CHAPTER SIX

Existing Environment

Chapter 6 EXISTING ENVIRONMENT

6.1 INTRODUCTION

It is important for any EIA that there should be an understanding of the environmental features on which the proposed Project may have an influence or be influenced by. This Chapter describes the main characteristics of the environment within 5 km radius zone of study from the Project boundary with particular attention being given to areas that may be sensitive to or may affect the proposed Project operations.

6.2 PHYSICAL ENVIRONMENT

6.2.1 TOPOGRAPHY

The Project site is located within the Rajawali/ Derawan Complex of Sime Darby Plantation. The site is situated about 9 km southeast from the Samalaju Industrial Park (SIP) and approximately 55 km northeast of Bintulu Town.

A topographical survey has been done on the proposed Project site and the site is found to be undulating with elevations ranging from 16 m to 100 m above mean sea level (AMSL). The lowest area of the proposed Project site is located at the north-western corner, around 16 m AMSL. The high area within the site is located at the middle, southern boundary and the eastern boundary, where elevation ranges from 80 m to 100 m AMSL.

The topography map is as shown in **Figure 6.2.1**.

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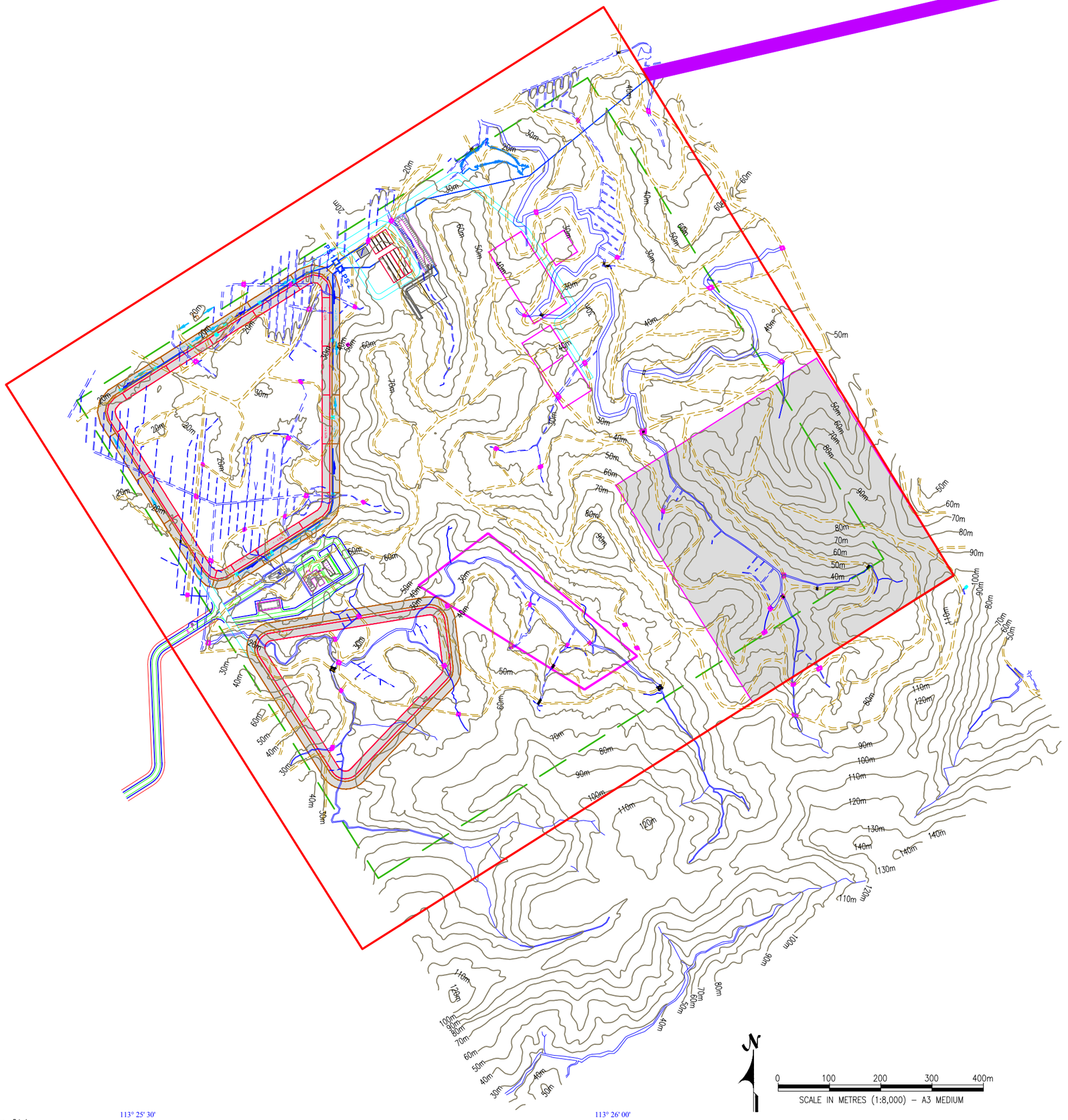
SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT
SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK

113° 25' 30"
113° 26' 30"
3° 29' 30"
3° 29' 00"



LEGEND:

- PROJECT BOUNDARY
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- EARTH ROAD
- EARTH DRAIN
- STREAM
- CONTOUR LINE IN METRES
- LOGGING CROSSING
- CULVERT

N

0 100 200 300 400m

SCALE IN METRES (1:8,000) – A3 MEDIUM

SOURCE : Trienekens (Samalaju) Sdn Bhd

TOPOGRAPHY MAP

FIGURE: 6.2.1

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-621.DWG

6.2.2 GEOLOGY

The study area consists of mainly sedimentary rocks of Setap Shale Formation. It consists of sandstones interbedded with shale and thin seams of lignite. The Setap Shale Formation is a succession of dark clay-shales generally with minor intercalations of thin bedded sandstone or siltstone. The shales are occasionally calcareous and a few thin lenses of biothermal or biostromal limestone occur. The geological age of Setap Shale Formation is between Oligocene to Late Miocene (Tertiary).

The proposed Project site is located in Setap Shale Formation as shown by a geological map in **Figure 6.2.2**. On the north, near the sea, outside of the Project area, the geology is comprised of quaternary deposits consisting of coastal and riverine alluvium, terraces of clay, silt, sand and gravel with layers of peat. The study area is also folded producing sets of anticlines and synclines. The depositional environment for Setap Shale Formation is clastic deeper marine environment.

The geological fieldwork was conducted at the proposed Project site on January 2019. The fieldwork involved a thorough investigation on the geology (rock exposures) that can be found at the proposed Project site and its surrounding area. **Figure 6.2.3** shows the google map of geological observation stations that were visited to describe the geology of the proposed Project site. There were eleven (11) localities visited. The geology descriptions and their photos are summarised in **Table 6.2.1**.

The work also involved collecting some rock specimens for laboratory analysis (petrographic study). The following observations were made at every geological localities; rock types, rock structures (faults and discontinuities), mineralogy and soil types/ profiles. This is an appropriate and practical approach of geological mapping – investigation particularly for the small domain of geologically unpretentious and homogenous lithologic area. The samples were taken to the laboratory for description of minerals and textures and identification of rock type/ classification. The samples collected were all sedimentary rocks that represent the main rock type at the proposed Project site. Laboratory study involved the microscopic analysis of the sedimentary rocks using a microscope to scientifically classify the rock types and their generic names.

Four (4) rock samples were collected for petrographic analysis in the laboratory – BLS2, BLS3, BLS5 and BLS11. These specimens are shown in **Table 6.2.1** (see **Plate 6.9**, **Plate 6.11**, **Plate 6.15** and **Plate 6.27**).

Rock specimen BLS2 is a medium to coarse grained dark grey dense sandstone. It contains well sorted medium to coarse grained minerals (0.25 mm to 1.0 mm). Minerals have low sphericity with round to subround degree of roundness. Quartz grains (50-60%) and rock fragments (20-30%) are dominant in this standstone specimen. This specimen can be classified according to classification scheme from Dott (1964) as sublitarenit. **Plate 6.28** shows the photomicrograph of rock specimen BLS2 with A (parallel nicol mode) and B (cross nicol mode).

Photomicrographs of medium grained calcareous sandstone (BLS3) are presented in **Plate 6.29**. This sandstone has a calcite cement that produce a positive reaction when tested with hydrochloric acid (HCl). This sandstone is grain supported type and cemented by calcite cement. The minerals are moderately sorted to poorly sorted with grains averaging from 0.25 to 1 mm (medium to coarse grained sandstone). The mineralogy of BLS3 is comprised of mainly quartz, alkali feldspar, cement calcite and rock fragments. Based on the percentage of quartz (70%), alkali feldspar (10%) and rock fragments (20%), this sandstone can be classified as sublitarenite.

Thin sections of rock specimen BLS5 (shale/ mudstone) are presented in **Plate 6.30**. This mudstone is dark grey and very fine grained. Minerals cannot be identified using naked eyes. Under the microscope, this mudstone contains high content of very fine quartz minerals.

Plate 6.31 shows rock thin section of calcareous sandstone from Locality BLS11. This sandstone has a positive reaction when tested with hydrochloric acid (HCl) indicating the calcareous type of this sandstone. The calcareous is due to calcite cement that presents in between the mineral grains. Under the microscope, this sandstone is grains supported type with very poor mineral sorting. The grain size is too small (0.062 mm to 0.25 mm) with calcite cement fill the spaces between mineral grains. The grains texture is low sphericity and very angular. Based on the percentages of quartz (35%), feldspar (5%) and rock fragments (60%), this sandstone has been classified as lithic arenite.

Figure 6.2.2: Geological Map of the Proposed Project Site

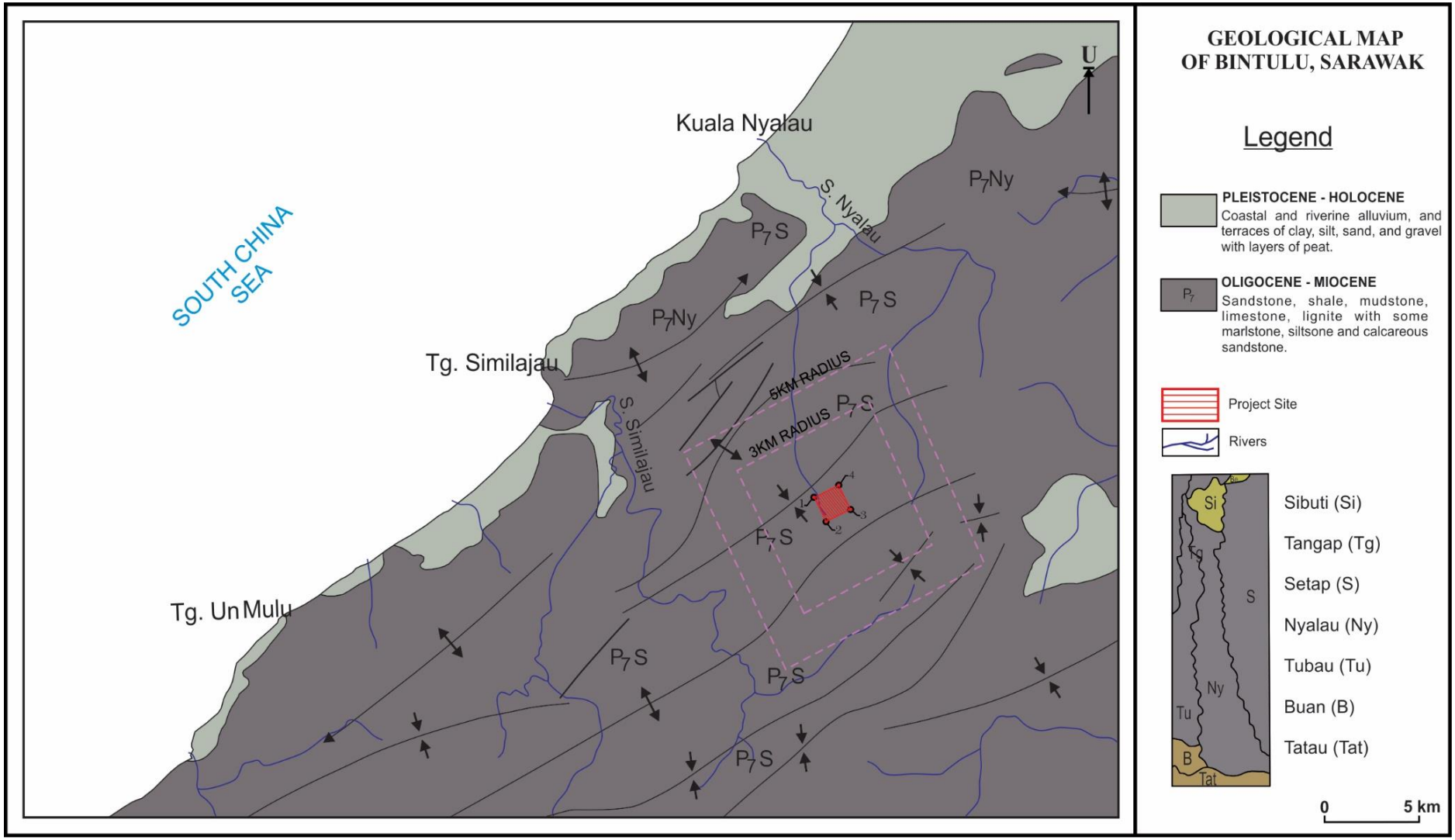


Figure 6.2.3: Geology Observation Stations at and Surrounding the Proposed Project Site

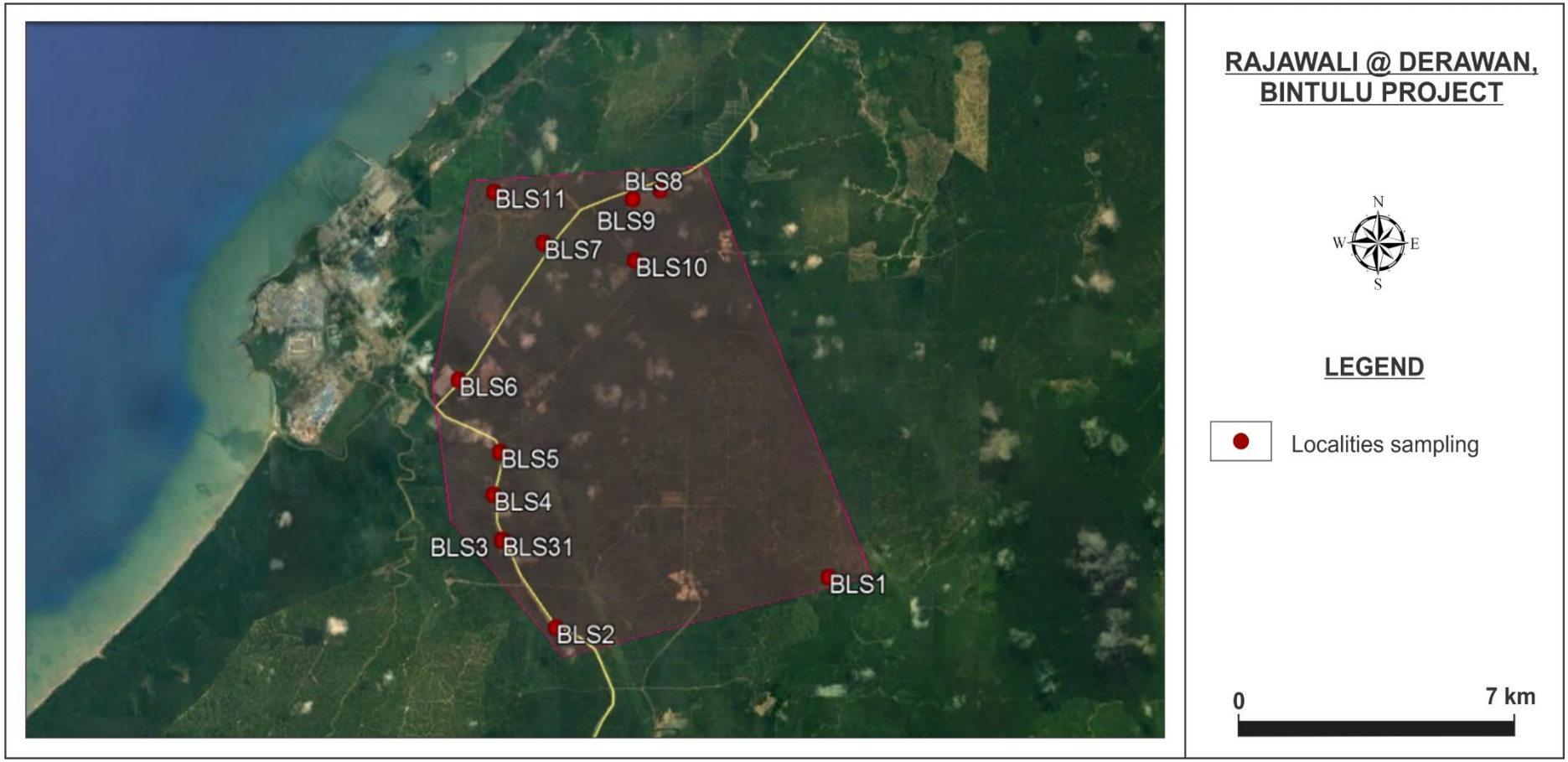


Table 6.2.1: Geological Description at the Proposed Project Site

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS1	N3° 29.140' E113° 25.697'	The geology of Setap Shale formation exposing here as small hills (**Plate 6.1**). It consists of interbedded of sandstone and mudstone where the sandstone is dominant. Sandstone is fine grained and yellow/ light grey in colour. Mudstone is very fine grained and grey/ yellow in colour (**Plate 6.2**). In between the hills, the geology is more to residual soil (weathered soil), comprising of red/ yellow soft silty soil, with the thickness of ~8/10 m (**Plate 6.3** and **Plate 6.4**).	 **Plate 6.1:** Typical geology of Setap Shale Formation

Plate 6.2: Close up view of soft mudstone

Plate 6.3: The soft residual soil exposed inside the proposed Project site area

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.4:** Thick layer of residual soil inside the proposed site area

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS2	N3° 28.483' E113° 21.954'	Sedimentary rocks from Setap Shale Formation, comprising of: - Sandstone layer. Sandstone is fine grained and light to dark grey in colour. Soft in strength and has been weathered to produce yellow and reddish residual soil. - Shale layer. Shale is dominant, thick layer and black in colour. - Interbedded of sandstone and black shale (mudstone) with some organic remnants. Plenty of mudclasts and coal/ organic nodules in shale. Orientation of bedding (strike/ dip = 270/30, 305/15). The thickness of sandstone layer is more than 1-2 m, soft dark brown clay (2 to 5 m) – **Plate 6.5**. **Plate 6.6** shows the contact between green sandstone with shale (mudstone).	 **Plate 6.5:** A geology sequence at Locality BLS2

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.6:** Thick layer of greenish sandstone at locality BLS2

Locality	GPS coordinate	Description	Photos of rocks and/or soils
		Plate 6.7 shows thick layer of dark/ black shale. **Plate 6.8** shows a close-up view of grey shale contains many fractures (at least 3 joint sets) that marks a common physical appearance of shale in this area.	 **Plate 6.7:** Thick layer of black shale

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.8:** Highly fractured of grey shale

Locality	GPS coordinate	Description	Photos of rocks and/or soils
		Plate 6.9 shows a sandstone specimen collected at BLS2 for rock petrographic analysis (coarse grained sandstone).	 **Plate 6.9:** Sandstone hand specimen collected at BLS2 for petrographic analysis

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS3	N3° 29.619' E113° 21.219'	Rock in Setap Shale Formation. Comprising of shale (black) with thin layer of sandstone. Bedding orientation is 23/15 – see **Plate 6.10**. **Plate 6.11** shows a calcareous sandstone specimen collected at BLS3 for rock petrographic analysis (medium grained sandstone). The rock was tested with hydrochloric acid (HCl) and produced a positive reaction (white bubbles appeared on the surface).	 **Plate 6.10:** Thick bedded black shale with thin layer of sandstone

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.11:** Calcareous sandstone hand specimen collected at BLS3 for petrographic analysis

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS4	N3° 30.213' E113° 21.098'	This site is dominated with black shale and thin layer of sandstone – see **Plate 6.12**.	 **Plate 6.12:** Shale dominant and thin layer of sandstone

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS5	N3° 30.770' E113° 21.190'	A typical sedimentary rock of Setap Shale comprising of thick layer of shale dominant. Bedding orientation is 250/10. Can also be seen as a thin layer of sandstone (**Plate 6.13**).	 **Plate 6.13:** Geological outcrop at Station BLS5

Locality	GPS coordinate	Description	Photos of rocks and/or soils
		Plate 6.14 shows a thick layer of dark grey shale with thin layer of sandstone. **Plate 6.15** shows very fine grained, dark grey shale rock specimen.	 **Plate 6.14:** Close up view of dominant shale layer with thin layer of hard sandstone

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.15:** Shale (mudstone) hand specimen was collected at BLS5 for rock petrographic analysis

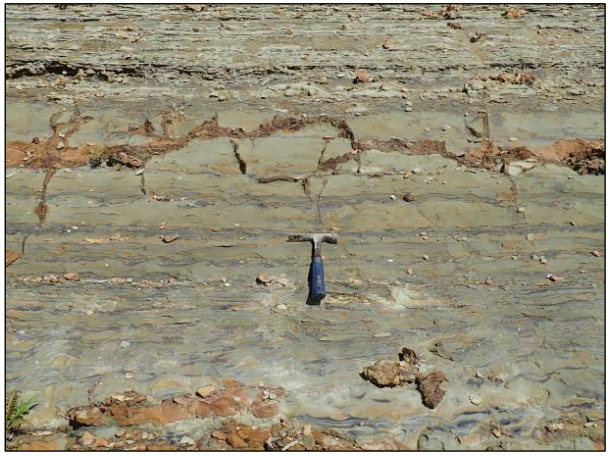
Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS6	N3° 31.709' E113° 20.620'	Sandstone dominant and interbedded with dark grey shale layer (**Plate 6.16** and **Plate 6.17**).	 **Plate 6.16:** The geological outcrop at BLS6  **Plate 6.17:** Sandstone layer (white) and dark grey shale

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS7	N3° 33.494' E113° 21.786'	Thick layer of black shale from Setap Shale Formation. The material is soft with total thickness if more than 5 m. Bedding orientation is 200/35 (**Plate 6.18**).	 **Plate 6.18:** Thick layer of dark shale
BLS8	N3° 34.185' E113° 23.386'	Bedded sandstone sedimentary rock and dark grey shale/ clay on top (probably from quaternary deposits?) (**Plate 6.19**). Orientation of bedding planes is 230/15.	 **Plate 6.19:** Thick bedded of sandstone is overlain by the thick layer of clay (shale) and red residual soil

Locality	GPS coordinate	Description	Photos of rocks and/or soils
BLS9	N3° 34.066' E113° 23.008'	Interbedded of sandstone and shale (bedding 250/15) (**Plate 6.20**). Many high angle reverse fault with the orientation of fault plane towards NS (310/80) – **Plate 6.21**.	 **Plate 6.20:** Interbedded of sandstone and shale layer

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.21:** Reverse fault

Locality	GPS coordinate	Description	Photos of rocks and/or soils
		Plate 6.22 shows a reverse fault and drag fold.	 **Plate 6.22:** Reverse fault and drag fold

BLS10	N3° 33.264' E113° 23.040'	Sandstone dominant in Setap Shale Formation with bedding orientation of 20/10 (**Plate 6.23).** **Plate 6.24** shows a close-up view of thick bed, medium grained, soft light grey sandstone layer.	 **Plate 6.23:** Boulders of sandstone and shale from Nyalau formation 

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			Plate 6.24: A close-up view of thick bed, medium grained, soft light grey sandstone layer
BLS11	N3° 34.156' E113° 21.109'	Sandstone massive beds and thick layer of shale. Bedding orientation 270/20. There is a thin layer of calcareous shale in thick shale layer (**Plate 6.25**). **Plate 6.26** shows a strong and highly fractured thin layer of calcareous sandstone. This layer can be found inside a thick layer of dark grey shale.	 **Plate 6.25:** Sandstone and shale layer at Locality BLS11

Locality	GPS coordinate	Description	Photos of rocks and/or soils
			 **Plate 6.26:** Strong and Fractured calcareous sandstone layer inside a thick shale layer

Locality	GPS coordinate	Description	Photos of rocks and/or soils
		Plate 6.27 shows a strong and dense fine grained, light brown calcareous sandstone. This calcareous sandstone had a positive reaction with HCl acid.	 **Plate 6.27:** Calcareous sandstone hand specimen

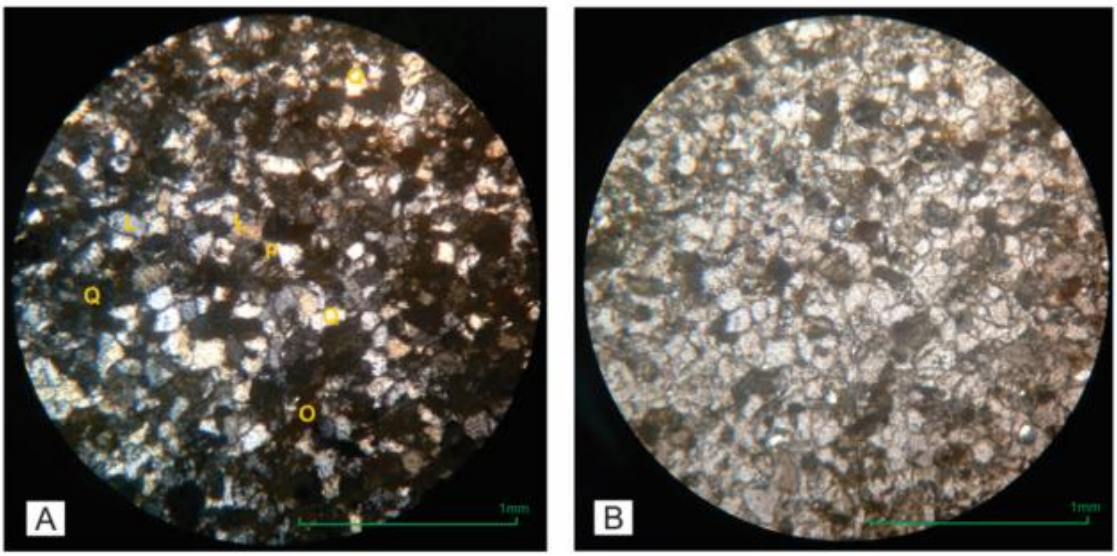


Plate 6.28: Thin sections of rock specimen BLS2 showing typical mineral content for sandstone, quartz (62%), feldspar (13%) and rock fragments (25%) – Q = Quartz, P = Plagioclase

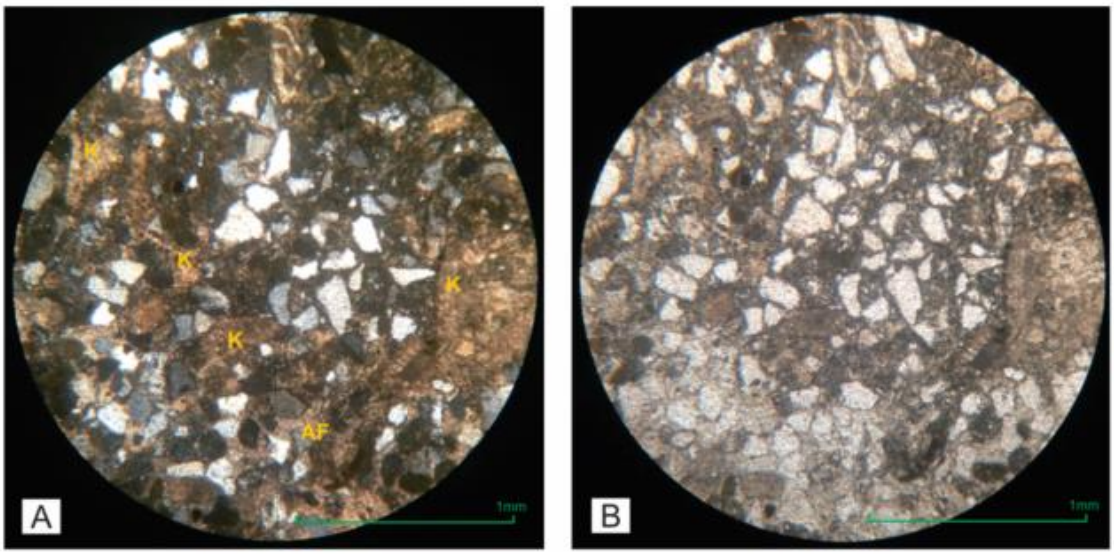


Plate 6.29: Thin sections of rock specimen BLS3 showing typical mineral content for sandstone, quartz (70%), feldspar (10%) and rock fragments (20%). These grains are cemented by calcite cement (k) – Q = Quartz, P = Plagioclase

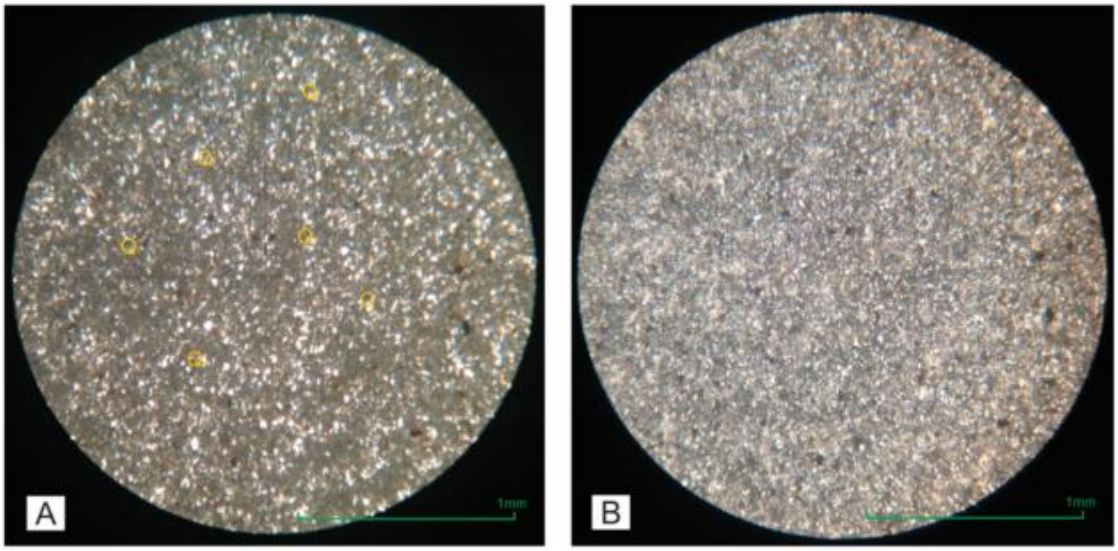


Plate 6.30: Thin sections of rock specimen BLS5 showing small grains of mainly quartz

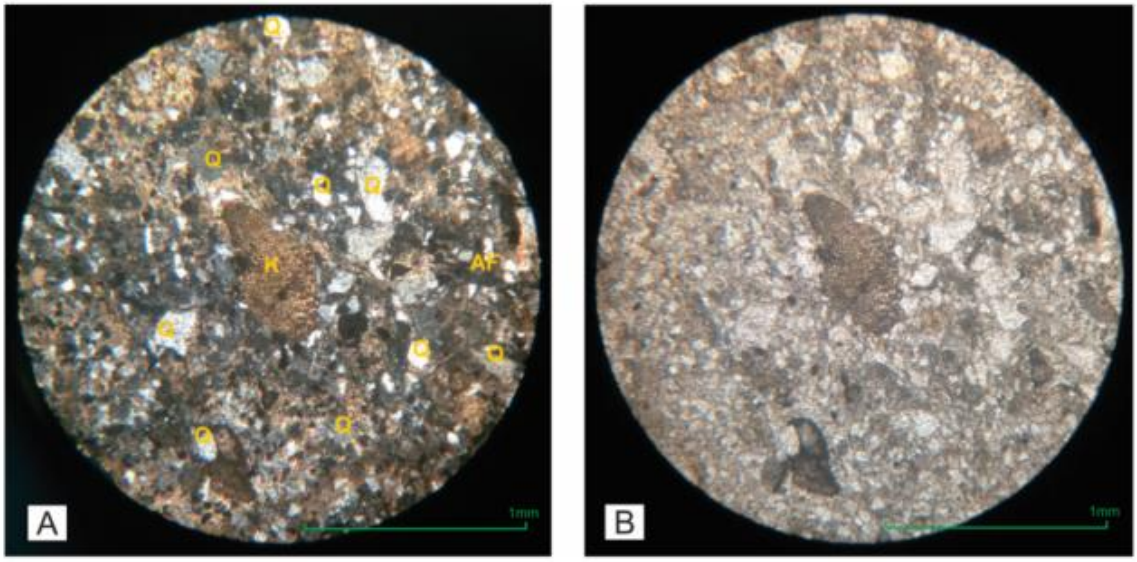
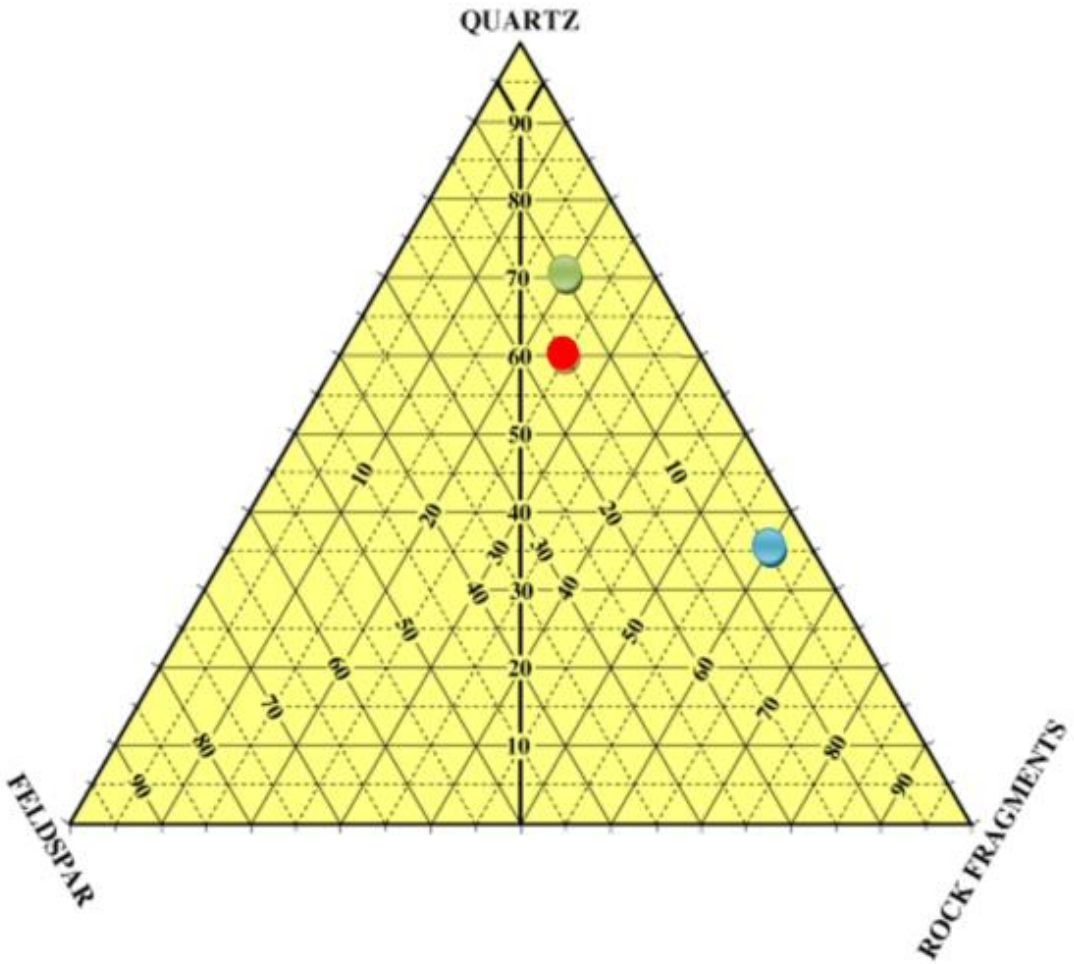


Plate 6.31: Thin sections of rock specimen BLS11

Figure 6.2.4: Sandstone Classification for BLS2, BLS3 and BLS11



6.2.3 SOIL

From the 1:50,000 Scale, Soil Map of Sarawak, Sheet 3/113/6 & 3/113/10 First Edition, the dominant soil series found within the Project are Bekenu 4/Bekenu/Kapit 1, Bekenu/Nyalau 2, Nyalau/Bekenu 2, Nyalau 4 and Nyalau 3/Nyalau/Kapit. The soil characteristics found at the Project site and its surrounding area is summarised in **Table 6.2.2** and illustrated in **Figure 6.2.5**.

Table 6.2.2: Key of Soil Series

Symbol	Series	Family (Group)	Main Characteristics	Terrain	Capability
Bkn	Bekenu	BEKENU (Red-Yellow Podzolic)	Fine loamy; <20% Gp. III oxides; non-calcareous; yellow	Moderately to very steeply dissected hills	Class 3 to 5 (slope, erosion hazard)
Kpt	Kapit	KAPIT (Skeletal Soils)	Residual; sedimentary rocks	Very steep hills and mountains	Class 5 (soil depth, erosion hazard, slope)
Mrt	Merit	MERIT (Red-Yellow Podzolic)	Fine clayey; residual; non-calcareous; yellow; high CEC	Moderately to very steeply dissected hills	Class 3 to 5 (slope, erosion hazard)
Mri	Miri	MIRI (Podzols)	Bh horizon indurated	Flat to undulating terrace summits	Class 5 (soil depth, moisture deficiency, etc.)
Nyl	Nyalau	NYALAU (Red-Yellow Podzolic)	Coarse loamy; residual; non-calcareous	Moderately steep to steep hills	Class 2 to 5 (fertility, slope, erosion hazard)
Sln	Silantek	BUSO (Podzols)	Bh horizon non-indurated; residual	Gentle dip slopes of cuesta terrain	Class 4 (fertility, moisture deficiency)

The Bekenu 4/Bekenu/Kapit 1 Series is covering most of the Project site from the western boundary through the middle towards the northwest. The Bekenu 2/Nyalau and Nyalau/Bekenu 2 Series covers the northern and western corner respectively. The Nyalau 3/Nyalau/Kapit and Nyalau 4 Series covers the Project site from the south to western boundary.

The Bekenu Family consists of red-yellow podzolic soils, which are residual over non-calcareous sedimentary rocks or old alluvial deposits derived mainly from them, and which have a silt particle-size class. Similarly, the Nyalau Family is red-yellow podzolic soils with residual over non-calcareous sedimentary rocks or old alluvial deposits derived mainly from them, but have a loam particle-size class. The Kapit Family consists of skeletal soils, where the underlying rocks is generally shale, sandstone or granite. The soils are normally brownish, well-drained, stony and heavy textured.

