



Hydrological Assessment Report

Prepared for

Acacia Forest Industries Sdn Bhd (AFI)

ACACIA FOREST INDUSTRIES SDN BHD(611076-A)

09.04
2019

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EnviroSolutions & Consulting
No. 65B, Jalan SS21/60
Damansara Utama
47400 Petaling Jaya
Selangor, Malaysia

Hydrological Assessment Report

For Acacia Forest Industries Sdn. Bhd. (AFI)

For and on behalf of
EnviroSolutions & Consulting Sdn Bhd,

Approved by,

Zai Abdul Rahman
Country Director
9th April 2019

Project Number: J18-818-MY-PA
Report Version: 03

Rev.	Description	Prepared	Reviewed	Approved	Date
00	Draft	TMM/ KM	ZAR	ZAR	24/09/18
01	Draft	TMM	ZAR	ZAR	25/10/18
02	Final	TMM	ZAR	ZAR	30/11/18
03	Final	TMM	ZAR	ZAR	12/02/19

Distribution
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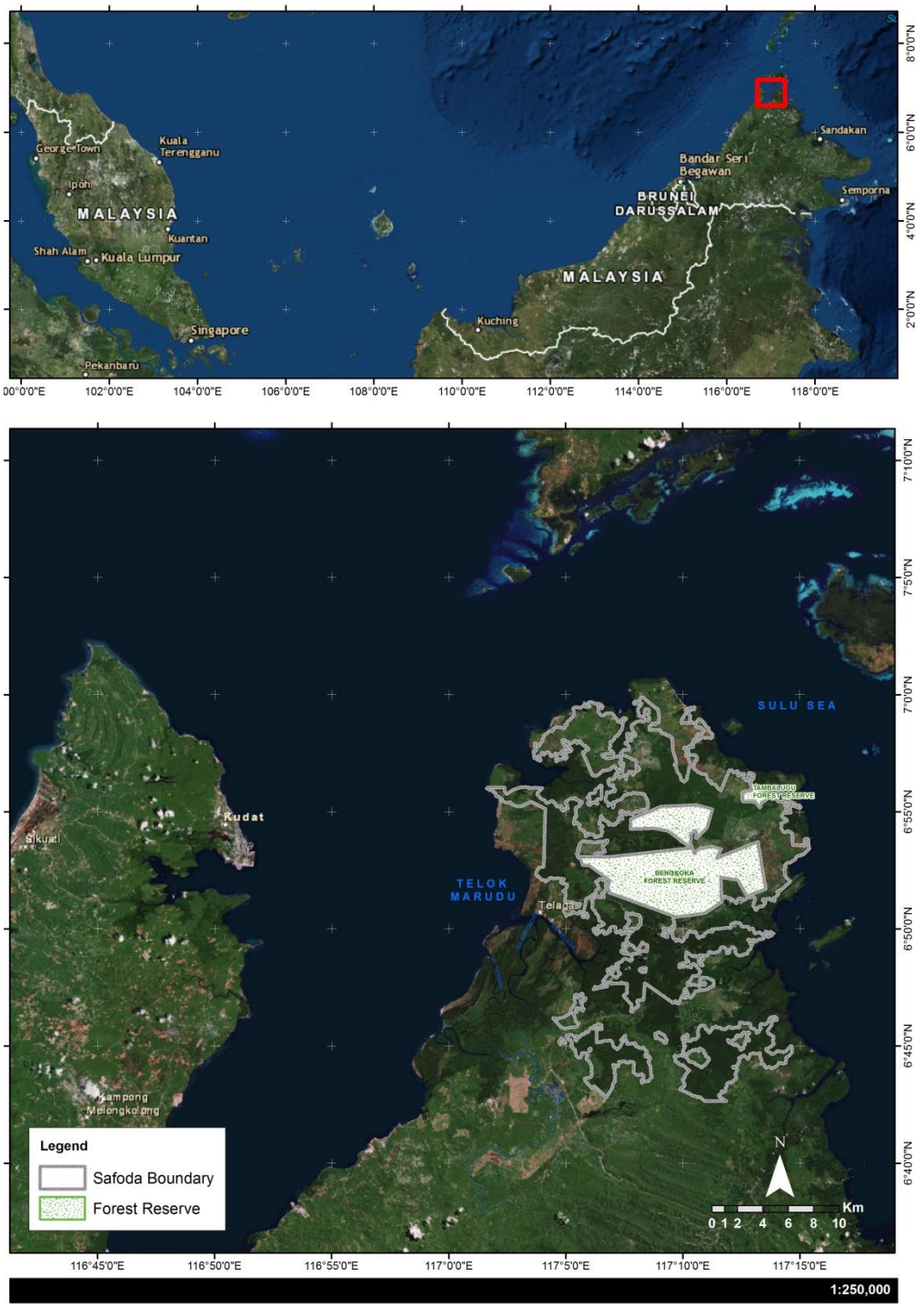
ACRONYMS

AFI	Acacia Forest Industries Sdn Bhd
amsl	Above mean sea level
API	Air Pollution Index
BFR	Bengkoka Forest Reserve
CBD	Convention on Biological Diversity
CO	Carbon monoxide
COC	Chain of custody
DOE	Department of Environment
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EQR	Environmental Quality Report
ES	Environmental and Social
ESMS	Environmental and Social Management System
FCP	Forest Conservation Policy
FM	Forest Management
GIIP	Good International Industry Practice
GSSB	Gerak Saga Sdn Bhd
HBP	Hijauan Bengkoka Plantations
HCV	High Conservation Value
HCVF	High Conservation Value Forest
IFC	International Finance Corporation
LMOs	(Living Modified Organism
NO2	Nitrogen dioxide
NWQS	National Water Quality Standards for Malaysia
O3	Ozone
PM10	Particulate matter of less than 10 microns in size
PS	Performance Standards
SAFODA	Sabah Forest Development Authority
SAGE	Sustainability and Grassroots Empowerment
SFMLA	Sustainable Forest Management Licensee Agreements
SCS	Scientific Certification Systems
SO2	Sulphur dioxide
SOP	Standard Operating Procedure
TAFF	Tropical Asia Forest Fund
TFR	Tambalugu Forest Reserve
USGS	United States Geological Survey
WQI	Water Quality Index

1 INTRODUCTION

1.1 Project Title

This Hydrological Assessment Report is prepared for the project entitled **Biodiversity and Hydrological Baseline Assessment for Acacia Forest Industries Sdn Bhd (AFI),** at AFI's Bengkoka Forestry Plantation in the Bengkoka Peninsula of Sabah, Malaysia. The 'Project Proponent' is Acacia Forest Industries Sdn Bhd, as the subsidiary of New Forests Asia (Singapore) Pte Ltd's (New Forest). Refer to *Figure 1* for the project area.



(Source: Esri & AFI)

Figure 1 – Regional Boundary of SAFODA

1.2 Background

AFI was established as a joint venture between the Sabah Forest Development Authority (SAFODA) and Hijauan Bengkoka Plantations (HBP) in 2003. The objective of the company was to plant and re-plant Acacia mangium and other timber species within a gazetted area of 25,000 ha. AFI's forests and operations are located within a contiguous block of land on the Bengkoka Peninsula in Sabah, Malaysia. The Bengkoka land was originally allocated by the State of Sabah in 1983 when the then Chief Minister reserved the State Land for an Afforestation Resettlement Scheme to SAFODA.

New Forests Asia (Singapore) Pte Ltd's (New Forest), through the Tropical Asia Forest Fund (TAFF), acquired a shareholding in HBP in 2013, and therefore has an interest in AFI as well. The following environmental and social impact assessments to Malaysian standards of the plantation area currently managed by AFI were completed between 2007 and 2009 by a local environmental consultancy:

- Environmental Impact Assessment of Proposed Harvesting of 10,000 Hectares of *Acacia Mangium* Plantation Trees at Bengkoka Peninsula, Pitas, Sabah by Mangium Plantations Sdn. Bhd., Kiwiheng Environmental Consultants, July 2007;
- Social Impact Assessment of Proposed Replanting and Planting of 25,000 ha of *Acacia Mangium* at Bengkoka Peninsular, District of Pitas, Sabah by Acacia Forest Industries Sdn. Bhd., Kiwiheng Wood & Environmental Consultants Sdn. Bhd., September 2009; and
- Environmental Impact Assessment of Proposed Replanting and Planting of 25,000ha of Acacia Mangium at Bengkoka Peninsular, District of Pitas, Sabah by Acacia Forest Industries Sdn. Bhd., Kiwiheng Wood & Environmental Consultants Sdn. Bhd., December 2009.

The Bengkoka forestry plantation managed by AFI has had certification to the SCS-FCP Interim Standard for Forest Management Certification in Malaysia under the Forest Stewardship Council (Version 1, March 2016) for Forest Management (FM) and Stump to- Forest Gate Chain of Custody (COC) since 20 June 2011, when it was certified by Scientific Certification Systems (SCS). Since then SCS has carried out annual surveillance visits, and a complete recertification audit was successfully completed in June 2016, which extends the certificate expiration date until 19 June 2021.

In June 2016 a detailed gap analysis of AFI performance against the International Finance Corporation (IFC) Performance Standards (PS) on Environmental and Social Sustainability identified a number of deficiencies. AFI proposes to address some of these issues through a biodiversity and hydrological baseline assessment.

The area managed by AFI is nominally 25,000 ha, but the boundary has not been fully surveyed and plotted in digital maps (at least 30% of the boundary is yet to be surveyed). The plantation area includes 1,588 ha of High Conservation Value Forest (HCVF) in eight areas, including 797 ha of mangrove forest; 480 ha of riparian zones, river catchments and steep slopes; 260 ha of Wasoi reserve (remnant of natural forest), lakes and wetlands; and 51 ha of burial sites / cultural heritage sites.

1.3 Scope and Objectives

The study objectives and scope of work for the water audit are as follows:

- Evaluate and update AFI's current water sampling points as part of their Water Management and Monitoring Plan;
- Review and revise AFI's standard operating procedures which affects water usage and quality;
- Identify water users and water balance along Sg. Bongkol; and
- Ensure that AFI's operations and programmes comply with the relevant IFC requirements.

The approach and scope of work will be as per ESC's proposal submitted to AFI via a letter J18-818-MY-PA AFI BHS Assessment dated 27th April 2018.

The main purpose of the assessment is to establish the current condition and quality of the waterbodies found within the AFI operating boundaries particularly areas which are still active where activities related to replantation is ongoing.

Additionally, as discussed in the kick-off meeting, ESC will also review the current monitoring locations, assess their suitability and suggest new/additional locations, if and as necessary. The new/ additional locations will be selected based on their relevance to AFI activities onsite (e.g. downstream of active planting area). Samples will be taken at the proposed locations and tested for parameters as per the National Water Quality Standards (NWQS).

1.4 Methodology

To meet the purpose of this assessment, several activities as listed below were carried out to collect the essential data and information:

- Field assessment –
    1. identified waterbody systems found in the active area of AFI plantation and their condition e.g. location and size of waterbody, existence of flowing stream, direction of flow, etc.;
    2. assessed the surrounding condition of waterbody e.g. water user, villages, activities by villagers – farm, fish pond, etc. Identification of water users was conducted through interviews of local residents;
- Data collection and testing – collected water sample to determine the water quality. Water sample parameters were tested in accordance with the National Water Quality Standards (NWQS).
- Data review and assessment – Results from water sample testing were analysed to determine the waterbody classification per NWQS.

1.5 Limitations

This report is based on secondary information and data gathered during the field assessment only. The field assessment was conducted during the dry season and there was no rain during the whole of the assessment period. As such, results of the monitoring exercise are only representative of conditions during the dry periods in Bengkoka.

1.6 Document Structure

The report is structured as follows:

- *Section 1* – Introduction
- *Section 2* – Legal Framework
- *Section 3* – Site Description
- *Section 4* – Hydrology Assessment
- *Section 5* – Sampling and water Quality Methodology and Theoretical Basis
- *Section 6* – Result, Discussion and Conclusion
- Appendix

2 LEGAL FRAMEWORK

The following are short summaries of the key legislations which are related to this report.

a. National Policy on Biological Diversity 2016 – 2025

The National Policy on Biological Diversity 2016-2025 provides the direction and framework for Malaysia to conserve their biodiversity. The Policy has five overarching goals encompassing stakeholder empowerment, reducing pressures on biodiversity, safeguarding ecosystems, species and genetic diversity, ensuring fair and equitable sharing of benefits from the utilisation of biodiversity, and building the capacity of all stakeholders. This Biodiversity Assessment is in line with the government's policy on conserving biodiversity in Malaysia. In particular, the assessment fulfils Goal 1 which seeks to encourage and empower all stakeholders to conserve our biodiversity and Goal 2 which aims to ensure that all sectors of the economy are planned and managed in a manner that does not impose pressures on our biological resources. The following are 3 national biodiversity targets that become the concerns of this study as to support Convention on Biological Diversity (CBD) implementation for Malaysia:

- Target 1: By 2025, more Malaysians are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.
- Target 2: By 2025, the contributions of indigenous peoples and local communities, civil society and the private sector to the conservation and sustainable utilisation of biodiversity have increased significantly
- Target 3: By 2025, biodiversity conservation has been mainstreamed into national development planning and sectoral policies and plans.

b. Pesticides Act 1973

This Act covers the management of all pesticides and other chemicals used in agriculture. It regulates the labelling, registration, importation, manufacture, advertising, sale and storage of pesticides; controls the presence of pesticide residues in food, and the reporting and investigation of accidents and injuries caused by pesticides.

According to the Department of Agriculture, the list of banned pesticides include Binapacryl, Butaclor, Dicofol, Methomyl, Monocrotophos, Dinoseb, HCH (mixed isomers), Aldrin, Chlordimeform, Dieldrin, Ethylene dibromide, Heptachlor, Mercury compounds, Chlordane, Captafol, Chlorobenzilate, 2,4,5-T Herbicide, Folpet, DDT, Sodium pentachlorophenate, DNOC, Ethylene dichloride, Ethylene oxide, Lindane, Fluoroacetamide, Hexachlorobenzene, Parathion, Calcium cyanide, Toxaphene, Phosphamidon, Methyl-parathon, Methamidosphos, Endosulfan, Acephate, Mixture of benomyl, carbofuran and thiram, Tributyltin compound, Aldicarb, Alachlor, and Azinphos-methyl.

c. Biosafety Act 2007

The objective of the Biosafety Act is to protect human, plant and animal health, the environment and biological diversity by regulating the release, importation, exportation and contained use of LMOs (Living Modified Organism), and the release of products of such organisms. The Biosafety Act 2007 establishes a process to vet all applications for the direct release of LMOs into the environment to ensure that the particular LMO is safe.

LMO is any living organism that possesses a novel combination of genetic material obtained through the use of modern biotechnology.

d. Environmental Quality Act 1974

An act relating to the prevention, abatement, control of pollution and enhancement of the environment. It controls all activities relating to the discharge of wastes into the environment and for preventing or controlling pollution and protecting and enhancing the quality of the environment.

e. Water Quality Standards

Water quality data were used to determine the water quality status whether it is clean, slightly polluted or polluted category and to classify the rivers in Class I, II, III, IV or V based on the Water Quality Index (WQI) and National Water Quality Standards for Malaysia (NWQS).

f. Access to Biological Resources and Benefit Sharing Act 2017

An act to implement the Convention on Biological Diversity and any protocol to the Convention dealing with access to biological resources and traditional knowledge associated with biological resources and the sharing of benefits arising from their utilisation and for matters connected therewith. The Convention enjoins Parties to take legislative, administrative or policy measures, as appropriate, to implement the provisions relating to access to genetic resources and the fair and equitable sharing of benefits arising from their commercial and other utilisation.

3 SITE DESCRIPTION

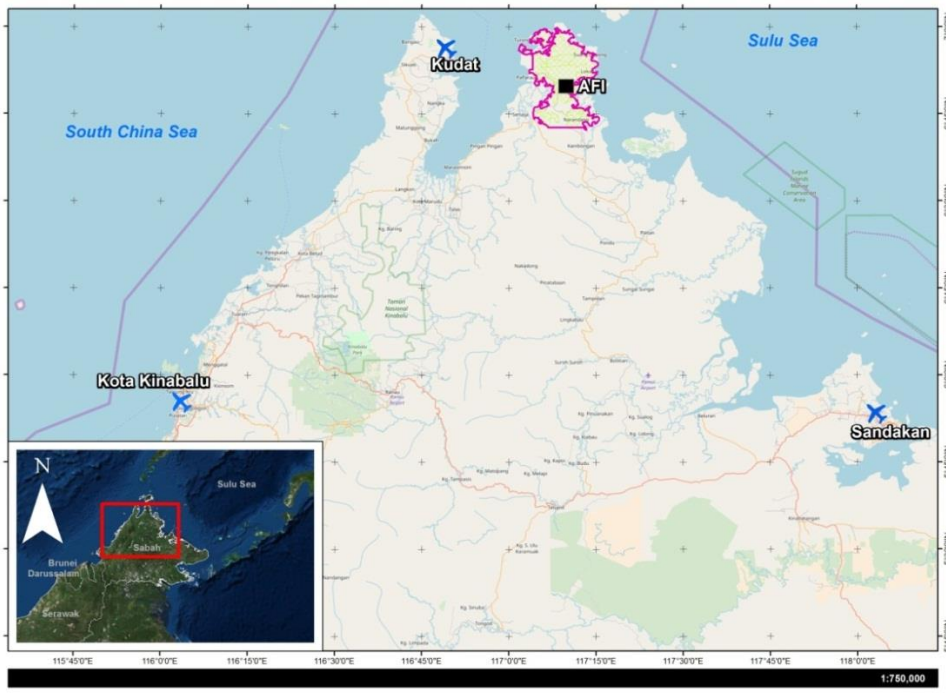
The data in the following subsection were gathered from desktop research based on the existing document provided by AFI such as EIA and SIA reports.

3.1 Site Setting

The project site covers an area of approximately 25,000 hectares and is located at the Bengkoka Peninsula in the District of Pitas. The project site is government gazetted land granted to SAFODA. The project site is approximately 4 km northeast of Pitas town, 47 km northeast of Kota Marudu and approximately 152 km northeast of Kota Kinabalu City. The project site is accessible via the Pitas-Kanibongan Highway. The specific geographical coordinates of the boundaries of the project site is given in *Table 1* while *Figure 2* illustrate access to project site.

Table 1 – Site Boundaries Coordinates

Project Boundaries	Coordinates	
	Latitude (N)	Longitude (E)
Northern	06° 59’ 53.0”	117° 08’ 35.2”
North-east	06° 55’ 11.1”	117° 15’ 7.41”
Southern	06° 42’ 57.7”	117° 08’ 23.7”
South-east	06° 42’ 55.0”	117° 14’ 34.5”
Within Site	06° 48’ 37.2”	117° 08’ 37.2’



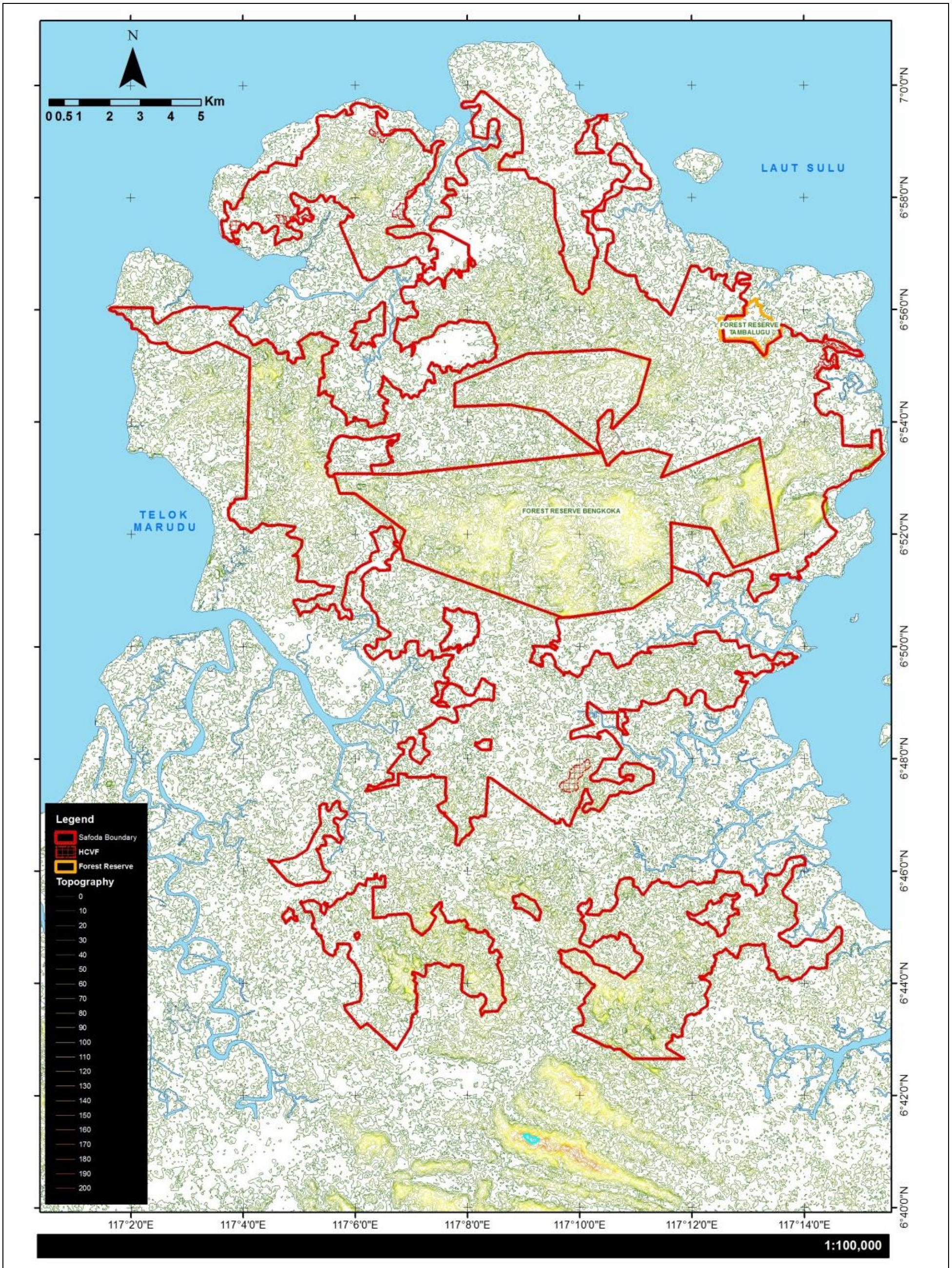
(Source: Esri & AFI)

Figure 2 – Access to Project Site

3.2 Topography and Site Conditions

About 99.8% (24,720 ha) of the total project site land is formed with ≤25° slope. Only 0.2% (49 ha) of the site area has steep land over 25° slope. The site topography is generally undulating hills ranging from 30.48 m to 60.96 m Above Mean Sea Level (AMSL) (*Figure 3).* Based on the site visit, several areas identified as plantation areas were seen in different stages i.e clearing, planting, full grown and ready for harvesting, as well as post plantation stages.

Topography in surrounding AFI areas based on GIS modelling on DEM from ASTGTM2 (N06E&07E117) is presented in *Figure 3* below.

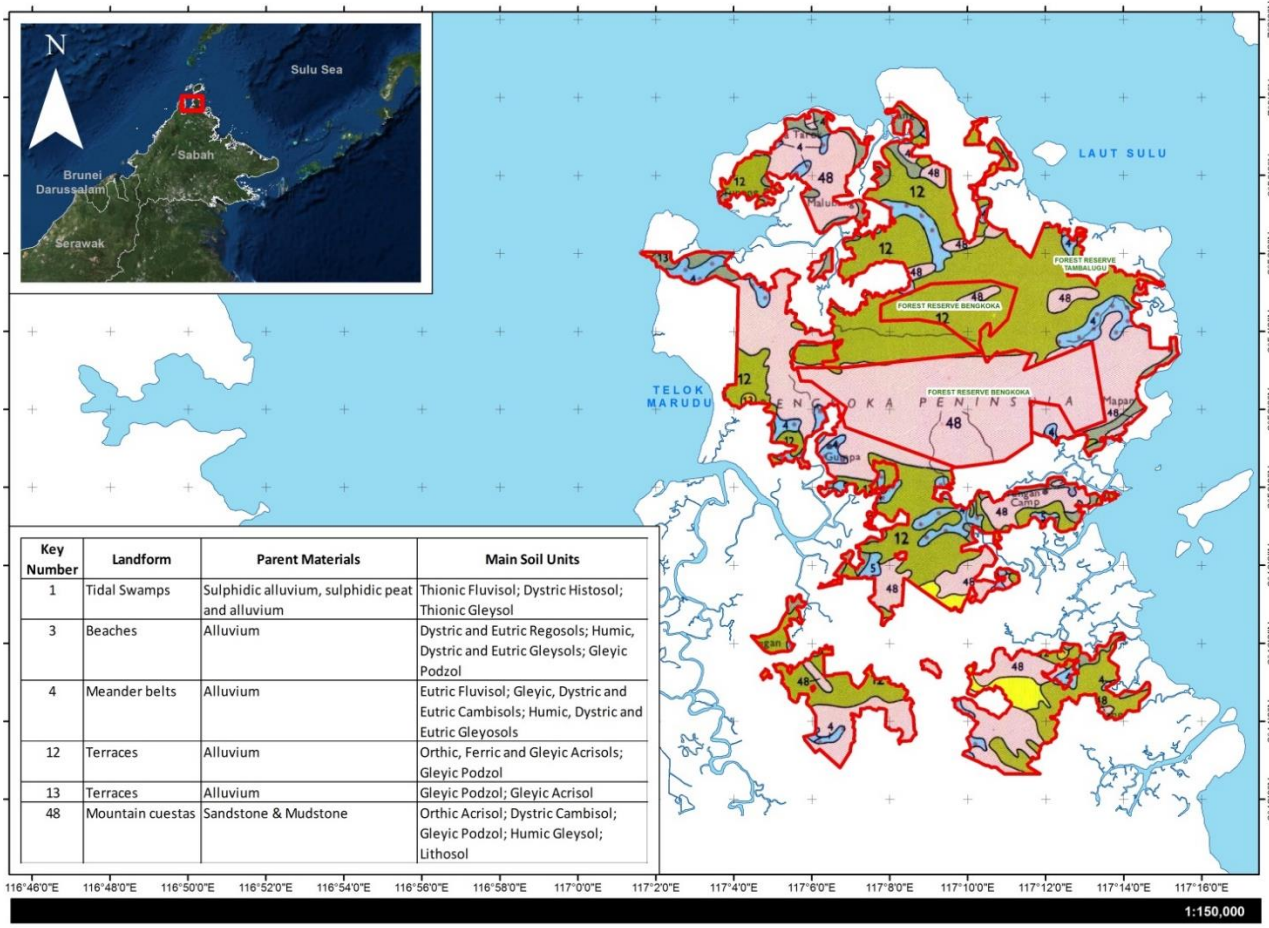


(Source: USGS ASTGTM2 https://gdex.cr.usgs.gov/gdex/ retrieved on 3rd May 2018 & AFI)

Figure 3 – Site Topography

3.3 Geology and Soils

As shown in *Figure 4*, most of the site falls within the Kudat Formation and Bongaya Farmation, with a small portion of South Banggi Formation as well as coastal & riverine alluvium. Kudat Formation is an Oligocene strata and consists of mudstone, sandstone, shale, siltstone, conglomerate and limestone. Bongaya Formation comprises sandstone, mudstone, siltstone, shale, conglomerate and lignite with minor limestone and tuff. In terms of soil formations, Maliau and Lokan Associations are the dominant soil within the project site with mudstone and sandstone as its parent materials. These associations occur on the mountain cuestas. The minor soil associations are Brantian and Tuaran Associations with alluvium as their parent material.



