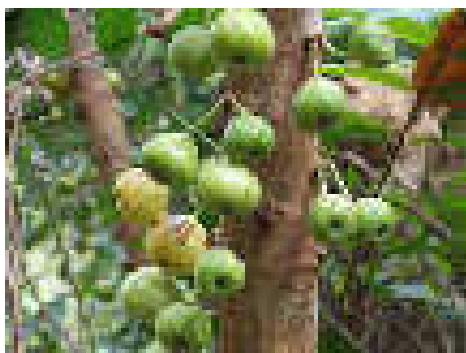
No.	Species Name	Tree		Sapling	
		1	2	1	2
6	<i>Ficus padana</i>	-	-	18.4	-
7	<i>Ficus variegata</i>	10.3	-	29.1	-
8	<i>Gigantochloa apus</i>	-	-	80.0	-
9	<i>Glochidion rubrum</i>	42.2	-	-	-
10	<i>Hevea brasiliensis</i>	124.3	-	16.1	-
12	<i>Macaranga javanica</i>	-	-	-	41.3
13	<i>Macaranga pruinosa</i>	45.2	-	36.8	-
14	<i>Melastoma malabathricum</i>	-	-	-	22.5
15	<i>Melicope lunu-akenda</i>	11.5	-	12.9-	35.6
16	<i>Vitex pinnata</i>	11.3	-	-	15.7



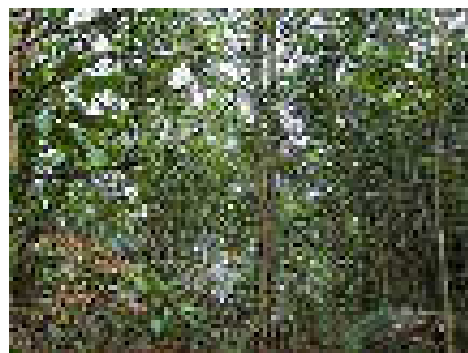
**Photo 3.1** Shrubs condition on water supply channel plan site at the border of Siak River in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City (3.1).



**Photo 3.2** Vegetation coverage condition on water supply channel construction plan site fragment in Industri TenayanVil., Tenayan Raya Sub-dist., Pekanbaru City



**Photo 3.3** Gedobuk (*Ficus variegata*) the main species in plot 3.1 in full fruit season



**Photo 3.4** Acacia (*Aacacia mangium*)'s pure stand shrubs condition on water supply channel construction plan site in Industri Tenayan Village (3.2).

#### 4.1.7 Vegetation Existence and Conservation Needs

The families, genus and species wealth of tree on seven plots with the size of 0.2 hectare on the main road segment side were 70 species recorded, include within 48 genus and 24 families. For sapling on seven plots of 0.05 hectare in size, covered 83 species which include within 62 genus and 36 families. On the above Table 4-4, it showed the wealth low of tree and sapling species on swamp forest stand at Gasib River border. It was possible by the high level of exploitation activities and forest function switch usability in the area. Similar pressure also happened on low-land forest stand, that is why sampling plots were purposely placed in the relatively better stands rather than oil palm coverage which were very dominant in this area. On the plot size 0.2 hectare of secondary low-land forest, 23 species of tree include in 20 genus and 12 families were found, while for sapling, there were 30 species found which were include in 28 genus and 19 families. Other than changing species composition, land purpose switching is making sure there were shifting in stands' structure. It cause environmental service shifting also, either for local environment or its surrounding. Environmental service that very felt are clean water source availability, micro climate controller, wind barrier, even forest product service. The service function is shifting and it was felt, Suratmin (2018, private communication) expressed that looking for wood for building material is getting difficult, now there was tendency to look for any available woods, even by looking for lumber woods that was buried under mud in the swamps. Also to obtain forest bee's honey now is very difficult.

Similar phenomenon also happened in other sites, such as SGPP construction plan site and water supply channel construction plan site. In the future, together with district/ city development, the pressure on low-land forest remaining stands is possibly will be harder. Wilson (1995) explained that mengemukakan bahwa conservation on biodiversity must support continuous development by protecting and carefully using bio-resources so not to reduce gen and species diversity or destroy the habitat and ecosystem. To embody those noble thoughts it need commitment from all parties in implementing three elements of biodiversity conservation, namely: i) conservation, ii) research, and iii) sustainable use.

For species conservation purposes, a plant status tracking is observed in the sampling plots and surrounding areas for certain species. Table 6 shows the results of status tracking of plant species that need attention for the importance of conservation. Of the plant species identified in the study sites, two types of protected species (PP No. 7/1999) were found: kantong semar (*Nepenthes* sp) and pinang merah (*Cyrtostachys renda*); while *Alstonia spatulata*, *Vatica pauciflora*, *Azalia rhomboidea*, and *Nephelium lappaceaum* include in the list of endangered plant species according to IUCN criteria

**Table 4-17. Species name, region name, location, and status of plant's species found in research location in Siak and Pekanbaru**

No.	Species Name	Region Name	Location	Plant status		
				PP 7/1999	CITES	IUCN
	<b>Areaceae</b>					
1	<i>Alstonia spatulata</i>	Pule	Main road side Segment 1, km 1-5, Swamps (1.1.1a)	-	-	LR/lc ver 2.3
	<b>Araceae</b>					
2	<i>Cyrtostachys renda</i>	Pinang merah	Main road side Segment 2, km	Dilindungi	-	-

No.	Species Name	Region Name	Location	Plant status		
				PP 7/1999	CITES	IUCN
			6-10 (diluar petak)			
	<b>Dipterocarpaceae</b>					
3	<i>Vatica pauciflora</i>	Rasak	Main road side Segment 1, km 1-5, Swamps (1.1.1b)	-	-	EN A1c ver 2.3
	<b>Leguminosae</b>					
4	<i>Afzelia rhomboidea</i>	-	Main road side Segment 2 dan 3, km 6-15, Shrubs (1.1.2a), oil palm and rubber plantation mixed with natural species (1.1.2b), secondary low-land forest (1.1.3), and Shrubs (2.2).	-	-	VU A1cd ver 2.3
	<b>Nepenthaceae</b>					
5	<i>Nepenthes</i> sp.	Kantung semar	Main road side Segment 2, km 6-10 (outside the plot, in the border of Danau Abdullah).	Protected	App. II	-
	<b>Sapindaceae</b>					
6	<i>Nephelium lappaceum</i>	Rambutan	Main road side Segment 2 (km 6-10) and Segment 3 (km 11-15), Shrubs (1.1.2a), oil palm and rubber plantation mixed with natural species (1.1.2b), and secondary forest (1.1.3).	-	-	LR/1c ver 2.3

**Remarks:** App –Appendix; LR/lc –Lower Risk/least concern (eroded/un-noticed); EN A1c –Endangered (Precarious; declining population because of habitat reduction); VUA A1cd –Vulnerable (Troubled, decline population because of habitat reduction and happening and which will come exploitation).

## 4.2 Terrestrial Fauna

### 4.2.1 Introduction

Data concerning Terrestrial Fauna species diversity in Combine- Cycle Gas Turbine Power Plant (CCGT-PP) Tenayan construction plan location is obtained from observation on January 31 until February 11 2018. Fauna data taken is consisted of 4 classes which are Amphibians, Reptiles, Avifauna and Mammals. Location of fauna observation is commonly at the same location and the method is adjusted with the fauna class living of observation object.

For terrestrial habitat, according to BirdLife International, Riau and Lingga island do not have an Important Bird Area. While on the aquatic habitat, the Siak River is referred as Black Water River. About Aquatic Habitat, this area makes Riau recorded as one of the 22 World Biosphere Reserves authorized by UNESCO as world heritage in the year 2009. Black Water River is defined as the type of river that has a color of dark waters, slow-flowing canals through weand Surrounding Areaand or wooded swamps. Along with vegetation decomposition, tannins are formed and dissolved into the waters, causing the acidic atmosphere and dark color, resembling the tea water or black coffee. The term is used in fluvial studies (concerning rivers and streams) with the process of Earth surface shaped by it). The term of Black Water is used in the discipline scope of Geology, Geography, Ecology and Biology.

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This Study will be conducted along approx.. 40 km Gas Pipe Route, Water Intake Lane, and Power Plant Area. On the Gas Pipe Route, the track will be categorized in two section according to vegetation density and profile, and scale of modified environment at the survey area. Section 1 would have around 25 km on paved road, and section 2 at around 11 km long unpaved road (Table 4-1). In addition to Transect Line and Point Count Methods, the Amphibians will be observed with Listening Point Count and located within the area of consecutive related Transect Line and Point Count (Table 4-2).



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#### 4.2.2 Animal Survey Methods And Techniques

Study Locations were put to represented Habitat Type. All sampling area based on or oriented to layout of Transect Line of Avifauna dan Mammals as main reference Taxa. Those transect line and point count are listed in Table 4-1 and supervisial glance as Figure 4-2 are shown.

##### **Herpetofauna**

On study of Herpetofauna will be using 2 different methods. One for Amphibians, it uses Listening Point, after area of high concentrations of the animals is selected. The areas that suit the criteria above have been spotted following the preliminary track survey, which referred to network of rivers, swamps and several small ponds. While method on Reptiles observations use the same transect along the Gas Pipe Route that already stated for Birds and Mammals.

The type and number of reptile and amphibian species will be recorded during the walked transect surveys. Areas of high concentrations of individuals will be captured with GPS.

Study area and observations of significance will be photographed.

##### **Avifauna**

Surveys were focused on the richness and abundance of bird species, based on the type of habitat available. Line Transect is used in the survey combined with the Point Count methods took place on designated tracks, as early as sunrise. On Point Count Method, the observations are obtained in 20 minute duration of Bird Watching (counting the Visual, sound and cue of any animals found), before moving to the next Point Count. Distance between 2 point counts are approx. 200-250 meters. While walked Transect Line length is around 1 km or more. Observation repeated in the afternoon.

Sampling can be done in total number of 13 transect line; as much as 5 Transect Lines for Road Section 1 (Tarmac section) and 3 Transect Lines on Road Section 2, 3 Transect Lines at Power Plant and surrounding area, and 2 Transect Lines at Water Intake Lane.

The Transect and Observation Survey covers 20 minutes of observation time at each count point, to count all bird species visible and heard, within a 50m radius of the census point. The bird's observation can be held within 4 hours of sunrise (at 6:30 am when it is appropriate to start observations where the sunlight is enough to illuminate the landscape). Surveys can not be conducted in bad weather conditions (eg, high winds and rain). Each observation position is noted and recorded in coordinates with the help of the GPS Receiver.

Bird watching is preferred to visual and sound observations. Important nest and food source for protected and rare species is recorded and coordinates is determined with the help of GPS Receiver. Where possible, surveys are directed to observe waterbirds.

##### **Mammals**

Diurnal (Medium and Large Sized) Mammals Line Transect observation will be conducted in overlay with Birds observation transect. At the start of each survey, the observer will record the date, transect identity, name of observers, general weather condition (sunny, overcast or cloudy) and start time.

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Observers will then start walking along the transect, looking for target species in all strata (in case of forest habitats) and on both sides of the transect.

Using Perpendicular Point Distance, upon a visual detection event, observers will record: the time, species name, number of individuals, sighting location along the transect, and the perpendicular distance from the animal (or first detected individual, in case of groups) to the trail, which needs to be accurately measured.

The type and number of mammal species will be recorded during the walked transect surveys. Visual and Calls identification of animals (direct evidences), refuges, scat (faecal)

or other signs (indirect evidences) are expected. It is not deemed necessary to use camera traps in this study.

**Note:**

**The methodology and sampling technique is referring to methodology and sampling techniques developed from the United State Environmental Protection Agency (EPA) and the National Research Council (NRC) and the National Museum of Natural History of the Smithsonian Institution.**

#### 4.2.3 Results And Discussions

##### Transect Lines and Point Count Determinations

Total line transect that in the Study were 13, consist of 5 Transect at Road section 1, 3 Transect at Road Section 2, 3 transect at Power Plant and Surrounding Area, and Water Intake Lane have 2 Transect. List of those Transect are presented in Table 4-3

Over all Main Reference Locations and Transects presented in Table 4-1, photographs of indicated locations are shown in Figure 4-2.

**Table 4-18. List of Location Coordinate regarding Transect Line and Point Count Sampling**

#CODE	SAMPLING POINT KOORDINAT		
	POINT COUNT	LATITUDE	LONGITUDE
TR1			
	TR01_PNT001	0°38'36.73"N	101°43'17.05"E
	TR01_PNT002	0°38'37.30"N	101°43'10.00"E
	TR01_PNT003	0°38'36.60"N	101°43'2.60"E
	TR01_PNT004	0°38'36.88"N	101°42'56.15"E
	TR01_PNT005	0°38'36.80"N	101°42'48.60"E
TR2			
	TR02_PNT001	0°38'40.88"N	101°40'48.26"E
	TR02_PNT002	0°38'42.10"N	101°40'41.70"E
	TR02_PNT003	0°38'38.30"N	101°40'37.10"E
	TR02_PNT004	0°38'38.50"N	101°40'18.90"E
	TR02_PNT005	0°38'37.60"N	101°39'55.50"E
TR3			

#CODE	SAMPLING POINT KOORDINAT		
	POINT COUNT	LATITUDE	LONGITUDE
	TR03_PNT001	0°38'9.60"N	101°39'52.80"E
	TR03_PNT002	0°38'4.40"N	101°39'51.50"E
	TR03_PNT003	0°37'58.60"N	101°39'48.40"E
	TR03_PNT004	0°37'50.00"N	101°39'45.00"E
	TR03_PNT005	0°37'44.31"N	101°39'34.98"E
TR4			
	TR04_PNT001	0°36'25.00"	101°38'51.00"E
	TR04_PNT002	0°35'59.90"N	101°38'48.30"E
	TR04_PNT003	0°35'51.00"N	101°38'47.90"E
	TR04_PNT004	0°35'26.60"N	101°38'36.10"E
	TR04_PNT005	0°35'23.10"N	101°38'22.30"E
TR5			
	TR05_PNT001	0°34'31.20"	101°37'15.70"E
	TR05_PNT002	0°34'20.20"N	101°37'8.80"E
	TR05_PNT003	0°34'18.20"N	101°37'0.60"E
	TR05_PNT004	0°34'7.60"N	101°36'59.30"E
	TR05_PNT005	0°33'58.30"N	101°36'57.60"E
UP1			
	UP01_PNT001	0°32'15.00"N	101°35'33.61"E
	UP01_PNT002	0°32'24.16"N	101°35'35.19"E
	UP01_PNT003	0°32'29.39"	101°35'29.09"E
	UP01_PNT004	0°32'36.17"N	101°35'24.69"E
	UP01_PNT005	0°32'43.53"N	101°35'16.47"E
UP2			
	UP02_PNT001	0°33'4.70"N	101°34'16.01"E
	UP02_PNT002	0°32'58.36"N	101°33'48.00"E
	UP02_PNT003	0°33'3.85"N	101°33'19.04"E
	UP02_PNT004	0°33'14.36"N	101°33'7.88"E
	UP02_PNT005	0°33'23.31"N	101°32'57.54"E
UP3			
	UP03_PNT001	0°33'5.95"N	101°32'36.63"E
	UP03_PNT002	0°33'10.50"N	101°32'17.90"E
	UP03_PNT003	0°33'14.09"N	101°32'8.03"
	UP03_PNT004	0°33'14.00"N	101°31'59.20"E
	UP03_PNT005	0°33'12.10"N	101°31'54.17"E
PS1			
	PS01_PNT001	0°32'30.31"N	101°31'10.44"E
	PS01_PNT002	0°32'25.94"N	101°31'7.58"E
	PS01_PNT003	0°32'15.51"N	101°31'11.54"E

#CODE	SAMPLING POINT KOORDINAT		
	POINT COUNT	LATITUDE	LONGITUDE
PS2			
	PS02_PNT001	0°32'28.41"N	101°31'16.60"E
	PS02_PNT002	0°32'21.31"N	101°31'17.46"E
	PS02_PNT003	0°32'15.44"N	101°31'18.95"E
PS3			
	PS03_PNT001	0°32'35.61"N	101°31'6.83"E
	PS03_PNT002	0°32'33.71"	101°31'11.15"E
	PS03_PNT003	0°32'34.86"N	101°31'16.33"E
WI1			
	WI01_PNT001	0°32'55.64"N	101°31'16.57"E
	WI01_PNT002	0°32'46.96"N	101°31'16.72"E
	WI01_PNT003	0°32'46.46"N	101°31'10.82"E
	WI01_PNT004	0°32'46.34"N	101°31'6.33"E
	WI01_PNT005	0°32'45.95"N	101°31'3.43"E
WI2			
	WI02_PNT001	0°33'14.52"N	101°31'8.53"E
	WI02_PNT002	0°33'34.51"N	101°31'7.71"E
	WI02_PNT003	0°33'44.71"N	101°31'8.25"E
	WI02_PNT004	0°33'55.11"N	101°31'11.25"E
	WI02_PNT005	0°33'59.86"N	101°31'9.76"E
Note;			
TR1-5	Section 1 Transect on Gas Pipe Route 1 to 5		
TR0#_PNT00#	> Point Count on Consecutive Transect.		
UP1-3	Section 2 Transect on Gas Pipe Route 1 to 3		
UP0#_PNT00#	> Point Count on Consecutive Transect		
PS1-3	Transect Line on Power Plan And Surrounding Area		
PS0#_PNT00#	> Point Count on Consecutive Transect		
WI1-2	Transect Line on Water Intake Lane		
WI0#_PNT00#	> Point Count on Consecutive Transect.		



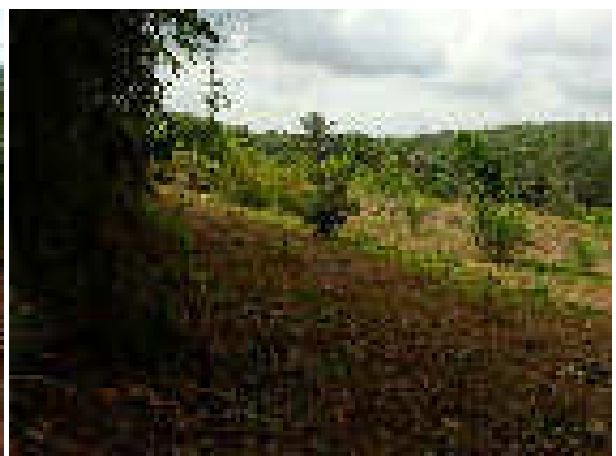
Section 1 Transect 1 (TR1)



Section 1 Transect 2 (TR2)



Section 1 Transect 3 (TR3)



Section 1 Transect 4 (TR4)



Section 1 Transect 5 (TR5)



Section 2 Transect 1 (TR1)



Section 2 Transect 2 (TR2)



Section 2 Transect 3 (TR3)



Power Plant and Site 1 (PS1)



Power Plant and Site 2 (PS2)



Power Plant and Site 3 (PS3)



Water Intake Lane Transect 1 (WI1)



**Figure 4-26. Transect and Site**

#### 4.2.4 Habitat Tipe

At Gas Pipe Route, mosly habitats have been observed as Palm Oil Plantation. At some spot there are still remnant forest dan old Rubber Plantation that overgrowth by native plants. It occur for instance in Road Section 1 Transect line 1to 3 (TR1-TR3). At TR4-TR5 mostly Palm Oil Plantation , and occur in small patches are Garden, and other Cultivated area.

Road Section 2 mostly Palm Oil Plantation, and occur in small patches Jabon

In Power Plant and Surrounding Area, mostly Palm Oil . Widely spread, Acacia mangium across the Northern border.

This Acacia dominated the area of Water Intake 2, while in Water Intake 1 mostly Palm Oil Plantation and secondary growth.

#### 4.2.5 Herpetofauna

##### 4.2.5.1 Amphibia

Listening points for Study on Amphibians is shown in Table 4-2. Data has been collected from 13 different highly concentration swamps, pounds or stream on consecutive locations.

**Table 4-19. Listening Point Count Designated Coordinates**

LISTENING POINT FOR AMPHIBIAN OBSERVATION		
#CODE	COORDINATE	
	LATITUDE	LONGITUDE
LP1	0°38'37.24"N	101°42'52.49"E
LP2	0°38'38.68"	101°40'48.45"E
LP3	0°37'38.96"N	101°39'35.16"E
LP4	0°35'44.60"N	101°38'46.23"E
LP5	0°34'20.69"N	101°37'3.09"E

LISTENING POINT FOR AMPHIBIAN OBSERVATION		
#CODE	COORDINATE	
	LATITUDE	LONGITUDE
LP6	0°32'33.49"N	101°35'20.32"E
LP7	0°33'22.50"N	101°33'0.20"E
LP8	0°33'6.42"N	101°32'14.23"E
LQ1	0°32'14.00"N	101°31'15.09"E
LQ2	0°32'29.69"N	101°31'14.65"E
LQ3	0°32'32.20"N	101°31'8.50"E
WL1	0°32'46.01"N	101°31'14.23"E
WL2	0°32'55.37"N	101°31'15.98"E
Note:		
LP1-8	Listening Point 1 to 8 on Gas Pipe Route	
LQ1-3	Listening Point 1 to 3 on Power Plant and Surrounding Area	
WL1-2	Listening Point 1 to 2 on Water Intake Lane	

Not more than 5 species of Frogs and Toad are found in the study sites, as shown in Table 4-3. All data of Amphibians collected base on Listening the sounds of the animals and species identification. Animals captured for further in-hand observation and species determination are photographed and released. No preserved specimen has been taken. Pictures of all species of Frogs and Toad are shown in Figs 4-3.

**Table 4-20. List of types of Amphibia observed from all Listening Points**

NO	SCIENTIFIC NAME	FAMILIA	IUCN	LISTENING POINT												
				LP1	LP2	LP3	LP4	LP5	LP6	LP7	LP8	LQ1	LQ2	LQ3	WL1	WL2
1	<i>Fejervarya limnocharis</i>	Dicroglossidae	LC	23	19	7	18	14	10	19	15	5	2	4	8	5
2	<i>Fejervarya cancrivora</i>	Dicroglossidae	LC	15	17	5	8	7	11	6	8	1	1	1	2	1
3	<i>Pulchrana glandulosa</i>	Ranidae	LC	37	25	11	12	16	16	4	8	3	2	2	5	6
4	<i>Hylarana erythraea</i>	Ranidae	LC	18	10	12	9	14	26	21	21	9	6	12	13	11
5	<i>Ingerophrynus melanostictus</i>	Bufo	LC	9	5	2	7	5	5	6	5	1	1	1	2	1
TOTAL INDIVIDU				102	76	37	54	56	68	56	57	19	12	20	30	24
TOTAL SPECIES				5	5	5	5	5	5	5	5	5	5	5	5	5

Notes :

IUCN Criteria

LC = Least Concern

NT = Near Trheated

VU = Vulnerable

EN = Endangered

CR = Critical  
Endangered

PP No. 7 Tahun 1999

DL = Protected

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LOCATION

LPT1 - LPT8 = Listening Point 1 to 8 at Pipeline Route

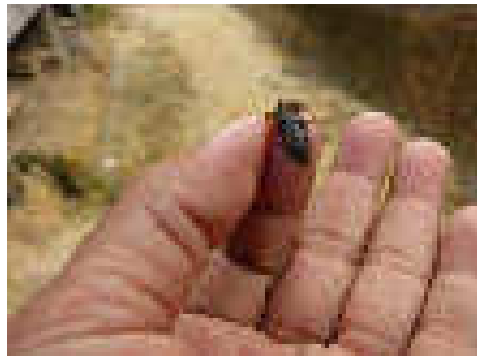
PS1 - PS2 = Listening Point at Power Plan and surrounding area

WI1 - WI2 = Listening Point at Water Intake Route

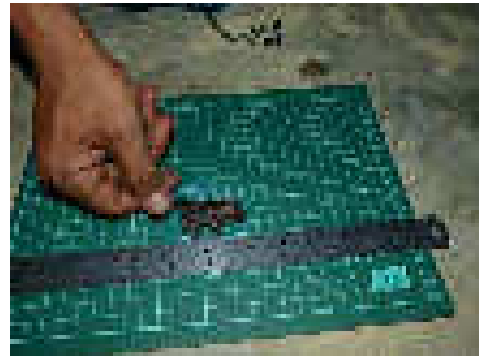
Note

Direct Evidence:

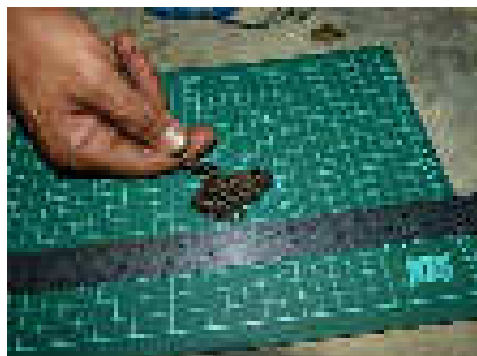
Sound



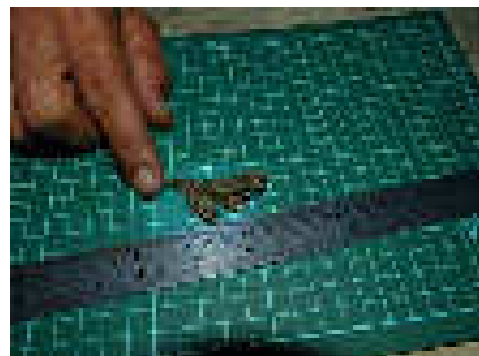
*Fejervarya cancrivora*



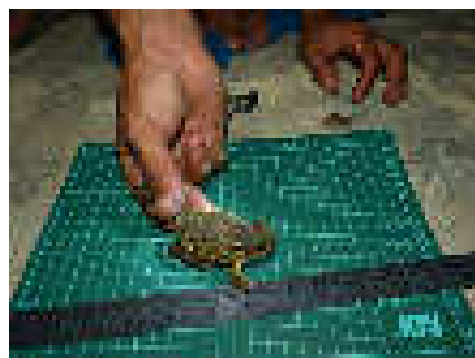
*Pulchrana glandulosa*



*Pulchrana glandulosa, in nature*



*Hylarana erythraea, in han*



*Ingerophrynus melanostictus*

**Figure 4-27. Pictures of all species of Frogs and Toad**

**Table 4-21. List of Reptile Types that can be found at survey sites and surrounding areas**

NO	SCIENTIFIC NAME	FAMILIA	IUCN	LOCATION												
				TR1	TR2	TR3	TR4	TR5	UP1	UP2	UP3	PS1	PS2	PS3	WI1	WI2
1	<i>Naja sumatrana</i>	Elapidae	LC				1			1						
2	<i>Dendrelaphis haasi</i>	Colubridae	LC		1	1										
3	<i>Eutropis multifasciata</i>	Scincidae	LC	3	2	2	1	2	1	1	1	1	1			
4	<i>Eutropis novemcarinata</i>	Scincidae	LC		1	1	1	1		1		1	1	1	1	
5	<i>Lygosoma (quadupes) sp.</i>	Scincidae			1	1	1	1						1	1	
6	<i>Aphaniotis fusca</i>	Agamidae	LC	1	1	1	2	1						1	1	
7	<i>Bronchocela cristatella</i>	Agamidae	LC	2	3	1	2	1			1				1	1
8	<i>Tytthoscincus temmincki</i>	Scincidae		1	1	1	2	1	1						1	
9	<i>Dendragama boulengeri</i>	Agamidae			1	1	1	1							1	
10	<i>Varanus salvator</i>	Varanidae	LC	2	2	1						1		1	2	3
11	<i>Varanus bengalensis</i>	Varanidae	LC		1	1	1	1		1					1	
<b>TOTAL INDIVIDU</b>				9	14	11	12	9	2	4	2	3	2	4	9	4
<b>TOTAL SPECIES</b>				5	10	10	9	8	2	4	2	3	2	4	8	2

Notes :

IUCN Criteria

LC = Least

Concern

NT = Near

Threatened

VU = Vulnerable

EN = Endangered

CR = Critical

Endangered

PP No. 7 Year 1999

DL = Protected

LOCATION

TR1 - TR5 = Transects on Pipeline Route at Road

Section

UP1 - UP3 = Transect on Pipeline Route at Unpaved

Section

PS1 - PS3 = Transect on Power Plan and Surrounding Area

WI1 - WI2 = Transect on Water

Intake Lane

Note

Direct Evidence:

Visual

## 4.2.6 Birds (AVIFAUNA)

Bird observations in this survey, resulted in a list of bird species from the inventory. In general it appears that bird species reflect the habitats and ecosystems of Weand Surrounding Areaands. With the discovery of 3 species of Shrimp King (Fam Alcedinidae), and other types of Sylvidae family, also

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Columbidae, which is Tekukur (*Spilopelia chinensis*) and Perhutut (*Geopelia striata*), commonly encountered in open lowland forest habitats and Weand Surrounding Areaands.