The Merit Family consists of red-yellow podzolic, which are generally yellowish-brown clay loams to clays over reddish yellow clays. They are derived from phyllites and fine-textured sedimentary rocks such as shales and mudstones. The Silantek Family is residual over sandstone or other siliceous sedimentary rocks. It tends to develop where parent materials are siliceous and highly leached, water tables are generally low, and the slope is sufficiently slight to reduce surface erosion losses and allow the development of a mature podzol profile form. The Miri Family are developed

in riverine or marine alluvium found mostly at flat or very gently undulating subrecent strand lines or marine terrace flats on the coastal plain.

The soils or surface layer at the Project site is mainly consisting of residual soil which is naturally produced through the weathering of sedimentary rocks of the Setap Shale Formation. The thickness of this residual soil is generally less than 15 m. It comprises of mostly clay and silt with some significant content of sand. Hence, the soil layers of silty or sandy CLAY and clayey or sandy SILT are very common and lay out to almost all over the study area. Layer of decayed organic matter (plant remains and/or peat) are occasionally found especially in the valley and swampy areas. Thickness of soil layer is greatly influenced by the topography of the area, which is generally undulating with low hills and valleys. On the low hills, it is relatively thinner compared to that in the valleys. The thickness of soil on low hills ranges between 2 m and 5 m. Whereas, the thickness of the soil in the valleys is much greater that is within the range between 5 m and 10 m. **Plate 6.32** shows the residual soils of dominant silt and clay that are exposed at the Project site.

Plate 6.32: Residual soil of mainly silt and clay expose at the Project site

The soil investigation report for the site is appended in **Appendix 6.2.1**.

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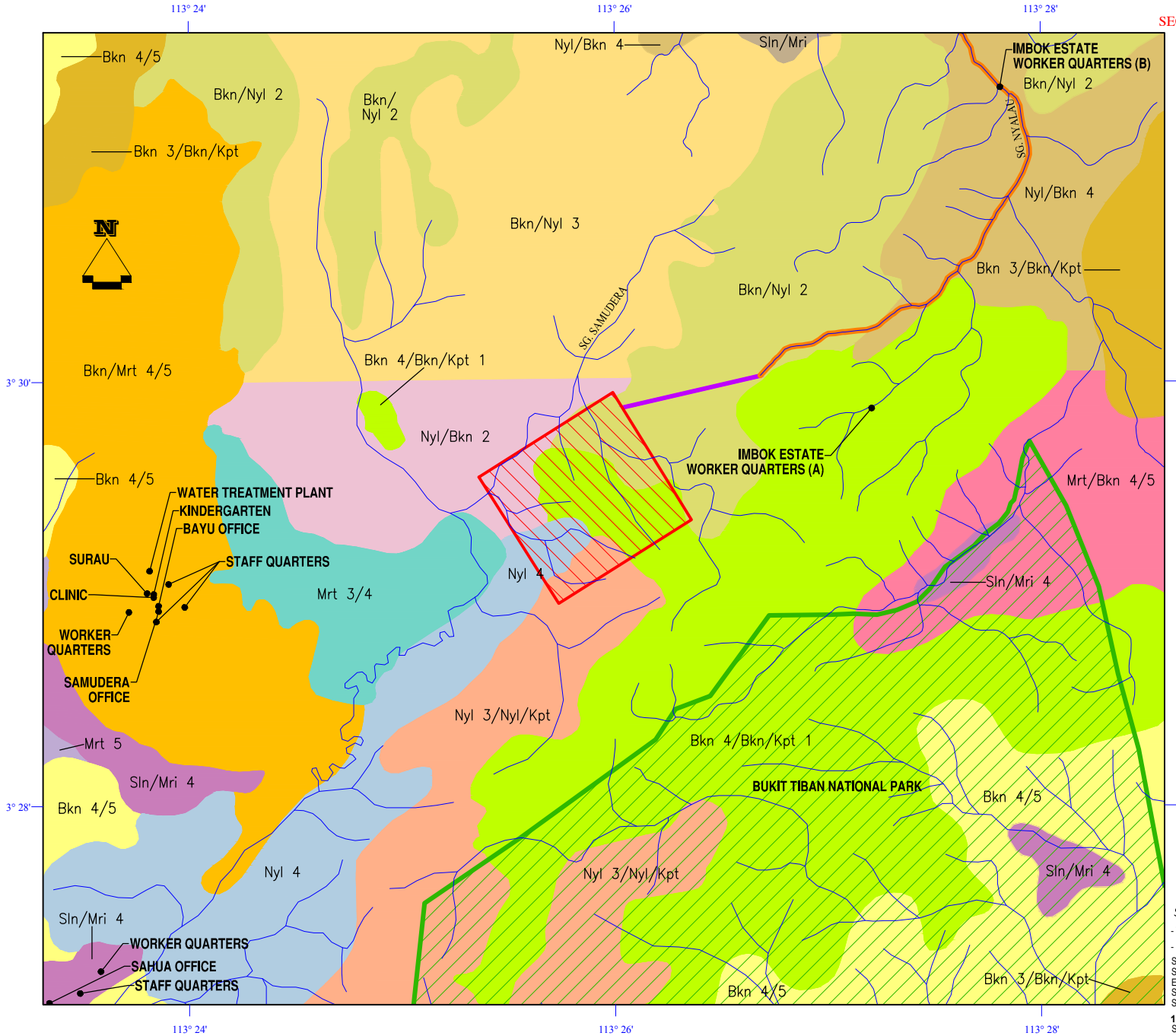
SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT
SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT SITE
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- RIVERS / STREAMS
- AFFECTED RIVER
- BEKENU / MERIT 4/5 (Bkn/Mrt 4/5)
- BEKENU / NYALAU 2 (Bkn/Nyl 2)
- BEKENU / NYALAU 3 (Bkn/Nyl 3)
- BEKENU 3 / BEKENU / KAPIT (Bkn 3/Bkn/Kpt)
- BEKENU 4/5 (Bkn 4/5)
- BEKENU 4 / BEKENU / KAPIT 1 (Bkn 4/Bkn/Kpt1)
- MERIT / BEKENU 4/5 (Mrt/Bkn 4/5)
- MERIT 3/4 (Mrt 3/4)
- MERIT 5 (Mrt 5)
- NYALAU / BEKENU 2 (Nyl/Bkn 2)
- NYALAU / BEKENU 4 (Nyl/Bkn 4)
- NYALAU 3 / NYALAU / KAPIT (Nyl 3/Nyl/Kpt)
- NYALAU 4 (Nyl 4)
- SILANTEK / MIRI (Sln/Mri)
- SILANTEK / MIRI 4 (Sln/Mri 4)

0 1 2 3Km

SCALE IN METRES (1:50,000) – A4 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

1:50,000 SOIL MAPS OF SARAWAK
SHEET 3/113/6 & 3/113/10
FIRST EDITION

SOIL MAP

FIGURE: 6.2.5

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-625.DWG

6.2.4 HYDROGEOLOGY

Hydrogeologic conditions of the proposed Project site are described with reference, particularly to its hydrogeologic system and some main hydrogeological behaviours of the site. Hydrogeologic system of the study area is essentially comprises of a few major components namely topography, geology which includes lithologic formation and its hydrogeological behaviours, surface hydrology that includes the drainage system and river condition, and land use activities which affect the hydrologic and hydrogeologic behaviours of the area. Integration of the behaviours and conditions of these components determines the natural hydrogeologic conditions of the area. Some of these components have been described above and some others such as surface hydrology and land use activities might have been presented in **Section 6.2.6** and **Section 6.4.6** of this chapter.

The area for hydrogeological study is importantly covering a wider domain instead of restricted to the Project site. The hydrogeological boundaries are usually defined by considering the hydrological and hydrogeological perimeters or divider. This will decisively determine all the potential affected areas with respect to hydrogeological points of view. For this exercise, the study covers most of the Similajau area in the Northeast of Bintulu, Sarawak.

Hydrogeologic setting and hydrologic characteristics of the soils and lithology formations are determined and verified via desktop studies, field verification and laboratory analysis. Groundwater flow modelling is then carried out to simulate the existing groundwater condition in the study area especially the trend of groundwater levels and its direction of flow. The finding is then be used to identify the potential impacts of the Project development and operation to groundwater condition that are mainly the groundwater flow, potential contaminant movement through the groundwater system and the potential affected areas.

Four (4) groundwater monitoring wells were constructed in the vicinity of the proposed Project site (refer to **Appendix 6.2.2** for the installation report). **Figure 6.2.17** shows the location of the constructed groundwater wells. The construction of the groundwater wells provided some information on lithologic profile of the area.

6.2.4.1 Water Bearing Formation

Hydrogeologic conditions of the study area are generally controlled by geology and topography of the area. Geologic formations and geological structures are mainly attributed to the conditions at regional and local levels. The study area is generally underlain by the residual soils and the completely to moderately weathered bedrock, which is the Setap Shale Formation underneath. This uppermost layer is mainly sandy CLAY to sandy/clayey SILT materials and considered as the water bearing layer for the local hydrogeological system.

The underlying bedrock, the Setap Shale Formation which generally comprises of interbedded sandstones, shales, and sometimes mudstone or siltstone is considerably moderately consolidated. Thus, its porosity and permeability are presumably moderate. At the Project site and the vicinity areas, sandstone layers are sometimes apparently quite dominant. Thickness of the layers is between 2 and 4 meters. However, there are more common to find interbedded of thin layers sandstone, shale and sandy shale (or siltstone). The existence of the shale layers at a significant thickness is common. Sand layers are seldomly more than 2 meters in thickness. Shale

contributes to low permeability and impervious nature of the formation. However, geological structures of rock fractures at various scales in particular may enhance permeability of the formation.

6.2.4.2 Groundwater levels and flow

Based on geological and topographical conditions of the central and western parts of Sarawak, the regional groundwater flow in the region including the Bintulu area is most likely directing towards the South China Sea in the West. However, the geological structures of synclines and anti-synclines that form a series of higher relief or ridges trending in Northeast-Southwest direction may affect the local groundwater flow.

Groundwater levels were measured at the four (4) groundwater monitoring wells that was constructed at the proposed Project site. The groundwater levels were between 0.1 m and 1.1 meter below ground surface. Information on groundwater levels at a few places in the study area that were measured by other studies was referred.

Table 6.2.3 shows groundwater levels at various locations in the study area obtained from various sources of references. Groundwater levels were measured during SI for a proposed land development project that is about 10 km to the Northwest of the proposed Project site in April 2012. It showed that groundwater levels at a total of 18 boreholes in the proposed development site ranged between 0.5 m and 5.9 m below the ground, representing the groundwater levels of between 20 and 32 m ASL. Topographic condition at the proposed development site is apparently affecting the local groundwater levels and flow. At some particular boreholes, especially on the Western side, groundwater levels are comparatively low that is in the range of 11.4 and 18 m ASL. It demonstrated that the local trend of groundwater flow is most likely in the West direction towards the coast.

Groundwater levels at a few private wells that were found in Kg. Hulu Nyalau, Klinik Desa Kg. Tengah Nyalau and Kg. Kuala Nyalau were also measured sometime in April 2017. The respective measured groundwater levels at those locations were 9.1 m, 16 m and 1.3 m below the ground surface. During the installation of the four (4) groundwater monitoring wells at the proposed Project site, groundwater levels were at 0.5 m, 2.0 m, 1.0 m and 1.2 m below the ground surface respectively.

Table 6.2.3: Groundwater Levels at Various Locations in the Model Area

Name	Location	X	Y	Water Level (mbgs)
GW1	The Project Site	4279844	1285296	0.5
GW2		4280544	1285706	1.1
GW3		4280793	1284806	Dry
GW4		4280798	1284552	0.1
WGW1	The proposed Wenan Steel project	4274624	1298532	22.7
WGW2		4273722	1296910	22.1
NYH	Kg. Nyalau	4274952	1301644	1.3
NYT		4278434	1298620	16
NYU		4279938	1297766	9.1

Name	Location	X	Y	Water Level (mbgs)
BH01	S.I. 10 km to Northwest of the Project Site	4272972	1292230	0.60
BH02		4273168	1292380	11.40
BH03		4273332	1292548	Dry
BH04		4273088	1292111	5.96
BH05	S.I. 10 km to Northwest of the Project Site	4273326	1292261	4.20
BH06		4273482	1292426	2.47
BH07		4273253	1291962	0.90
BH08		4273436	1292136	2.63
BH09		4273580	1292310	1.36
BH10		4273363	1291809	1.50
BH11		4273543	1292017	2.65
BH12		4273717	1292157	4.60
BH13		4273512	1291696	5.80
BH14		4273671	1291849	3.68
BH15		4273848	1292023	3.20
BH16		4273639	1291569	5.26
BH17		4273827	1291742	5.50
BH18		4274007	1291916	1.70

6.2.4.3 Physical Characteristics of Formation

It has been mentioned that the residual soils and the completely to moderately weathered Setap Shale Formation represent the water bearing layer in the study area. Site investigation has shown that the thickness of this uppermost layer ranged approximately between 5 and 10 meters. At the higher elevation areas, the layer may be thinner with thickness of between 2 and 4 meters.

The water bearing layer is underlain by the Setap Shale bedrock. Thickness of this formation at the West coast of Sarawak in general is estimated at between 7000 and 8000 meters (Hall *et al.*, 2008).

It has been mentioned above that the uppermost layer in the study area comprises of silty/sandy CLAY to clayey/sandy SILT materials. Grain size analysis on soil samples collected during Site Investigation for the proposed Project indicated various ranges of grain content (size). The grain-size contents of the soil are generally within the range listed in **Table 6.2.4**. It denotes the dominant of silt and sand in grain particle of the soils in the Project site.

Table 6.2.4: Summary of Results for Grain-Size Analysis of Soil Samples

Grain Size (Type)	Percentage (%)
Clay	15 – 45
Silt	10 – 55
Sand	20 – 62

Permeability, hydraulic conductivity and porosity of soils/rocks are among the important parameters that characterise hydrogeological behaviour of the formation. The parameters determine the rate of groundwater flow and subsequently the contaminant movement through the formation. Permeability for example, is a function of the size of the pore opening. The smaller the size of the soil or sediment grains the larger the surface area of water contacts. This increases the frictional resistance to flow, which reduces the permeability.

However, these hydrogeological parameters were not directly quantified during Site Investigation and field assessment of this study. Thus, for the purpose of groundwater flow and radionuclide transport modelling especially, the parameters will be estimated based on the material or grain size that determine the type of soil. Accordingly, the common values of these parameters that characterised by different sediment or soil materials are adopted (see **Table 6.2.5** and **Table 6.2.6**).

Table 6.2.5: Ranges of Permeability and Hydraulic Conductivity for Sediments

Material	Intrinsic Permeability (darcys)	Hydraulic Conductivity (m/sec)
Clay	$10^{-6} – 10^{-3}$	$10^{-11} – 10^{-8}$
Silt, sandy silts, clayey sands, till	$10^{-3} – 10^{-1}$	$10^{-8} – 10^{-6}$
Silty sands, fine sands	$10^{-2} – 1$	$10^{-7} – 10^{-5}$
well-sorted sands	$1 – 10^{2}$	$10^{-5} – 10^{-3}$
Well-sorted gravel	$10 – 10^{3}$	$10^{-4} – 10^{-2}$

Source: Fetter, 1988

Table 6.2.6: Range of Porosity for Sediments

Material	Porosity (%)
Gravel, coarse	24 – 36
Gravel, fine	25 – 38
Sand, coarse	31 – 46
Sand, fine	26 – 53
Silt	34 – 62
Clay	34 – 60

Source: Davis, 1969

6.2.4.4 Groundwater Usage

Groundwater resource in the study area had been significantly used some time ago particularly in the years of early 1990's. Two (2) groundwater production wells were constructed by the Mineral and Geosciences Department of Malaysia at Kg. Hulu Nyalau, which is about 13 km to the North of

the proposed Project site. The wells were meant for domestic use to serve local villagers of about 10 to 20 houses. However, the wells have no longer in use as the water supply system for the area had been upgraded and connected to the public water utility network.

There is another one groundwater production well at the Klinik Desa of Kg. Tengah Nyalau. As this area also is also connected to the public water utility network, the well is being alternatively used by the clinic management during the periods of water shortage. There is no other private well found in the study area.

6.2.5 METEOROLOGY

6.2.5.1 General Climate

Bintulu Division is located on the northwest coast of the State of Sarawak on the Borneo Island, overlooking the South China Sea. Being located close to the equator, the region generally experiences an equatorial type of climate characterised by hot and humid weather all year round.

The movement of the Inter-Tropical Convergence Zone (ITCZ) and the associated movement of the warm air with the monsoons influence the climate of the Project area. There are two distinct monsoon regimes, the Northeast Monsoon from November to March, and the Southwest Monsoon from May to September. The period between the monsoons is commonly referred to as the inter-monsoon or transition period.

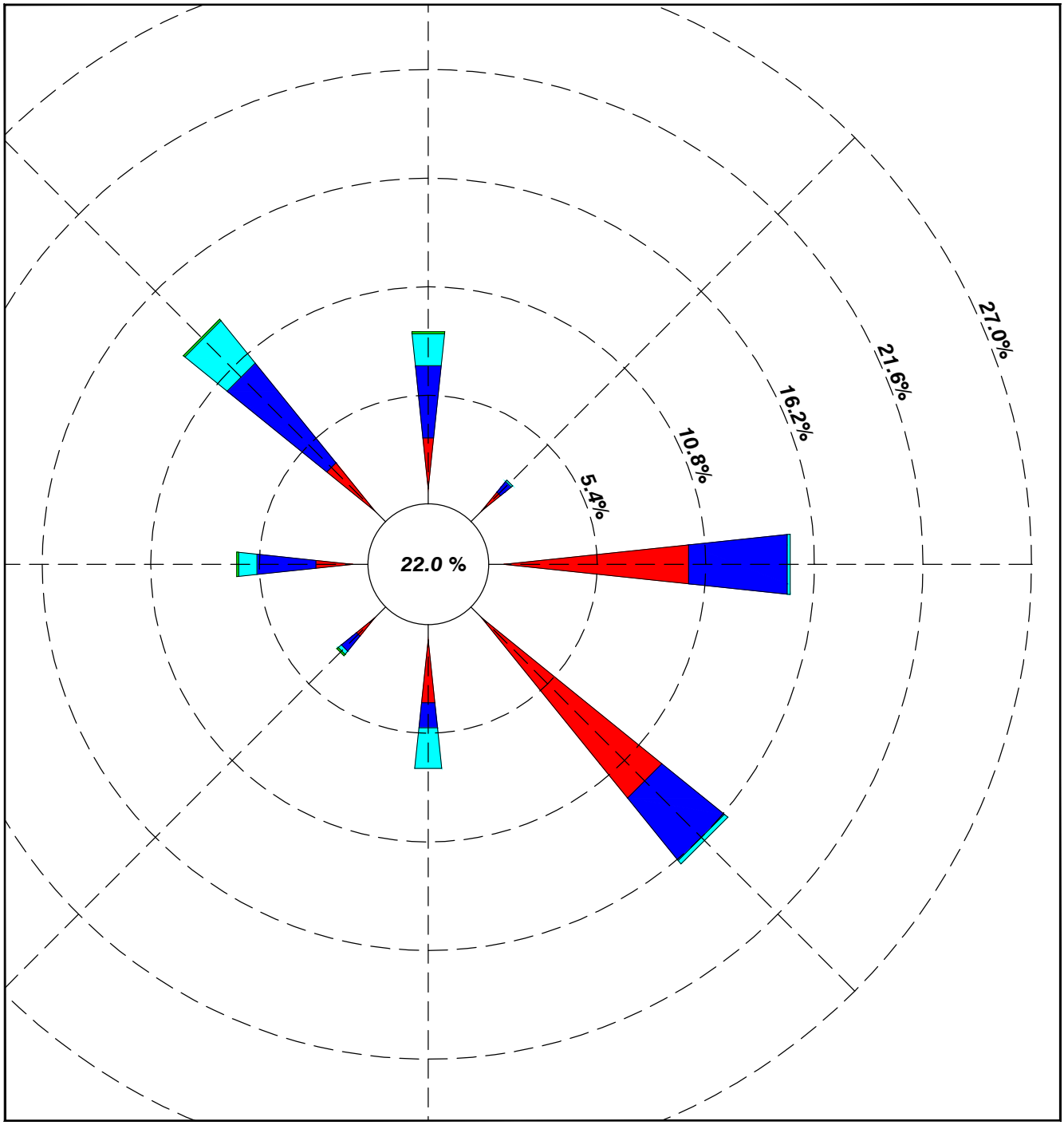
Data from the Malaysian Meteorological Service (MMS) station located at the Bintulu Airport (latitude 03° 07' 12" N, longitude 113° 01' 29" E) is used for this study. The MMS station is approximately 65 km from the Project site. Climate data, evaporation rate and rainfall were also obtained from the Sarawak Hydrological Yearbook published by the Department of Irrigation and Drainage, Sarawak (DID).

6.2.5.2 Surface Wind

The land and sea breezes have a strong influence on the behaviour of the diurnal wind, which is typical at a coastal site. The sea breeze attains its maximum strength in the mid-afternoon in the presence of strong surface heating. However, it begins to weaken in the evening when the thermal difference that drives the local circulation becomes negligible. The land breeze, which normally sets during predawn, is much weaker with wind speeds not exceeding 5 m/s.

Annually, Bintulu Division experiences 22% calm wind (refer to **Figure 6.2.6** for the annual wind rose summary). The predominant direction is from south east with wind speed of up to 5.4 m/s.

During times of the year when prevailing winds are light, such as the inter-monsoon months, the sea breeze will play a dominant role in transportation of air borne pollutants in the area. During the Northeast monsoon, the sea breeze reinforces the prevailing wind resulting in strong northerlies and north westerly with speed of up to 7.9 m/s. During the Southwest monsoon the predominant wind is from the south easterly. Refer to **Figure 6.2.7** for the seasonal wind rose summary.



SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT
SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK

M/S	
	>10.7
	8.0 - 10.7
	5.5 - 7.9
	3.4 - 5.4
	1.6 - 3.3
	0.3 - 1.5
CALM	<0.3

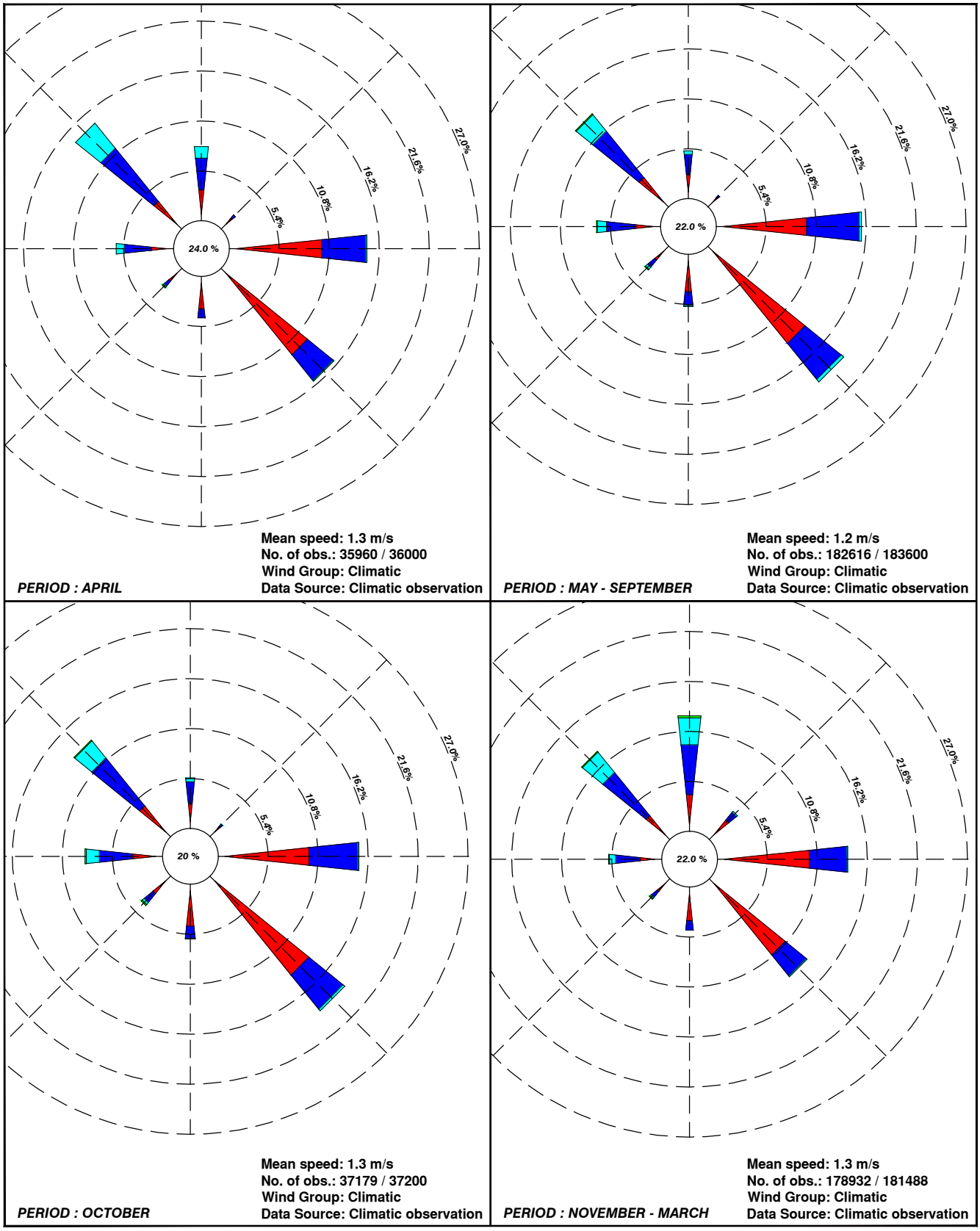
Station: Bintulu
WMO Index: 96441
Date: 1983-2017

Mean speed: 1.3 m/s
No. of obs.: 436797 / 438312
Wind Group: Climatic
Data Source: Climatic observation

SOURCE: JABATAN METEOROLOGI MALAYSIA

BINTULU ANNUAL WIND ROSE SUMMARY

FIGURE: 6.2.6



M/S

	>10.7
	8.0 - 10.7
	5.5 - 7.9
	3.4 - 5.4
	1.6 - 3.3
	0.3 - 1.5
CALM	<0.3

Station: Bintulu
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Date: 1983-2017

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SOURCE: JABATAN METEOROLOGI MALAYSIA

BINTULU SEASONAL WIND ROSE SUMMARY

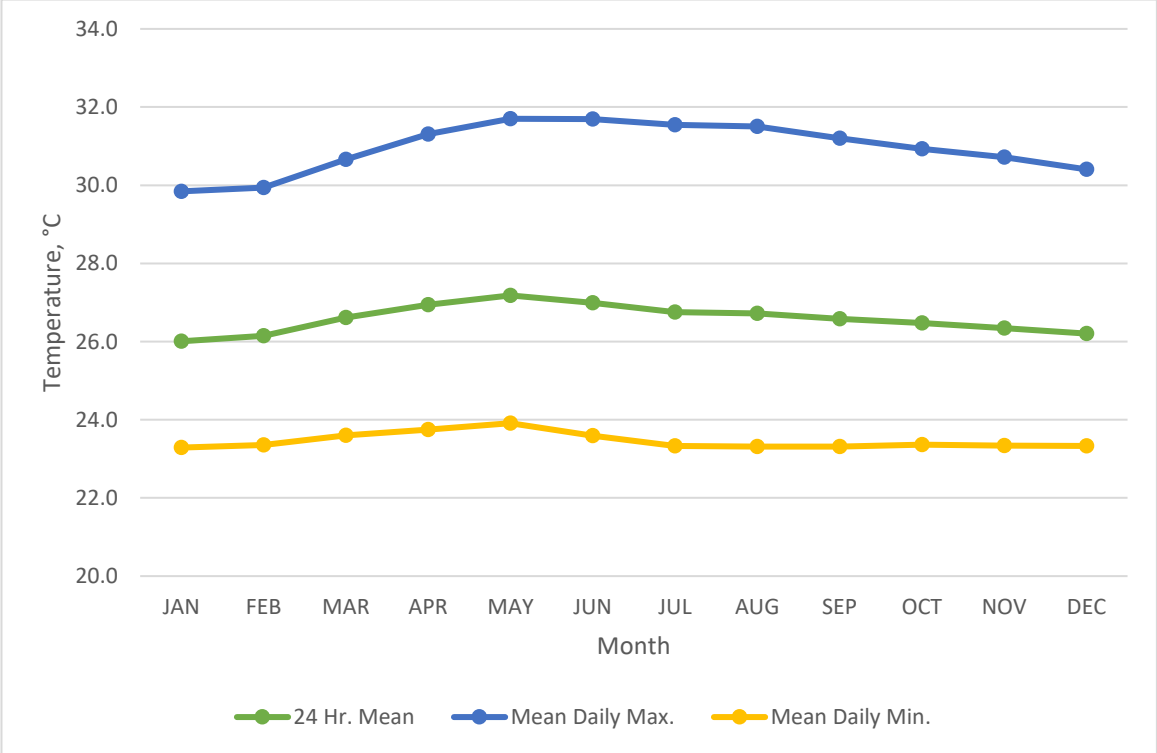
FIGURE: 6.2.7

6.2.5.3 Temperature

The monthly 24-hour mean temperature, mean maximum and mean minimum temperature are shown in **Table 6.2.7** and **Figure 6.2.8**. The figure indicates the following:

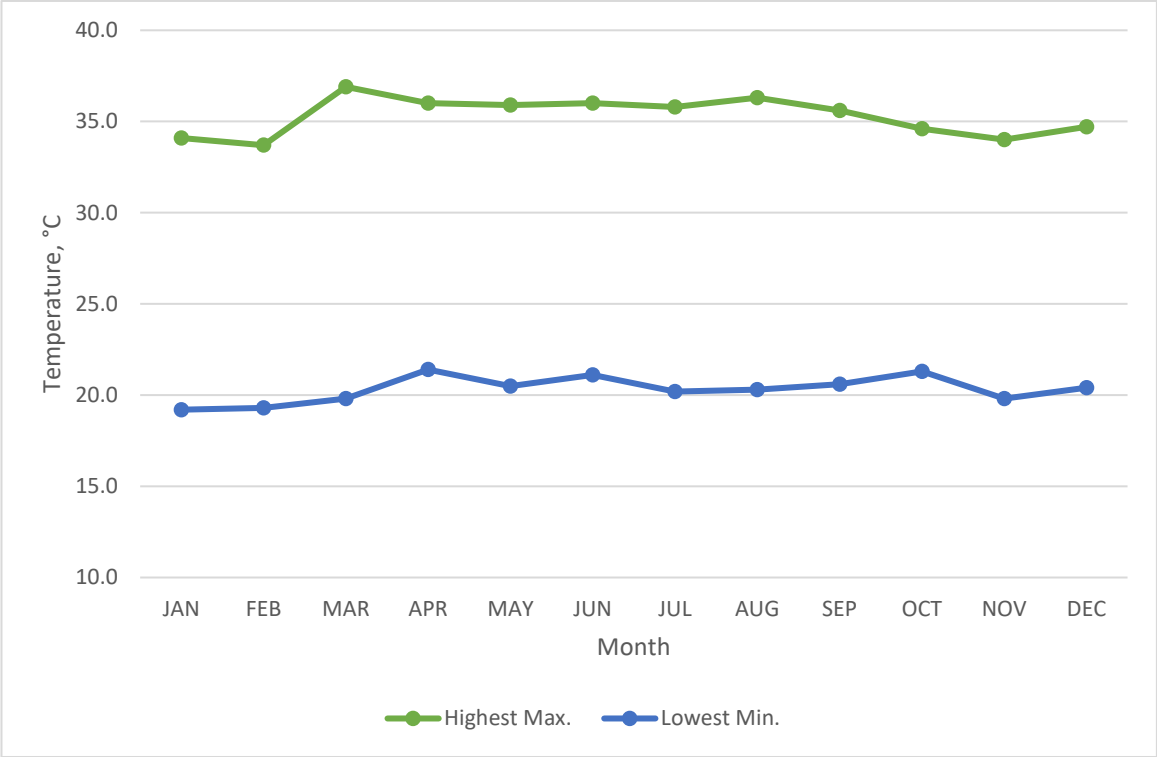
- 24-hr mean temperature fluctuates in a small range around 26.6 °C, mean daily maximum temperature around 31.0 °C and the mean daily minimum temperature around 23.5 °C;
- All three parameters attained their highest values during the relatively drier Southwest Monsoon months of May to July; and
- Lowest values are recorded in January and February.

Figure 6.2.8: 24-hr Mean, Mean Daily Maximum and Minimum Temperature in Bintulu (1951 – November 2017)



The highest maximum temperature of 36.9 °C was recorded in the month of March while the lowest minimum temperature of 19.2 °C was recorded in the month of January (over the period of 1951 – November 2017, **Figure 6.2.9**). Since Bintulu is relatively close to the coast, the sea has a moderating effect on diurnal fluctuations in temperature.

Figure 6.2.9: Highest Maximum and Lower Minimum Temperature (1951 – November 2017)



Station: Bintulu

Period: 1951 – 27 November 2017

Lat. / Long.: 03° 07' 12" / 113° 01' 29"

Ht. above M.S.L: 24.3 m

Table 6.2.7: Records of Temperature and Relative Humidity

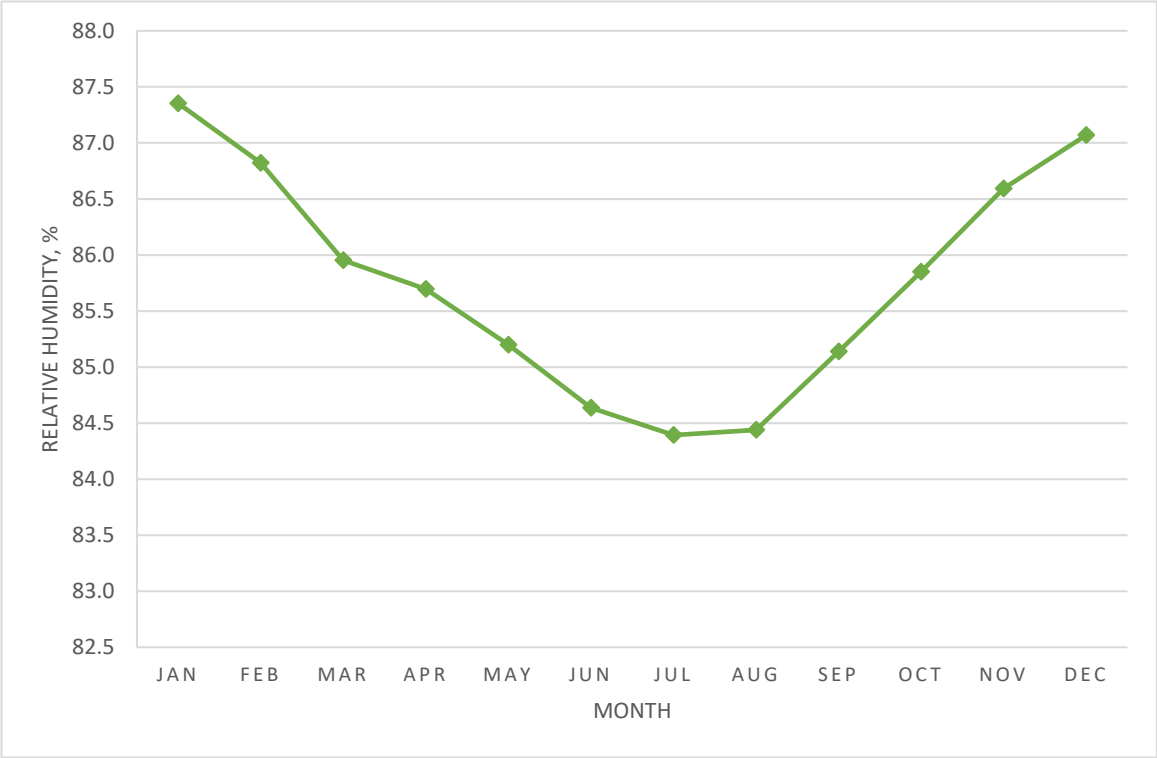
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Temperature (°C)													
24 Hr. Mean	26.0	26.2	26.6	26.9	27.2	27.0	26.8	26.7	26.6	26.5	26.3	26.2	26.6
Mean Daily Max.	29.8	29.9	30.7	31.3	31.7	31.7	31.5	31.5	31.2	30.9	30.7	30.4	31.0
Mean Daily Min.	23.3	23.4	23.6	23.7	23.9	23.6	23.3	23.3	23.3	23.4	23.3	23.3	23.5
Highest Max.	34.1	33.7	36.9	36.0	35.9	36.0	35.8	36.3	35.6	34.6	34.0	34.7	36.9
Year of Highest Max.	2013	2010	1954	1998	2003	2009	2015	2002	2009	1995	1996	1996	1954
Lowest Min.	19.2	19.3	19.8	21.4	20.5	21.1	20.2	20.3	20.6	21.3	19.8	20.4	19.2
Year of Lowest Min.	1965, 1961, 1972	1965	1955	1963, 1956, 1958	1952	1985, 1954	1953	1953	2008	1968	1964	1964	1965, 1961, 1972
Relative Humidity (%)													
24 Hr. Mean	87.4	86.8	86.0	85.7	85.2	84.6	84.4	84.4	85.1	85.9	86.6	87.1	85.8

6.2.5.4 Humidity

Humidity refers to the moisture content of the air and can be expressed in a number of ways. The most common method of expressing relative humidity is the measure of the actual water vapor pressure compared to the saturation vapor pressure, expressed as a percentage. At this saturation vapor pressure, excess water vapor begins to appear as fine cloud droplets or fog if at ground level. The mean relative humidity for Bintulu is shown in **Table 6.2.7** and **Figure 6.2.10** and shows the following features:

- 24-hr mean relative humidity fluctuates in a narrow range between 84.4%-87.4%; and
- 24-hr mean relative humidity is lower during the Southwest Monsoon Period and higher during the Northeast Monsoon Period.