(Source: British Government's Overseas Development Administration (Land Resources Division), UK, 1974, for Sabah Government)

Figure 4 – Soil and Geological Map of the Site

3.4 Land Use

The project site is dominated by a blend of shrub, secondary forest for mixed horticulture, and wild Acacia forest, which was previously planted by Safoda. Villages are located scattered around and within the gazetted area. Currently, the project site is predominantly covered with natural vegetation of secondary forest, *Acacia Mangium* planted by AFI, and Acacia wildings as well as undergrowth vegetation such as ferns and coarse grasses.

The project site is also surrounded by several forest reserves as listed in *Table 2* below.

Table 2 – Forest Reserve Near to Site

Land Use	Location From The Project Site
Bengkoka Protection Forest Reserve	In the centre of the project boundary
Tambulugu Protection Forest Reserve	North-east boundary of the project site
Bengkoka Peninsula mangrove Forest Reserve	Eastern boundary of the project site
Paitan Commercial Forest Reserve	Southern boundary of the project site

3.4.1 Sensitive Receptors

The identification of sensitive receptors surrounding the project site is based on available reference documents namely Environmental Impact Assessment (EIA) Study performed by Kiwiheng Wood & Environmental Consultants Sdn. Bhd. in 2009 and Social Impact Assessment Study done by Sustainability and Grassroot Empowerment Consultant (SAGE Consult) in 2017.

The sensitive receptors include:

Villages

There are approximately 59 existing villages scattered within the project site and some of them are as below:

1. Kg. Malubang,
2. Kg. Maringan
3. Kg. Suang Duyung
4. Kg. Bawing
5. Kg. Kapok
6. Kg. Serupil
7. Kg. Liu
8. Kg. Kodong
9. Kg. Jambu
10. Kg. Gumpa
11. Kg. Telaga,
12. Kg. Ungkup
13. Kg. Bongkol
14. Kg. Tg. Piring
15. Kg. Lukan
16. Kg. Wasoi
17. Kg. Polod
18. Kg. Pangkalan Mangkapon
19. Kg. Boluuh
20. Kg. Datong
21. Kg. Sungai Eloi
22. Kg. Manggis
23. Kg. Radap
24. Kg. Ampungoi
25. Kg. Petani Baru
26. Kg. Kabatasan Darat, and
27. Kg. Tampakahu.

Based on the EIA there were approximately 12,000 inhabitants in these villages in total. The largest ethnic group was Rungus, followed by a small number of Sungai and Bajau.

By estimates based on available data (EIA, 2009), these villagers have been living in the area for a period of more than 30 years, and are mainly involved in agricultural cultivation of paddy and small-scale oil palm plantation, while some work for the government and private sectors.

Most of the local populations derive their drinking water from rainwater and well water however, Sg. Bongkol is utilised for bathing and washing purposes by the local populations of Kg. Bongkol during drought season.

In the EIA conducted for AFI in 2009, it was stated that there was a government water intake point located within Bengkoka Protection Forest Reserve area which is outside the AFI project site however based on the site observation the only water intake at Bengkoka Forest Reserve is the Safoda/AFI dam which is not a government water intake point. No other water intake point was observed in the area.

The majority of the area in the Bengkoka peninsular is not provided with electricity supply and telecommunication. Primary schools can be found in Kg. Bongkol and Kg. Pangkalan Mangkapon whilst a secondary school is located in Kg. Bongkol.

Forest Reserve

There are seven classes of Forest Reserves in Sabah, which are Protection Forest (Class I), Commercial Forest (Class II), Domestic Forest (Class III), Amenity Forest (Class IV), Mangrove Forest (Class V), Virgin Jungle Reserve (Class VI) and Wildlife Reserve (Class VII)[1]. AFI plantation area is located in the vicinity of two Forest Reserves that has been newly classified as Class II, namely Bengkoka Forest Reserve and Tambalugu Forest Reserve and one Class V Forest (mangrove forest). These Class II Forest Reserves were dominated by secondary forests mixed with *Acacia* species. The Bengkoka Forest Reserve harbours a substantial portion of native plant species, whereas the vegetation in Tambalugu Forest Reserve has been altered into permanent and unproductive grassland. A combined 6,467 Ha area of BFR and TFR is now under a "Sustainable Forest Management Licensee Agreements" (SFMLAs) company namely Gerak Saga Sdn Bhd (GSSB) for industrial tree plantation development. Both forest reserves will be managed in single FMU in 4 coupes. GSSB has also an approved 10-year Forest Managed Planting (FMP) from 1st January 2017 – 31st December 2026 for both Bengkoka Forest Reserve & Tambalugu Forest Reserve. BFR and TFR will be planted with *Eucalyptus* and *Acacia mangium* with rotation period of 10 year in 5,625 Ha plantable areas. SFMLA for GSSB was signed in 2016 and expires in 2115. EIA for this project was conducted by Chemsain Konsultant Sdn. Bhd. and approved in December 2017.

Forest fire is reported as common in these areas and may affect the Forest Reserve and also the plantation. The Forest Reserves were also logged previously before they were gazetted as Class I Protection Forests in 1984. Based on the previous soil survey carried out, the soil is characterized as podzol which is featured by bleach white substrate and low in nutrient due to leaching.

3.4.2 Historical Landuse

AFI plantation area is located in the vicinity of two Class II Forest Reserves, namely Bengkoka Forest reserve and Tambalugu Forest Reserve, and one Class V Mangrove Forest, namely Bengkoka Peninsula. Bengkoka Forest Reserve was gazetted as a forest reserve in 1968 and was reclassified as Protection Forest Reserve Class I in 1984. In 1995, an area of 86 ha was excised for villagers, leaving 6,270 ha. The Tambalugu Forest Reserve was gazetted as a forest reserve (Class II) in 1971 and then reclassified as Protection Forest Reserve Class I in 1984. Bengkoka Peninsula as Class 5 Mangrove Forest was gazetted in 1984. SAFODA started doing forest plantation activities in 1983 prior to AFI taking over in2003.

Satellite images taken from Google Earth shows changes in the landuse surrounding Project Site from 1984 to 2018. The following describes images taken during these years is presented in *Figure 5*.

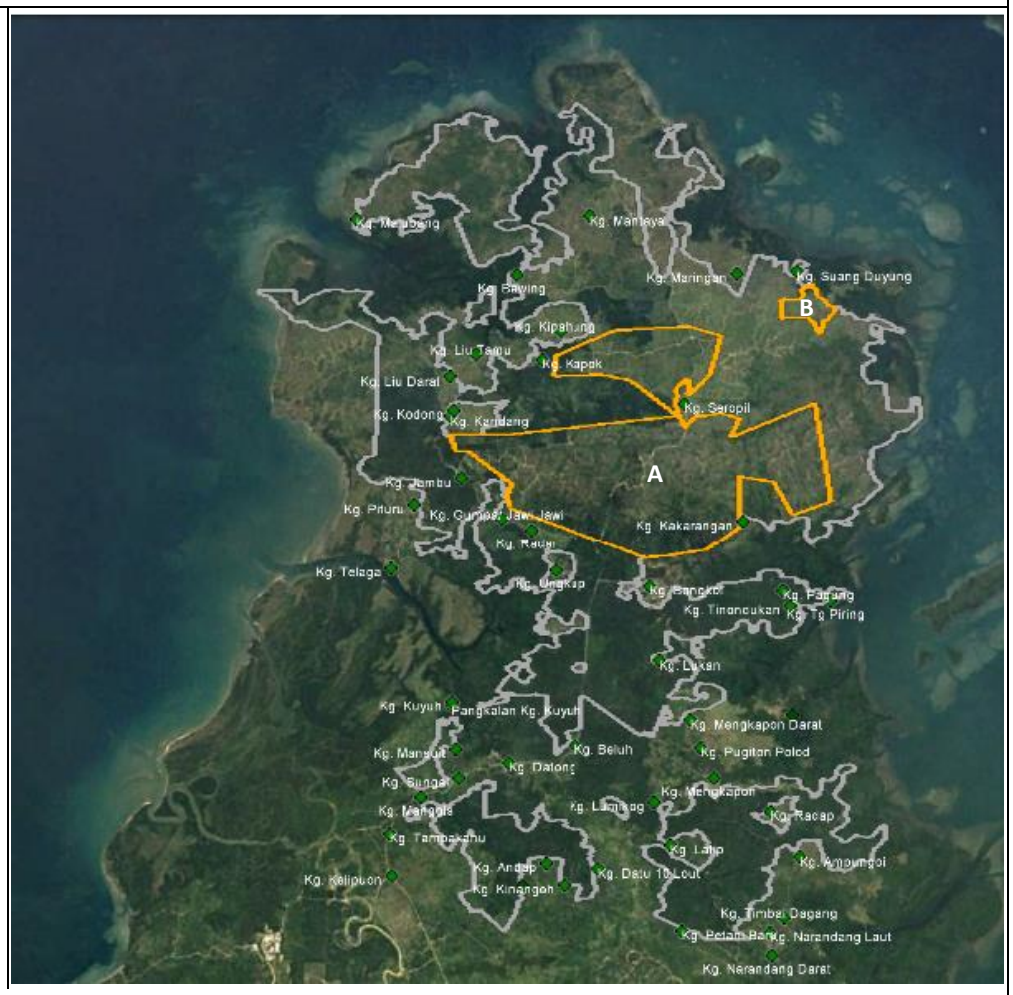
The images from 1984 show clear logging activities especially in the area now known as Bengkoka Forest Reserve. The logging activities in the Bengkoka Forest Reserve seems to have ceased in late 1990s and the area appear to have recovered by 2010. The only areas that did not show clear encroachment activities are the coastal mangrove areas in the vicinity of Kg Tanjung Piring and Kg Pituru. However, mangrove area in the vicinity of Kg Telaga was disturbed since early 2014. Establishment of residential areas (kampungs) with clear influx of population increase starts showing on the images from mid 2000s especially in the areas of, Kg Liu, Kg Kandang, Kg. Bongkol and Kg. Telaga.

[1] Sabah Forestry Department, International Society for Mangrove Ecosystems and Tokio Marine & Nichido Fire Insurance Co., Ltd. (2014). Rehabilitation of Mangroves In Sabah. The SFD-ISME Collaboration (2011–2014).

1984

1986

1990



1996

2000

2006

2010

2016

(Source: Google Earth & AFI)

Figure 5 – Satellite Images of Site Surrounding Areas from 1984 to 2016 (Demarcated areas in orange are Bengkoka Forest Reserve (A) and Tambalugu Forest Reserve (B))

3.5 Hydrology & Hydrogeology

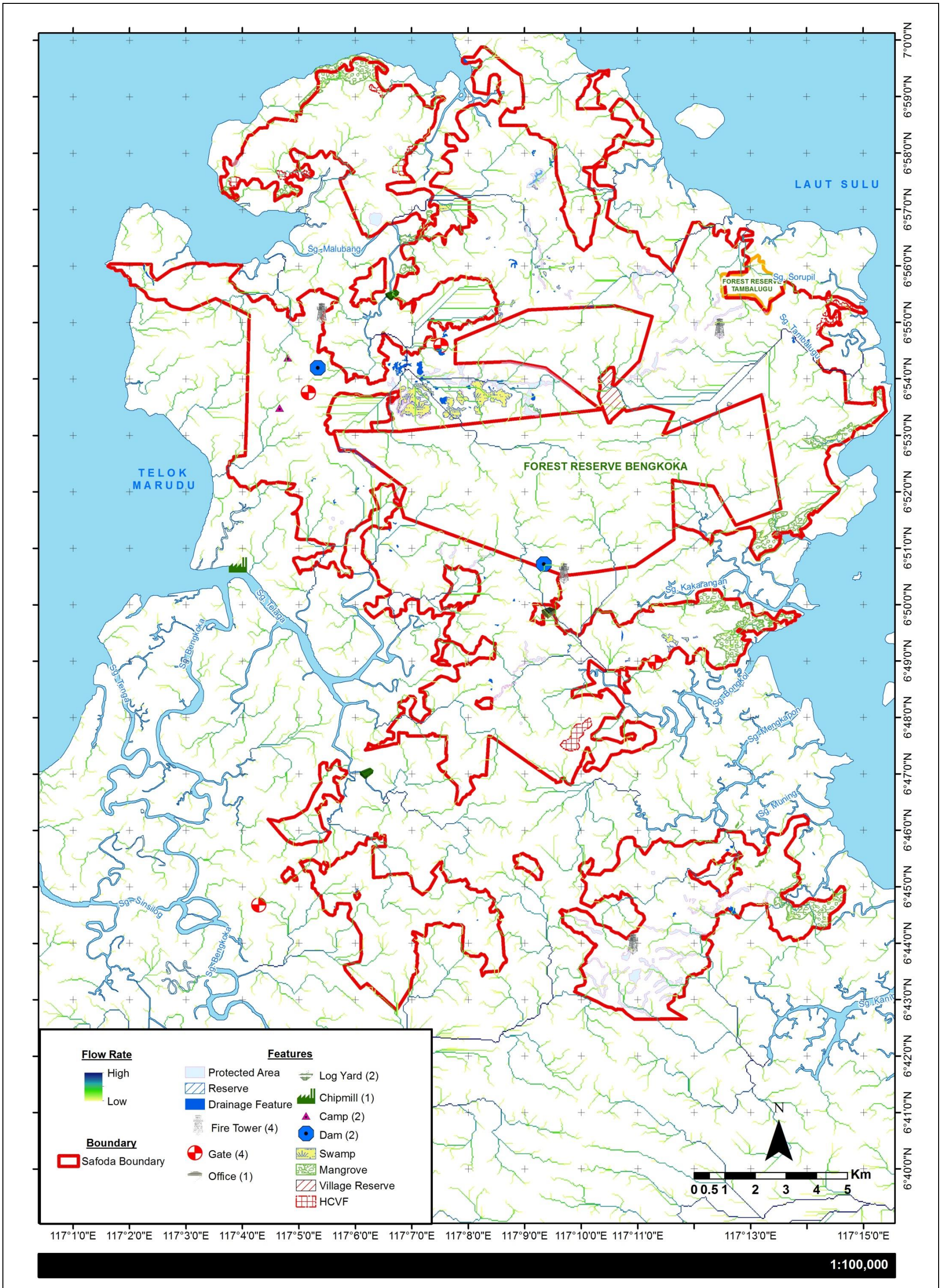
Based on EIA 2009, there are five (5) major rivers in the vicinity of the project site namely, Sg. Telaga, Sg. Malubang, Sg. Kakarangan, Sg. Bongkol and Sg. Badong (*Figure 6*). Sg. Kakarangan and Sg. Bongkol flow eastward into the Sulu Sea, while Sg. Telaga, Sg. Malubang and Sg. Badong flow westward into Marudu Bay. Currently, all the aforementioned rivers flow in the vicinity of AFI active areas except for Sg Badong.

Sg. Telaga forms the largest catchment in the area which encompasses approximately 140.42 km2 and is located on the southwest side of the Bengkoka peninsular. It passes through 3 AFI working areas operated by Pemborong Silanra, Mega Uni, Paulus Enterprise and Borneo Harvest and 12 villages that include Kg. Jambu, Kg. Telaga, Kg. Gumpa, Kg. Radap, Kg. Ungkup, Kg. Pituru, Kg. Kuyuh, Kg. Mansuit, Kg. Boluuh, Kg. Sungai, Kg. Manggis and Kg. Datong.

Sg Malubang's water catchment encompasses an area of approximately 94.82 km^2 and is located in on the northern part of Bengkoka peninsular. This basin is currently located in area operated by Perusahaan Usaha Ladang and BVLU. This catchment passes through villages in northwest side of AFI area that include Kg. Liu, Kg. Mantaya, Kg. Bawing, Kg Kodong, Kg Kandang, Kg. Kapok and Kg. Kipahung.

Sg. Bongkol's water catchment encompasses approximately 35.6 km^2 while Sg Kakarangan's water catchment is 22.93 km^2. Both of these catchments are located in the eastern part of Bengkoka peninsular. Sg. Bongkol's catchment passes through area of Kg. Bongkol and Kg Lukan while Sg. Kakarangan's catchment passes through Kg. Kakarangan, Kg. Tinondukan, Kg. Pagung and Kg. Tanjung Piring. Catchment area of Sg. Bongkol is also located at areas operated by MTM Contractors and Mega Uni.

The streams and river flow lines within and in the surrounding AFI areas based on GIS modelling on ASTGTM2 (N06E&07E117) is presented in *Figure 6* below.



(Source: ASTGTM2 (N06E&07E117) https://gdex.cr.usgs.gov/gdex/ retrieved on 3rd May 2018 & AFI)

Figure 6 – Streams and rivers' flow lines at and around the Project Site

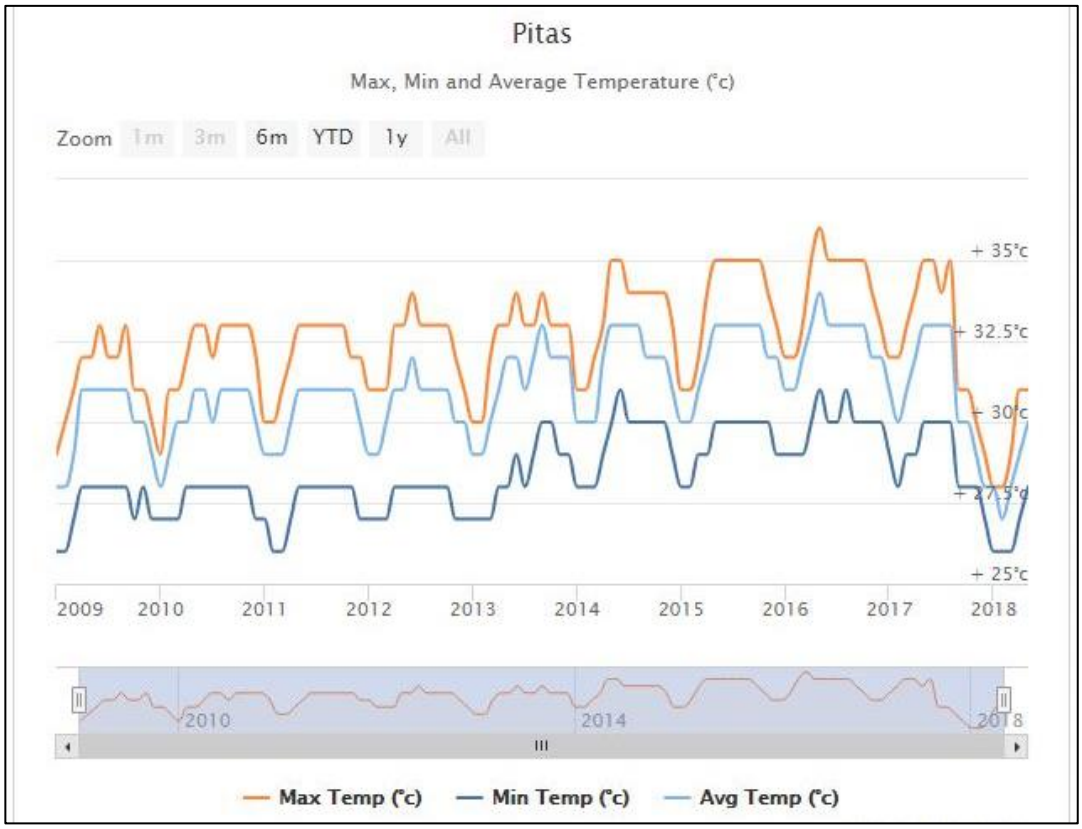
3.6 Climate & Meteorological Conditions

The climate in Bengkoka is typical of tropical equatorial climate with abundant rainfall, high and uniform temperatures, and high humidity all year round. Data for the annual rainfall, temperatures and humidity for Bengkoka or Pitas which in the vicinity of project site were not made available; therefore, the data in these sections were extracted from a secondary source, i.e. World Weather Online.

3.6.1 Temperature and Humidity

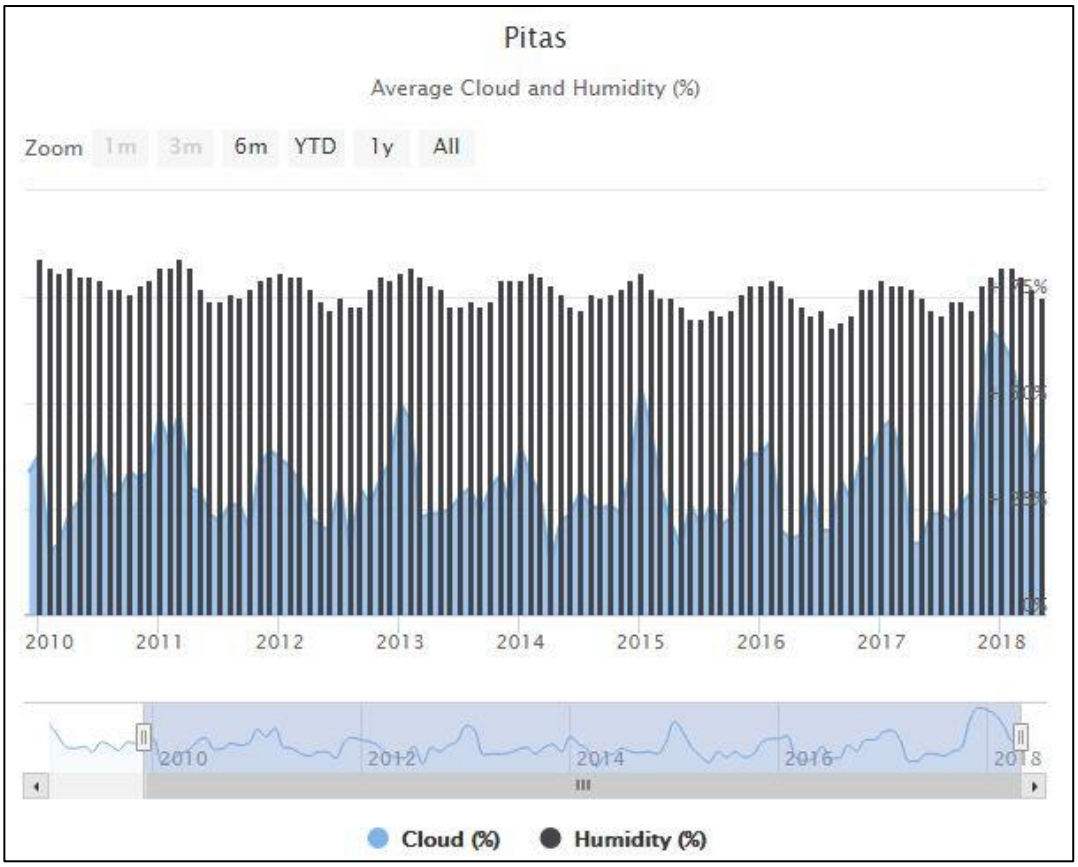
Temperature trends from January 2009 to May 2009 illustrated in *Figure 7* below shows average temperatures of Pitas district ranging from a minimum of 26°C (2009) to maximum of 36°C (2016). Further analysis of the graph shows a repeated trend of increase in temperature in June and September and decrease temperature from the months of January to February.

Change in temperature is relative to the change in humidity. Data presented in *Figure 8* is the average humidity from January 2010 to May 2018. Lowest humidity at 68% was recorded in August 2016 while the higest was in January 2010 at 84%. The graph, however, recorded that cloud cover in December 2017 as maximum (67%) and February 2010 (15%) as minimum.