Predator birds most commonly observed species of bird predators are the Snake Eagle (*Spilornis cheela*). The bird is often observed flying spin (Soaring) on open land, looking for reptilian prey exposed on open land. Other interesting types also to be observed are Sikep Madu/ crested honey buzzard (*Varnish ptilorhynchus*), honey and oil plam fruit feeding specialist birds.

Considering by the time the survey has been conducted within migration season (December to February) , Migratory Birds already appear in the area, represented by *Hirundo rustica* that spesies was observed in large number from TR2 and roosting on High Wire.

Observers managed to release (free up) from snare entanglement an immature Cinnamon Bittern (*Ixobrychus cinnamomeus*) near BM2 pole in WI2 Transect Line. It is indicated that the species just passed breeding season.

Population abundance of each speciesis mentioned and grouped into each Transect can be checked in Table 4-4 bellow.

Table 4-22. List Of Birds Species

NO.	LOCAL NAME	SCIENTIFIC NAME	FAMILIA	IUCN	PP-7/1999	LOCATION																											
						TR1		TR2		TR3		TR4		TR5			UP1		UP2		UP3		PS1		PS2		PS3		WI1		WI2		
						V	S	V	S	V	S	V	S	V	S	RST	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V
1	Cangak abu	<i>Ardea cinerea</i>	Ardeidae	LC		1		1		1		1		1							1						1		1				
2	Cangak merah	<i>Ardea purpurea</i>	Ardeidae	LC		1		1		1		1		1											1		1		1				
3	Kokoan laut	<i>Butorides striata</i>	Ardeidae	LC		1		1										1											1				
4	Kuntul kecil	<i>Egretta garzetta</i>	Ardeidae	LC		1		1										1							1		1		1				
5	Bambangan merah	<i>Ixobrychus cinnamomeus</i>	Ardeidae	LC				1				1															1		1				
6	Belibis batu	<i>Dendrocygna javanica</i>	Anatidae					2																					1				
7	Sikep madu Asia	<i>Pernis ptilorhynchus</i>	Accipitridae	LC	DL					1				1						1													
8	Elang-laut perut-putih	<i>Haliaeetus leucogaster</i>	Accipitridae	LC	DL	1												1		1								1		1			
9	Elang-ikan kepala-kelabu	<i>Ichthyophaga ichthyaetus</i>	Accipitridae	NT	DL			1										1												1			
	synonim	<i>Haliaeetus ichthyaetus</i>																															
10	Elang ular bido	<i>Spilornis cheela</i>	Accipitridae	LC	DL	2		2		2		2		2			2				2		2		2		2						
11	Elang brontok	<i>Nisaetus cirrhatus</i>	Accipitridae	LC	DL	2		2		2		2		2			2				2		2		2		2		3				
12	Puyuh siul-selanting	<i>Rhizothera longirostris</i>	Phasianidae	NT				1		1		1		1														1					
13	Puyuh hitam	<i>Melanoperdix niger</i>	Phasianidae	VU		1				1		1		1						1								1					
14	Puyuh-gonggong Sumatera	<i>Arborophila rUbrostris</i>	Phasianidae	lc				2				1																					
15	Kareo padi	<i>Amauornis phoenicurus</i>	Rallidae	LC			8		7	1	7	1	4	1	4					2				1	1			1		2	3		
16	Punai gading	<i>Treron vernans</i>	Coulumbidae	LC		3		6		9								2												3			
17	Pergam hijau	<i>Ducula aenea</i>	Columbidae	LC		5		6		8		2												1				3		2			
18	Pergam gunung	<i>Ducula badia</i>	Columbidae	LC		3		2		2		2		2						1						1		1		1			
19	Tekukur	<i>Spilopelia chinensis</i>	Columbidae	LC		13	10	15	12	8	1	10	8	12	4		13	8	4		7		5		6		3		10	4	6		
20	Perkutut	<i>Geopelia striata</i>	Columbidae	LC		9	4	15	7	5		18		12	12		8	4	5		10	3	7		4		2		11	6	5		
21	Betet ekor panjang	<i>Psittacula longicauda</i>	Psittacidae	NT	DL	6		5		17		3		5			3			4						3		3		5			
22	Serindit melayu	<i>Loriculus galgulus</i>	Psittacidae	LC		5		1		6		2		1			1				1		1				1		2				
23	Wiwik kelabu	<i>Cacomantis merulinus</i>	Cuculidae	LC		8		3		7		9		3			2		2		2		3		3		1		4		2		
24	Wiwik uncuang	<i>Cacomantis sepulcralis</i>	Cuculidae	LC		3		2		5		3		5			2		3		5		3		3				6		3		
25	Kedasih hitam	<i>Surniculus lugubris</i>	Cuculidae	LC		1		2		6		2		2						1								1					
26	Butbut besar	<i>Centropus sinensis</i>	Cuculidae	LC		7		10		5		12		8			1				1		3		2			3					
27	Butbut Alang-alang	<i>Centropus bengalensis</i>	Cuculidae	LC		1		2		3		6		8			3		2		3		4		4		3		5		5		
28	Serak Jawa	<i>Tyto alba</i>	Tytonidae	LC												1																	
29	Cabak maling	<i>Caprimulgus macrurus</i>	Caprimulgidae	LC		1	3		2	1	8	1	2	3	4			2			1	5		3				4		7	5		
30	Cabak kota	<i>Caprimulgus affinis</i>	Caprimulgidae	LC		5	14		4	1	4	2	5	1	2		1				2	4	1	2	1		1	3	3	5	2		
31	Walet sarang burung	<i>Collocalia fuciphaga</i>	Apodidae	LC		13		17		4		6		2			2				3		4		2		7		6		8		
	synonim	<i>Aerodramus fuciphagus</i>																															
32	Walet sapi	<i>Collocalia esculenta</i>	Apodidae	LC		28		10		3		9		13			5		6		3		3		3		3		9		2		
33	Tepekong jambul	<i>Hemiprocne longipennis</i>	Hemiprocidae	LC		2						5		3														2					
34	Tepekong rangkang	<i>Hemiprocne comata</i>	Hemiprocidae	LC		2						3																					
35	Raja udang Erasia	<i>Alcedo atthis</i>	Alcedinidae	LC	DL	3		4		1		1		1				2				1		1		1		2		1			
36	Raja udang meninting	<i>Alcedo meninting</i>	Alcedinidae	LC	DL	2		3		2		1		1				1				1		1		1		1		1			
37	Pekaka emas	<i>Pelargopsis capensis</i>	Alcedinidae	LC	DL	2		2		1																		1		2			

NO.	LOCAL NAME	SCIENTIFIC NAME	FAMILIA	IUCN	PP- 7/1999	LOCATION																											
						TR1		TR2		TR3		TR4		TR5			UP1		UP2		UP3		PS1		PS2		PS3		WI1		WI2		
						V	S	V	S	V	S	V	S	V	S	RST	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V
38	Cekakak belukar	<i>Halcyon smyrnensis</i>	Alcedinidae	LC	DL	9		5		3		5		6			3		2		2		3		1		2		3		1		
39	Cekakak China	<i>Halcyon pileata</i>	Alcedinidae	LC	DL	3		2		1		1										1				1		1					
40	Cekakak sungai	<i>Todirhamphus chloris</i>	Alcedinidae	LC	DL	2		2		2		2		2			1		1				1					2		1			
41	Pelatuk besi	<i>Dinopium javanense</i>	Picidae	LC		5		4		5		3		2			2		2		2		1				1		2		2		
42	Pelatuk Raffles	<i>Dinopium rafflesii</i>	Picidae	LC		1		1		1		2		2			1		1		1				1		1		1		1		
43	Caladi tilik	<i>Picoides moluccensis</i>	Picidae	LC		2		2		2		3		2			1				1						1		1				
	synonim	<i>Dendrocopos moluccensis</i>	Picidae	LC																													
44	Sriti api	<i>Hirundo rustica</i>	Hirundinidae	LC		103		187		78		35		21			3				5						15		5				
45	Sriti batu	<i>Hirundo tahitica</i>	Hirundinidae	LC		11		7		3		5		9			6		2		7		3		1		3		8		8		
46	Jingjing bukit	<i>Hemipus picatus</i>	Campephagidae	LC		2		1		1		1																1		1			
47	Jingjing batu	<i>Hemipus hirundinaceus</i>	Campephagidae	LC		1		1		1		1										1						1		1			
48	Kepudang-sungu kecil	<i>Lalage fimbriata</i>	Campephagidae			3		2		2		2		2			1											1		1			
49	Kapasan kemiri	<i>Lalage nigra</i>	Campephagidae	LC		6		7		2		2		2			3				3		6		5		2		5		2		
50	Kutitang	<i>Pycnonotus aurigaster</i>	Pycnonotidae	LC		13		15		21		30		15			12		6		18		10		5		9		14		15		
51	Jogjog/Terucuk	<i>Pycnonotus goiavier</i>	Pycnonotidae	LC		9		11		11		3		15			7		5		13		12		8		16		10		11		
52	Merbah belukar	<i>Pycnonotus plumosus</i>	Pycnonotidae	LC		7		7		8		11		14			2		2		3		3		2		2		5		3		
53	Merbah corok-corok	<i>Pycnonotus simplex</i>	Pycnonotidae	LC		5		2		1		3		1			1				1		1		1		1		1		1		
54	Merbah mata merah	<i>Pycnonotus brunneus</i>	Pycnonotidae	LC		3		2		2		2		2			2				2		2		2				2				
55	Srigunting keladi	<i>Dicrurus aeneus</i>	Dicruridae	LC		2		1		1		2		1							1		1						1				
56	Kepodang kuduk Hitam	<i>Oriolus chinensis</i>	Oriolidae	LC		1		1		1		1					2				2												
57	Taktabau Malaysia	<i>Lyncornis temminckii</i>	Caprimulgidae	LC		1		1		1															1			1		1			
58	Gagak kampung	<i>Corvus macrorhynchos</i>	Corvidae	LC		1		2		1				1			1				1				1			1					
59	Gelatik batu	<i>Parus major</i>	Paridae	LC		11		13		7		5		8			6		1		5		5		5		1		9		5		
60	Remetuk laut	<i>Gerygone sulphurea</i>	Acanthizidae	LC		3		2		1		2		2							1		2					2					
61	Cinenen belukar	<i>Orthotomus atrogularis</i>	Sylviidae	LC		9		10		13		15		10			5		2		2		5		4		5		19		6		
62	Cinenen kelabu	<i>Orthotomus ruficeps</i>	Sylviidae	LC		14		13		11		12		10			8		8		9		5		3		4		9		6		
63	Prenjak Perut Kunig	<i>Prinia flaviventris</i>	Costicolidae	LC		10		13		12		14		15			5		3		7		7		8		5		8		5		
64	Prenjak Sayap Garis	<i>Prinia familiaris</i>	Costicolidae	LC		8		5		9		18		14			4				6		2				1		2				
65	Cici padi	<i>Cisticola juncidis</i>	Costicolidae	LC		12		8		2		12		11			5				7		5						9		2		
66	Sikatan biru-langit	<i>Cyornis caerulatus</i>	Muscicapidae	VU		1		3		2		2																			1		
67	Sikatan Melayu	<i>Cyornis turcosus</i>	Muscicapidae	NT		1		2		2		2																			2		
68	Sikatan bakau	<i>Cyornis rufigastra</i>	Muscicapidae	LC		2		2																							2		
69	Kipasan mutiara	<i>Rhipidura perlata</i>	Rhipiduridae	LC		7		5		8		5		5			2				4		3		1		1		3		2		
70	Kipasan belang	<i>Rhipidura javanica</i>	Rhipiduridae	LC		3		2		4		2		2			1				1								2		2		
71	Kekep babi	<i>Artamus leucorynchus</i>	Artamidae	LC		2		3		1		2		3									2				2		2				
72	Bentet	<i>Lanius schach</i>	Lanidae	LC		5		5		5		2		3			1				1												
73	Perling kumbang	<i>Aplonis panayensis</i>	Sturnidae	LC		18		5																									
74	Jalak suren	<i>Sturnus contra</i>	Sturnidae	LC		8		7				3											2				2		3				
75	Jalak ungu	<i>Acridotheres tristis</i>	Sturnidae	LC		5		3				7		5							1								3		2		
76	Jalak kerbau	<i>Acridotheres javanicus</i>	Sturnidae	LC		9		2		1		2		3			2				3						1		2		3		
77	Sesap madu kelapa	<i>Anthreptes malacensis</i>	Nectariniidae	LC	DL	4		12		3		15		13			7		2		8		7		5						2		

NO.	LOCAL NAME	SCIENTIFIC NAME	FAMILIA	IUCN	PP- 7/1999	LOCATION																											
						TR1		TR2		TR3		TR4		TR5			UP1		UP2		UP3		PS1		PS2		PS3		WI1		WI2		
						V	S	V	S	V	S	V	S	V	S	RST	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V	S	V
78	Burung madu Sriganti	<i>Cinnyris jugularis</i>	Nectariniidae	LC	DL	3		6		5		8		9			4		2		5		3		1		2		6		4		
79	Cabean bunga-api	<i>Dicaeum trigonostigma</i>	Dicaeidae	LC		9		10		16		19		12												1		1		4			
80	Cabean jawa	<i>Dicaeum trochileum</i>	Dicaeidae	LC		6		12		3		12		14					1				6		2		3		4		6		
81	Burung kacamata	<i>Zosterops palpebrosus</i>	Zosteropidae	LC		12		8		7		15		7			4				3		2				2		2		1		
82	Burung gereja	<i>Passer montanus</i>	Passeridae	LC				7		5		22		36					3		5												
83	Emprit tunggir putih	<i>Lonchura striata</i>	Estrildidae	LC		12		5		5		13		11			12		7		10		3		9				7		5		
84	Emprit perut putih	<i>Lonchura leucogastra</i>	Estrildidae	LC		11		11		7		8		5			5				6		2		2				4		1		
85	Bondol peking	<i>Lonchura punctulata</i>	Estrildidae	LC		14		5		8		16		17			9		3		7		5		3		1		6		4		
86	Bondol haji	<i>Lonchura maja</i>	Estrildidae	LC		12		10		2		13		11			2				2		2		2		1		6		3		
TOTAL INDIVIDU						533	39	572	32	391	20	468	19	415	26	1	175	14	84	2	206	12	154	6	109	0	117	8	260	24	173	8	

IUCN Criteria

- LC = Least Concern
- NT = Near Trheatened
- VU = Vulnerable
- EN = Endangered
- CR = Critical Endangered

PP No. 7 Year 1999

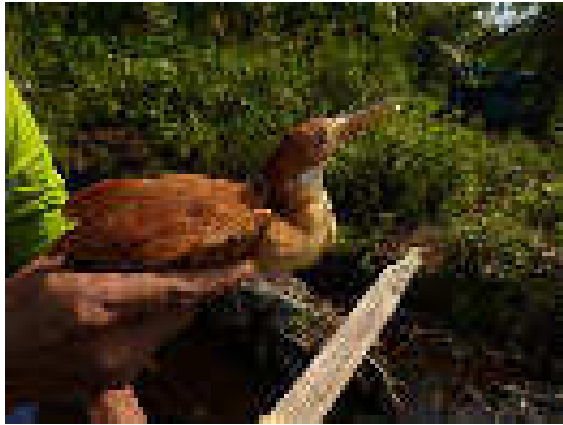
- DL = Dilindungi  
(Protected)

LOCATION

- TR1 - TR5 = Transects on Pipeline Route at Road  
Section
- UP1 - UP3 = Transect on Pipeline Route at Unpaved Section
- PS1 - PS3 = Transect on Power Plan and Surrounding Area
- WI1 - WI2 = Transect on Water Intake Lane

EVIDENCE:

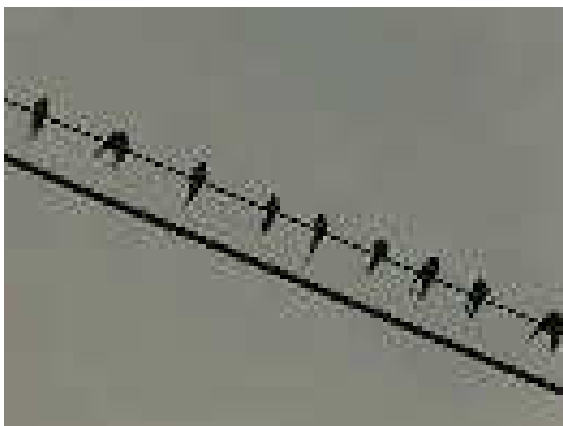
- DRT Direct Evidence Visual; Sound/Call; Cue  
v=Visual; S=Sound; C=Cue
- IDT Indirect Evidence Faecal; Nest; Footprint; Roosting Site; Left  
over
- RST=Roosting Site



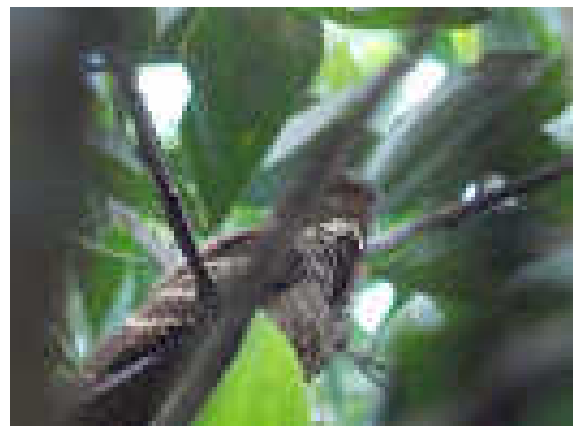
*Immature Ixobrychus cinnamomeus*



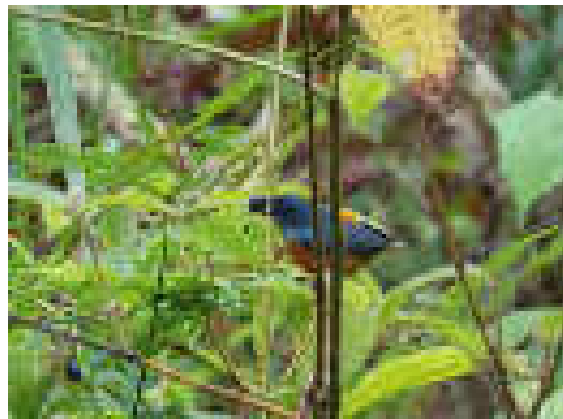
*Psittacula longicauda*



*Hirundo rustica*



*Caprimulgus affinis*



*Cyornis caeruleus*

**Figure 4-28. Bird Species**

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#### 4.2.7 Mammals

Important note for Mammals is coming from especially Transect 3 and 4 (TR3, TR4) at Road Section 1. Several species that have important Conservation Status occupy a small patch of remnant forest near that transect. Nest and Claw mark on tree come from Asian honey Bear (*Helarctos malayanus*) shown in Figure 4-5. Also Agile Gibbon visually engaged in group of 3 individuals and more 2 calls from different group nearby point count TR03\_PNT001. And *Manis javanica* has been spotted it's Left over in Palm Oil Plantation feeding on Termites. *Rusa unicolor* was also spotted his left over near TR03\_PNT002.

List of Mammals species are shown in Table 4-5. Some of evidence of the Mammals that have been found during the survey are shown in Figures 4-5.

There is An Annotated Checklist of Mammals Finding shown below.

*Manis javanica*

Indirect evidence : Left Over

TR3 0°37'58.60"N 101°39'48.40"E

TR4 0°35'51.00"N 101°38'47.90"E

TR5 0°33'58.30"N 101°36'57.60"E

*Rusa unicolor*

Indirect evidence: left over

TR3 0°37'58.60"N 101°39'48.40"E

*Helarctos malayanus*

Indirect evidence : 2 nesting sites; 1 bark ripped off

(Evidences assumed come from one individual)

TR3 0°37'59.76"N 101°39'47.20"E

*Macaca nemestrina*

Direct evidence: Visual.

TR3 0°37'58.60"N 101°39'48.40"E

TR4 0°35'59.90"N 101°38'48.30"E

TR5 0°33'58.30"N 101°36'57.60"E

*Trachypithecus cristatus*

Direct Evidence

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Visual

TR3 0°37'38.37"N 101°39'37.39"E

TR4 0°35'59.90"N 101°38'48.30"E

*Hylobates agilis*

Direct evidence:

Visual (3 individu in one group/family)

Calls (come from 2 individuals)

TR3 0°38'9.60"N 101°39'52.80"E

Table 4-23. List of Mammalian species

NO	SCIENTIFIC NAME	FAMILIA	IUCN	PP. No.7 Year 1999	LOCATION																															
					TR1				TR2				TR3				TR4				TR5				UP1				UP2				UP3			
					DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT	
1	<i>Callosciurus notatus</i>	Sciuridae	LC		1	V			2	V			3	V			3	V			1	V			1	V										
2	<i>Manis javanica</i>	Manidae	CR										1	L			1	L			1	L														
3	<i>Sus scrofa</i>	suidae								3	FP			1	FP			1	FP			1	FP	1	V					1	FP			1	FP	
4	<i>Tragulus kanchil</i>	Tragulidae	LC										1	FP			1	FP			1	FC														
5	<i>Rusa unicolor</i>	Cervidae	VU										1	L																						
6	<i>Helarctos malayanus</i>	Ursidae	VU										1	NS;BRO																						
7	<i>Macaca nemestrina</i>	Cercopithecidae	VU									15	V			12	V			1	V															
8	<i>Macaca fascicularis</i>	Cercopithecidae	LC		17	V			5	V			12	V																						
9	<i>Trachypithecus cristatus</i>	Cercopithecidae	NT									17	V			8	V																			
10	<i>Hylobates agilis</i>	Hylobatidae	EN									5	3V;2S																							
TOTAL INDIVIDU					18		0		7		3		52		5		23		3		2		3		2		0		0		1		0		1	
TOTAL SPECIES					2		0		2		1		5		5		3		3		2		3		2		0		0		1		0		1	

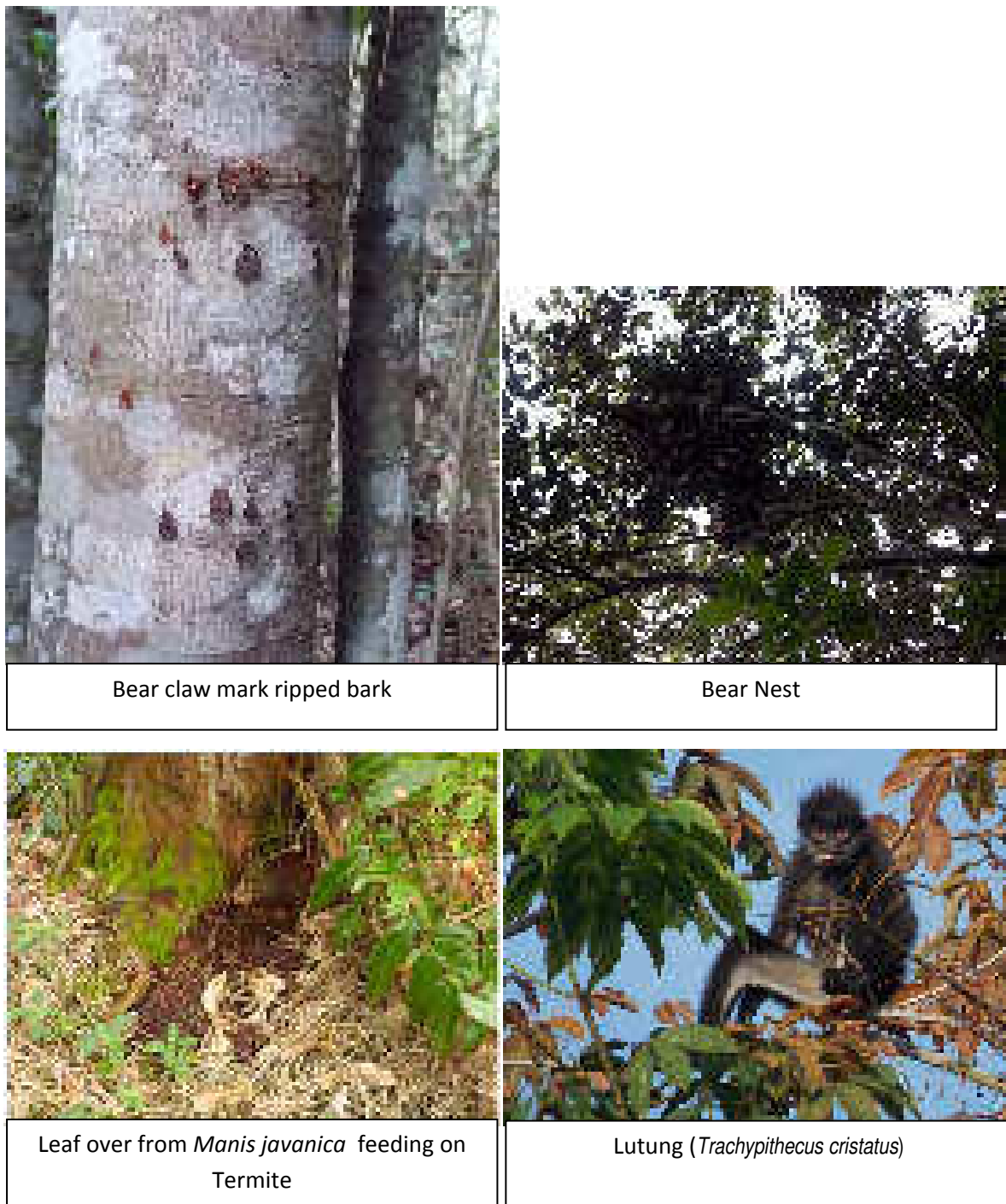
NO	SCIENTIFIC NAME	FAMILIA	IUCN	PP. No.7 Year 1999	LOCATION																		
					PS1				PS2				PS3				WI1				WI2		
					DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT		DRT		IDT
1	<i>Callosciurus notatus</i>	Sciuridae	LC		1	V																	
2	<i>Manis javanica</i>	Manidae	CR																				
3	<i>Sus scrofa</i>	suidae												1	FP			1	FP				
4	<i>Tragulus kanchil</i>	Tragulidae	LC																				
5	<i>Rusa unicolor</i>	Cervidae	VU																				
6	<i>Helarctos malayanus</i>	Ursidae	VU																				
7	<i>Macaca nemestrina</i>	Cercopithecidae	VU													21				9			
8	<i>Macaca fascicularis</i>	Cercopithecidae	LC													10				27			
9	<i>Trachypithecus cristatus</i>	Cercopithecidae	NT													12				8			
10	<i>Hylobates agilis</i>	Hylobatidae	EN																				
TOTAL INDIVIDU					1		0		0		0		0		1		43		1		44		
TOTAL SPECIES					1		0		0		0		0		1		3		1		3		

Notes :  
Conservation Status IUCN  
LC = Least Concern  
NT = Near Theatened  
EN = Endanger  
PP No. 7 Year 1999  
DL = Protected  
LOCATION

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TR1 - TR5 = Transects on Pipeline Route at Road Section  
UP1 - UP3 = Transect on Pipeline Route at Unpaved Section  
PS1 - PS3 = Transect on Power Plan and Surrounding Area  
WI1 - WI2 = Transect on Water Intake  
Lane

EVIDENCE:  
DRT    Direct Evidence    Visual; Sound/Call; Cue  
         V=Visual; S=Calls;  
         C=Cue  
IDT    Indirect Evidence    Faecal; Nest; Footprint; Roosting Site; Left over  
         FC=Faecal; NS=Nest; FP=Footprint; RST=Roosting Site; L=Left Over.; BRO=Bark Ripped Off



**Figure 4-29. Some of evidence of the Mammals that have been found during the survey**

#### 4.2.8 Conclusion

Based on the Habitat Type review, it can be concluded that the Initial measure of the Survey Area as a whole is derived from the Fresh Water Swamp Forest. While the waters area of the River Siak System is the Black Water River Ecosystem, which is a warehouse of diversity of freshwater fish species. Evidence through the inventory of species of animals, especially the bird species (Avifauna), shows support for these allegations. Some bird species are as indicator of weand Surrounding Areaand or weand Surrounding Areaand ecosystem (Weand Surrounding Areaand).