Figure 6.2.10: 24-hr Mean Relative Humidity in Bintulu (1953 – November 2017)



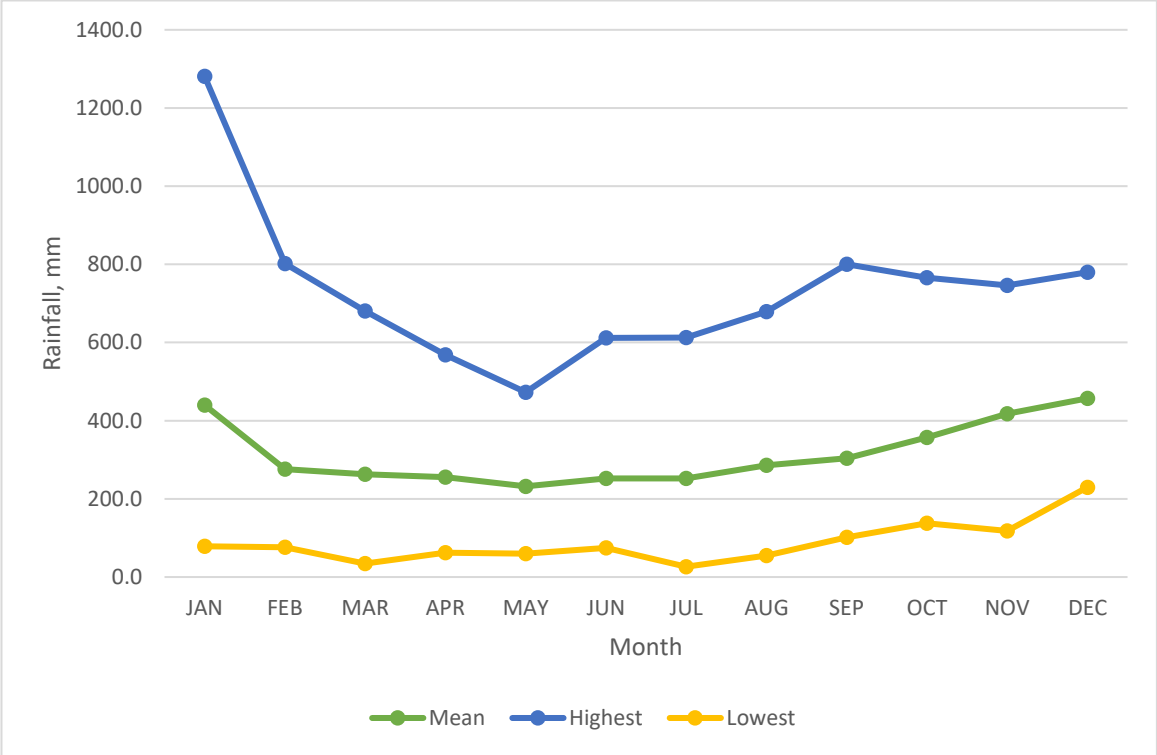
6.2.5.5 Rainfall

6.2.5.5.1 Bintulu Region

Like the rest of the state, Bintulu region generally has rainfall all year round. However, there are fluctuations from year to year with total annual rainfall fluctuating between 1,707 mm and 5,414.2 mm. The monthly mean, maximum and minimum rainfall is presented on **Figure 6.2.11** and shows the following:

- A drier period occurs during the Southwest Monsoon period from May to July since the southwesterly wind does not carry much moisture from the mainland;
- During the Northeast Monsoon months, the rainfall amount and the corresponding number of rain days increased;
- The maximum monthly rainfall exceeded a monthly total of 1,280.8 mm during the exceptionally wet month in January, even though the mean monthly rainfall is 439.9 mm.

Figure 6.2.11: The Monthly Mean, Maximum and Minimum Rainfall in Bintulu (1951 – 11 August 2016)



The Bintulu region experiences a rainfall regime of one maximum and one minimum. The maximum rainfall occurs during January, whereas the minimum rainfall occurs in July (see **Table 6.2.8**). Under this regime, much of the rainfall is received during the northeast monsoon months of September to February.

Station: Bintulu Period: 1951 – 11 August 2016

Lat. / Long.: 03° 07' 12" / 113° 01' 29" Ht. above M.S.L: 24.3 m

Table 6.2.8: Records of Mean, Highest, Lowest of Monthly and Annual Rainfall and Rain Days

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Rainfall (mm)													
Mean	439.9	276.2	263.0	255.9	232.1	252.4	252.2	286.1	303.5	356.8	417.4	457.2	3,769.3
Highest	1,280.8	801.8	680.8	568.2	472.9	612.2	612.7	679.0	800.3	766.1	746.4	780.0	5,414.2
Year of Highest	1963	1971	1985	1991	1970	1979	1984	1995	1983	1999	1983	2013	2008
Lowest	78.5	76.4	34.1	61.9	59.5	74.9	26.4	54.9	101.3	137.9	118.0	229.7	1,707.0
Year of Lowest	1998	1998	1997	1993	1966	1982	1958	1990	1994	1972	2005	1986	2016*
Number of Rain Days													
Mean	21	17	18	18	16	15	16	17	18	21	22	24	221
Highest	30	25	26	28	24	25	27	27	25	27	26	31	257
Year of Highest	2009	1971	2008, 1985, 1962	1970	2006, 1993, 1984, 1965	2007	1964	1998	1979, 1974	1969	2006, 2002, 1997, 1976, 1964	1999	1970
Lowest	10	8	6	8	9	6	6	3	9	14	12	14	129
Year of Lowest	2005	2014, 2004	1997	1963	1966	1952	1958	2016	2012, 1994	2013, 2004	1953	1972	2016*

6.2.5.5.2 Rainfall Data in Surrounding Area

Rainfall data from Kuala Similajau rainfall station (Hydrology Network ID: 3533001) was referred due to its proximity to the proposed Project site of 12 km, compared to the rainfall data recorded by MMD station located at Bintulu Airport, which is 65 km from the Project site. However, there is limitation for the use of rainfall data from DID station in this study, which is the published rainfall record by DID, only available up to year 2013 at the time of report writing.

Based on the nearest rainfall data from DID's Kuala Similajau rainfall station, it is observed that the Similajau basin is experience a total of 3,871.5 mm of rainfall annually. The daily mean rainfall for the area is 10.6 mm with the highest maximum daily rainfall at 223.5 mm in January. The highest monthly rainfall recorded is 700.5 mm in December.

Similajau Estate rainfall station (Hydrology Network ID: 3334001) was chosen for this study due to its longer historical data as compared to Kuala Similajau rainfall station data, even though Kuala Similajau rainfall station is nearer to the Project site (12 km compared to 15.5 km). The record for Similajau Estate spans from 1984 to 2015, a total of 32 years (see **Table 6.2.9**).

Table 6.2.9: Historical Rainfall Data for Similajau Estate

Stn No. 3334001

Stn Name: Similajau Estate 32 YEARS RECORD

Unit: mm/month

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1984	294	190	215	230	267	177	355	97	267	394	153	585
1985	373	320	387	193	177	138	221	279	291	250	264	264
1986	369	155	207	392	140	221	162	258	360	250	447	165
1987	251	33	61	202	158	213	168	295	186	326	421	508
1988	470	312	380	328	205	158	209	540	413	182	418	319
1989	216	176	285	198	302	143	170	217	475	312	317	256
1990	307	165	140	193	248	136	232	43	263	320	375	378
1991	197	92	57	454	199	231	16	171	326	392	321	411
1992	84	135	181	220	192	286	423	130	346	318	273	468
1993	353	173	423	140	404	155	201	128	195	286	248	302
1994	427	215	291	159	273	290	268	245	104	242	225	189
1995	150	94	290	125	107	38	159	156	108	65	105	163
1996	107	256	85	117	161	39	36	385	191	517	259	412
1997	91	252	111	248	199	103	66	96	265	302	380	407
1998	294	192	214	229	14	255	365	458	407	443	305	435
1999	442	183	172	166	292	170	183	302	317	699	243	534
2000	340	171	164	135	146	183	146	209	370	436	332	300
2001	579	188	402	343	136	118	132	83	176	306	413	357
2002	197	198	160	326	116	116	217	302	167	178	263	213
2003	338	101	182	237	171	255	166	155	141	369	320	510

Stn No.	3334001											
Stn Name:	Similajau Estate			32	YEARS	RECORD						
Unit:	mm/month											
YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2004	300	242	173	135	200	12	314	129	205	312	302	156
2005	70	200	316	115	179	277	203	112	171	236	212	447
2006	360	169	135	396	275	77	162	88	295	138	320	312
2007	450	392	115	212	150	430	266	167	372	224	407	457
2008	150	169	438	440	187	302	359	426	257	516	335	442
2009	978	190	320	219	247	197	89	196	269	287	502	196
2010	431	157	112	305	376	371	268	226	364	300	493	449
2011	362	154	308	284	182	276	224	253	127	287	281	343
2012	342	215	316	251	165	187	220	122	158	291	331	316
2013	415	334	249	330	309	102	88	295	226	219	294	624
2014	480	59	123	198	199	87	211	443	254	340	328	284
2015	452	69	83	205	158	68	158	204	105	228	428	367

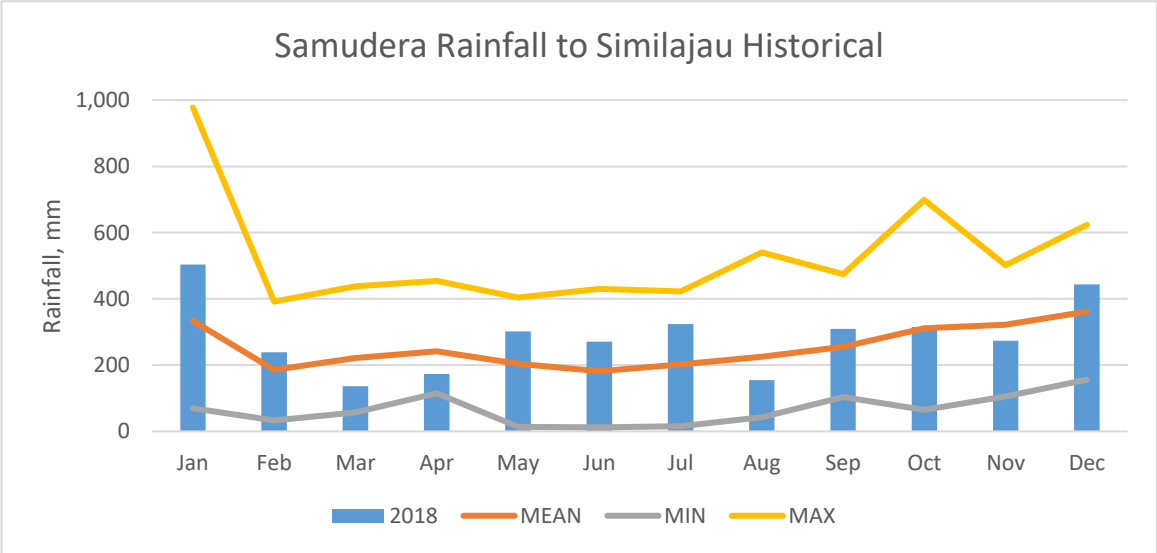
Table 6.2.10 below shows the monthly rainfall data for Year 2018 at Samudera Estate. The one (1) year data for Samudera Estate is sufficient to prove that the rainfall at the location can be related to rainfall at Similajau Estate.

Table 6.2.10: Rainfall Data for Samudera Estate – Year 2018

Month	2018	
	Volume (mm)	No. of Days Raining
January	504	25
February	239	12
March	136	15
April	173	11
May	302	17
June	271	16
July	324	11
August	155	11
September	309	15
October	315	18
November	274	22
December	444	24
Total Volume (mm)	**3,445**	
	Days	**197**

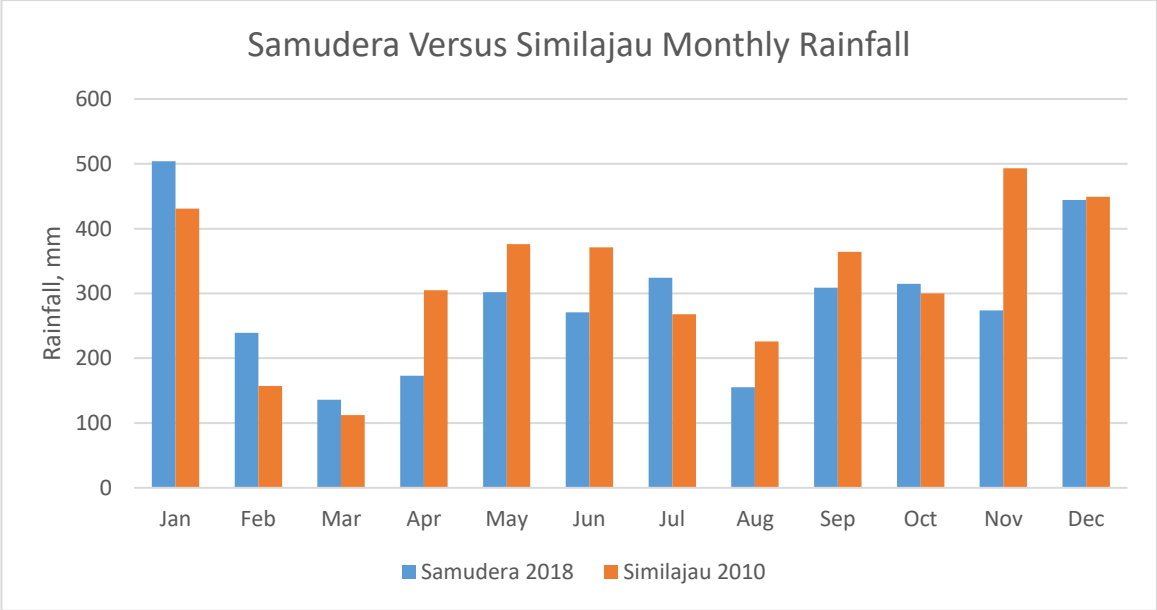
Comparing the Mean, Max and Min values of the 32 years data for Similajau Estate, the 2018 data from Samudera Estate falls within the range of the historical data and shows higher rainfall during end the year and lower rainfall during the middle of the year (see **Figure 6.2.12**).

Figure 6.2.12: Comparison of Monthly Mean, Maximum and Minimum Rainfall for Similajau Estate Historical Data with Samudera Estate 2018 Rainfall Data



Comparing the 2018 data (Samudera Estate) to 2010 (Similajau Estate), the rainfall pattern for dry and wet season are similar suggesting both locations are homogeneous, i.e. shares the same hydrology characteristic (see **Figure 6.2.13**).

Figure 6.2.13: Comparison of Monthly Rainfall for Similajau Estate 2010 Rainfall Data with Samudera Estate 2018 Rainfall Data



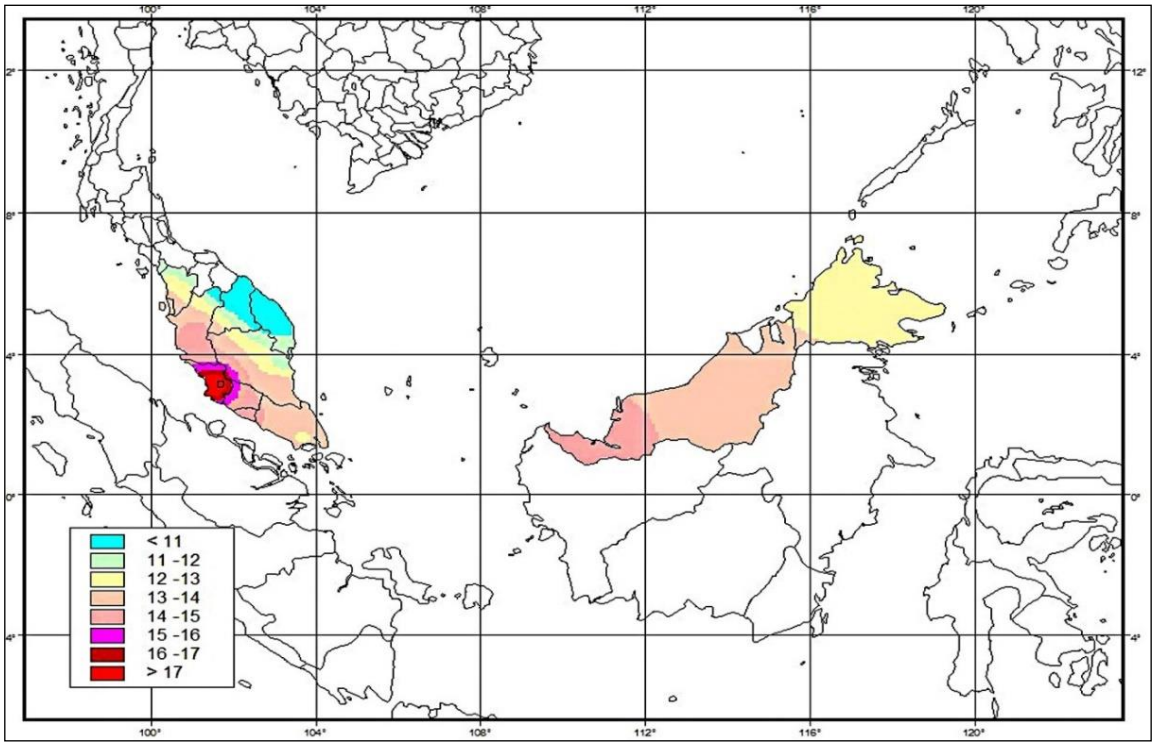
6.2.5.6 Sunshine and Solar

Being a maritime country close to the equator, Malaysia has abundant sunshine and thus solar radiation. However, it is extremely rare to have a full day with completely clear sky even in periods of severe drought. The cloud cover cuts off a substantial amount of sunshine and solar radiation. On the average, Malaysia receives about 6 hours of sunshine per day. There are, however, seasonal and spatial variations in the amount of sunshine received.

Based on data obtained from Malaysia Meteorological Department (MMD), the mean daily sunshine duration at Bintulu Airport varies from 5.0 to 5.5 hours. During the hot and drier months of the Southwest monsoon, 7 hours of sunshine is not uncommon. Conversely, in the presence of significant amount of clouds such as during Northwest monsoon is taking its toll, the daily sunshine hours will be reduced to an approximate average of 3 hours. In general, maximum sunshine is evident between the hours of 0830 to 1400.

On average, Bintulu receives an average of ±14-15 mega joule per meter square (MJm^{-2}) of radiation throughout the year (see **Figure 6.2.14**).

Figure 6.2.14: Mean Daily Solar Radiation (MJm^{-2})



6.2.6 HYDROLOGY AND DRAINAGE

6.2.6.1 River Systems

The Project site is drained by the tributaries of Sg. Samudera. Sg. Samudera is a river located on the north of the Project site that flows towards the west and eventually towards the southwest of the Project site. Sg. Samudera will flows into Sg. Similajau before discharging to the South China Sea to the far west of the Project site (see **Figure 6.2.15**).

The other major river identified in the vicinity of the Project site are Sg. Perihas and Sg. Nyalau. Both river flows towards the north before Sg. Perihas converge with Sg. Nyalau and discharge to the South China Sea at Kuala Nyalau. Sg. Perihas is located approximately 4.7 km northwest of the Project site while the distance between the Project site and the nearest tributary of Sg. Nyalau is approximately 1.7 km. Sg. Nyalau is subjected to tidal influence and seasonal fluctuations.

In general, drainage of the Project site during construction and later in operation will be by drains constructed to divert surface flow to discharge into the nearby stream, which will flow into Sg. Similajau.

6.2.6.2 River Usage

Sg. Samudera is a tributary upstream of Sg. Similajau, which has an active raw water intake point for the Samalaju water treatment plant, that supply water to SIP and Samalaju area. Downstream of Sg. Samudera, the Damai Estate workers' quarter is located next to the river, and they utilise the river water as their main water source. They have a simple water treatment plant that treat the river water before supplying to their worker.

Sg. Nyalau is subjected to tidal influence, therefore they do not serve as water supply sources due to saline intrusion. The villages identified along Sg. Nyalau, i.e. Kg. Kuala Nyalau, Kg. Tengah Nyalau, Kg. Hulu Nyalau and Rh. Sagoh, they don't utilise the river water for drinking, as their villages are equipped with treated water supply, except for Rh. Sagoh. Rh. Sagoh utilise rain water as their main water source. However, the villagers do fish and body contact activity along Sg. Nyalau. The river is also a major passage for the local fishermen to go fishing at the South China Sea.

Further upstream of Sg. Nyalau, within the Imbok plantation area, there are two (2) workers' quarters, consists about 16-20 person, situated by the river bank. The workers don't utilise the river water as drinking water because bottled water is supplied to them. However, they do bath and washing using the river water.

6.2.6.3 Pollution Source along Sg. Nyalau

Based on secondary source (e.g. Google Earth), there is no major pollution source identified along Sg. Nyalau, from the proposed discharge point for the treated leachate, upstream of the tributary of Sg. Nyalau down to the river mouth of Sg. Nyalau. However, based on the interview with the local villagers from Kg. Hulu Nyalau, it is made known that there is one palm oil mill (POM), operated by Imbok plantation, located upstream of their village that discharges into Sg. Nyalau. Other than Imbok POM, Sg. Nyalau and its tributaries receives non-point source runoff from oil palm plantations, both Imbok plantation and Tawakal Sejati plantation, upstream of the villages (i.e. Kg. Hulu Nyalau, Kg. Tengah Nyalau, Rh. Sagoh and Kg. Kuala Nyalau).

The land use map is as shown in **Figure 6.4.2**.

6.2.6.4 Water Catchments

There is only one water catchment identified in the vicinity of the Project site which is the Similajau Water Catchment (30,100 ha) (see **Figure 6.2.15**). The raw water intake point, the Similajau raw water intake point, is located approximately 9.3 km west of the Project site. The proposed Project site is also located outside of the Similajau Water Catchment area.

Initially, the proposed Project site was found to be located within the Kuala Nyalau water catchment area, a previously proposed to be gazetted water catchment area. However, this was later clarified by Sarawak Rural Water Supply Department (JBALB) that Kuala Nyalau water catchment area was no longer in use (see **Appendix 6.2.3**). Also, from the onsite investigation work, it was observed that the stream within the proposed Project site, and the nearby river, Sg. Samudera, are all flowing towards southwest direction, discharging into Sg. Similajau. Hence, any discharge at the Project site and the immediate surrounding will potentially affect the Similajau raw water intake point.

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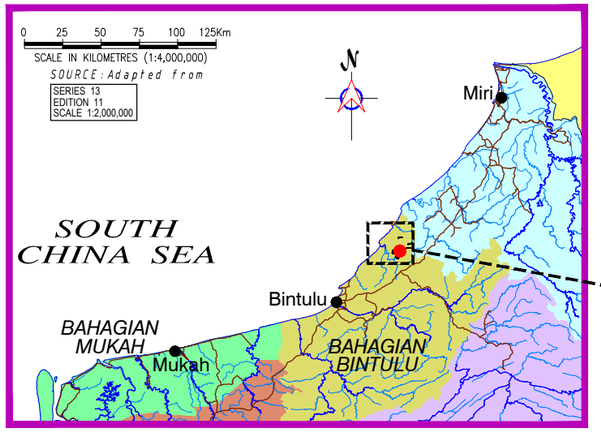
FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT
SYSTEM (IWMS) IN SAMALAJAU, BINTULU, SARAWAK



LEGEND:

- PROJECT SITE
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- WATER CATCHMENT AREA
- RIVERS / STREAMS
- AFFECTED RIVER
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT
- RAW WATER INTAKE POINT

WATER CATCHMENT AREA AND RIVER SYSTEM

FIGURE: 6.2.15

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIG-6215.DWG

6.2.6.5 Tides

The tidal regime along the southwest coast of Borneo is a mixed diurnal/ semidiurnal type. Generally, spring tides tend to show diurnal nature while neap tides appear semidiurnal. Tidal planes at Bintulu Port and Kuala Kemena are shown in **Table 6.2.11**.

Table 6.2.11: Tidal Levels at Bintulu with Reference to Chart Datum

Tidal Planes	Bintulu Port	Kuala Kemena
	Tidal Level (m)	
Lowest Astronomical Tide (LAT)	0.2	0.0
Mean Lower Low Water (MLLW)	0.7	0.7
Mean Higher Low Water (MHLW)	#	1.1
Mean Sea Level (MSL)	1.7	1.6
Mean Lower High Water (MLHW)	#	2.2
Mean Higher High Water (MHHW)	2.7	2.6
Highest Astronomical Tide (HAT)	2.8	2.8

Source: Sarawak Marine Department, 2010

(#) denotes tidal is usually - diurnal

Note:

- *Lowest Astronomical Tide (LAT): This is the height of the water at the lowest possible theoretical tide.*
- *Mean Lower Low Water (MLLW): This is the average of the lower low water height of each tidal day observed over a period of time (generally 19 years).*
- *Mean Higher High Water (MHHW): This is the average of the higher high-water height of each tidal day observed over a period of time (generally 19 years).*
- *Highest Astronomical Tide (HAT): The highest sea level that can be expected to occur under the average meteorological conditions and under any combination of astronomical conditions.*

6.2.7 ENVIRONMENTAL BASELINE SAMPLING

Baseline sampling is important to ascertain and characterise the existing environment within the vicinity of the Project area. Collection of these data involves sampling of river and marine surface water, groundwater, air and noise. The sampling locations were carefully chosen and selected to represent the existing natural water, air, noise and ecology conditions in the area prior to the implementation of the Project.

6.2.7.1 Surface Water Quality

Fourteen (14) riverine water sampling locations were selected for sampling. The water sampling locations are described in **Table 6.2.12** and shown on **Figure 6.2.16**. The baseline water quality data was obtained from *in-situ* testing and analysis of samples taken along the main rivers and streams traversing and surrounding the Project site. All samples were preserved in ice and stored in cooler boxes as they were delivered to the laboratory for analysis.

Two (2) water sampling points (W12 and W13) were sampled twice, one each during the flood tide and ebb tide. Meanwhile, the other twelve (12) sampling points were sampled once for grab sample. All samples were sampled within three (3) days from 11th November 2018 to 13th November 2018.

A summary of the river water analysis is shown in **Table 6.2.13** and the complete test reports are shown in **Appendix 6.2.4**. The water quality results have been compared against Class IIB of the National Water Quality Standards for Malaysia (NWQSM) (refer to **Appendix 6.2.5**).

Table 6.2.12: Description of River Sampling Points

Sampling Point	GPS Reading	Date and Sampling Time		Description
W1	N3° 30' 6.98" E113° 26' 45.77"	12-Nov-18 4.10 PM		Stream 1, tributary of Sg. Nyalau (Option 1)
W2	N3° 29' 54.64" E113° 27' 15.04"	12-Nov-18 9.50 AM		Stream 2, tributary of Sg. Nyalau (Option 2)
W3	N3° 30' 28.32" E113° 27' 34.23"	12-Nov-18 3.40 PM		Downstream of Stream 1
W4	N3° 30' 15.45" E113° 27' 40.15"	12-Nov-18 3.15 PM		Downstream of Stream 2
W5	N3° 30' 49.41" E113° 27' 47.47"	12-Nov-18 2.50 PM		Sg. Nyalau, downstream from the confluence of Stream 1 and 2
W6	N°3 31' 23.06" E113° 27' 47.95"	12-Nov-18 2.23 PM		Sg. Nyalau, near to Imbok Estate workers' quarter
W7	N3° 31' 47.99" E113° 27' 29.28"	12-Nov-18 4.50 PM		Sg. Nyalau
W8	N3° 33' 18.72" E113° 26' 57.78"	10-Nov-18 12.05 PM		Sg. Nyalau, within Tawakal Sejati Estate
W9	N3° 35' 39.91" E113° 28' 33.24"	13-Nov-18 3.10 PM		Sg. Nyalau, midstream
W10	N3° 36' 11.46" E113° 25' 56.54"	13-Nov-18 6.00 PM		Sg. Nyalau, at Kg. Hulu Nyalau
W11	N3° 36' 48.47" E113° 24' 54.67"	13-Nov-18 6.40 PM		Sg. Nyalau, at Kg. Tengah Nyalau
W12	N3° 38' 0.58" E113° 23' 51.57"	Flood Tide 11-Nov-18 12.30 AM	Ebb Tide 11-Nov-18 12.40 PM	Sg. Nyalau, near Rh. Sagoh
W13	N3° 38' 26.27" E113° 23' 14.86"	Flood Tide 11-Nov-18 12.50 AM	Ebb Tide 11-Nov-18 12.57 PM	Sg. Nyalau, near to river mouth (Kuala Nyalau)
W14	N3° 36' 25.98" E113° 25' 14.64"	13-Nov-18 6.25 PM		Sg. Perihas, upstream of confluence with Sg. Nyalau

Plate 6.33: W1, Stream 1, tributary of Sg. Nyalau

Plate 6.34: W2, Stream 2, tributary of Sg. Nyalau

Plate 6.35: W3, downstream of Stream 1

Plate 6.36: W4, downstream of Stream 2

Plate 6.37: W5, Sg. Nyalau

Plate 6.38: W6, Sg. Nyalau**,** close to Imbok Estate workers' quarter (B)

Plate 6.39: W7, Sg. Nyalau within Imbok Estate

Plate 6.40: W8, Sg. Nyalau within Tawakal Sejati Estate

Plate 6.41: W9, Sg. Nyalau within Imbok Estate

Plate 6.42: W10, Sg. Nyalau at Kg. Hulu Nyalau

Plate 6.43: W11, Sg. Nyalau at Kg. Tengah Nyalau

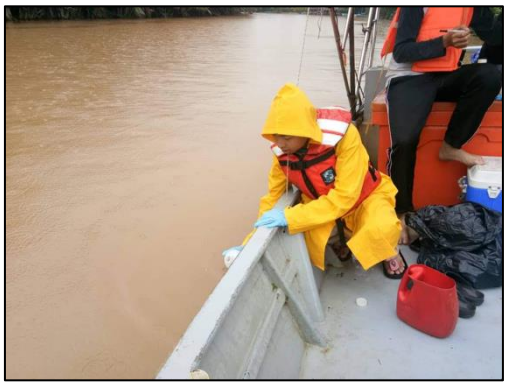


Plate 6.44: W12, Sg. Nyalau near to Rh. Sagoh

Plate 6.45: W13, river mouth of Sg. Nyalau

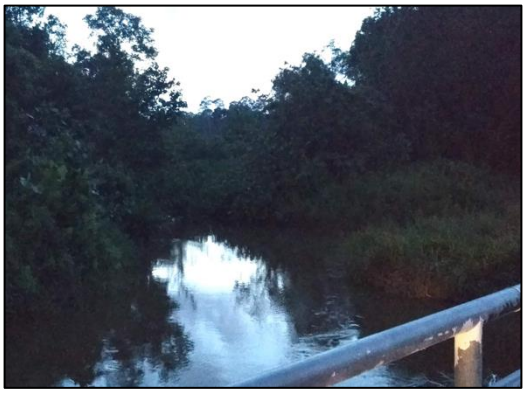


Plate 6.46: W14, Sg. Perihas

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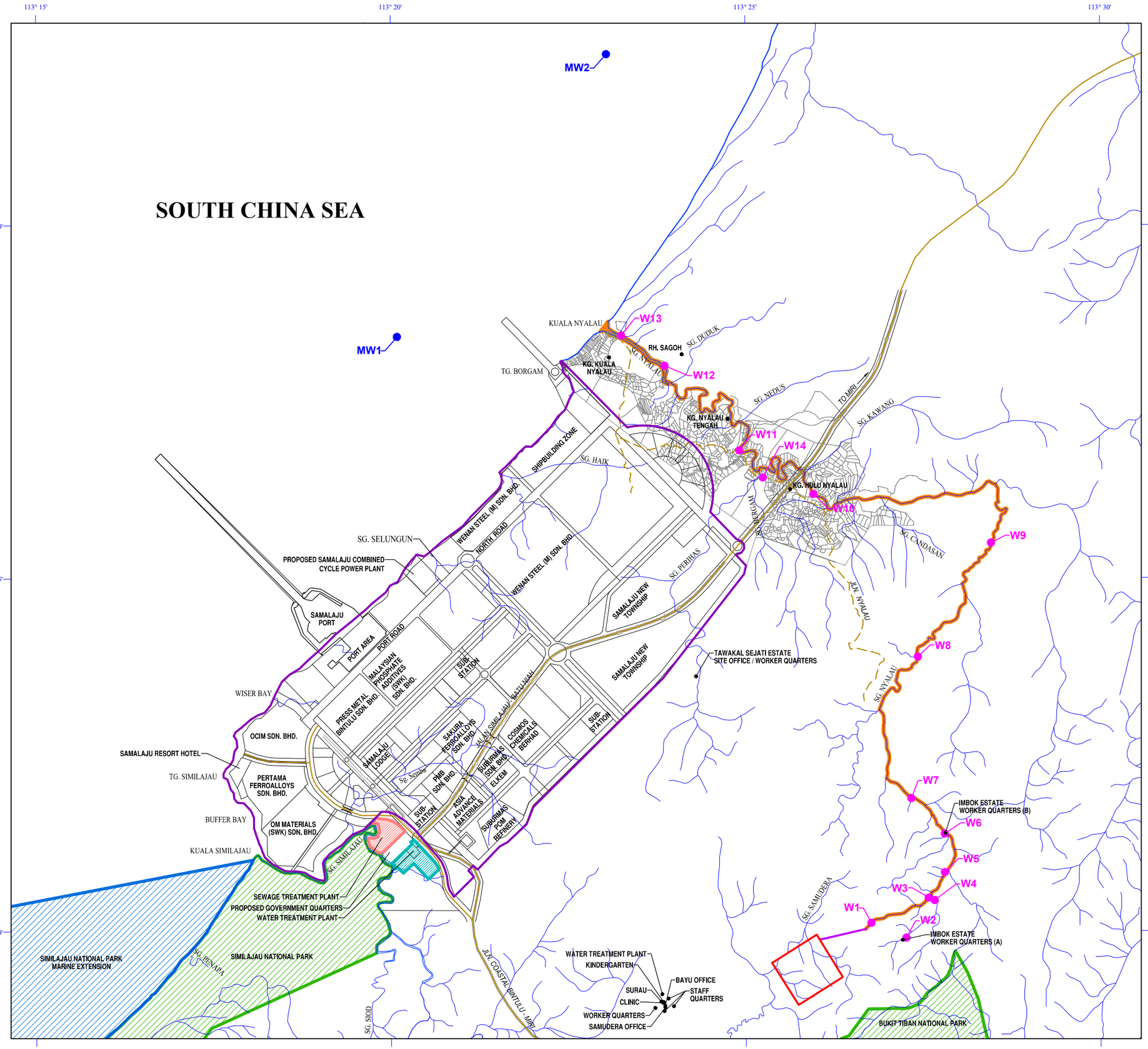
SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT BOUNDARY
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- RIVERS / STREAMS
- AFFECTED RIVER
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT
- ENVIRONMENTAL BASELINE MARINE WATER SAMPLING LOCATIONS - **(W1 - W2)**
- ENVIRONMENTAL BASELINE SURFACE WATER SAMPLING LOCATIONS - **(W1 - W14)**

N

0 1 2 3 4 5Km

SCALE IN KILOMETRES (1:100,000) – A3 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

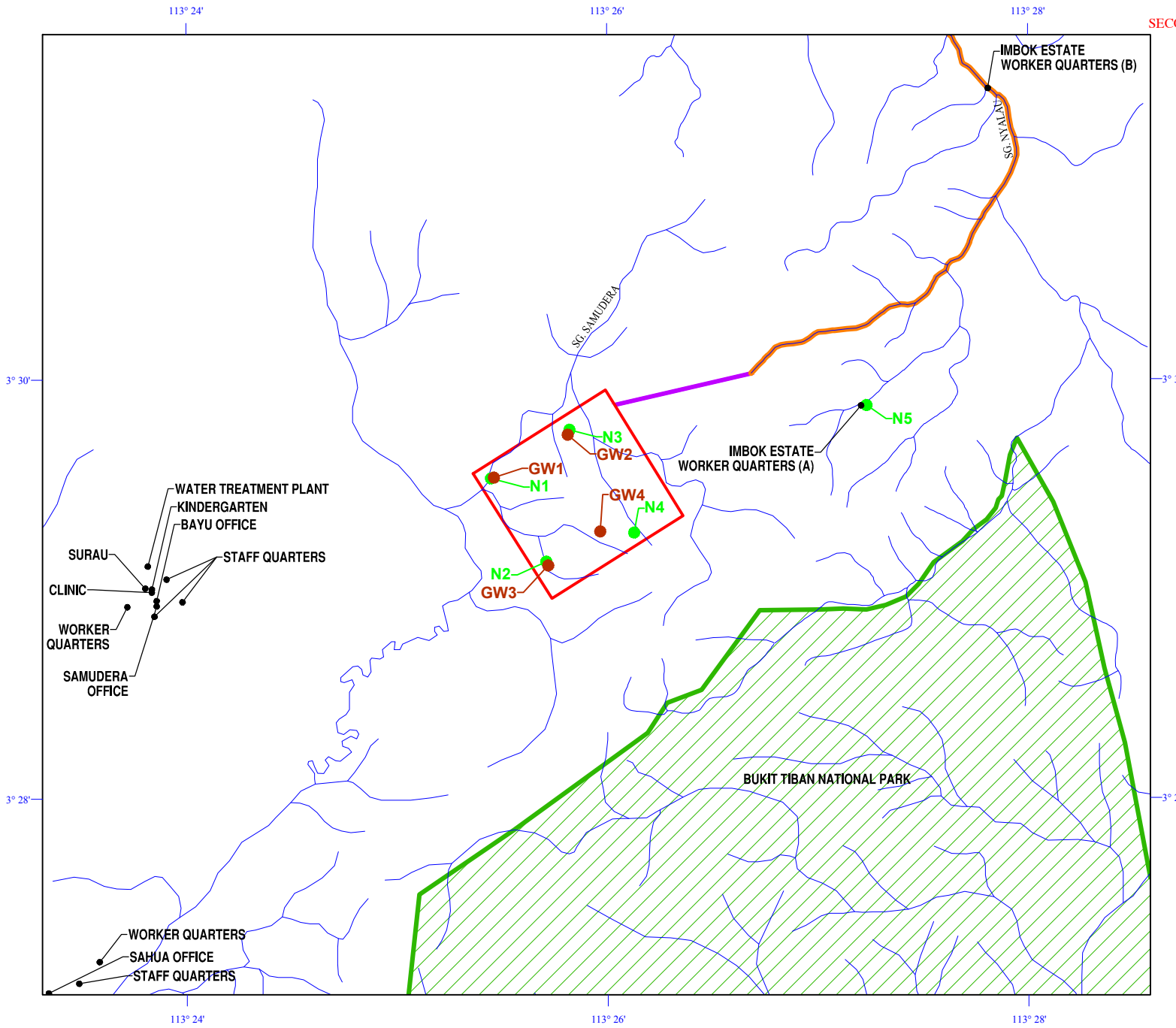
ENVIRONMENTAL BASELINE SAMPLING LOCATIONS FOR SURFACE WATER AND MARINE WATER

FIGURE: 6.2.16

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-6216.DWG

CHEMSAIN KONSULTANT SDN. BHD.

SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT
SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT BOUNDARY
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- RIVERS / STREAMS
- AFFECTED RIVER
- PROPOSED BASELINE GROUNDWATER SAMPLING LOCATIONS - (GW1 -GW4)
- PROPOSED BASELINE NOISE SAMPLING LOCATIONS - (N1 -N5)

N

0 1 2 3Km

SCALE IN METRES (1:50,000) – A4 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

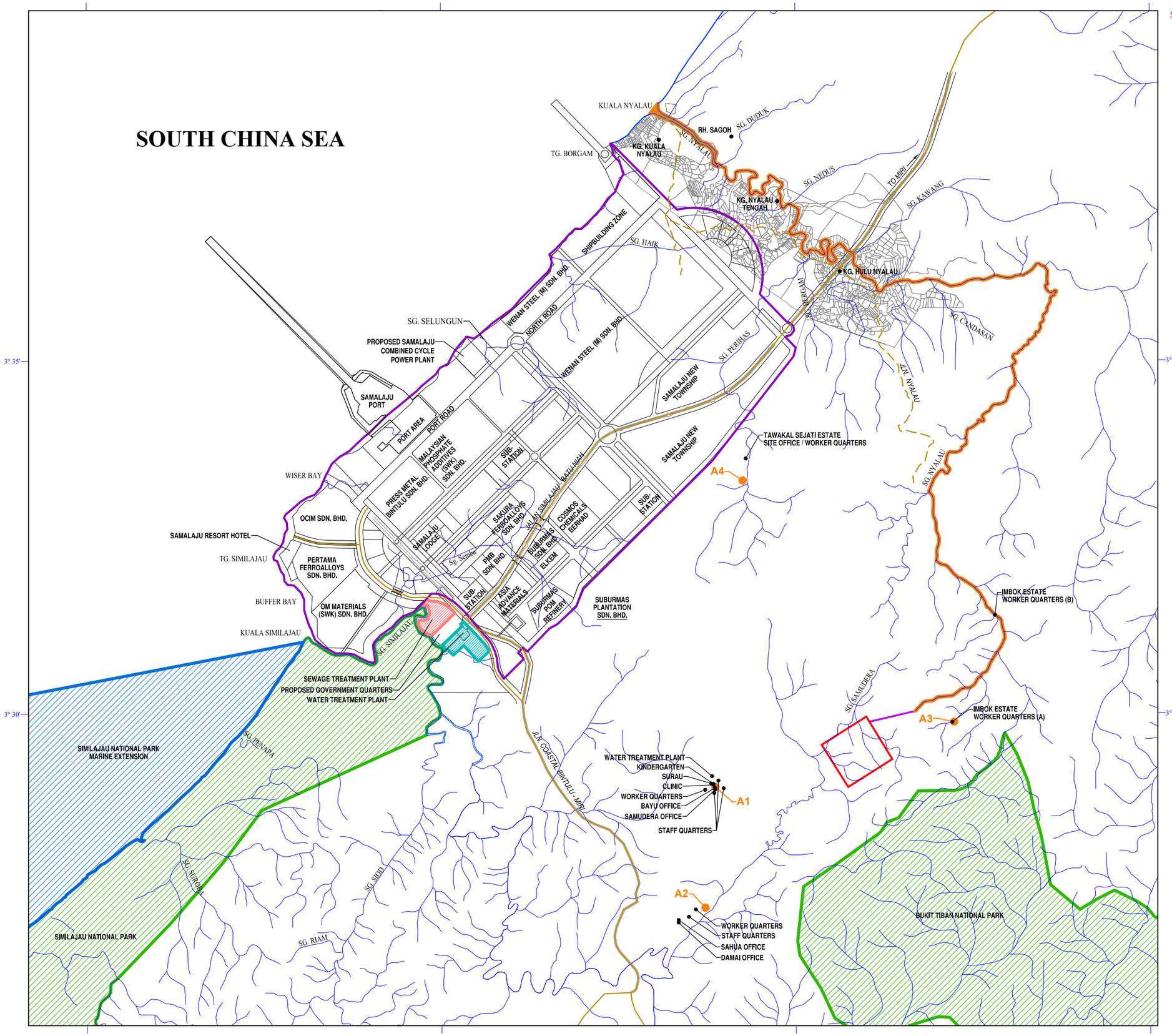
ENVIRONMENTAL BASELINE SAMPLING LOCATIONS FOR GROUNDWATER AND AMBIENT NOISE LEVEL

FIGURE: 6.2.17

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-6217.DWG

CHEMSAIN KONSULTANT SDN. BHD.

SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT BOUNDARY
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- RIVERS / STREAMS
- AFFECTED RIVER
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT
- ENVIRONMENTAL BASELINE AMBIENT AIR QUALITY SAMPLING LOCATIONS - (A1 -A4)

N

0 1 2 3 4 5Km

SCALE IN KILOMETRES (1:100,000) – A3 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

EVIRONMENTAL BASELINE SAMPLING LOCATIONS FOR AMBIENT AIR QUALITY

FIGURE: 6.2.18

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIIGURES\FIG-6218.DWG

Table 6.2.13: Laboratory Analysis of Surface Water Samples

Parameter	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12		W13		W14	Class IIB NWQSM
												Ebb	Flood	Ebb	Flood		
Temperature, °C (*in-situ*)	29.1	26.2	29.3	30.6	29.5	29.7	29.3	29.8	29.7	29.3	28.6	31.7	27.0	30.1	28.1	29.6	-
pH Value (*in-situ*)	6.7	7.2	6.9	7.0	7.0	7.2	7.1	7.9	6.3	7.4	6.3	6.7	6.6	6.2	6.4	6.8	6 – 9
Dissolved Oxygen, mg/L	**4.6**	**4.9**	5.8	5.4	5.2	5.6	5.5	5.6	6.9	6.6	5.2	**4.0**	**4.2**	5.2	**4.2**	5.4	5 – 7
Dissolved Oxygen Saturation, mg/L	7.7	8.1	7.6	7.5	7.6	7.6	7.6	7.6	7.6	7.6	7.7	7.3	8.0	7.5	7.8	7.6	-
Conductivity @ 25°C, µmho/cm	65.6	80.8	85.7	66.3	89.6	56.0	56.3	55.6	144	114	108	186	175	214	55.6	112	-
Salinity, ppt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-
Free Chlorine (as Cl_2), mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	-
Fluoride (as F), mg/L	0.05	0.05	0.05	0.06	0.08	0.05	0.04	0.07	0.06	0.06	0.07	0.08	0.07	0.07	0.08	0.08	1.5
Biochemical Oxygen Demand in 5 days @ 20°C, mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3
Chemical Oxygen Demand, mg/L	18	20	22	19	**25**	17	18	16	23	**26**	23	23	**27**	**30**	18	**25**	25
Total Suspended Solids, mg/L	16.2	<5.0	12.6	<5.0	7.3	13.8	15.6	**213**	14.0	15.6	9.2	**53.6**	48.6	48.4	38.2	40.9	50
Ammoniacal-Nitrogen (as N), mg/L	0.25	**0.62**	**0.61**	0.25	**0.51**	0.21	**0.41**	**0.66**	**0.62**	0.28	0.24	**0.42**	**0.71**	0.23	0.21	**0.34**	0.3
Nitrate Nitrogen (as N), mg/L	0.15	0.32	0.67	0.32	0.36	0.30	0.23	0.34	0.26	0.47	0.06	1.11	0.55	0.62	0.34	0.12	-
Phosphorus (as P), mg/L	0.08	0.08	0.11	0.10	0.19	0.13	0.12	0.13	0.16	0.15	0.08	0.09	0.09	0.04	0.11	0.11	0.2
Oil & Grease, mg/L	1.2	1.1	1.2	1.1	1.2	1.3	1.2	1.3	1.4	1.4	1.3	1.4	1.4	1.2	1.3	1.3	-
Lead (as Pb), mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Copper (as Cu), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.11**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.11**	<0.02	<0.02	0.02
Zinc (as Zn), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	5
Nickel (as Ni), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Cadmium (as Cd), mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Chromium, Hexavalent (as Cr^{6+}), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Chromium, Trivalent (as Cr^{3+}), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	-
Iron (as Fe), mg/L	0.99	0.56	0.60	0.37	0.72	0.65	0.60	**2.69**	**1.88**	0.63	0.62	**1.62**	**1.57**	**1.30**	0.61	**1.02**	1
Manganese (as Mn), mg/L	0.10	0.10	**0.15**	0.07	0.10	0.06	0.04	0.05	0.08	0.04	**0.12**	0.05	0.07	0.05	0.07	**0.19**	0.1
Mercury (as Hg), mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Silver (as Ag), mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	**0.50**	**0.69**	<0.02	0.03	<0.02	**0.69**	0.05
Tin (as Sn), mg/L	1.78	1.01	1.27	0.93	1.48	1.18	1.30	6.16	2.93	1.91	2.72	3.43	3.52	2.53	2.37	3.47	-
Arsenic (as As), mg/L	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	<0.006	0.05
Aluminium (as Al), mg/L	0.19	0.12	0.21	0.18	0.68	0.74	0.58	8.52	2.30	2.73	1.75	4.88	4.91	3.25	2.65	4.85	-
Barium (as Ba), mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.23	<0.01	<0.01	<0.01	1
Selenium (as Se), mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Phenol, mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Boron (as B), mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1
Cyanide (as CN), mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02

Parameter	W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12		W13		W14	Class IIB NWQSM
												Ebb	Flood	Ebb	Flood		
Sulphide (as S^{2-}), mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.05
Formaldehyde, mg/L	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	-
Colour, ADMI	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	-
Total Coliform Count, MPN/100 mL, 35±0.5°C/48 h	<1.1	3.3 x 10^2	9.4 x 10^2	<1.1	<1.1	<1.1	1.7 x 10^3	1.4 x 10^3	2.4 x 10^3	7.9 x 10^2	<1.1	3.5 x 10^3	**5.4 x 10^3**	2.4 x 10^3	1.1 x 10^3	3.3 x 10^2	5000
Fecal Coliform Count, MPN/100 mL, 44.5±0.2°C/24 h	<1.1	2.3 x 10^2	**4.9 x 10^2**	<1.1	<1.1	<1.1	3.3 x 10^2	**7.9 x 10^2**	**2.4 x 10^3**	**4.9 x 10^2**	<1.1	**4.9 x 10^2**	**5.4 x 10^3**	**4.9 x 10^2**	**7.9 x 10^2**	3.3 x 10^2	400
Water Quality Index (WQI)	81 (II, C)	80 (II, SP)	84 (II, C)	86 (II, C)	82 (II, C)	87 (II, C)	84 (II, C)	**76 (III, SP)**	86 (II, C)	86 (II, C)	83 (II, C)	79 (II, SP)	**74 (III, SP)**	78 (II, SP)	**75 (III, SP)**	84 (II, C)	76.5 – 92.7

Note: Figure shaded means exceeding the Class IIB limits or not within the Class IIB limits.

Temperature

The temperature of samples taken ranges from 26.2 °C to 31.7 °C. Temperature impacts both the chemical and biological characteristics of surface water. It affects the water's ability to hold dissolved oxygen and since water warms, it has a reduced ability to retain oxygen. Temperature not only influences the amount of soluble oxygen, but also is responsible indirectly for the consumption of dissolved oxygen. Increased temperature speeds up biochemical reactions including those of biological systems. The highest temperature was recorded at W12 during the ebb tide.

The temperature profile for each station is illustrated on **Figure 6.2.19**.

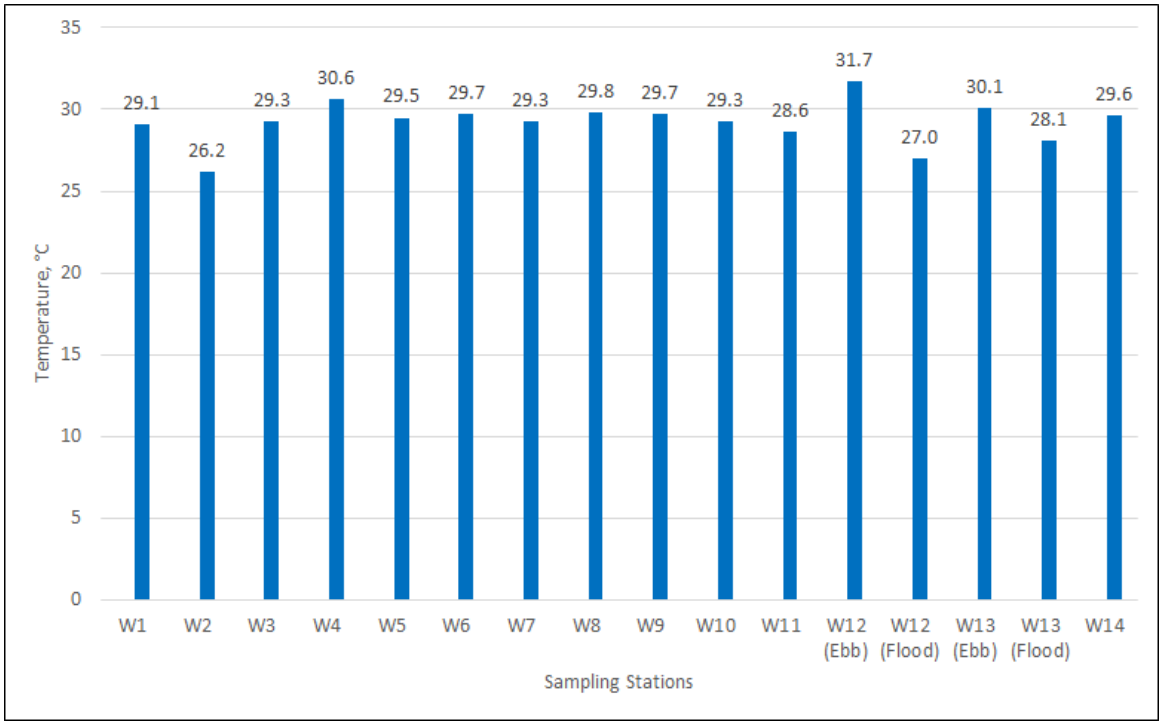


Figure 6.2.19: Temperature Profile

pH Value

The pH is the negative logarithm (base 10) of the chemical activity of the hydrogen ion in solution. The pH scale indicates a neutral solution at pH 7.0, an acidic solution below 7.0, and an alkaline (basic) solution above 7.0. A unit change in pH corresponds to a tenfold change in the hydrogen ion concentration; thus, small changes in pH can significantly alter the chemistry of marine water.

The pH value for the samples ranged from 6.2 to 7.9. The low pH value was reported at sampling station W13 during ebb tide. The pH profile for each station is illustrated on **Figure 6.2.20**.

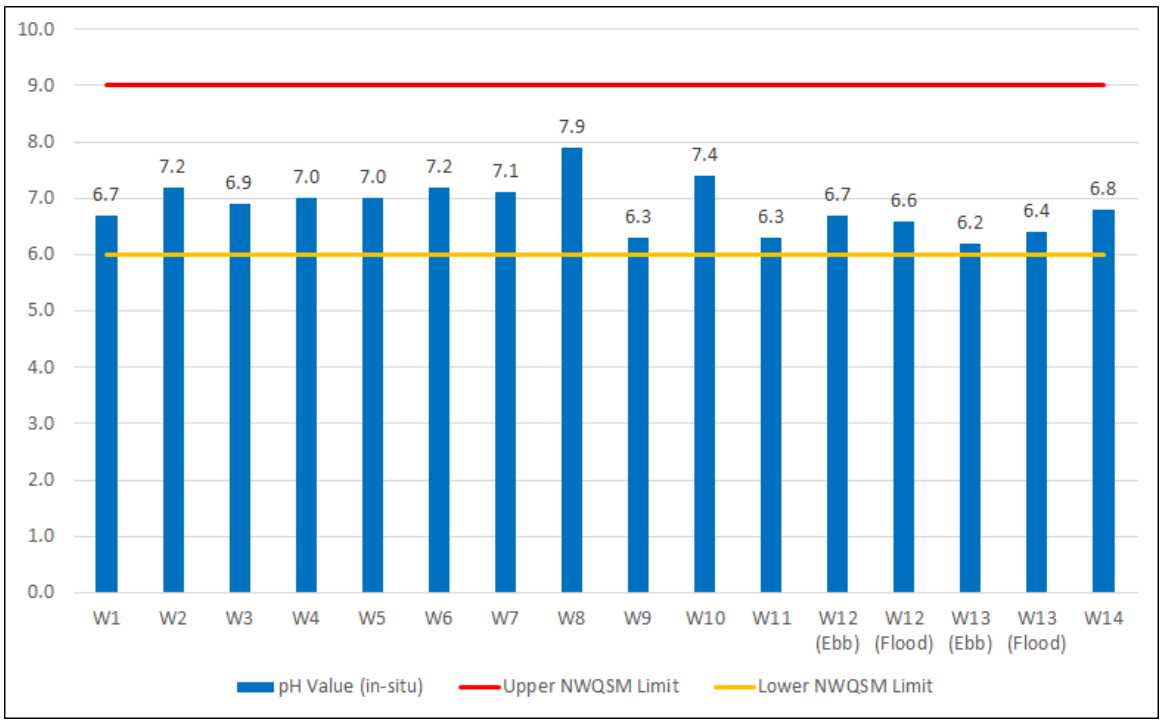


Figure 6.2.20: pH Value Profile

Dissolved Oxygen

Dissolved oxygen is the amount of gaseous oxygen (O_2) dissolved in the water. Oxygen enters the water by direct absorption from the atmosphere, by rapid movement or as a waste product of plant photosynthesis. The dissolved oxygen concentration in the samples were reported to range from 4.0 – 6.9 mg/L. The dissolved oxygen (DO) concentration reported at W1, W2, W12 during ebb tide, W12 during flood tide and W13 during flood tide, were not within the stipulated limit of 5-7 mg/l. Low DO could be due to low assimilative capacity (flow) or an excessive demand on the oxygen in the system. The volume of oxygen dissolved in water at any given time is dependent upon the temperature of the water, the partial pressure of the gas in the atmosphere and contact with the water and the concentration of dissolved salts in the water.

Inadequate dissolved oxygen in these surface waters means there would be little or no aquatic life due to its unfavourable environment. The dissolved oxygen profile for each station is illustrated on **Figure 6.2.21**.

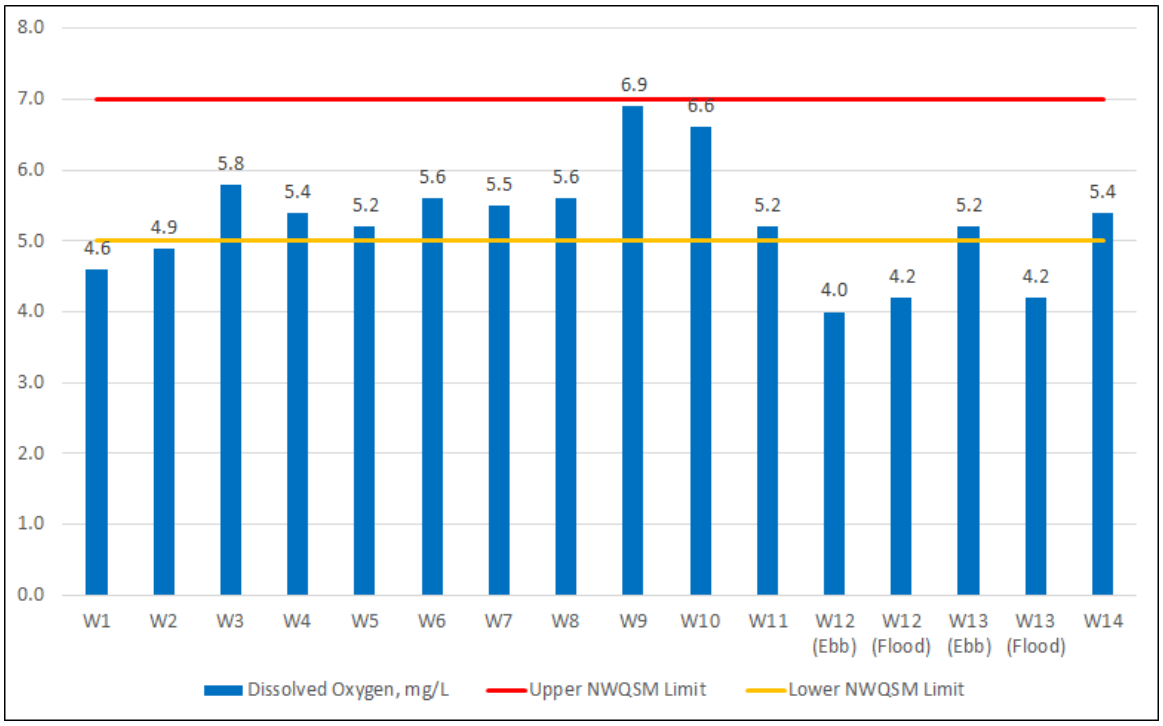


Figure 6.2.21: Profile of Dissolved Oxygen

Oxygen Demands

Biochemical oxygen demand (BOD) is defined as the amount of oxygen required by bacteria while stabilising decomposable organic matter under aerobic conditions. The BOD for all samples was within the Class IIB limit of 3 mg/l.

The chemical oxygen demand (COD) test determines the oxidisable material with strong oxidising agents. The oxidant used in the determination oxidises inorganic and organic compounds. The COD level that exceeded the Class IIB limit of 25 mg/l are reported at W10, W12 during flood tide and W13 during ebb tide. W5 and W14 were reported with COD level of 25 mg/L. The high oxygen demands are most probably from oil palm plantation activities in the catchments from which the streams flow through. The oxygen demands profile for each station is illustrated on **Figure 6.2.22**.

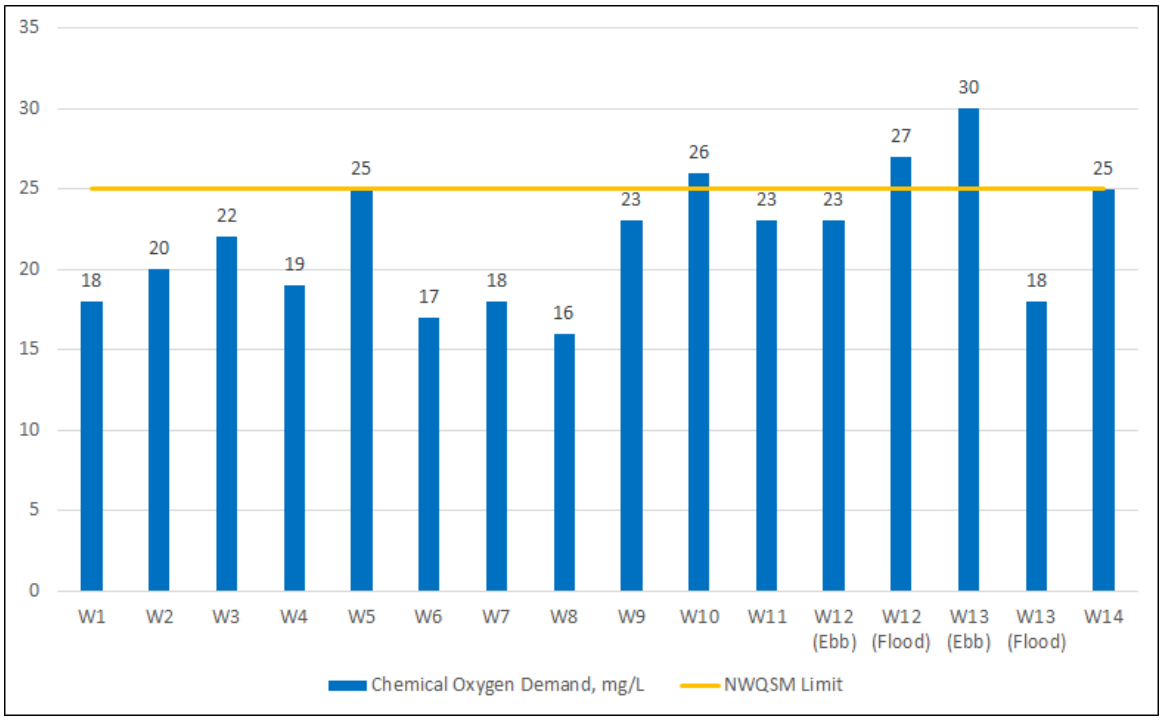


Figure 6.2.22: Chemical Oxygen Demand Profile

Total Suspended Solids

Total suspended solids (TSS) include all particles suspended in water. Suspended solids absorb heat from sunlight, which increases water temperature and subsequently decreases levels of dissolved oxygen.

The TSS levels of all the water samples are below the Class IIB limit except for the high TSS levels for W8 and W12 during ebb tide. This could be due to sediment eroded from the riverbank and surface runoffs from the oil palm plantation. High TSS in a water body is also often associated with higher concentrations of bacteria, nutrients, pesticides, and metals in the water. These pollutants may attach to sediment particles on the land and be carried into water bodies with stormwater. The TSS profile for each station is illustrated on **Figure 6.2.23**.

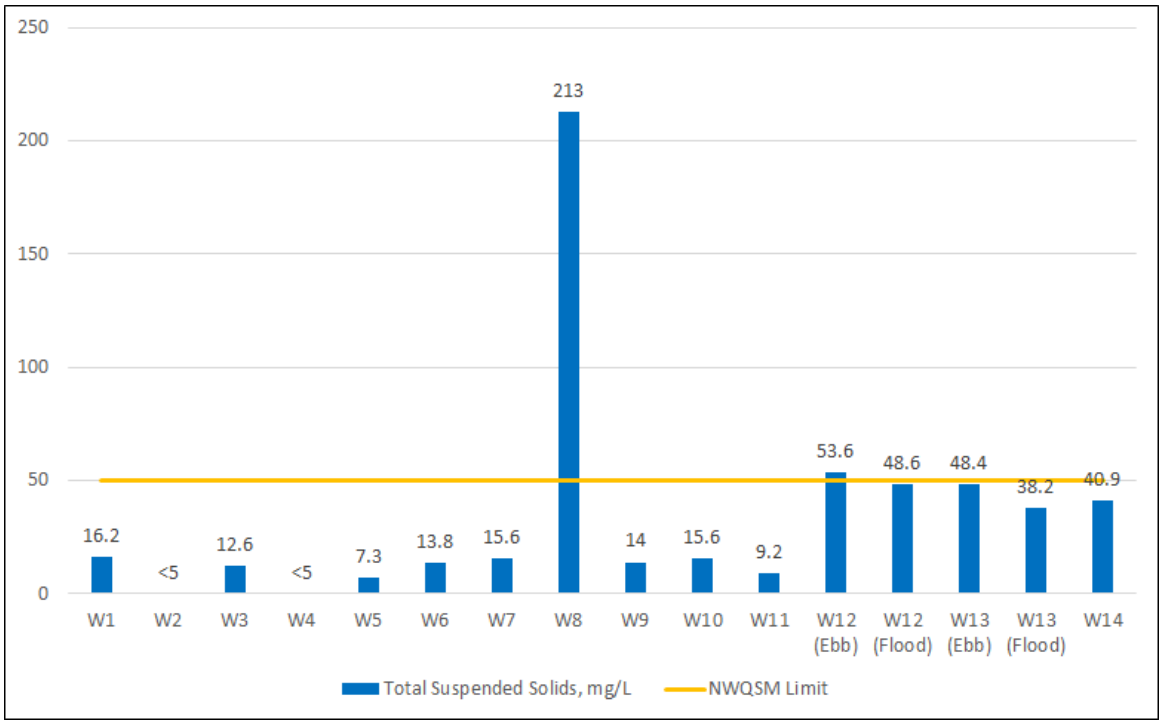


Figure 6.2.23: Total Suspended Solids Concentration Profile

Ammoniacal Nitrogen

Ammonia concentrations ranged from 0.21 – 0.71 mg/L. The ammoniacal nitrogen profile for each station is illustrated on **Figure 6.2.24**. Nitrogenous compounds in natural waters may be derived from outside sources (allochthonous) or may be fixed within the body of water (autochthonous). The allochthonous forms or sources of nitrogen are:

1) Precipitation carrying compounds in the form of nitrate and ammonia;

2) Surface runoff which contains terrestrial compounds of nitrogen including nitrate from the soil. Through decomposition of plants, some nitrate is lost from the land in drainage and runoff which later appears in river water; and

3) Inflow of groundwater from springs and seepages which can be particularly influenced by agricultural practices.

There are at least two possible sources for elemental or uncombined nitrogen in natural waters. One source of nitrogen, and very likely the most important, is the atmosphere. The second reservoir of uncombined nitrogen is that produced by bacteria nitrification of ammonia.

The ammoniacal nitrogen levels of seven (7) out of the total of sixteen (16) samples were reported with level exceeded the Class IIB limit of 0.30 mg/L. Ammonia can indicate pollution of water body, by either sewage or industrial effluent. Under normal conditions, the amount of dissolved nitrate in a body of water at any given time is determined by metabolic processes, i.e. production and decomposition of organic matter. Nitrate is also contributed to the ecosystem as a by-product of bacterial nitrification.

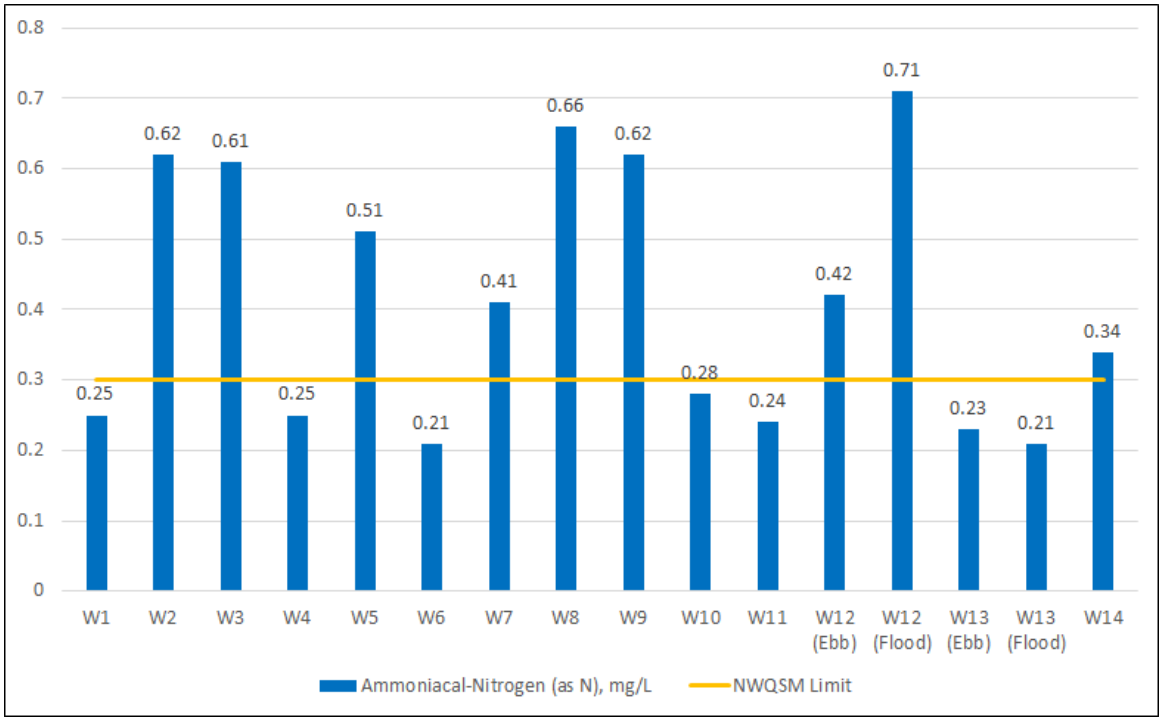


Figure 6.2.24: Profile for Ammoniacal Nitrogen

Oil and Grease

Petroleum oils are extensively used as solvents or vehicles for pesticides. While the oil may not in itself be toxic, it frequently increases the toxicity of the pesticide. Generally, the oil and grease levels of all the water samples are considered high with values ranging from 1.1 to 1.4 mg/L. The high oil and grease levels may be attributed by the pesticides used on the oil palm plantations.

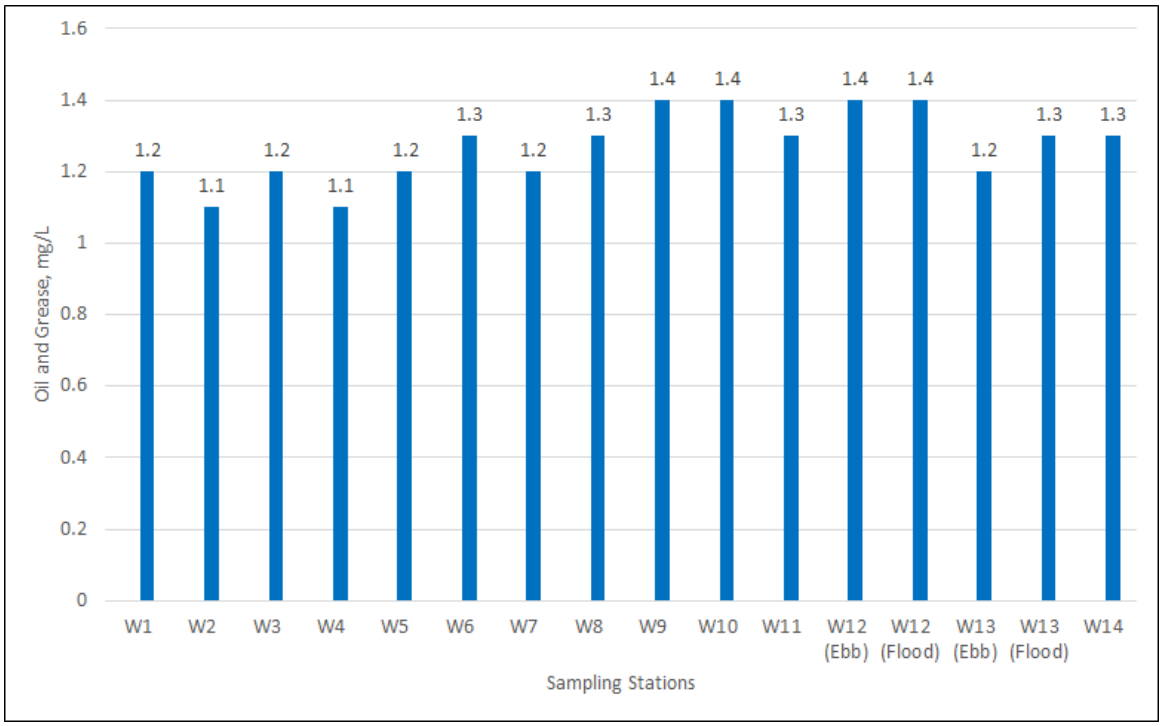


Figure 6.2.25: Profile for Oil & Grease Concentration

Heavy Metals

Mercury, silver, arsenic, cadmium, chromium, copper, lead, nickel and zinc are heavy metal compounds present in water. They may be toxic to man and aquatic organisms depending on their concentration, and are considered as problematic because they form stable compounds that can have persistent toxic effects for many years following their deposit. The compounds of heavy metals, such as chromium, cadmium, mercury and lead have no known biological function in animal life and can act synergistically with other substances to increase toxicity. Some toxic effects are cumulative and are harmful to the degree that the dosage and resultant concentrations may approach lethal thresholds.

The element iron is abundant and widespread constituent of rocks and soils. The samples that were reported with iron concentration exceeded the Class IIB limits of 1 mg/L are W8, W9, W12 (both ebb and tide samples), W13 during the ebb tide and W14. The exceedance may be due to the wash down of iron minerals, which are a dominant trace element in local soil during the rain into the river system. In unpolluted flowing waters, this ion usually takes the ferric (Fe^{3+}) form because of continual aeration and the presence of oxygen. However, organic decomposition is high in these surface waters, oxygen depletion may result in the transformation to the ferrous (Fe^{2+}) state and the precipitation of iron hydroxide. Iron bacteria may grow rapidly and form masses of ferruginous substances in the pools, further contributing to the high iron level. Heavy metal concentration profile

is shown in **Figure 6.2.26** (iron)**, Figure 6.2.27** (copper), **Figure 6.2.28** (manganese) and Figure **6.2.29** (silver).