Source: WorldWeatherOnline.com

Figure 7 – Average Pitas Temperature

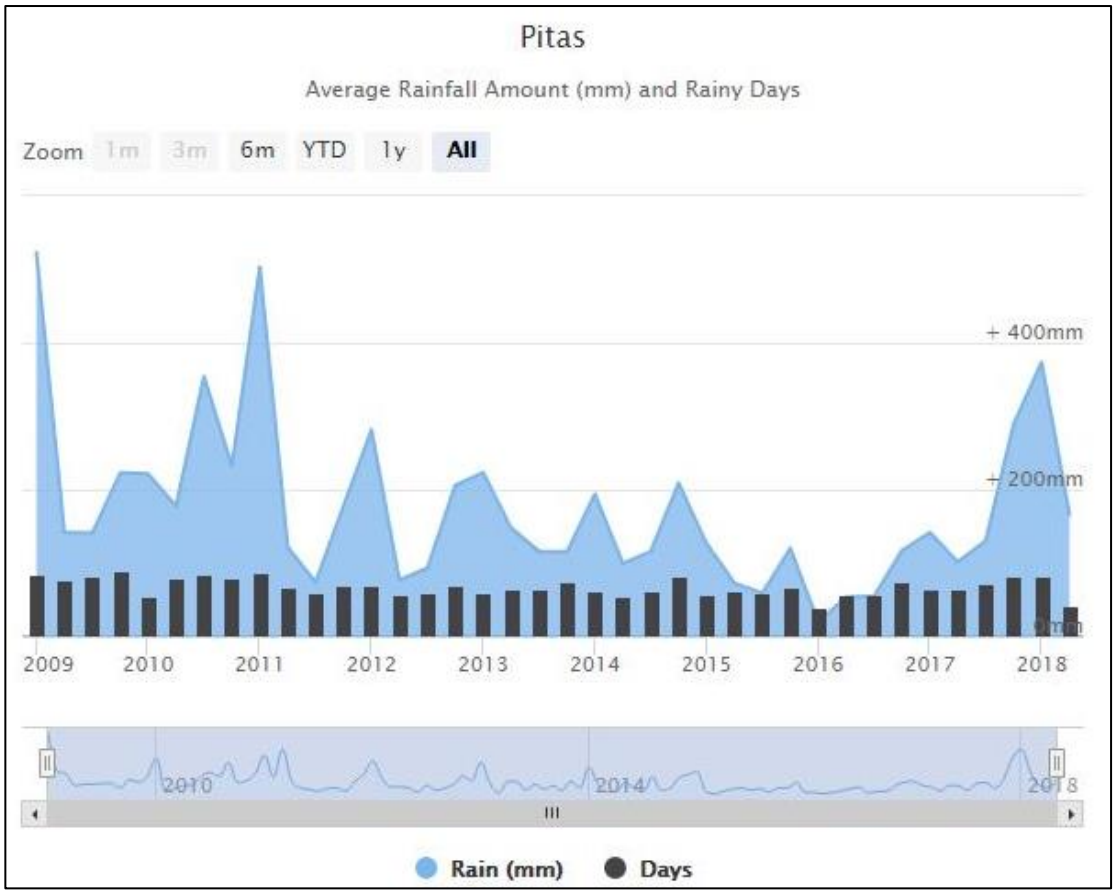


Source: WorldWeatherOnline.com

Figure 8 – Average Cloud and Humidity (%) at Pitas

3.6.2 Rainfall

The rainfall data in *Figure 9* illustrates the average rainfall data and rainy days from January 2009 to May 2018. The record indicated unsimilar pattern of driest and wettest months of each year. The web recorded that the lowest average rainfall amount was occurred in January – March 2016 (19.7 mm) however, in the same period of months in 2009 the highest average rainfall amount was also recorded (522.9 mm). This pattern may occur due to climate changes phenomenon.

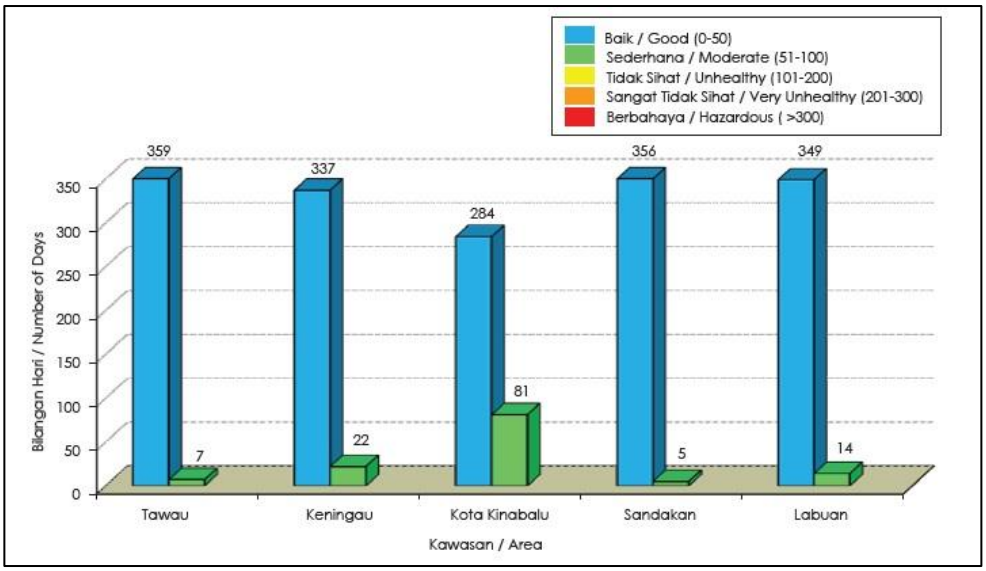


Source: WorldWeatherOnline.com

Figure 9 – Average Rainfall and Rainy Days at Pitas

3.7 Air Quality

Air quality status is reported in terms of Air Pollution Index (API) where the API is calculated based on the concentration of five major pollutants which are ground level ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter of less than 10 microns in size (PM_{10}). The API is categorised as good, moderate, unhealthy, very unhealthy and hazardous. There are no industrial areas that producing dangerous discharge to the air within 5 km from the project site therefore, no major sources of air pollution in the surrounding area. Based on the DOE's Environmental Quality Report, 2016, the nearest location of Continuous Air Quality Monitoring (CAQM) station is at Kota Kinabalu (±152 Km) and Sandakan (±154 Km). The air quality in both CAQM was ranging from good to moderate as shown in *Figure 10* below.



Source: Environmental Quality Report 2016

Figure 10 –Air Quality of Sabah in 2016

4 HYDROLOGY ASSESSMENT

The hydrology assessment was conducted based on the observations during the field study and review of previous sampling activities. Result of field studies that were conducted in May and July 2018 are also summarised in the following sections.

4.1 Proposed Sampling Location

Due to the large size of the gazetted area, ESC, as agreed with AFI, proposed a total of 14 sampling locations for the Hydrological Assessment around the AFI gazetted area, focussing on areas where there is active work. The locations were selected based on a review of Google Earth data, USGS based river flow map as well as AFI's on-the-ground information. To establish the quality of the water, sampling points are taken from the upstream and downstream of a river system that runs through the active plantation areas within or beyond AFI boundary. The upstream sampling points of each river system will be used as the benchmark for the respective downstream sampling points results.

There are 3 river systems that have been identified to be flowing through the AFI's active plantation areas and therefore have been selected for this assessment namely Sg. Malubang, Sg. Telaga and Sg. Bongkol. Sg. Malubang and Sg. Telaga flow towards the west part of the peninsula into Marudu Bay whereas Sg. Bongkol flows into Sulu Sea on the east.

By referring to AFI active areas and USGS based stream flow map, ESC, on 27th June 2018, had initially proposed new sampling points to represent the aforementioned river systems. The last letter in the sampling location name denotes the river system where the points are located. System A, B, E represent points located on Sg. Telaga; System C on Telok Marudu; System D on Sg. Malubang; and System F on Sg. Bongkol. Initial selections of 20 sampling points were proposed for consideration (the 6 extra points were proposed as backup prior to ground truthing) as listed in *Table 3* below:

Table 3 – ESC's Proposed Sampling Points Location

		DRAFT 27-06-2018				
NO	Name	X*	Y*	Location & Justification	River System	AFI Remarks (03-07-2018)
1	W01A	117° 5'58.33"E	6°52'12.95"N	Kg. Jambu (TELA), upstream of Borneo Harvest Plantation Area (upstream A)	Sg. Telaga	Kg. Jambu
2	W02A	117° 5'22.62"E	6°50'46.20"N	Kg. Telaga (TELA), downstream of Borneo Harvest Plantation Area (downstream A)	Sg. Telaga	Kg. Telaga
3	W03A	117° 5'10.89"E	6°52'21.54"N	Kg. Telaga (TELA), upstream of Pemborong SIlanra Plantation Area (upstream A)	Sg. Telaga	No River
4	W04B	117° 5'14.27"E	6°52'38.94"N	Kg. Telaga (TELA), upstream of Pemborong SIlanra Plantation Area (upstream B)	Sg. Telaga	Rubber area no river
5	W05B	117° 4'10.38"E	6°51'43.24"N	Kg. Pituru, downstream of Pemborong SIlanra Plantation Area (downstream B	Sg. Telaga	River exist

		DRAFT 27-06-2018				
NO	Name	X*	Y*	Location & Justification	River System	AFI Remarks (03-07-2018)
6	W06C	117° 4'38.62"E	6°53'43.00"N	Kg. Kandang (KAND), upstream of BVLU Plantation Area (upstream C)	Telok Marudu	River exist
7	W07C	117° 3'39.95"E	6°52'17.90"N	Near to Telok Merudu, Kg Telaga (TELA), downstream of Borneo harvest Plantation Area (downstream C)	Telok Marudu	No river
8	W08D1	117° 6'31.20"E	6°53'39.51"N	BODU, upstream of Perusahaan Usaha Ladang Plantation Area (upstream D)	Sg. Malubang	Swamp Area
9	W08D2	117° 6'39.44"E	6°53'8.26"N	BODU, inside Perusahaan Usaha Ladang Plantation Area (upstream D)	Sg. Malubang	No River
	W08D3	117° 7'12.76"E	6°53'9.97"N	BODU, inside to Perusahaan Usaha Ladang Plantation Area (upstream D)	Sg. Malubang	Swamp Area in Forest reserve
	W08D4	117° 7'30.97"E	6°53'18.55"N	BODU, inside to Perusahaan Usaha Ladang Plantation Area (upstream D)	Sg. Malubang	Swamp area
10	W09D	117° 6'54.57"E	6°54'31.69"N	Kg Kapok (KAPO), downstream of Perusahaan Usaha Ladang Plantation Area (downstream D)	Sg. Malubang	No river
11	W10D	117° 6'15.06"E	6°54'22.78"N	Kg Liu Darat (KPLI), downstream of Perusahaan Usaha Ladang Plantation Area (downstream D)	Sg. Malubang	River exist
12	W11D	117° 6'10.60"E	6°54'55.74"N	Kg Liu Tamu (KPLI), downstream of Perusahaan Usaha Ladang Plantation Area (downstream D)	Sg. Malubang	River exist
13	W12E	117° 8'13.98"E	6°49'50.05"N	TOBI, inside Paulus Enterprise Plantation Area (upstream E)	Sg. Telaga	No river
14	W13E	117° 7'42.85"E	6°49'54.24"N	TOBI, after Paulus Enterprise Plantation Area (downstream E)	Sg. Telaga	No river

		DRAFT 27-06-2018				
NO	Name	X*	Y*	Location & Justification	River System	AFI Remarks (03-07-2018)
15	W14F	117° 8'59.52"E	6°48'52.01"N	KGT, upstream of Mega Uni Plantation Area (upstream F)	Sg. Bongkol	River exist
16	W15F	117° 9'48.90"E	6°49'5.43"N	BAK, after MTM and Mega Uni Plantation Area (donwstream F)	Sg. Bongkol	River exist
17	W16F	117° 9'18.85"E	6°50'0.21"N	Kg. Bongkol, upstream of nursery (upstream F)	Sg. Bongkol	River exist
18	W17F	117°10'14.51"E	6°49'3.10"N	BAK (donwstream F)	Sg. Bongkol	River exist
19	W18	117° 3'10.83"E	6°50'26.28"N	Sg. Telaga	Telok Marudu	River exist
20	W19F	-	-	Forest reserve, Bongkol Dam	Sg. Bongkol	Dam

*WGS 1984 UTM 50 N

Following ground truthing and site verification by AFI, several sampling points (columns highlighted in red - i.e. Nos. 3, 4, 5, 9, 13 &14) were excluded because no suitable water bodies were found at the proposed locations. Sampling points located in Kg. Jambu (columns highlighted in orange i.e. Nos. 1&2) also had to be excluded due to the socio-political situation in those areas post Malaysia's General Elections.

The revised list is shown in *Table 4* below:

Table 4 – ESC's Proposed Sampling Points Location (Revised)

No	Name	X	Y	Sampling Point	Justification
1	W06C	117° 4'38.62"E	6°53'43.00"N	**1**	Telok Marudu river system – upstream water quality before BVLU area (active plantation)
2	W07C	117° 4' 19.20" E	6° 52' 55.12" N	**2**	Telok Marudu river system – downstream water quality after BVLU and Pemborong SIlanra (active plantation)
3	W08D1	117° 6'31.20"E	6°53'39.51"N	**3**	Sg Malubang river system – upsteam water quality based on water from Kg Kandang and Kg Kodong.
4	W08D3	117° 7' 15.59" E	6° 53' 06.97" N	**4**	Sg Malubang river system – upstream water quality from forest reserve (baseline) before active plantation
	W08D4	117° 7' 33.60" E	6° 53' 08.55" N		

No	Name	X	Y	Sampling Point	Justification
					at Bodu (Perusahaan Usaha Ladang)
5	W09D	117° 6' 39.60" E	6° 54' 47.30" N	**5**	Sg Malubang river system – downstream water quality after active plantation at Kapok (Perusahaan Usaha Ladang).
6	W10D	117° 6'15.06"E	6°54'22.78"N	**6**	Sg Malubang river system – water quality of river in between W08D1 and W11D and possible downsteam of streams from Kg. Kapok and Kg. Liu Darat
7	W11D	117° 6'10.60"E	6°54'55.74"N	**7**	Sg Malubang river system – water quality of river (downstream) from Kg Kandang, Kg Kodong and possible streams from Bodu.
8	W14F	117° 8'59.52"E	6°48'52.01"N	**8**	Sg Bongkol river system - water quality of upstream before active plantation (Mega Uni) area at Bongkol.
9	W15F	117° 9'48.90"E	6°49'5.43"N	**9**	Sg Bongkol river system - water quality of downstream after active plantation (MTM Contractor) area at Bongkol.
10	W16F	117° 9'18.85"E	6°50'0.21"N	**10**	Sg Bongkol river system – water quality of upstream before active plantation (MTM Contractor) at Bongkol
11	W17F	117° 10'14.51"E	6°49'3.10"N	**11**	Sg Bongkol river system – Water quality of downstream after active plantation (MTM Contractor) at Bongkol
12	W18	117° 3'10.83"E	6°50'26.28"N	**12&13**	Sg Telaga river system (low tide and high tide) – water quality of Sg Telaga as a baseline after the excluded sample points of A & B
13	W19F	117° 9' 21.60" E	6° 50' 40.88" N	**14**	Sg Bongkol river system – water quality of AFI

No	Name	X	Y	Sampling Point	Justification
					Dam as a baseline for upstream of river system F.

4.2 Actual Sampling Location

During the actual sampling period, ESC encountered several issues relating to location and condition of some of the sampling points e.g. location not the same as suggested in the USGS, some points are not/ no longer connected to the designated river system and some were not accessible. As such, some of the points were relocated to new locations, new points were added and some were eliminated. However, the new selected points are still located near the original proposed locations and within the same river systems.

The affected points are listed below and the new revised sampling point locations are shown in *Figure 12* below.

The relocated points were:

- River System C (Telok Marudu): W06C and W07C

  Location W06C was not accessible and ESC was told that it only flows during or after heavy rain in wet season. A new point to replace W06C was identified and selected and renamed as W06Ca (6°53'33.10"N, 117°4'39.20"E).

  For W07C, the location was not suitable as it was located in the middle of an active plantation. A new location was selected further downstream and renamed as W07Ca (6°52'35.80"N, 117°4'13.20"E).

- River system D (Sg. Malubang) : W08D3, W09D, W10D and W11D

  W08D3 was relocated to W08D3a because the stream could not be found due to accessibility issues. W08D3a (6°53'15.88"N, 117°7'4.43"E) was selected however, it should be noted the waterbody is shallow with very slow water flow.

  For the same reason as above, W09D was relocated to W09Da (6°54'48.59"N, 117° 6'28.62"E) which is more accessible. The sample would represent water sample downstream from an active plantation area in Bodu.

  W10D was relocated to a wider stream line further downstream of its original location. The width of the stream for W10D new location (6°54'27.30"N, 117°6'14.30"E) was observed to be more representative as a sampling point to determine water quality from Kg. Kapok and Kg. Liu Darat.

  Point W11D which is about 400m from bridge of Kg. Liu Tamu was not accessible and therefore relocated to W11da (6°54'48.05"N, 117°6'11.76"E) situated 100m from bridge of Kg Liu. Proper distance from the bridge of Kg Liu was important to ensure lesser contamination from activities at the jetty area (boats, restaurant and school).

- River System F (Sg. Bongkol): W15F and W17F

  Since W15F was not accessible for sampling, the other points within the system (including W17F and W14F) had to be excluded. W15Fa (6°49'29.70"N, 117°9'46.00"E) and W17Fa (6°49'17.40"N, 117°10'1.80"E) have been identified as replacement for the downstream points at Sg. Bongkol river system. An additional sampling point, W16Fa (6°50'2.70"N, 117°9'31.30"E) was included to represent water quality in AFI dam for the nursery.

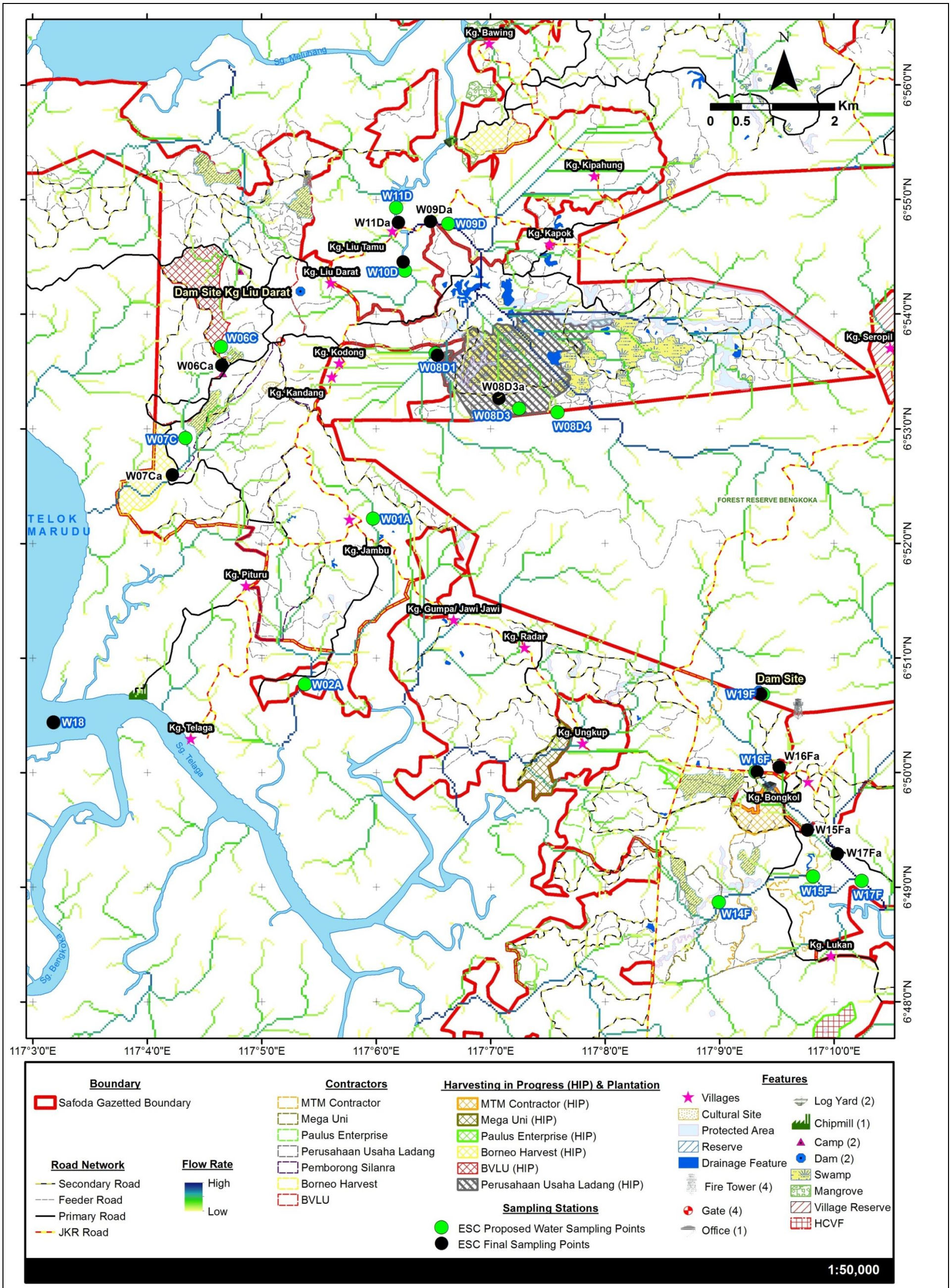
In summary, the excluded sampling points were:

- River system F (Sg. Bongkol): W14F

  W14F was excluded due to its relocation to W15F.

- River System D (Sg. Malubang): W08D4

As there were 2 locations (W08D3 and W08D4) that can determine conditions of upstream at Bodu area, the study excluded W08D4 and selected W08D3a as the new point for W08D3.



(Source: ASTGTM2 (N06E&07E117) https://gdex.cr.usgs.gov/gdex/ retrieved on 3rd May 2018 & AFI)

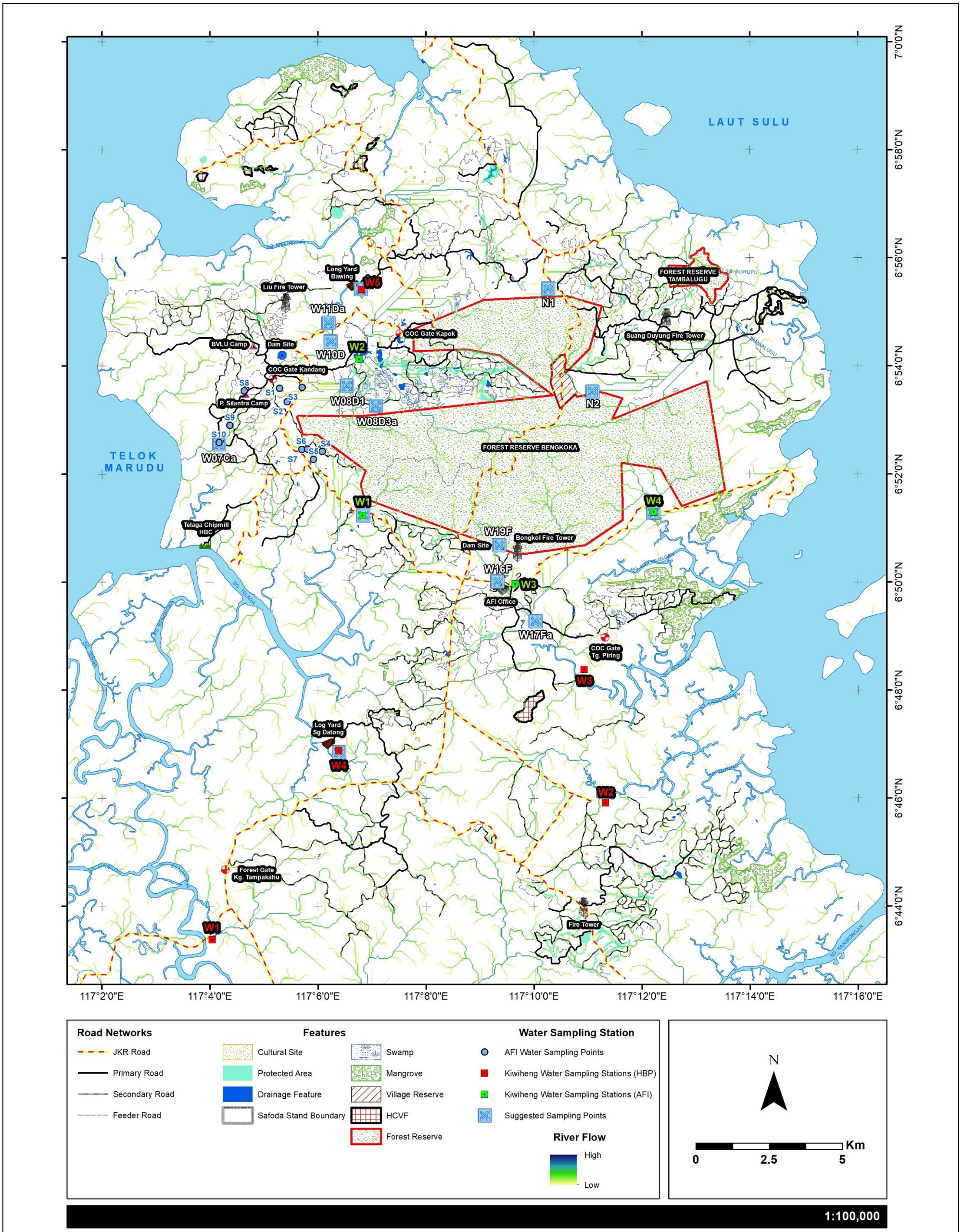
Figure 11 – ESC Water Sampling Points on 10th-18th July 2018

4.3 Evaluation of AFI's Water Management and Monitoring Plan

As part of AFI's ongoing management and monitoring plan, AFI had established several sampling points – identified by Kiwiheng, their EIA contractor (included in *Figure 12*) – to monitor the quality of the water bodies. Based on site observations and information provided by AFI, some of the existing sampling points are not relevant as they are located in non-active plantation areas. This may be due to changes in plans since the establishment of the sampling points. To ensure the relevance of the existing sampling point locations, ESC performed a gap analysis between AFI's existing sampling points and ESC's proposed sampling points to establish relevant locations.