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Migratory Birds are already appeared in the area, represented by *Hirundo rustica*. It is likely less important note if there is no other migratory birds occurred in the area, but yet it is more important to take a note that the area has been visited at all.

In some area where small patches of remnant forest still emerge, some species that considered has important Conservation Status has been observed.

Biota of freshwater is relatively less disturbed. The extent of open land, which was originally a weand Surrounding Areaand of swamps and streams, and forests, is often seen drying. Aquatic animals are very sensitive to such micro-climate change, as well as Herpetofauna. According to some fishermen and locals, their acquisition in the field of fisheries has declined, since the amount of land cleared for plantations and construction. The size of the fish is also observed by them, smaller, unlike some decades ago.

Due to the development of plantationindustry, causing the ecosystem of freshwater swamp forest and weand Surrounding Areaand turned into arid and open area at certain periods on a regular basis. The Oil palm plantation is regenerated periodically in 25 years. Such dramatic environmental changes will cause pressure on the Habitat or Ecosystem concerned. The carrying capacity of the environment will continue to experience continuous decline in quality rapidly. The entire load of such environmental changes will continue to burden the Ecosystem, so that it is only a matter of time before the ecosystem will fail to function and its structure will collapse.

It will be a biased to review of micro-environments and that's exacand Surrounding Areay what happens. If the construction of the Power Plantt and Surrounding Area installation is implemented, it will be difficult to assess whether the impact of environmental change is derived from the activity. Therefore, the construction of the Power Plantt and Transmission line should seriously consider the natural conservation sector, in ways that minimize environmental impacts in its implementation.

Study says more species with important conservation status are found in the are, although deforestation and habitat degradation shown very high disturbance and pressure to the ecosystem, but yet from the species survival prespective, the are still can hold the odds.

## 5 GROUNDWATER RESOURCES

### 5.1 Groundwater Quality

Ground water sampling was conducted at three locations on power plant site plan and seven location on Pipe Line. The sampling results show fulfill the designated quality standard. The groundwater quality test report is presented in **Table. 5-1**.

**Table 5-1. Goundwater quality result January 2018 (Power Plant)**

No	Parameter	Unit	Detection Limit	Regulation Limit PerMenKes No. 32 Tahun 2017	Result		
					GW 1 PP	GW 2 PP	GW 3 PP
					Location reference key at bottom of table		
1	pH	-	-	6,5 – 8,5	7,03	5,84	5,81
2	Total Suspended Solids (TSS)	mg/L	1	NA <sup>3</sup>	32	1	12
3	Biochemical Oxygen Demand (BOD)	mg/L	2	NA <sup>3</sup>	<2	<2	<2
4	Chemical Oxygen Demand (COD)	mg/L	3	NA <sup>3</sup>	<5	<5	<5
2	Oil and Grease	µg/L	1000	NA <sup>3</sup>	2600	3200	3200
3	Total Arsenic (As)	mg/L	0.005	NA <sup>3</sup>	<0,0005	<0,0005	<0,0005
4	Total Boron (B)	mg/L	0.04	NA <sup>3</sup>	<0,04	<0,04	<0,04
5	Total Cadmium (Cd) <sup>2</sup>	mg/L	0.002	NA <sup>3</sup>	<0,002	<0,002	<0,002
6	Total Chromium (Cr)	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
7	Total Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	NA <sup>3</sup>	<0,004	<0,004	<0,004
8	Total Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
9	Total Iron (Fe)	mg/L	0.09	NA <sup>3</sup>	0,18	<0,09	0,12
10	Total Lead (Pb) <sup>2</sup>	mg/L	0.005	NA <sup>3</sup>	<0,005	<0,005	<0,005
11	Total Mercury (Hg)	mg/L	0.0005	NA <sup>3</sup>	<0,0005	<0,0005	0,0021
12	Total Manganese (Mn)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
13	Total Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
14	Total Zinc (Zn)	mg/L	0.02	NA <sup>3</sup>	<0,02	0,05	0,06
15	Ammonia (as NH <sub>3</sub> -N)	mg/L	0.07	NA <sup>3</sup>	0,14	<0,07	0,10
16	Fluoride (F)	mg/L	0.1	1,5	<0,1	<0,1	0,1
17	Total Nitrogen	mg/L	0.06	NA <sup>3</sup>	1,00	1,17	1,20
18	Nitrate (NO <sub>3</sub> )	mg/L	0.003	10	0,064	0,103	0,112

No	Parameter	Unit	Detection Limit	Regulation Limit PerMenKes No. 32 Tahun 2017	Result		
					GW 1 PP	GW 2 PP	GW 3 PP
					Location reference key at bottom of table		
19	Nitrite (NO <sub>2</sub> )	mg/L	0.005	1	0,020	<0,005	0,040
20	Phosphorus (P)	mg/L	0.03	NA <sup>3</sup>	<0,03	<0,03	<0,03
21	Temperature	°C	-	NA <sup>3</sup>	27,9	28,1	29,8
22	Conductivity	µs/cm	1	NA <sup>3</sup>	65,8	14,0	216
23	Turbidity	NTU	0.5	25	12,5	2,91	3,90
24	Dissolved Arsenic (As)	mg/L	0.005	0,05	<0,0005	<0,0005	<0,0005
25	Dissolved Boron (B)	mg/L	0.04	1	<0,04	<0,04	<0,04
26	Dissolved Cadmium (Cd) <sup>2</sup>	mg/L	0.002	0.01	<0,002	<0,002	<0,002
27	Dissolved Chromium	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02
28	Dissolved Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	0.05	<0,004	<0,004	<0,004
29	Dissolved Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
30	Dissolved Iron (Fe)	mg/L	0.09	1	<0,09	<0,09	<0,09
31	Dissolved Lead (Pb) <sup>2</sup>	mg/L	0.005	0,05	<0,005	<0,005	<0,005
32	Dissolved Mercury (Hg)	mg/L	0.0005	0,001	<0,0005	<0,0005	<0,0005
33	Dissolved Manganese (Mn)	mg/L	0.01	0,5	<0,01	<0,01	<0,01
34	Dissolved Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,01	<0,01	<0,01
35	Dissolved Zinc (Zn)	mg/L	0.02	15	<0,02	<0,02	<0,02
36	Total Dissolved Solid (TDS)	mg/L		1000	28	38	67
37	Total Coliform	colony/100mL	-	50	310	71	<1

Note(s):

1 PerMenKes 32/2017 I

2 This parameter (in the described matrix) has not been accredited by KAN

3 Not Applicable or Not Available

GW 1 ; Coordinate: N= 00°32'30,49" E= 101°31'19,03"

GW 2 ; Coordinate: N= 00°32'26,79" E= 101°31'11,93"

GW 3 ; Coordinate: N= 00°32'29.37" E= 101°30'35.78"

**Table 5-2. Goundwater quality result February 2018 (Pipe Line)**

No	Parameter	Unit	Detection Limit	Regulation Limit PerMenKes No. 32 Tahun 2017	Result						
					GW 1 PP	GW 2 PP	GW 3 PP	GW 4 PP	GW 5 PP	GW 6 PP	GW 7 PP
					Location reference key at bottom of table						
1	pH	-	-	6,5 – 8,5	4,21	7	6,26	6,81	4,44	6,27	4,97
2	Total Suspended Solids (TSS)	mg/L	1	NA <sup>3</sup>	1	<1	<1	<1	6	26	<1
3	Biochemical Oxygen Demand (BOD)	mg/L	2	NA <sup>3</sup>	<2	<2	<2	<2	<2	4,7	<2
4	Chemical Oxygen Demand (COD)	mg/L	3	NA <sup>3</sup>	<5	<5	<5	8	<5	141	<5
2	Oil and Grease	µg/L	1000	NA <sup>3</sup>	<1000	<1000	<1000	<1000	<1000	9	<1000
3	Total Arsenic (As)	mg/L	0.005	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
4	Total Boron (B)	mg/L	0.04	NA <sup>3</sup>	<0,04	4,87	<0,04	2,22	2,08	0,38	0,36
5	Total Cadmium (Cd) <sup>2</sup>	mg/L	0.002	NA <sup>3</sup>	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,02
6	Total Chromium (Cr)	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
7	Total Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	NA <sup>3</sup>	<0,004	<0,004	<0,004	<0,004	<0,004	0,006	<0,004
8	Total Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,02	0,06	<0,02	<0,02	<0,02	<0,02	<0,02
9	Total Iron (Fe)	mg/L	0.09	NA <sup>3</sup>	0,05	<0,02	<0,02	0,03	0,03	0,43	<0,02
10	Total Lead (Pb) <sup>2</sup>	mg/L	0.005	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
11	Total Mercury (Hg)	mg/L	0.0005	NA <sup>3</sup>	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005
12	Total Manganese (Mn)	mg/L	0.01	NA <sup>3</sup>	<0,02	0,04	<0,02	0,02	<0,02	<0,02	<0,02
13	Total Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
14	Total Zinc (Zn)	mg/L	0.02	NA <sup>3</sup>	0,08	0,36	0,09	0,10	0,13	0,05	0,07
15	Ammonia (as NH <sub>3</sub> -N)	mg/L	0.07	NA <sup>3</sup>	<0,07	<0,07	<0,07	<0,07	<0,07	<0,07	<0,07

No	Parameter	Unit	Detection Limit	Regulation Limit PerMenKes No. 32 Tahun 2017	Result						
					GW 1 PP	GW 2 PP	GW 3 PP	GW 4 PP	GW 5 PP	GW 6 PP	GW 7 PP
					Location reference key at bottom of table						
16	Fluoride (F)	mg/L	0.1	1,5	<0,1	<0,1	0,2	0,2	<0,1	0,4	0,1
17	Total Nitrogen	mg/L	0.06	NA <sup>3</sup>	1,35	1,19	1,94	1,33	1,04	0,89	1,21
18	Nitrate (NO <sub>3</sub> )	mg/L	0.003	10	<0,003	0,136	0,540	0,28	0,206	<0,003	0,604
19	Nitrite (NO <sub>2</sub> )	mg/L	0.005	1	<0,005	<0,008	0,007	0,012	<0,005	0,017	0,007
20	Phophorus (P)	mg/L	0.03	NA <sup>3</sup>	<0,03	<0,03	<0,03	<0,03	<0,03	<0,03	0,04
21	Temperature	°C	-	NA <sup>3</sup>	27,5	28,4	26,5	27,1	26,7	27,5	27,4
22	Conductivity	µs/cm	1	NA <sup>3</sup>	11,3	109	119	76,2	16,6	67,1	65,5
23	Turbidity	NTU	0.5	25	2,94	<0,5	1,78	3,12	0,46	12,2	0,25
24	Dissolved Arsenic (As)	mg/L	0.005	0,05	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
25	Dissolved Boron (B)	mg/L	0.04	1	<0,04	0,68	<0,04	<0,04	<0,04	0,29	0,19
26	Dissolved Cadmium (Cd) <sup>2</sup>	mg/L	0.002	0.01	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002	<0,002
27	Dissolved Chromium	mg/L	0.02	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
28	Dissolved Chromium Hexavalent (Cr <sup>6+</sup> )	mg/L	0.004	0.05	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004	<0,004
29	Dissolved Copper (Cu)	mg/L	0.01	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
30	Dissolved Iron (Fe)	mg/L	0.09	1	0,03	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
31	Dissolved Lead (Pb) <sup>2</sup>	mg/L	0.005	0,05	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
32	Dissolved Mercury (Hg)	mg/L	0.0005	0,001	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005	<0,00005
33	Dissolved Manganese (Mn)	mg/L	0.01	0,5	<0,02	0,04	<0,02	0,02	<0,02	<0,02	0,02
34	Dissolved Nickel (Ni)	mg/L	0.01	NA <sup>3</sup>	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02	<0,02
35	Dissolved Zinc (Zn)	mg/L	0.02	15	<0,02	0,29	0,03	<0,02	<0,02	<0,02	0,02
36	Total Dissolved Solid (TDS)	mg/L		1000	105	11	33	12	41	9	15
37	Total Coliform	colony/ 100mL	-	50	<1	<1	<1	<1	<1	49	5

Note(s):

1 PerMenKes 32/2017 I

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*2 This parameter (in the described matrix) has not been accredited by KAN*

*3 Not Applicable or Not Available*

*GW 1 ; Coordinate: N= 00°33'13,02" E= 101°32'21,84"*

*GW 2 ; Coordinate: N= 00°33'25,84" E= 101°32'59,54"*

*GW 3 ; Coordinate: N= 00°33'02.79" E= 101°33'48.01"*

*GW 4 ; Coordinate: N= 00°33'09,48" E= 101°34'38,97"*

*GW 5 ; Coordinate: N= 00°32'04,34" E= 101°35'36,87"*

*GW 6 ; Coordinate: N= 00°38'37.42" E= 101°43'35.22"*

*GW 7 ; Coordinate: N= 00°38'39.00" E= 101°39'40.00"*

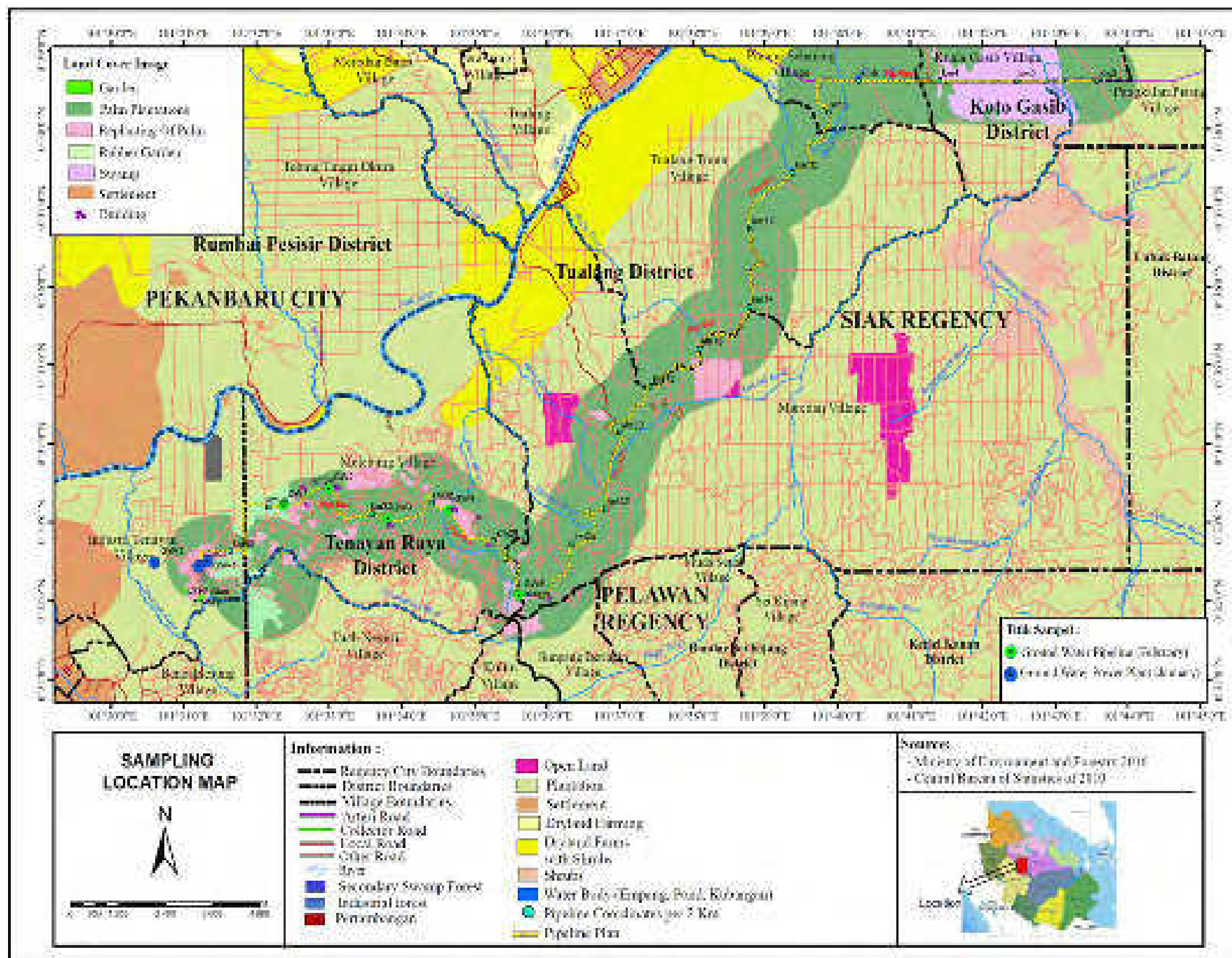


Figure 5-1. Ground Water Sampling Location



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### 5.2.3.1 *Types of work as follows :*

- **General geological condition in research area**

Based on the geological survey conducted, the research area is included into the Minas Formation which is the Quarter Sediment that is not aligned deposited above the Petani Formation . The Minas Formation is composed of thin layers of alluvial gravel and sandstone (Heidrick and aulia, 1993). Its characteristic is better but contains Kaolinite which has low soil porosity characteristic that can hold aluminium compound, so the soil is acidic and highly corrosive to metal material.

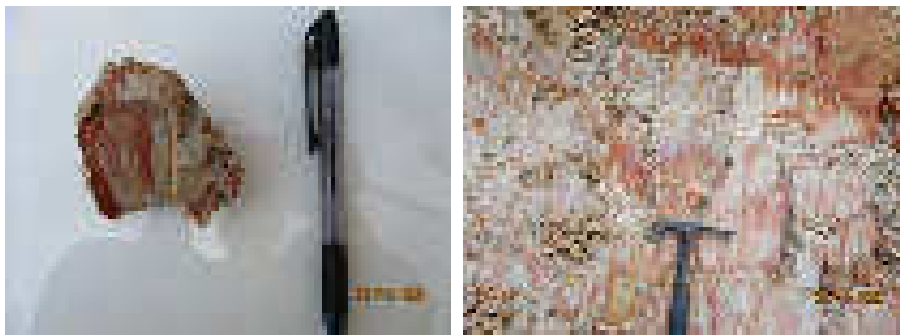
- **Types of soil in research area**

In general, the soil type along the pipe line is sedimentation soil or alluvial soil, developed on hills to the plains regions. It is commonly found around rivers and swamps area. There were also peaty soils found in plantation area at the end of the pipe line.

- **Geological condition along the pipe line**

Based on the geological survey conducted along the pipe line, there were two types of grain size, namely sandy loam and sandy silt, and in several places there were oxidized sandstone insert to be found. The region along the pipe line plan is an active sedimentation zone, so it was very hard to find fresh outcrop. The outcrop that exists in research area are generally soil outcrop of the weathered sandy clay and sandy silt grains, with variant weathering levels. In general, high level of weathering is caused by several factors, in between are climate, vegetation, also types and structures of the region's rocks.

- **Clay Stone**



Clay Stone Outcrop S.19

Clay stoness is the general term for silicate base structure with diameter less than 4 micrometer. Clay contains silica and/or fine aluminium smelting. Silicon, oxygen, and aluminium are the elements that make up most of the earth's crust. Clays are formed from the process of silica rocks weathered by carbonic acid and partly generated from geothermal activity. Clays form hard lump when its dry and sticky when its wet by water. This characteristic is determined by type of dominated clay mineral.

Clay minerals are classified according to the layers of silicon oxide and aluminum oxide that form the crystals. Group 1:1 has one layer of silicon oxide and one layer of aluminium oxide, while group 2:1 has two layers of silicon oxide and one layer of aluminium oxide. The clay mineral of group 2:1 has strong elasticity, shrink when its dry and enlarge when its wet. Because of this behavior some types of soil can form wrinkles or cracked" when dry. On the research area, the soil on 0 Km until 25th Km is include in clay group of 2:1 which has strong elasticity.

- **Silt Stone**



*Silt Rock Outcrop S.28*

Silt stone is middle clastic sediment stone in its mineral composition, between sand and clay. Unfolded starting from 25th Km to 33rd Km. Based on the observation, these silt stones has very fine particles, but still big enough for sand size.

Along the ± 38 km pipe line, Researchers were classifying geological condition and composed soil into 5 lanes. They were classified based on each characteristic.

#### 5.2.4 Work Result

To determine soil bearing capacity along the pipe line plan, we can refer to the Table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005.

***Table 5-3. Table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005***

Bearing Material	Field Consistency	Nominal Permit Bearing Capacity $q_{na}$ (ksf) 1 ksf = 0.4882 kg/cm <sup>2</sup>
Metamorphic rocks and massive crystal igneous rocks : granite, diorite, basalt, gneiss, fully cemented conglomerate rocks (it sounds like glass cracks)	Loud sounding rocks	160
Foliated metamorphic rocks: slate, schist (it sounds like glass cracks)	Medium loud sounding rocks	70
Sediment rocks, strong cemented shale rocks, siltstone, sandstone, limestone without cavity.	Medium loud sounding rocks	40
Weathered or broken bedrock from every stone except for high argillaceous (shale) rock content, RQD <25	Soft rocks	20
Solid shale or high argillaceous (shale) rock content with loud sound	Soft rock	20

Bearing Material	Field Consistency	Nominal Permit Bearing Capacity $q_{na}$ (ksf) 1 ksf = 0.4882 kg/cm <sup>2</sup>
Graded mixture either from fine and coarse grains: 'glacial till', 'hardpan', clay chunk ( <b>GW-GC, GC, SC</b> ).	Very solid	20
Gravel, mixed sand-gravel, mixed chunk gravel ( <b>SW, SP, SW, SP</b> ).	Very Solid Medium to solid Loose	14 10 6
Coarse to medium sand, sand with little gravel ( <b>SW, SP</b> ).	Very Solid Medium to solid Loose	8 6 3
Fine to medium sand, medium to coarse clay or silt sand ( <b>SW, SM, SC</b> ).	Very Solid Medium to solid Loose	6 5 3
Homogeneous in-organic clay, sandy clay or silt clay (CL, CH).	Very stiff to hard Medium to stiff Soft	8 4 1
In-organic silt, sandy silt or clay silt, fine sand contains varved silt clay	Very stiff to hard Medium to stiff Soft	6 3 1
<ul style="list-style-type: none"> <li>Hit by sledge hammer</li> </ul> Note: Bold Print is soil		

The pipe line length is ±38 km, and divided into 5 zone.