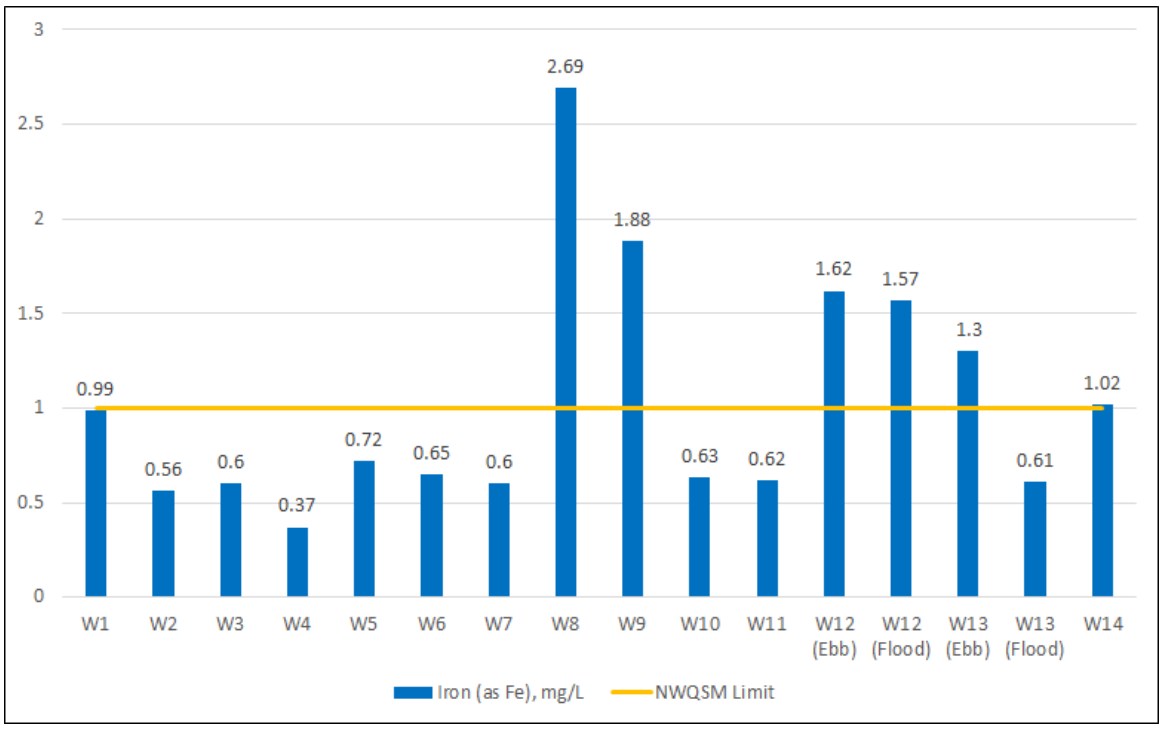


Figure 6.2.26: Iron Profile

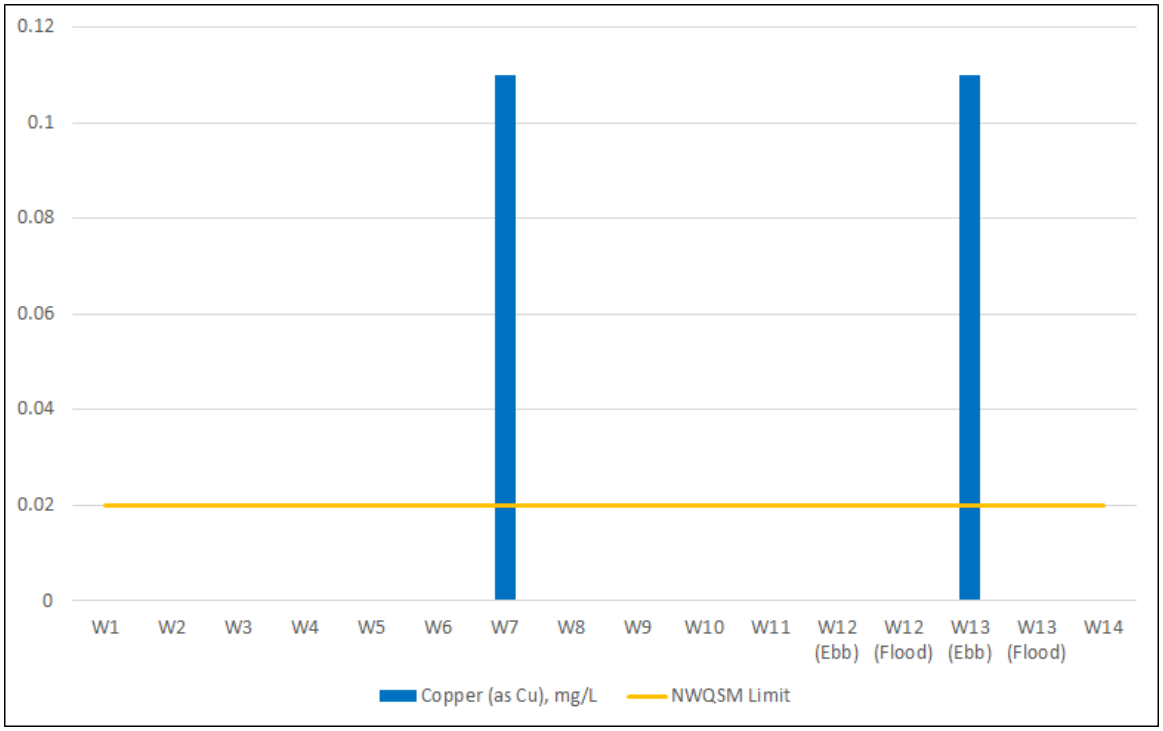


Figure 6.2.27: Copper Profile

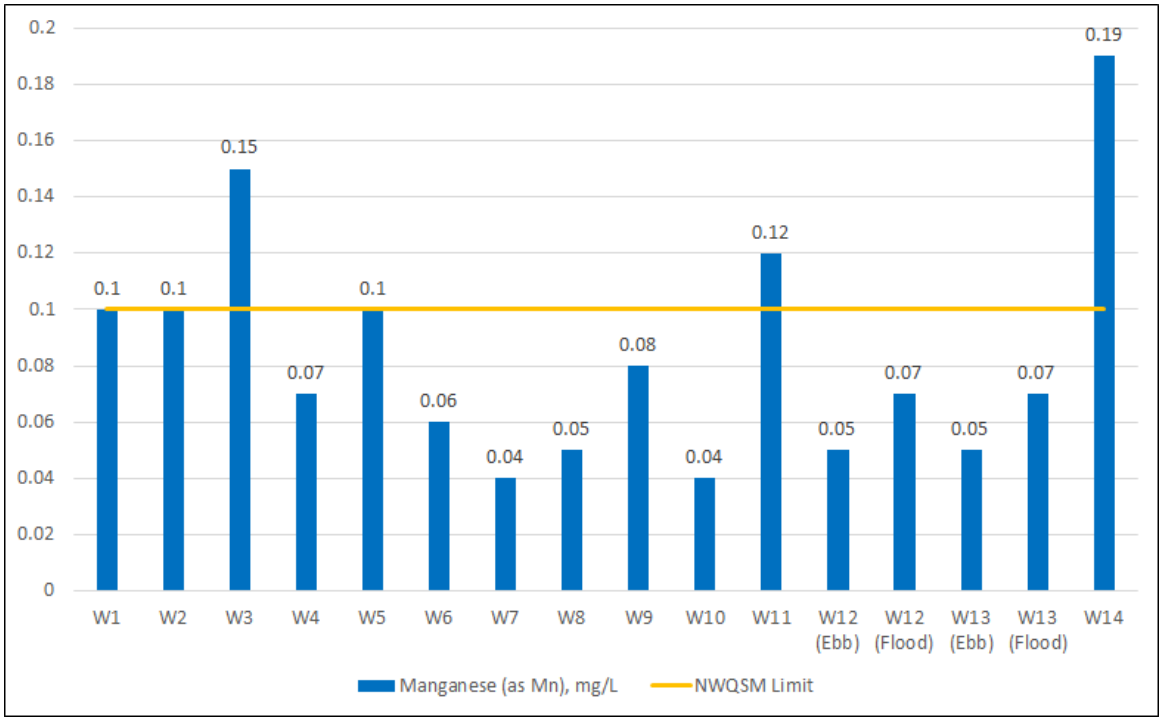


Figure 6.2.28: Manganese Profile

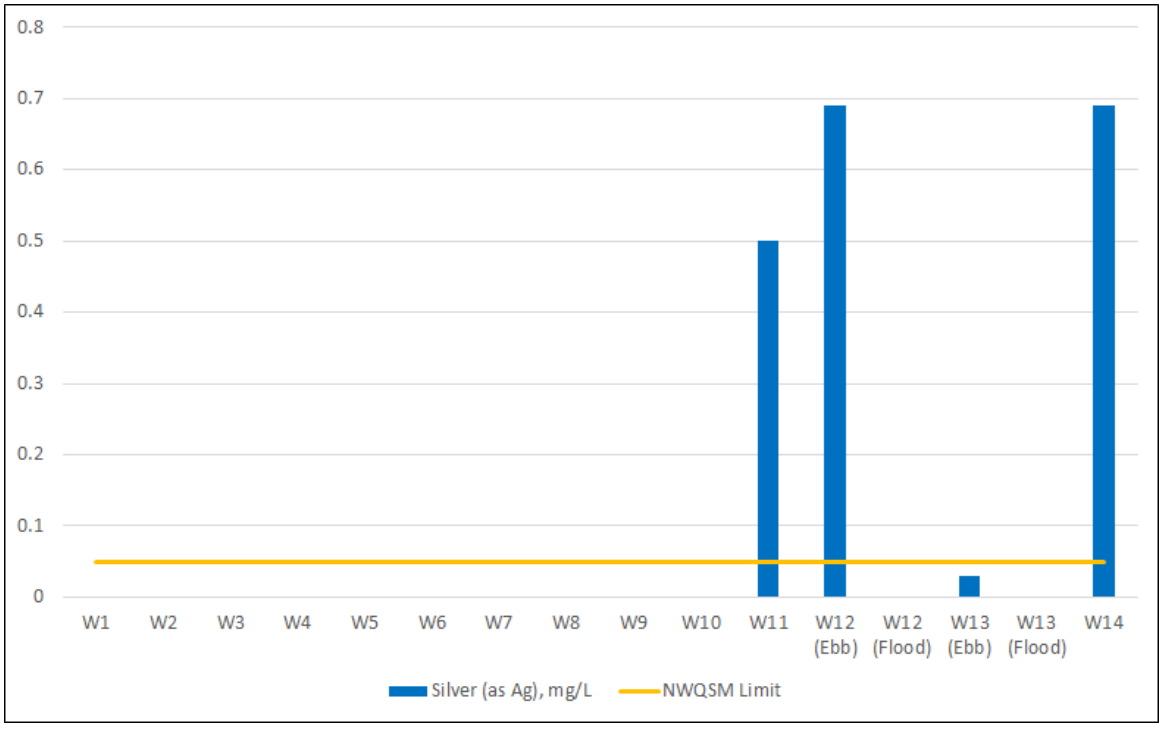


Figure 6.2.29: Silver Profile

Levels of lead, zinc, nickel, cadmium, chromium, mercury, arsenic, aluminium, barium, selenium, boron and cyanide in all the water samples are generally low and below the Class IIB limits of the NWQSM.

Coliform Content

Total coliform counts give a general indication of the sanitary condition of a waterbody. Total coliforms include bacteria that are found in the soil, in water that has been influenced by surface water, and in human or animal waste, whilst faecal coliforms are the group of the total coliforms that are present specifically in the gut and faeces of warm-blooded animals. Total Coliform Count for all samples complied with the Class IIB limit of 5000 MPN/100 mL except for W12 during the flood tide. The Faecal Coliform Count at W3, W8, W9, W10, W12 (both ebb and tide samples) and W13 (both ebb and tide samples) exceeded the Class IIB limit of 400 MPN/100 ml. These exceedances are likely to be contributed by sewage contamination from the village area, workers' quarter and activities in the oil palm estates.

Summary

The monitoring results (see **Table 6.2.13**) depicted almost pristine water quality in the upstream segments of Sg. Nyalau, (W1 – W4) where organics and TSS remained low. BOD was less than 1 mg/L (Class I), phosphorous around 0.1 mg/L and TSS did not even exceed 20 mg/L (Class II). DO also hovered around the 5 mg/L range. Nutrients, such as NH_3-N ranged between 0.25 – 0.62 mg/L and NO_3-N was not more than 0.7 mg/L. NH_3-N and NO_3-N may have originated from surrounding plantations, due from fertiliser runoff upstream of the catchment. The WQI analysis depicted a Class II denotation at all upstream stations.

The good water quality status continued mid-stream (W5 – W7), where again organics remained < 1 mg/L and TSS did not exceed 16 mg/L. NH_3-N ranged between 0.21 – 0.51 mg/L and NO_3-N between 0.3 – 0.36 mg/L; whereas T-P was not more than 0.2 mg/L. Faecal coliform was also < 400 cfu/100 mL, which indicated the river was suitable for body contact.

At W8 however, Sg. Nyalau, TSS deteriorated up to 213 mg/L. This TSS spike was rather anomalous, but could be attributed to erosion, as it rained the previous night. NH_3-N was also slightly more elevated here; up to 0.66 mg/L. Other constituents remained low. The good water quality persisted at W9, W10 and W11. The good water quality in major parts of the catchment implied Sg. Nyalau should support diverse aquatic life.

Approaching Kg. Kuala Nyalau (W12 and W13), TSS depleted to around 50 mg/L during ebbing and flooding; while other parameters remained low.

6.2.7.2 Temporal River Water Quality

One river water sampling location was selected for temporal sampling where each tidal change will be sampled, optimally at the highest (flood tide) and lowest period (ebb tide), for at least continuously 3 days. W11 was selected for this temporal sampling and a total of thirteen (13) samples were collected from 10th to 13th November 2018. The description and hydraulic measurement for the temporal sampling is as tabulated in **Table 6.2.16**.

Table 6.2.14: Description and Hydraulic Measurement for Temporal Sampling

Sampling ID	Date	Sampling Time	Tidal Phase	Avg. Depth (m)	Width (m)	Flow (m/s)
W11(1)	10-Nov-18	10.55 AM	Ebb	2.7	20.2	0.5
W11(2)	10-Nov-18	5.30 PM	Flood	3.8	21.0	0.6
W11(3)	10-Nov-18	11.30 PM	Flood (highest)	3.5	21.3	0.7
W11(4)	11-Nov-18	6.00 AM	Ebb	3.5	21.3	0.7
W11(5)	11-Nov-18	11.50 AM	Ebb (lowest)	3.3	20.3	0.5
W11(6)	11-Nov-18	6.00 PM	Flood	3.5	21.2	0.2
W11(7)	11-Nov-18	11.30 PM	Flood (highest)	3.9	21.3	0.2
W11(8)	12-Nov-18	6.00 AM	Ebb	3.5	21.0	0.4
W11(9)	12-Nov-18	12.30 PM	Ebb (lowest)	2.7	20.5	0.2
W11(10)	12-Nov-18	6.30 PM	Flood	3.4	21.5	0.3
W11(11)	12-Nov-18	11.45 PM	Flood (highest)	3.6	21.5	0.2
W11(12)	13-Nov-18	6.00 AM	Ebb	3.1	20.5	0.3
W11(13)	13-Nov-18	12.50 PM	Ebb (lowest)	2.7	19.5	0.2

A summary of the temporal water result is shown in **Table 6.2.17** and the complete test reports are shown in **Appendix 6.2.4**. The water quality results are compared against Class IIB of the National Water Quality Standards for Malaysia (NWQSM) (refer to **Appendix 6.2.5**).

Plate 6.47: Temporal sampling at W11

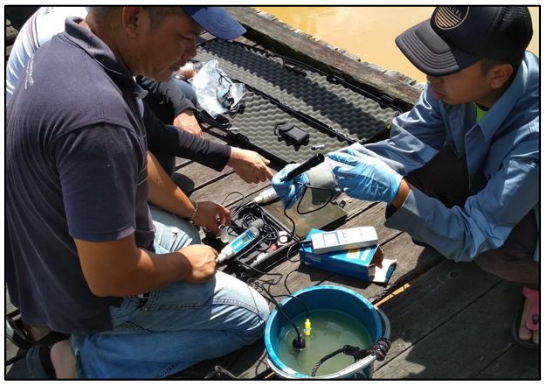


Plate 6.48: Measuring *in-situ* reading

Plate 6.49: Measuring the river flow

Plate 6.50: Transferring sample into sampling bottles

Plate 6.51: Sampling during night time

Table 6.2.15: Results of Laboratory Analysis of Temporal Water Samples at W11

Parameter(s)	W11(1) Ebb	W11(2) Flood	W11(3) Flood	W11(4) Ebb	W11(5) Ebb	W11(6) Flood	W11(7) Flood	W11(8) Ebb	W11(9) Ebb	W11(10) Flood	W11 (11) Flood	W11 (12) Ebb	W11 (13) Ebb	Class IIB of NWQSM
Temperature, ºC (*in-situ*)	27.2	27.6	28.4	27.1	27.3	27.5	29.4	28.2	30.1	29.7	29.7	28.5	30.2	-
pH Value, (*in-situ*)	7.4	7.2	7.1	7.1	7.1	8.2	7.6	7.0	7.0	6.5	6.9	6.4	6.8	6 – 9
Dissolved Oxygen, mg/L	5.5	5.6	5.5	5.3	4.6	5.4	5.4	5.1	5.2	5.6	5.5	5.3	5.1	5 – 7
Dissolved Oxygen Saturation, mg/L	7.9	7.9	7.8	8.0	7.9	7.9	7.6	7.8	7.5	7.6	7.6	7.8	7.5	-
Salinity, ppt	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-
Conductivity @ 25ºC, µmho/cm	117	77.2	67.7	75.2	79.4	98.5	83.0	101	94.2	96.8	91.9	102	106	-
Biochemical Oxygen Demand in 5 days @ 20ºC, mg/L	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	3
Chemical Oxygen Demand, mg/L	<10	20	**42**	**31**	24	25	**35**	**32**	24	**31**	16	14	18	25
Total Suspended Solids, mg/L	37.7	**136**	**91.6**	**89.6**	47.0	40.7	27.1	28.6	**50.7**	31.2	20.9	17.0	17.3	50
Ammoniacal-Nitrogen (as N), mg/L	**0.52**	0.18	0.10	**0.68**	**0.45**	**0.61**	**0.53**	0.27	0.26	**0.39**	**0.36**	**0.43**	**0.40**	0.3
Total Phosphorus (as P), mg/L	0.09	0.08	0.10	0.09	0.11	0.04	0.10	0.12	0.13	0.14	0.07	0.10	0.10	0.2
Nitrate Nitrogen (as N), mg/L	0.12	0.09	0.59	0.69	0.64	0.14	0.26	0.42	0.48	0.35	0.27	0.32	0.35	-
Total Coliform Count, MPN/100 mL, 35±0.5°C/48h	<1.1	3.3×10^2	7.0×10^2	<1.1	<1.1	3.3×10^2	4.9×10^2	7.9×10^2	<1.1	1.3×10^3	<1.1	<1.1	<1.1	5000
Fecal Coliform Count, MPN/100 mL, 44.5±0.2°C/24h	<1.1	2.3×10^2	4.9×10^2	<1.1	<1.1	2.3×10^2	2.3×10^2	2.3×10^2	<1.1	1.3×10^3	<1.1	<1.1	<1.1	400

Class IIB of NWQSM (National Water Quality Standards for Malaysia), which the water beneficial uses are meant for recreational and protection of sensitive aquatic species, is used for comparison.

Summary

The results have shown that the COD, TSS and ammoniacal nitrogen were reported with concentrations exceeded the Class IIB limit of NWQSM. The result for temporal sampling will be used for the calibration of the model to be used for the water quality modelling.

6.2.7.3 Marine Water Quality

Four (4) marine water samples were collected on 11 November 2018 (refer **Figure 6.2.16**) from two (2) marine sampling locations during flood and ebb tide respectively. The water sampling locations are described in **Table 6.2.16**. The water samples were collected during fine weather condition with calm sea condition.

Table 6.2.16: Description of Marine Water Sampling Stations

Sampling Point	GPS Reading	Tidal Phase		Description
		Date and Sampling Time		
MW1	N3° 38' 25.28" E113° 20' 5.30"	Flood Tide	Ebb Tide	South China Sea, approximately 5.3 km west off the estuary of Sg. Nyalau.
		11-Nov-18 1.20 AM	11-Nov-18 1.20 PM	
MW2	N3° 42' 25.28" E113° 23' 2.42"	Flood Tide	Ebb Tide	South China Sea, approximately 7.2 km north off the estuary of Sg. Nyalau.
		11-Nov-18 1.50 AM	11-Nov-18 1.57 PM	

A summary of the marine water result is shown in **Table 6.2.17** and the complete test reports are shown in **Appendix 6.2.4**. The water quality results are compared against Class 2 of the Marine Water Quality Criteria and Standards for Malaysia (MWQCSM) (refer to **Appendix 6.2.5**).

Table 6.2.17: Results of Laboratory Analysis of Baseline Marine Water Samples

Parameter(s)	MW1 (Flood)	MW1 (Ebb)	MW2 (Flood)	MW2 (Ebb)	Class 2 of MWQSM
Temperature, ^{o}C (*in-situ*)	30.3	29.2	30.5	30.1	≤2 °C increase
pH Value, (*in-situ*)	7.8	7.9	7.7	7.6	-
Dissolved Oxygen, mg/l	5.4	5.7	5.3	5.4	5
Dissolved Oxygen Saturation, mg/L	6.3	6.7	6.2	6.3	-
Conductivity @ 25^{o}C, µmho/cm	40,400	32,900	41,300	39,200	-
Salinity, ppt	26	21	27	25	-
Free Chlorine (as CL_2), mg/L	<0.1	<0.1	<0.1	<0.1	-
Fluoride (as F), mg/L	0.88	0.71	0.87	0.86	-
Biochemical Oxygen Demand in 5 days @ 20^{o}C, mg/L	<2.0	<2.0	<2.0	<2.0	-
Chemical Oxygen Demand, mg/L	25	29	12	33	-
Total Suspended Solids, mg/l	<5.0	<5.0	<5.0	<5.0	50

Parameter(s)	MW1 (Flood)	MW1 (Ebb)	MW2 (Flood)	MW2 (Ebb)	Class 2 of MWQSM
Ammoniacal-Nitrogen (as N), mg/L	0.28	0.26	0.23	0.34	-
Nitrite Nitrogen (as N), mg/L	0.11	0.25	0.02	0.03	-
Phosphorus (as P), mg/L	0.08	0.17	0.07	0.08	-
Oil & Grease, mg/L	**1.5**	**1.2**	**1.4**	**1.6**	0.14
Lead (as Pb), mg/L	<0.001	<0.001	<0.001	<0.001	0.0085
Copper (as Cu), mg/L	<0.001	**0.045**	<0.001	0.001	0.0029
Zinc (as Zn), mg/L	<0.005	0.023	<0.005	<0.005	0.05
Nickel (as Ni), mg/L	<0.001	0.002	<0.001	<0.001	-
Cadmium (as Cd), mg/L	<0.001	<0.001	<0.001	<0.001	-
Chromium, Hexavalent (as Cr^{6+}), mg/L	<0.02	<0.02	<0.02	<0.02	0.01
Chromium, Trivalent (as Cr^{3+}), mg/L	<0.02	<0.02	<0.02	<0.02	-
Iron (as Fe), mg/L	0.019	0.082	0.018	0.044	-
Manganese (as Mn), mg/L	0.003	0.032	0.003	0.006	-
Mercury (as Hg), mg/L	<0.0001	<0.0001	<0.0001	<0.0001	0.00014
Silver (as Ag), mg/L	<0.001	<0.001	<0.001	<0.001	-
Tin (as Sn), mg/L	<0.001	<0.001	<0.001	<0.001	-
Arsenic (as As), mg/L	<0.001	<0.001	<0.001	<0.001	0.003
Aluminium (as Al), mg/L	0.027	0.140	0.027	0.053	-
Barium (as Ba), mg/L	0.006	0.008	0.006	0.007	-
Selenium (as Se), mg/L	0.001	0.002	<0.001	<0.001	-
Phenol, mg/L	<0.01	<0.01	<0.01	<0.01	0.01
Boron (as B), mg/L	3.39	2.37	3.22	3.27	-
Cyanide (as CN), mg/L	<0.01	<0.01	<0.01	<0.01	0.007
Sulphide (as S^{2-}), mg/L	<0.1	<0.1	<0.1	<0.1	-
Formaldehyde, mg/L	<0.3	<0.3	<0.3	<0.3	-
Colour, ADMI	<10	<10	<10	<10	-
Total Coliform Count, MPN/100 mL, 35±0.5°C/48h	<1.1	<1.1	<1.1	<1.1	-
Fecal Coliform Count, MPN/100 mL, 44.5±0.2°C/24h	<1.1	<1.1	<1.1	<1.1	100

Class 2 of MWQSM (Marine Water Quality Standards for Malaysia), which the water beneficial uses are meant for marine life, fisheries, coral reefs, recreational and mariculture, is used for comparison. This is because the area is a known fishing area for the local fishermen.

All the parameters comply with Class 2 of the MWQCSM except for oil & grease and copper. Oil & grease concentrations were reported in all the samples collected, ranging from 1.2 to 1.6 mg/L. For copper, only the sample collected from MW1 during the ebb tide was reported with copper concentration of 0.045 mg/L.

The coastal water quality monitoring results (see **Table 6.2.17**) also indicated very good water quality as most nutrients (ammonia, nitrate and phosphorous) remained very low at MW1 and MW2 during ebbing and flooding. Faecal coliform was also undetected.

Plate 6.52: Marine water sampling at MW1

6.2.7.4 Groundwater Quality

The groundwater quality was evaluated by analysing the chemistry of groundwater samples. Four (4) groundwater samples were collected from four (4) monitoring wells that were constructed within the boundary of the proposed Project Site. The groundwater sampling locations are described in **Table 6.2.18**. The sampling exercise was conducted on 22 November 2018 for GW1, GW2, GW3 and GW4. The summary of the groundwater results is shown in **Table 6.2.19**.

A standard sampling procedure was used to sample the groundwater. The stagnant water in the borehole was firstly removed by pumping three pore volumes the amount of groundwater in order to collect a clean and fresh groundwater. The borehole was then left for 24 hours to recover before the sampling was conducted. Groundwater samples were collected using a plastic bailer or low flow pumping rates using standard water pump.

The groundwater samples were sampled and collected using clean glass pre-labelled bottles that were prepared by the laboratory. All samples were stored in a cool box with dry ice pack to make sure the temperature in the box is within 4^{o}C. The groundwater samples were delivered to the laboratory within 24 hours for analysis.

The full test report is attached in **Appendix 6.2.4**. The groundwater quality results are compared with two Environmental Standards namely (i) the Malaysian Industrial Effluent Discharge of Standard A and Standard B and (ii) National Guidelines for Raw Drinking Water Quality from the Ministry of Health, Malaysia (KKM 2000). (refer to **Appendix 6.2.5**).

Table 6.2.18: Location and Description of Groundwater Monitoring Wells

Sampling Point	GPS Reading	Description
GW1	N 03° 29' 31.92" E 113° 25' 27.69"	Northwest corner of the Project site
GW2	N 03° 29' 47.20" E 113° 25' 50.90"	North boundary of the Project site
GW3	N 03° 29' 6.74" E 113° 25' 43.13"	Southwest corner of the Project site
GW4	N 03° 29' 16.48" E 113° 25' 57.99"	South boundary of the Project site

Plate 6.53: Sampling at GW1

Plate 6.54: Sampling at GW2

Plate 6.55: Sampling at GW3

Plate 6.56: Sampling at GW4

Table 6.2.19: Summary of Groundwater Sampling Results

Parameters	GW 1	GW 2	GW3	GW4	EQ (Industrial Effluent) Reg. 2009*		National Guidelines for Raw Drinking Water Quality**
					Standard A	Standard B	
Temperature, ºC	27.6	27.9	27.6	27.8	40	40	NA
pH Value	**4.8**	6.1	5.9	6.3	6.0 – 9.0	5.5 – 9.0	5.5 – 9.0
Conductivity @ 25 ºC, µmho/cm	280	228	144	190	NA	NA	NA
Salinity, ppt	<1	<1	<1	<1	NA	NA	NA
Bicarbonate (as HCO_3), mg/L	7	113	55	108	NA	NA	NA
Carbonate (as CO_3), mg/L	Absent	Absent	Absent	Absent	NA	NA	NA
Hardness, EDTA Titrimetric (as CaCO3), mg/L	70	13	18	46	NA	NA	500
Biochemical Oxygen Demand @ 20 ºC, mg/L	<2.0	3.6	12.8	4.8	20	50	NA
Chemical Oxygen Demand, mg/L	21	**70**	**66**	**64**	50	100	NA
Total Suspended Solids, mg/L	**51.6**	**262**	**176**	**240**	50	100	50
Total Dissolved Solids, mg/L	202	208	118	186	NA	NA	1,500
Nitrate (as NO_3), mg/L	19.4	0.83	4.46	0.95	NA	NA	NA
Sulphate (as SO_4^{2-}), mg/L	56	5	9	10	NA	NA	400
Chloride (as CL^-), mg/L	**20**	**17**	**3**	**4**	1	2	0.05
Ammoniacal-Nitrogen (as N), mg/L	0.10	0.15	0.16	0.11	10	20	200
Calcium (as Ca), mg/L	16.7	11.6	10.7	24.1	NA	NA	NA
Magnesium (as Mg), mg/L	1.81	1.62	5.17	3.67	NA	NA	150
Sodium (as Na), mg/L	12.8	18.7	4.56	11.3	NA	NA	200
Potassium (as K), mg/L	2.04	5.18	1.17	3.90	NA	NA	NA
Lead (as Pb), mg/L	0.03	0.02	0.01	0.02	0.1	0.5	0.1
Copper (as Cu), mg/L	0.02	0.02	<0.02	<0.02	0.2	1	1

Parameters	GW 1	GW 2	GW3	GW4	EQ (Industrial Effluent) Reg. 2009*		National Guidelines for Raw Drinking Water Quality**
					Standard A	Standard B	
Zinc (as Zn), mg/L	0.12	<0.02	<0.02	0.02	2	2	1.5
Cadmium (as Cd), mg/L	0.003	0.002	0.002	0.002	0.01	0.02	0.005
Chromium, Hexavalent (as Cr^{6+}), mg/L	<0.02	<0.02	<0.02	<0.02	0.05	0.05	0.05
Iron (as Fe), mg/L	**7.55**	**65.2**	**63.0**	**21.3**	1	5	1
Manganese (as Mn), mg/L	**1.81**	**1.62**	**0.54**	**0.50**	0.2	1	0.2
Arsenic (as As), mg/L	<0.006	<0.006	<0.006	<0.006	0.05	0.1	0.05
Aluminium (as Al), mg/L	8.51	**18.0**	1.55	**12.2**	10	15	NA
Selenium (as Se), mg/L	**0.164**	**0.096**	**0.100**	**0.133**	0.02	0.5	0.01

*Note: Figure in **bold / shaded** means the parameter exceeded the National Guidelines for Raw Drinking Water Quality*

**Environmental Quality (Industrial Effluent) Regulations, 2009*

***KKM (2000). National Guidelines for Raw Drinking Water Quality from the Ministry of Health, Malaysia.*

NA – Data not available

Summary

The results have shown that the Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), chloride, iron, manganese, aluminium and selenium were all exceeded the Environmental Standards.

pH value was recorded higher than the standard especially in GW1 with the groundwater was acidic (pH = 4.8). Other groundwater samples were low acidic and within the Standard range.

Chemical Oxygen Demand (COD) were measured higher in GW2, GW3 and GW4 with the values ranged from 64 – 70 mg/L and exceeded the Effluent Standard A, but below the Effluent Standard B. Therefore, the groundwater COD values were classified as satisfy the requirement of Effluent Standard B.

Total Suspended Solids (TSS) were measured higher than the Standards in all groundwater samples. The TDS values ranged from 51 to 262 mg/L and well above the Environmental Standards of Effluent Standard A, Standard B and KKM (2000). This TSS values may indicate that the groundwater samples were cloudy and there were sampled immediately after purging the well.

Chloride (Cl) concentrations in all groundwater samples were recorded higher (3 to 20 mg/L) and exceeded the Environmental Standards of Effluent Standard A/B and KKM (2000).

Heavy Metals

Iron (Fe) concentrations in all groundwater samples were measured in a range of 7 to 65 mg/L. These values were exceeded the Environmental Standards especially for groundwater samples GW2 (65 mg/L) and GW3 (63 mg/L).

Manganese concentrations in all groundwater samples were exceeded the Environmental Standards with the values ranging from 0.5 to 1.8 mg/L.

Aluminium concentration was measured higher in only GW2 and GW4 groundwater samples with the values of 18 mg/L and 12 mg/L, respectively.

Selenium concentration was also measured higher compared to Environmental Standard with the values ranging from 0.09 to 0.16 mg/L.

6.2.7.5 Air Quality

The existing ambient air quality level was sampled at four (4) locations from 5th to 12th November 2018. The sampling locations were identified based on its proximity of the human settlement and other sensitive receptors to the proposed Project site. The description of the baseline air sampling locations is presented in **Table 6.2.20**. The air monitoring locations are shown in **Figure 6.2.18**.

The level of PM_{10} and $PM_{2.5}$, were measured over a period of 24 hours. Sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), methane (CH_4)) and hydrogen sulphide (H_2S) were measured over a period of 1 hour. The baseline results are shown in **Table 6.2.21**. The test report is attached in **Appendix 6.2.4**. The value obtained is compared with the Malaysian Ambient Air Quality Standard (MAAQS) (**Appendix 6.2.5**).

Table 6.2.20: Baseline Air Monitoring Locations

Monitoring Point	GPS Coordinates	Description
A1	3° 28' 54.79" N 113° 23' 52.30" E	Samudera Estate Workers' Quarter
A2	3° 27' 8.23" N 113° 23' 27.95" E	Damai Estate Workers' Quarter
A3	3° 33' 36.14" N 113° 24' 18.39" E	Tawakal Sejati Estate Workers' Quarter
A4	3° 29' 52.49" N 113° 27' 12.40" E	Imbok Estate Workers' Quarter

Plate 6.57: A1 – PM_{10} and $PM_{2.5}$ sampling, within Samudera Estate

Plate 6.58: A2 – PM_{10} and $PM_{2.5}$ sampling, within Damai Estate

Plate 6.59: A3 – PM_{10} and $PM_{2.5}$ sampling, within Tawakal Sejati Estate

Plate 6.60: A4 – PM_{10} and $PM_{2.5}$ sampling, within Imbok Estate

Plate 6.61: A3 – SOx, NOx, CO, H_2S and CH_4 sampling

Table 6.2.21: Baseline Air Monitoring Results

Monitoring Point	Level of Gaseous Concentration						
	PM_{10} ($\mu g/m^3$)	$PM_{2.5}$ ($\mu g/m^3$)	SO_2 ($\mu g/m^3$)	NO_2 ($\mu g/m^3$)	CO (ppm)	H_2S (ppm)	CH_4 (% LEL)
A1	30.1	14.7	<20	18.7	0.0	0	<1.00
A2	<10.0	<10.0	<20	15.9	0.0	0	<1.00
A3	<10.0	<10.0	27	10.8	0.0	0	<1.00
A4	10.3	<10.0	<20	8.6	0.1	0	<1.00
MAAQS (IT-2, 2018)	120	50	300	300	35	-	-
Averaging Time	24 hrs	24 hrs	1 hr	1 hr	1 hr	1 hr	1 hr

Sulphur Dioxide (SO_2)

SO_2 is an invisible gas with an unpleasant, acrid smell. It reacts easily with other substances to form potentially harmful compounds, such as sulfuric acid, sulphurous acid and sulphate particles. About 99% of the SO_2 in air comes from human sources. The main source of SO_2 in the air is industrial activity that processes materials that contain sulphur, for example the generation of electricity from sulphur-bearing coal, oil or gas. Some mineral ores also contain sulphur, and SO_2 is released when they are processed. SO_2 is also present in motor vehicle emissions, as the result of fuel combustion.

All the levels of SO_2 recorded were significantly lower than the MAAQS limit of 300 $\mu g/m^3$.

Nitrogen Dioxide (NO_2)

NO_2 is an unpleasant smelling gas, contributes to the formation of photochemical smog, which can have significant impacts on human health. Major sources of NO_2 are from the burning of fossil fuels, motor vehicle exhaust fumes, petrol and metal refining, electricity generation from coal-fired power stations, other manufacturing industries and food processing. All the levels of NO_2 reported were significantly lower than the MAAQS limit of 300 $\mu g/m^3$.

Carbon Monoxide (CO)

CO is a gas that naturally occurs at a concentration of 0.2 ppm and is not harmful to humans in this concentration. High concentrations of CO are poisonous to humans and, unfortunately, it cannot be detected by humans, as it has no taste or smell and cannot be seen. The main sources of CO from human activities are motor vehicle exhaust and some industrial activities, such as making steel. The CO measured at all sampling points was significantly lower than the MAAQS limit of 35 mg/m^3.

PM_{10} and $PM_{2.5}$

PM_{10} and $PM_{2.5}$ are measures of coarse particles in the air including dust, dirt, soot, smoke, and liquid droplets. Particle emissions related to human activity are from motor vehicle exhausts, industrial processes (for example electricity generation, incinerators and stone crushing) and unpaved roads. All the levels of PM_{10} and $PM_{2.5}$ reported were significantly lower than the MAAQS limit of 120 µg/m^3 and 50 µg/m^3, respectively.

6.2.7.6 Noise Level

Noise levels were measured at four boundaries of the Project site and the nearest human receptor (see **Table 6.2.22** and **Figure 6.2.17**). **Table 6.2.23** summarises the details of the baseline noise monitoring results and **Table 6.2.24** presents the main sources of noise in the noise monitoring stations. The full monitoring results are attached in **Appendix 6.2.4**.

Table 6.2.22: Baseline Noise Monitoring Locations

Monitoring Point	GPS Coordinates	Description
N1	3° 29' 34.01" N 113° 25' 30.35" E	Northwestern boundary of Project site
N2	3° 29' 14.89" N 113° 25' 38.57" E	Southwestern boundary of Project site
N3	3° 29' 46.51" N 113° 25' 48.82" E	Northern boundary of Project site
N4	3° 29' 22.38" N 113° 26' 9.44" E	Southeastern boundary of Project site
N5	3° 29' 52.49" N 113° 27' 12.40" E	Imbok Estate Workers' Quarter approximately 1.9 km to the east of the Project site

Table 6.2.23: Baseline Noise Monitoring Results

Parameters, dB(A)		Monitoring Locations					Maximum Permissible Sound Level**
		N1	N2	N3	N4	N5	
L_{eq}	Daytime	63.6	58.2	67.5	53.4	58.2	Designated Industrial Zone 70 dB(A) for day time 60 dB(A) for night time
	Night-time	46.3	52.7	57.2	51.8	51.2	
L_{max}	Daytime	97.3	88.5	100.6	79.6	88.5	
	Night-time	72.7	77.3	86.0	62.2	82.4	
L_{min}	Daytime	27.0	30.7	35.6	27.9	30.7	
	Night-time	28.0	38.8	33.4	43.2	40.6	
L_{10}	Daytime	55.5	55.1	64.2	52.7	57.0	
	Night-time	52.3	56.3	59.6	53.7	53.6	
L_{90}	Daytime	34.9	35.7	45.3	40.1	35.7	
	Night-time	32.6	44.9	48.5	48.5	43.9	

***Schedule 1, Annex A, DOE's Planning Guidelines for Environmental Noise Limits and Control 2007.*

Note: The duration of daytime noise monitoring is 7 am to 10 pm. The duration of night-time noise monitoring is from 7pm to 10 am.

Table 6.2.24: Sources of Noise

Monitoring Stations	Duration	Sources of Noise
N1	Daytime	Vehicle movements within the plantation, human activity, animals, insects, wind
	Night-time	Animals, insects, wind
N2	Daytime	Vehicle movements within the plantation, human activity, animals, insects, wind
	Night-time	Animals, insects, wind
N3	Daytime	Vehicle movements within the plantation, human activity, animals, insects, wind
	Night-time	Animals, insects, wind
N4	Daytime	Vehicle movements within the plantation, human activity, animals, insects, wind
	Night-time	Animals, insects, wind
N5	Daytime	Vehicle movements within the plantation, human activity, animals, insects, wind
	Night-time	Animals, insects, wind

The recorded baseline noise levels are compared with Schedule 1 in Annex A of 'The Planning Guidelines for Environmental Noise Limits and Control, 2007' by DOE (see **Appendix 6.2.5**).

Leq during the daytime and night-time for all monitoring points complied with the stipulated limits. The noise sampling at the Project site was conducted prior to site clearing activities.

Plate 6.62: Monitoring location at N1

Plate 6.63: Monitoring location at N2

Plate 6.64: Monitoring location at N3

Plate 6.65: Monitoring location at N4

Plate 6.66: Monitoring location at N5

6.2.8 EXISTING TRAFFIC

6.2.8.1 Existing Road Network

The Project site is located approximately 9 km southeast of the SIP. It is accessible via the Bintulu-Miri Coastal Road (four-lane dual carriageway). The Bintulu-Miri Coastal Road follows the coastline, commencing from Tg. Kidurong in Bintulu and ending at Tg. Lobang at the northern end of Jalan Bakam in Miri. For ease of reference, the Bintulu-Miri Coastal Road is referred as 'Coastal Road' hereafter in this report.