Based on the desk review and the ESC site assessment conducted on 14th – 16th May 2018, ESC has recommended AFI to establish new sampling points and discontinue the use of some of Kiwiheng's sampling points except for the points that are located upstream of plantation areas which are still deemed relevant. Therefore, based on current AFI active areas, ESC concludes the following:

- Sampling points for Kiwiheng – AFI, namely W1&W4 (Sg Telaga and Sg Kakarangan river system) are located in non-active area however, these sampling points can be used to monitor water quality that coming from southern part of Bengkoka Forest Reserve (BFR) where Gerak Saga Sdn Bhd is operated. Sampling point W3 is replaced with W19F, W16F, and W17Fa to monitor water quality of river system F (Sg. Bongkol) while W2 is replaced with W08D1 to monitor water quality at Bodu area that coming from Kg. Kandang, and Kg Kodong.
- In addition to Kiwiheng – AFI sampling points, additional monitoring points at the northern part of BFR are required to be established. The recommendation for these additional monitoring points is to use W08D3a, W10D, and W11Da in northwest part of BFR and to establish new monitoring points to monitor the northeast part of BFR. This is important as northeast part of BFR is started to be developed as plantation areas (Kg. Maringan and Kg. Suang Duyung) in 2019. Suggested points to monitor upstream water quality of AFI plantation in northeast part of BFR are N1 which to be located at stream that flows to Kg Maringan and N2 at stream that flows to Kg. Suang Duyung. Approximate location of N1 and N2 are shown in in *Figure 12.* Map of streams and river line in surrounding AFI areas (*Figure 6* and in *Figure 12*) shows that suggested location of N1 is part of Kg. Maringan river system while N2 is part of Sg. Tambalugu river system. As to serves its function, sampling at N1 & N2 should be started prior to land preparation in Kg. Maringan and Kg. Suang Duyung.
- Kiwiheng-HBP sampling points W1 & W2 (Sg Bengkoka & Sg Mengkapon river system) are located in non-active area hence not suitable for monitoring purposes. However, W4 & W5 may still be used to monitor water quality near the log yard. Sampling point W3 is suggested to be replaced with W17Fa to give a better description on water quality at downstream of Sg. Bongkol.
- AFI sampling points, namely S8, S9 & S10 that were used to monitor water conditions in plantation area at Telok Marudu river system are still observed to be located in active area. In this study, sampling point W06Ca was located at S8 while W07Ca was located at S10. However, as W06Ca/ S8 was observed not located in upstream of the river system therefore, the recommendation is to find the upstream, namely N5 at KGLI05/ KGLI06/ KGLI09 then use together with S10 as monitoring points for Telok Marudu river system. Due to this uncertainty, exact location of N5 is not shown in *Figure 12*.
- AFI water quality sampling points to monitor the downstream of N1 & N2, namely N3 & N4 respectively, are suggested to be placed right after Kg. Maringan and Kg. Suang Duyung plantation boundaries in 2019. Exact locations for these downstream monitoring points are not to be indicated in this report as actual stream lines may be different from stream or river lines shown in *Figure 12*.



(Source: ASTGTM2 (N06E&07E117) https://gdex.cr.usgs.gov/gdex/ retrieved on 3rd May 2018 & AFI)

Figure 12 – AFI & Kiwiheng Sampling Points & ESC Suggested Sampling Points

4.4 AFI's Standard Operating Procedures

Being aware of the effects of the plantation activities to the surround environment, AFI has developed and implemented Standard Operating Procedures (SOP) for each plantation process.

Based on desk review, several SOPs related to hydrology were found such as SOP for erosion control, clearing and replanting, chemical application, barrier zone to destructive fire, establishment of river buffer zones for all streams & rivers, watershed protection, and also the Protection of HCV.

As part of the water audit exercise, ESC water sampling was conducted also to measure the effectiveness of the SOP in place by comparing the water quality results from regular monitoring program perform by AFI. Other purpose of sampling from the river systems found within the active area of AFI plantation is to check the current water quality of the river systems and the results may also be used as a baseline data for future monitoring. The details and results of water sampling exercise are discussed and presented in Section 5.

SOP is an active document which needs to be updated regularly. Based on water sampling result, it seems that a thorough review of current SOP is required to improve water quality and avoid or reduce pollution to soil and ultimately the river system within the plantation.

While effects to water quality resulting from AFI plantation activities may be quantified, monitored and controlled, the same cannot be applied for the impacts pose by the villagers who also have their community farms and domestic activities. Hence to support the effectiveness of SOP that related to environmental conservation, it is important for AFI to educate and create awareness to the surrounding communities on the importance of preserving the natural environment as part of their community service programme.

4.5 Water Usage along Sg. Bongkol

SAFODA has built a dam located upstream of Sg. Bongkol river (System F) within the Bengkoka Forest Reserve. The river system F is observed to be connected to the main stream that flows to the mouth of Sg Bongkol. Water from the dam flow by gravity to an intermediate concrete water tank with a capacity of ±22.7 m^3. The water from the dam is treated via a newly installed filtration system before being collected in the intermediate tank. From the intermediate tank, the treated water will be pumped to the next storage tank with the capacity of ±91 m^3 before being distributed to the villagers in Kg. Bongkol.

Initially, the water was supplied to about 200 household in Kg. Bongkol. However, due to lack of maintenance, some of the pipes have started to deteriorate, broken, and had not been replaced. Thus, water supply has been reduced to around less than 50 household, AFI office and living quarters, surau and clinic.

There is also a second dam built by AFI (downstream of SAFODA dam) located in the vicinity of AFI office to supply water to AFI's pond (±8100 m^3) through a man-made canal and from there the water will be pumped to the newly constructed tank in nursery area. In addition, a rainwater harvesting pond is also made available recently in the nursery and therefore AFI have sufficient capacity for the nursery operations the water from AFI's pond (8100 m^3) will only be used in dry season.

Observation and information gathered from AFI and community suggest that the water from Sg. Bongkol is not being used for drinking and cooking but only for washing and other domestic use. Water for domestic use by the community is obtained by harvesting rain water. Rain water is commonly collected in the water tank and ponds. Water for drinking and cooking is normally supplied by vendors via water trucks that frequently deliver fresh water to community.

From observations and interviews, it was found that the water balance of Sg. Bongkol is steady because the source of water supply for community and AFI nursery in Kg. Bongkol is not mainly taken from Sg. Bongkol except when the area is experiencing a severe drought season. As such, there is no threat of overused river water of Sg. Bongkol for the livelihood of the communities.

4.6 AFI's Operations and Programmes compliance to the Relevant IFC Requirements

The Acacia Forest Industries (AFI) Environmental and Social Policy outlines the general principles of Environmental and Social (ES) management in the company. It sets corporate goals on the level of ES performance required by AFI staff and contractors.

The implementation of the Policy is through an Environmental and Social Management System (ESMS) aligned to the international standard ISO 14001, which is based on the Plan-Do-Check-Act cycle, and on the International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (and associated World Bank Group Environmental, Health and Safety (EHS) Guidelines, which define Good International Industry Practice (GIIP)).

The management system has also been designed to implement Forest Stewardship Council (FSC) environmental and social requirements. The ESMS enables AFI to identify all relevant ES requirements in its operations and to systematically control the risks and impacts.

Based on ESMS, several AFI operations and programmes have been incorporated to comply relevant IFC requirements in preserving waterbody conditions which are:

- Water Resources Efficiency and Pollution Prevention Management Plan - IFC PS 3 & IFC PS 6
- Water Waste Management Plan – IFC PS 3
- Surface Run Off, Erosion and Sedimentation Control Management Plan - IFC PS 3
- Aquatic Biota and Habitat Protection Management Plan - IFC PS 6
- Terrestrial Flora and Habitat Conservation Management Plan - IFC PS 6

As to ensure effective implementation, the clarity of objective and targets; specific and measurable actions; location of actions; timing and realistic frequency or duration of actions, person in charge (implementer) with applicable procedures are important in Management Plan. Clarity of Monitoring Plan should also be developed after Management Plan is being established. Several important points that required clarity in Monitoring Plan, namely: specific and measurable indicators; and method/locations/timing and realistic frequency or duration of monitoring. IFC compliance and Detail of Management and Monitoring Plan are presented in Biodiversity Management and Monitoring Plan (BMMP) and High Conservation Value Forest (HCVF) Reassessment reports.

5 WATER QUALITY SAMPLING METHODOLOGY

Water is an essential requirement of human life and activities associated with industry, agriculture, and others, and are considered as one of the most delicate parts of the environment. In the last few decades, the accelerated pace of industrial development and progressive growth of population caused in tremendous increase in the demand of fresh water. The quality of surface and groundwater is identified in terms of its physical, chemical, and biological parameters. The water quality of rivers is characterized by a high level of heterogeneity in time and space, because of the distinction of cover-land around. This often creates difficulties to identify water conditions and pollution sources, which is necessary to control effectively pollution in addition to construct successful strategies for minimizing of contamination resources.

Anthropogenic pollutants related to land use result in drastic deterioration of aquatic systems in watersheds. Additionally, the rivers play an important role in assimilating municipal and industrial effluent as well as runoff from agricultural land and the surrounding area in a watershed. On the other hand, rivers comprise the most important water resources for irrigation, domestic water supply, industrial, and other purposes in a watershed, thereby tending to stimulate serious hygienic and ecological problems. Consequently, prevention and controlling of river pollution and reliable evaluation of water quality are an imperative stipulation for effective management.

Human activities in particular husbandry livestock and agriculture play an important role in contributing contamination of river water among others pollutants. Wastewater of livestock contains high concentrations of ammonia nitrogen, organic and inorganic nitrogen compound, and pathogenic bacteria. Furthermore, serious environmental damage as a result of animal waste has been well documented in rivers which receive runoff of nutrient rich waste that caused oxygen depletion and increased the algae production. Study of surface water pollution of the river is important due to effluents from sewage, livestock wastewater, industrial activities, agricultural activities, and runoff which discharge into the river resulting in extensive variations in the water quality. Generally, all of land use and anthropogenic activities pose a grievous threat not only to aquatic ecosystem in the river but also the provinces if the river water is used as domestic supply.

Moreover, the range of deterioration in water quality in the river varied depending on the percentage of change in land use. Therefore, the land use activities in the basin must be carefully planned and controlled on account of protecting the water resource and quality status. In this study, the physicochemical and microbiological parameters were measured and classified based on National Water Quality Standard (NWQS) to identify the effects of anthropogenic land use activities on the water quality condition.

5.1 Surface Water Sampling Methodology

The surface water sampling techniques and tools described in this section were used to minimize effects on the chemical and physical integrity of the sample. The physical location when collecting a sample dictates the equipment to be used. Ideally, samples should be collected directly into the laboratory supplied containers where possible, as this will reduce the risk of contamination. Direct sample collection is the preferred method if the environment is safe and if sample bottles do not contain preservative. Where the waterbody is shallow, samples will be collected using a container or bucket secured to a pole/stick, rather than wading in, so as not to disturb the substrate. Pole/stick or bucket was also used during high flow conditions or where direct dipping into the water was too risky (e.g. sea water).

To collect a surface water sample from a water body or other surface water conveyance, a variety of methods can be used:

- Dipping Using Sample Container
- Scoops
- Peristaltic Pumps
- Discrete Depth Samplers
- Bailers
- Buckets
- Submersible Pumps

• Automatic Samplers

Regardless of the method used, precaution has to be taken to ensure that the sample collected is representative of the selected water body or sampling location. Selected methods for sampling conducted for AFI on 10th - 18th July 2018 by ESC were by combining buckets and scoop with the support of pole/stick whenever required. Procedure for selected water sampling method and sampling transport as described below:

Sampling Procedure:

1. Identify the area to collect the water sample and determine an appropriate and safe access route to minimise the risk of disturbance of the substrate prior to sampling.
2. All tools and equipment were inspected to ensure they are in good working order and has been cleaned appropriately before in-situ measurement was taken.
3. On reaching the sampling site, clean work area was prepared and all equipment was unpacked and ready to be used.
4. Pre-label of all sample containers was conducted when necessary.
5. Cooler box filled with sufficient amount of ice for preserving the sample was prepared before the sampling.
6. Before collecting water samples, in situ water condition readings were taken using AMK, AM 2000 - multiparameter probe to measure in-situ water quality parameters such as DO. (mg/L); EC. (uS/cm); TDS. (mg/L); Turbidity (NTU); Salinity (ppt); SSG. (σt); pH; ORP. (mV); and Temperature (°C). The probe was immersed directly into the waterbody. All measurement were recorded in water log forms for further recap. RO water was used to wash and rinsed the probe before use as to ensure quality of readings.
7. Powder free gloves were worn immediately prior to collection of the water sample. Gloves were stored and disposed in a clean environment (e.g. in a plastic bag).
8. A plastic bucket was lowered by rope and upon retrieval, the water is poured into the appropriate sample containers with a scoop. Samples were taken in careful manner by pulling/carrying slowly the bucket/scoop to location where water samples were poured into sample bottles. All tools were washed and rinsed thoroughly before sampling with water from sampling locations.
9. Samples were then placed into cooler box filled with ice for preservation.

Figure 13 shows the photos on method of taking water sample practiced during AFI water sampling.

	
Probe immersed in waterbody to take water condition readings	Bucket is used to collect water from waterbody

Sample bottles properly labelled and laid out on clean sheet

Sample transferred to sample bottle using scoop from the bucket

Figure 13 – Sampling Procedure

Sample transport:

1. Chain of custody (CoC) form was filled by ESC before the cooler box was handed over to transporter that has been assigned to send the samples to the the laboratory. Chain of custody was signed by ESC and transporter as to transfer the responsibility of sample handling from ESC to transporter.
2. Water from ice in the cooler box was drained every 1 hour by the transporter during transport to the laboratory in Kota Kinabalu (±4hrs ride) to avoid water contamination.
3. Transporter took a copy of CoC that has been signed by the laboratory personnel as a proof that the samples have been received by the laboratory.
4. Date and timing recorded in CoC were stated that all samples were received by the laboratory within the permitted handling time.

Collected samples are tested for parameters as per the National Water Quality Standards (NWQS). The NWQS parameters are listed in *Table 5* below.

Table 5 – Water sampling parameters

No.	Parameters	Test Method
1	pH	In-situ measurement
2	Temperature	In-situ measurement
3	DO	In-situ measurement
4	Biological Oxygen Demand	APHA 5210 B
5	Chemical Oxygen Demand	APHA 5520 D
6	Total suspended solid (TSS)	APHA 2540 D
7	Oil & grease	APHA 5520 B
	Organics	
8	Phenol	APHA 5530 B & D
9	Cyanide	APHA –CN C&E
10	Sulphide	APHA 4500-S D
11	Nitrate	APHA 4500-NO_3 H
12	Nitrite	APHA 4500- NO_2 B

No.	Parameters	Test Method
13	Ammoniacal Nitrogen	APHA 4500- NH3C
14	Phosphate	APHA 4500 – P F
	Metals	
15	Mercury	USEPA 6020
16	Chromium trivalent	APHA 3120 B & 3500-Cr B
17	Ferrous ion	APHA 3500-Fe B
18	Arsenic	APHA 3125
19	Boron	APHA 3125
20	Cadmium	APHA 3125
21	Tin	APHA 3125
22	Copper	APHA 3125
23	Iron	APHA 3125

5.2 Theoretical Basis

5.2.1 Required Parameter as per EIA and AFI's 2010 Commitment

Agreed parameters to be analysed during water quality monitoring were Turbidity, pH, TSS, oil & grease, BOD, COD and NH_3-N. These parameters are required to be tested in all sampling points identified in *Table 6.1 Environmental Monitoring Station* in AFI's EIA 2009 report.

5.2.2 Water Quality

Water quality specifies water suitability for certain use in human lives, such as for drinking, water for plantation and animal husbandry or others. One of strategic potential source of water that often used is river which also acts as waste or pollution collector from human activities and therefore adds to reduction of qualified water for human use. Water pollution is contamination or addition of organism into water that disrupt the use, utilization and preservation of water. This suggest, that water pollution is related to water quality which in river management act as basic foundation to define physical and chemical characteristic of the river.

Water quality is dynamic based on seasons, types and number of wastes that flows to water and its debit. In regards to water debit, the pollution also depends on the ability of flow rate to balance the turbidity from eroded organic sediment. Waste that flows to water will reduce water quality and change its ecological condition. Physical effect is seen in turbidity, suspended solid and water colour/taste, where chemical/ biological effect is seen in the increase of nutrients/metals and bacteria in the water.

River contamination based on Klein (1972) will cause:

1. Fermented organic material will be ravelled and cause deoxygenation. This process will cause fish kill if number of organic materials is found in large quantity due to the needs of oxygen in the ravel process.
2. Suspended solid will be settled in river base can damage aquatic organism and cause shallow river.
3. Corrosive and toxic materials will cause fish kill and reduction of bacteria and other aquatic organisms.
4. Industrial contamination will increase turbidity, colour changing, foaming, temperature changing and radio activities.
5. Materials that provide taste, smell, hardness, toxic and other heavy metal will not make river usable as drinking water.
6. Unbalanced ecology will cause the abundance of certain species that contribute to lower water quality.

Water is needed by all creatures especially for drinking and it could also cause significant trouble to consumer's health because of: water ability to dissolving solid materials, gas and other liquid hence all minerals and other materials from air and soil can be found in water and affect consumer's health; and water as prime factor in disease transmissions that affect water quality.

Water quality is determined by considering the following:

1. Drinking water that complies with health standard is playing the important role in preserve, protect and increase people's health.
2. The needs to avoid supply of water that is not conforming to health standard.

5.2.3 Water Quality Threshold

In Malaysia, water quality from the river systems is classified following the National Water Quality Standards (NWQS). Based on the NWQS, water quality is classified into 5 classes namely:

Class I, represents water body of excellent quality. Standards are set for the conservation of natural environment in its undisturbed state. Water bodies such as those in the national park area, fountain heads, and in high land and undisturbed areas come under this category where strictly no discharge of any kind is permitted. Water bodies in this category meet the most stringent requirements for human health and aquatic life protection;

Class II, represents water bodies of good quality. Most existing raw water supply sources come under this category. In practice, no body contact activity is allowed in this water for prevention of probable human pathogens. There is a need to introduce another class for water bodies not used for water supply but of similar quality which may referred to as Class IIB. The determination of Class IIB standard is based on the criteria for recreational use and protection of sensitive aquatic species;

Class III, which is defined with the primary objective of protecting common and moderately tolerant aquatic species of economic value. Water under this classification maybe used for water supply with extensive/ advance treatment. This class of water is also defined to suit livestock drinking needs;

Class IV, defines water quality required for major agricultural irrigation activities which may not cover minor applications to sensitive crops; and

Class V, which represents other waters which do not meet any of the said uses. To determine water classification as above, a threshold based on parameters level that would affect the water quality per NWQS for Malaysia is given in *Table 6* and *Table 7* below:

Table 6 – Water Quality Classification

Parameters	Unit	Class				
		I	IIA/IIB	III#	IV	V
Al	mg/l	NATURE	-	-0.06	0.5	LEVEL
As	mg/l		0.05	0.4 (0.05)	0.1	
Ba	mg/l		1	-	-	
Cd	mg/l		0.01	0.01* (0.001)	0.01	
Cr (IV)	mg/l		0.05	1.4 (0.05)	0.1	
Cr (III)	mg/l		-	2.5	-	
Cu	mg/l		0.02	-	0.2	
Hardness	mg/l		250	-	-	
Ca	mg/l		-	-	-	
Mg	mg/l		-	-	-	
Na	mg/l		-	-	3 SAR	
K	mg/l		-	-	-	
Fe	mg/l		1	1	1 (Leaf) 5 (Others)	
Pb	mg/l		0.05	0.02* (0.01)	5	
Mn	mg/l		0.1	0.1	0.2	
Hg	mg/l		0.001	0.004 (0.0001)	0.002	

Parameters	Unit	Class				
		I	IIA/IIB	III#	IV	V
Ni	mg/l	ALL LEVELS OR ABSENT	0.05	0.9*	0.2	SABOVE IV
Se	mg/l		0.01	0.25 (0.04)	0.02	
Ag	mg/l		0.05	0.0002	-	
Sn	mg/l		-	0.004	-	
U	mg/l		-	-	-	
Zn	mg/l		5	0.4*	2	
B	mg/l		1	-3.4	0.8	
Cl	mg/l		200	-	80	
Cl_2	mg/l		-0.02	-0.02	-	
CN	mg/l					
F	mg/l			0.06 (0.02)	-	
NO_2	mg/l		1.5	10	1	
NO_3	mg/l		0.4	0.4 (0.03)	-	
P	mg/l		7	-	5	
Silica	mg/l		0.2	0.1	-	
SO_4	mg/l					
S	mg/l		50	-	-	
CO_2	mg/l		250	-	-	
Gross-α	Bq/l		0.05	-0.001	-	
Gross-ß	Bq/l		-	-	-	
Ra-226	Bq/l		0.1	-	-	
Sr-90	Bq/l		1	-	-	
CCE	µg/l		< 0.1	-	-	-
MBAS/BAS	µg/l		< 1	-	-	-
O & G (Mineral)	µg/l		500	-	-	-
O & G (Emulsified Edible)	µg/l		500	5000 (200)	-	-
PCB	µg/l		40; N	N	-	-
Phenol	µg/l		7000; N	N	-	-
Aldrin/Dieldrin	µg/l		0.1	6 (0.05)	-	-
BHC	µg/l		10	-	-	-
Chlordane	µg/l		0.02	0.2 (0.01)	-	-
t-DDT	µg/l		2	9 (0.1)	-	-
Endosulfan	µg/l		0.08	2 (0.02)	-	-
Heptachlor/Epoxide	µg/l		0.1	-1	-	-
Lindane	µg/l		10	-	-	-
2,4-D	µg/l		0.05	0.9 (0.06)	-	-
2,4,5-T	µg/l		2	3 (0.4)	-	-
2,4,5-TP	µg/l		70	450	-	-
Paraquat	µg/l		10	160	-	-

Notes :
* = At hardness 50 mg/l CaCO3
# = Maximum (unbracketed) and 24-hour average (bracketed) concentrations
N = Free from visible film sheen, discolouration and deposits

Table 7 – Water Quality Classification (with separation of Class IIA & IIB)

		Class					
Parameter	Unit	I	IIA	IIB	III	IV	V
Ammoniacal Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2.7
Biochemical Oxygen Demand	mg/l	1	3	3	6	12	> 12

		Class					
Parameter	Unit	I	IIA	IIB	III	IV	V
Chemical Oxygen Demand	mg/l	10	25	25	50	100	> 100
Dissolved Oxygen	mg/l	7	5 - 7	5 – 7	3 - 5	< 3	< 1
pH	-	6.5 - 8.5	6 - 9	6 – 9	5 - 9	5 - 9	-
Colour	TCU	15	150	150	-	-	-
Electrical Conductivity*	µS/cm	1000	1000	-	-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	2	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solid	mg/l	500	1000	-	-	4000	-
Total Suspended Solid	mg/l	25	50	50	150	300	300
Temperature	°C	-	Normal + 2 °C	-	Normal + 2 °C	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Coliform**	count/ 100 ml	10	100	400	5000 (20000) a	5000 (20000)a	-
Total Coliform	count/ 100 ml	100	5000	5000	50000	50000	> 50000

Notes :
N : No visible floatable materials or debris, no objectional odour or no objectional taste
* : Related parameters, only one recommended for use
** : Geometric mean
A : Maximum not to be exceeded

Table 8 – DOE Water Quality Index Classification

		Class				
Parameter	Unit	I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/l	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/l	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	-	> 7	6 – 7	5 – 6	< 5	> 5
Total Suspended Solid	mg/l	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index (WQI)		< 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

Table 9 – DOE Water Classification Based On Water Quality Index

Sub Index & WQI	Index Range		
	Clean	Slightly Polluted	Polluted
Biochemical Oxygen Demand (BOD)	91 - 100	80 - 90	0 - 79
Ammoniacal Nitrogen (NH_3-N)	92 - 100	71 - 91	0 - 70
Suspended Solids (SS)	76 - 100	70 - 75	0 - 69
Water Quality Index (WQI)	81 - 100	60 - 80	0 - 59

5.2.4 Water Quality Index

Water quality is one of the most important factors that must be considered when evaluating the sustainable development of a region. Therefore, a method called Water Quality Index (WQI) was created to measure quality of water that has many influential factors. Water quality index is a risk communication tool used to describe the status of water by translating a large amount of non-commensurate data into a single value and provide a simple and understandable tool for managers and decision makers on the quality and possible uses

of sample of water body. WQI provides a single number (like a grade) that expresses overall water quality at a certain location and time based on several water quality parameters. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public.

The most recognized WQI in Southeast Asia region is the Malaysian DOE"s WQI. The WQI was developed by the Department of Environment of Malaysia and used as standard calculation for water quality in Water Quality Monitoring Program in Malaysia. The measured level is between the range of 0-100 where 100 is being the cleanest. The formula to calculate the water quality is as below.

WQI = 0.22SIDO + 0.19SIBOD + 0.16SICOD + 0.15SIAN + 0.16SISS + 0.12SIpH

Where:

- SIDO=Sub-index DO in % saturation unit
- SIBOD =Sub-index BOD in mg/L unit
- SICOD =Sub-index COD in mg/L unit
- SIAN =Sub-index NH3N in mg/L unit
- SISS =Sub-index Suspended Solid S in mg/L unit
- SIpH =Sub-index pH in no unit

Every sub-index is calculated based on the equation in certain condition and the result will then be classified as follows:

Table 10 – Usage and Classification of Water Based on Water Quality Index

Use	WQI result (x)	Classification
General use	0 ≤ x < 60	Very polluted water
	60 ≤ x < 80	Slightly polluted water
	x > 80	Clean water
Water Class	0 ≤ x <40	Class V
	40 ≤ x < 50	Class IV
	60 ≤ x < 80	Class III
	80 ≤ x < 90	Class II
	x > 90	Class 1
Public Water Supply	0 ≤ x < 40	Not acceptable for public water supply
	40 ≤ x < 50	Doubtful for public water supply
	60 ≤ x < 80	Needs expensive treatment for public water supply
	80 ≤ x < 90	Need minor treatment for public water supply
	x > 90	No treatment is needed for public water supply
Recreational	0 ≤ x < 20	Not acceptable for recreation
	20 ≤ x < 30	Obvious pollution appearing, still not acceptable for all recreation
	30 ≤ x < 40	Acceptable only for boating
	40 ≤ x < 50	Doubtful for water contact
	50 ≤ x < 70	Acceptable for water contact but needs bacteria count
	x > 70	Acceptable for all water sport
Fisheries	0 ≤ x < 30	Not acceptable for fisheries
	30 ≤ x < 40	Acceptable only for coarse fish
	40 ≤ x < 50	Acceptable only for handy fish
	50 ≤ x < 60	Doubtful for sensitive fish
	60≤ x < 70	Marginal for trout
	x > 70	Acceptable for all fish
Navigation	0 ≤ x < 30	Not acceptable for navigation
	30 ≤ x < 40	Obvious pollution appearing
Transportation	0 ≤ x < 10	Not acceptable for water transportation
	x > 10	Acceptable for water transportation

6 RESULT, DISCUSSION & CONCLUSION

6.1 Previous monitoring results

Baseline data in 2009 showed that the water qualities in tributaries surrounding AFI area are as follows:

Table 11 – Baseline data in 2009

Parameter	Sg. Gumpa	Tributaries of Sg. Malubang	Sg. Bongkol	Sg. Kakarangan	Class IIB of INWQSM
Chemical Oxygen Demand (COD)	<6	10	<6	6	25
Biological Oxygen Demand (BOD)	2	2	2	<2	3
Turbidity	4.1	31	3.0	16	50
Total Suspended Solids (TSS)	27	***59***	21	33	50
Ammoniacal Nitrogen	<l	<1	<1	<1	0.3
Oil & Grease (O&G)	<10	<10	<10	<10	N

2015 to 2017 samplings that were conducted in tributaries of Sg Telaga, Sg. Bongkol, Sg. Kakarangan and Sg Malubang (*Figure 14*) indicated that the water quality that classified as Class II B in EIA 2009 has dropped to Class III. Result in 2017 showed different levels of BOD and COD in each sampling points at the period of Y1 to Y3 2017 AFI. Please refer to *Appendix C* for detailed results. Sampling period for Kiwiheng sampling was divided into 3 periods namely Y1, Y2 and Y3. Y1 is period of November 2016 – February 2017; Y2 is period of March – June 2017; and Y3 is period of July – October 2017. *Table 12* and *Table 13* below describe the BOD and COD result in Kiwiheng and AFI sampling in 2017.