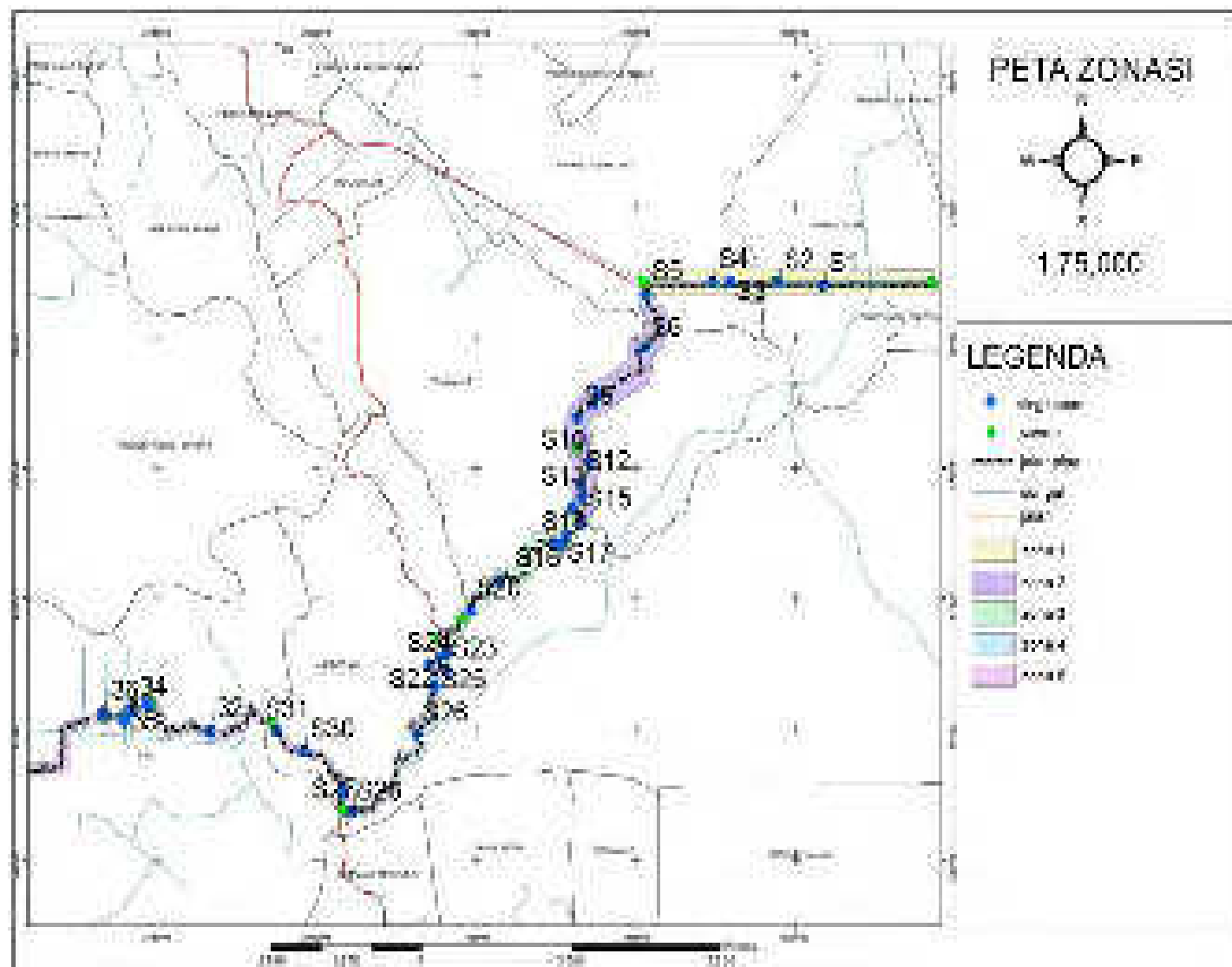


Figure 5-3. Zoning Map





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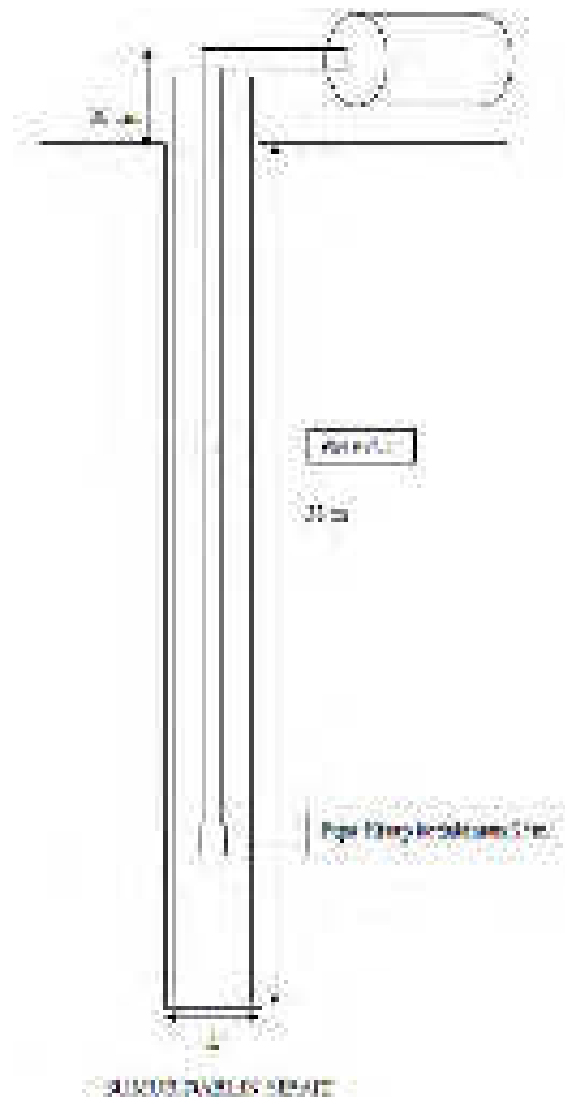
**a. 1<sup>st</sup> – 8.3<sup>rd</sup> KM, End of line until Gasib cross. (zone 1)**

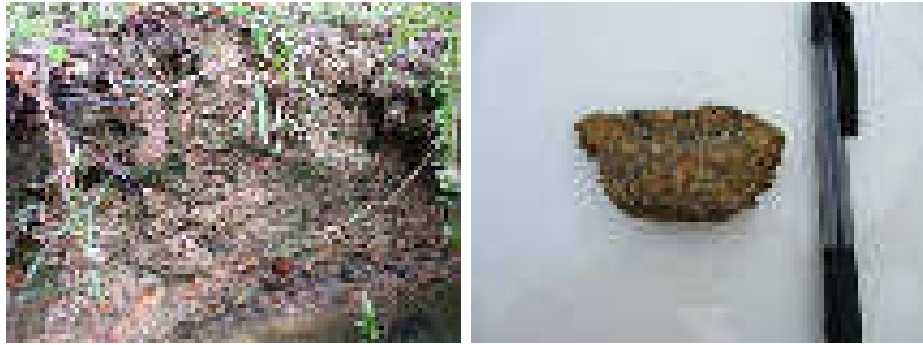
There were 5 outcrops with the same characteristic, sandy and pliant texture, dominated with yellow colour, alluvial soil type (dian fiantis). With soil parent material came from weathered sandy clay stone, with consistency of hard when dry and firm when moist or wet. This zone 1 is included in low land.

Based on the table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005, the soil bearing capacity in zone 1 is included in the category of fine to medium sand, silt clay or medium to coarse clay (SW, SM, SC) with field consistency of medium to solid with bearing capacity value of 5. It is being destined for continuous and light building.

Besides outcrop observation, the data were supported with observing the lithology condition of community's wells that available on the pipe line surrounding. There were 5 wells available.

**Mr. Darlin Sirait's well**, was a still active drilling well with 38 meters in depth. It is used for Bath-Wash-Toilet necessity, with sandy clay lithology which refers to garden well lithology that exists at approx 150 meters.

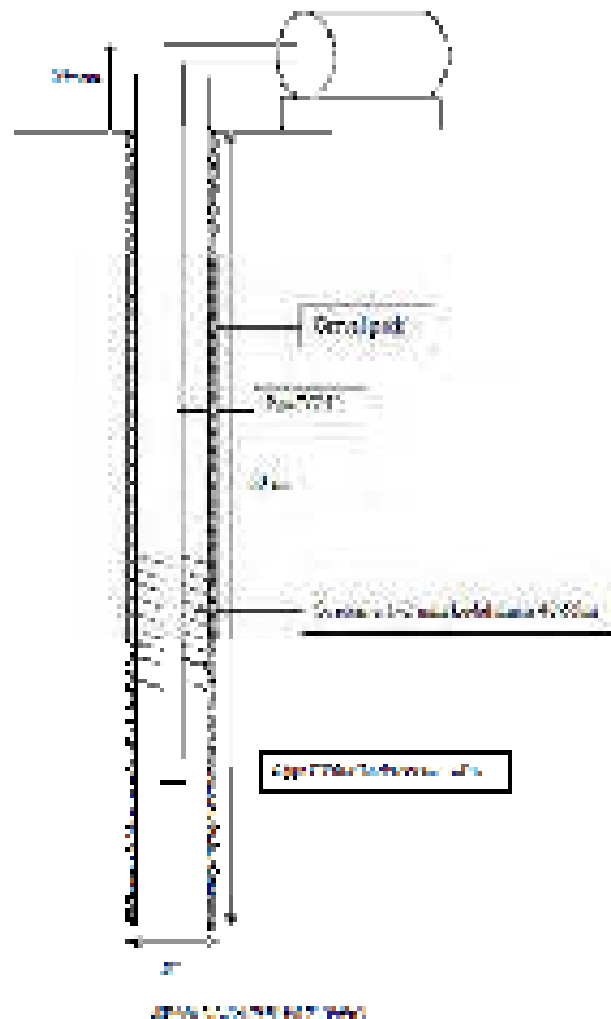


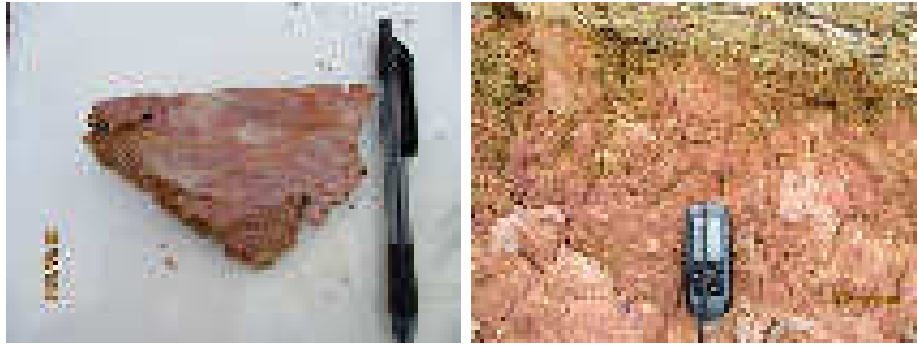


**Soil type in Mr. Darlin Sirait's well location**

Sample was taken on the well's wall, the color was blackened brown, not fresh color because of the obsolete. However, the soil texture was sticky and sandy clay which is known that the soil is weathering of sandy clay rocks. Corresponding with the grain size it was included in minas formation. The location was  $\pm 50$  m N49°E bound from Mr. Sirait's well, to be exact was on the garden well's wall.

**Mr. Jhoni Gultom's Well**, was an in-active drilling well with 60 meters in depth. Based on the sample taken from  $\pm 100$  meters of the well, the lithology was composed of sandy caly rocks.





***Soil type in Mr. Jhoni Gultom's well location***

The sample was taken on the cliff area,  $\pm 100$  m west side of the well N68°E bound. It was redish with sticky and sandy texture, which is a weathering of sandy clay rocks include in minas formation.

**Mr. Sarbini's well**, is an active dug well with 10 meters in depth of concrete pipe construction and being used for bath-wash-toilet necessity, drinking, and cooking. Based on the sample taken  $\pm 50$  meters of the well, the well's lithology was composed of sandy clay rocks.

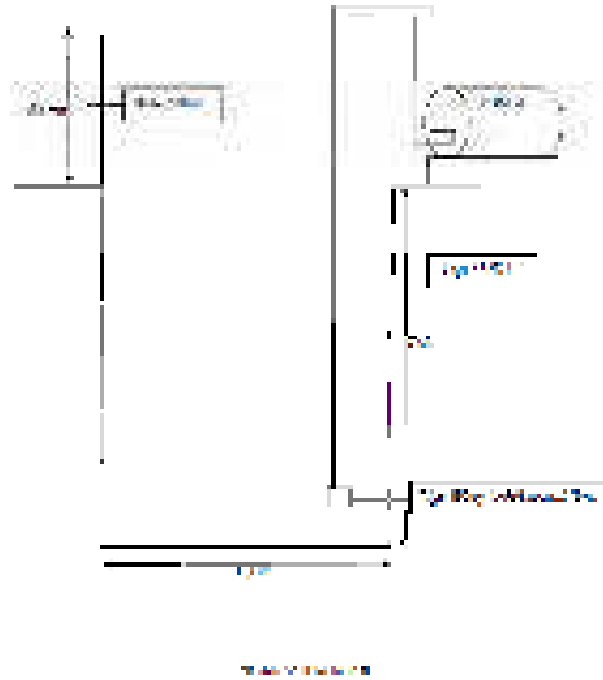


***Soil type on Mr. Sarbini's well location***

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Sample was taken on the cliff area north side of the well location,  $\pm 50$  meters N49°E northbound. It was brownish, the outcrop was not fresh and sticky and sandy texture. It is known that outcrop is a weathering of sandy clay rocks which is include in minas formation.

**Mrs Adui's well**, is an active dug well with 7 meters in depth of concrete pipe construction and being used for bath-wash-toilet necessity. Based on the sample taken from  $\pm 50$  meters of lithology well, the well was composed of sandy clay rocks.



***Soil Type in Mrs Adui's well location***

The sample was taken on the cliif that was located on the south side of the well location  $\pm 50$  meters, N157°E bound. It was bright brown in color, sticky and sandy. The outcrop soil was not fresh and a weathering of sandy clay rocks which include in minas formation.

**Garden well**, located at the end of the pipe, it was a dug well without construction with 1.3 meters in depth. It was used for community's garden needs. Based on the sample taken from the topside of the well's wall. The well's lithology was composed of sandy clay rocks.

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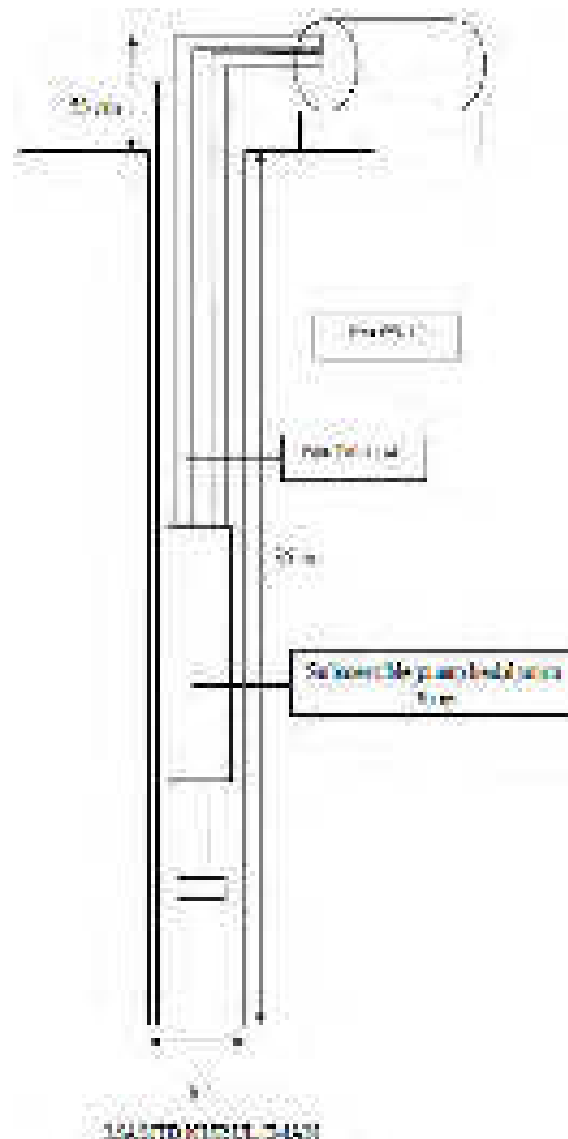
### b. 8,4<sup>th</sup> -15,5<sup>th</sup> KM, Gasib cross to Perawang cross (zone 2)

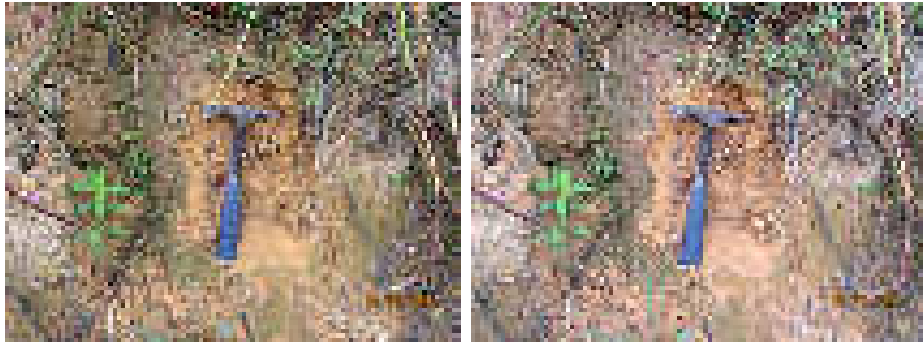
There were 10 outcrops with the same characteristic, sandy and pliant texture, dominated with yellow colour, alluvial soil type (dian fiantis). With soil parent material came from weathered sandy clay stone, with consistency of hard when dry and firm when moist or wet. This zone 2 is included in hills area.

Based on the table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005, the soil bearing capacity in zone 2 is included in the category of fine to medium sand, silt clay or medium to coarse clay (SW, SM, SC) with field consistency of medium to solid with bearing capacity value of 5. It is being destined for continous and light building.

Besides outcrop observation, the data were supported with observing the lithology condition of community's wells that available on the pipe line surrounding. There were 2 wells available.

**Nurul iman mosque's well**, is an active drilling well with 35 meters in depth which was being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 100$  meters from the well, the well's lithology was composed of sandy clay rocks.

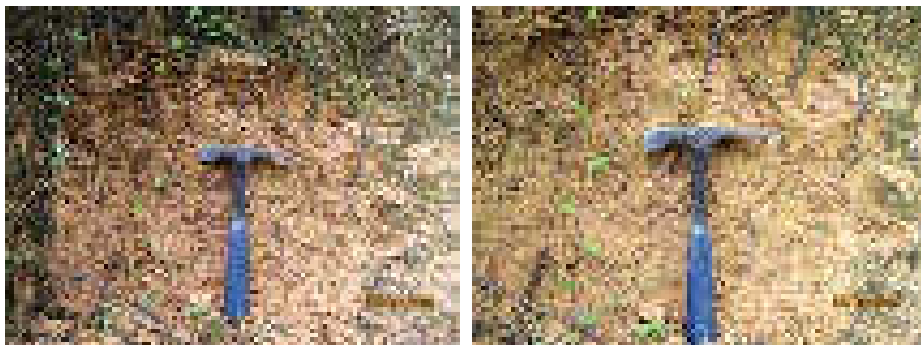




***Soil type in Nurul Iman Mosque's Well location***

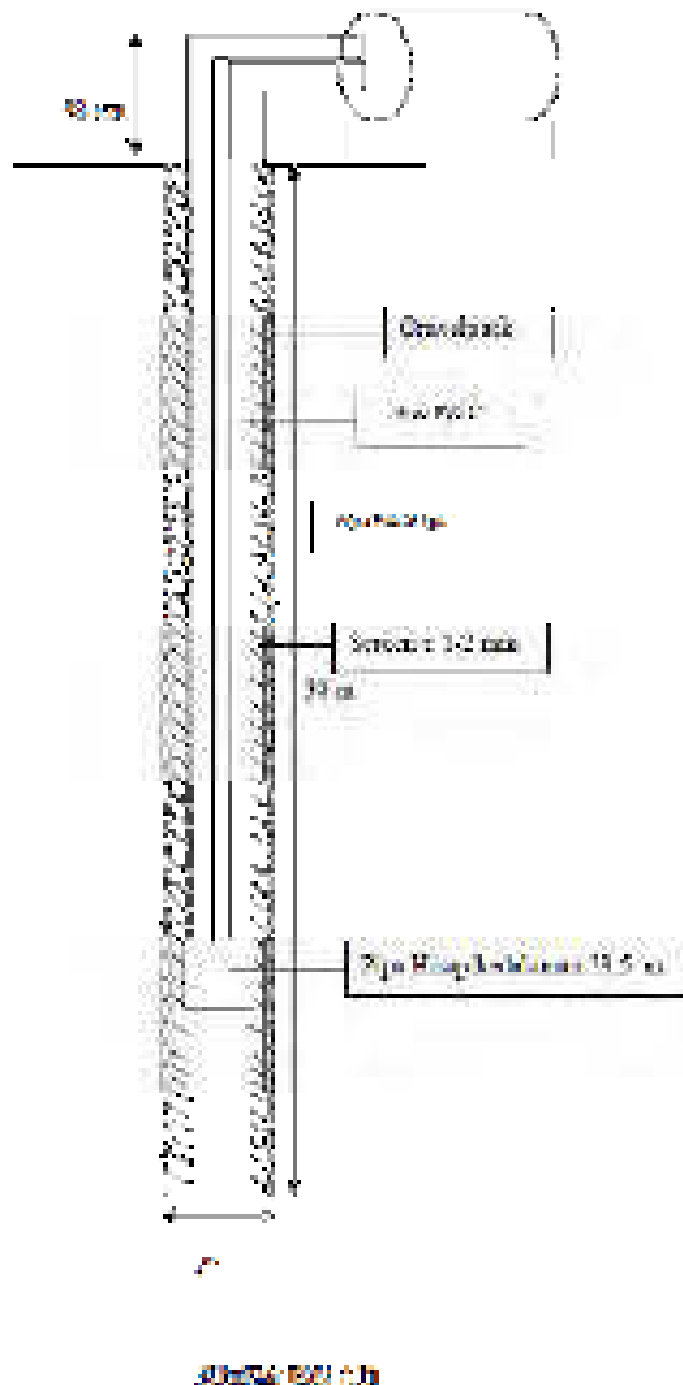
The sample was taken on the cliff area on the west side  $\pm 100$  m of the well location N61°E bound. It was brown in color, sticky and sandy. The outcrop soil was not fresh and a weathering of sandy clay rocks which include in minas formation.

**Mrs. Ati's well** is an active drilling well with 30 meters in depth being used for bath-wash-toilet necessity, drinking and cooking. Based on the sample taken  $\pm 50$  meters from the well, the well's lithology was composed of sandy clay rocks.



***Soil type in Mrs. Ati's Well location***

The sample was taken on the cliff area  $\pm 50$  m west side of the well, N 81°E bound. It was brown in color, sticky and sandy. The outcrop soil was not fresh and a weathering of sandy clay rocks which include in minas formation.



### c. 15,6<sup>th</sup> -21,2<sup>nd</sup> KM, Perawang cross to Meredan cross (zone 3)

There were 6 outcrops with the same characteristic, sandy and pliant texture, dominated with yellow colour and red in some places, alluvial soil type (dian fiantis). With soil parent material came from weathered sandy clay stone, with consistency of hard when dry and firm when moist or wet. This zone 3 is included in hills and valleys area.

Based on the table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005, the soil bearing capacity in

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zone 3 is included in the category of fine to medium sand, silt clay or medium to coarse clay (SW, SM, SC) with field consistency of medium to solid with bearing capacity value of 5. It is being destined for continuous and light building.

Besides outcrop observation, the data were supported with observing the lithology condition of community's wells that available on the pipe line surrounding. There were 2 wells available.

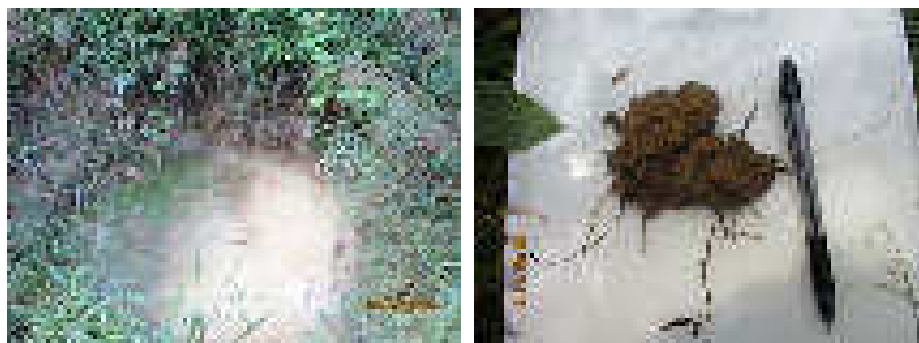
**Mr. Sugiono's well** is an active dug well without construction with 2.4 meters in depth and is being used for bath-wash-toilet necessity. Based on the sample taken from upper-side of the well's wall, the well lithology was composed of sandy clay rocks.



***Soil Type in Mr Sugiono's well location***

The sample was taken from the soil on the upperside of the well's wall. It was brown in color, sticky and sandy. It was a weathering of sandy clay rocks which include in minas formation.

**Mrs. Nur Aidah's well** is an active dug well with 4.8 meters in depth of concrete pipe construction and being used for bath-wash-toilet necessity. Based on the sample taken from  $\pm 50$  meters of the well, the well's lithology was composed of sandy clay rocks.



***Soil Type in Mrs. Aidah's well location***

The sample was taken from  $\pm 50$  m south side of the well, N218°E bound. It was brown in color, sticky and sandy, and a weathering of sandy clay rocks which include in minas formation.

#### **d. 21,3<sup>rd</sup> -27,5<sup>th</sup> KM, Meredan cross to Gabus cross (zone 4)**

There were 4 outcrops with several characteristics, sandy, pliant to brittle texture, with yellow color, and in some places it were red and white, alluvial soil type (dian fiantis). With soil parent material

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came from weathered sandy clay rock, and sandy silt with consistency of hard when dry and firm when moist or wet on sandy clay soil. It was also cracks and dusty when dry and easily eroded when wet. This zone 4 is included in hills and valleys area.

Based on the table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005, the soil bearing capacity in zone 4 is included in the category of fine to medium sand, silt clay or medium to coarse clay (SW, SM, SC) with field consistency of medium to solid with bearing capacity value of 5. It is being destined for continuous and light building.

Besides outcrop observation, the data were supported with observing the lithology condition of community's wells that available on the pipe line surrounding. There was 1 well available.

**Mr. Tukino's well** is an in-active drilling well with construction (attached), with 30 meters in depth. Based on the sample taken  $\pm 300$  meters of the well, the well's lithology was composed of sandy clay rocks.

#### **e. 27,6th-38<sup>th</sup> KM, Gabus to SPP (zone 5)**

There were 9 outcrops found with silt and peat characteristics, brittle and sandy texture, with brownish yellow to dark color on peaty soil, alluvial soil type (dian fiantis). With soil parent material came from weathered sandy slit rock, with consistency of low, cracks and dusty when dry and easily eroded when wet. On the end area especially within the oil plam plantation, there was dark colored peaty soil with high content of organic material. This zone 5 is included in lowland area dominated by plantation and swamp.

Based on the table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005, the soil bearing capacity in zone 5 is included in the category of fine to medium sand, silt clay or medium to coarse clay (SW, SM, SC) with field consistency of loose with bearing capacity value of 3. It is being destined for continuous and light building.

Besides outcrop observation, the data were supported with observing the lithology condition of community's wells that available on the pipe line surrounding. There was 9 wells available.

**Mr. Miftah's well** is an active dug well without construction with 1.28 meters in depth, it was being used for bath-wash-toilet necessity. Based on the sample taken from the top of the well, the well's lithology was composed of sandy clay rocks.



***Soil type in Mr. Miftah's well***

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The sample was taken on the cliff area on the north side  $\pm 100$  m of the well location N358°E bound. It was brownish yellow in color, brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.

**Mr. Hendra's well** is an active dug well with concrete pipe construction with 2.1 meters in depth, it was being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 50$  meters of the well, the well's lithology was composed of sandy silt rocks.