To the north of the Project site, the Coastal Road forms a T-junction with the access road to the SIP. The total length of the Coastal Road north of the T-junction is approximately 180 km and with the exception of the last 10 km of the road, which is a four-lane dual carriageway, the road is a two-lane single carriageway. The Coastal Road south of the T-junction is approximately 49 km long and is a four-lane dual carriageway.

To the south of the Project site, the Coastal Road forms a 3-legged roundabout linking to the Mile 32 Link Road. This intersection provides an alternative route for the commuters from Samalaju heading towards Bintulu, Bakun and Miri.

6.2.8.2 Site Background

The Project site is located approximately 9 km southeast of SIP with a total Project area of about 182 ha. The Project site is located within an existing oil palm plantation estate with several human settlements nearby.

6.2.8.3 Traffic Survey

Traffic survey has been carried out on 14th November 2018 during the morning and evening peak hour periods along the Coastal Road near the proposed accessway to the Project site.

The traffic was recorded at 15-minute intervals under six different vehicle categories, namely, passenger car/ 4-wheel drive, motorcycle, van/ utility, light truck, heavy truck and bus. The directional morning and evening peak hour traffic volumes in vehicles per hour (vph) and passenger cars per hour (pcph) have been computed as shown in **Figure 6.2.30**.

The number of vehicles of various classes have also been converted to passenger car unit (PCU) based upon the conversion factors as recommended in **Table 6.2.25**.

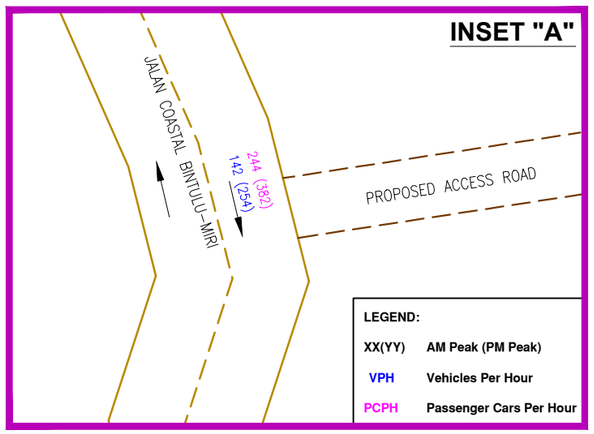
Table 6.2.25: Conversion Factors to Passenger Car Unit (PCU)

Type of Vehicle	Rural Road
Passenger car/ 4-wheel drive	1.00
Motorcycle	1.00
Van/ utility	2.00
Light truck	2.50
Bus	3.00
Heavy truck	3.00

Source: REAM – GL 10/2011 "Guidelines for Traffic Impact Assessment"

CHEMSAIN KONSULTANT SDN. BHD.

SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT SITE
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- RIVERS / STREAMS
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- PROPOSED ACCESS ROAD (BY OTHERS)
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT

N

0 1 2 3 4 5Km

SCALE IN KILOMETRES (1:100,000) – A3 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

EXISTING TRAFFIC VOLUME

FIGURE: 6.2.30

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-6230.DWG

From the results of the traffic survey, the peak hour at the survey station occurred from 0600 to 0700 during the morning peak and from 1730 to 1830 during the evening peak. Comparatively, the traffic during evening peak is more critical than the morning peak where the highest volume at the survey station is 414 pcph compared to 282 pcph during the morning peak.

Figure 6.2.31 present the total volume (PCU) at every 15-minute interval from 0600 to 0800 while **Figure 6.2.32** shows the volume from 1630 to 1830 on a typical weekday at the surveyed station.

With reference to **Figure 6.2.31** and **Figure 6.2.32**, the peak 15-minute volume occurred from 0600 to 0615 with 115 PCU I the morning and from 1730 to 1745 with 161 PCU in the evening.

Figure 6.2.31: 15-Minute Traffic Volume (PCU) from 0600 to 0800

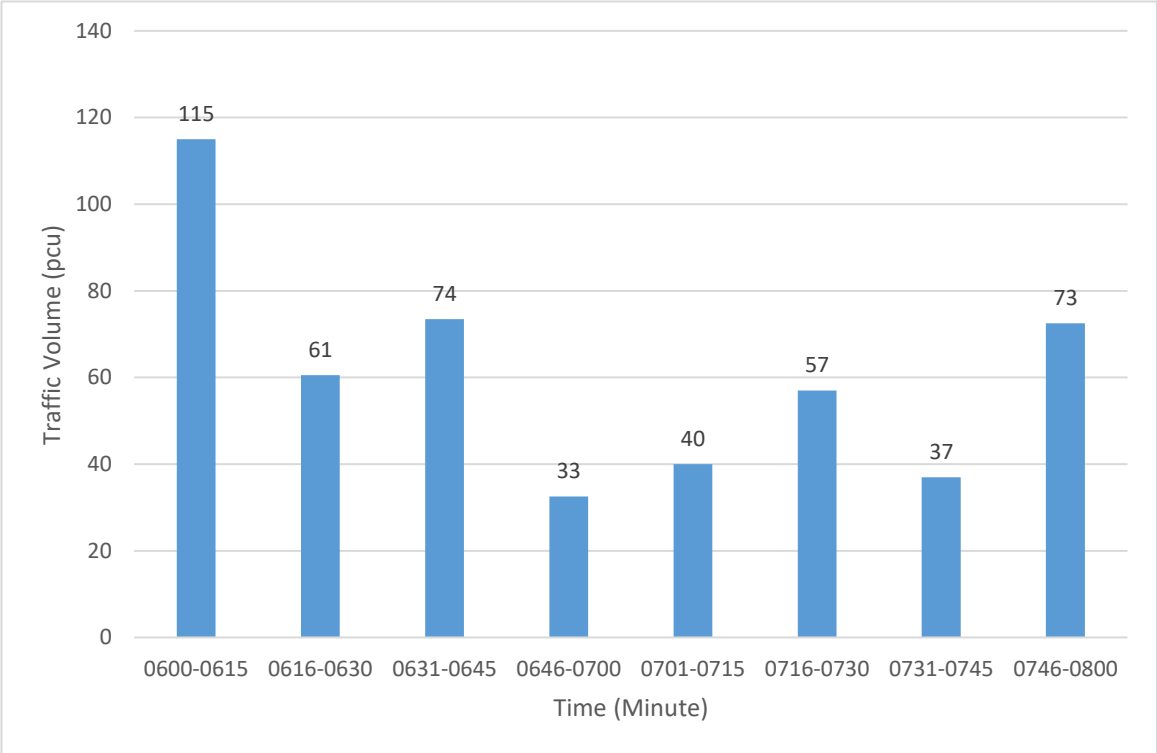
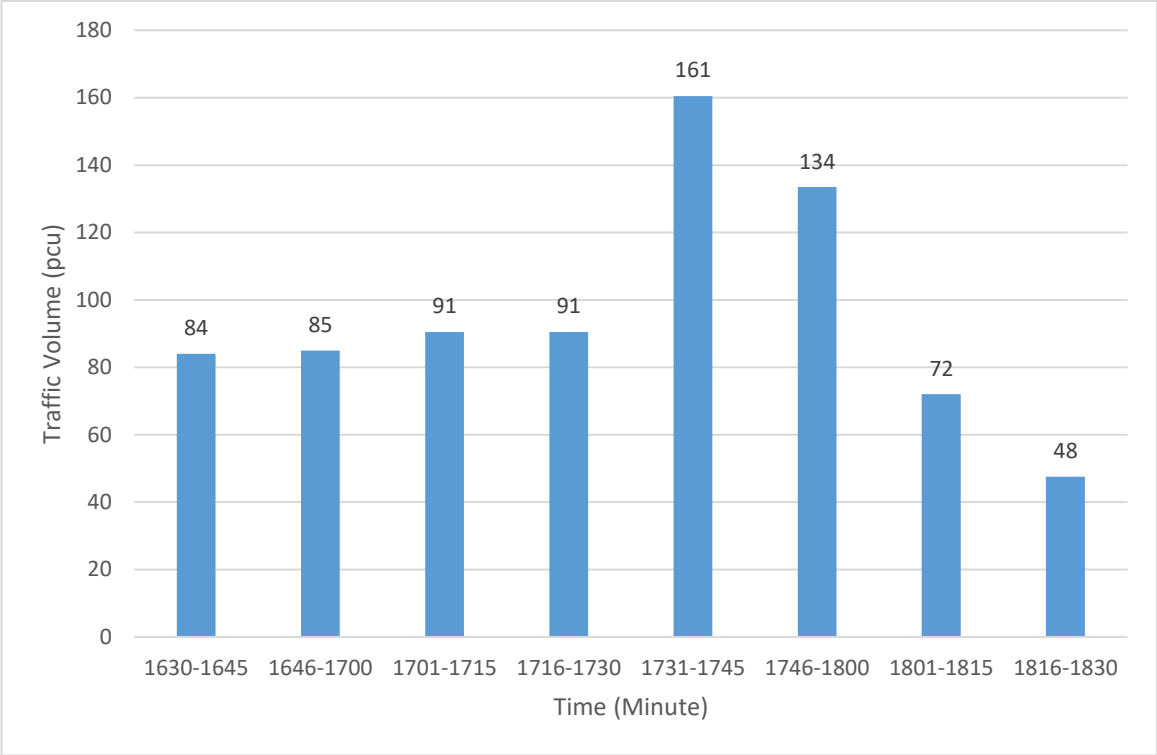


Figure 6.2.32: 15-Minute Traffic Volume (PCU) from 1630 to 1830



6.3 BIOLOGICAL ENVIRONMENT

6.3.1 FLORA

The Project site is predominantly covered by oil palm plantation, weeds and shrubs. The southern part of the Project site consists of small patched of secondary forest. Common species of plant normally found in secondary forest are lalang (*Imperata cylindrical*), nibong (*Oncosperma tigillarium*), pandan (*Pandanus* sp.), akar ulan (*Merremia peltata*), balik angin (*mallotus paniculatus*) and pokok ara (*Ficus* sp.). Therefore, there is no significant flora and fauna to be expected within the Project site.

6.3.2 FAUNA

The Project site is currently occupied by oil palm plantation and patches of secondary forest. Due to human activity, the diversity of fauna in this area is low and no significant fauna expected within the Project site.

6.3.2.1 Herpetofauna

The diversity of reptile in the Project area is considered low due to human activities. Common reptiles found in the surrounding area are frogs, lizards, crocodiles and snakes. Crocodile is commonly spotted in Sg. Nyalau, especially the downstream part where it is common to see the warning signboard warning the local people of the crocodile. In Sarawak, estuarine crocodile is classified as a protected animal under the Wildlife Protection Ordinance, 1998.

6.3.2.2 Birds

The adjacent oil palm estates are very poor in diversity for birds due to disturbance caused by human activities. These have destroyed natural ecosystems which could provide habitat. Common bird species spotted in the oil palm estate and the surrounding are storks, bulbuls, kingfisher, egrets, swifts, cuckoos and tailorbird. The egrets and kingfishers are protected species under the Wild Life Protection Ordinance 1998.

6.3.2.3 Mammals

In general, mammal density in the surrounding area of oil palm estate is considered low due to the loss of natural habitats. Common mammals known to be found in oil palm estate are wild boar, squirrel, treeshrews, bats and porcupine, which is considered protected species.

6.3.3 FISHERIES

6.3.3.1 Sampling Stations and Coordinates

Fish fauna sampling was carried out in December 2018 at seven (7) stations along Sg. Nyalau (see **Figure 6.3.1**). Station 1 is located at the upstream of the river and Station 7 is near the mouth of the river. The coordinates for each station are shown in **Table 6.3.1**.

Table 6.3.1: Coordinates for the Fish Fauna Sampling Station

Station	Coordinates	Fishing Method	Habitat Description
1.	3° 30' 07.2" N 113° 26' 45.7" E	Three-layered net	Upstream of Sg. Nyalau, at pool area with width of 1- 3 m and depth of 0.2 – 1 m, turbid water and very slow flowing, muddy bottom, semi-shaded, in oil palm plantation. Non-tidal.
2.	3° 30' 28.3" N 113° 27' 34.4" E	Three-layered net	Located downstream of St. 1 with width of 3 – 4 m and depth of 1.5 m, turbid water and slow flowing, muddy bottom, semi-shaded, in oil palm plantation. Non-tidal.
3.	3° 30' 49.5" N 113° 27' 47.9" E	Three-layered net	Located downstream of St. 2, below a pool with width of 2.5 – 3 m and depth of 0.7 – 1.5 m, moderately fast flowing, muddy bottom, mostly shaded by oil palm & shrubs, in oil palm plantation. Non-tidal.
4.	3° 31' 55.7" N 113° 27' 19.0" E	Three-layered net	Located downstream of St. 3, with width of 4 – 5 m and depth of 1 – 2 m, moderately fast flowing, muddy bottom, partially shaded by shrubs, in oil palm plantation. Non-tidal.
5.	3° 36' 34.5" N 113° 25' 14.6" E	Three-layered net & monofilament gill nets	Located downstream of St. 4 at Kg. Hulu Nyalau, above Sg. Perihas (tributary of Sg. Nyalau), with width of 7 – 11 m and depth of 2 – 3 m, muddy bottom, turbid water and slow flowing & exposed river. Secondary vegetation on river banks. Intertidal.
6.	3° 37' 23.0" N 113° 24' 28.7" E	Three-layered net & monofilament gill nets	Located downstream of St. 5 at Tg. Memang, with width of 20 – 30 m and depth of 3 – 4 m, muddy bottom, turbid water, slow flowing & exposed river. Nipah grows on river banks. Intertidal.
7.	3° 38' 19.3" N 113° 23' 27.7" E	Three-layered net & monofilament gill nets	Located near the mouth of Sg. Nyalau, near Kg. Kuala Nyalau, with width of 35 – 45 m and depth of 3 – 5 m, muddy bottom, peat water, slow flowing & exposed river. Nipah grows on river banks. Intertidal.

6.3.3.2 Methodology

Sampling of fish fauna were carried out using two (2) sampling methods, namely three-layered net with mesh sizes of 13.5 cm x 3.5 cm x 13.5 cm and mono-filament gill net with mesh size of 5.08 cm and 6.35 cm. At stations 1 to 4, only three-layered nets were used as the river at these stations is smaller, shallower and have very few places suitable for placing the net. Therefore, the three-layered net was chosen for such sites as this type of net is the most suitable due to its ability to capture fishes of different sizes. At the downstream area where the river is wider and deeper, combinations of three-layered net and mono-filament gill nets were used.

Three-layered net and gill nets were employed in deeper and slower flowing water. They were left in the water for a period of 14 to 22 hours, from 1100 hr to 0900 hr the next day.

Fish species were identified *in-situ* following Inger and Chin (2002), Kottelat *et al.* (1993) and Mohsin and Ambak (1983).

The values for diversity index, richness index and similarity index were calculated for each station based on the following formula below:

Diversity Indexes

Shannon-Weiner Diversity Index (*H*) (Shannon and Weaver, 1963),

$$H = \frac{n \log_e n - \sum f_i \log_e f_i}{n}$$

where n = total number of individuals

f_i = number of individuals in species i, i=1,2,3,…, n

Margalef Richness Index (*D*) (Margalef, 1968),

$$D = \frac{S - 1}{\log_e n}$$

where S = total number of species

n = total number of individuals

Pielou Similarity Index (*J*) (Pielou, 1966)

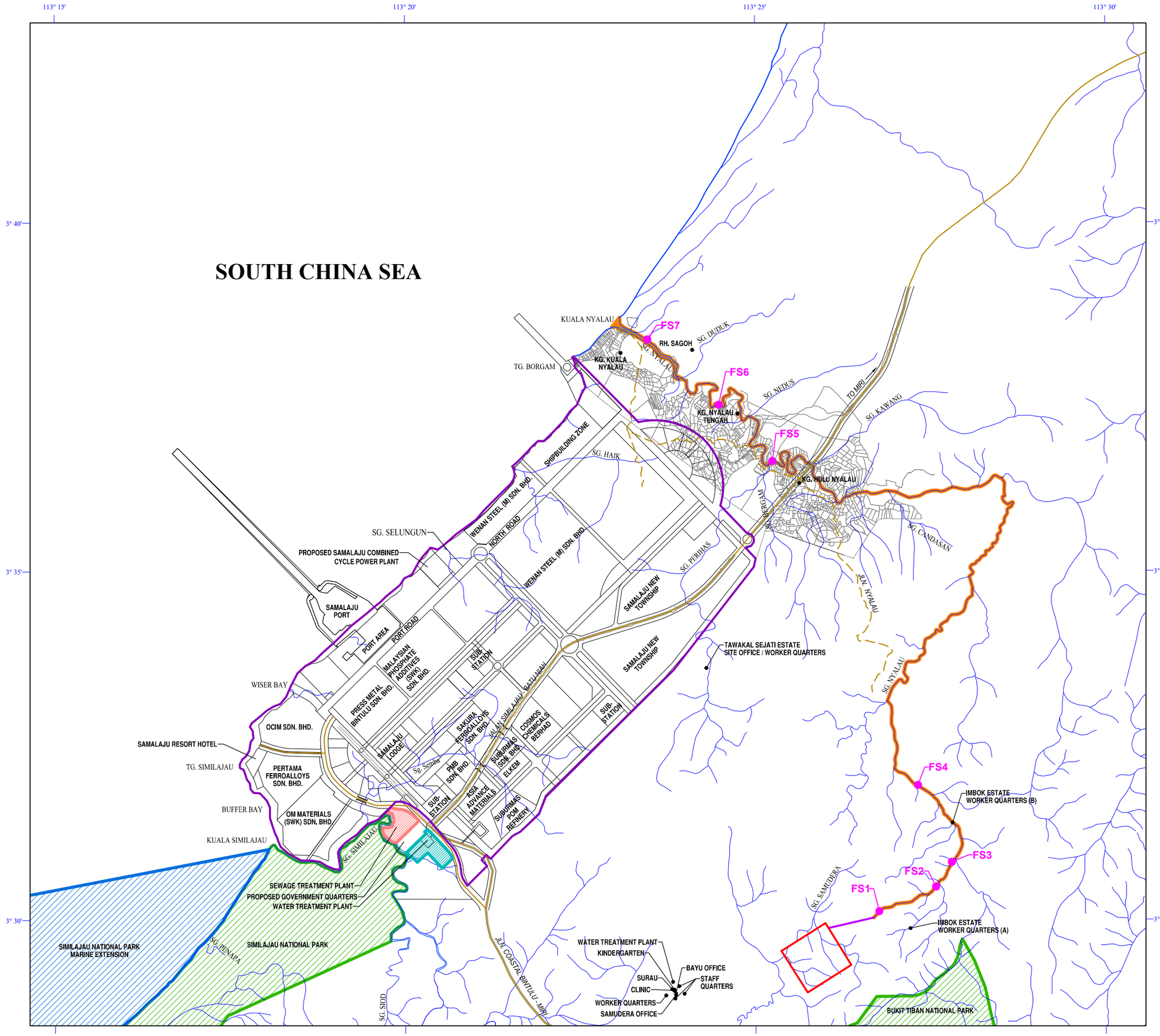
$$J = \frac{H}{\log_e S}$$

where H = diversity of species

S = total number of species

CHEMSAIN KONSULTANT SDN. BHD.

SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT BOUNDARY
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- RIVERS / STREAMS
- AFFECTED RIVER
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT
- FISH FAUNA SAMPLING STATION LOCATIONS - (FS1 - FS7)

N

0 1 2 3 4 5Km

SCALE IN KILOMETRES (1:100,000) – A3 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK

SUAI
SERIES 12
EDITION 2
SHEET 13
SCALE 1:1,125,000

SAMPLING STATION FOR FISH FAUNA AT SUNGAI NYALAU

FIGURE: 6.3.1

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIGURES\FIG-631.DWG

Riverine Fisheries

Field visits to determine the status of riverine fisheries in the study area, especially the stretch of the river between Kg. Hulu Nyalau and Kg. Kuala Nyalau were made in November and December 2018. Commercial fish and crustacean species were caught using three-layered nets and monofilament gill nets place at three stations in the lower stretch of Sg. Nyalau. The intensity of fishing activities was estimated by counting the number of trap nets placed along the river to target freshwater prawn *Macrobrachium rosenberaii* or locally known as udang galah. In addition, questionnaires and interviews were carried out on some of the fishermen in Kg. Nyalau during the study period.

Based on the data collected, a few assumptions made in the estimation of total catch and retail market values of riverine fisheries in Sg. Nyalau were, (i) fishing activities to target prawns were carried out by 12 persons using a total of 300 traps (*derong*) and were carried out for 10 months annually and the traps were checked 10 times per month with a catch of 200 g per trap, (ii) fishing to target prawns using hook and line were carried out by 8 persons with a catch of 1 kg/day for 20 days a month and were carried out for 10 months annually. Mangrove crab were caught by 10 persons using a total of 300 traps and were carried out for 3 times per month for a period of 10 months annually with a catch of 300 g per trap, (iv) gill net to catch *betutu* were carried out by 4 persons with using one net each and were carried out for 3 times per month for a period of months annually with a catch of 30 kg/day, (v) gill net to catch *siakap* and *manchong* were carried out by 3 persons with using one net each and were carried out for 3 times per month for a period of 3 months annually with a catch of 30 kg/day, and (vi) miscellaneous fish species from (vi) were estimated at 10 kg per day.

6.3.3.3 Results

A total of 184 fishes and crustacean were caught from the seven (7) sampling stations. The list of fish and crustacean families and species as well as the number of individuals caught from each of the station is shown in **Table 6.3.2**.

At Station 1, which is located at the upstream of Sg. Nyalau, only 3 fishes were caught comprising 2 families and 2 species (see **Table 6.3.2**). Clariidae is the dominant family comprising 66.7% of the total number of individuals caught. The dominant species is *Clarias teijsmanni*, comprising 66.7% of all total number of individuals caught (see **Table 6.3.3**).

At Station 2, 12 fishes were caught comprising 3 families and 6 species (see **Table 6.3.2**). The dominant family is Cyprinidae and the dominant species is *Barbodes binotatus*, comprising 66.7% and 58.3% of all the number of individuals caught, respectively (see **Table 6.3.3**).

At Station 3, 8 fishes were caught comprising 2 families and 4 species (see **Table 6.3.2**). Both Cyprinidae and Clariidae dominate the station at 50% each. *Clarias teijsmanni* is the dominant species, comprising 50.0% of all the number of individuals caught (see **Table 6.3.3**).

At Station 4, 16 fishes were caught comprising 3 families and 6 species (see **Table 6.3.2**). The dominant family is Cyprinidae and the dominant species is *Barbodes binotatus*, comprising of 81.3% and 37.5% of all the number of individuals caught, respectively (see **Table 6.3.3**).

Forty-five (45) individuals of fishes and crustacean were caught from Station 5, comprising 8 families and 10 species (see **Table 6.3.2**). Palemonidae is the dominant family, comprising 71.1% and *Macrobrachium rosenbergii* is the dominant species, comprising of 68.9% of the total number of individuals caught (see **Table 6.3.3**).

At Station 6, 40 fishes and crustacean were caught comprising 11 families and 12 species (see **Table 6.3.2**). The dominant family is Palemonidae and the dominant species is Macrobrachium rosenbergii, each comprising 47.5% of all the number of individuals caught (see **Table 6.3.3**).

The most number of individuals of fishes and crustacean were caught at Station 7, which is near the mouth of Sg. Nyalau. At this station, 60 individuals were caught, comprising of 7 families and 10 species (see **Table 6.3.2**). The dominant family is Ariddae and the dominant species is Arius maculatus, comprising of 43.3% and 30.0% of all the number of individuals caught, respectively (see **Table 6.3.3**).

The six (6) dominant fish families in the study area are Palaemonidae comprising of 27.7% of the total number of individuals caugh, Ariddae (20.1%), Cyprinidae (15.8%), Sciaenidae (12.5%), Clariidae (4.9%), Engraulidae (2.7%) (see **Figure 6.3.2**). The six (6) dominant species caught are *Macrobrachium rosenbergii* comprising of 27.2%, *Arius maculatus* (15.2%), *Barbodes binotatus* (8.2%), *Dendrophysa russelii* (6.5%), *Nibea soldado* (5.4%), *Arius sagor* (4.9%) and *Clarias teijsmanni* (4.9%) (see **Figure 6.3.3**).

Two (2) species of introduced aquatic species were caught in the study area. One species of fish, *Barbonymus gonionotus* was introduced for aquaculture industry and one species of crustacean *Cherax quadricarinatus* was introduced for aquarium industry.

None of the fish and crustacean species that were caught from the study area are listed as threatened in the 2018 IUCN Red List of Threatened Species (IUCN, 2018).

Table 6.3.2: List of Fish Family, Species and Number of Individuals Caught (N) as well as the Range of Total Length (TL) and Weight (WT) of Each Species Caught at Each Station

Station	Family	Species	N	TL (cm)	WT (g)
1	Cyprinidae	*Barbodes binotatus*	1	10.9	19.2
	Clariidae	*Clarias teijsmanni*	2	15.0	48.8
	2	**2**	**3**		
2	Channidae	*Channa bankanensis*	1	36.4	320.2
		Channa melanopterus	1	31.9	260.0
		Channa pleurophthalma	1	35.2	406.0
	Clariidae	*Clarias teijsmanni*	1	17.7	42.4
	Cyprinidae	*Barbodes binotatus*	7	10.8 – 14.0	19.8 – 38.0
		Hampala macrolepidota	1	21.8	121.0
	3	**6**	**12**		
3	Cyprinidae	*Barbodes binotatus*	1	10.9	19.2
		Barbonymus gonionotus	2	15.0 – 16.4	45.6 – 48.8
		Osteochilus vittatus	1	spoilt	
	Clariidae	*Clarias teijsmanni*	4	22.2 – 30.2	88.7 – 263.5
	2	**4**	**8**		

Station	Family	Species	N	TL (cm)	WT (g)
4	Channidae	*Channa striata*	1	29.5	258.8
	Clariidae	*Clarias teijsmanni*	2	29.4 – 31.0	217.4 – 279.6
	Cyprinidae	*Barbodes binotatus*	6	12.0 – 13.8	22.2 – 39.0
		Barbonymus gonionotus	5	14.9 – 18.0	53.7 – 94.7
		Hampala macrolepidota	1	20.9	87.9
		Osteochilus vittatus	1	14	32.5
	3	**6**	**16**		
5	Ambassidae	*Ambassis* sp.	2	11.4 – 12.4	19.1 – 22.2
	Bagridae	*Hemibagrus planiceps*	1	26.7	168
	Cyprinidae	*Hampala macrolepidota*	1	20.2	82.6
		Osteochilus vittatus	2	13.4 – 23.2	32.8 – 140.0
	Gobiidae	*Glossogobius* sp.	1	26.5	116.0
	Latidae	*Lates calcarifer*	1	51.5	2094
	Megalopidae	*Megalops cyprinoides*	1	33.6	295.6
	Palaemonidae	*Macrobrachium rosenbergii*	31	10.0 – 24.8	15.5 – 216.1
		Macrobrachium sp.	1	10.0	15.5
	Parastacidae	*Cherax quadricarinatus*	4	10.3 – 14.7	26.0 – 73.4
	8	**10**	**45**		
6	Ambassidae	*Ambassis* sp.	1	11.4	17.1
	Ariidae	*Arius maculatus*	10	21.0 – 25.2	95.2 – 139.2
		Arius sagor	1	28.3	218.5
	Carangidae	*Atropus atropus*	1	10.4	23.8
	Engraulidae	*Coilia borneensis*	1	spoilt	7.5
	Gerreidae	*Gerres filamentosus*	2	10.3 – 11.9	16.1 – 23.2
	Latidae	*Lates calcarifer*	1	28.9	174.2
	Sciaenidae	*Panna microdon*	1	15	39.9
	Toxotidae	*Toxotes chatareus*	1	15.8	67.8
	Eleotridae	*Oxyleotris marmorata*	1	31.2	367.7
	Palaemonidae	*Macrobrachium rosenbergii*	19	13.2 – 20.4	20.2 – 76.6
	Scorpaenidae	*Synanceja* sp.	1	11.1	17.9
	11	**12**	**40**		
7	Ambassidae	*Ambassis* sp.	1	10	10.5
	Ariidae	*Arius maculatus*	18	15.2 – 26.5	35.1 – 223.0
		Arius sagor	8	16.4 – 25.7	44.0 – 132.6
	Carangidae	*Carangoides chrysophrys*	3	11.2 – 19.9	15.7 – 110.2
	Engraulidae	*Coilia borneensis*	3	10.9 – 11.5	5.3 – 6.3
		Stolephorus indicus	1	8.4	5
	Gerreidae	*Gerres filamentosus*	2	10.5 – 11.5	20.0 – 24.7
	Pristigasteridae	*Raconda russeliana*	2	15.0 – 15.3	22.7 – 26.2
	Sciaenidae	*Dendrophysa russelii*	12	12.0 – 19.2	18.1 – 80.3
		Nibea soldado	10	14.0 – 18.5	31.4 – 68.4
	7	**10**	**60**		

Table 6.3.3: The Dominant Family and Species Found at Each Station

Station	Family	Percent (%)	Species	Percent (%)
1	Clariidae	66.7	*Clarias teijsmanni*	66.7
2	Cyprinidae	66.7	*Barbodes binotatus*	58.3
3	Cyprinidae/Clariidae	50.0	*Clarias teijsmanni*	50.0
4	Cyprinidae	81.3	*Barbodes binotatus*	37.5
5	Palaemonidae	71.1	*Macrobrachium rosenbergii*	68.9
6	Palaemonidae	47.5	*Macrobrachium rosenbergii*	47.5
7	Ariidae	43.3	*Arius maculatus*	30.0

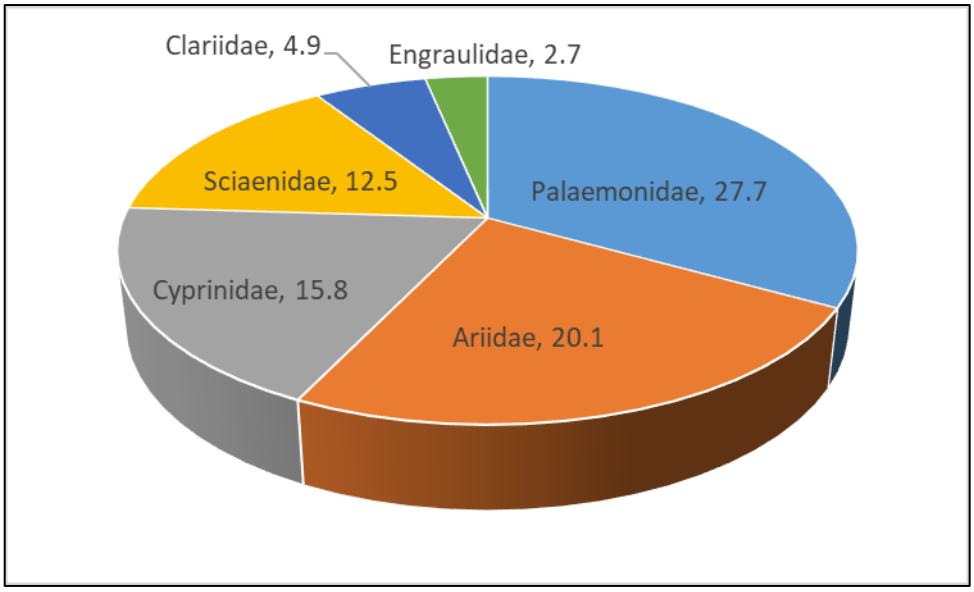


Figure 6.3.2: The Six Dominant Fish Families Caught in the Study Area

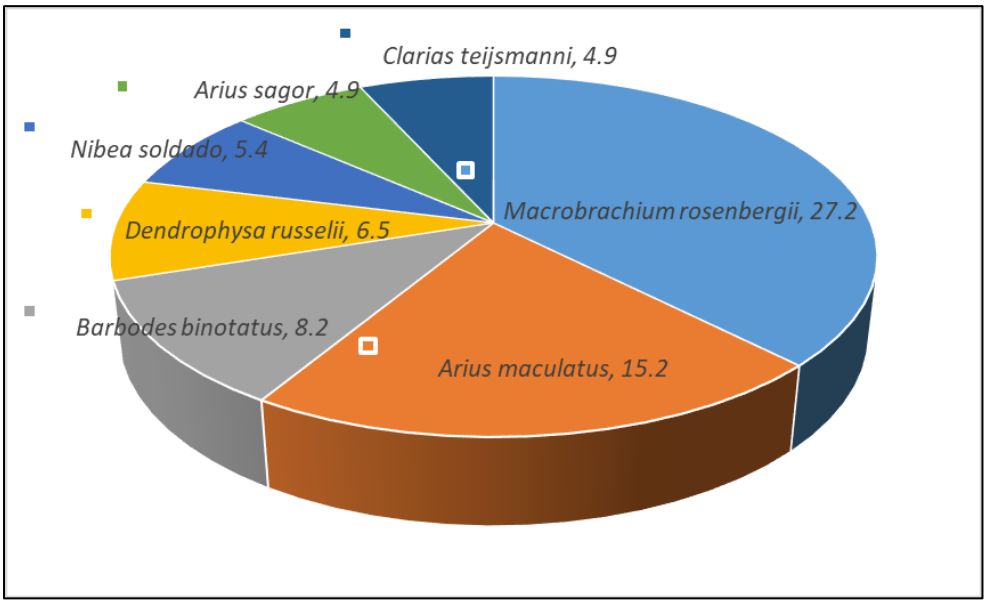


Figure 6.3.3: The Six Dominant Fish Species Caught in the Study Area

Indices

In the study area, the values of species diversity index (H') ranged from 0.64 at Station 1 to 1.91 at Station 7, richness index (D) ranged from 0.91 at Station 1 to 2.98 at Station 6, and evenness index (J) ranged from 0.55 at Station 5 to 0.92 at Station 1 (see **Table 6.3.4**).

Overall, diversity and richness indices were lowest at all the stations inside the oil palm plantation but increases at stations located downstream of the river. The low diversity at Station 4 is likely due to the fish kill reported to occur sometime in July 2018, due to reportedly input of large amount of effluent from the palm oil mill retention pond (Local communities, personal communication).

Table 6.3.4: The Values of Species Diversity (H'), Richness (D) and Evenness (J) Recorded from All the Study Stations

Station	H (e)	D (e)	J (e)
1	0.64	0.91	0.92
2	1.35	2.01	0.75
3	1.21	1.44	0.88
4	1.51	1.80	0.84
5	1.26	2.36	0.55
6	1.68	2.98	0.68
7	1.91	2.20	0.83

6.3.3.4 Riverine Fisheries

In Sg. Nyalau, riverine fisheries are important activities for some of the communities from Kg. Hulu Nyalau, Kg. Tengah Nyalau and Kg. Kuala Nyalau. Some people from these villages fish in Sg. Nyalau and the number increases when it is not possible to fish in the sea during the bad weather.

The fishing methods employed in Sg. Nyalau are shown in **Table 6.3.5**. The popular fishing methods are trap for freshwater prawn *Macrobrachium rosenbergii* locally known as *derong*, trap for mangrove crab (*bintur*), trap made from bamboo to target *betutu Oxyeleotris marmorata* and hook and line to catch freshwater prawn. In addition, during rough sea s, gill nets are also used where they are placed closed to the nipah palms along the selected stretch of the river banks to target *betutu Oxyeleotris marmorata*. When gill nets are place across the river, the targeted fish species are barramundi (*Lates calcarifer*) and Indian threadfin (*Leptomelanosoma indicum*).

Occasionally, when the dry season is longer and the water is clearer, spear fishing is also used to catch freshwater prawn *Macrobrachium rosenbergii*.

Table 6.3.5: Fishing Methods used in Sg. Nyalau

Fishing Methods	Local Name	Target Species
Trap	*Derong*	Freshwater prawn (*Macrobrachium rosenbergii*)
Trap	*Bintur*	Mangrove crab (*Scylla* spp.*)*
Trap	*Bubu*	Sleepers (*Oxyeleotris marmorata*)
Hook & Line	*Pancing*	Freshwater prawn (*Macrobrachium rosenbergii*)
Gill net (along bank)	*Pukat*	Sleepers (*Oxyeleotris marmorata*)
Gill net (across river)	*Pukat*	Barramundi (Lates calcarifer), Indian threadfin (*Leptomelanosoma indicum*)
Spear fishing	*Timbak udang*	Freshwater prawn (*Macrobrachium rosenbergii*)

The three main targeted commercial species in Sg. Nyalau are freshwater prawn *Macrobrachium rosenbergii*, sleepers *Oxyeleotris marmorata* and mangrove crab *Scylla* spp. (see **Table 6.3.6**).

Table 6.3.6: The Three Main Commercial Fish and Crustacean Species Caught from Sg. Nyalau

Commercial Species	Local Name
Macrobrachium rosenbergii	Udang galah
Oxyeleotris marmorata	Betutu
Scylla spp.*	Ketam bakau

** targeted species but not caught during this study*

Fish and crustacean caught are not only an important source of food and protein but also as a source of income to those fishermen. For instance, some of those fishing using hook and line are housewives. Most of the fish and crustacean caught are sold to the middlemen who come to purchase the fish and crustacean three times a week, which is on Monday, Wednesday and Friday. The price of fish and crustacean at Kg. Nyalau is shown in **Table 6.3.7**.

Table 6.3.7: Prices of Fish and Crustacean at Sg. Nyalau

Species	RM/kg
Macrobrachium rosenbergii (large size)	60
Macrobrachium rosenbergii (mix sizes)	50
Oxyeleotris marmorata	30 – 50
Scylla spp.*	20 – 30

Based on the assumptions earlier, the annual estimated value for freshwater prawn was RM319,000, mangrove crab was estimated annually at RM70,500, betutu was estimated annually at RM27,000, siakap and manchong were estimated annually at RM15,300 and other species were estimated at RM437,700.00 per annum.

Plate 6.67: Placing 3-layered net at Station 1

Plate 6.68: *Derong* (trap for freshwater prawn)

Plate 6.69: View of Station 3

Plate 6.70: *Clarias teijsmanni*

Plate 6.71: View at Station 5

Plate 6.72: *Channa striata*

Plate 6.73: Placing net at Station 7

Plate 6.74: *Lates calcarifer*

Plate 6.75: *Macrobrachium rosenbergii*

Plate 6.76: *Hampala macrolepidota*

Plate 6.77: *Oxyeleotris marmorata*

Plate 6.78: *Cherax quadricarinatus*

Plate 6.79: *Toxotes chatareus*

Plate 6.80: Middleman purchasing fish and prawn at the jetty of Kg. Tengah Nyalau

6.4 Human Environment

6.4.1 REGIONAL POPULATION PROFILE

The proposed Project site is located in Bintulu District (under Bintulu Division), Sarawak. The population of Bintulu Division was 212,994 people in 2010[1], as compared to 162,253 in 2000. This implies a growth rate of 32% over the period of 10 years (2000 to 2010). Over the same period, the overall population density has also increased from 13 persons/km^2 to 18 persons/km^2 (see **Table 6.4.1**).