Table 12 – BOD & COD Result in Kiwiheng Sampling Points (2017)

Kiwiheng Y1-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	BOD_5	mg/l	**24**	**9**	3	3	-	6
2	COD	mg/l	**160**	16	8	8	-	50

Kiwiheng Y2-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	BOD_5	mg/l	3	**14**	**11**	2	-	6
2	COD	mg/l	8	48	24	8	-	50

Kiwiheng Y3-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	BOD_5	mg/l	12	-	**13**	**19**	-	6
2	COD	mg/l	33	-	41	**106**	-	50

Table 13 – BOD & COD Result in AFI Sampling Points (2017)

AFI Mar 23/3/2017

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	BOD	mg/l	**11**	**8**	**14**	**12**	**14**	**8**	**8**	**14**	**14**	**17**	6
2	COD	mg/l	23	16	47	31	47	16	16	39	39	**70**	50

AFI Mar 22/9/2017

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	BOD	mg/l	**9**	**11**	**13**	**14**	**11**	4	4	-	-	-	6
2	COD	mg/l	16	32	40	48	32	8	8	-	-	-	50

AFI Mar 4/10/2017

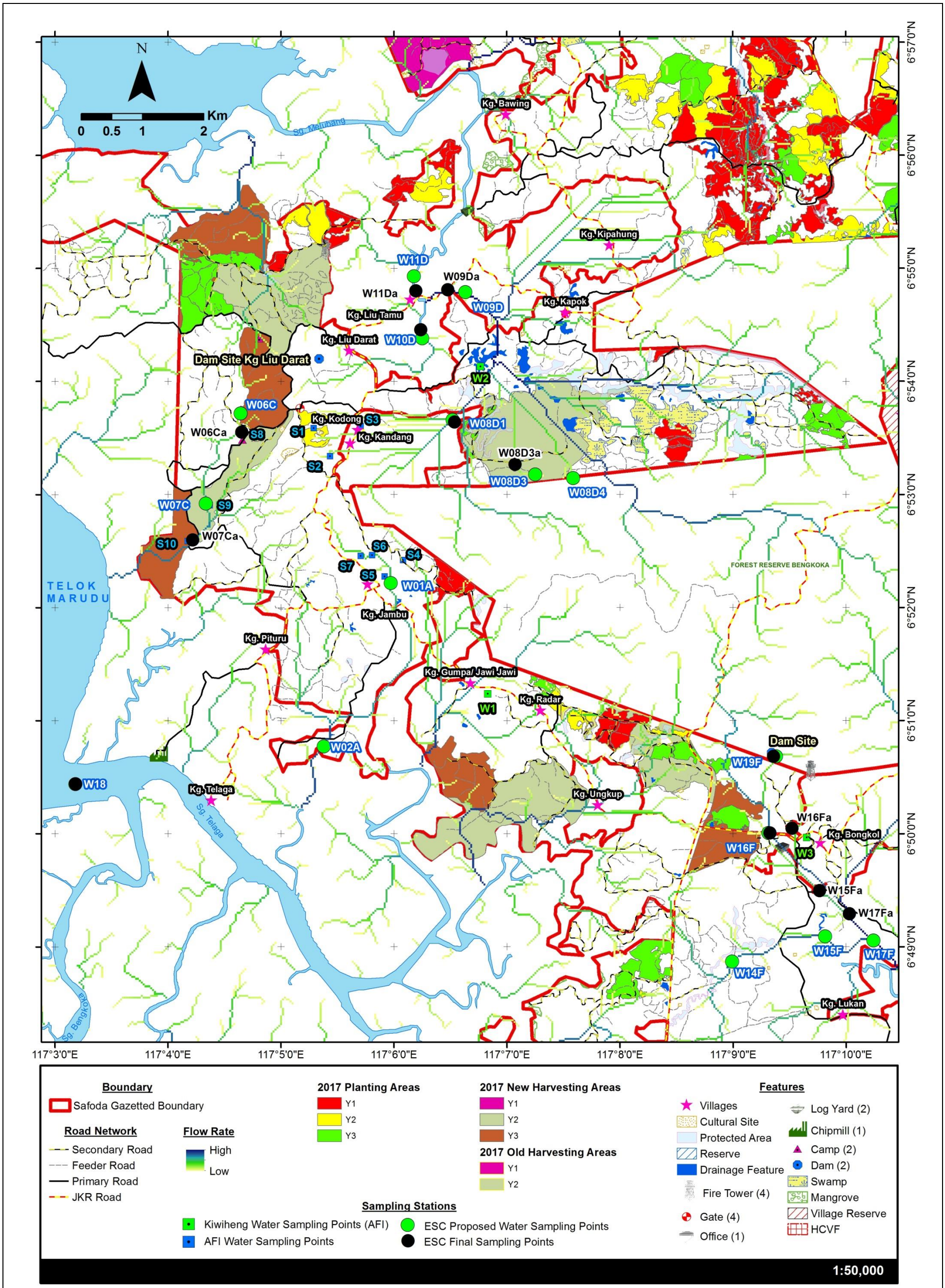
No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	BOD	mg/l	**12**	**11**	**14**	**14**	**11**	4	**14**	**8**	**12**	**11**	6
2	COD	mg/l	32	24	47	39	24	8	**55**	16	39	24	50

Notes: **Red coloured number** indicates parameter level is higher than threshold;
Parameter with decreasing quality

In Kiwiheng sampling result, sampling point W3 was shown to have low level of COD and BOD in Y1 but increased beyond threshold in Y3 when harvesting and planting took place in the area adjacent to the sampling point. Increased COD and BOD level also occurred during Y3 at W4, however, this may be due to natural occurrence as there were no plantation activities at the time of sampling. W1 were observed to have high COD (160mg/L) in Y1 but drastically dropped to 8 mg/L at Y3 after the completion of harvesting and planting activities. Increase of BOD at W2 was also found to occur only at the plantation and harvesting period.

AFI's 2017 samplings at all sampling points in March 2017 showed that the BOD levels in tributaries that flow into Sg. Telaga and Telok Marudu were beyond threshold level while COD levels were found below the threshold of Class III for all sampling points except for S10. The result also showed an increase of COD and BOD in October 2017 sampling at S7 which is probably due to community farming activities that are located in Kg. Jambu or AFI's plantation activities at Kg Kandang/ Kg. Liu.

Review of the results suggests that the high BOD and COD levels correspond loosely with the harvesting and planting activities. As high BOD and COD levels are indicative or organic matters in the water, it is suggested that AFI review their planting and harvesting SOP to include measures that would minimise the amount of organic matter from going into the rivers.



(Source: ASTGTM2 (N06E&07E117) https://gdex.cr.usgs.gov/gdex/ retrieved on 3rd May 2018 & AFI)

Figure 14 – ESC Water Sampling Points on 10th-18th July 2018 & AFI – Kiwiheng 2017 Sampling Points

6.2 Results

Based on the EIA report (2009) for AFI, water quality parameters of the surrounding water bodies (Sg. Gumpa, Tributary of Sg. Malubang, Sg. Bongkol and Sg. Kakarangan) has been classified as Class IIB except for TSS in tributaries of Sg Malubang. However, based on available record, results from AFI's water quality monitoring conducted since 2015 in Sg. Bongkol, Sg. Mengkapon, Sg. Malubang, and tributaries toward Sg. Bengkoka and Sg. Kakarangan show that the water quality from all locations have deteriorated to Class III.

The results of the water analysis from samples collected by ESC from 10th July to 18th July are tabulated in *Table 14* below. The reading of each parameter of the water samples are then compared against NWQS threshold to determine the Water Quality Index (WQI) reading as well as the river classification. The final outcome is presented in *Table 15*.

For clarity, schematic flow diagrams have made to sampling points at Sg Bongkol, Sg. Malubang and Telok Marudu river systems to illustrate the results' discussions. The schematic flows follow the stream lines as shown in *Figure 11* – ESC Water Sampling Points on 10th-18th July 2018 which were confirmed during the time of sampling. The schematic flow diagrams of Sg Bongkol, Sg. Malubang and Telok Marudu river systems are presented in *Figure 15, Figure 16,* and *Figure 17.*

Table 14 – Water Sample Analysis Result

Sub-Matrix: SURFACE WATER					10-Jul-18		11-Jul-18			12-Jul-18		13-Jul-18		15-Jul-18		16-Jul-18	18-Jul-18		
				NWQS for Malaysia	Sg. Bongkol					Sg. Malubang					Sg. Telaga		Telok Marudu		
Compound	Method	LOR	Unit	IIB	W 16 Fa	W 19 F	W 17 Fa	W 15 Fa	W 16 F	W 08 D1	W 11 Da	W 10 D	W 08 D3A	W 09 DA	W 18 (Low Tide)	W 18 A (High Tide)	W 06 CA	W 07 CA	CA*
Physical and Aggregate Properties																			
Total Suspended Solids	APHA2540D	1	mg/L	**50**	9	6	11	33	19	18	12	15	25	37	11	11	4	17	14
Aggregate Organics																			
Biochemical Oxygen Demand	APHA5210B	1	mg/L	**3**	3	**4**	**15**	**5**	**12**	**4**	**9**	3	**7**	**12**	**15**	**15**	**4**	**7**	**6**
Chemical Oxygen Demand	APHA5220D	1	mg/L	**25**	10	15	**45**	15	**46**	12	**32**	14	25	**34**	**45**	**45**	12	18	16
Oil & Grease	APHA5520B	1	mg/L	**40**	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Total Phenols	APHA5530B&D	0.02	mg/L	**10**	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.3	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Inorganic and Nonmetallic Properties																			
Ammoniacal Nitrogen	APHA4500 NH3 G	0.01	mg/L	**0.36**	0.22	**0.45**	0.17	0.10	0.05	0.07	0.15	0.06	**0.57**	0.24	0.12	0.17	**0.49**	**0.46**	**0.45**
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	**n/a**	0.04	0.03	<0.01	0.08	0.16	0.07	<0.01	<0.01	0.01	0.03	<0.01	<0.01	0.03	0.04	0.04
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	**7**	1.78	<0.01	<0.01	1.86	0.08	1.75	<0.01	<0.01	0.87	<0.01	<0.01	<0.01	1.52	1.51	1.65
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	**n/a**	<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
Total Cyanide	APHA4500CN	0.05	mg/L	**n/a**	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	**-**	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	**0.4**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.04	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphate as PO4	APHA4500-P F	0.01	mg/L	**n/a**	0.05	0.05	0.07	<0.01	0.13	0.03	<0.01	<0.01	0.09	0.06	0.07	0.07	0.04	<0.01	<0.01
Metals and Major Cations - Total																			
Arsenic	APHA3125B	0.001	mg/L	**0.05**	0.001	<0.001	0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	0.001	0.001	0.001	<0.001	<0.001	<0.001
Boron	APHA3125B	0.001	mg/L	**n/a**	0.038	0.031	6.05	0.04	0.052	0.029	2.78	0.31	0.062	4.5	6.05	6.05	0.025	0.026	0.026
Cadmium	APHA3125B	0.000	mg/L	**0.01**	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Copper	APHA3125B	0.001	mg/L	**0.02**	0.001	<0.001	<0.001	0.001	0.006	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.002	0.001	0.002
Iron	APHA3125B	0.001	mg/L	**1**	**1.87**	**1.93**	0.319	0.745	1.82	0.816	0.56	**3.71**	**7.06**	**4.29**	0.319	0.319	**2.49**	**2.14**	**2.36**
Lead	APHA3125B	0.001	mg/L	**0.05**	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Manganese	APHA3125B	0.001	mg/L	**0.1**	**0.199**	0.099	0.053	**0.341**	**0.695**	**0.59**	**0.278**	**0.304**	**0.278**	**0.344**	0.053	0.053	**0.809**	**0.788**	**0.812**
Mercury	USEPA6020A	0.001	mg/L	**0.001**	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010	<0.0010
Tin	APHA3125B	0.001	mg/L	**n/a**	<0.001	<0.001	**0.002**	<0.001	<0.001	<0.001	0.001	**0.002**	<0.001	**0.002**	**0.002**	**0.002**	<0.001	<0.001	<0.001
Organochlorine Pesticides																			
alpha-BHC	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
beta- & gamma-BHC	USEPA8270C	10	µg/L	**n/a**	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10
delta-BHC	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Heptachlor	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Aldrin	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Heptachlor epoxide	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
trans-Chlordane	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endosulfan 1	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

Sub-Matrix: SURFACE WATER					10-Jul-18		11-Jul-18			12-Jul-18		13-Jul-18		15-Jul-18	16-Jul-18	18-Jul-18		
				NWQS for Malaysia	Sg. Bongkol					Sg. Malubang				Sg. Telaga		Telok Marudu		
Compound	Method	LOR	Unit	IIB	W 16 Fa	W 19 F	W 17 Fa	W 15 Fa	W 16 F	W 08 D1	W 11 Da	W 10 D	W 08 D3A	W 09 DA	W 18 (Low Tide)	W 18 A (High Tide)	W 06 CA	W 07 CA	CA*
cis-Chlordane	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dieldrin	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
4.4`-DDE	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endrin	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endosulfan 2	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
4.4`-DDD	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endrin aldehyde	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endosulfan sulfate	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
4.4`-DDT	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Endrin ketone	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Methoxychlor	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Organophosphorus Pesticides																			
Dichlorvos	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Demeton-S-methyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Monocrotophos	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Dimethoate	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Diazinon	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Parathion-methyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Malathion	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fenthion	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorpyrifos	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Parathion	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Pirimphos-ethyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Bromophos-ethyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Fenamiphos	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Prothiofos	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Ethion	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Carbophenothion	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Azinphos Methyl	USEPA8270C	5	µg/L	**n/a**	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Microbiological Testing																			
Total E. coli Count	MB-17-22	1	CFU/ 100m L	**5000**	80	390	1090	730	1020	1100	**5200**	1300	900	800	300	2000	300	<1	<1

Notes: *CA is a duplicate for W07Ca;
Red coloured number indicates parameter level is higher than threshold;
Parameter level is at the same level as threshold

Table 15 – Water Quality Index & River Classification

Sub-Matrix: SURFACE WATER	Sampling Dates:		10-Jul-18		11-Jul-18			12-Jul-18		13-Jul-18		15-Jul-18	16-Jul-18		18-Jul-18		
	River System:		Sg. Bongkol					Sg. Malubang					Sg. Telaga		Telok Marudu		
Compound	Unit	NWQS for Malaysia Class IIB	W 16 Fa	W 19 F	W 17 Fa	W 15 Fa	W 16 F	W 08 D1	W 11 Da	W 10 D	W 08 D3a	W 09 Da	W 18 (Low Tide)	W 18a (High Tide)	W 06 Ca	W 07 Ca	CA*
DO	mg/L	5-7	**4.74**	7.12	8.21	**3.5**	**3.35**	5.2	7.3	8.7	**3.34**	**2.25**	7.72	5.88	6.39	7.72	7.72
pH	-	6-9	6.03	6.5	**5.07**	**5.69**	**5.38**	**5.82**	6.65	**5.65**	**5.91**	**5.87**	6.9	6.24	**2.33**	**2.85**	**2.85**
Biochemical Oxygen Demand	mg/L	3	3	**4**	**5**	**5**	**12**	**4**	**9**	3	**7**	**12**	**8**	**15**	**4**	**7**	**6**
Chemical Oxygen Demand	mg/L	25	10	15	16	15	**46**	12	**32**	14	25	**34**	22	**45**	12	18	16
Ammoniacal Nitrogen	mg/L	0.36	0.22	**0.45**	<0.01	0.10	0.05	0.07	0.15	0.06	**0.57**	0.24	0.12	0.17	**0.49**	**0.46**	**0.45**
Total Suspended Solids	mg/L	50	9	6	29	33	19	18	12	15	25	37	25	11	4	17	14
Total E. coli Count	CFU/ 100ml	5000	80	390	1090	730	1020	1100	**5200**	1300	900	800	300	2000	300	<1	<1
		WQI	**68**	**65**	**63**	**64**	**55**	**68**	**61**	**68**	**58**	**54**	**63**	**55**	**54**	**51**	**52**
		CLASS	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**III**	**IV**	**III**
	General Use		SP	SP	SP	SP	**VP**	SP	SP	SP	**VP**	**VP**	SP	**VP**	**VP**	**VP**	**VP**
	Public Water Supply		ET	ET	ET	ET	ET	ET	ET	ET	ET	ET	ET	ET	ET	ET	ET
	Recreational		AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC	AWC
	Fisheries		MFT	MFT	MFT	MFT	DSF	MFT	MFT	MFT	DSF	DSF	MFT	DSF	DSF	DSF	DSF

Remarks:	
General Use	**SP**: Slightly Polluted; **VP**: Very Polluted
Public Water Supply	**ET**: Expensive Treatment is required for public supply use; **D**: Doubtful for public supply use
Recreational	**AWC**: Acceptable for water contact but needs bacteria count; **DWC**: Doubtful for water contact
Fisheries	**MFT**: Marginal for Trout; **DSF**: Doubtful for Sensitive Fish; **HF**: Acceptable only for Handy Fish

Notes: *CA is a duplicate for W07Ca

The red coloured number indicates decreasing quality based on the comparison to the threshold

Parameter level is at the same level as the threshold

6.2.1 Sg. Bongkol Schematic Flow

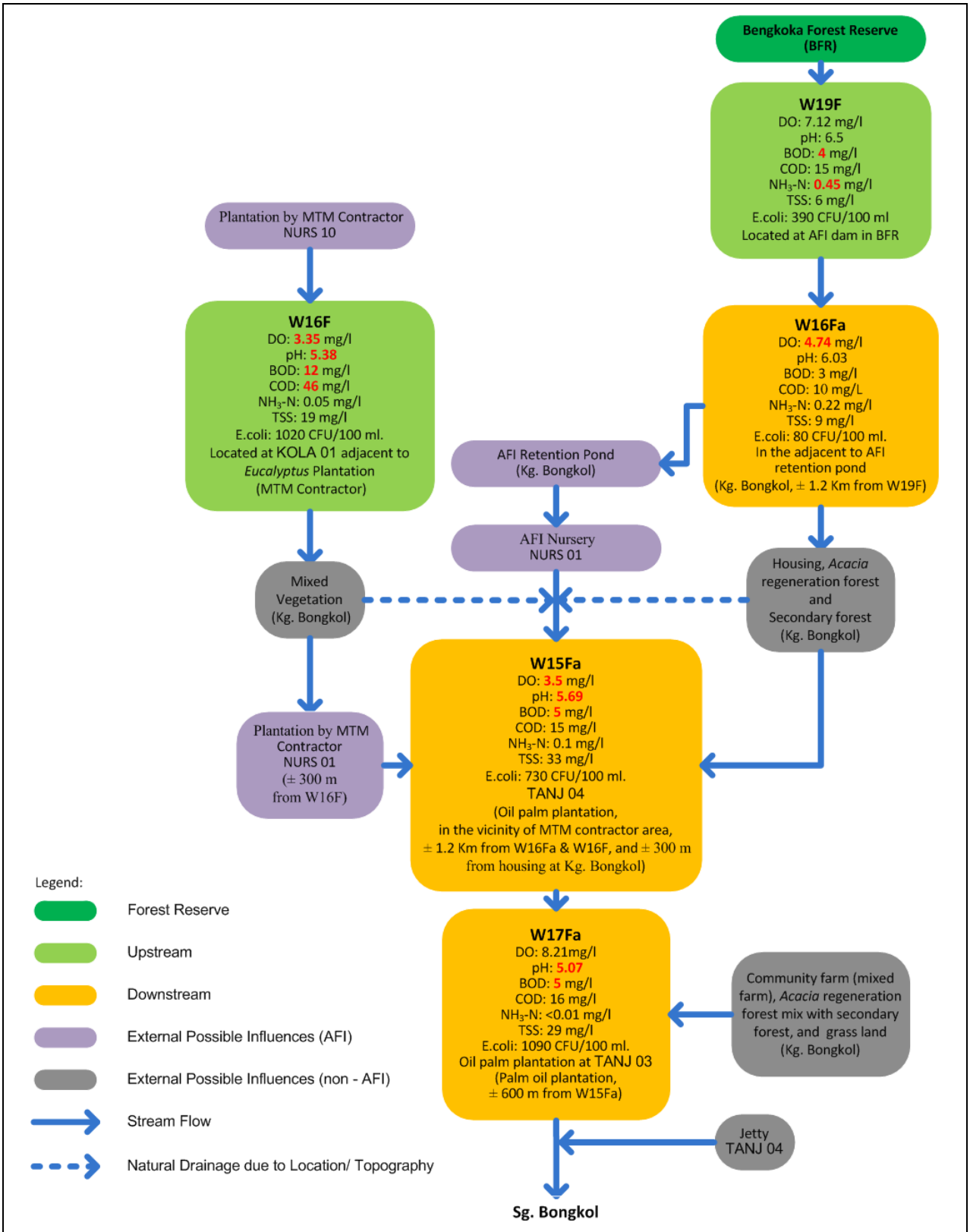


Figure 15 – Sg. Bongkol Schematic Flow

The upstream sampling locations for Sg. Bongkol river system were taken from 2 locations namely Safoda dam in BFR (W19F) and a waterbody that flows from the plantation area managed by MTM contractor at NURS 10 (W16F). As shown on *Figure 11* these locations are influenced by the BFR and plantation area at KOLA 7 (MTM).

Water from Safoda dam (W19F) was observed to have high level of BOD (4 mg/l) and NH_3-N (0.45 mg/l). As this location is within the BFR, the high level may be derived from natural organic pollutants occurrences and/or human interference in BFR. The high BOD levels indicate high levels of organic pollutants and high ammoniacal nitrogen levels could be from runoffs of fertilizer and/ or organic decomposition by-product (refer to Section 6.3 on further discussion of sources). The water from W19F flows into AFI dam (W16Fa) located in Kg Bongkol with results showing improved water quality in BOD and NH_3-N but slightly low in DO (4.74 mg/l). The decreased level of DO may be due to natural occurrences of aquatic plants that absorb DO and/or the presence of organic pollution or lack of re-aeration. As stream from Safoda dam in BFR to AFI dam in Kg. Bongkol passes through land covered with various vegetation and in the vicinity of Kg. Bongkol, the possibility of organic litter can come from both natural occurrence and/or human influence.

The water from the AFI retention pond (8100 m^3) in Kg. Bongkol will be pumped (only in dry season) to the newly constructed tank in nursery area for nursery operations. To reduces the dependency on Sg. Bongkol, a rainwater harvesting pond is also made available recently in the nursery for nursery operations in rainy season.

Naturally, all water from the nursery area eventually flows into the stream (W15Fa) that flow adjacent to the oil palm plantation located in the vicinity of the MTM contractor area at approximately 1.2 Km south of W16F and W16Fa. Water from the nursery area is one out of three sources that supply water to this stream (W15Fa). The second source to W15Fa is water from the Safoda dam (W19F), which passes through W16Fa (AFI Dam) and further on through housing areas, acacia regeneration forest and secondary forest of Kg. Bongkol. The third source to W15Fa is from W16F (which is one of the 2 upstream sampling locations for Sg. Bongkol river system) which is influenced by mixed vegetation and MTM plantation area at NURS 01.

Water quality at W16F was found to be very polluted with levels of DO (3.35 mg/l), pH (5.38), BOD 12 mg/l), and COD (46 mg/l) found below or over permitted threshold. Site observations suggest that any residue collected in W16F stays undiluted during the dry season and therefore influencing its water quality. As W15Fa is located adjacent to the roadway, runoffs and CO_2 may cause weak acid when dissolved in water. The low DO combined with high BOD and COD suggest pollution through organic waste matter decomposition. Especially during dry season, the organic waste matter will accumulate and without enough flow to move the waste, decomposition will occur in an almost stagnant water and hence results in low DO and high BOD and COD.

Water quality from these three sources merges into W15Fa as water from W16F being the most influential factor to water quality at W15Fa. Dilution for ±1.2 Km journey from W16Fa and W16F reduced the levels of BOD to 5 mg/l and COD to the permitted level of Class IIB in W15Fa. Additional risk factors such as aquatic plant and moss, organic litter and human influence along the stream line however, may be the factors that contribute to the DO level of 3.5 mg/l.

Water from W15Fa then flows to W17Fa located adjacent to an oil palm plantation at TANJ 03. The stream line from W15Fa to W17Fa goes through the vicinity of community farms, *Acacia* regeneration forest and secondary forest and therefore risk factors that came from organic litter and human interference may influence the DO and BOD levels. However, water quality at W17Fa showed that dilution/ aeration has increased DO level to 8.21 mg/l while BOD remains at 5 mg/l and pH found to have dropped to 5.07. The improvement of DO may be due to dilution/ aeration in the ±600 m length of travel which shows that the BOD level is maintained even though W17Fa is located adjacent to an oil palm plantation. pH level in the other hand may be influenced by pesticides/ fertilizer runoffs that can create a weak acid when dissolved in water.

There were no detectable levels of pesticides found in the samples of the observed streams of Sg. Bongkol.