***Soil type in Mr. Hendra's well***

The sample was taken on the cliff area on the west side  $\pm 50$  m of the well location N49°E bound. It was dark in color, brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.

**Community's well** is an active dug well without construction with 1.3 meters in depth, it was being used for garden necessity. Based on the sample taken from the top of the well, the well's lithology was composed of peaty soil.

**Mr. Amran 2's well** is an active dug well with concrete pipe construction with 6 meters in depth, it was being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 50$  meters of the well, the well's lithology was composed of sandy silt rocks.

**Mr. Ruslan's well** is an active dug well with concrete pipe construction with 3.5 meters in depth, it was being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 50$  meters of the well, the well's lithology was composed of sandy silt rocks.



***Soil Type in Mr. Ruslan's well location***

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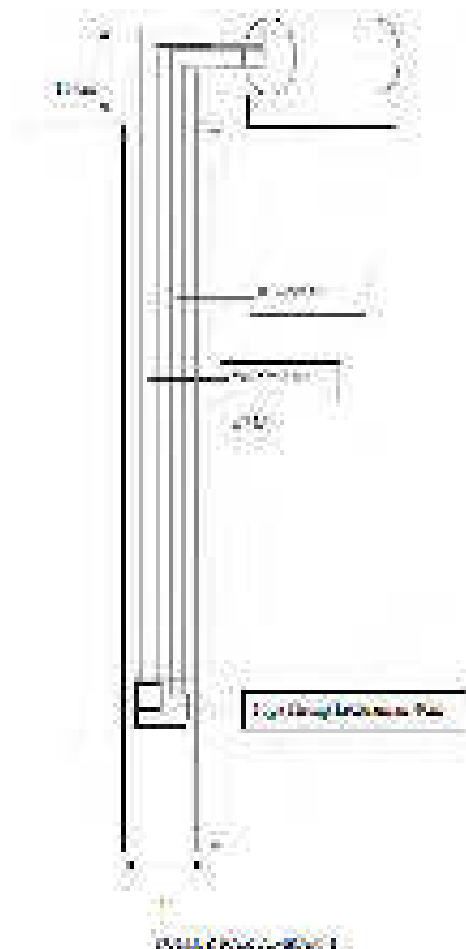
The sample was taken on land on the west side  $\pm 50$  m of the well location N6°E bound. It was brown in color, brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.

**Mr. Amran 1's well** is an active drilling well with 45 meters in depth and being used for bath-wash-toilet necessity, drinking and cooking. Based on the sample taken  $\pm 50$  meters from the well, the well's lithology was composed of sandy silt rocks.

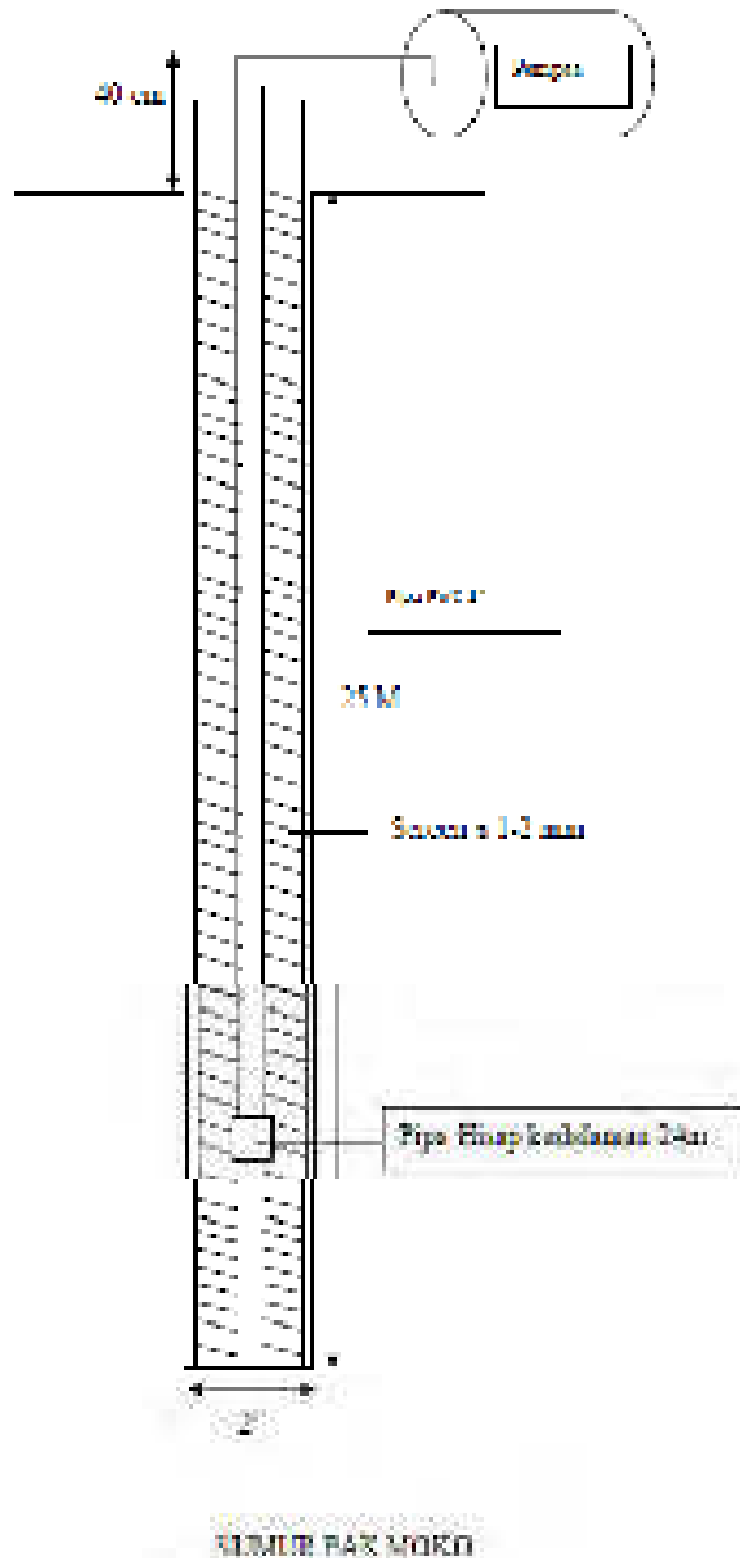


***Soil type in Mr. Amran's well location***

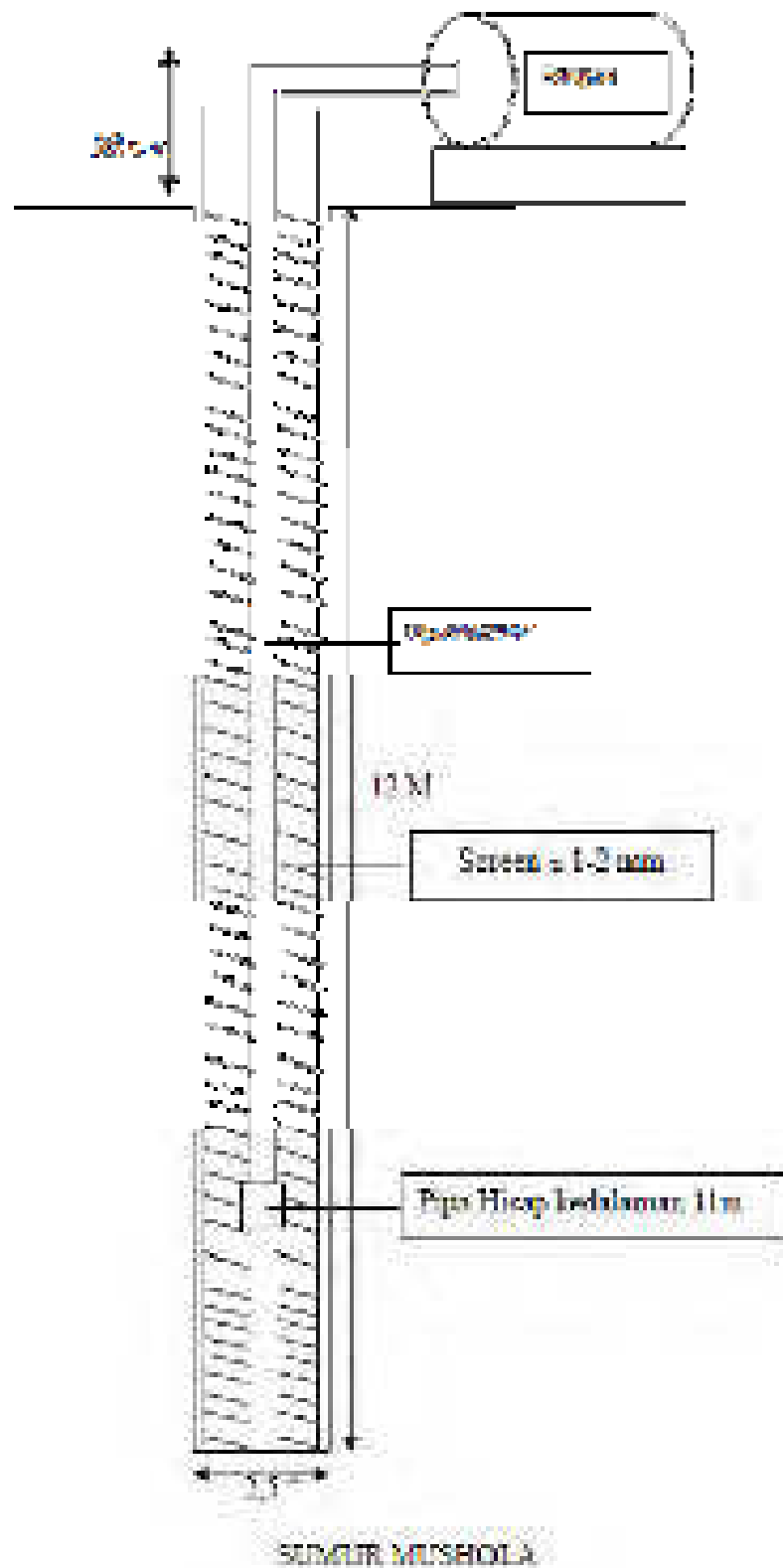
The sample was taken on the river cliff area on the west side  $\pm 50$  m of the well location N357°E bound. It was brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.



**Mr. Moko's well** is an active drilling well with 25 meters in depth and being used for bath-wash-toilet necessity, drinking and cooking. Based on the sample taken  $\pm 300$  meters from the well, the well's lithology was composed of sandy silt rocks.



**Prayer Building's well** is an active drilling well with 12 meters in depth and being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 300$  meters from the well, the well's lithology was composed of sandy silt rocks.

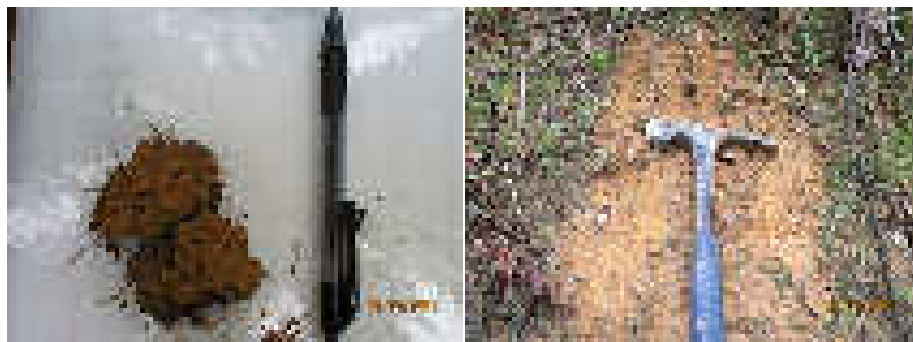




***Soil type in Mr. Moko's and Prayer building's wells location***

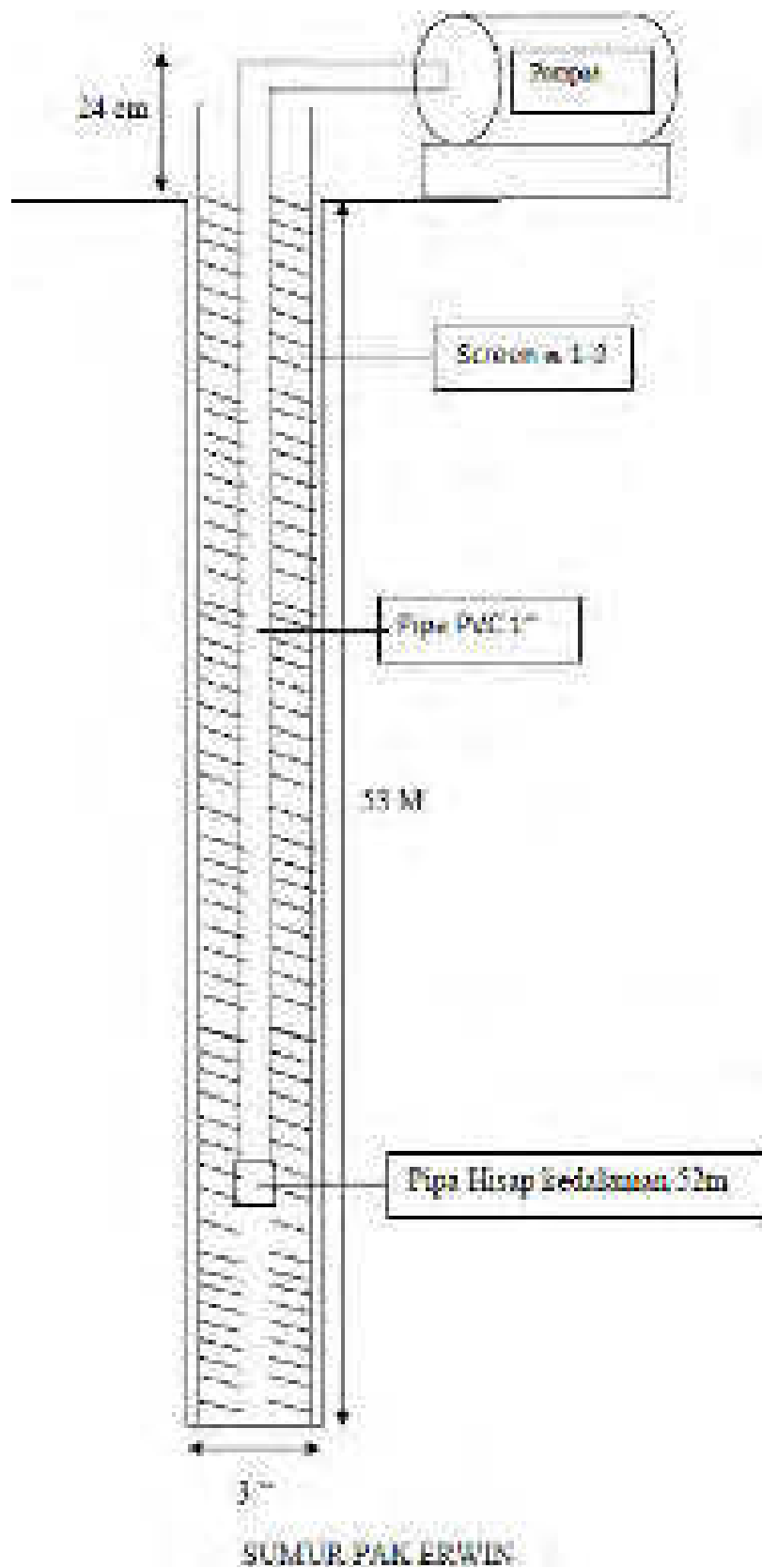
The sample was taken from the soil around the waterpond on the southwest side  $\pm 300$  m of Mr Moko's well location N289°E bound. From Mr. Moko's well it was on the southeast of the prayer buildin's well location,  $\pm 300$  m N111°E bound. It was brown in color, brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.

**Mr. Erwin's well** is an active drilling well with 53 meters in depth and being used for bath-wash-toilet necessity. Based on the sample taken  $\pm 50$  meters from the well, the well's lithology was composed of sandy silt rocks.



***Soil Type in Mr. Erwin's well location***

The sample was taken on the cliff area on the southeast side  $\pm 300$  m of the well location N142°E bound. It was brown in color, brittle and sandy. It was a weathering of sandy silt rocks which include in minas formation.



**Table 5-4. Identification Data of Dug Well**

No	Owner's Name	Location		Depth (m)	MAT (m from the well's edge)	Diameter	Production Year	Construction	Lithology	Use	Condition		Construction Detail							Remarks
											Dry	Rainy	Pipe's type	Pipe's height above ground	screen	Screen dimension	gravel	Suction pipe position	Gathering containment	
1	Garden Well	0°38'37.42"U	101°43'35.22"T	1,3	0,5	1,7		Dug well without construction	Sandy clay, Sample was taken from topside of well's wall	Garden needs	-	-	-	-	-	-	-	-	-	
2	Mr. Darlin Sirait	0°38'38.86"U	101°43'32.51"T	38	0,5	4"	2015	Drilling well	Sandy clay, Sample was taken ± 200 m, N89°E bound (sample from garden's dug well's wall)	Bath-Wash-Toilet	normal	normal	pvc 1"	20 cm	-	-	-	35 M	Bathtub	
3	Mr. Jhoni Gultom	0°38'39.02"U	101°41'28.40"T	60	30	4"	2014	Drilling well	Lempung pasiran, Sample diambil ± 100 m, ke arah N68°E	Bath-Wash-Toilet	normal	normal	pvc 1"	50 cm	48-55	1-2 mm	yes	55 M	torent 1500ℓ x 2, 1000ℓ x 1	In-active
4	Mr. Sarbini	0°38'39.77"U	101°41'27.06"T	10	6,7	1	2009	Dug well, with cemented red bricks wall all the way to the bottom	Sandy clay, Sample was taken ± 50 m, N49°E bound	Bath-Wash-Toilet, Drinking, Cooking	normal	+1m	pvc 1"	10 cm	-	-	-	8,5 M	Bathtub	Using pump (attached)
5	Mrs. Adui	0°38'39.00"U	101°39'40.00"T	7	5,7	1,5	2008	1 Dug well with concrete base construction, 1.5m inside diameter and 90cm in height	Sandy clay, Sample was taken ± 50 m, N157°E bound	Bath-Wash-Toilet	-2m	+5m	pvc 1"	90 cm	-	-	-	6,5 M	Bathtub	Using pump (attached)
6	Nurul Iman Mosque's Well	0°36'34.06"U	101°38'46.68"T	35		6"	2017	Drilling well	Lempung pasiran, Sample diambil ± 100 m, kearah N61°E	Bath-Wash-Toilet	normal	normal	pvc 1 1/4 "	50 cm	-	-	-	30 M	torent 1000ℓ	Using pump submarsible
7	Mrs. Ati	0°35'40.79"U	101°38'47.18"T	30	20	4"	2014	Drilling well	Lempung Pasiran, Sample diambil ± 50 m, kearah N 81°E	Bath-Wash-Toilet, Drinking, Cooking	normal	normal	pvc 1" & 1 1/4"	40 cm	Along the pipe	1-2 mm	yes	20 M	Filtering tub	
8	Mr. Sugiono	0°34'26.97"U	101°37'13.20"T	2,4	1,55	2,15	2010	Dug well without construction	Sandy clay, Sample was taken from topside of well's wall	Bath-Wash-Toilet	dry	normal	-	-	-	-	-	-	-	

No	Owner's Name	Location		Depth (m)	MAT (m from the well's edge)	Diameter	Production Year	Construction	Lithology	Use	Condition		Construction Detail							Remarks
											Dry	Rainy	Pipe's type	Pipe's height above ground	screen	Screen dimenssion	gravel	Suction pipe position	Gathering containment	
9	Mrs.Nur Aidah	0°34'12.06"U	101°36'50.42"T	4,8	3,46	1,05	2013	1 Dug well with concrete base 1,05 m in and 7- cm, in height cemented red bricks wall all the way to the bottom	Sandy clay, Sample was taken ± 50 m, N218°E bound	Bath-Wash-Toilet	normal	normal	-	-	-	-	-	-	-	using Dorsmeer engine
10	Mr. Tukino	0°32'04.34"U	101°35'36.87"T	30		4"	2017	Drilling well	Sandy clay, Sample was taken ± 300 m, N125°E bound	-	-	-	pvc 1 1/4"	50 cm	-	-	-	-	-	In-active, has not being used yet
11	Mr. Miftah	0°32'16.04"U	101°35'37.08"T	1,28	0,58	1,62	2012	Dug well without construction	Sandy silt, Sample was taken ± 100 m, N358°E bound	Bath-Wash-Toilet	normal	normal	-	-	-	-	-	-	-	
12	Mr. Amran 1	0°33'09.56"U	101°34'38.86"T	45	2,3	4"	2016	Drilling well	Sandy silt, Sample was taken ± 50 m, N357°E bound	Bath-Wash-Toilet, Drinking, Cooking	normal	high MAT equal to footing ground	pvc 1" & 1 1/4"	15 cm	Along the pipe	1-2 mm	-	40 M	bathtub	
13	Mr. Amran 2	0°33'09.48"U	101°34'38.97"T	6	1,6	0,85		Dug well using concrete base with 70 cm in height	Sandy silt, Sample was taken ± 50 m, N357°E bound	Bath-Wash-Toilet,	normal	normal	-	-	-	-	-	-	-	
14	Mr. Ruslan	0°33'02.79"U	101°33'48.01"T	3,5	1,53	0,8		3 Dug wells with concrete base 80c m inside diameter and 90 cm, in height	Sandy silt, Sample was taken ± 50 m, N 6°E bound	Bath-Wash-Toilet	normal	normal	-	-	-	-	-	-	-	
15	Mr. Moko	0°33'23.96"U	101°33'01.55"T	25		2"	2009	Drilling well	Sandy silt, Sample was taken ± 300 m, N289°E bound	Bath-Wash-Toilet, Drinking, Cooking	normal	normal	pvc 1"	20 CM	Along the pipe	1-2 mm	-	24 M	bathtub	
16	Mr. Hendra	0°33'19.76"U	101°32'45.97"T	2,1	0,88	0,8	2009	1 dug well with concrete base construction with 80 cm inside diameter and 90 cm in height planted 20cm below the ground surface	Sandy silt, sample was taken ± 50 m, N49°E bound	Bath-Wash-Toilet	Kering	normal	-	-	-	-	-	-	-	

No	Owner's Name	Location		Depth (m)	MAT (m from the well's edge)	Diameter	Production Year	Construction	Lithology	Use	Condition		Construction Detail							Remarks
											Dry	Rainy	Pipe's type	Pipe's height above ground	screen	Screen dimenssion	gravel	Suction pipe position	Gathering containment	
17	Prayer building	0°33'25.84"U	101°32'59.54"T	12		2,5"	2017	Drilling well	Sandy silt, sample was taken ± 300 m, N111°E bound	Bath-Wash-Toilet	normal	normal	pvc 3/4"	20 cm	Along the pipe	1-2 mm	-	11	torent 550ℓ	
18	Mr. Erwin	0°33'14.88"U	101°32'39.51"T	53		3"	2010	Drilling well	Sandy silt, sample was taken ± 300 m, N142°E bound	Bath-Wash-Toilet	normal	normal	pvc 1"	24 cm	Along the pipe	1-2 mm	-	52	bathtub	
19	Community's well	0°33'13.02"U	101°32'21.84"T	1,3	30	1,27		Dug well without construction	Peat	Oil Palm infiltration	-	-	-	-	-	-	-	-	-	

Table 5-5. Pump Spesification

No	Owner's Name	Brand	Model	Q	H	I	n	F	U
1	Mr. Darlin Sirait	Paloma	pp260jp	60 ℓ/min	60 m	1,2 A		12μF/450v	220v
2	Mr. Sarbini	shimizu	jet 108 bit	7-50 ℓ/min	21-5	1,6 A	2900 min <sup>-1</sup>	8μF/370 V	1x220 v
3	Mrs. Adui	sanyo	pw H137	23 ℓ/min	30-9	1,1 A		6μF/220 v	220 v
4	Sumur Masjid Nurul Iman		Submersible pump						
5	Mrs. Ati	Sanju	SJ370	85ℓ/min	40 m	3,3 A		12μF/450v	220v
6	Mrs. Nur Aidah		Dorsmeer pump engine						
7	Mr. Amran 2	Sanwa	sw-225dp	54 ℓ/min	30 m	1,2 A		12μF/450v	220v
8	Mr. Moko	Shimizu	ps 128 bit	10-18 ℓ/m	20-10 m	1,3A	2900 min <sup>-1</sup>	8μF/370 V	220v
9	Mushola								
10	Mr. Erwin	Shimizu	ps 128 bit	10-18 ℓ/m	20-10 m	1,3A	2900 min <sup>-1</sup>	8μF/370 V	220v

keterangan    Q : Debit (ℓ/min)  
                   H : Total Head Pompa (m)  
                   I   : Flow (A)  
                   n   : Engine rotation speed  
                   F   : capacitance  
                   U   : Voltage

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### 5.2.5 Conclusions and Recommendations

- In general the type of soil along the pipeline is the sediment soil or commonly called alluvial soil,
- Alluvial soils are generally sensitive to erosion.
- One of the factor in erosion is the absence of vegetation on it, so that erosion as a physical weathering agent will easily occur.
- Condition of bearing capacity referring to soil is referring to table of Estimated Permit Bearing Capacity for lane/continuous foundation (Department of the Navy 1982), Decree of Public Work Ministry No. 498/KPTS/M/2005.

- **1<sup>st</sup> – 8.3<sup>rd</sup> KM, End of line until Gasib cross. (zone 1)**

Soil bearing capacity in zone 1 is include in the category of fine to medium sand, medium to coarse silt or clay sand (SW, SM, SC) with field consistency medium to solid with bearing capacity value of 5, it is destined for light and continuous building.

- **8.4<sup>th</sup> -15.5<sup>th</sup> KM, Gasib cross to Perawang cross (zone 2)**

Soil bearing capacity in zone 2 is include in the category of fine to medium sand, medium to coarse silt or clay sand (SW, SM, SC) with field consistency medium to solid with bearing capacity value of 5, it is destined for light and continuous building

- **15.6<sup>th</sup> -21.2<sup>nd</sup> KM, Perawang cross to Meredan cross (zone 3)**

Soil bearing capacity in zone 3 is include in the category of fine to medium sand, medium to coarse silt or clay sand (SW, SM, SC) with field consistency medium to solid with bearing capacity value of 5, it is destined for light and continuous building

- **21.3<sup>rd</sup> -27.5<sup>th</sup> KM, Meredan cross to Gabus cross (zone 4)**

Soil bearing capacity in zone 4 is include in the category of fine to medium sand, medium to coarse silt or clay sand (SW, SM, SC) with field consistency medium to solid with bearing capacity value of 5, it is destined for light and continuous building.