Table 6.4.1: Population Characteristics of Bintulu Division

Year	District	Population		Population Density (Persons/km^2)		Average Annual Growth Rate	
		District	Divisional	District	Division	District	Divisional
1991	Bintulu	86,132	107,256	12	9	6.4	6.0
	Tatau	21,124		4		4.8	
2000	Bintulu	139,012	162,253	19	13	5.3	4.6
	Tatau	23,241		5		1.1	
2010	Bintulu	183,402	212,994	25	18	2.8	2.7
	Tatau	29,592		6		2.4	

Source: Dept. of Statistics, 2000, 2003 and 2010

The growth of Bintulu over the past 20 years have been attributed to the development of various oil and gas related industries which have drawn many people from other parts of the division, Sarawak, Malaysia and abroad. This growth is expected to continue as Bintulu plans to be elevated to city status by 2020, with a target population of 300,000 people.

6.4.2 ETHNICITY, RELIGION, GENDER STRUCTURE AND HOUSEHOLD

Table 6.4.2 summarises the ethnic distribution in Bintulu Division in year 2010. Ibans are the dominant ethnic group in Bintulu Division, accounting for 43% of the total population, similar with the rest of Sarawak. This is followed by the Chinese (15%), Malays (10%) and Melanau (9%). Malaysian citizens accounts for 85% of the population in the Division, while the remaining 15% are non-citizens, the vast majority being foreign workers of Indonesian origin.

In Malaysia, religion is strongly correlated with ethnicity, a pattern that also applies to Sarawak and Bintulu. Christianity is dominant which is mostly followed by the Ibans. In 2000, 42.5% of Sarawak's population was Christians where majority of them were Bumiputras. All of the Malays in Sarawak are Muslims, which is the second dominant religion in the State.

[1] *Department of Statistics, Malaysia. 2010. Population Distribution by Local Authority Areas and Mukims, 2010*

Table 6.4.2: Ethnic Groups and Gender Distribution of Bintulu Division, 2010

Ethnic Group	Bintulu District		Tatau District		Total	
	Population	%	Population	%	Population	%
Bumiputera						
Malay	20,036	10.9%	959	3.2%	20,995	9.9%
Iban	72,809	39.7%	18,176	61.4%	90,985	42.7%
Bidayuh	2,225	1.2%	135	0.5%	2,360	1.1%
Melanau	17,029	9.3%	1,547	5.2%	18,576	8.7%
Other Bumiputera	11,421	6.2%	3,025	10.2%	14,446	6.8%
Non-Bumiputera						
Chinese	30,831	16.8%	1,520	5.1%	32,351	15.2%
Indians	430	0.2%	38	0.1%	468	0.2%
Others	728	0.4%	189	0.6%	917	0.4%
Non-Malaysian Citizens	27,893	15.2%	4,003	13.5%	31,896	15.0%
Total	**183,402**	**100%**	**29,592**	**100%**	**212,994**	**100%**

Source: Dept. of Statistics, 2010

Table 6.4.3 summarises the gender distribution of Bintulu. Bintulu has a dominant male population, with a gender ratio of 118 male for every 100 females. The higher number of male in Bintulu District may be due to the industrial nature of employment in the area.

Table 6.4.3: Gender Distribution and Households of Bintulu, 2010

Division	Male	Female	Total	Ratio	Households	Household Size
Bintulu District	99,489	83,913	183,402	119	40,222	5
Tatau District	15,714	13,878	29,592	113	7,064	4
Total	**115,203**	**97,791**	**212,994**	**118**	**47,286**	**5**

Source: Dept. of Statistics, 2010

Bintulu Division reported a total number of 47,286 in 2010, of which 40,222 households reside in Bintulu District. The average household size was five, slightly higher than the State's average of four.

6.4.3 AGE STRUCTURE AND LABOUR FORCE

Table 6.4.4 and **Figure 6.4.1** provide the age structure of the population Bintulu Division for 2010. Approximately 29% of the population of Bintulu falls into the age group of 15 and below, and is typical of a growing population. The Division has the greatest proportion of persons between age 15-64 age group (68%) while only 3% fall within the age group 65 year old and above.

The dependency ratio is the ratio of the number of persons falling in the age groups of 15 years and below and 65 years, compared to the number of persons in the working age group 15-64 years. The dependency ratio for Bintulu is 47.3 per 100 persons.

Table 6.4.4: Age Structure of Sarawak and Bintulu, 2010

Age Group	Bintulu Division	%	Bintulu District	%	Tatau District	%
0-4	18,199	9%	15,793	9%	2,406	8%
5-9	22,471	11%	18,808	10%	3,663	12%
10-14	20,862	10%	18,422	10%	2,440	8%
15-19	20,616	10%	18,029	10%	2,587	9%
20-24	24,844	12%	21,135	12%	3,709	13%
25-29	22,970	11%	20,003	11%	2,967	10%
30-34	16,993	8%	14,950	8%	2,043	7%
35-39	16,736	8%	15,090	8%	1,646	6%
40-44	13,547	6%	11,990	7%	1,557	5%
45-49	11,602	5%	9,340	5%	2,262	8%
50-54	7,935	4%	6,754	4%	1,181	4%
55-59	5,284	2%	4,424	2%	860	3%
60-64	4,063	2%	3,251	2%	812	3%
65-69	2,649	1%	2,086	1%	563	2%
70-74	1,675	1%	1,326	1%	349	1%
75 and above	2,548	1%	2,001	1%	547	2%
Total	**212,994**	**100**	**183,402**	**100**	**29,592**	**100**

Source: Dept. of Statistics, 2010

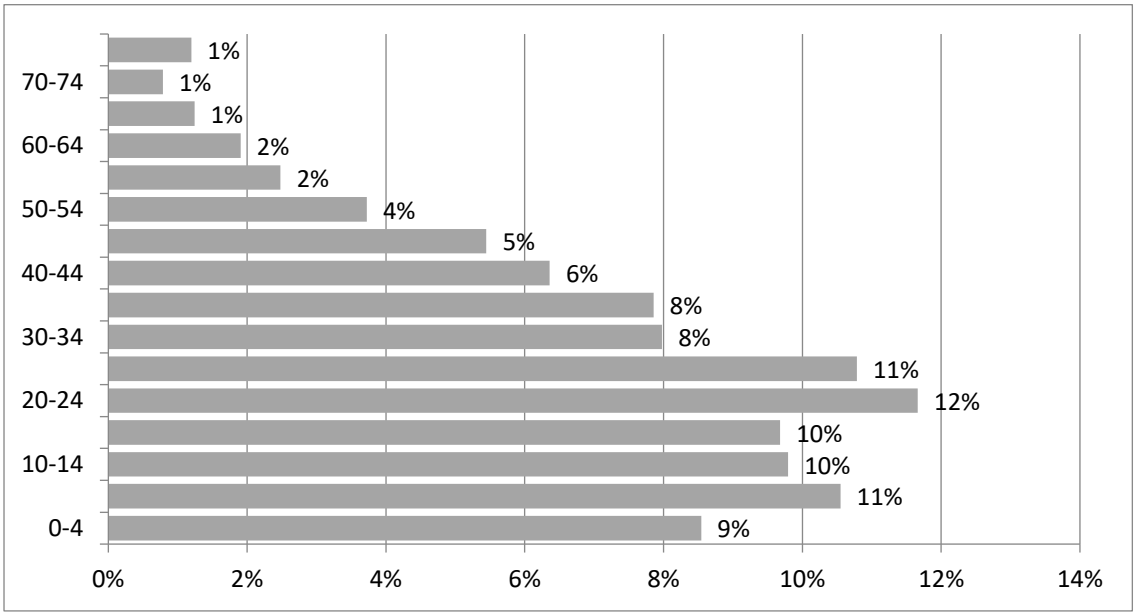


Figure 6.4.1: Age Structure (%) of Bintulu Division, 2010

Bintulu District had a labour force population of 19,718 in year 2005, of which 70% (13,841) of them were male (see **Table 6.4.5**).

Table 6.4.5: Labour Force Population, 2005

Gender	Total Labour Force
Male	13,841
Female	5,877
Total	**19,718**

Source: Bintulu Development Authority, 2005

6.4.4 ECONOMY

Manufacturing is Bintulu's main source of revenue and the largest sector in the Division (48.3%), followed by agriculture, forestry, livestock and fishing (41%), and construction sectors (7.2%). **Table 6.4.6** provides a summary of the main economic contribution by sector in Bintulu.

Most of these heavy industries are situated at Tg. Kidurong and in recent years at SIP. It is envisioned that these industries will continue to draw more people to Bintulu and contribute to the population expansion.

Following the opening up of land along the Bintulu-Miri Road in the mid 1970s and the new coastal road, large-scale plantations, especially for oil palm, have been developed.

Table 6.4.6: Labour Force Based on Sector, 2005

Sector	Total Labour Force			
	Local	Foreign	Grand Total	%
Agriculture, Forestry, Livestock & Fishing	5,209	13,707	18,707	41.0
Mining & Quarrying	23	12	35	0.1
Manufacturing	4,438	17,634	22,072	48.3
Electricity, Gas & Water Services	0	0	0	0
Construction	1,768	1,509	3,277	7.2
Wholesale, Retail, Restaurants & Hotels	383	186	569	1.2
Transport, Storage & Communication	642	9	651	1.4
Finance, Insurance, Real Estate & Business Services	163	7	170	0.4
Community Services, Social and personal	143	45	188	0.4
Total	**12,769**	**33,109**	**45,669**	**100**

Source: District Office Bintulu, 2005

Although fishery was once an important economic activity of Bintulu, its significance has declined considerably due to rapid development in the oil and gas industries. Fishery remains significant to the villagers living in the coastal area especially along the coast of Bintulu as well as some of the nearby coastal rivers. According to the Fisheries Department, generally the drop of marine fish landings was due to the reduction in numbers of fishermen and fishermen are not willing to fish further offshore due to the high cost of diesel.

6.4.5 INFRASTRUCTURE, SOCIAL AMENITIES, FACILITIES AND SERVICES

Bintulu is well provided for in terms of basic infrastructures and amenities. Infrastructure and amenities include treated water supply (Lembaga Air Kawasan Utara – LAKU), electricity supply (SESCO), sewage management (BDA), telecommunication facilities (Telekom Malaysia Berhad and others), solid waste management (BDA), drainage, roads, postal services, shops, markets, educational facilities, religious centres, community halls, health services, public transport, sports and recreational areas.

Air service connects Bintulu with all major towns in Malaysia. The airport is of international standard and is located about 24 km south of the town of Bintulu. The airport provides direct air linkages with major cities including Kuching, Kuala Lumpur, Kota Kinabalu, Singapore, Manila and Jakarta.

6.4.5.1 Existing Road Network

The Project site is located within the Samudera Estate of Rajawali/ Derawan oil palm complex and is accessible by the plantation road, linking to the Bintulu-Miri Coastal Road. Bintulu-Miri Coastal Road traverses along the coastline and commences from Tg. Kidurong in Bintulu and ends at Tg. Lobang at the northern end of Jalan Bakam in Miri. For ease of reference, Bintulu-Miri Coastal Road is referred as 'Coastal Road' hereinafter in this report.

This Coastal Road forms a T-junction with the tar-sealed Site Access Road south of the Project site. In this report, the Coastal Road is divided into two sections, i.e. 'Coastal Road (North) representing the northern section and 'Coastal Road (South)' representing the southern section of the Coastal Road from the T-junction.

The total length of this Coastal Road (North) is approximately 180 km and with the exception of the last 10 km of the road which is a four-lane divided carriageway, the road is of tar-sealed two-lane single carriageway. This existing Site Access Road is about 6.5 km in length. The road which leads directly to the Project Site is a two-lane tar-sealed road that forms a T-junction with the existing Site Access Road. Coastal Road (North) have a road reserve of 200 m.

Coastal Road (South) is approximately 49 km long and is a tar-sealed two-lane single carriageway. Two overtaking/climbing lanes section are located at this road. The coastal road (south) also caters to entries to adjacent several palm oil plantations, a few heavy machinery warehouses as well as a gas plant which is under construction.

6.4.6 EXISTING LAND USES

6.4.6.1 Existing Land Uses within 5 km of Project Site

The proposed Project site is located within the Samudera Estate of Rajawali/ Derawan oil palm complex. The land uses surrounding the Project site are mostly oil palm plantation (refer to **Figure 6.4.2**). The immediate surrounding to the Project site are mainly occupied by oil palm plantation under Sime Darby Plantation Sdn Bhd.

To the south and southeast of the Project site is Bukit Tiban National Park which is approximately 1.1 km away. To the east and northeast of the Project site is the oil palm plantation operated by Imbok Enterprise Sdn Bhd. To the further east, about 3 km away, is the area under license planted forest (LPF/0002), operated under Zumida Sdn Bhd. To the north of the Project site is another oil palm plantation operated by Tawakal Sejati Sdn Bhd. A rock quarry is also found at about 3.0 km to the south of the site.

The list of the land uses found within the 5 km radius from the Project site is summarised in **Table 6.4.7**.

Table 6.4.7: List of Land Uses Found Within 5 km Radius of the Project Site

No.	Type of Land Uses	Owner	Approximately Distance / Direction
1.	Bukit Tiban National Park	-	1.1 km southeast
2.	Imbok Estate Workers' Quarter (A)	Imbok Enterprise Sdn Bhd	2.3 km east
3.	License planted forest (LPF/0002)	Zumida Sdn Bhd	3 km east
4.	Rock quarry	Unknown	3 km south
5.	Samudera Estate Workers' Quarter	Sime Darby Plantation Sdn Bhd	3.1 km west
6.	Imbok Estate Workers' Quarter (B)	Imbok Enterprise Sdn Bhd	4.3 km northeast
7.	Damai Estate Workers' Quarter	Sime Darby Plantation Sdn Bhd	5.0 km southwest

Plate 6.81: Workers' quarter (A) close to W2, within Imbok Estate

Plate 6.82: Samudera Estate site office

Plate 6.83: Samudera Estate workers' quarters

Plate 6.84: Samudera Estate water treatment plant

6.4.6.2 Existing Land Uses within 5 – 15 km of Project Site

The existing land uses further from the Project site are made up of oil palm plantations, industrial activities, infrastructures, Similajau National Park and the local villages. Suburmas Plantation Sdn Bhd is located about 6.4 km northwest of the Project site while Tawakal Sejati Estate workers' quarter is located about 7.5 km north of the Project site.

SIP is located about 9 km northwest of the Project site and the prominent activities within the SIP are OCIM Sdn Bhd, Pertama Ferroalloys Sdn Bhd, OM Materials (SWK) Sdn Bhd, Press Metal Bintulu Sdn Bhd, Sakura Ferroalloys Sdn Bhd, etc. Samalaju Eco Park, which is part of the Samalaju New Township, is located about 9.4 km northwest of the Project site. The other area of the Samalaju New Township is currently being constructed.

Similajau raw water intake point is located about 9.2 km northwest of the Project site. The river water will be pumped to the water treatment plant which located about 10 km northwest of the Project site, for treatment. The treated water will be supplied to SIP and the surrounding area.

On the southwest side of the Samalaju Industrial Park is the Similajau National Park (10.3 km northwest of the Project site). The boundary of the National Park is separated by the Sg. Similajau

from the SIP. The National Park covers an area of 8,996 hectares starting from Sg. Likau in the south and stretches about 30 km to Sg. Similajau in the north.

To the further north of the Project site, approximately 11 km, are the villages of Kg. Kuala Nyalau, Kg. Tengah Nyalau, Rh. Sagoh and Kg. Hulu Nyalau. Kg. Kuala Nyalau, Kg. Nyalau Tengah and Kg. Hulu Nyalau are made up of the Kedayan community while Rh. Sagoh is an Iban community. Among the various village facilities are two primary schools, a public clinic and library. Each of the village is served with a community hall and place of worship (*surau*).

The list of the land uses found within the 5 km to 15 km radius from the Project site is summarised in **Table 6.4.8**.

Table 6.4.8: List of Land Uses Found Within 5 – 15 km Radius of the Project Site

No.	Type of Land Uses	Approximately Distance / Direction
1.	Suburmas Oil Palm Plantation	6.4 km northwest
2.	Tawakal Sejati Estate Workers' Quarter	7.5 km north
3.	Samalaju Industrial Park (SIP)	9 km northwest
4.	Similajau Raw Water Intake Point	9.2 km northwest
5.	Samalaju Eco Park (Samalaju New Township)	9.4 km northwest
6.	Samalaju Water Treatment Plant	10 km northwest
7.	Similajau National Park	10.3 km northwest
8.	Kg. Hulu Nyalau	11.2 km north
9.	Samalaju Lodge	11.8 km northwest
10.	Kg. Tengah Nyalau	13.1 km north
12.	Rh. Sagoh	15.8 km north
13.	Kg. Kuala Nyalau	16.4 km north

Plate 6.85: Suburmas Palm Oil Mill Sdn Bhd

Plate 6.86: Tawakal Sejati Estate workers' quarter

Plate 6.87: Samalaju water treatment plant

Plate 6.88: Samalaju Eco Park (Samalaju New Township)

Plate 6.89: Imbok Estate site office

Plate 6.90: Kg. Hulu Nyalau

Plate 6.91: Kg. Kuala Nyalau

Plate 6.92: Rh. Sagoh

Plate 6.93: SK Kg. Nyalau

Plate 6.94: SK Kuala Nyalau

Plate 6.95: Surau at Kg. Tengah Nyalau

Plate 6.96: Klinik Kesihatan Nyalau

Plate 6.97: Similajau National Park

6.4.6.3 Nearest Environmentally Sensitive Receptors

For human environment and social aspects of the impact assessment, the EIA assessment will focus on the identified potential nearest environmentally sensitive receptors around the Project site. The list of receptors, distances and location from the Project site are outlined in **Table 6.4.9** and shown on **Figure 6.4.2**.

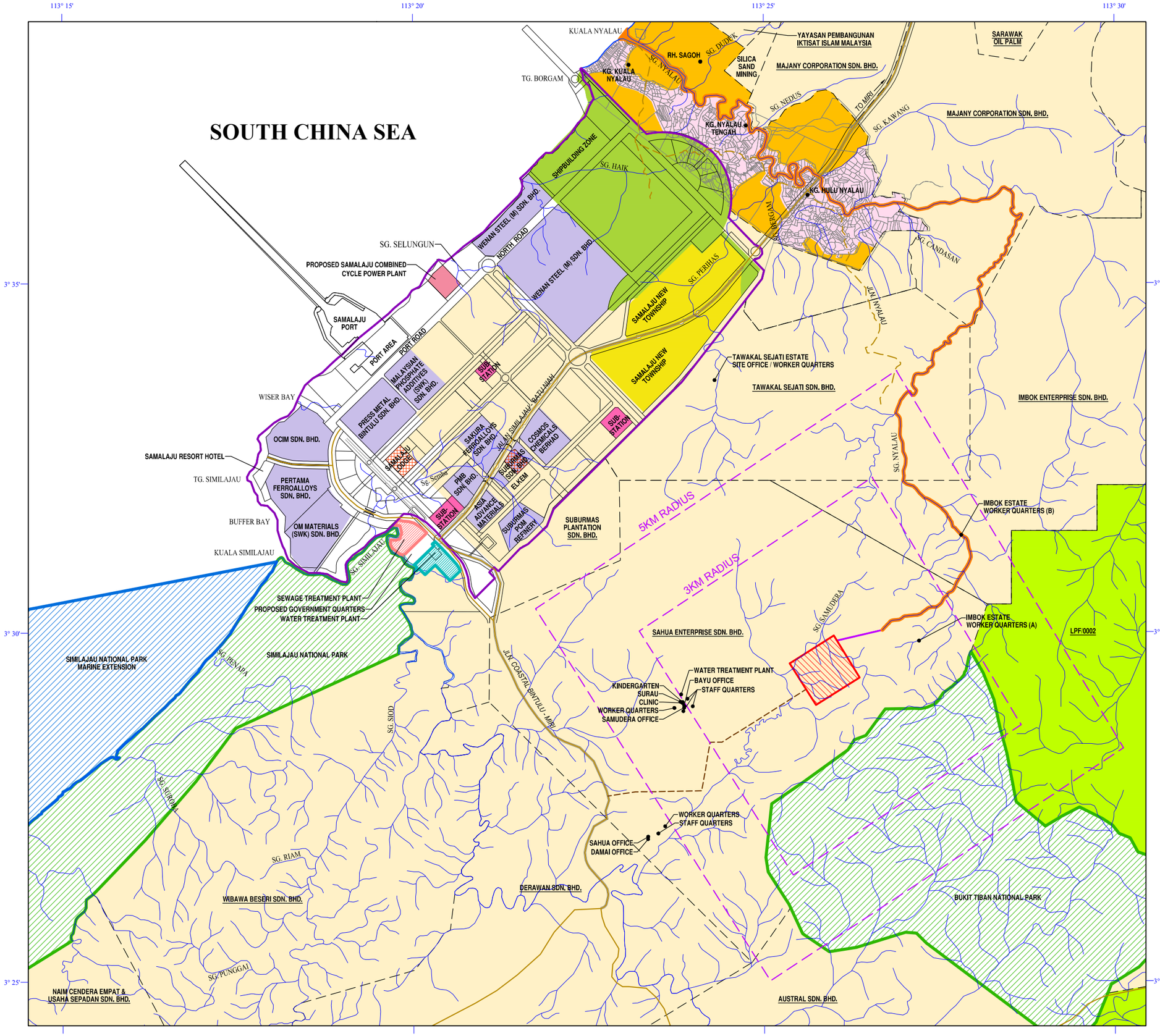
Table 6.4.9: Nearest Environmentally Sensitive Receptors

No.	Distance	Sensitive Receptor	Direction from Project Site
1	2.3 km	Imbok Estate Workers' Quarter (A)	East
2	3.1 km	Samudera Estate Workers' Quarter	West
3	4.3 km	Imbok Estate Workers' Quarter (B)	Northeast
4	5.0 km	Damai Estate Workers' Quarter	Southwest
5	11.2 km	Kg. Hulu Nyalau	North
6	13.1 km	Kg. Tengah Nyalau	North
7	15.8 km	Rh. Sagoh	North
8	16.4 km	Kg. Kuala Nyalau	North

There are four settlements downstream of Sg. Nyalau from the proposed discharge point, namely Kuala Nyalau, Nyalau Tengah, Hulu Nyalau and Rumah Sagoh. The first three villages are made up of Kedayan community while the fourth is an Iban community. These villages are located about 11-16 km (straight line distance) away north of the Project site. Kg. Hulu Nyalau, being the upper most village from the river mouth, is about 30 km downstream from the proposed discharge point from the Project site. The river is currently being used by some local household for fishing and transportation. Detailed descriptions of these four communities are outlined in **Section 6.4.7**.

CHEMSAIN KONSULTANT SDN. BHD.

SECOND SCHEDULE ENVIRONMENTAL IMPACT ASSESSMENT (EIA) FOR THE PROPOSED INTEGRATED WASTE MANAGEMENT SYSTEM (IWMS) IN SAMALAJU, BINTULU, SARAWAK



LEGEND:

- PROJECT SITE
- PROPOSED HDPE TREATED LEACHATE DISCHARGE PIPELINE
- NATIONAL PARK
- SIMILAJAU NATIONAL PARK MARINE EXTENSION
- RIVERS / STREAMS
- AFFECTED RIVER
- MAIN ROAD/ COSTAL ROAD
- ACCESS ROAD TO VILLAGES
- PROPOSED ACCESS ROAD (BY OTHERS)
- SAMALAJU INDUSTRIAL PARK BOUNDARY
- CULVERT
- OIL PALM PLANTATION
- INDUSTRIAL AREA
- NEW TOWNSHIP
- LAND CURRENTLY IDENTIFIED AS STATED LAND
- AREA UNDER LICENCE PLANTED FOREST (LPF)
- MIXED DIPTEROCARP / LOGGED OVER SECONDARY FOREST AND REGROWTH
- SENSITIVE RECEPTOR WITHIN 5KM INFLUENCE ZONE FOR THE PROJECT
- SETTLEMENTS AREA FOR KAMPUNG KUALA NYALAU, KAMPUNG NYALAU TENGAH, KAMPUNG HULU NYALAU, RUMAH SAGOH, FARMING AGRICULTURE ACTIVITY

N

0 1 2 3 4 5Km

SCALE IN KILOMETRES (1:100,000) – A3 MEDIUM

GRID
–The outer ticks indicate the Latitude and Longitude

SOURCE :

- TRIENEKENS (SAMALAJU) SDN. BHD.
- LAND AND SURVEY DEPARTMENT, SARAWAK
  SUAI
  SERIES 12
  EDITION 2
  SHEET 13
  SCALE 1:1,125,000

EXISTING LAND USE

FIGURE: 6.4.2

D:\ACAD\DRAWINGS\EV103\720\720(1)\FIG-642.DWG

6.4.7 PROFILE OF THE NYALAU COMMUNITY

For the purpose of this study, the socioeconomic survey was carried out for Nyalau communities i.e. potential sensitive receptors, due to their connection to Sg. Nyalau. Nyalau communities are made of Kg. Kuala Nyalau, Kg. Tengah Nyalau, Kg. Hulu Nyalau and Rh. Sagoh. These communities are located about 11-16 km to the north of the Project site. Sg. Nyalau is currently used by some households for fishing, transportation, bathing/ washing and crop watering.

The information regarding the villages or the Project's surrounding areas were gathered in key-informant interviews (i.e. interviews with the heads of village), household survey and during social dialogue. A sample of village information gathering form can be found in **Appendix 6.4.1** (Borang Maklumat Kampung).

6.4.7.1 Settlements

The list of villages/ settlements found in Nyalau is shown in **Table 6.4.10**. Kg. Kuala Nyalau, Kg Tengah Nyalau and Kg Hulu Nyalau are Kedayan majority villages while Rh. Sagoh, is an Iban longhouse community,

Table 6.4.10: **List of Settlements, Estimated Population, Main Ethnic and Religion**

Settlement	Doors	Est. Population	Main Ethnic	Main Religion
Kg Kuala Nyalau	102	241	Kedayan	Islam
Kg Tengah Nyalau	18	114	Kedayan	Islam
Kg Ulu Nyalau	120	400	Kedayan	Islam
Rh Sagoh	21	167	Iban	Kristian

Source: Field data, 2019

Kg. Kuala Nyalau was first established in the Nyalau area, followed closely by Kg. Hulu Nyalau while Kg. Nyalau Tengah and Rh. Sagoh are relatively young villages.

6.4.7.2 Economic Activities

People living in the nearby villages are mostly farmers. They are involved in various types of small-scale agriculture activities, both for cash generation and subsistence purposes. Oil palm is the most important cash crop among rural households. Other crops include coconut palms, fruit trees (banana, papaya, rambutan, mangoes and durian), vegetables (ensabai, terung asam, tapioca leaves), roots (tapioca, taro, sweet potato) and herbs (ginger, turmeric, lemongrass, basil). Other than oil palm fruits, farm produces are mainly for own consumption although extra produces are sold by the farmers at village stalls, farmer markets (locally known as tamu) or sold to middlemen.

There are also some households who are involved in small-scale fishing, especially those of Kg Kuala Nyalau. Fishing activities are normally carried out near coastal and estuarine areas (including Sg. Nyalau), and during favourable weather. Catches are either sold in the village or processed into valuable products such as fish crackers and shrimp paste (belacan). Kg. Kuala Nyalau is known for its good quality shrimp paste, which fetches high price at local markets. Some young people work

in civil service (schools, government offices) in Bintulu Town, other places in the Bintulu District or other districts/divisions. A few locals work at the nearby SIP and oil palm plantations.

Other economic activities include livestock keeping and collecting jungle produces. Livestock keeping is a minor economic activity among rural households which is confined to backyard scale of poultry and small ruminants. Livestock keeping is carry out as part-time activity, mostly for subsistent needs. Some households also involve in collecting jungle produces especially wild vegetables (e.g. fern shoots, palm/rattan shoots) for own consumption as well as for sell. A few households operate small grocery/village shops and stalls selling basic necessities as well as fresh fishes/seafood and vegetables in their villages.

Those who are working and living at SIP (i.e. at Samalaju Lodge and Samalaju New Township), or commuters from outside are mostly workers of the industries, many are foreigners (including expatriates). Their incomes are from employments in the industries.

6.4.7.3 Social Institution

Every village has its own village council called the Village Development and Security Committee (locally known as Jawatankuasa Keselamatan dan Kemajuan Kampung, JKKK). The committee comprises the elected villagers and chaired by the head of village or Ketua Kaum/ Tuai Rumah. The council holds meetings to discuss matters pertaining to village security, development activities or anything related to the village. The organisation helps to enhance security and also facilitates social developments/activities at the villages.

6.4.7.4 Infrastructures and Utilities

The infrastructure and utilities in the villages are summarised in **Table 6.4.11**.

Table 6.4.11: Summary of Available Physical and Public Infrastructure

Utilities	Kg. Kuala Nyalau	Kg. Tengah Nyalau	Kg. Hulu Nyalau	Rh. Sagoh
Drinking Water Supply	Rain and piped water (JKR)	Rain and piped water (JKR)	Rain and piped water (JKR)	Rain water
Power	SESCO	SESCO	SESCO	Generator
Transportation	Tar-sealed road	Tar-sealed road	Tar-sealed road	Plantation road River – boat
Telecommunication	Cellular	Cellular	Cellular	Cellular
Primary School	SK Kuala Nyalau	SK Kuala Nyalau	SK Kg. Nyalau	SK Kuala Nyalau
Clinic	KK Nyalau	KK Nyalau	KK Nyalau	KK Nyalau
Community Facilities	Community hall, library, surau	Community hall, surau	Community hall, surau	Not available
Recreational	Football field	NA	Football field/court and badminton court	Not available
Shops/ Commercials	Sundry shop/stalls	Sundry shop	Sundry shop/stalls	Not available

Utilities	Kg. Kuala Nyalau	Kg. Tengah Nyalau	Kg. Hulu Nyalau	Rh. Sagoh
Burial Ground	Communal burial ground at Kg. Kuala Nyalau			Rh. Sagoh burial ground
Sewerage	Flush and pour flush	Flush and pour flush	Flush and pour flush	Pour flush
Waste Disposal	Open burning and burial	Open burning and burial	Open burning and burial	Open burning and burial
Most needed infrastructure and facilities	Telephone line	Telephone line	Telephone line	Treated water Electricity Road

6.4.7.4.1 Accessibility

All the villages are accessible by the Bintulu-Miri Coastal Road, which is also the main road serving the area. Kg. Hulu Nyalau is located adjacent to the coastal road. Kg. Tengah Nyalau is approximately 2 km further away towards the coast and is accessible by tar-sealed road branching off from the Coastal Road. The same road also links to Kg. Kuala Nyalau, which is located near the coast at Sg. Nyalau river mouth. Rh. Sagoh is accessible by plantation road (Maharani OPP) from the coastal road or by boat from Kg. Kuala Nyalau and Kg. Hulu Nyalau.

6.4.7.4.2 Water Supply

Treated piped water (JBALB) is connected to all the villages except for Rh. Sagoh. Rh. Sagoh relies on rainwater as its main drinking water supply. Some household from Rh. Sagoh also fetch/ pump water from Sg. Nyalau for washing/ bathing, especially during drought periods.

6.4.7.4.3 Electricity Supply

SESCo/SEB supplied electricity is available at Kg. Kuala Nyalau, Kg. Tengah Nyalau and Kg. Hulu Nyalau. Rh Sagoh community has to depend on their own generator sets for power supply.

6.4.7.4.4 Waste and Sewage Disposal Facilities

Open burning and dumping of wastes at the compounds of residence are the common methods of waste disposal practiced by the villagers. This is due to a lack of municipal waste collection service in the area.

Most of the houses in the villages are equipped with flush toilets as reliable supply of treated piped water is available. However, those of Rh. Sagoh still largely rely on pour-flush toilets. All local toilets are usually equipped with individual septic tank as on-site sewage treatment measure.

6.4.7.4.5 School

There are two primary schools in Nyalau namely; SK Kuala Nyalau located at Kg. Kuala Nyalau and SK Kg. Nyalau located at Kg. Hulu Nyalau. The villagers send their children to schools in Bintulu or Miri for their secondary education.

6.4.7.4.6 Health Services

Klinik Kesihatan Nyalau at Kg. Nyalau Tengah is a government medical clinic attended by a medical assistant and a few nurses. The clinic provides basic medical treatment such as fever, common cold and minor injuries. Patients are usually referred to hospitals in Bintulu or Miri for serious medical cases.

6.4.7.4.7 Community and Recreational Facilities

Community halls are available at Kg. Kuala Nyalau, Kg. Tengah Nyalau and Kg. Hulu Nyalau. Library, surau, football field and a homestay are found at Kg. Kuala Nyalau.

The burial ground at Kg. Kuala Nyalau caters collectively for the three Kedayan villages.

6.4.7.4.8 Historic and Archaeological Sites

There are no records of any historical, cultural, religious or archaeological sites of importance within or surrounding the proposed Project Sites.

6.4.8 SOCIO-ECONOMIC SURVEY

A social survey for the study was conducted in February 2019. A total of 73 respondents that include the heads of village and JKK members from Kg. Kuala Nyalau, Kg. Tengah Nyalau, Kg Hulu Nyalau and Rh. Sagoh were interviewed. A sample of questionnaire used in the survey can be found in **Appendix 6.4.2**.

The objectives of this survey were:

1. To understand the existing socioeconomic conditions of the community; and

2. To gauge awareness level, perceptions and views of the local communities regarding the proposed Project.

6.4.8.1 Respondent Profile

Table 6.4.12 shows the characteristics of the respondents interviewed in the social survey. Most of the respondents were males (73%), and heads of the households (79%). The respondents comprised mainly Kedayan (71%) who are all Muslim (100%). Others include Iban, Malay and Melanau. The majority of the respondents (81%) aged 31 to 64-year-old, and mostly working adults. Many of them did not have formal education (34%). Those with formal education are either secondary (37%) or primary (21%) education. Only 8% have some forms of tertiary education.

Most of the respondents indicated that they involve in multiple types of occupation. Fishing (36%) and farming (32%) were reported as their major types of occupation and sources of income. About 19% of the respondents reported they grow oil palms. Some of the respondents also reported they work in non-agricultural/ fishing (10%) or self-employed (3%).

Table 6.4.12: Respondent's Profile

	Percentage (%)
Ethnic	
Kedayan	71
Iban	18
Others (Malay, Melanau)	11
Sex	
Male	73
Female	27
Head of Households	
Yes	79
No	21
Age of Respondents	
30 and below	5
31-40	26
41-50	25
51-64	30
65+	14
Educational Attainment	
Never been to school	34
Primary school	21
Secondary school	37
College/ Institute	5
University	3
Main Occupation / Source of cash income	
Fishery	36
Small-scale farming	32
Oil palm	19
Employed (other than farming/ fishery)	10
Self-employed (incl. own business)	3

Note: Total percentage may not add up to 100 due to rounding up.

6.4.8.2 Household Characteristic

The characteristics of the surveyed households are tabulated in **Table 6.4.13**Error! Reference source not found.. Respondent's household size ranged from 1 to 10 persons per household. Most of these households (68%) have 3 to 6 members. The average size of a household is 4.7 persons. Household incomes of the study area generally ranged from RM1,000 to RM3,499 per month with more than two third (71%) earning between RM1,500 and RM2,999 per month. Farming is the main

source of household cash income (68%). Other important sources of income include salary/ wages from employments, or self-employment (other farming sector).

Fishery was reported as the major source of household income as admitted by 41% of the respondents. Other major sources of household income are oil palm farming (29%) and employments in non-agricultural/ fishing (22%). Other sources of income include other small-scale farming activities (5%) or self-employments (3%). The majority (81%) of the respondents admitted that they are satisfied with the amounts of their current household income.

Table 6.4.13: Household Characteristics

	Percentage (%)
Household size	
1-2	16
3-4	32
5-6	36
More than 6	16
Monthly Household Cash Income (RM)	
Less than 1000	1
1000 – 1499	11
1500 – 1999	30
2000 – 2499	18
2500 – 2999	23
3000 – 3499	11
3500 or more	6
Main Source of Household Income	
Fishery	41
Small-scale farming	29
Oil palm	22
Employment (other than farming/ fishery)	5
Self-employed (incl. own business)	3
Sufficiency of Household Cash Income	
Enough	81
Not enough	3
Not sure	16

Note: Total percentage may not add up to 100 due to rounding up.

The total percentage of the surveyed household members in the age groups below the age of 25 years constituted roughly half (47%) of the survey population. These groups consist of young members who are in school (including tertiary), pre-school or toddlers (see **Table 6.4.14**). Eighty-nine percent of the surveyed population falls within the 15 to 64 year old age group where potential active workforce can be found. There are slightly more males (51%) compared to female (49%) in the surveyed households with a sex ratio of 103 males versus 100 females.

Table 6.4.14: Age Group and Sex of the Surveyed Population

Age Groups	No. of Persons	%
1-14	24	7
5-15	76	22
15-24	62	18
25-64	168	49
65+	13	4
Total	**343**	**100**

Note: Total percentage may not add up to 100 due to rounding up.

6.4.8.3 Current Uses of Sg. Nyalau

Sg. Nyalau plays important roles to the Nyalau communities. About half (50%) of the respondents reported that they still fish in Sg. Nyalau, both for own consumption and sale for household cash income (see **Table 6.4.15**). Water of Sg. Nyalau us also utilised for agricultural uses (37%) such as crop watering/ irrigation; and washing/ bathing (22%). Recreational and transportation are few other uses mentioned.

Table 6.4.15: Current Uses of Sg. Nyalau

Uses of Sg. Nyalau	Percentage (%)
Fishing/ source of income	50
Agricultural (crop watering, animal drink)	37
Domestic needs (washing/ bathing)	22
Recreation (e.g. angling)	4
Transportation	3

6.4.8.4 Awareness of the Project

The survey found that nearly all of the respondents (99%) were aware of the proposed Project (see **Table 6.4.16**). The survey indicates that the level of awareness regarding the proposed Project among the locals is high. The main source of information regarding the Project was from the social dialogue conducted on 16 February 2019 at Dewan Rajawali Complex, Sime Darby. Very small number of the respondents (1%) were not aware of the proposed Project.

Table 6.4.16: Awareness of the Proposed Project

	Percentage (%)
Awareness (N=73):	
Aware	99
Unaware	1
Not sure	0
Sources of Information (n=73):	
District office / government agencies	7
Social/ community dialogue at Dewan Rajawali Complex (Sime Darby)	12
Friends / relatives	78
Others	3

6.4.8.5 Perceptions of the Project

All respondents (100%) perceived that the Project is unlikely to benefit them and thought it would be detrimental/ adversely affect them (100%), instead. As many local households have members involve in fishing activities (river/ sea), many respondents (88%) are worry of the river/ water pollution would affect their fishing activities. Hence, fearing their household income from fishing would be affected as well (64%) (see **Table 6.4.17**). The Project is also thought would be source of diseases (19%) and foul smell (18%) which would affect local population. Few thought it would affect their agricultural activities (7%) as some local are extracting water from Sg. Nyalau.