6.2.2 Sg. Malubang Schematic Flow

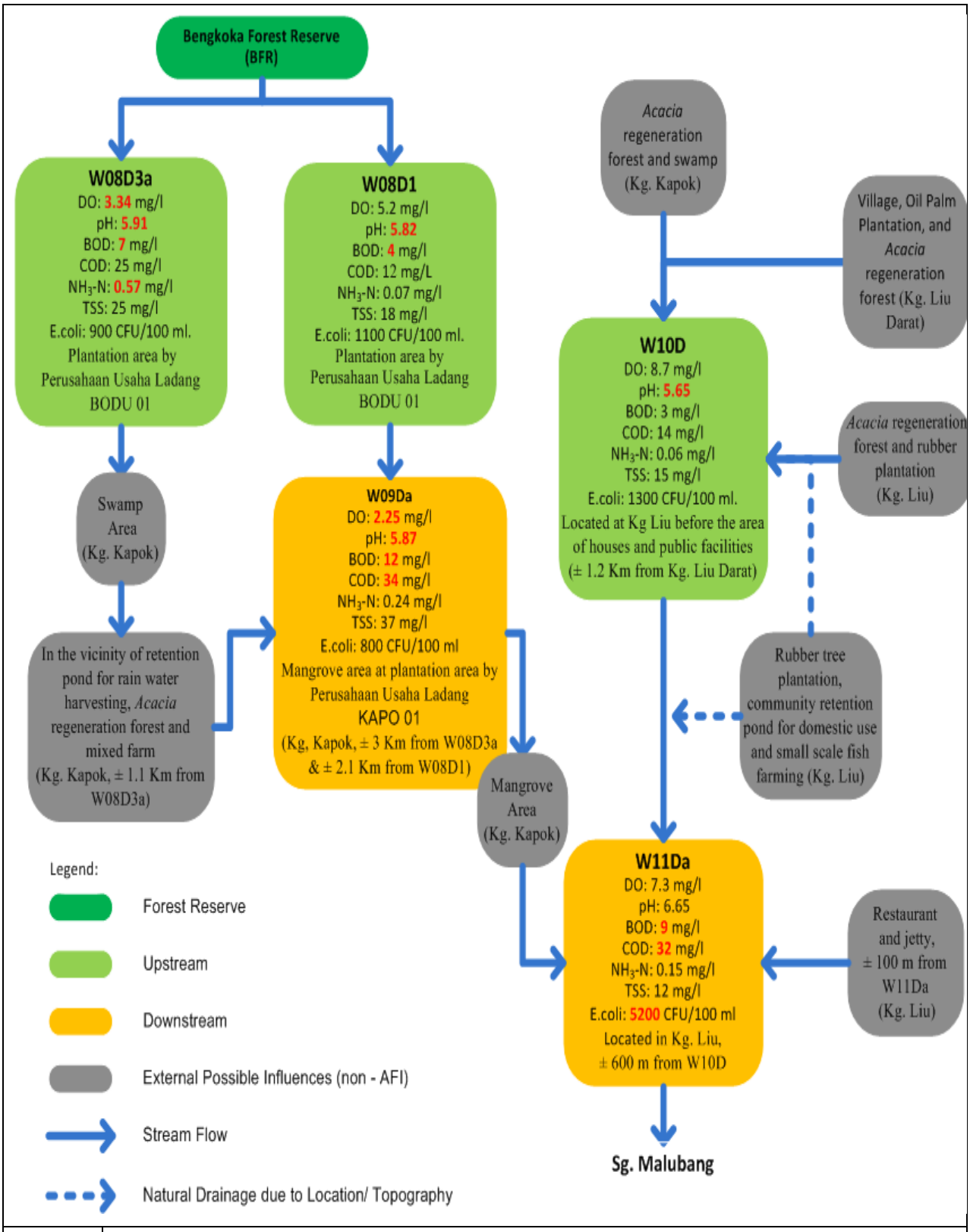


Figure 16 – Sg. Malubang Schematic Flow

The upstream sampling locations for Sg Malubang were observed in 2 locations in Bodu (Perusahaan Usaha Ladang, BODU 01) and 1 location in Kg. Liu. The upstream locations in Kg. Bodu were located at the stream that came only from BFR (W08D3a) and a stream that came from BFR, Kg. Kandang and Kg. Kodong (W08D1). Meanwhile upstream in Kg. Liu was located at the stream (W10D) that originates from Kg. Liu Darat.

Water from BFR (W08D3a) was found classified based on WQI as very polluted. The BOD and ammoniacal nitrogen levels are similar to the other sample taken in BFR, (i.e W19F) but with the addition of low DO and pH levels. Because it was observed in adjacent to BFR therefore, it may be derived from natural organic pollutants occurrences and human activities in BFR. Sampling analysis showed that the stream has low DO (3.34 mg/l), high in BOD (7 mg/l) and NH3-N (0.57 mg/l), and pH slightly below threshold (5.91 mg/l). This water flows to the swamp area in Kg. Kapok then through an *Acacia* regeneration forest as well as a community mixed farm. A retention pond was also observed to be present in the vicinity of this stream.

This stream then flows into a mangrove area (W09Da) at Kg. Kapok and was also classified as very polluted because it has low DO (2.25 mg/l), high BOD (12 mg/l) and COD (12 mg/l), and slightly low pH (5.87). High BOD and COD will decrease oxygen in water as it is being consumed during decomposition of organic matters. Another source that feed into W09Da is a stream that came from BFR, Kg. Kandang and Kg. Kodong (W08D1) which classified as slightly polluted based on WQI because it has only slightly low pH (5.82) and slightly high BOD (4 mg/l), therefore it's concluded that water from W08D3a is more influential to the W09Da water quality. Water from W09Da area was supposed to flow to W11Da through a stream as indicated by Figure 6, however as it was found to be almost stagnant with very low flow rate and dry in some part of the stream.

W10D flows from Kg. Liu Darat and observed to have only slightly low pH (5.65). Oil palm plantation in Kg. Liu Darat may not be a direct influence to the BOD level at W10D as it is located ±1.2 Km away. Physical characteristics of the stream at W10D, i.e much wider width than other streams in BODU may be a factor that increases the dilution/ aeration rate which improved the water quality from W09Da which was classified as very polluted to slightly polluted at W11Da before it discharged into Sg. Malubang. High BOD (9 mg/l) and COD (32 mg/l) at W11Da was observed along with high presence of E. coli (5200 CFU/100 ml) that may come from the exposure to biodegradable organic matter, liquid manure and other liquid organic waste products to the waterbody in the surrounding populated areas (Kg. Liu Tamu).

There were no detectable levels of pesticides found in the samples of the observed streams of Sg. Malubang.

6.2.3 Telok Marudu Schematic Flow

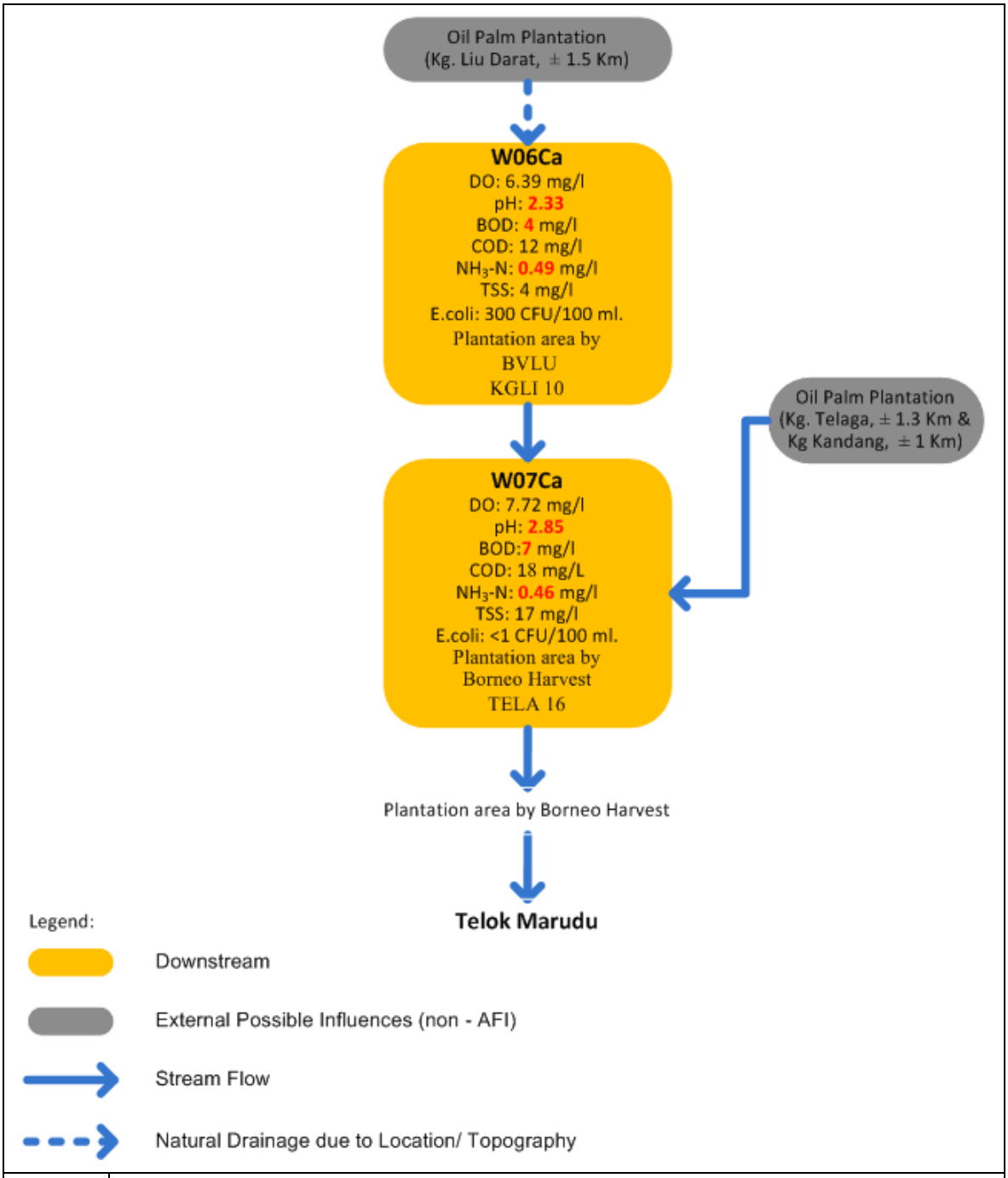


Figure 17 – Telok Marudu Schematic Flow

There were no feasible upstream location in Telok Marudu river system to observe the water quality for the BVLU operated area in Kg. Liu as the location was not accessible due to natural conditions. Therefore, the original AFI own sampling points namely S8 and S10 were established as W06Ca and W07Ca respectively to observe the Telok Marudu river system.

W06Ca located at plantation area operated by BVLU was classified based on WQI as very polluted with the pH acidic (2.33) with slightly high BOD (4 mg/l) and NH3-N (0.49 mg/l). Organic litter from and runoffs from

oil palm plantation located ±1.5 Km to the north and BVLU harvesting area may be the source of high BOD and NH_3-N. This sampling location was also observed as bathing/ washing location for the workers based on the evidence of soap and shampoo onsite. The DO (6.39 mg/l) for this location is in the permitted threshold. The same water characteristics were also found in W07Ca, the stream located in Borneo Harvest operated areas, downstream of W06Ca. The water is found to be acidic with low pH (2.85) which tends to slow down decomposition in water hence the DO (7.72 mg/l) level stays in the permitted level. However, the BOD level is still elevated (7 mg/l). Other factor that may contribute to the increase of the level of BOD is the organic litter from oil palm plantation located ±1.3 Km away at Kg Telaga and ±1 Km away at Kg. Kandang. These 2 oil palm plantations were observed in the vicinity of the stream that influence W07Ca. However, further sampling should be taken downstream of the oil palm plantation to determine the potential effects of the oil palm plantations to the water quality at the stream adjacent to BVLU operating areas and W07Ca.

There were no detectable levels of pesticides found in the samples of the observed streams in Telok Marudu river system.

6.3 Discussion

Based on the above result, concentrations of DO, pH, BOD, COD, and ammoniacal nitrogen were summarised as below:

- Low DO was found at all river systems except in Sg. Telaga river system. Sampling points with low DO were W 16 Fa, W 15 Fa, W 16 F, W 08 D3a, and W 09 Da.
- Low pH was found at all river systems except in Sg. Telaga river system. Sampling points with low pH were W 17 Fa, W 15 Fa, W 16 F, W 08 D1, W 10 D, W 08 D3a, W 09 Da, W 06 Ca, and W 07 Ca.
- High BOD was found at all sampling points except W16Fa in Sg Bongkol river system.
- High COD was found at all river systems except Telok Marudu river system. Sampling points with high COD were W 16 F, W 11 Da, W 09 Da, and W 18a (High Tide).
- High ammoniacal nitrogen was found at all river systems except Sg. Telaga river system. Sampling points with high ammoniacal nitrogen were W 19 F, W 08 D3a, W 06 Ca, and W 07 Ca.

A duplicate sample was also taken in this study to ensure the consistency and accuracy of laboratory analysis. Duplicate (CA) was taken at Telok Marudu river system (same as W07CA location). W07Ca serves as one of the downstream points in this study and currently located between 3 active plantation areas. From the laboratory report, the duplicate (CA) analysis was found to be consistent based on ±20% RPD (Relative Percentage Difference). Despite small discrepancy level between CA and W07Ca readings in BOD, COD, Ammoniacal Nitrogen and TSS, the classification of Telok Marudu river system was concluded to be in the Class III.

Parameters affecting water classification based on DOE Water Quality Index Classification are discussed below.

a) Temperature

The increase of temperature will decrease dissolved oxygen level and accelerate chemical reaction that can disturb aquatic biota and may contribute to fish kill. Generally, many factors such as the weather condition, sampling time, and location impact on the increase or decrease of temperature by which its role effect on the percentage of dissolved oxygen, biological activities, and other parameters. Temperature values in the sampling points ranged from 25.6 – 27.5 °C. Sampling points W08D1 located in stream that flows from Kg Kondong and Kg Kandang taken at 11pm recorded to have the highest temperature while sampling point W18 located in Sg Telaga which was taken at 16.35 recorded to have the lowest temperature. In addition, the results are within the standard acceptable levels of National Water Quality Standards, Malaysia (NWQS). Furthermore, the temperature seemed to increase progressively from upstream to downstream.

b) DO

Dissolved oxygen is the concentration of free molecular oxygen dissolved in water which can cause fish kill if the level is lesser than 3 mg/L. The amount of dissolved oxygen in the river water can be affected by several factors and processes going on in the river. Aquatic plants have a big impact on oxygen levels. Plants produce dissolved oxygen during the day and consume oxygen overnight so there can be swings in oxygen levels over the course of the day. When there are too many plants in a river or stream, oxygen levels can drop so low overnight that aquatic creatures leave the area. Based on the in-situ readings, sampling location that has DO level less than 3 mg/L was W09Da which is situated in the vicinity of mangroves area which is generally known to have lower DO. This low content may be depressed further in areas of organic pollution, to the point of creating an anoxic zone in the water column. Oxygen in the soil between sediment particles (interstitial oxygen) is used up by the decay and respiration of bacteria.

c) pH

pH normal value is 6 – 8, however different value will be present in waste or contaminated water depending on its waste source. In regards to river biota, a low pH levels can cause fish kill by stressing animal systems and causing physical damage, which in turn makes them more vulnerable to disease. Therefore, based on the in-situ result, streams that have pH level below 6 are of less concern than streams that have ph level below 3 as it may damage the water conditions. Sampling points with ph level below 3 are located in the vicinity of eucalyptus plantation area by BVLU, Pemborong Silanra and Borneo Harvest in Kg Kandang (W06Ca & W07Ca). External factors that can cause fluctuations in the river pH for these areas include agricultural runoff and fossil fuel emissions such as carbon dioxide, which creates a weak acid when dissolved in river water. The effects of low pH levels however, can be lessened by the provision of limestone along river banks and in soil.

d) Biochemical Oxygen Demand (BOD)

BOD is a measure of the quantity of oxygen used by microorganisms (e.g., aerobic bacteria) in the oxidation of organic matter. Natural sources of organic matter include plant decay and leaf fall. However, plant growth and decay may be unnaturally accelerated when nutrients and sunlight are overly abundant due to human influence. When BOD levels are high, dissolved oxygen (DO) levels decrease because the oxygen that is available in the water is being consumed by the bacteria. Runoff carries all wastes from pathways; nutrients from fertilizers; leaves, grass clippings, and other organic/inorganic materials, which increase oxygen demand.

The highest BOD level was found in W18a at 15 mg/L and the lowest was found in W16Fa and W10D at 3 mg/L. BOD level in the upstream sample was found to be higher than its downstream sample. This condition could be due to the possibility of organic materials that are being broken down by microbes. Inconsistency was traced in W16F (upstream) where the BOD was at the level of 12 mg/L and the entire downstream BOD was at lower level. This anomaly however, took place at stream originating from active plantation site. The stream was contained with small volume of water with low flow rate/ almost stagnant, hence the possible accumulation of runoff wastes from the plantation that would affect the BOD level in the stream. As the sampling was taken in a non-rainy season, it is then suggested that the high BOD is due to the accumulation of organic matter in the stagnant water from the previous months.

Current findings also recorded the concentration of 12 mg/L from sampling point W09Da which located downstream of W08D3a and in the vicinity of Kg. Kapok and Kg. Liu, mangrove forest, mixed community farm, oil plantation, acacia regeneration forest and secondary forest. Retention pond for domestic use was also found near to the sampling point. This sampling point location seemed to have flowing water in moderate flow only during low tide. Otherwise the stream was observed with very low flow rate or almost stagnant. Sample from this point was taken close to the time of lowest tide and as such at a point of very low flow rate.

e) Chemical Oxygen Demand

Chemical Oxygen Demand or COD is a measurement of the oxygen required to oxidize soluble and particulate organic matter in water. Chemical Oxygen Demand is an important water quality parameter because, similar to BOD, it provides an index to assess the effect discharged wastewater will have on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which

will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter testing time. COD is normally greater than the BOD in water, which suggests that pollutant in the water is not readily biodegradable, and as such may be toxic to the microorganism. If the COD is similar to the BOD, then the pollutant in the water is readily biodegradable.

Based on the sampling result, it can be shown that the streams within AFI plantation have pollutants that are not easily biodegradable since the COD level reading ranges from 32 to 46 (highest at W16F) which exceeds NWQS Class II B. From the result (taken at the mouth of Sg Telaga W18a) we can also assume that Telok Marudu has higher oxidizable organic material which caused higher COD level.

f) Ammoniacal Nitrogen

It is a component of nitrogen referred to as ammoniacal nitrogen, which is a natural product of decay of organic nitrogen compounds and one of the many contaminants in water and being adopted as an indicator to determine pollution in water. Ammoniacal Nitrogen is extremely soluble in water, reacting with water to produce ammonium hydroxide and one of the transient constituents in water as it is part of the nitrogen cycle, which is influenced by biological activity. Excessive ammoniacal nitrogen in waterways can cause taste and odour problems and excessive discharges of pollutants will disturb the natural waterways. Various sources of ammonia in rivers are: fertilizers for land and agricultural developments; uncontrolled land development; untreated water from farms/plantations or any water discharges from domestic or commercial activities (anthropogenic sources); and surface runoff and washouts resulting from rainfall.

Based on the source of ammoniacal nitrogen we can conclude that the high ammoniacal nitrogen levels that were found in sampling points may have caused by anthropogenic sources. The recorded levels range from 0.45 mg/L to 0.57 mg/L which exceed Class II B threshold. The location with highest ammoniacal nitrogen level was at W8D3a (upstream) which is located in the boundary of forest reserve and active plantation area. The sample was taken at a low flow (almost stagnant) stream and therefore the results could be due to accumulated residue. This result may have been different if taken in a rainy season. Another slightly higher ammoniacal nitrogen levels at an upstream location was W19F. Higher concentration in W19F suggested that it is due to its natural occurrence as the sampling point was located at the dam in the forest reserve area.

Slightly higher ammoniacal nitrogen level at the active plantation at W06Ca and W07Ca/CA suggested that it could be originated from untreated water from farms/plantations, surface runoff and washouts resulting from rainfall in Kg. Kandang.

g) Total Suspended Solids

Total Suspended Solids (TSS) is composed from variety of material, such as silt, decaying plant and animal matter, wastes, and sewage. High concentrations of suspended solids can cause many problems for stream health and aquatic life. High TSS can block light from reaching submerged vegetation and slows down photosynthesis which causes less dissolved oxygen to be released into the water by plants. Continuation of this condition may kill the plant and as it being decomposed, bacteria will use up even more oxygen from the water which can create low dissolved oxygen in the water and can lead to fish kills. As TSS particles absorb heat from sunlight and create warmer water which can hold less DO then it can also cause dissolved oxygen levels to fall even further and can harm aquatic life. High TSS in a water body can often mean 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 storm water. In the water, the pollutants may be released from the sediment or travel farther downstream. Factors affecting TSS are: high flow rates; soil erosion; urban runoff; wastewater discharges; and decaying plants/ animals.

The result from the laboratory indicates that the factors affecting the concentration of TSS coming from the sampling points surroundings were not significant.

6.4 Conclusion

The comparison between data from AFI and Kiwiheng in 2017 and current data based on the river system that discharge to Sg Bongkol, Sg Malubang and Telok Marudu is presented below.

Table 16 – 2017 & 2018 Comparison Data

	River System					
	Sg. Bongkol		Sg. Malubang		Telok Marudu	
Parameters	2017 Kiwiheng AFI (W3)	2018 ESC (W17Fa, W15Fa, W16Fa)	2017 Kiwiheng AFI (W2)	2018 ESC (W08D1, W11Da, W10D, W08D3a)	2017 AFI (S8 & S10)	2018 ESC (W06Ca, W07Ca)
pH	5.42 - 6.63	5.07 - 6.03	6.3 - 6.38	5.65 - 6.65	3.17 - 3.69	2.33 - 2.85
BOD (mg/L)	3 - 13	3 - 5	9 - 14	3 - 9	8-17	4 - 7
COD (mg/L)	8 - 41	10 - 15	16 - 48	12 - 32	16 -70	12 - 18
TSS (mg/L)	13 - 15	9 - 33	9 - 14	12 - 25	2 - 25	4 - 17
Ammoniacal Nitrogen (mg/L)	0 - 0.28	0 - 0.22	0 - 0.23	0.07 - 0.57	0.05 - 1.59	0.4 6- 0.49

Decreasing quality based on 2017 readings

Based on WQI calculation, the above data indicate that currently Sg. Bongkol, Sg. Malubang and Telok Marudu river systems do not meet the criteria of Class IIB conditions/ original water class as stated in EIA 2009. In general, all river systems in this assessment are found to have high BOD and certain locations of the river system registered high COD. The possible causes of this condition are given in Section 6.2. Even though the water quality of the river system has deteriorated from Class IIB (as recorded in EIA report 2009) to Class III, it has not changed since 2015 (Class III as recorded and monitored by AFI). In fact, based on individual reading of the parameters compared to the results in 2017, BOD and COD (except for the TSS and ammoniacal nitrogen in Sg. Malubang and pH level in Telok Marudu river system) showed slight improvement.

Water quality at the upstream and downstream of Sg Bongkol is classified as Class III. This classification is also occurred at Sg. Malubang and the mouth of Sg. Telaga. As for the stream that flows into the Telok Marudu (points W06Ca and W07Ca), the upstream is classified as Class III and the downstream is slightly towards Class IV. Telok Marudu river system also observed to be more acidic than 2017 conditions, however this current reading result may be affected from dry seasons. Observation during sampling also found that oil palm plantation at the northern part of W06Ca and W07Ca may affect the water quality in both sampling points, however sampling at downstream of these oil palm plantations should be made to clarify its impact.

From the data analysis above, it seems that the overall water quality for the river system around AFI active plantation is found to be of Class III. The quality based on NWQS is only suitable for water supply with extensive/ advance treatment. This class of water is also defined to suit livestock drinking needs hence the water quality is still in a level that is not threatening and endangering the environment. From the community survey on water usage, it is understood that the villagers are not using the river water for drinking or cooking. The domestic usage is mainly for washing and cleaning. They also use the water for irrigation purposes for community agriculture.

Based on the result and discussion above, the current water quality is suitable for current usage (irrigation and domestic use excluding drinking & cooking). Water quality for 3 observed river systems namely Sg. Bongkol River System, Sg Malubang River System, and Telok Marudu River System were observed as follows:

i. Sg. Bongkol River System

Schematic flow in *Figure 15* indicates that water quality of downstream of Sg. Bongkol (W15Fa and W17Fa) was influenced by the water quality from accumulated low flowing and almost stagnant water in adjacent to *Eucalyptus* plantation at NURS 10 (16F) rather than water from BFR (W19F). However, end result at W17Fa suggested that dilution has improved water quality before reaching Sg. Bongkol.

ii. Sg Malubang River System

Schematic flow in *Figure 16* suggests that Sg. Malubang water system may be influenced by water conditions at seasonal stream located at BODU 01. Based on the stream lines showed in *Figure 11*, Water from BODU 01 can impact the water quality at Mangrove area at Kg Kapok. Some part of stream line that connects mangrove area and stream at Kg. Liu Tamu was found to be seasonal and was low- flowing during the sampling. However, topography map indicates that water from mangrove area will eventually flows to area around Sg. Malubang. The schematic flow in *Figure 16* also suggested that dilution at mangrove area has improved water quality at stream at Kg. Liu Tamu before it flows to Sg Malubang.

iii. Telok Marudu River System

Schematic flow in *Figure 17* suggests water quality sampling results from both sampling points in Telok Marudu river system are noted to be similar. The sampling locations are located at the stream that flows from the plantation area operated by BVLU to the plantation area operated by Borneo Harvest. Dilution was found not improving water quality at BVLU operating area as BOD level at the sampling point (W07Ca) prior to Borneo harvest area was observed to be higher than the BOD level at downstream of BVLU operating area. (W06Ca) This occurrence may be influenced by the presence of a stream which also flows into W07a which originates from an oil palm plantation located northeast of the sampling point.

The above conditions were observed to be influenced by risk factors from within and surrounding streams. Influential risk factors are concluded as follows:

Table 17 – Possible Risk Factors

No	Risk Factors	Observed Location	Risk Value
1.	Organic litter (Natural Occurrence) that comes from natural occurrence (aquatic plants, moss, and falling leaves/ branches).	BFR, acidic stream at W06Ca and W07Ca, and stream located adjacent to palm oil plantations and mangrove areas.	**Medium**, Observed to raise organic pollution.
2.	Organic litter that comes from human interference (organics from runoffs and littering)	BFR (Gerak Saga Plantation Area), Community farm, AFI Plantation Area, Buffer Zone, and Streamline in Sg. Bongkol, Sg. Malubang and Telok Marudu River System.	**High**, Observed to be the most likely possible influences.
3.	Chemical influences from human interference (CO_2, soap and shampoo)	Stream adjacent to roadway & Perennial Streams at KGLI09 Buffer Zone (BVLU).	**Low**, Observed to cause minimum organic pollution due to small occurrences.