- **27.6<sup>th</sup>-38<sup>th</sup> KM, Gabus to SPP (zone 5)**

Soil bearing capacity in zone 5 is include in the category of fine to medium sand, medium to coarse silt or clay sand (SW, SM, SC) with field consistency loose with bearing capacity value of 3, it is destined for light and continuous building

- To increase the soil carrying capacity to the erosion level existing in the area of research, it needs to be planted with vegetation above.
- To be more definitive in determining the bearing capacity of the soil in the location of the study, it is advisable to do Soil Investigation / Sondir / DCPT (Duch Cone Penetration Test) Untuk lebih pasti didalam menentukan daya dukung tanah dilokasi penelitian disarankan untuk dilakukan penelitian Soil Investigation / DCPT ( Duch Cone Penetration Test )

## 6 CONTAMINATED SOIL

Surface soil samples was undertaken at 4 sampling points surrounding the Pipe Line and analysed for pesticides being organochlorine, organophosphorous and organo nitrous. Analysis result shown that no contamination indication of pesticides.

Chemical compounds of OCPs, OPPs and Carbamate are not found naturally in the soil, the presence of such chemical compounds in the soil will increase as a result of agricultural activities using pesticide chemicals to be deposited in the soil as organochlorine, organophospor and carbamate groups. In general, land clearing using herbicides containing active substances of organochlor and/or organophospor grou, which is one type of plant-inhibiting pesticides. Meanwhile, the chemical compound category of carbamate is widely used as an active substance of insecticide products to inhibit the damage of plants or plant seeds from insecticide disorders.

The result of soil sampling test of Soil-1 to Soil-4 was not detecting any residue group of organochloric, organophospor and carbamate chemicals group. This indicates the soil is safe to use. The existence of a chemical compound of pesticides will cause the residue of the material so that it will migrates parts of it to the plant grown in the soil.

**Table 6-1. Soil Contamination Analysis Result Pipe Line**

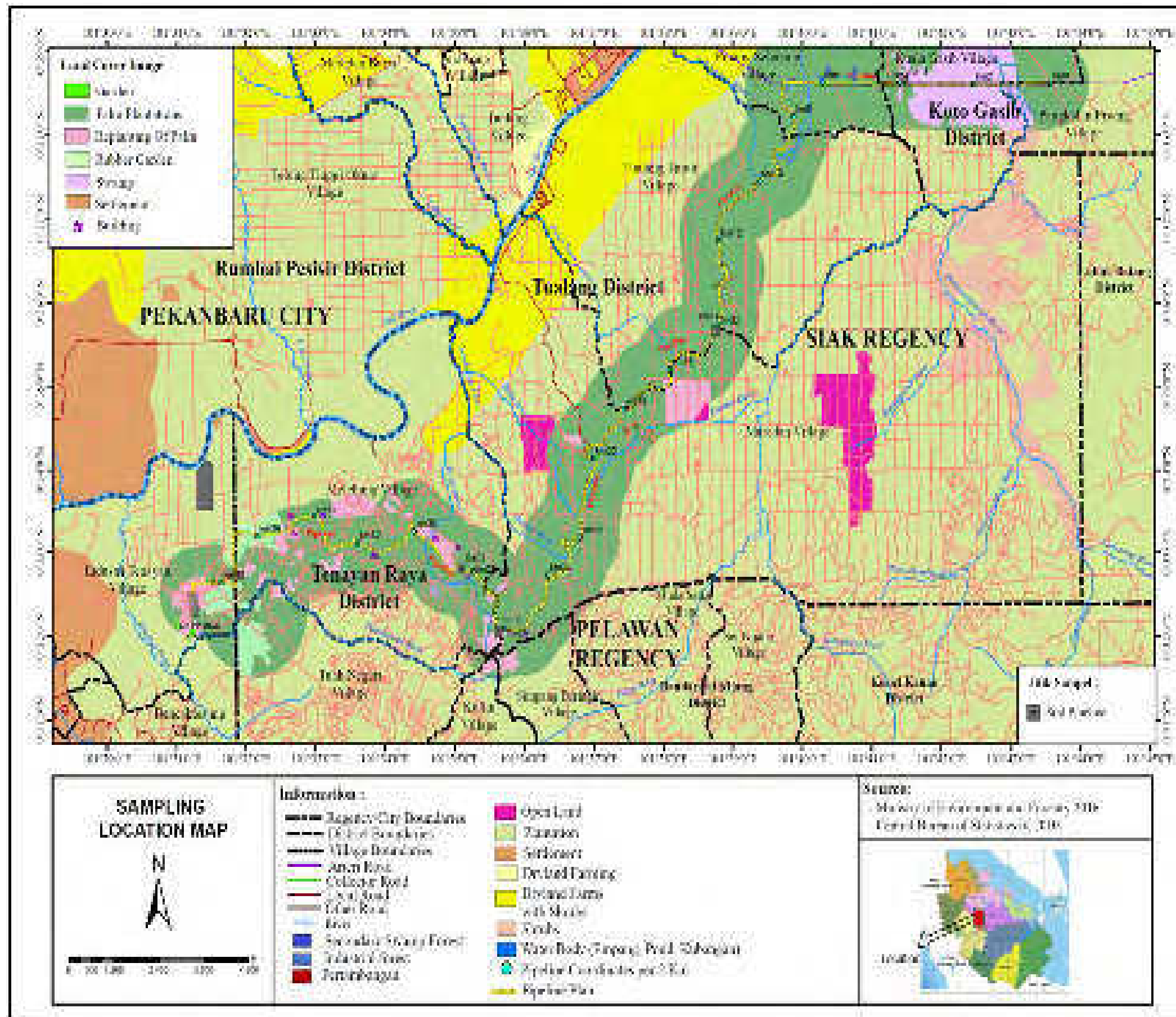
No	Parameter	Unit	Analysis Result			
			Soil 1 PL	Soil 2 PL	Soil 3 PL	Soil 4 PL
<b>A.</b>	<b>Heavy Metals</b>					
1.	Mercury	mg/Kg	0,06	0.07	0.08	0,06
2.	Arsenic	mg/Kg	<1.00	2.27	1.63	2.79
3.	Boron	mg/Kg	<5.00	<5.00	<5.00	<5,00
4.	Cadmium	mg/Kg	<1.00	<1.00	<1.00	<1,00
5.	Chromium	mg/Kg	12.8	17.0	14.0	14.5
6.	Copper	mg/Kg	1.10	1.13	<1.00	<1.00
7.	Iron	mg/Kg	7930	15000	7630	6810
8.	Lead	mg/Kg	2.55	4.59	2.34	2.02
9.	Manganese	mg/Kg	8.84	6.38	8.46	4.10
10.	Nickel	mg/Kg	1.40	1.21	1.08	<1.00
11.	Zinc	mg/Kg	5.96	<5.00	<5.00	<5.00
<b>B.</b>	<b>Organic</b>					
12.	Polynuclear Aromatic Hydrocarbon	mg/Kg	<1,0	<1,0	<1,0	<1,0
13.	Polychlorinated BiPhenyls	mg/Kg	<0.25	<0.25	<0.25	<0.25
14.	Chlordane	mg/Kg	<0,5	<0,5	<0,5	<0,5
15.	Endosulfan	mg/Kg	<0,5	<0,5	<0,5	<0,5
16.	Diedrin	mg/Kg	<0,5	<0,5	<0,5	<0,5
17.	DDT	mg/Kg	<1,0	<1,0	<1,0	<1,0
18.	Mirex	mg/Kg	<0.001	<0.001	<0.001	<0.001

L-1 PL Lokasi Tapak Coordinate: N=00°38'37.19"E= 101°41'28.28"

L-2 PL Lokasi Tapak Coordinate: N=00°35'39.09"E= 101°38'45.23"

L-3 PL Lokasi Tapak Coordinate: N=00°32'03.42"E= 101°35'37.53"

L-4 PL Lokasi Tapak Coordinate: N=00°32'48.33"E= 101°35'05.89"





**Figure 6-2.** *L-1 PL Sampling location*



**Figure 6-3.** *L-2 PL Sampling location*



**Figure 6-4.** *L-3 PL Sampling location*



**Figure 6-5. L-4 PL Sampling location**

## **7 AIR QUALITY**

### **7.1 Ambient Air Quality**

Ambient air quality monitoring was undertaken at 9 sampling points (*see Figure 8-1*) in January - February 2018 which was align with Indonesian Government Regulation No. 41 Year 1999 concerning Air Pollution Control.

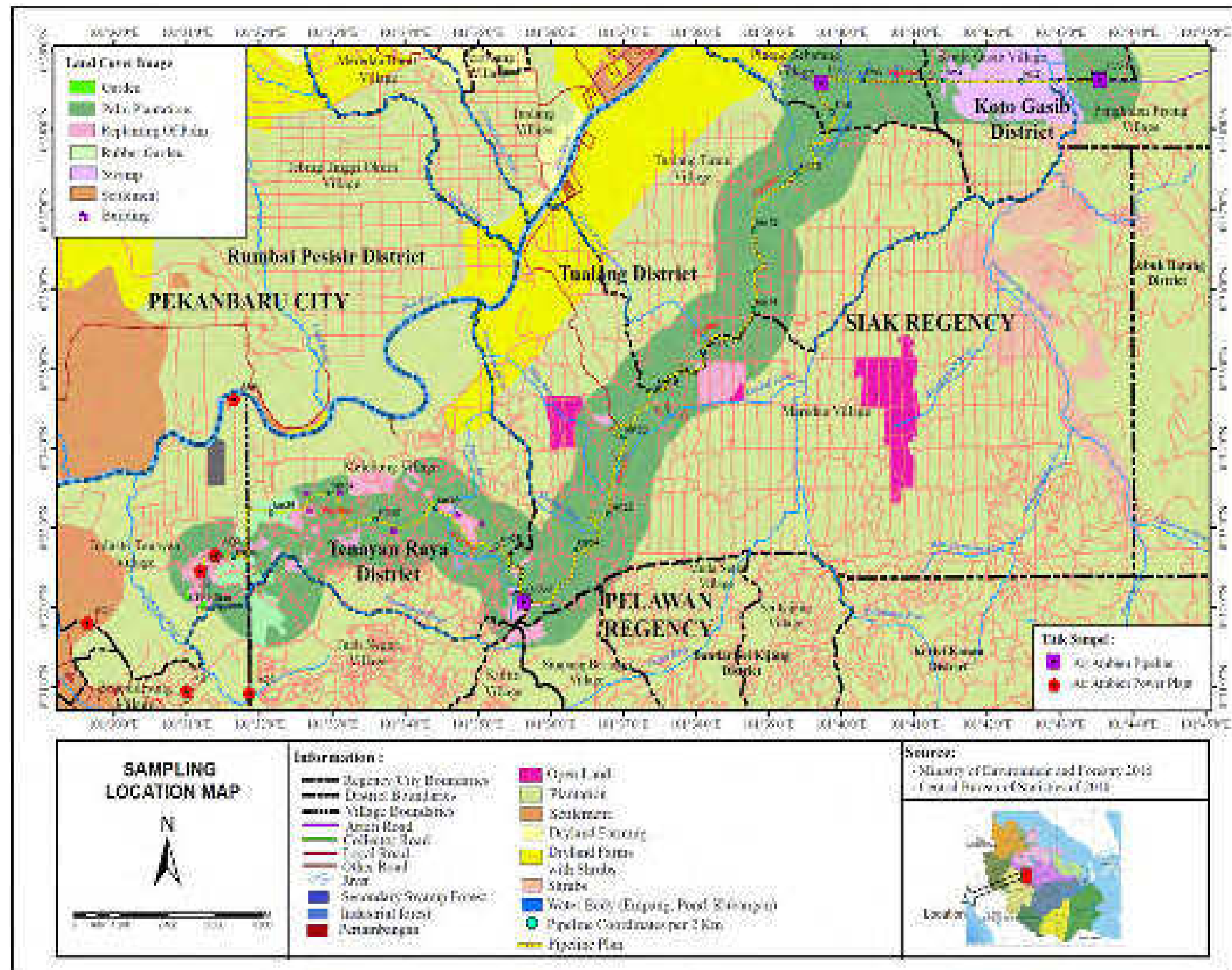


Figure 7-1. Air Quality Sampling Location

Monitored ambient air parameters consists of Sulfur dioxide (SO<sub>2</sub>), Oxidant (O<sub>3</sub>), Nitrogen dioxide (NO<sub>2</sub>), Total Suspended Particulate (TSP), Lead (Pb), Hydrocarbon (HC), Carbon monoxide (CO) and particulates (PM<sub>10</sub> and PM<sub>2.5</sub>) with monitoring result as presented at Table 8-1-Table 8-4. The sampling result demonstrates that all sampling point meet the Indonesian Regulation Standard.

**Table 7-1. Ambient air result Pipe Line**

No	Parameter	Average period (hours)	Unit	Standard	Sampling result		
					AQ1	AQ2	AQ3
1	SO <sub>2</sub>	1	µg/m <sup>3</sup>	900	<33	<33	<33
2	O <sub>3</sub>	1	µg/m <sup>3</sup>	235	<34	<34	69
3	NO <sub>2</sub>	1	µg/m <sup>3</sup>	400	<17	<17	<17
4	TSP	24	µg/m <sup>3</sup>	230	88	81	71
5	Pb	24	µg/m <sup>3</sup>	2	<0.06	<0.06	<0.06
6	CO	1	µg/m <sup>3</sup>	30,000	<114	<114	<114
7	HC	3	µg/m <sup>3</sup>	160	<1,6	<1,6	<1,6
8	PM 2,5		µg/m <sup>3</sup>	65	10	23	21
9	PM 10		µg/m <sup>3</sup>	150	14	34	38

Source: Laboratory analysis Report (2018)

*Remark(s):*

AQ 1 PL: Coordinate: N= 00°38'37.3"E= 101°43'33.2"

AQ 2 PL: Coordinate: N= 00°38'34.6"E= 101°39'43.0"

AQ 3 PL: Coordinate: N= 00°32'04.1"E= 101°35'37.7"

**Table 7-2. Ambient air result Power Plant**

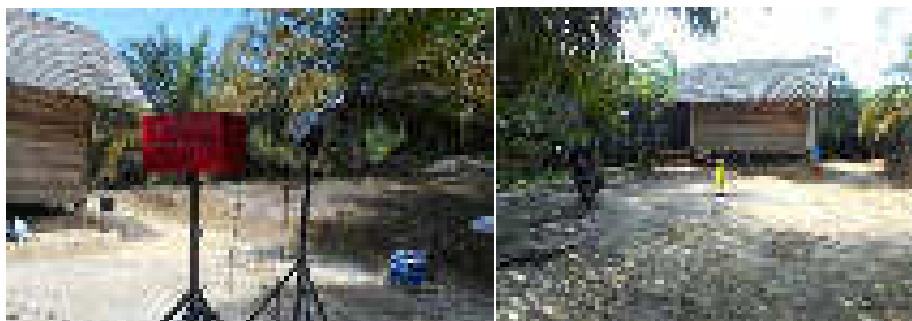
No	Parameter	Unit	Standard	Sampling result			
				AQ1	AQ2	AQ3	AQ4
1	NO <sub>2</sub>	µg/m <sup>3</sup>	400	<17	<17	<17	<17

AQ 1 PP: Coordinate: N= 00°32'27.9"E= 101°31'11.4"

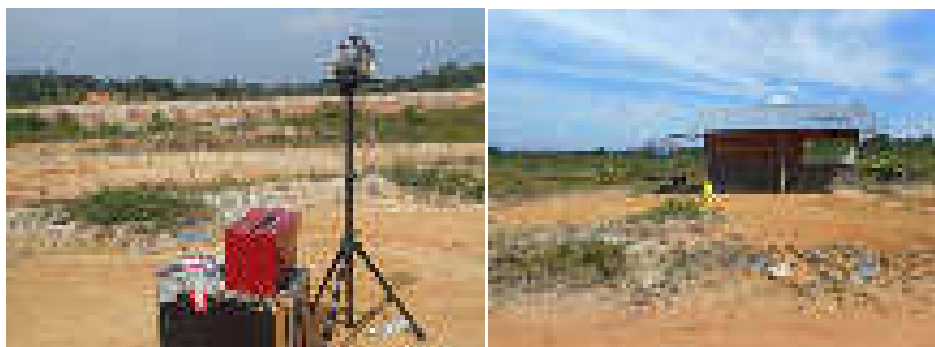
AQ 2 PP: Coordinate: N= 00°32'40.1"E= 101°31'23.2"

AQ 3 PP: Coordinate: N= 00°30'57.5"E= 101°30'59.5"

AQ 4 PP: Coordinate: N= 00°31'48.7"E= 101°29'38.2"



**Figure 7-2.** *AQ1 Sampling location*



**Figure 7-3.** *AQ2 Sampling location*



**Figure 7-4.** *AQ3 Sampling location*



**Figure 7-5.** *AQ4 Sampling location*

## 7.2 PM<sub>10</sub>/PM<sub>2.5</sub> Total Suspended Particulate

Total Suspended Particulate (TSP) and Partikulat Matter (PM<sub>10</sub> and PM<sub>2.5</sub>) monitoring undertaken at 2 sampling point with duration 24 hours for twice a month frequent for three month.

**Table 7-3. Particulate Matter result Power Plant**

No	Parameter	Period Hours	Unit	Standard	Sampling result			
					AQ5		AQ6	
					Jan	Feb	Jan	Feb
2	PM 2,5	24	µg/m <sup>3</sup>	65	20	5	23	13
3	PM 10	24	µg/m <sup>3</sup>	150	53	10	43	17

AQ 5 PP: Coordinate: N= 00°30'55.9"E= 101°31'51.6"

AQ 6 PP: Coordinate: N= 00°34'36.8"E= 101°31'38.8"

**Table 7-4. Particulate Matter result Pipe Line**

No	Parameter	Average period (hours)	Unit	Standard	Sampling result					
					AQ1		AQ2		AQ3	
					Jan	Feb	Jan	Feb	Jan	Feb
1	TSP	24	µg/m <sup>3</sup>	230	88	-	81	-	71	-
2	PM 2,5	24	µg/m <sup>3</sup>	65	10	10	23	24	21	14
3	PM 10	24	µg/m <sup>3</sup>	150	14	12	34	56	38	26

Source: Laboratory analysis Report (2018)

Remark(s):

AQ 1 PL: Coordinate: N= 00°38'37.3"E= 101°43'33.2"

AQ 2 PL: Coordinate: N= 00°38'34.6"E= 101°39'43.0"

AQ 3 PL: Coordinate: N= 00°32'04.1"E= 101°35'37.7"



**Figure 7-6. AQ5 Sampling location**



**Figure 7-7. AQ6 Sampling location**

### 7.3 Passive Sampling

Passive sampling conducted with duration of 14 days 1 time a month for three month to measure Nitrogen (NO<sub>2</sub>) at 4 sampling point.

**Table 7-5. Passive Sampling result**

No	Time	Period (days)	Unit	Standard	Sampling result			
					AQ1	AQ2	AQ3	AQ4
1	1 <sup>st</sup> month	14	µg/Sample	NA	<0.01	<0.01	<0.01	<0.01

Figure 7.2 and 7.3 demonstrates that land uses near the project area are dominated by palm oil plantation with that the nearest sensitive receptors (educational areas, religious area, public facility and public health facility) are identified. However, the ambient air near those sensitive receptors were not recorded. Moreover, the ambient air near the stockpile inside the Tenayan Coal Power Station and any potential pollution sources were not recorded as well.

## 8 NOISE

### 8.1 Power Plant Area

Noise measurement was conducted in January with accordance to World Bank EHS Guideline. Monitoring period was in 48 hours with continuous measurement at 8 sampling points located near the proposed Pipe Line.

The sampling result (Table 9-1) demonstrates that generally, all sampling point met the national regulation (MoE Decree No. 48/1996). Meanwhile, compared to day time noise level based on WHO (1999), two were four sampling points (Power Plant N-01 and Power Plant N-03) exceeded day time noise level standard and all sampling points exceeded night time noise level standard.

**Table 8-1. Noise Measurement Report Around Pipe Line**

NO	KODE	COORDINATE	Result
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		S	E	(dBA)
1	N-1 PL	00 <sup>0</sup> 38'55,74"	101 <sup>0</sup> 43' 35,52"	57
2	N-2 PL	00 <sup>0</sup> 38'36,70"	101 <sup>0</sup> 41' 27,20"	62
3	N-3 PL	00 <sup>0</sup> 38'35,65"	101 <sup>0</sup> 39' 43,21"	70
4	N-4 PL	00 <sup>0</sup> 35'38,39"	101 <sup>0</sup> 38' 45,21"	67
5	N-5 PL	00 <sup>0</sup> 32'10,10"	101 <sup>0</sup> 36' 03,20"	72
6	N-6 PL	00 <sup>0</sup> 32'02,43"	101 <sup>0</sup> 35' 39,33"	58
7	N-7 PL	00 <sup>0</sup> 32'44,52"	101 <sup>0</sup> 35' 09,52"	53
8	N-8 PL	00 <sup>0</sup> 33'07,56"	101 <sup>0</sup> 33' 08,38"	37

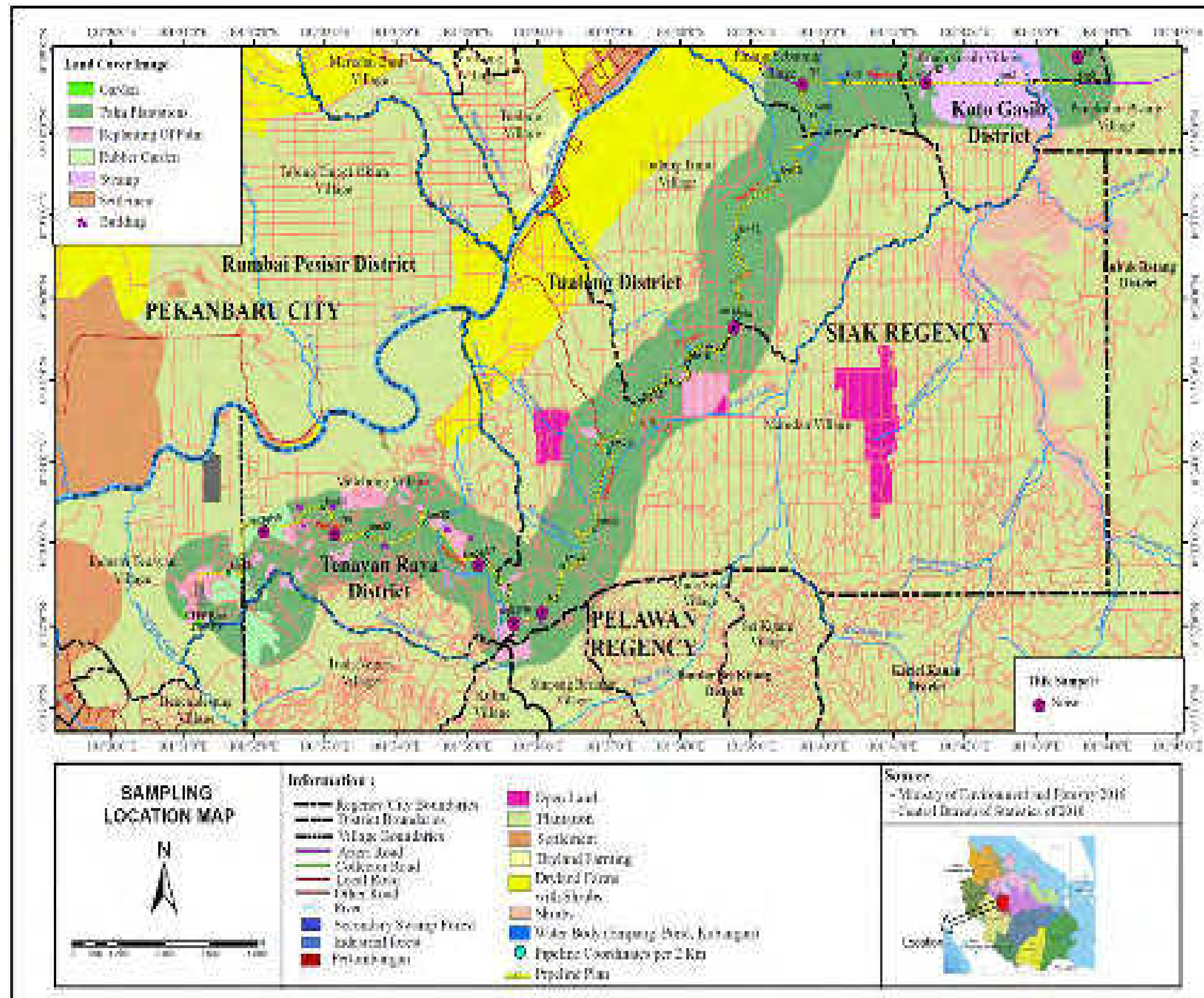


Figure 8-1. Noise Sampling Location



**Figure 8-2.** *Pipe Line N-01 Sampling location*



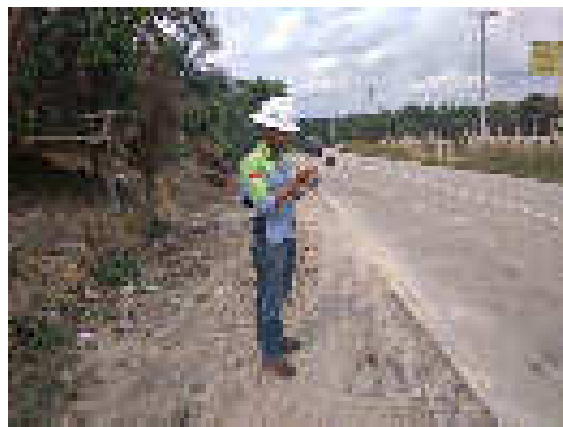
**Figure 8-3.** *Pipe Line N-02 Sampling location*



**Figure 8-4.** *Pipe Line N-03 Sampling location*



**Figure 8-5.** *Pipe Line N-04 Sampling location*



**Figure 8-6.** *Pipe Line N-05 Sampling location*



**Figure 8-7.** *Pipe Line N-06 Sampling location*



**Figure 8-8.** *Pipe Line N-07 Sampling location*



**Figure 8-9.** *Pipe Line N-08 Sampling location*

The higher value of noise level shall be investigated by field record and measure the background noise level (L90) which can describe the real baseline noise level standard without any triggers caused peak noise. The field note shall describe attenuation near the sampling points with detail documentations and identify sensitive receptors around the project areas.

## **9 TRAFFIC**

### **9.1 Road Traffic**

Traffic Observation is carried out at (1) Pemda Gasip Road covers the traffic flow of Pekanbaru to Gasip and Gasip path to Pekanbaru, (2) Simpang meredan for the traffic flow from Maredan to Pekanbaru and from Pekanbaru to maredan and (3) Jalan Badak Ujung for traffic from direction Badak Ujung towards Hangtuah and from Hangtuah road to Badak Ujung. Observations were conducted in January and February 2018.