Table 6.4.17: Perceived Potential Adverse Impacts of the Proposed Project

Potential Adverse Impacts	Percentage (%)*
River/ water pollution	88
Affects household income	64
Source of diseases	19
Source of foul smell	18
Affects agricultural activities	7

Note: Non-cumulative (multiple responses).

6.4.8.6 Perception on the Potential Environmental Impacts

The respondents were generally worried about the potential impacts of the proposed Project as depicted in **Table 6.4.18**. The main concerns include impacts on water and air qualities, fishing activities, crops/ trees and health. The concern on water quality is largely linked to any potential impacts on fishery resources (i.e. fish, prawn, clam, crab), which is important sources of household income and food, as well as potential health impacts associated with their consumption. There are also worries about the possibilities of the proposed Project emitting foul smell although it is unlikely due to proper waste treatment to be used and its remote distant from Nyalau.

Table 6.4.18: Perceptions on the Potential Environmental Impacts of the Project

Perceptions	Percentages (%)				
	NW	LW	W	VW	NS
Changes in water quality	-	-	3	97	-
Impacts on fishing activities	-	-	4	96	-
Impact on local people health	-	-	4	96	-
Changes in air quality	-	-	3	96	1
Impacts on crops and trees	-	-	3	94	3
Changes to local tranquillity	-	1	36	36	27
Disturbance due to foreign workers	1	4	35	36	24
Impacts on road traffic	2	4	35	30	29
Changes to landscape and environment	-	3	29	27	31
Competition for business opportunities	2	14	31	47	6

Note: Total percentage may not add up to 100 due to rounding up.

Note: NW - Not Worried; LW - Less Worried; W - Worried; VW - Very Worried; NS - Not Sure

6.4.8.7 Other Concerns/ Comments

The respondents also given opportunities to raise up potential issues with regard to the implementation of the Proposed Project, both during the social survey and community dialogue. Other concerns/ issues raised are summarised in **Table 6.4.19**. Most of the respondents (79%) opined the Project should be relocated somewhere else as the leachate (even though it is treated) will pollute Sg. Nyalau (33%), which they thought would be troublesome (27%) and posing threat to local livelihood and safety/ health. One-third (33%) of the respondents thought the Project should be stopped, with 8% of them clearly stated that they are against the Project. Written feedbacks from Nyalau communities also reflect the same concerns/ sentiments (see **Section 0** and **Appendix 6.4.3**).

Table 6.4.19: Other Concerns/ Comments

Other Concerns/ Comments	Percentage (%)*
Relocate the Project	79
Stop the Project	34
Pollution due to the Project	33
Troublesome	27
Against the Project	8

6.4.9 NEARBY OIL PALM ESTATES/ PLANTATIONS

The proposed Project site is located within the Samudera oil palm estate which belongs to Sime Darby Plantation. The surrounding areas within 8 km from the Project site are largely occupied by oil palm estates/ plantations (except for Bukit Tiban National Park and Planted forest in the south/ southeast, and east, respectively). Bayu, Sahua and Damai oil palm estates are also belong to Sime Darby Plantation Sdn Bhd. Other oil palm plantations belong to Tawakal Sejati Sdn Bhd and Imbok Enterprise Sdn Bhd.

All Sime Darby's estate offices and staff/ workers' quarters have access to electricity from SESCO but the other plantations rely on generator sets. Sime Darby's estates also supplied with treated water, from estate owned water treatment plants; hence, staff/ worker quarters are equipped with flushing toilets. Raw water is either extracted from rivers/ streams within the estate, or stored rainwater (i.e. rainwater harvesting ponds). Other plantations either depend on rainwater/ bottled water for drinking, while washing/ bathing is commonly carried out in nearby rivers/ streams. Estates/ plantation offices/ workers' quarters are accessible by either gravel-paved or partially gravel-paved/ unpaved dirt plantation roads.

Staff and workers live in the estates/ plantations. Staff/ workers quarters are mostly located at the same locations as the estate/ plantation offices although some workers' quarters could be strategically located away from the main offices. The management staff generally comprises of Malaysians while general workers/ labourers are mostly foreigners, especially Indonesians. Indonesians workers are largely Muslims; hence, *surau* are usually available in the estate office/ staff quarter compounds. Sime Darby also provides primary schools for the children for their Indonesian workers. More details of the estates/ plantations are summarised in **Table 6.4.20**.

Few estate managements of the estates/ plantations found in the vicinity of the Project site were interviewed to gauge their opinions with regard to the proposed Project. Among the potential impacts/ concerns/ issues they thought could arise as a result of the implementation of the Project are:

- Foul garbage odour;
- Garbage blown off/ fallen from garbage trucks;
- River pollution – potentially affect the workers using the river for washing/ bathing. River pollution could affect local fishing activities;
- Vermin (rats, flies);
- Heaps of garbage waiting to be treated can aesthetically unpleasing (eye sore);
- Social issues; and
- Traffic accidents involving foreign workers.

More on the concerns/ issues raised by the estate/ plantation management are present in **Section 6.4.10**.

Table 6.4.20: Summarised Details of the Estate/ Plantation Offices and Staff/ Workers' Quarters found in the Vicinity of the Project Site

Estate/Plantation	Approx. Distance /Direction of Offices & Staff/Workers' Quarters	Approx. Numbers of Staff and Workers	Facilities	Concerns/ Issues
Samudera Estate	3.5km/ west	200	SESCO/genset (emergency); portable water (a tributary of Sg. Samudera, rainwater); garbage disposal by burial; kindergarten, health clinic, *surau*, playing field, badminton court, grocery store, mobile phone coverage	Bad odour, noise, traffic jam, fallen/blown off garbage, river pollution, social issue, potential road accidents involving foreign workers.
Bayu Estate	3.5km/ west	200	SESCO/genset (emergency); Portable water (a tributary of Sg. Samudera, rainwater); garbage disposal by burial; kindergarten, health clinic, *surau*, playing field, badminton court, grocery store, mobile phone coverage	No concern raised
Sahua Estate	5.2km/ southwest	250	SESCO/genset (emergency); portable water source (Sg. Samudera; rainwater); garbage disposal by burial; kindergarten, health clinic, *surau*, hall, playing field, badminton court, grocery store, mobile phone coverage	Bad/garbage odour, pests/vermin (rats, flies), eye sore (heaps of yet to be processed garbage/waste)
Damai Estate	5.2km/ southwest	240	SESCO/genset (emergency); portable water source (Sg. Samudera; rainwater); garbage disposal by burial; kindergarten, health clinic, *surau*, hall, playing field, badminton court, grocery store, mobile phone coverage	River/water pollution (for released treated leachate); bad/garbage odour, pests/vermin (rats, flies), aesthetically unpleasing/eye sore (heaps of yet to be processed garbage/waste)
Tawakal Sejati Plantation (Tawakal Sejati Sdn Bhd)	7.2km/northwest	245	Genset; Portable water source (a tributary of Sg. Perihas; rainwater); garbage disposal by burial; kindergarten, health clinic, *surau*, hall, playing field, badminton court, grocery store, mobile phone coverage	No concern raised
Imbok Plantation (Imbok Enterprise Sdn Bhd)	10km / northeast Two worker's quarters found within 5k from Project site.	800	Genset; Portable water source (rainwater - storage pond, tanks); garbage disposal by burial; kindergarten, health clinic, *surau*, playing field, grocery store, fixed line phone coverage River/streams are used for washing/ bathing	River/water pollution has potential to affect people health, hazard; affects local fishing activities; Air pollution/bad smell - health hazard

6.4.10 STAKEHOLDER ENGAGEMENTS

The objectives of the stake holder engagements were:

- To disclose appropriate Project information to the potentially affected stakeholders i.e. relevant government agencies, nearby oil palm estates/ plantations and local communities;
- To involve the stakeholders in the public consultation, seeking their opinions and concerns regarding the Project before crucial decision is taken;
- To be inclusive and accessible to all interested parties and be designed to include disadvantaged or potentially vulnerable groups (if any);
- To act as a communication tool between the affected communities, authorities concerned and the Project Proponent; and
- To ensure that the Project Proponent conducts itself in a way which preserves and enhances its reputation for being an open transparent organisation which strives to involve, inform, listen and incorporate stakeholders' views.

Stakeholder engagement activities carried out in the course of this EIA study are further described in the following subsections.

6.4.10.1 Terms of Reference Adequacy Check (TORAC)

Feedbacks from relevant government agencies/ private entities were seek during the preparation of the Terms of Reference (TOR) of the Study to ensure a comprehensive EIA study will be carried out. Letters were sent to the relevant government and private agencies seeking their advice and on the issues/ concerns to be studied. Among those consulted include Bintulu Development Authority (BDA), Bomba dan Penyelamat Malaysia, Department of Safety and Health (DOSH), Sarawak Forestry Corporation (SFC), Sarawak Rural Water Supply Department (JBALB), Natural Resources and Environment Board (NREB) Sarawak, Tawakal Sejati Sdn Bhd. Subsequently, Terms of Reference Adequacy Check (TORAC) meeting was held on 9th January 2019 at DOE Office (Kuching), seeking direct feedbacks/ clarifications on issues/ concerns raised by the stakeholders.

6.4.10.2 Visit to Kuching Integrated Waste Management Park (KIWMP)

A visit to KIWMP at Mambong in Kuching was organised to help the stakeholders to grasp the idea of how the proposed IWMS would work, on 12th February 2019. A total of 22 representatives from BDA, Bintulu District Office, Sime Darby Plantation Sdn Bhd, Tawakal Sejati Sdn Bhd, and Nyalau communities, made the trip to KIWMP (see **Appendix 6.4.4**). The attendees were briefed on the operation of KIWMP, where the stakeholders are encouraged to give their feedbacks. The entourage was brought touring the KIWMP site.

Plate 6.98: Sanitary landfill at KIWMP

Plate 6.99: Group Photo

6.4.10.3 Community Dialogue

A community dialogue was also carried out in the presence of the Project Proponent, Environmental Consultant, representatives from government agencies (Bintulu District Office, BDA, JPS, NREB, DOE, SFC); representatives from Sime Darby Plantation and Imbok Enterprise;and the Nyalau communities (Kg. Kuala Nyalau, Kg. Tengah Nyalau, Kg. Hulu Nyalau, Rh. Sagoh) on 16th February 2019. The community dialogue attendant list is appended in **Appendix 6.4.4**.

An oral-and-slide presentation of the proposed Project, explaining the scale of construction and operation as well as the purpose of the assessment was given. This was followed by a question-and-answer session during which feedbacks (i.e. issues, concerns, comments, suggestions, hopes/wishes, aspirations) from the stakeholders were recorded. The participants were also requested to fill a feedback form and return to the Consultant. A copy of the presentation slides is attached in **Appendix 6.4.5**.

Questions and comments raised during the dialogue session, and answers from the Project Proponent and environmental consultant are found in **Table 6.4.21**.

Written feedbacks were also collected during the community dialogue. Response forms were given to the attendees at registration. Written feedback allows those who did not have the opportunity to raise question or give comment during the community dialogue, to give feedbacks on the Project. A total of 29 feedback forms were returned. These feedbacks are summarised as follow:

- Nyalau communities indicated that they are against the release of treated leachate into Sg. Nyalau (i.e. “not agree”);
- Locals perceive that the released treated leachate will pollute Sg. Nyalau; hence, will pollute the water/ fish and affect the livelihood of local fishermen; and
- Project is thought to be not beneficial to the local people.

Also refer to **Appendix 6.4.6** for more on written feedback from the stakeholders.

Plate 6.100: Dialogue banner at Rajawali Complex Hall, Sime Darby

Plate 6.101: Environmental Consultant briefing the participants at dialogue

Plate 6.102: Participants at the dialogue

Plate 6.103: Participant asking question during the dialogue

Table 6.4.21: Questions Raised by the Stakeholders and the Corresponding Replies from Project Proponent/ EIA Consultant

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
1.	 **Plate 6.104:** Salwa Yazid – Sime Darby Plantation	1. Requesting for data/report on the treated effluent from the treatment plant of existing facility on the listed parameters.	1. The Proponent can provide the existing treated effluent data from their Mambong facility in Kuching as evidence of compliance.
		2. What is the pest management for this proposed Project? (e.g. on flies, rats, stray dogs etc.).	2. There a few ways to control the pest, as below: a. Engage the pest control specialist and may use the environmental friendly insecticides/pesticides as required. b. Daily compacting of Sanitary Landfill, to reduce the oxygen and to prevent stagnant water in the working cells. c. Covering of the in-active cells of the landfill with HDPE sheet. d. The operation area (including the whole Project site) will be fenced. e. Periodically fogging activities. f. Good housekeeping.
		3. What is the plan/preparation to be carried out during rainy season? Flood is a concern at the area.	3. The final platform level for the Project site will take into account the highest flood level at the area. With this, flood can be prevented during the operation stage. We hope Sime Darby can share the flood level at this area to Trienekens to assist in the design of the platform level.
		4. What is the management plan for leachate during transportation of waste (along the access roads) to the proposed Project site?	4. Each and every truck to be used for transporting the waste to the Project site will be equipped with leachate storage tank that will prevent the leaking of leachate during transportation.
		5. How long does it take for the raw leachate to be treated?	5. Based on the design calculation, the treatment will take about 7 days through the biological, chemical and physical treatment.
		6. For KIWMP, how far is the nearest sensitive receptor from the site boundary and what are the sensitive receptors?	6. The nearest sensitive receptor (by radius): a. Kg. Sidanu (approx. 1.1km) b. Kg. Mambong (approx. 1.4km) c. Kg. Seratau (approx. 2.0km) d. Paddy field & farm surrounding

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
		7. It is estimated that 70 plantation workers (including family members, if any) will be laid off when the land is acquired (not inclusive of access road). Is there any consideration taken for this case?	7. Trienekens will prioritise the working opportunity to the affected locals provided that they are qualified and meet the requirements. For the affected foreign workers, it will subject to their working permit and further discussion with SDP to be carried out.
		8. What is the Emergency Plan in case of plant failure, which includes explosion and untreated discharge to Sg. Similajau?	8. Trienekens internal HSE Department will establish a comprehensive ERP and an engagement with the other stakeholders will be considered to seek other opinion prior to the establishment of the ERP. An emergency retention pond will be built to contain the untreated/partially treated effluent in case of plant failure besides to have a polishing/maturation pond prior discharging the treated effluent. There will be a reed/plant and fish in the polishing pond as an ecological indicator.
		9. The intake point of the plantation water treatment plant is close (less than 8 km radius) to the Project site. What will be the best or safe distance in this case?	9. There is no safe distance from any guideline or regulation can be referred to for private water intake point. The 8 km radius distance clearance is for public raw water intake point. The Proponent have designed the discharge waterway/pipeline towards Sg. Nyalau and will ensure that no effluent to be discharge to Sg. Samudera.
2.	 Plate 6.105: Muhd. Radzuan – Kg. Tengah Nyalau	1. Can the discharge be diverted to Sg. Similajau instead of Sg. Nyalau?	1. Not recommended as the discharge will affect the active water intake point at Sg. Similajau. Besides looking into the discharge standards set by DOE, this EIA will also include the ecological studies and any potential impacts from the discharge.
		2. Suggestions from DOE on how the villagers can be informed of the discharge results?	2. Refer to the answer from DOE Bintulu (**Item 3**).

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
3.	 **Plate 6.106:** Abdul Mazli Hafiz – DOE Bintulu	Referring to **Question 2(2).** DOE Bintulu: Villagers can refer to DOE if they require any info on water or air pollution. The reports on environmental quality and data will be displayed on DOE website for viewing. Additional comments: 1. The duty of DOE is not easy and we require the cooperation from the public too. 2. From our view, this Project will benefit the environment if done properly with guidelines and mitigation measures in place.	
		3. Information on any pollution should be relayed to the villagers properly so that they are aware of what is happening in their area. Also, the villagers can have a visiting trip to the Project site from time to time such as during a CSR programme.	3. Villagers can refer to DOE if they require any info on water or air pollution. The reports on environmental quality and data will be displayed on DOE website for viewing. The Proponent will take this suggestion into consideration.
		4. Briefing on pollutions should also be done with the villagers so that they know that the Project Proponent is also taking care of the environment.	4. Villagers can refer to DOE if they require any info on water or air pollution. The reports on environmental quality and data will be displayed on DOE website for viewing.
		5. The existing source of pollution along Sg. Nyalau should be identified and recorded in the EIA.	5. EIA Consultant will include the existing source of pollution along Sg. Nyalau into the EIA.

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
4.	 **Plate 6.107:** Tasim bin Sabtu – Kg. Hulu Nyalau	1. I do not agree that the discharge water is to be discharged into Sg. Nyalau. It would be fair if it is discharged into Sg. Similajau (with water intake point) so if there is any impact it will affect everyone in the area. 2. There surely will be some problem despite being called "clean". Last year, Sg. Nyalau was polluted but until now there is still no result from the investigation by DOE on the source of the pollution. 3. Villagers in Nyalau are the one suffering when the fishes die especially the fishermen as it is part of their income.	1. Comments are noted and will be included in the EIA.
5.	 **Plate 6.108:** Alton William – Imbok Enterprise	1. Will there be any perimeter fencing for this proposed Project? Concern on stray dogs around. 2. How will the air pollution be monitored? 3. Will this proposed Project receive any clinical waste?	1. Yes, there will be perimeter fencing around the proposed Project site. 2. The waste will be compacted, and the gas produced will be collected and channelled to be flared off safely. Besides that, the covering of the landfill will minimise the gas emission and odour. The air quality will be monitored at nearby sensitive receptor and the results will be compared with the ambient air quality guideline. 3. No. Clinical waste will have to be incinerated but this proposed Project has no incinerator for the time being. It will be sent to the existing disposal plant in KIWMP or to be dispose by the hospital through their incinerator.

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
		4. What is the Emergency Plan in the event of plant explosion?	4. An emergency response plan (ERP) will be developed to handle the emergencies scenarios (Same with Item 1, answer no.8).
		5. Environmental result/data for this Project should be shared.	5. Yes, it will be made available upon request and these data will also be in the EIA report. Access to the data/EIA report also will be available at the selected government agencies.
		6. How will the gas produced be managed?	6. The gas will be extracted via pipeline underneath the landfill and will be channelled into a flaring plant. The gas will be flared off safely and the direct release of gas into the environment is minimised. Besides that, in future the gas can be converted into green energy.
		7. How can you educate or influence other people especially the villagers that the water is safe since the current perception is that waste water is being discharged?	7. The daily water/discharge quality monitoring will be conducted internally in addition to the periodic engagement with the third-party consultant to conduct the environmental monitoring for reporting to the authority. The biomonitoring also will be conducted at Sg. Nyalau from time to time. The treated discharge will first be discharged into a polishing pond containing fishes and plants which will indicate the discharge impact before being discharged into the river. The discharge will be channelled into the treatment plant again for re-treatment until it is considered safe in case the quality is not achieving the legal requirements. Also, the results of water quality monitoring will be shared. The EIA will not only focus on the discharge quality but also the impact on the fishes in the river. A health impact assessment will also be conducted. These impact assessments will indicate the potential impact (during normal and worst-case scenario) from the discharged of the treated leachate water into Sg. Nyalau towards the fishes and the local people.

No.	Name / Village / Company	Question	Reply by Proponent / EIA Consultant
		8. What are the proposed CSR programmes?	8. In terms of CSR, there are varieties of programmes to be done. Villagers can also propose programmes to be done with the Proponent. In addition, collaboration among agencies (government and private sectors) can also be done. We are not only aiming to raise awareness but also to educate the public about the environment.
6.	 **Plate 6.109:** Nawang bin Sail – Kg. Kuala Nyalau	1. Can this Project be moved to Sg. Similajau side? The Government has land across Sg. Similajau. The villagers of Kuala Nyalau do not agree to the proposed Project to be done at Ulu Nyalau.	1. As consultants, we have no say in this matter and it is up to the Government to decide.
7.	 **Plate 6.110:** Disem Holimen – Sarawak Forestry Corporation	1. What is the distance from the Project site to Bukit Tiban National Park?	1. Distance from the Project site to the national park is about 1.1 km excluding the buffer zone.
		2. What are the impacts of the Project development on the flora and fauna of Bukit Tiban National Park?	2. The impact assessment on the flora and fauna will be included in the EIA report.
		3. I would like the impact assessment report to be shared with our department for future references.	3. A copy of the EIA report will be forwarded to the forestry department/SFC.

6.4.11 PUBLIC HEALTH

6.4.11.1 Public Health Survey

A study of the public health status of the community residing in the vicinity of the proposed Integrated Waste Management System (IWMS) in Samalaju, Bintulu, Sarawak, was conducted. The objective was to describe the existing, baseline information on the state of health of the community prior to the construction and operation of the proposed Project. Health data was extracted from a health survey of the community in the vicinity of the proposed Project site which was conducted together with the socioeconomic survey in November 2017. This survey was conducted for a prior EIA project in the Samalaju Industrial Park, and not for this particular Project. Nevertheless, we believe that the environmental and public health status of the community in the area has not changed much since the survey was first conducted.

6.4.11.2 Background of Respondents

A total of 64 households were surveyed which comprised a total of 290 household members. This gives an average of 4.5 members per household. **Table 6.4.22** shows the distribution of these households by residential location, average years of residency and average family income. The majority (71.9%) of the respondents were from Kuala Nyalau. All the households surveyed had an average of 26.1 years of residency. There were four households that had only 1 to 2 years of residency. Previously, they had been staying at their family's homes. Both Kuala Nyalau and Rumah Sagoh had the highest average years of residency at 28 years. The average family income was RM2,102.00, with Kuala Nyalau having the highest (RM2,255.00) and Rumah Sagoh having the lowest (RM850.00) average family income.

Among the members of the households surveyed, 141 (48.6%) were males while 149 (51.4%) were females which was in contrast to the national distribution of gender (see **Table 6.4.23**). With respect to their education level, the majority of respondents had never been to school (39.1%), while only 7.8% of them had tertiary education (see **Table 6.4.24**).

Of the 290 household members, most (75.5%) of them were productive adults aged 15 to 64 years old. This percentage is larger than that of the Malaysian average of 69.5% in 2017. Children below 15 years of age made up of 20.0% of the sample which is slightly lower than the Malaysian average of 24.5% in 2017. Elderly people of 65 years and older made up only 4.5% of the sample, slightly lower than the Malaysian average of 6.0% in 2017. There was one live birth each in three households among the households surveyed. Therefore, we can conclude that the communities surrounding the proposed Project comprise of young adults who are generally less sensitive to the health effects related to air and water pollution, and communicable diseases (see **Table 6.4.25**).

Table 6.4.22: Distribution of Households Surveyed by Residential Location, Average Years of Residency and Total Family Income

Residential Location	Total, N (%)	Average Years of Residency	Average Family Income (RM)
Kuala Nyalau	46 (71.9)	28.2	2,255.00
Tengah Nyalau	5 (7.8)	15.2	1,960.00
Hulu Nyalau	11 (17.2)	21.8	1,755.00
Rumah Sagoh	2 (3.1)	28.0	850.00
Total	64 (100.0)	26.08	2,102.00

Table 6.4.23: Distribution of Households Members Surveyed by Gender

Gender	Number	Percent (%)	Malaysia (%)[a]
Males	141	48.6	51.6
Females	149	51.4	48.4
Total	290	100.0	100.0

Source: [a] Department of Statistics Malaysia, 2017

Table 6.4.24: Distribution of Respondents Interviewed by Highest Education Level Attained

Education Level	Number	Percent (%)
Never been to school	25	39.1
Primary school	14	21.9
Form 3 (SRP/PT3)	7	10.9
Form 5 (SPM)	9	14.1
Form 6 (STPM)	4	6.2
Diploma	4	6.2
First degree	1	1.6
Total	64	100.0

Table 6.4.25: Distribution of Households Members Surveyed by Age Groups

Age Group	Number	Percent (%)	Malaysia (%)[a]
Children (<1 year old)	4	1.4	
Children (1- 4 years old)	9	3.1	24.5
Children (5 – 14 years old)	45	15.5	
Adults (15 – 64 years old)	219	75.5	69.5
Adults (65 years old and above)	13	4.5	6.0
Total	290	100.0	100.0

Source: [a] Department of Statistics Malaysia, 2017

6.4.11.3 Housing and Environmental Sanitation Status

The status of housing and environmental sanitation in the surveyed area was assessed based on the type of houses and their basic amenities related to toilet, water supply and garbage disposal. All of the respondents lived in traditional houses of detached village or long houses (see **Table 6.4.26**). **Table 6.4.27** shows that 39.1% of the houses were built from wood and brick, 32.8% were completely built from bricks, while 28.1% were completely built from wood. A majority (90.6%) of the houses were without air conditioning (see **Table 6.4.28**). Among the households, 60.9% had household members who smoked inside the house (see **Table 6.4.29**). This is a high percentage of smokers in the house which could lead to serious indoor air pollution in the homes.

Table 6.4.26: Respondents House Type

Type of House	Number	Percent (%)
Detached village	62	96.9
Long house	2	3.1
Total	64	100.0

Table 6.4.27: Types of Material of Respondents' Houses

Type of material	Number	Percent (%)
Completely wood	18	28.1
Completely brick	21	32.8
Wood and brick	25	39.1
Total	64	100.0

Table 6.4.28: Availability of Air Conditioning in the Respondents' Houses

Availability of Air Conditioning	Number	Percent (%)
Yes	6	9.4
No	58	90.6
Total	64	100.0

Table 6.4.29: Presence of Household Member Who Smokes Inside the Respondents' House

Smoking Inside the House	Number	Percent (%)
Yes	39	60.9
No	25	39.1
Total	64	100.0

Table 6.4.30 shows that all of the houses surveyed possessed a hygienic toilet in the form of either a flush toilet or a pour-flush latrine. Most (96.9%) of the houses had piped water supply (see **Table 6.4.31**), while 3.1% used rainwater. In terms of garbage disposal practices of the households surveyed, only 43.8% practised proper garbage disposal by either burning and burying their garbage or throwing it into a hole and then bury. Unfortunately, 51.5% of the households still only burn their garbage without burying it. Burning garbage without burying can lead to the breeding of pests like mosquitoes and rats. There were 2 households that threw the garbage into a hole and burn, while one household sent the garbage to Bintulu (see **Table 6.4.32**). A majority of the households had pest problems from mosquitoes (100%), flies (96.9%), cockroaches (96.9%), ants (96.9%), and rats (95.3%) (see **Table 6.4.33**). Not surprisingly, this could be the consequences of poor garbage disposal practices.

Table 6.4.30: Types of Toilet used in the Houses Surveyed

Type of toilet	Number	%
Pour-flush latrine	25	39.1
Flush toilet	39	60.9
Total	64	100.0

Table 6.4.31: Source of Water Supply for Drinking, Washing or Bath in the Houses Surveyed

Source of Water Supply	Drinking, N (%)	Washing or Bath, N (%)
Rainwater	2 (3.1)	2 (3.1)
Piped water to the house (JBALB)	62 (96.9)	62 (96.9)
Total	64 (100.0)	64 (100.0)

Table 6.4.32: Garbage Disposal Practices by the Households Surveyed

Garbage Disposal Practice	Number	Percent (%)
Burn only	33	51.5
Burn and then bury	22	34.4
Throw into a hole and then bury	6	9.4
Other	3	4.7
Total	64	100.0

Table 6.4.33: Presence of Pest Problem in the House

Presence of Pest	Number (%)				
	Mosquitoes	Flies	Cockroaches	Ants	Rats
Yes	64 (100.0)	62 (96.9)	62 (96.9)	62(96.9	61 (95.3)
No	0 (0)	2 (3.1)	2 (3.1)	2 (3.1)	3 (4.7)
Total	64 (100.0)				

Based on the environmental sanitation factors studied, we may deduce that the environmental sanitation status of the communities surveyed is satisfactory with respect to housing, toilet facility and water supply, but unsatisfactory with respect indoor air pollution due to smoking, garbage disposal and pest problems.

6.4.11.4 Community Health Status

Table 6.4.34 gives the prevalence of selected diseases that were diagnosed by doctors within the last 1 year, among the 290 residents from the 64 households that were surveyed. The highest prevalence rates were for hypertension (1.7%), followed by diabetes mellitus (1.0%), cough and skin disease (0.7%). However, the prevalence was very low, probably also due to the small sample size. The prevalence rates for hypertension and diabetes were also well below the national prevalence rates.

Table 6.4.34: Residents Diagnosed with Selected Diseases by Doctors within the Last 1 Year (N=290)

Disease	Number	Prevalence Rate (%)	National Prevalence (%)
Chronic bronchitis	1	0.3	NA
Cough	2	0.7	NA
Hypertension	5	1.7	30.3[a]
Diabetes	3	1.0	17.5[a]
Liver disease	1	0.3	NA
Skin disease	2	0.7	NA
Appendix disease	1	0.3	NA

NA: Not available
Sources: [a] Institute for Public Health, 2015

As shown by **Table 6.4.35**, the main reasons residents sought medical treatment at hospitals or clinics within the last 3 months were for cough and cold (5.5%), fever (2.1%) and diarrhoea (2.1%). These seem to be the normal and typical medical complaints that most communities experience.

Table 6.4.35: Reasons for Seeking Medical Treatment by Residents within the Last 3 Months (N=290)

Disease/Health Problem	Number	Prevalence Rate (%)
Fever	6	2.1
Cough and cold	16	5.5
Shortness of breath (dyspnoea)	1	0.3
Diarrhoea	6	2.1
Vomiting	2	0.7
Skin disease	3	1.0
Accident/injury	2	0.7
Diabetes	1	0.3

Table 6.4.36 shows that 12.5% of the households surveyed had members hospitalised within the last 1 year. The reasons for hospitalisation included leg pain (14 days), appendicitis (4 days and 2 months), fever and anaemia (5 days and 6 days), fever (4 days), fainted (2 days), child birth (1 day), and accident (1 day).

Table 6.4.36: Hospitalisation of Household Members Surveyed within the Last 1 Year

Hospitalisation	Number	Percent (%)
Yes	8	12.5
No	39	60.9
No feedback	17	26.6
Total	64	100.0

6.4.11.5 Morbidity Statistics

Data on disease cases related to air pollution, water pollution, animal vectors and reservoir and skin diseases were requested from Klinik Kesihatan Nyalau for a period of one year from January to December 2017. Of these, only disease cases related to air pollution and skin diseases were reported at the clinic throughout 2017. Klinik Kesihatan Nyalau is about 12 km northeast of the proposed Project site.

Table 6.4.37 gives the disease cases related to air pollution seen at Klinik Kesihatan Nyalau in 2017. Respiratory diseases normally aggravated by air pollution as represented by upper respiratory tract infection and asthma made up of 27.3% of all adult cases and 77.3% of all children cases seen at the clinic. These figures seem rather high. A majority (60.9%) of the households had members who smoke inside their homes (see **Table 6.4.29**). This may contribute to poor indoor air quality leading to asthma, Cardiovascular diseases which may be worsen by air pollutions as represented only hypertension made up of 20.3% of all adult cases. Air pollution tends to impact children through respiratory diseases and adults through cardiovascular diseases.

The surveyed population showed unsatisfactory garbage disposal practices. A majority of the households also had pest problems. Animal vectors and reservoirs may be associated with a poorly managed environment. Often, discarded containers that are improperly disposed or the presence of water within homes and surroundings may become excellent breeding sites for mosquitoes which transmit diseases. However, no disease case related to animal vectors and reservoirs was seen at the clinic.

Table 6.4.38 indicates skin diseases seen at Klinik Kesihatan Nyalau in 2017. They made up only 1.6% of all adult cases and 4.7% of all children cases. We can see that the percentages of skin diseases seen at the clinic were very minimal. Of all these skin diseases, dermatitis and eczema, urticaria and erythema, are allergic forms of skin reactions that may be exacerbated by allergens and irritants that may be present in air or water. Among these, only urticaria and disorders of skin appendages were reported at the clinic.

Table 6.4.37: Disease Cases Related to Air Pollution Seen at Klinik Kesihatan Nyalau

Year	Month	Conj.		URTI		Inf.		Asth.		TB		Pneu.		Bron.		Emphy.		Lung Ca		HF		HPT		IHD		CVA		*Total (all patients)	
		A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
2017	J	0	0	17	5	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	101	17
	F	0	0	26	15	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	216	24
	M	0	0	30	12	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	119	28
	A	0	0	19	32	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	36	0	0	0	0	0	142	38
	M	0	0	32	11	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0	0	105	15
	J	0	0	37	10	0	0	2	3	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	133	15
	J	0	0	16	13	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	123	17
	A	0	0	66	17	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0	193	24
	S	0	0	53	26	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	26	0	0	0	0	0	151	42
	O	0	0	46	20	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	0	133	26
	N	0	0	45	20	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	34	0	0	0	0	0	144	25
	D	0	0	32	25	0	0	4	2	0	0	0	0	0	0	0	0	0	0	0	0	21	0	0	0	0	0	105	24
Total		0	0	419	206	0	0	35	22	0	0	0	0	0	0	0	0	0	0	0	0	338	0	0	0	0	0	1,665	295

Conj.	:	Conjunctivitis	Emphy.	:	Emphysema
URTI	:	Upper respiratory tract infections	Lunfg Ca	:	Lung cancer
Inf.	:	Influenza	HPT	:	Hypertension
Asth.	:	Asthma	HF	:	Heart failure
TB	:	Tuberculosis	IHD	:	Ischaemic heart disease
Pneu	:	Pneumonia	CVA	:	Cerebrovascular accident/ stroke
Bron.	:	Chronic bronchitis			

*Total (all patients): Total attendance of all patients at the clinic during that month

A: Adult C: Children

Table 6.4.38: Skin Disease Cases Seen at Klinik Kesihatan Nyalau

Year	Month	Cutan.		Cell.		Derm.		Psor.		Urti.		Dis.		Eryth.		Rad.		*Total (all patients)	
		A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C	A	C
2017	J	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	101	17
	F	0	0	0	0	0	0	0	0	1	3	0	1	0	0	0	0	216	24
	M	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	119	28
	A	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	142	38
	M	0	0	0	0	0	0	0	0	5	2	0	0	0	0	0	0	105	15
	J	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	15
	J	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	123	17
	A	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	193	24
	S	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	151	42
	O	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	26
	N	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	144	25
	D	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105	24
Total		0	0	0	0	0	0	0	0	24	13	2	1	0	0	0	0	1,665	295

Cutan. : Cutaneous abscess/ furuncle & carbuncle
Cell. : Cellulitis
Derm. : Dermatitis and eczema
Psor. : Psoriasis
Rad. : Radiodermatitis & other radiation-related disorders of the skin & subcutaneous tissue
Urti. : Urticaria
Dis. : Disorders of skin appendages
Eryth. : Erythemas

*Total (all patients): Total attendance of all patients at the clinic during that month
A: Adult C: Children

Table 6.4.39 shows the prevalence rates of selected environment-related notifiable communicable diseases in the District of Bintulu in 2017. The prevalence rates of most of the diseases are below the national prevalence rates in 2016, except for malaria and leptospirosis, which are transmitted by mosquitoes and rodents, respectively. All (100%) and 95.3% of the respondents surveyed complained about the presence of mosquitoes and rats in their houses, respectively (see **Table 6.4.33**). The respondents also practised poor garbage disposal methods which may lead to the breeding of rodents (see **Table 6.4.32**).

Table 6.4.39: Prevalence Rates of Selected Notifiable Communicable Diseases in the District of Bintulu in 2017

Disease	No. of Cases	Prevalence Rates in 2017 (per 100,000 population)	Prevalence Rates for Malaysia in 2016 (per 100,000 population)[a]
Waterborne and Foodborne Diseases	0	0	
Cholera	0	0	0.54
Typhoid	0	0	0.57
Hepatitis A	0	0	0.27
Dysentery	0	0	0.40
Poliomyelitis	0	0	0
Food poisoning	12	4.73	55.21
Vertorborne and Zoonotic Diseases	0	0	
Dengue fever	73	28.80	318.13
Dengue haemorrhagic fever	0	0	2.01
Chikungunya	0	0	-
Malaria	61	**24.06**	7.27
Filariasis	0	0	-
Typhus	0	0	0
Rabies	0	0	0
Leptospirosis	70	**27.61**	16.69

Population of the District of Bintulu in 2017 is 253,500.
Sources: [a] Ministry of Health Malaysia 2017. Health facts 2017.

6.4.12 ROUNDTABLE ON SUSTAINABLE PALM OIL (RSPO)

Sime Darby Plantation Sdn Bhd is a member under the Roundtable Sustainable Palm Oil (RSPO).

6.4.12.1 About RSPO

RSPO is a non-profit organisation that unites the stakeholders from the 7- sector of the palm oil industry: oil palm producers, processors or traders, consumer goods manufacturers, retailers, bank/ investors, and environmental and social non-governmental organisations (NGO), to develop and implement global standards for sustainable palm oil.

RSPO has developed a set of environmental and social criteria which companies must comply with in order to produce Certified Sustainable Palm Oil (CSPO). When the criteria are properly applied, it can help to minimise the negative impact on pal oil cultivation on the environment and communities in palm oil-producing regions.

RSPO has more than 4,000 members worldwide who represent all links along the palm oil supply chain. They have committed to produce, source and/or use sustainable palm oil certified by the RSPO.

6.4.12.2 RSPO Certification

There is an ever-urgent need and growing global concern that commodities are produced without causing harm to the environment or society. RSPO certification is an assurance to the customer that the standard of palm oil production is sustainable.

Palm oil producers are certified through strict verification of the production process to the stringent RSPO Principles & Criteria for Sustainable Palm Oil Production by accredited Certifying Bodies, and can be withdrawn at any time in case of infringement of the rules and standards. All organisations in the supply chain that use RSPO certified sustainable oil products are audited to prevent overselling and mixing palm oil with conventional (or non-sustainable) oil palm products.

6.4.12.3 RSPO Principles & Criteria

Sustainable palm oil production is comprised of legal, economically viable, environmentally appropriate and socially beneficial management and operations. At the heart of RSPO certification are the RSPO Principles and Criteria for Sustainable Palm Oil Production, the global guidelines for producing palm oil sustainably.

The Principles & Criteria are generic document. Since countries differ in their laws for the same criteria, such as minimum wages for workers for example, and there are cultural and other differences, the Principles & Criteria are further adopted for use by each country through National Interpretations. The Malaysia RSPO Principles & Criteria is appended in **Appendix 6.4.7**.

This crucial step not only allows for negating potential conflicts between an international standards and national laws, but also to allow for national level stakeholder consultation. This would translate to addressing key concerns at local or regional level, giving specific points to unique situations and complementing national laws with a higher benchmark (where applicable) for industry to achieve.