6.5 Recommendations

6.5.1 Buffer Zone

This assessment shows that the existing SOPs implemented throughout the plantation operation life is effective and has helped to maintain and preserve the water quality of the river system. To achieve better sustainability, the SOPs should be reviewed, updated and revised accordingly to suit any changes as the business grows.

Crucial SOP that needs to be reviewed is the SOP for buffer zone to ensure appropriate buffer width is applied. AFI is encouraged to follow the reserved width as buffer zone for the perennial streams which is 20 m for river with > 3 m wide and 5 m for river with < 3 m wide as agreed in 2010. However, as many seasonal streams found in AFI plantation area, the Department of Irrigation and Drainage, Ministry of Water, Land and Natural

Resources regulation on reserve width based on the width of the waterway between the banks that has been adopted by EPD Sabah may be used. The required width to be applied for the seasonal stream is as follows:

Table 18 – Reserve width based on the width of the waterway between the banks based on Department of Irrigation and Drainage, Ministry of Water, Land and Natural Resources, Malaysia

The width of the waterway between the banks	Reserve width
> 40 m	50 m
20 - 40 m	40 m
10 – 20 m	20 m
5 – 10 m	10 m
< 5 m	5 m

Reserve width as buffer zones which should also act as a floodplain as necessary are currently only located at non-seasonal stream. Therefore, it is recommended that buffer zones are also to be located at seasonal streams. Further recommendations include constructing a ditch between the plantation and buffer zone as sediment traps that is not connected to any waterbody that may flow into the surrounding river systems. To ensure the effectiveness, length of sediment trap should be at least twice the width of the ditch with bank side slope of 2 horizontal to 1 vertical or flatter to ensure its stability; sediments or muddy water should not be released to downstream; riparian vegetation along the banks of the watercourse should always be preserved; mud and oily sheen removal always be conducted whenever trench is half full; and screen to ensure the organics not passing the sediment trap is placed properly. Periodic cleaning of the ditch is required to ensure it functions efficiently. However, cleaning off organic litter at seasonal streams in dry season is also suggested as the first effort to reduce influential elements that can affect water quality in the adjacent streams. Ditch as sediment traps will then be applied when periodic stream cleaning is found inefficient to improve water quality and while the area is under clearing/ planting/ harvesting activities.

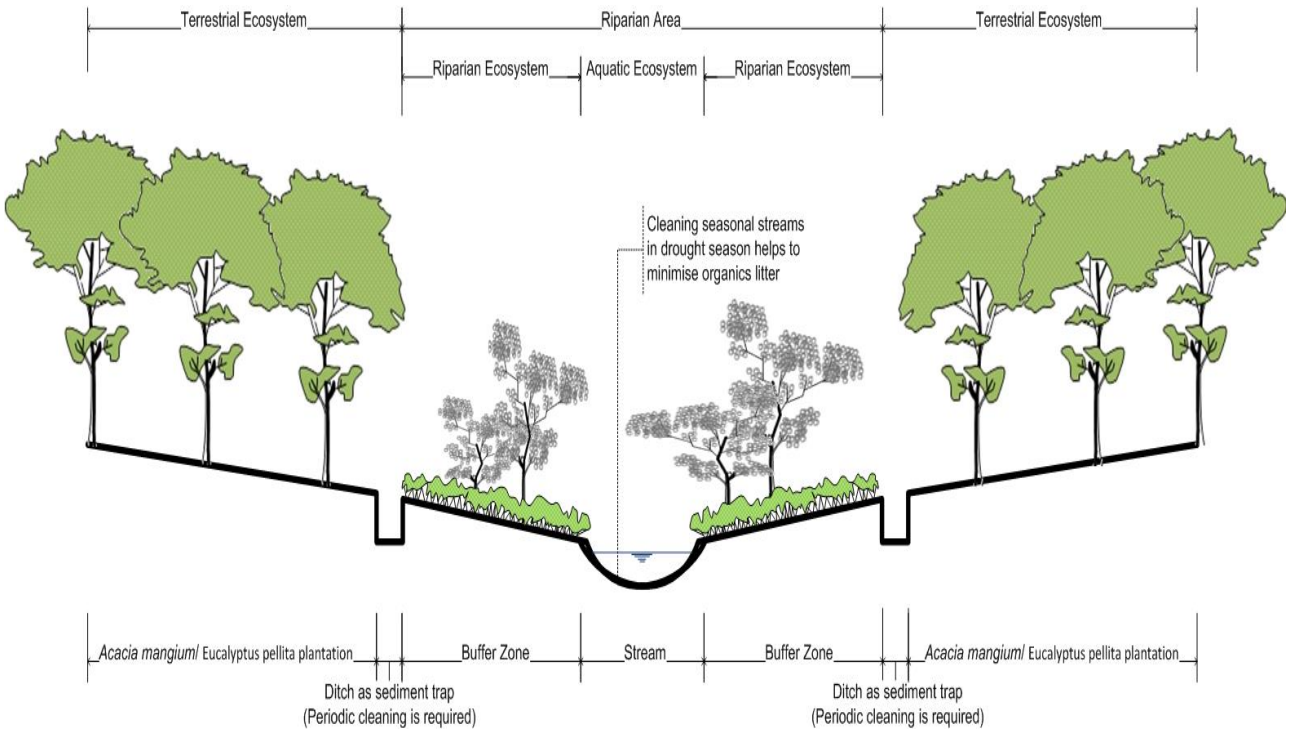


Figure 18 – Schematic of Buffer Zone for AFI

6.5.2 Herbicides/ Pesticides

Based on the chemicals used by AFI, only Starane 200, Antracol 70 WP and Oshin could pose potential harm to the waterbodies and other beneficial fauna/ insects. Care must be given when using the said products to ensure that they do not get into any waterbodies as they may harm aquatic organisms. All other chemicals used show very low toxicity and as such safe for use without additional controls. It is recommended that pesticides/herbicides with lower active ingredients toxicity alternatives such as Glyphosate and Triclopyr be used except as otherwise required by law.

6.5.3 Water Sampling

For report completeness, it is suggested that the water quality baseline is also conducted during the rainy season. This suggested sampling period will allow AFI to compare the result and analyse the water quality by including water quality from seasonal stream that may only flow during rainy season.

Sampled water in dry and rainy seasons is to be analysed for parameters as specified in National Water Quality Standards (NWQS), which are:

PHYSICAL & AGGREGATES PROPERTIES
- pH*
- Turbidity*
- Temperature*
- DO*
- Biological Oxygen Demand (BOD)*
- Chemical Oxygen Demand (COD)*
- Total suspended solid (TSS)*
- Oil & grease

ORGANICS
- Phenol
- Cyanide
- Sulphide
- Nitrate
- Nitrite
- Ammoniacal Nitrogen
- Phosphate

BIOLOGICAL
- E Coli

METALS
- Mercury
- Chromium trivalent
- Ferrous ion
- Arsenic
- Boron
- Cadmium
- Tin
- Copper
- Iron
- Lead
- Manganese

OTHER
- Pesticides

*as agreed in AFI's 2010 commitment.

Full NWQS parameters are only recommended to be analysed at upstream of each river system to describe its overall water conditions. Other sampling points is recommended to be analysed only for key parameters as agreed in AFI's 2010 commitment and also influence Water Quality Index (WQI) namely Turbidity, DO, pH, BOD, COD, TSS and NH_3-N. Monitoring locations based on *Section 4.3 Evaluation of AFI's Water Management and Monitoring Plan* along with the parameters to be tested is as follows:

Table 19 – Suggested Monitoring Locations and Tested Parameters

River Systems	Locations*	Parameters
Sg. Bongkol	W19F (upstream)	NWQS
	W16F, & W17Fa (downstream)	WQI & Turbidity
Sg Malubang	W08D3a (upstream)	NWQS
	W08D1, W10D, and W11D (downstream)	WQI & Turbidity
Telok Marudu	Upstream at KGLI05/KGLI06/KGLI09	NWQS
	W07Ca (downstream)	WQI & Turbidity

River Systems	Locations*	Parameters
Sg. Telaga	W1 (Kiwiheng AFI)	WQI & Turbidity
Sg. Kakarangan	W4 (Kiwiheng AFI)	WQI & Turbidity
Sg. Telaga	W4 (Kiwiheng HBP)	WQI & Turbidity
Sg. Malubang	W5 (Kiwiheng HBP)	WQI & Turbidity
Sg. Kg. Maringan	N1 (upstream)	NWQS
	N3 (downstream)	WQI & Turbidity
Sg. Tambalugu	N2 (upstream)	NWQS
	N4 (downstream)	WQI & Turbidity

Remarks:
* Sampling is to be conducted prior, during, and after plantation/ harvesting activities at AFI's active plantation areas. Sampling is not necessary to be conducted at the above locations whenever related plantation areas are no longer active.

Water sampling can be conducted by Laboratory Staff or by AFI Protection Staff. A summary of water sampling procedure to be used to examine water quality as described in *Section 5.1 Surface Water Sampling Methodology* of this report, is as follows:

- To request non-preservative sampling bottles for water sampling unless required (note that sampling bottle with preservative maybe required for some parameter and therefore different sampling method is required) to simplify sampling collection. Ensure all sample bottle from the lab retrieved in good and clean conditions.
- To Identify the area to collect the water sample and determine an appropriate and safe access route to minimise the risk of disturbance of the substrate prior to sampling. Transport time for the sample should conforms sample handling time set by laboratory.
- Cooler box filled with sufficient amount of ice for preserving the sample should be prepared before the sampling.
- All tools and equipment should be inspected to ensure they are in good working order and has been cleaned appropriately before in-situ measurement was taken.
- On reaching the sampling site, clean work area should be prepared and all equipment to be unpacked and make ready for use.
- To label all sample bottles before sample collection.
- Powder free glove is to be worn immediately prior to collection of the water sample. Gloves should be stored in clean and dry compartment then disposed in a plastic bag.
- Before collecting water samples, in situ water condition readings should be taken by in-situ water quality meter for parameters such as DO. (mg/L); EC. (uS/cm); TDS. (mg/L); Turbidity (NTU); Salinity (ppt); SSG. (σt); pH; ORP. (mV); and Temperature (^{o}C). The probe can be immersed directly into the waterbody or to the bucket that has been filled with sample water. All measurement should be recorded in water log forms for further recap. Probe should be washed and rinsed **only by using RO/ not mineral water** before use as to ensure quality of readings.
- To use buckets and scoop with the support of pole/stick whenever required for sample collection. Bucket/ scoop used for sampling is to be washed and rinsed thoroughly before sampling with water from sampling locations. Bucket to be lowered by rope and upon retrieval, the water is poured into the appropriate sample containers with a scoop. Sample water cap should always be closed and can only be opened before pouring especially sample bottle with preservative as to avoid loss of preservative. Samples were taken in careful manner by pulling/carrying slowly the bucket/scoop to location where water samples can be poured into sample bottles. Fill the sample bottle to just overflowing (without passing air bubbles through the sample or trapping any air bubbles in the bottle). Carefully screw the cap back onto the bottle so as not to entrap any air. Turn the bottle over and check to see that no air bubbles are present. If air is present, remove the cap and add more water to the bottle then check for air once again.
- Samples were then placed into cooler box filled with ice for preservation.

- Chain of custody (CoC) form to be filled appropriately before the cooler box is sent by transporter to the laboratory.
- Water from ice in the cooler box should be drained every 1 hour by the transporter during transport to the laboratory in Kota Kinabalu (±4hrs ride) to avoid water contamination.

Complete recommendations on the management and monitoring of the water quality within AFI site that include additional sampling points to accommodate 2019 plantation area (i.e. N1, N2, N3, & N4) are presented in the Biodiversity Management and Monitoring Plan (BMMP).

Appendix A

In-situ Measurement

Stream C (Telok Marudu River System)

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG. (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
18/7	W06Ca	8.45	6.39	215	140	0	0.08	0	**2.33**	+581.1	26.7	Stream (moderate flow) that flows to Telok Marudu which is situated in the vicinity of Kg. Kandang. This point serves as the upstream within the BVLU working area for Eucalyptus plantation.
18/7	W07Ca	8.20	**7.72**	265	172	0	0.09	0	**2.85**	+530.8	26.3	Stream (high flow)that flows to Telok Marudu which is situated in the vicinity of Kg. Kandang. This point serves as the downstream within Pemborong Silanra and Borneo Harvest working area for Eucalyptus plantation.

Stream D (Sg. Malubang River System)

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG. (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
12/7	W11Da	9.55	**7.30**	27.85	18.9	0	14.06	11.5	6.65	+115.8	26.8	River (high flow) that flows to Sg Melubang is situated in the vicinity of Kg. Liu, SK Liu, mangrove forest, restaurant and jetty. Retention pond and small fish pond was also found 1Km radius of this river.
12/7	W08D1	11.00	5.2	96	63	0	0.03	0	**5.82**	+16.1	27.5	Stream (low flow almost stagnant) that flows from Kg Kondong and Kg Kandang is located in the vicinity of acacia regeneration forest. This sampling point is located in the west of Bodu. This stream serves as the upstream of W11Da.

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG. (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
13/7	W10D	8.30	**8.7**	26.71	17.38	0	1.52	0	**5.65**	+140	26.7	River (low flow) is situated in the middle of secondary forest and rubber plantation and located between W08D1 and W11Da before the area of houses and Kg Liu facilities. Community retention pond for domestic use was also found in the vicinity of this sampling point.
13/7	W08D3a	11.00	**3.34**	62	40	0	2	0	**5.91**	+152.5	26.3	W08D3a was taken at a low flow (almost stagnant) steam which is located in acacia regeneration forest near Bengkoka Reserve Forest. Eucalyptus plantation was situated in the adjacent of sampling point.

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG. (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
15/7	W09Da	17.45	**2.25**	34.37	22.23	0	23.9	15.1	**5.87**	+94.6	27.1	W09Da is the downstream of W08D3a and located in the vicinity of Kg Kapok and Kg Liu, mangrove forest, mixed community farm, oil plantation, acacia regeneration forest and secondary forest. Retention pond use for domestic use was found near to the sampling point. This sampling point was observed to have flowing water (moderate flow) only near to the peak of low tide otherwise the stream was observed only to have a very low flow rate or stagnant.

Stream F (Sg. Bongkol River System)

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
10/7	W19F	8.30	**7.12**	249	164	0	0.09	0	6.5	+97.4	26.7	W19F was taken at AFI Dam (stagnant water) that serves as upstream of river system F. Located in Bengkoka Forest Reserve and in the vicinity of AFI's fire tower and the 91 cubic meter retention pond. Water to the retention pond is supplied through AFI's pump house wich located near the Dam next to AFI's water tank (22.7 cubic meter). Currenty the retention pond is supplying water to less than 50 HH Kg Bongkol, office and compoundeven though it was designed to serves 200 HH. Broken pipe was reported as the cause for the reduction fo this supply.

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
10/7	W16Fa	9.45	**4.74**	56	36	0	0.02	0	6.03	+138	26.9	W16Fa was taken at AFI Dam (moderate flow) that located downstream of W19F and supply water to AFI's pond (45x45x4m3) for nursery use. Located in Kg Bongkol and in the vicinity of Klinik Kesihatan, AFI's office, nursery, compound and active plantation. This point serves as the upstream for W17Fa. Pump house is used to supply water to the nursery from pond. Water from this pond will also supply the new pond located inside the nursery.
11/7	W17Fa	9.25	**8.21**	165	107	0	0.06	0	**5.07**	+166.1	26.3	W17Fa was taken at downstream (low flow) of river system F which located in the vicinity of palm oil, regeneration acacia forest mix with secondary forest, grass land and jetty. Community farm (mixed farm) was also found in the adjacent of sampling points

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	Sampling Points	Start Time	DO. (mg/L)	EC. (uS/cm)	TDS. (mg/L)	Turbidity (NTU)	Salinity (ppt)	SSG (σ_t)	pH	ORP. (mV)	Temperature (^{o}C)	Remarks
11/7	W15Fa	10.00	**3.5**	65	41	0	0.02	0	**5.69**	+119.7	26	W15Fa was taken at downstream (low flow) of W16F which flows to W17Fa located in the vicinity of regeneration acacia plantation, palm oil and secondary forest.
11/7	W16F	10.30	**3.35**	33	20	0	0.01	0	**5.38**	+60.3	26	W16F was taken at upstream (low flow almost stagnant)of W15Fa that receive water from former regeneration acacia plantation area that currently planted with eucalyptus near AFI's guest house. Information from AFI suggests that the W16F will have higher flow rate in between October – February.

Sg. Telaga

			NWQS threshold for Malaysia for Class 2B River									
			5-7	-	-	50	-	n/a	6-9			
Date (2018)	**Sampling Points**	**Start Time**	**DO. (mg/L)**	**EC. (uS/cm)**	**TDS. (mg/L)**	**Turbidity (NTU)**	**Salinity (ppt)**	**SSG (σ_t)**	**pH**	**ORP. (mV)**	**Temperature ($^{\circ}$C)**	**Remarks**
15/7	W18	16.35	**7.72**	39.54	25.74	0	28.3	18.2	**6.9**	+114.8	25.6	W18 is the low tide sampling location located in the mouth of Sg Telaga and Telok Marudu, within the vicinity of Kg. Telaga, AFI's Chipmill and mangrove forest. This river is the downstream of River System A & B.
16/7	W18a	8.30	5.88	41.92	27.11	0	29.72	19.4	**6.24**	+154.2	26.3	W18a is the high tide sampling location located in the same point as W18.

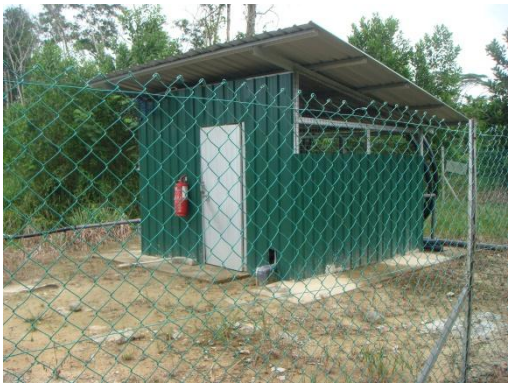
Appendix B

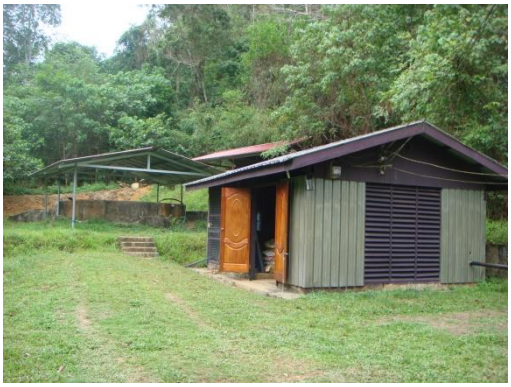
Photo Logs

1) W08D1	
	
W08D1 – Stream flowing from Kg. Kodong and Kg. Kandang	W08D1 - Stream flowing to swamp area in Bodu
2) W8D3a	
	
W8D3a	W8D3a
3) W09Da	
	
W09Da – Flowing toward north into Sg. Melubang	W09Da – Flowing toward north into Sg. Melubang

4) W10D	
	
W10D	W10D
5) W11D	
	
W11D – Jetty and school nearby the sampling point	W11D – Nearby jetty
	
W11D – Sampling point location	W11D – Sampling point about 100 m downstream of the jetty and school

6) W15Fa	
	
W15Fa – from upstream (active plantation in Kg Bongkol)	W15Fa – towards downstream
7) W16F	
	
W16F – from upstream (Active plantation in Sg. Bongkol)	W16F- towards downstream (W17Fa)
8) W16Fa	
	
W16Fa – towards retention pond for nursery	W16Fa – water from AFI dam (W19F)

	
W16Fa – Retention pond next to the dam	W16Fa – Pump house – for pumping water from retention pond to AFI nursery.
9) W17Fa	
	
W17Fa – from upstream (W15Fa)	W17Fa – towards Sg. Bongkol
10) W19F	
	
W19F – Retaining wall for Dam	W19F - Dam

	
W19F – Pump house near dam	W19F – Water tank near dam
11) W18	
	
W18 – Sampling point at the mouth of Sg. Telaga	W18 – Kg. Telaga in adjacent of Sg. Telaga.
12) W6C	
	
W6C – From upstream (active plantation in Kg Kandang)	W6C – Towards downstream (W07Ca)

13) W07Ca	
	
W07Ca – from W06Ca, before the culvert	W07Ca – After the culvert

Appendix C

AFI and Kiwiheng Monitoring (2017) Data

Kiwiheng Y1-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	pH	-	7.39 @ 25.5°C	6.30 @ 25.1°C	5.42 @ 25.4°C	6.42 @ 24.1°C	-	5-9
2	BOD_5	mg/l	**24**	**9**	3	3	-	6
3	COD	mg/l	**160**	16	8	8	-	50
4	TSS	mg/l	84	14	15	14	-	150
5	Ammoniacal Nitrogen	mg/l	ND (<0.01)	0.23	0.28	0.14	-	0.9
6	Oil & Grease	mg/l	ND (<1)	ND (<1)	ND (<1)	ND (<1)	-	N
7	Turbidity	NTU	14.3	20.8	15.5	21.9	-	-

Kiwiheng Y2-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	pH	-	**4.48** @27.2°C	6.38 @ 27.5°C	5.87 @ 27.1°C	6.67 @ 27.8°C	-	5-9
2	BOD_5	mg/l	3	**14**	**11**	2	-	6
3	COD	mg/l	8	48	24	8	-	50
4	TSS	mg/l	2	9	14	13	-	150
5	Ammoniacal Nitrogen	mg/l	0.09	ND (<1)	ND (<1)	0.14	-	0.9
6	Oil & Grease	mg/l	ND (<1)	0.23	ND (<1)	ND (<1)	-	N
7	Turbidity	NTU	4.66	22.5	25.3	18.3	-	-

Kiwiheng Y3-2017 AFI

No	Parameter	Unit	W1	W2	W3	W4	W5	NWQSM (class III)
1	pH	-	6.62 @ 25.4°C	-	6.63 @ 25.3°C	6.88 @ 25.9°C	-	5-9
2	BOD_5	mg/l	12	-	**13**	**19**	-	6
3	COD	mg/l	33	-	41	**106**	-	50
4	TSS	mg/l	43	-	13	38	-	150
5	Ammoniacal Nitrogen	mg/l	ND (<1)	-	ND (<1)	ND (<1)	-	0.9
6	Oil & Grease	mg/l	0.19	-	0.33	0.14	-	N
7	Turbidity	NTU	84.2	-	28.2	18.6	-	-

AFI Mar 23/3/2017

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	pH	-	3.57 @25.3°C	4.52 @26.4°C	6.57 @27.1°C	4.82 @27.3°C	3.60 @25.8°C	3.64 @27.4°C	4.11 @23.7°C	3.43 @24.8°C	3.45 @24.9°C	3.41 @25.2°C	5-9
2	BOD	mg/l	11	8	14	12	14	8	8	14	14	17	6
3	COD	mg/l	23	16	47	31	47	16	16	39	39	70	50
4	TSS	mg/l	4	4	9	6	2	2	16	8	5	2	150
5	Ammoniacal Nitrogen	mg/l	0.09	0.05	ND (<0.01)	ND (<0.01)	0.05	0.09	ND (<0.01)	0.05	0.05	0.14	0.9
6	Oil & grease	mg/l	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	N*
7	Turbidity	NTU	4.3	4.87	18.9	10.7	0.67	0.75	21.7	5.24	1.75	0.86	-

AFI Mar 4/10/2017

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	pH	-	3.42 @26.4°C	4.35 @26.2°C	6.55 @ 25.9°C	5.92 @ 26.1°C	3.75 @ 25.6°C	3.81 @ 26.6°C	5.30 @26.6°C	3.69 @26.5°C	3.82 @27.2°C	3.17 @26.6°C	5-9
2	BOD	mg/l	12	11	14	14	11	4	14	8	12	11	6
3	COD	mg/l	32	24	47	39	24	8	55	16	39	24	50
4	TSS	mg/l	16	9	11	54	6	15	16	5	25	2	150
5	Ammoniacal Nitrogen	mg/l	0.19	0.14	0.05	0.09	0.19	0.14	0.09	0.14	0.19	1.59	0.9
6	Oil & grease	mg/l	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	ND (<1)	N*
7	Turbidity	NTU	23.7	11.3	27.6	107	3.6	14.1	27.8	2.81	18	1.78	-

AFI Mar 22/9/2017

No	Parameter	Unit	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	NWQSM (class III)
1	pH	-	6.21 @ 27.2°C	5.77 @ 27.5°C	**4.56** @26.8°C	5.24 @27.3°C	**3.73** @26.8°C	**3.84** @27.4°C	**3.76** @27.4°C	-	-	-	5-9
2	BOD	mg/l	**9**	**11**	**13**	**14**	**11**	4	4	-	-	-	6
3	COD	mg/l	16	32	40	48	32	8	8	-	-	-	50
4	TSS	mg/l	14	25	14	3	27	2	2	-	-	-	150
5	Ammoniacal Nitrogen	mg/l	ND (<0.01)	**0.9**	ND (<0.01)	0.09	0.14	ND (<0.01)	ND (<0.01)	-	-	-	0.9
6	Oil & grease	mg/l	ND (<1)	ND (<1)	2	ND (<1)	1	ND (<1)	ND (<1)	-	-	-	N*
7	Turbidity	NTU	5.85	30.6	20.2	6.25	21.7	0.78	0.86	-	-	-	-

* N = Free from visible film sheen, discolouration and deposits

Appendix D

COC and COA

ALS Life Sciences

CERTIFICATE OF ANALYSIS

Work Order	: **KL1806715**	Page	: 1 of 5
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: J18-818	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: POMY 18-014	Date Samples Received	: 11-Jul-2018 10:00
C-O-C number	: ----	Date Analysis Commenced	: 11-Jul-2018
Sampler	: ----	Issue Date	: 20-Jul-2018 17:32
Site	: ----		
		No. of samples received	: 2
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

This laboratory is accredited under STANDARDS MALAYSIA. The tests reported herein have been performed in accordance with laboratory's Terms of Accreditation. This document has been electronically signed by authorized signatories indicated below. Electronic signing has been carried out in compliance with procedure specified in 21 CFR Part 11.