### 9.1.1 Pemda Gasip Road

**Table 9-1. Number and Type of Vehicles Passing through Pemda Gasip, from Pekanbaru to Gasip on 27 January 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. Morning									
1	07.00 - 07.15	11	0	0	5	0	35	0	0
2	07.15 - 07.30	25	1	0	9	1	27	0	0
3	07.30 - 07.45	22	2	0	10	2	28	0	0
4	07.45 - 08.00	14	0	0	21	0	51	0	0
5	08.00 - 08.15	10	1	0	7	1	40	0	0
6	08.15 - 08.30	14	0	0	8	2	27	0	0
7	08.30 - 08.45	17	0	0	12	1	30	0	0
8	08.45 - 09.00	24	0	1	14	2	28	0	0
Total A		137	4	1	86	9	266	0	0
B. Daytime									
9	11.00 - 11.15	33	2	2	12	2	42	7	0
10	11.15 - 11.30	24	3	1	12	0	35	0	0
11	11.30 - 11.45	34	0	2	15	1	44	0	0
12	11.45 - 12.00	24	1	0	7	0	17	0	0
13	12.00 - 12.15	31	1	1	19	2	39	0	0
14	12.15 - 12.30	26	0	1	14	2	25	0	0
15	12.30 - 12.45	24	0	0	12	0	24	0	0
16	12.45 - 13.00	15	0	0	7	1	22	2	0
Total B		211	7	7	98	8	248	9	0
C. Afternoon									
17	14.00 - 14.15	22	1	2	12	0	46	0	0
18	14.15 - 14.30	10	3	1	4	2	22	0	0
19	14.30 - 14.45	38	0	0	11	1	51	0	0
20	14.45 - 15.00	27	0	0	16	0	37	0	0
21	15.00 - 15.15	15	0	0	4	2	48	1	1
22	15.15 - 15.30	36	2	0	19	0	38	0	0
23	15.30 - 15.45	45	2	0	13	0	39	0	0
24	15.45 - 16.00	50	2	0	16	0	33	0	0
25	16.00 - 16.15	28	1	0	6	0	34	1	0
26	16.15 - 16.30	31	1	0	10	1	46	0	0
27	16.30 - 16.45	30	0	0	10	1	44	0	0
28	16.45 - 17.00	35	0	0	16	1	57	0	0
29	17.00 - 17.15	31	1	0	12	0	41	1	0
30	17.15 - 17.30	43	0	0	8	0	45	0	0
31	17.30 - 17.45	43	0	0	14	1	56	0	0
32	17.45 - 18.00	34	0	0	28	0	60	0	0
33	18.00 - 18.15	34	0	0	9	0	52	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
34	18.15 - 18.30	43	0	0	6	0	45	0	0
35	18.30 - 18.45	38	0	1	16	0	38	0	0
36	18.45 - 19.00	38	0	0	13	0	24	0	0
<b>Total C</b>		<b>671</b>	<b>13</b>	<b>4</b>	<b>243</b>	<b>9</b>	<b>856</b>	<b>3</b>	<b>1</b>
<b>Total A+B+C</b>		<b>1019</b>	<b>24</b>	<b>12</b>	<b>427</b>	<b>26</b>	<b>1370</b>	<b>12</b>	<b>1</b>
<b>Grand Total</b>		<b>2891</b>							

**Table 9-2. Number and Type of Vehicles Passing through Pemda Gasip, from Gasip to Pekanbaru on 27 January 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	11	0	0	15	2	32	4	0
2	07.15 - 07.30	9	0	0	13	0	20	0	0
3	07.30 - 07.45	11	0	0	5	0	24	0	0
4	07.45 - 08.00	16	1	3	6	0	9	0	0
5	08.00 - 08.15	28	1	0	12	1	21	0	0
6	08.15 - 08.30	26	1	0	12	0	28	0	0
7	08.30 - 08.45	25	1	0	6	0	34	0	0
8	08.45 - 09.00	38	0	0	11	0	36	0	0
Total A		164	4	3	80	3	204	4	0
B. Daytime									
9	11.00 - 11.15	38	0	0	11	0	40	0	0
10	11.15 - 11.30	29	1	0	11	2	30	0	0
11	11.30 - 11.45	27	0	0	8	0	38	0	0
12	11.45 - 12.00	30	2	1	10	0	20	0	0
13	12.00 - 12.15	23	0	1	13	0	33	0	0
14	12.15 - 12.30	31	1	0	17	3	33	0	0
15	12.30 - 12.45	26	0	0	2	0	29	0	0
16	12.45 - 13.00	24	0	0	12	0	27	0	0
Total B		228	4	2	84	5	250	0	0
C. Afternoon									
17	14.00 - 14.15	34	0	1	20	0	45	3	0
18	14.15 - 14.30	33	1	1	8	1	31	0	0
19	14.30 - 14.45	61	2	0	12	3	60	0	0
20	14.45 - 15.00	43	0	0	16	0	57	0	0
21	15.00 - 15.15	42	3	0	9	0	63	0	0
22	15.15 - 15.30	43	2	1	12	0	38	0	0
23	15.30 - 15.45	29	0	0	8	0	54	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
24	15.45 - 16.00	40	2	2	10	2	40	1	0
25	16.00 - 16.15	35	1	0	14	0	35	0	0
26	16.15 - 16.30	39	0	1	11	0	26	0	0
27	16.30 - 16.45	49	0	4	22	0	60	0	0
28	16.45 - 17.00	34	0	0	8	0	58	0	0
29	17.00 - 17.15	50	0	0	12	2	48	0	0
30	17.15 - 17.30	36	2	1	8	0	41	0	0
31	17.30 - 17.45	51	0	0	10	0	40	0	0
32	17.45 - 18.00	38	0	1	9	0	41	0	0
33	18.00 - 18.15	24	0	3	12	2	41	0	0
34	18.15 - 18.30	59	0	0	13	1	47	0	0
35	18.30 - 18.45	23	0	1	11	0	25	0	0
36	18.45 - 19.00	18	0	1	7	0	23	0	0
Total C		781	13	17	232	11	873	4	0
Total A+B+C		1173	21	22	396	19	1327	8	0
Grand Total		2966							

**Table 9-3. Number and Type of Vehicles Passing through Pemda Gasip, from Pekanbaru to Gasip on 1 February 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	13	0	0	8	0	34	0	0
2	07.15 - 07.30	14	1	0	10	1	32	0	0
3	07.30 - 07.45	11	0	0	9	2	30	0	0
4	07.45 - 08.00	19	1	0	9	10	40	0	0
5	08.00 - 08.15	16	1	2	8	4	27	2	0
6	08.15 - 08.30	9	1	1	3	4	22	0	0
7	08.30 - 08.45	34	0	0	9	8	30	0	0
8	08.45 - 09.00	30	0	0	5	6	22	0	0
Total A		146	4	3	61	35	237	2	0
B. DAYTIME									
9	11.00 - 11.15	19	0	1	15	8	27	0	0
10	11.15 - 11.30	17	0	0	11	5	23	0	0
11	11.30 - 11.45	18	0	0	0	2	16	0	0
12	11.45 - 12.00	19	1	0	9	5	19	0	0
13	12.00 - 12.15	23	0	1	6	7	23	1	0
14	12.15 - 12.30	13	0	0	3	0	13	0	0
15	12.30 - 12.45	12	0	0	10	1	24	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
16	12.45 - 13.00	15	0	0	13	11	16	0	0
<b>Total B</b>		<b>136</b>	<b>1</b>	<b>2</b>	<b>67</b>	<b>39</b>	<b>161</b>	<b>1</b>	<b>0</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	30	0	2	6	3	29	0	0
18	14.15 - 14.30	27	0	1	15	3	23	0	0
19	14.30 - 14.45	24	1	2	10	2	20	1	0
20	14.45 - 15.00	13	0	0	13	5	19	0	0
21	15.00 - 15.15	14	0	0	3	4	22	0	1
22	15.15 - 15.30	26	0	0	4	2	11	0	0
23	15.30 - 15.45	17	0	0	8	1	16	0	0
24	15.45 - 16.00	15	0	0	10	3	13	0	0
25	16.00 - 16.15	15	1	0	10	0	25	0	0
26	16.15 - 16.30	21	0	0	12	1	50	0	0
27	16.30 - 16.45	19	0	0	19	6	42	0	0
28	16.45 - 17.00	36	0	0	32	0	43	0	0
29	17.00 - 17.15	11	1	0	7	1	3	0	0
30	17.15 - 17.30	15	0	1	8	1	9	0	0
31	17.30 - 17.45	11	0	0	8	1	13	0	0
32	17.45 - 18.00	20	0	0	8	6	12	0	0
33	18.00 - 18.15	7	0	0	9	1	8	0	0
34	18.15 - 18.30	34	0	0	10	9	38	0	0
35	18.30 - 18.45	11	0	0	8	3	5	0	0
36	18.45 - 19.00	1	0	0	2	0	0	0	0
<b>Total C</b>		<b>367</b>	<b>3</b>	<b>6</b>	<b>202</b>	<b>52</b>	<b>401</b>	<b>1</b>	<b>1</b>
<b>Total A+B+C</b>		<b>649</b>	<b>8</b>	<b>11</b>	<b>330</b>	<b>126</b>	<b>799</b>	<b>4</b>	<b>1</b>
<b>Grand Total</b>		<b>1928</b>							

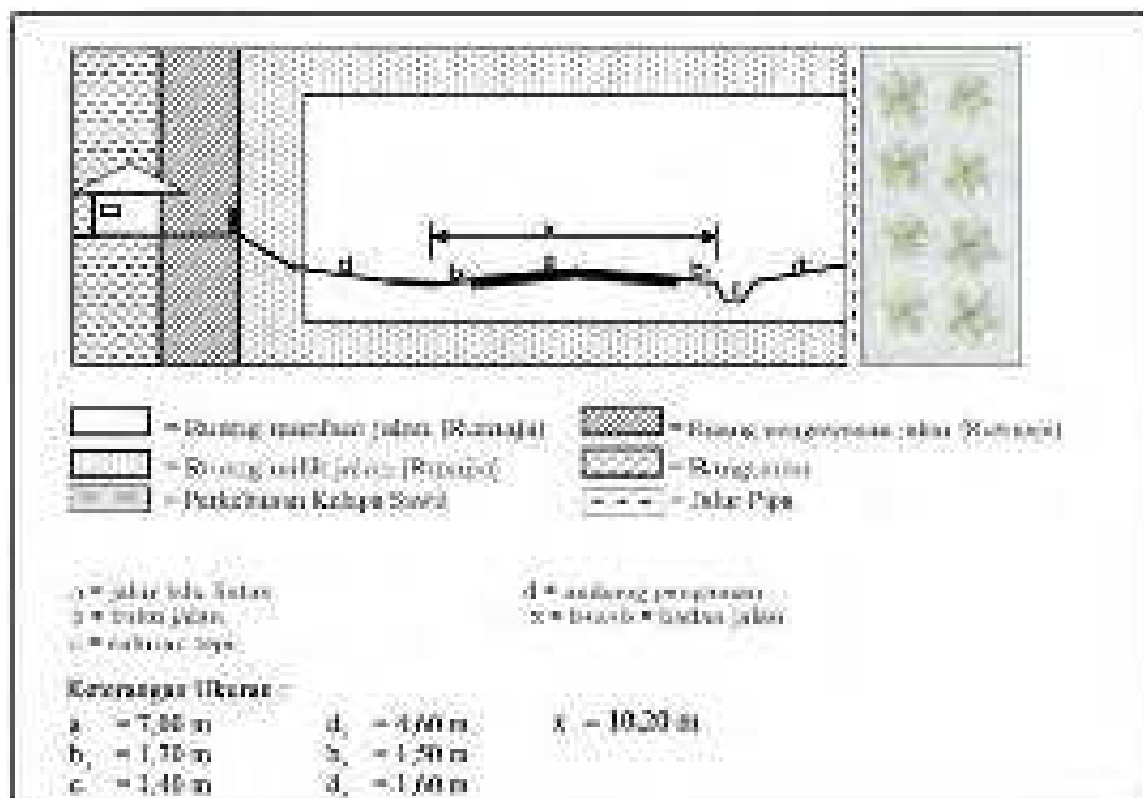
**Table 9-4. Number and Type of Vehicles Passing through Pemda Gasip, from Gasip to Pekanbaru on 1 February 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	12	0	0	12	0	35	0	0
2	07.15 - 07.30	10	0	0	10	1	30	0	0
3	07.30 - 07.45	10	0	0	14	3	32	0	0
4	07.45 - 08.00	9	2	0	9	1	29	0	0
5	08.00 - 08.15	20	0	0	5	0	31	0	0
6	08.15 - 08.30	23	0	0	6	0	30	0	0
7	08.30 - 08.45	15	0	0	9	0	32	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
8	08.45 - 09.00	24	0	1	14	2	27	0	0
<b>Total A</b>		<b>123</b>	<b>2</b>	<b>1</b>	<b>79</b>	<b>7</b>	<b>246</b>	<b>0</b>	<b>0</b>
<b>B. DAYTIME</b>									
9	11.00 - 11.15	23	1	0	7	1	30	0	0
10	11.15 - 11.30	14	0	0	6	0	26	0	0
11	11.30 - 11.45	12	0	1	8	2	28	0	0
12	11.45 - 12.00	21	1	1	9	0	24	0	0
13	12.00 - 12.15	22	1	1	14	1	31	0	0
14	12.15 - 12.30	24	0	0	14	0	24	0	0
15	12.30 - 12.45	14	0	0	13	1	17	0	0
16	12.45 - 13.00	14	0	0	5	0	20	0	0
<b>Total B</b>		<b>144</b>	<b>3</b>	<b>3</b>	<b>76</b>	<b>5</b>	<b>200</b>	<b>0</b>	<b>0</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	19	1	0	8	0	21	0	0
18	14.15 - 14.30	31	0	0	12	0	14	0	0
19	14.30 - 14.45	38	0	0	5	0	29	0	0
20	14.45 - 15.00	30	1	0	7	0	32	0	0
21	15.00 - 15.15	33	2	0	14	0	29	0	1
22	15.15 - 15.30	34	0	0	11	1	39	0	0
23	15.30 - 15.45	25	0	1	10	1	14	0	0
24	15.45 - 16.00	48	3	1	8	2	37	0	1
25	16.00 - 16.15	42	0	3	13	1	22	0	0
26	16.15 - 16.30	45	1	3	13	0	41	0	0
27	16.30 - 16.45	49	1	2	22	0	84	0	0
28	16.45 - 17.00	17	1	1	10	0	28	0	0
29	17.00 - 17.15	27	0	1	11	0	14	0	0
30	17.15 - 17.30	26	0	1	7	0	32	0	0
31	17.30 - 17.45	28	0	1	6	0	26	0	0
32	17.45 - 18.00	27	0	1	17	2	13	0	0
33	18.00 - 18.15	19	0	0	8	1	12	0	0
34	18.15 - 18.30	27	0	1	7	1	14	0	0
35	18.30 - 18.45	26	0	0	11	2	16	0	0
36	18.45 - 19.00	35	2	2	12	3	20	0	0
<b>Total C</b>		<b>626</b>	<b>12</b>	<b>18</b>	<b>212</b>	<b>14</b>	<b>537</b>	<b>0</b>	<b>2</b>
<b>Total A+B+C</b>		<b>893</b>	<b>17</b>	<b>22</b>	<b>367</b>	<b>26</b>	<b>983</b>	<b>0</b>	<b>2</b>
<b>Grand Total</b>		<b>2310</b>							



**Figure 9-1. Pemda Gasip Road**



**Figure 9-2. Pemda Gasip Road Dimention**

### 9.1.2 Meredan Cross Section

**Table 9-5. Number and Type of Vehicles Passing through Meredan Cross Section, from Maredan to Pekanbaru on 25 January 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. PAGI HARI									
1	07.00 - 07.15	9	1	0	8	0	19	0	0
2	07.15 - 07.30	8	1	0	10	0	23	0	0
3	07.30 - 07.45	10	0	0	11	1	20	0	0
4	07.45 - 08.00	13	0	0	7	0	22	0	0
5	08.00 - 08.15	12	1	0	15	0	19	0	0
6	08.15 - 08.30	13	1	0	8	2	20	0	0
7	08.30 - 08.45	18	1	1	14	1	28	0	0
8	08.45 - 09.00	32	0	1	11	0	22	0	0
Total A		115	5	2	84	4	173	0	0
B. SIANG HARI									
9	11.00 - 11.15	22	0	0	12	0	18	0	0
10	11.15 - 11.30	23	1	0	7	5	21	0	0
11	11.30 - 11.45	23	0	0	5	2	21	0	0
12	11.45 - 12.00	16	0	0	21	3	21	0	0
13	12.00 - 12.15	20	0	0	3	4	22	0	0
14	12.15 - 12.30	19	1	0	12	2	12	0	0
15	12.30 - 12.45	17	0	0	5	1	18	0	0
16	12.45 - 13.00	22	0	0	8	0	10	0	0
Total B		162	2	0	73	17	143	0	0
C. SORE HARI									
17	14.00 - 14.15	28	2	0	7	2	16	0	0
18	14.15 - 14.30	17	0	0	11	3	11	0	0
19	14.30 - 14.45	33	1	0	12	1	20	0	0
20	14.45 - 15.00	32	0	0	14	1	15	0	0
21	15.00 - 15.15	38	0	0	21	1	27	0	0
22	15.15 - 15.30	35	0	0	15	0	28	0	0
23	15.30 - 15.45	34	1	0	12	0	19	0	0
24	15.45 - 16.00	35	1	0	8	0	22	0	0
25	16.00 - 16.15	42	0	0	16	0	23	0	0
26	16.15 - 16.30	30	1	0	15	1	25	0	0
27	16.30 - 16.45	30	0	0	16	0	27	0	0
28	16.45 - 17.00	16	0	0	6	0	27	0	0
29	17.00 - 17.15	32	0	0	25	0	31	0	0
30	17.15 - 17.30	27	2	1	19	0	32	0	0
31	17.30 - 17.45	29	1	1	20	2	27	0	0
32	17.45 - 18.00	43	2	5	8	2	32	0	0
33	18.00 - 18.15	27	0	0	4	1	34	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
34	18.15 - 18.30	45	1	9	13	1	29	0	0
35	18.30 - 18.45	24	0	0	6	1	17	0	0
36	18.45 - 19.00	22	0	0	9	3	16	0	0
Total C		619	12	16	257	19	478	0	0
Total A+B+C		896	19	18	414	40	794	0	0
Grand Total		2181							

**Table 9-6. Number and Type of Vehicles Passing through Meredan Cross Section, from Pekanbaru to Meredan on 25 January 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	32	1	0	10	1	29	0	0
2	07.15 - 07.30	29	0	0	12	3	24	0	0
3	07.30 - 07.45	31	1	0	9	2	22	0	0
4	07.45 - 08.00	37	0	0	10	2	27	0	0
5	08.00 - 08.15	24	0	0	6	5	21	0	0
6	08.15 - 08.30	32	1	0	11	1	29	0	0
7	08.30 - 08.45	31	0	0	9	0	21	0	0
8	08.45 - 09.00	39	0	0	15	1	28	0	0
Total A		255	3	0	82	15	201	0	0
B. DAYTIME									
9	11.00 - 11.15	25	0	0	9	0	16	0	0
10	11.15 - 11.30	19	1	0	14	1	14	0	0
11	11.30 - 11.45	21	1	0	8	0	11	0	0
12	11.45 - 12.00	15	0	0	18	0	14	0	0
13	12.00 - 12.15	33	0	0	5	0	17	0	0
14	12.15 - 12.30	17	0	0	9	3	15	0	0
15	12.30 - 12.45	19	1	0	10	0	9	0	0
16	12.45 - 13.00	19	1	0	11	2	12	0	0
Total B		168	4	0	84	6	108	0	0
C. AFTERNOON									
17	14.00 - 14.15	21	0	0	6	1	18	0	0
18	14.15 - 14.30	19	0	0	12	0	14	0	0
19	14.30 - 14.45	19	0	0	6	0	17	0	0
20	14.45 - 15.00	25	1	0	15	0	15	0	0
21	15.00 - 15.15	20	0	0	8	0	15	0	0
22	15.15 - 15.30	22	2	0	6	1	24	0	0
23	15.30 - 15.45	35	0	0	14	2	23	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
24	15.45 - 16.00	29	0	0	10	0	27	0	1
25	16.00 - 16.15	26	1	0	7	1	24	0	0
26	16.15 - 16.30	36	0	0	16	2	20	0	0
27	16.30 - 16.45	29	2	0	18	0	22	0	0
28	16.45 - 17.00	31	0	0	18	1	25	0	0
29	17.00 - 17.15	25	0	0	13	2	23	0	0
30	17.15 - 17.30	30	0	0	11	1	32	0	0
31	17.30 - 17.45	17	0	0	2	0	28	0	0
32	17.45 - 18.00	25	0	0	18	0	21	0	0
33	18.00 - 18.15	20	0	0	5	0	16	0	0
34	18.15 - 18.30	16	0	0	5	0	14	0	0
35	18.30 - 18.45	20	0	0	6	0	13	0	0
36	18.45 - 19.00	11	0	0	8	0	10	0	0
Total C		476	6	0	204	11	401	0	1
Total A+B+C		899	13	0	370	32	710	0	1
Grand Total		2025							

**Table 9-7. Number and Type of Vehicles Passing through Meredan Cross Section, from Maredan to Pekanbaru on 27 Januari 2018.**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	10	0	0	6	1	20	0	0
2	07.15 - 07.30	19	1	0	14	0	12	0	0
3	07.30 - 07.45	12	0	0	7	0	11	0	0
4	07.45 - 08.00	20	0	0	10	0	18	0	0
5	08.00 - 08.15	12	0	0	7	0	14	0	0
6	08.15 - 08.30	23	2	0	7	0	8	0	0
7	08.30 - 08.45	28	0	0	13	0	16	0	0
8	08.45 - 09.00	34	1	0	15	1	20	0	0
Total A		158	4	0	79	2	119	0	0
B. DAYTIME									
9	11.00 - 11.15	40	2	0	8	2	21	0	0
10	11.15 - 11.30	38	0	0	9	1	21	0	0
11	11.30 - 11.45	20	0	0	20	2	34	0	0
12	11.45 - 12.00	38	0	0	6	2	18	0	0
13	12.00 - 12.15	25	0	0	11	4	20	0	0
14	12.15 - 12.30	25	0	0	11	1	29	0	0
15	12.30 - 12.45	24	0	0	14	2	11	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
16	12.45 - 13.00	27		0	26	2	16	0	0
<b>Total B</b>		<b>237</b>	<b>2</b>	<b>0</b>	<b>105</b>	<b>16</b>	<b>170</b>	<b>0</b>	<b>0</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	45	0	0	10	1	14	0	0
18	14.15 - 14.30	31	0	0	11	1	21	0	0
19	14.30 - 14.45	44	1	1	13	0	32	0	0
20	14.45 - 15.00	32	1	0	12	0	15	0	0
21	15.00 - 15.15	36	0	0	8	0	31	0	0
22	15.15 - 15.30	41	0	0	13	7	24	0	0
23	15.30 - 15.45	45	3	0	16	1	25	0	0
24	15.45 - 16.00	41	1	0	11	0	44	0	0
25	16.00 - 16.15	23	0	0	10	0	15	0	0
26	16.15 - 16.30	47	1	0	12	0	33	0	0
27	16.30 - 16.45	20	1	0	13	0	36	0	0
28	16.45 - 17.00	40	0	0	10	0	31	0	0
29	17.00 - 17.15	60	0	0	11	1	40	0	0
30	17.15 - 17.30	18	1	0	11	0	22	0	0
31	17.30 - 17.45	60	0	0	24	0	44	0	0
32	17.45 - 18.00	52	3	0	14	0	24	0	0
33	18.00 - 18.15	53	1	0	9	0	36	0	0
34	18.15 - 18.30	41	0	1	9	1	28	0	0
35	18.30 - 18.45	21	0	0	3	1	8	0	0
36	18.45 - 19.00	36	0	0	10	0	20	0	0
<b>Total C</b>		<b>786</b>	<b>13</b>	<b>2</b>	<b>230</b>	<b>13</b>	<b>543</b>	<b>0</b>	<b>0</b>
<b>Total A+B+C</b>		<b>1181</b>	<b>19</b>	<b>2</b>	<b>414</b>	<b>31</b>	<b>832</b>	<b>0</b>	<b>0</b>
<b>Grand Total</b>		<b>2479</b>							

**Table 9-8. Number and Type of Vehicles Passing through Meredan Cross Section, from Pekanbaru to Meredan on 27 Januari 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	17	1	0	7	6	35	0	0
2	07.15 - 07.30	18	0	0	10	1	28	0	0
3	07.30 - 07.45	17	1	0	10	3	20	0	0
4	07.45 - 08.00	18	0	0	9	1	17	0	0
5	08.00 - 08.15	12	0	0	14	2	18	0	0
6	08.15 - 08.30	23	0	1	6	0	26	0	0
7	08.30 - 08.45	29	1	0	5	0	18	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
8	08.45 - 09.00	28	1	0	13	1	13	0	0
<b>Total A</b>		<b>162</b>	<b>4</b>	<b>1</b>	<b>74</b>	<b>14</b>	<b>175</b>	<b>0</b>	<b>0</b>
<b>B. DAYTIME</b>									
9	11.00 - 11.15	32	1	1	8	0	24	0	0
10	11.15 - 11.30	21	3	0	19	1	19	0	0
11	11.30 - 11.45	27	1	0	8	0	36	0	0
12	11.45 - 12.00	26	0	0	5	0	22	0	0
13	12.00 - 12.15	18	1	0	8	1	21	0	0
14	12.15 - 12.30	23	0	0	18	1	19	0	0
15	12.30 - 12.45	13	1	0	5	2	9	0	0
16	12.45 - 13.00	25	2	0	13	2	15	0	0
<b>Total B</b>		<b>185</b>	<b>9</b>	<b>1</b>	<b>84</b>	<b>7</b>	<b>165</b>	<b>0</b>	<b>0</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	19	0	0	9	1	8	0	0
18	14.15 - 14.30	32	2	0	17	2	27	0	0
19	14.30 - 14.45	29	0	0	8	1	22	1	0
20	14.45 - 15.00	30	1	0	10	0	12	0	0
21	15.00 - 15.15	47	1	0	6	1	26	0	0
22	15.15 - 15.30	33	1	0	8	0	26	0	0
23	15.30 - 15.45	37	2	0	9	0	26	0	0
24	15.45 - 16.00	33	1	0	11	0	31	0	0
25	16.00 - 16.15	25	1	0	9	0	26	0	0
26	16.15 - 16.30	35	0	0	17	1	30	0	0
27	16.30 - 16.45	27	2	0	14	1	26	0	0
28	16.45 - 17.00	24	0	0	4	1	31	0	0
29	17.00 - 17.15	48	2	0	7	2	28	0	0
30	17.15 - 17.30	29	1	0	7	0	35	0	0
31	17.30 - 17.45	37	3	0	9	4	30	0	0
32	17.45 - 18.00	36	0	0	3	2	25	0	0
33	18.00 - 18.15	46	0	1	10	1	17	0	0
34	18.15 - 18.30	45	2	0	11	0	44	0	0
35	18.30 - 18.45	12	0	0	2	1	12	0	0
36	18.45 - 19.00	25	1	0	4	3	29	0	0
<b>Total C</b>		<b>649</b>	<b>20</b>	<b>1</b>	<b>175</b>	<b>21</b>	<b>511</b>	<b>1</b>	<b>0</b>
<b>Total A+B+C</b>		<b>996</b>	<b>33</b>	<b>3</b>	<b>333</b>	<b>42</b>	<b>851</b>	<b>1</b>	<b>0</b>
<b>Grand Total</b>		<b>2259</b>							