Signatories	*Position*
Norain Yahya	Chemist (IKM No: M/4233/7042/15)
William Chum	Senior Microbiologist (MJMM No: 0667)
YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, ASTM, NIOSH and BS EN. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not accredited for these tests.
~ = Indicates an estimated value.

- ALS TECHNICHEM prepares this Test Report based on the tests requested and on the specific sample(s) submitted for analysis. The significance of this Report is subject to the adequacy and representative character of the sample(s) and to the comprehensiveness of the tests requested or made. ALS TECHNICHEM assumes no responsibility for variations in quality or other characteristic of the product produced or supplied under conditions over which ALS TECHNICHEM has no control.
  ALS TECHNICHEM acts for the customer from whom the instructions to act have originated. No other party is entitled to give instructions, particularly on the scope of analysis or delivery of report or certificate, unless so authorized by the customer.
- ALS TECHNICHEM undertakes to exercise due care and skill in the performance of its analytical and consultancy services but no warranties are given and none may be implied directly or indirectly relating to ALS TECHNICHEM's test results, services or facilities. In no event shall ALS TECHNICHEM be liable to collateral, special or consequential damage.
- Total Escherichia coli Count and Oil and Grease analysis was performed by ALS Kota Kinabalu

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W 16 Fa Sampling date/time: 10-Jul-2018 09:30 KL1806715-001	Client sample ID: W 19 Fa Sampling date/time: 10-Jul-2018 08:30 KL1806715-002	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	9	6	----	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	3	4	----	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	10	15	----	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	----	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	<0.02	<0.02	----	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	0.18	0.37	----	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	0.04	0.03	----	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	1.78	<0.01	----	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	----	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	----	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	----	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	<0.01	----	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	0.05	0.05	----	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	0.001	<0.001	----	----	----
Boron	APHA3125B	0.001	mg/L	0.038	0.031	----	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	----	----	----
Copper	APHA3125B	0.001	mg/L	0.001	<0.001	----	----	----
Iron	APHA3125B	0.001	mg/L	1.87	1.93	----	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	APHA3125B	0.001	mg/L	0.199	0.099	----	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	----	----	----
Tin	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	----	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	----	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	----	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	----	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	----	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W 16 Fa Sampling date/time: 10-Jul-2018 09:30 KL1806715-001	Client sample ID: W 19 Fa Sampling date/time: 10-Jul-2018 08:30 KL1806715-002	---- ---- --------	---- ---- --------	---- ---- --------
Organochlorine Pesticides - Continued								
Endosulfan 1	USEPA8270C	5	µg/L	<5	<5	----	----	----
cis-Chlordane	USEPA8270C	5	µg/L	<5	<5	----	----	----
Dieldrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDE	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endosulfan 2	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDD	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin aldehyde	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDT	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin ketone	USEPA8270C	5	µg/L	<5	<5	----	----	----
Methoxychlor	USEPA8270C	5	µg/L	<5	<5	----	----	----
Organophosphorus Pesticides								
Dichlorvos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Monocrotophos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Dimethoate	USEPA8270C	5	µg/L	<5	<5	----	----	----
Diazinon	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Parathion-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Malathion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Fenthion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorpyrifos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Parathion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	<5	<5	----	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Fenamiphos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Prothiofos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Ethion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Carbophenothion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Azinphos Methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Microbiological Testing								

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**W 16 Fa**	**W 19 Fa**	**----**	**----**	**----**
				Sampling date/time	10-Jul-2018 09:30	10-Jul-2018 08:30	----	----	----
Compound	*Method*	*LOR*	*Unit*		**KL1806715-001**	**KL1806715-002**	**--------**	**--------**	**--------**
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		80	390	----	----	----

CERTIFICATE OF ANALYSIS

Work Order	: **KL1806757**	Page	: 1 of 5
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: J18-818	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: PO MY 18-014	Date Samples Received	: 12-Jul-2018 11:00
C-O-C number	: ----	Date Analysis Commenced	: 12-Jul-2018
Sampler	: KAMARUSZAMAN MOHAMED	Issue Date	: 23-Jul-2018 16:07
Site	: ----		
		No. of samples received	: 3
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

This laboratory is accredited under STANDARDS MALAYSIA. The tests reported herein have been performed in accordance with laboratory's Terms of Accreditation. This document has been electronically signed by authorized signatories indicated below. Electronic signing has been carried out in compliance with procedure specified in 21 CFR Part 11.

Signatories	*Position*
Nazirah Ariffin	Lab Supervisor - Environmental (IKM No: M/3878/6603/13)
Norain Yahya	Chemist (IKM No: M/4233/7042/15)
William Chum	Senior Microbiologist (MJMM No: 0667)
YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, ASTM, NIOSH and BS EN. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not accredited for these tests.
~ = Indicates an estimated value.

- ALS TECHNICHEM prepares this Test Report based on the tests requested and on the specific sample(s) submitted for analysis. The significance of this Report is subject to the adequacy and representative character of the sample(s) and to the comprehensiveness of the tests requested or made. ALS TECHNICHEM assumes no responsibility for variations in quality or other characteristic of the product produced or supplied under conditions over which ALS TECHNICHEM has no control.
  ALS TECHNICHEM acts for the customer from whom the instructions to act have originated. No other party is entitled to give instructions, particularly on the scope of analysis or delivery of report or certificate, unless so authorized by the customer.
- ALS TECHNICHEM undertakes to exercise due care and skill in the performance of its analytical and consultancy services but no warranties are given and none may be implied directly or indirectly relating to ALS TECHNICHEM's test results, services or facilities. In no event shall ALS TECHNICHEM be liable to collateral, special or consequential damage.

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W 17 Fa Sampling date/time: 11-Jul-2018 09:25 KL1806757-001	Client sample ID: W 15 Fa Sampling date/time: 11-Jul-2018 10:00 KL1806757-002	Client sample ID: W 16 F Sampling date/time: 11-Jul-2018 10:30 KL1806757-003	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	29	33	19	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	5	5	12	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	16	15	46	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	<1	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	0.03	<0.02	<0.02	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	<0.01	0.08	0.04	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	0.02	0.08	0.16	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	<0.01	1.86	0.08	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	<0.1	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	<0.050	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	<0.01	<0.01	0.13	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	<0.001	<0.001	0.002	----	----
Boron	APHA3125B	0.001	mg/L	0.046	0.040	0.052	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	<0.0005	----	----
Copper	APHA3125B	0.001	mg/L	0.002	0.001	0.006	----	----
Iron	APHA3125B	0.001	mg/L	1.16	0.745	1.82	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	0.001	----	----
Manganese	APHA3125B	0.001	mg/L	3.73	0.341	0.695	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	<0.0010	----	----
Tin	APHA3125B	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	<10	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	<5	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W 17 Fa Sampling date/time: 11-Jul-2018 09:25 KL1806757-001	Client sample ID: W 15 Fa Sampling date/time: 11-Jul-2018 10:00 KL1806757-002	Client sample ID: W 16 F Sampling date/time: 11-Jul-2018 10:30 KL1806757-003	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------
Organochlorine Pesticides - Continued								
Endosulfan 1	USEPA8270C	5	µg/L	<5	<5	<5	----	----
cis-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dieldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDE	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan 2	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDD	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin aldehyde	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDT	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin ketone	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Methoxychlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Organophosphorus Pesticides								
Dichlorvos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Monocrotophos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dimethoate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Diazinon	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Malathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenthion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenamiphos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Prothiofos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Ethion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Carbophenothion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Azinphos Methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Microbiological Testing								

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**W 17 Fa**	**W 15 Fa**	**W 16 F**	**----**	**----**
				Sampling date/time	11-Jul-2018 09:25	11-Jul-2018 10:00	11-Jul-2018 10:30	----	----
Compound	*Method*	*LOR*	*Unit*		**KL1806757-001**	**KL1806757-002**	**KL1806757-003**	**--------**	**--------**
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		1090	730	1020	----	----

ALS Life Sciences

CERTIFICATE OF ANALYSIS

Work Order	: **KL1806811**	Page	: 1 of 5
Amendment	: **1**		
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: J18-818	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: MY-18-014	Date Samples Received	: 13-Jul-2018 11:00
C-O-C number	: ----	Date Analysis Commenced	: 15-Jul-2018
Sampler	: KAMARUSZAMAN MOHAMED	Issue Date	: 06-Aug-2018 15:17
Site	: ----		
		No. of samples received	: 2
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

This laboratory is accredited under STANDARDS MALAYSIA. The tests reported herein have been performed in accordance with laboratory's Terms of Accreditation. This document has been electronically signed by authorized signatories indicated below. Electronic signing has been carried out in compliance with procedure specified in 21 CFR Part 11.

Signatories	*Position*
Nazirah Ariffin	Lab Supervisor - Environmental (IKM No: M/3878/6603/13)
Norain Yahya	Chemist (IKM No: M/4233/7042/15)
William Chum	Senior Microbiologist (MJMM No: 0667)
YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, ASTM, NIOSH and BS EN. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

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^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not accredited for these tests.
~ = Indicates an estimated value.

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  ALS TECHNICHEM acts for the customer from whom the instructions to act have originated. No other party is entitled to give instructions, particularly on the scope of analysis or delivery of report or certificate, unless so authorized by the customer.
- ALS TECHNICHEM undertakes to exercise due care and skill in the performance of its analytical and consultancy services but no warranties are given and none may be implied directly or indirectly relating to ALS TECHNICHEM's test results, services or facilities. In no event shall ALS TECHNICHEM be liable to collateral, special or consequential damage.

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W08D1 Sampling date/time: 12-Jul-2018 11:00 KL1806811-001	Client sample ID: W11Da Sampling date/time: 12-Jul-2018 09:55 KL1806811-002	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	18	12	----	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	4	9	----	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	12	32	----	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	----	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	<0.02	<0.02	----	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	0.06	0.12	----	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	0.07	<0.01	----	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	1.75	<0.01	----	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	----	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	----	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	----	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	<0.01	----	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	0.03	<0.01	----	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Boron	APHA3125B	0.001	mg/L	0.029	2.78	----	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	----	----	----
Copper	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Iron	APHA3125B	0.001	mg/L	0.816	0.560	----	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	APHA3125B	0.001	mg/L	0.590	0.278	----	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	----	----	----
Tin	APHA3125B	0.001	mg/L	<0.001	0.001	----	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	----	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	----	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	----	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	----	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	----	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W08D1 Sampling date/time: 12-Jul-2018 11:00 KL1806811-001	Client sample ID: W11Da Sampling date/time: 12-Jul-2018 09:55 KL1806811-002	---- ---- --------	---- ---- --------	---- ---- --------
Organochlorine Pesticides - Continued								
Endosulfan 1	USEPA8270C	5	µg/L	<5	<5	----	----	----
cis-Chlordane	USEPA8270C	5	µg/L	<5	<5	----	----	----
Dieldrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDE	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endosulfan 2	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDD	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin aldehyde	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L	<5	<5	----	----	----
4.4`-DDT	USEPA8270C	5	µg/L	<5	<5	----	----	----
Endrin ketone	USEPA8270C	5	µg/L	<5	<5	----	----	----
Methoxychlor	USEPA8270C	5	µg/L	<5	<5	----	----	----
Organophosphorus Pesticides								
Dichlorvos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Monocrotophos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Dimethoate	USEPA8270C	5	µg/L	<5	<5	----	----	----
Diazinon	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Parathion-methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Malathion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Fenthion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorpyrifos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Parathion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	<5	<5	----	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	<5	<5	----	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Fenamiphos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Prothiofos	USEPA8270C	5	µg/L	<5	<5	----	----	----
Ethion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Carbophenothion	USEPA8270C	5	µg/L	<5	<5	----	----	----
Azinphos Methyl	USEPA8270C	5	µg/L	<5	<5	----	----	----
Microbiological Testing								

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**W08D1**	**W11Da**	**----**	**----**	**----**
				Sampling date/time	12-Jul-2018 11:00	12-Jul-2018 09:55	----	----	----
Compound	*Method*	*LOR*	*Unit*		**KL1806811-001**	**KL1806811-002**	**--------**	**--------**	**--------**
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		1100	5200	----	----	----

ALS Life Sciences

CERTIFICATE OF ANALYSIS

Work Order	: **KL1806875**	Page	: 1 of 5
Amendment	: **1**		
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: J18-818	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: MY-18-014	Date Samples Received	: 14-Jul-2018 10:30
C-O-C number	: ----	Date Analysis Commenced	: 19-Jul-2018
Sampler	: KAMARUSZAMAN MOHAMED	Issue Date	: 06-Aug-2018 15:17
Site	: ----		
		No. of samples received	: 2
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

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Signatories	*Position*
Nazirah Ariffin	Lab Supervisor - Environmental (IKM No: M/3878/6603/13)
Norain Yahya	Chemist (IKM No: M/4233/7042/15)
William Chum	Senior Microbiologist (MJMM No: 0667)
YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, ASTM, NIOSH and BS EN. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not accredited for these tests.
~ = Indicates an estimated value.

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  ALS TECHNICHEM acts for the customer from whom the instructions to act have originated. No other party is entitled to give instructions, particularly on the scope of analysis or delivery of report or certificate, unless so authorized by the customer.
- ALS TECHNICHEM undertakes to exercise due care and skill in the performance of its analytical and consultancy services but no warranties are given and none may be implied directly or indirectly relating to ALS TECHNICHEM's test results, services or facilities. In no event shall ALS TECHNICHEM be liable to collateral, special or consequential damage.

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W 10D Sampling date/time: 13-Jul-2018 08:30 KL1806875-001	Client sample ID: W 8D3A Sampling date/time: 13-Jul-2018 11:00 KL1806875-002	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------	Client sample ID: ---- Sampling date/time: ---- --------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	15	25	----	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	3	7	----	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	14	25	----	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	----	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	<0.02	0.30	----	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	0.05	0.47	----	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	<0.01	0.01	----	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	1.09	0.87	----	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	----	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	----	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	----	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	0.04	----	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	0.07	0.09	----	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Boron	APHA3125B	0.001	mg/L	0.310	0.062	----	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	----	----	----
Copper	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Iron	APHA3125B	0.001	mg/L	3.71	7.06	----	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	APHA3125B	0.001	mg/L	0.304	0.278	----	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	----	----	----
Tin	APHA3125B	0.001	mg/L	0.002	<0.001	----	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	----	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	----	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	----	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	----	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	----	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	----	----	----

Analytical Results

Sub-Matrix: WATER				Client sample ID	W 10D	W 8D3A	----	----	----
				Sampling date/time	13-Jul-2018 08:30	13-Jul-2018 11:00	----	----	----
Compound	Method	LOR	Unit		KL1806875-001	KL1806875-002	--------	--------	--------
Organochlorine Pesticides - Continued									
Endosulfan 1	USEPA8270C	5	µg/L		<5	<5	----	----	----
cis-Chlordane	USEPA8270C	5	µg/L		<5	<5	----	----	----
Dieldrin	USEPA8270C	5	µg/L		<5	<5	----	----	----
4.4`-DDE	USEPA8270C	5	µg/L		<5	<5	----	----	----
Endrin	USEPA8270C	5	µg/L		<5	<5	----	----	----
Endosulfan 2	USEPA8270C	5	µg/L		<5	<5	----	----	----
4.4`-DDD	USEPA8270C	5	µg/L		<5	<5	----	----	----
Endrin aldehyde	USEPA8270C	5	µg/L		<5	<5	----	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L		<5	<5	----	----	----
4.4`-DDT	USEPA8270C	5	µg/L		<5	<5	----	----	----
Endrin ketone	USEPA8270C	5	µg/L		<5	<5	----	----	----
Methoxychlor	USEPA8270C	5	µg/L		<5	<5	----	----	----
Organophosphorus Pesticides									
Dichlorvos	USEPA8270C	5	µg/L		<5	<5	----	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Monocrotophos	USEPA8270C	5	µg/L		<5	<5	----	----	----
Dimethoate	USEPA8270C	5	µg/L		<5	<5	----	----	----
Diazinon	USEPA8270C	5	µg/L		<5	<5	----	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Parathion-methyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Malathion	USEPA8270C	5	µg/L		<5	<5	----	----	----
Fenthion	USEPA8270C	5	µg/L		<5	<5	----	----	----
Chlorpyrifos	USEPA8270C	5	µg/L		<5	<5	----	----	----
Parathion	USEPA8270C	5	µg/L		<5	<5	----	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L		<5	<5	----	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L		<5	<5	----	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Fenamiphos	USEPA8270C	5	µg/L		<5	<5	----	----	----
Prothiofos	USEPA8270C	5	µg/L		<5	<5	----	----	----
Ethion	USEPA8270C	5	µg/L		<5	<5	----	----	----
Carbophenothion	USEPA8270C	5	µg/L		<5	<5	----	----	----
Azinphos Methyl	USEPA8270C	5	µg/L		<5	<5	----	----	----
Microbiological Testing									

Analytical Results

Sub-Matrix: **WATER**				Client sample ID	**W 10D**	**W 8D3A**	**----**	**----**	**----**
				Sampling date/time	13-Jul-2018 08:30	13-Jul-2018 11:00	----	----	----
Compound	*Method*	*LOR*	*Unit*		**KL1806875-001**	**KL1806875-002**	**--------**	**--------**	**--------**
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		1300	900	----	----	----

ALS Life Sciences

CERTIFICATE OF ANALYSIS

Work Order	: **KL1806934**	Page	: 1 of 5
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: J18-818	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: MY-18-014	Date Samples Received	: 17-Jul-2018 12:00
C-O-C number	: ----	Date Analysis Commenced	: 19-Jul-2018
Sampler	: KAMARUSZAMAN MOHAMED	Issue Date	: 26-Jul-2018 16:57
Site	: ----		
		No. of samples received	: 3
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

This laboratory is accredited under STANDARDS MALAYSIA. The tests reported herein have been performed in accordance with laboratory's Terms of Accreditation. This document has been electronically signed by authorized signatories indicated below. Electronic signing has been carried out in compliance with procedure specified in 21 CFR Part 11.

Signatories	*Position*
Nazirah Ariffin	Lab Supervisor - Environmental (IKM No: M/3878/6603/13)
William Chum	Senior Microbiologist (MJMM No: 0667)
YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, ASTM, NIOSH and BS EN. In house developed procedures are employed in the absence of documented standards or by client request.

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Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W18 (LOW TIDE)	W9DA	W18A (HIGH TIDE)	----	----
				Sampling date/time: 15-Jul-2018 16:35	15-Jul-2018 17:45	16-Jul-2018 00:00	----	----
				KL1806934-001	KL1806934-002	KL1806934-003	--------	--------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	25	37	11	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	8	12	15	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	22	34	45	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	<1	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	<0.02	<0.02	<0.02	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	0.10	0.20	0.14	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	0.02	0.03	<0.01	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	<0.1	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	<0.050	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	<0.01	0.06	0.07	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	0.002	0.001	0.001	----	----
Boron	APHA3125B	0.001	mg/L	5.60	4.50	6.05	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	<0.0005	----	----
Copper	APHA3125B	0.001	mg/L	0.001	<0.001	<0.001	----	----
Iron	APHA3125B	0.001	mg/L	1.26	4.29	0.319	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Manganese	APHA3125B	0.001	mg/L	0.039	0.344	0.053	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	<0.0010	----	----
Tin	APHA3125B	0.001	mg/L	0.008	0.002	0.002	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	<10	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	<5	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W18 (LOW TIDE)	W9DA	W18A (HIGH TIDE)	----	----
				Sampling date/time: 15-Jul-2018 16:35	15-Jul-2018 17:45	16-Jul-2018 00:00	----	----
				KL1806934-001	KL1806934-002	KL1806934-003	--------	--------
Organochlorine Pesticides - Continued								
Endosulfan 1	USEPA8270C	5	µg/L	<5	<5	<5	----	----
cis-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dieldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDE	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan 2	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDD	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin aldehyde	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDT	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin ketone	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Methoxychlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Organophosphorus Pesticides								
Dichlorvos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Monocrotophos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dimethoate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Diazinon	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Malathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenthion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenamiphos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Prothiofos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Ethion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Carbophenothion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Azinphos Methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Microbiological Testing								

Analytical Results

Sub-Matrix: **WATER**

				Client sample ID	W18 (LOW TIDE)	W9DA	W18A (HIGH TIDE)	----	----
				Sampling date/time	15-Jul-2018 16:35	15-Jul-2018 17:45	16-Jul-2018 00:00	----	----
Compound	Method	LOR	Unit		KL1806934-001	KL1806934-002	KL1806934-003	--------	--------
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		300	800	2000	----	----

ALS Life Sciences

CERTIFICATE OF ANALYSIS

Work Order	: **KL1807128**	Page	: 1 of 5
Client	: **ENVIROSOLUTIONS & CONSULTING SDN BHD**	Laboratory	: ALS Technichem (M) Sdn. Bhd.
Contact	: MR KAMARUSZAMAN MOHAMED	Contact	: Nurul Huwaida
Address	: NO 65B, JALAN SS21/60, DAMANSARA UTAMA, PETALING JAYA, SELANGOR 47400	Address	: WISMA ALS, 21, Jalan Astaka U8/84, Bukit Jelutong Shah Alam Selangor Malaysia 40150
E-mail	: kamaruszaman@envirosc.com	E-mail	: nurul.huwaida@alsglobal.com
Telephone	: 03 7733 8816	Telephone	: +60378478257
Facsimile	: 03 7733 8817	Facsimile	: +603 7845 8258
Project	: ----	QC Level	: ALS Malaysia Standard Quality Schedule
Order number	: MY-18-014	Date Samples Received	: 20-Jul-2018 12:00
C-O-C number	: ----	Date Analysis Commenced	: 23-Jul-2018
Sampler	: ----	Issue Date	: 31-Jul-2018 16:41
Site	: ----		
		No. of samples received	: 3
Quote number	: KL2018ENVIROSOLU0005	No. of samples analysed	: 3

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

MS ISO/IEC 17025
TESTING
SAMM NO. 147

Signatories

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Signatories	*Position*
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Norain Yahya	Chemist (IKM No: M/4233/7042/15)
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YiuLay Lee	Lab Manager - Environmental (IKM No: M/2712/4566/04/08)

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~ = Indicates an estimated value.

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Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W6CA Sampling date/time: 18-Jul-2018 08:45 KL1807128-001	W7CA 18-Jul-2018 08:20 KL1807128-002	CA 18-Jul-2018 00:00 KL1807128-003	---- ---- --------	---- ---- --------
Physical and Aggregate Properties								
Total Suspended Solids	APHA2540D	1	mg/L	4	17	14	----	----
Aggregate Organics								
Biochemical Oxygen Demand	APHA5210B	1	mg/L	4	7	6	----	----
Chemical Oxygen Demand	APHA5220D	1	mg/L	12	18	16	----	----
Oil & Grease	APHA5520B	1	mg/L	<1	<1	<1	----	----
Total Phenols	APHA5530B&D	0.02	mg/L	<0.02	<0.02	<0.02	----	----
Inorganic and Nonmetallic Properties								
Ammonia as N	APHA4500 NH3 G	0.01	mg/L	0.40	0.38	0.37	----	----
Ferrous Iron	APHA3500-Fe-B	0.01	mg/L	0.03	0.04	0.04	----	----
Nitrate as NO3	APHA4500-NO3-H	0.01	mg/L	1.52	1.51	1.65	----	----
Sulphide as S2-	APHA4500-S2-D	0.1	mg/L	<0.1	<0.1	<0.1	----	----
Total Cyanide	APHA4500CN C&E	0.050	mg/L	<0.050	<0.050	<0.050	----	----
Trivalent Chromium	APHA3500-Cr-D	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Nitrite as NO2	APHA4500-NO2-B	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Phosphate as PO4	APHA4500-P F	0.01	mg/L	0.04	<0.01	<0.01	----	----
Metals and Major Cations - Total								
Arsenic	APHA3125B	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Boron	APHA3125B	0.001	mg/L	0.025	0.026	0.026	----	----
Cadmium	APHA3125B	0.0005	mg/L	<0.0005	<0.0005	<0.0005	----	----
Copper	APHA3125B	0.001	mg/L	0.002	0.001	0.002	----	----
Iron	APHA3125B	0.001	mg/L	2.49	2.14	2.36	----	----
Lead	APHA3125B	0.001	mg/L	<0.001	<0.001	0.001	----	----
Manganese	APHA3125B	0.001	mg/L	0.809	0.788	0.812	----	----
Mercury	USEPA6020A	0.0010	mg/L	<0.0010	<0.0010	<0.0010	----	----
Tin	APHA3125B	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Organochlorine Pesticides								
alpha-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Hexachlorobenzene (HCB)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
beta- & gamma-BHC	USEPA8270C	10	µg/L	<10	<10	<10	----	----
delta-BHC	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Aldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Heptachlor epoxide	USEPA8270C	5	µg/L	<5	<5	<5	----	----
trans-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----

Analytical Results

Sub-Matrix: **WATER**

Compound	Method	LOR	Unit	Client sample ID: W6CA Sampling date/time: 18-Jul-2018 08:45 KL1807128-001	W7CA 18-Jul-2018 08:20 KL1807128-002	CA 18-Jul-2018 00:00 KL1807128-003	---- ---- --------	---- ---- --------
Organochlorine Pesticides - Continued								
Endosulfan 1	USEPA8270C	5	µg/L	<5	<5	<5	----	----
cis-Chlordane	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dieldrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDE	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan 2	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDD	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin aldehyde	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endosulfan sulfate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
4.4`-DDT	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Endrin ketone	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Methoxychlor	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Organophosphorus Pesticides								
Dichlorvos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Demeton-S-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Monocrotophos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Dimethoate	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Diazinon	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion-methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Malathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenthion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorpyrifos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Parathion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Pirimphos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (E)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Chlorfenvinphos (Z)	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Bromophos-ethyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Fenamiphos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Prothiofos	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Ethion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Carbophenothion	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Azinphos Methyl	USEPA8270C	5	µg/L	<5	<5	<5	----	----
Microbiological Testing								

Analytical Results

Sub-Matrix: **WATER**

				Client sample ID	W6CA	W7CA	CA	----	----
				Sampling date/time	18-Jul-2018 08:45	18-Jul-2018 08:20	18-Jul-2018 00:00	----	----
Compound	Method	LOR	Unit		KL1807128-001	KL1807128-002	KL1807128-003	--------	--------
Microbiological Testing - Continued									
Total Escherichia coli Count	MB-17-22	1	CFU/100mL		300	<1	<1	----	----