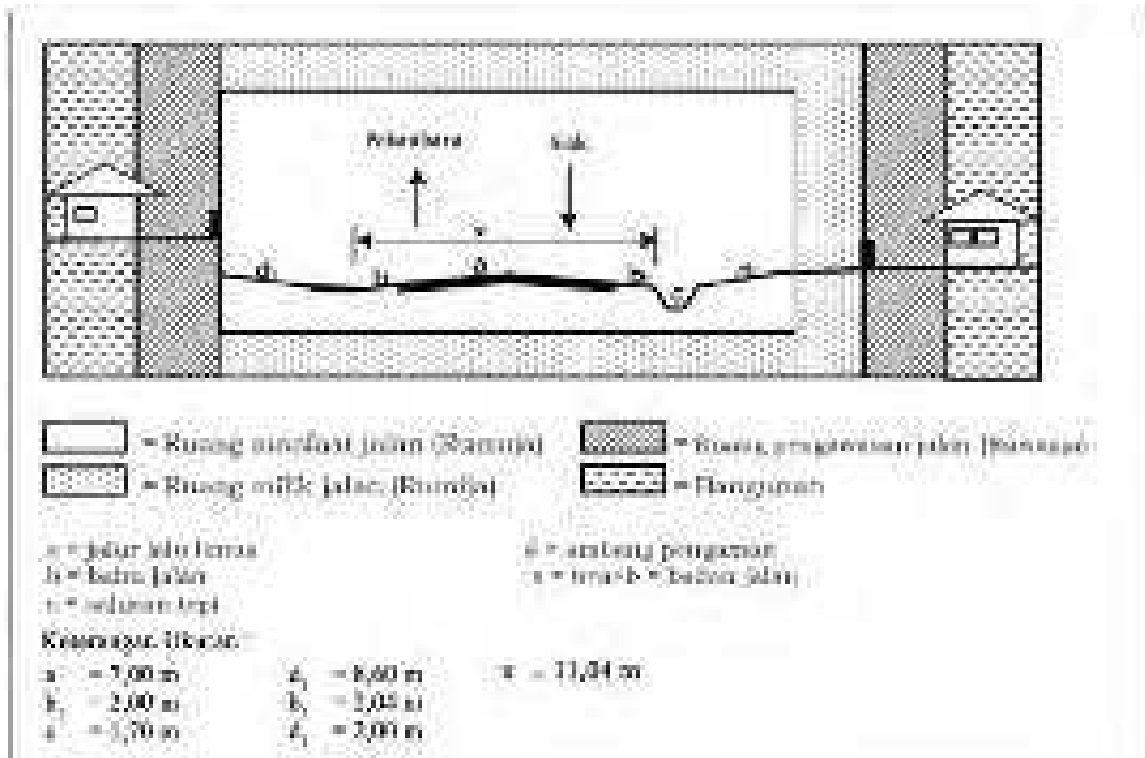


Figure 9-3. Maredan Road Dimention

### 9.1.3 Ujung Badak Road

Table 9-9. Number and Type of Vehicles Passing through Jalan Ujung Badak, from Ujung Badak to Hangtuah on 25 January 2018

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	8	0	0	5	0	107	0	0
2	07.15 - 07.30	2	0	0	9	0	127	0	0
3	07.30 - 07.45	6	2	0	11	0	109	0	0
4	07.45 - 08.00	6	1	0	7	0	119	0	0
5	08.00 - 08.15	2	0	0	9	0	59	0	0
6	08.15 - 08.30	4	1	0	14	0	68	0	0
7	08.30 - 08.45	13	0	0	13	0	57	0	0
8	08.45 - 09.00	5	1	0	15	0	70	0	0
Total A		46	5	0	83	0	716	0	0
B. DAYTIME									
9	11.00 - 11.15	13	1	0	8	0	53	0	0
10	11.15 - 11.30	13	0	0	9	0	73	0	0
11	11.30 - 11.45	9	1	0	10	0	70	0	1
12	11.45 - 12.00	7	0	0	10	0	56	0	0
13	12.00 - 12.15	7	0	0	9	0	65	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
14	12.15 - 12.30	12	0	0	11	0	71	0	0
15	12.30 - 12.45	6	0	0	9	0	93	0	0
16	12.45 - 13.00	11	0	0	7	0	71	0	0
<b>Total B</b>		<b>78</b>	<b>2</b>	<b>0</b>	<b>73</b>	<b>0</b>	<b>552</b>	<b>0</b>	<b>1</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	2	0	0	10	0	78	0	0
18	14.15 - 14.30	7	1	0	8	0	87	0	0
19	14.30 - 14.45	12	1	0	7	0	78	2	0
20	14.45 - 15.00	3	1	0	17	0	47	0	0
21	15.00 - 15.15	12	1	0	4	0	67	0	0
22	15.15 - 15.30	11	1	0	8	0	89	0	1
23	15.30 - 15.45	7	0	0	10	0	116	0	0
24	15.45 - 16.00	5	0	0	6	0	71	0	0
25	16.00 - 16.15	10	1	0	11	0	68	0	1
26	16.15 - 16.30	10	2	0	12	0	179	0	0
27	16.30 - 16.45	12	1	0	11	0	156	0	1
28	16.45 - 17.00	8	2	2	8	0	122	0	0
29	17.00 - 17.15	4	1	0	4	0	148	0	0
30	17.15 - 17.30	15	0	0	5	0	116	0	0
31	17.30 - 17.45	19	0	0	10	0	159	1	0
32	17.45 - 18.00	20	0	0	2	0	116	0	0
33	18.00 - 18.15	8	1	0	4	0	121	0	0
34	18.15 - 18.30	8	0	0	3	0	120	0	0
35	18.30 - 18.45	7	1	0	5	0	95	0	0
36	18.45 - 19.00	2	0	0	4	0	93	0	0
<b>Total C</b>		<b>182</b>	<b>14</b>	<b>2</b>	<b>149</b>	<b>0</b>	<b>2126</b>	<b>3</b>	<b>3</b>
<b>Total A+B+C</b>		<b>306</b>	<b>21</b>	<b>2</b>	<b>305</b>	<b>0</b>	<b>3394</b>	<b>3</b>	<b>4</b>
<b>Grand Total</b>		<b>4035</b>							

**Table 9-10. Number and Type of Vehicles Passing through Jalan Ujung Badak, from Hangtuah to Ujung Badak on 25 Januari 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	6	1	1	2	0	139	0	0
2	07.15 - 07.30	8	1	1	5	0	110	0	0
3	07.30 - 07.45	9	0	0	6	0	102	0	0
4	07.45 - 08.00	5	0	0	5	0	80	0	0
5	08.00 - 08.15	10	0	0	11	0	92	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
6	08.15 - 08.30	11	0	0	10	0	73	0	0
7	08.30 - 08.45	6	0	0	7	0	68	0	0
8	08.45 - 09.00	13	0	0	8	0	79	2	0
<b>Total A</b>		<b>68</b>	<b>2</b>	<b>2</b>	<b>54</b>	<b>0</b>	<b>743</b>	<b>2</b>	<b>0</b>
<b>B. DAYTIME</b>									
9	11.00 - 11.15	3	0	0	10	0	47	0	0
10	11.15 - 11.30	5	0	0	4	0	77	0	0
11	11.30 - 11.45	5	0	0	11	0	75	0	0
12	11.45 - 12.00	9	1	0	8	0	60	0	0
13	12.00 - 12.15	5	0	0	9	0	54	0	0
14	12.15 - 12.30	8	0	0	9	0	69	0	0
15	12.30 - 12.45	8	0	0	13	0	71	0	0
16	12.45 - 13.00	4	0	0	14	0	76	0	0
<b>Total B</b>		<b>47</b>	<b>1</b>	<b>0</b>	<b>78</b>	<b>0</b>	<b>529</b>	<b>0</b>	<b>0</b>
<b>C. AFTERNOON</b>									
17	14.00 - 14.15	7	0	0	16	0	73	0	0
18	14.15 - 14.30	8	1	0	9	0	93	0	0
19	14.30 - 14.45	8	2	0	6	0	83	0	0
20	14.45 - 15.00	7	5	0	8	0	53	0	0
21	15.00 - 15.15	8	2	0	8	0	93	0	0
22	15.15 - 15.30	8	2	0	14	0	65	0	0
23	15.30 - 15.45	10	0	0	7	0	80	0	0
24	15.45 - 16.00	9	0	0	10	0	82	0	0
25	16.00 - 16.15	9	1	0	13	0	73	1	0
26	16.15 - 16.30	2	1	0	10	0	106	0	0
27	16.30 - 16.45	4	0	0	10	0	97	0	0
28	16.45 - 17.00	3	0	0	7	0	96	0	0
29	17.00 - 17.15	15	0	1	7	0	110	1	0
30	17.15 - 17.30	8	0	0	3	1	127	0	0
31	17.30 - 17.45	5	0	0	10	0	110	0	0
32	17.45 - 18.00	6	0	0	5	0	112	0	0
33	18.00 - 18.15	6	0	0	8	0	110	0	0
34	18.15 - 18.30	6	0	0	11	0	101	0	0
35	18.30 - 18.45	5	0	0	7	0	94	0	0
36	18.45 - 19.00	4	1	0	2	0	81	0	0
<b>Total C</b>		<b>138</b>	<b>15</b>	<b>1</b>	<b>171</b>	<b>1</b>	<b>1839</b>	<b>2</b>	<b>0</b>
<b>Total A+B+C</b>		<b>253</b>	<b>18</b>	<b>3</b>	<b>303</b>	<b>1</b>	<b>3111</b>	<b>4</b>	<b>0</b>
<b>Grand Total</b>		<b>3693</b>							

**Table 9-11. Number and Type of Vehicles Passing through Jalan Ujung Badak, from Hangtuhah to Ujung Badak to on 27 Januari 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	6	1	0	2	0	156	2	0
2	07.15 - 07.30	3	0	0	6	0	110	0	0
3	07.30 - 07.45	8	0	0	10	0	96	0	0
4	07.45 - 08.00	6	0	0	5	0	95	0	0
5	08.00 - 08.15	8	0	0	5	0	100	0	0
6	08.15 - 08.30	5	1	0	8	0	71	0	0
7	08.30 - 08.45	7	0	0	11	0	80	0	1
8	08.45 - 09.00	5	0	0	5	0	80	0	0
Total A		48	2	0	52	0	788	2	1
B. DAYTIME									
9	11.00 - 11.15	8	0	0	3	0	90	1	0
10	11.15 - 11.30	6	0	0	12	0	70	0	0
11	11.30 - 11.45	11	1	0	11	0	85	0	0
12	11.45 - 12.00	4	0	0	11	0	58	0	0
13	12.00 - 12.15	4	0	0	7	0	62	0	0
14	12.15 - 12.30	3	0	2	4	0	75	0	0
15	12.30 - 12.45	4	0	0	8	0	69	1	0
16	12.45 - 13.00	13	0	0	2	0	60	0	1
Total B		53	1	2	58	0	569	2	1
C. AFTERNOON									
17	14.00 - 14.15	14	0	0	8	0	51	0	0
18	14.15 - 14.30	10	2	0	6	0	57	0	0
19	14.30 - 14.45	11	1	0	8	0	69	0	0
20	14.45 - 15.00	4	0	0	12	0	58	0	1
21	15.00 - 15.15	7	0	0	9	0	55	0	0
22	15.15 - 15.30	8	0	0	3	0	66	0	0
23	15.30 - 15.45	6	0	0	10	0	50	0	1
24	15.45 - 16.00	8	0	0	10	0	60	0	0
25	16.00 - 16.15	8	0	0	7	0	70	0	0
26	16.15 - 16.30	8	0	0	5	0	56	0	0
27	16.30 - 16.45	7	0	0	10	0	73	0	0
28	16.45 - 17.00	5	0	0	2	0	35	0	0
29	17.00 - 17.15	4	0	0	4	0	65	0	0
30	17.15 - 17.30	4	0	0	4	0	80	0	0
31	17.30 - 17.45	8	0	0	16	0	88	0	0
32	17.45 - 18.00	4	0	0	10	0	97	0	0
33	18.00 - 18.15	5	0	0	5	0	95	0	0
34	18.15 - 18.30	9	0	0	4	0	125	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
35	18.30 - 18.45	2	0	0	6	0	81	0	0
36	18.45 - 19.00	4	1	0	8	0	83	0	0
<b>Total C</b>		<b>136</b>	<b>4</b>	<b>0</b>	<b>147</b>	<b>0</b>	<b>1414</b>	<b>0</b>	<b>2</b>
<b>Total A+B+C</b>		<b>237</b>	<b>7</b>	<b>2</b>	<b>257</b>	<b>0</b>	<b>2771</b>	<b>4</b>	<b>4</b>
<b>Grand Total</b>		<b>3282</b>							

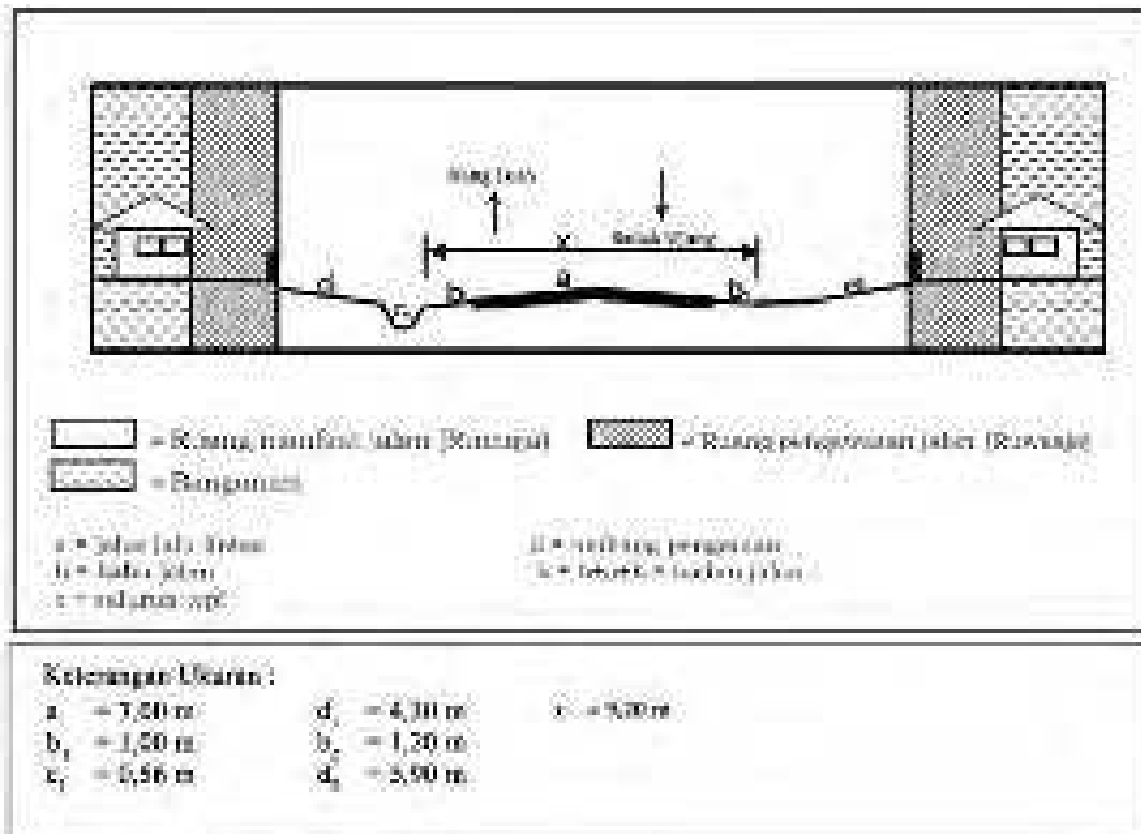
**Table 9-12. Number and Type of Vehicles Passing through Jalan Ujung Badak, from Ujung Badak to Hangtuh on 27 Januari 2018**

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non- Motorized Vehicles	Three- wheeled motorcycle
A. MORNING									
1	07.00 - 07.15	1	0	0	3	0	120	0	0
2	07.15 - 07.30	6	0	0	3	0	101	0	0
3	07.30 - 07.45	5	1	0	12	0	84	0	0
4	07.45 - 08.00	7	3	0	12	0	95	0	0
5	08.00 - 08.15	7	2	0	11	0	75	0	0
6	08.15 - 08.30	7	0	0	7	0	80	0	0
7	08.30 - 08.45	5	1	0	8	0	70	0	0
8	08.45 - 09.00	9	0	0	6	0	76	2	0
Total A		47	7	0	62	0	701	2	0
B. DAYTIME									
9	11.00 - 11.15	17	0	0	10	0	160	0	0
10	11.15 - 11.30	4	0	0	7	0	94	0	2
11	11.30 - 11.45	8	1	0	10	0	65	0	0
12	11.45 - 12.00	3	0	0	6	0	66	0	1
13	12.00 - 12.15	8	0	0	2	0	75	0	0
14	12.15 - 12.30	7	0	2	8	0	65	0	0
15	12.30 - 12.45	5	0	0	6	0	78	0	0
16	12.45 - 13.00	10	0	0	10	0	58	0	1
Total B		62	1	2	59	0	661	0	4
C. AFTERNOON									
17	14.00 - 14.15	9	0	0	7	0	47	0	0
18	14.15 - 14.30	5	1	0	4	0	70	0	0
19	14.30 - 14.45	9	0	0	3	0	52	0	0
20	14.45 - 15.00	7	0	0	7	0	65	0	1
21	15.00 - 15.15	8	0	0	8	0	74	0	0
22	15.15 - 15.30	9	1	0	12	0	66	0	0
23	15.30 - 15.45	10	2	0	7	0	75	0	0
24	15.45 - 16.00	7	0	0	7	0	89	0	0

No.	Time	Number of Vehicles (Unit)							
		Personal 4 Wheel Vehicles	Public transport	Bus	Truck	Tronton Truck	Motor Cycle	Non-Motorized Vehicles	Three-wheeled motorcycle
25	16.00 - 16.15	16	0	0	9	0	68	0	0
26	16.15 - 16.30	7	0	0	4	0	80	0	1
27	16.30 - 16.45	9	0	0	8	0	104	0	1
28	16.45 - 17.00	10	0	0	4	0	68	0	0
29	17.00 - 17.15	10	0	0	2	0	105	0	0
30	17.15 - 17.30	11	0	0	6	0	106	0	1
31	17.30 - 17.45	10	0	0	3	0	89	0	0
32	17.45 - 18.00	6	0	0	4	0	118	0	0
33	18.00 - 18.15	15	0	0	5	0	103	0	0
34	18.15 - 18.30	2	0	0	4	0	125	0	0
35	18.30 - 18.45	10	0	0	2	0	103	0	0
36	18.45 - 19.00	2	0	0	2	0	71	0	0
<b>Total C</b>		<b>172</b>	<b>4</b>	<b>0</b>	<b>108</b>	<b>0</b>	<b>1678</b>	<b>0</b>	<b>4</b>
<b>Total A+B+C</b>		<b>281</b>	<b>12</b>	<b>2</b>	<b>229</b>	<b>0</b>	<b>3040</b>	<b>2</b>	<b>8</b>
<b>Grand Total</b>		<b>3574</b>							



**Figure 9-4. Badak Ujung Road**



**Figure 9-5. Badak Ujung Road Dimention**

## 9.2 River Traffic

Observation of the trafic flow of Siak river to Pekanbaru was conducted in February and March, on March 1, 2018, the vessel that crossed the siak river amounted to 30 vessels and on the 24th of february 2018 amounted to 26 ships. The following shows the number and types of vessels that pass through the Siak River.

**Table 9-13. Ship That Passes Through The Siak River on March 1, 2018**

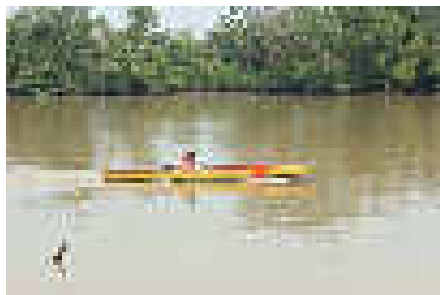
No	Time	Type	Name
1	8:33	Sampan Dayung	No name
2	9:02	Sampan Dayung	No name
3	9:24	Sampan TS	No name
4	9:34	Sampan Dayung	No name
5	10:04	Sampan TS	No name
6	10:05	Spead Boad	No name
7	10:07	Sampan Dayung	No name
8	10:32	Sampan TS	No name
9	11:11	Sampan TS	No name
10	12:13	Tengker	MV. Intan Daya 5 Batam
11	12:38	Spead Boad	Naga Line 2

No	Time	Type	Name
12	12:40	Spead Boad	Porti Expres
13	12:52	Sampan Dayung	No name
14	12:57	Tugboad dan Tongkang	APM 5
15	13:04	Spead Boad	Polisi IV 2002
16	13:27	Spead Boad	Poisi IV 2004
17	14:07	Sampan TS	No name
18	14:11	Tengker	KM Cahaya Abadi 203 Jakarta
19	14:29	Sampan TS	No name
20	14:32	Sampan Dayung	No name
21	14:48	Tengker	Sarana Prima
22	14:50	Sampan TS	No name
23	15:54	Spead Boad	No name
24	16:48	Spead Boad	Naga Line 2
25	17:02	Tengker	Berkat Anugerah 05
26	17:06	Spead Boad	Meranti Expres
27	17:17	Spead Boad	Porti Expres
28	17:38	Kapal Barang	No name
29	17:59	Pompong dan Sampan Dayung	No name
30	18:11	Sampan TS	No name

**Table 9-14. Ship That Passes Through The Siak River on February 24, 2018**

No	Time	Type	Name
1	8:01	Sampan TS	No Name
2	8:29	Jelatik	KLM Tujuh Saudara
3	8:34	Sampan dayung	No Name
4	8:36	Sampan dayung	No Name
5	8:44	sampan dayung	No Name
6	9:20	Sampan TS	No Name
7	9:27	Jelatik	Victory Scorpio
8	9:56	Sampan TS	No Name
9	10:14	Pompong	No Name
10	10:16	Pompong	KM CIP
11	10:33	Spead Boat	SB Siak Wisata 009
12	10:49	Sampan TS	No Name
13	12:55	Spead Boat	Naga Line 2
14	13:05	Sampan dayung	No Name
15	13:16	Spead Boat	Porti exspress
16	14:39	Pompong	No Name
17	14:47	Tugboat dan tongkang	ASP 26 dan Persada 2710
18	15:09	Sampan TS	No Name

No	Time	Type	Name
19	15:44	Sampan TS	No Name
20	16:21	Speed boat	SB Siak Wisata 009
21	17:09	Speed Boat	Naga Line 2
22	17:22	Speed Boat	meranti Exspress
23	17:36	Speed Boat	Porti exspress
24	17:38	Sampan TS	No Name
25	17:46	Sampan dayung	No Name
26	18:04	Sampan TS	No Name



Sampan TS



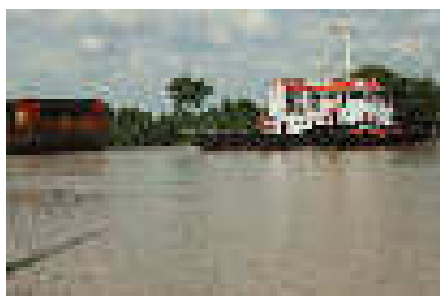
Sampan Dayung



Speed Boat



Jelatik



Tug Boat Tongkang



Pompong

**Figure 9-6. Types of Ships Passing through the Siak River**

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## 10 SOCIAL AND ECONOMIC

*Social reports are sent in Indonesian and in separate files*

# 1 PREFACE

## 1.1 BACKGROUND

In order to meet the national electricity demand, especially in Riau Province, a 275MW Gas Steam Power Plant (GSPP) Riau facility will be built. This project will be located approximately 10 km east of Pekanbaru City in Tenayan Raya Subdistrict, about 5 km south of Siak River. The Power Plant and substation will be built above the land of 9 hectares and will be acquired by Medco Ratch Power Riau (MRPR) as the Project Proponent.

To fulfill the gas needs of GSPP, the MRPR will also installing 40km gas pipe. This gas pipeline will passing several administrative area stretching from Kuala Gasib Village of Siak District to the power plant location in Industri Tenayan Village of Pekanbaru City. Other than that, there will be GSPP's supporting facilities built, such as temporary jetty and water intake which are located on the bank of Siak River in Industri Tenayan Village area.

In connection with the project's development, the project proponent is preparing the Environmental Impact Assessment (AMDAL) document as required by the Government of Indonesia. Therefore, as part of the AMDAL, the social survey on the social, economic, cultural and health conditions of the communities at the project site will be conducted with reference to the Draft Baseline Data Terms of Reference JIG and the Decree of the Head of BAPEDAL No. 299 of 1996 on Technical Guidelines for Social Aspect Review in the Preparation of AMDAL. In addition, considering that the project will be funded by Lenders, the project proponent is also obliged to prepare the Environmental and Social Impact Assessment (ESIA) with reference to International Finance Cooperation (IFC) Performance Standards.

This socioeconomic survey will be a great benefit to the project proponent, not only to meet AMDAL and IFC or ESIA requirements, but moreover, the results of this socioeconomic survey will be a useful data and knowledge for project implementation in order to understand the socio-economic conditions of the communities at the project site.

The result of this study is expected to facilitate the project proponent during the engagement process with the community. Moreover, when the land acquisition process is carried out, the results of this socio-economic survey will help to understand the household conditions that will be exposed to land acquisition, so that the compensation and restoration of their livelihood conditions as required by the government and IFC can be done properly by the company.

These surveys use the theory of Sustainable Livelihood developed by Chambers and Conway (1992), which places five major capitals that affect the quality of life of a family, namely human, nature, social, physical, and finance. The combination of ownership of these five livelihood capitals will give a special picture of the social and economic conditions of a family as well as describe the quality of living conditions of a wider social community. As for the formulation of livelihood strategies, Chambers and Conway theories are further developed into the Sustainable Livelihood Framework (SLF) concept.