State Environmental Conservation Department
(ECD), Sabah Malaysia

Environmental Impact Assessment (EIA) Guidelines for Oil Palm Plantation Development

Third Draft

November 2000

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Abbreviations

ACLR	Assistant Collector of Land Revenue
AEC	Agreement on Environmental Conditions
DID	Department of Irrigation and Drainage
DOA	Department of Agriculture (Malaysia)
DOE	Department of Environment (Malaysia)
ECD	Environmental Conservation Department (State of Sabah)
EIA	Environmental Impact Assessment
FFB	Fresh fruit bunches
ha	hectare
km	kilometre
LSD	Lands and Survey Department
m	metre
m^3	cubic metre
m/s	metre per second
mg/L	milligram per litre
MPOB	Malaysian Palm Oil Board
MT	metric tonnes
NAHRIM	National Hydraulic Research Institute of Malaysia
POM	Palm oil mill
PORIM	Palm Oil Research Institute of Malaysia
PORLA	Palm Oil Registration and Licensing Authority
RM	Malaysian Ringgit
NRO	Natural Resources Officer
Sg	Sungai (river)
TOL	Temporary Occupation Licence
TSS	Total Suspended Solids
WHO	World Health Organisation

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Preface

Oil palm cultivation is one of the main economic activities of the state, which not only effect extensive land development but also provides substantial revenue to the state as well as the nation as a whole. It is also one of the pivotal aspects that act as the catalyst for regional infrastructural development, particularly road network within interior areas.

Oil palm cultivation, that is economically viable to be developed in the scale of plantations, may result in destruction of ecological habitats, change in hydrological regime of the region, and contribute to waterway pollution in terms of increased suspended solids content and elevated levels of agro-chemicals therein. As oil palm cultivation normally takes place covering large areas, the impacts are regional in nature and thus activities related to its development and implementation need to be subject to a holistic planning in order to control and eliminate as much as possible any adverse repercussions.

In Sabah, the Environmental Conservation Department is charged with regulating the development of oil palm plantation effective September 1999 to ensure that the implementations are conducted in an environmentally responsible manner.

This guideline is produced to provide guidance on the scope of environmental considerations required during the planning, implementation and abandonment stage of oil palm plantation development activities. It should be regarded as complementary to the *Handbook for Environmental Impact Assessment (EIA) in Sabah* and should be used in conjunction with *EIA Guidelines for Forestry and Land Conversion*, both also published by the Environmental Conservation Department.

This Guideline is intended for use by project proponents, environmental consultants and approving authorities when initiating, assessing and approving the EIA for oil palm plantation development activities in the State of Sabah.

Through use of this document it is intended that the key environmental considerations will be identified in the planning of oil palm plantation development activities. Early identification of potential environmental considerations will ensure that subsequent developments will be carried out with minimal adverse environmental impacts.

Eric Juin
Director
Environmental Conservation Department

Introduction

Definition

Oil palm plantation development is defined as opening up of land areas for the purpose of cultivating oil palm and carrying out other related activities such as land clearing, biomass management and disposal, earthworks, planting and replanting activities. Throughout this Guideline, ***oil palm plantation development*** is used as an abbreviated form to cover all of the above activities.

Aim of Guidelines

The aim of this Environmental Impact Assessment (EIA) Guideline is to provide a framework for the preparation of EIA for oil palm plantation development activities under the requirements specified in the Sabah's *Conservation of Environment Enactment 1996* and *Conservation of Environment (Prescribed Activities) Order 1999.*

Guideline Usage

The Guideline provides an easy to follow and practical means for assessing environmental impacts, recommending mitigation measures and proposing monitoring programmes for:

- Land clearing, biomass management and disposal, earthworks, infrastructure development, planting, palm maintenance, harvesting and transportation within the State of Sabah.

This Guideline also includes replanting activities for oil palm plantation already exceeding their reproductive life span and conversion of other types of cultivation and crops into oil palm plantation.

Relevant Guidelines

This Guideline should be used in conjunction with the *Handbook for Environmental Impact Assessment (EIA) in Sabah*, published by the Environmental Conservation Department Sabah (ECD).

Acknowledgements

ECD would like to express their appreciation to the Danish Co-operation for Environment and Development (DANCED) for overseeing and assistance in preparation of these Guidelines through ECD's Capacity Building Project. Appreciation is also extended to all government agencies, organisations and individuals for their contribution and support in formulation of these Guidelines.

1 Sabah Context

1.1 Geographical Overview

As of December 1999, Sabah is by far the state in Malaysia that has the largest land area planted with oil palm at a total area of 941,322 ha (Table 1.1). Based on the 1998 data, the division and district that has the largest areas planted with oil palm is Sandakan (464,038 ha) and Kinabatangan (265,111 ha) respectively (Table 1.2).

Table 1.1:Distribution of Oil Palm Planted Areas by State in Malaysia [as of December 1999]

State	*Total Oil Palm Planted Area, ha (%)*	
Johor	612,708	(18.5)
Kedah	52,558	(1.6)
Kelantan	80,407	(2.4)
Melaka	39,596	(1.2)
Negeri Sembilan	118,781	(3.6)
Pahang	542,855	(16.4)
Pulau Pinang	13,968	(0.4)
Perak	303,089	(9.1)
Selangor	132,149	(4.0)
Terengganu	155,484	(4.7)
Sabah	941,322	(28.4)
Sarawak	320,476	(9.7)
Malaysia	3,313,393	(100.0)

Source: PORLA (http://161.142.157.2/home2/home)

(**The map showing the oil palm area throughout Sabah will be obtained by ECD from Agriculture Dept.**)

Table 1.2:Distribution of Oil Palm Planted Areas by Division and District in Sabah, Malaysia [as of December 1997]

Division	District	Area, ha	Area Percentage (%)	
			Divisional	Sabah
Tawau	Tawau	85,410	23.8	10.1
	Semporna	32,777	9.1	3.9
	Lahad Datu	188,826	52.7	22.4
	Kunak	51,385	14.3	6.1
	Total	358,398	100.0	42.5
Sandakan	Sandakan	85,788	18.5	10.2
	Kinabatangan	265,111	57.1	31.4
	Tongod	474	0.1	0.1
	Beluran	78,322	16.9	9.3
	Telupid	34,343	7.4	4.1
	Total	464,038	100.0	55.0
Kudat	Kudat	1,440	21.2	0.2
	Pitas	1,725	25.4	0.2
	Kota Marudu	3,625	53.4	0.4
	Total	6,790	100.0	0.8
Pantai Barat	Kota Belud	46	1.4	0.0
	Ranau	144	4.5	0.0
	Tuaran	413	12.8	0.0
	Kota Kinabalu	0	0.0	0.0
	Penampang	0	0.0	0.0
	Papar	2,630	81.3	0.0
	Total	3,233	100.0	0.4
Pedalaman	Beaufort	10,543	91.7	1.2
	Sipitang	20	0.2	0.0
	Kuala Penyu	113	1.0	0.0
	Tenom	34	0.3	0.0
	Keningau	374	3.3	0.0
	Sook	405	3.5	0.0
	Tambunan	0	0.0	0.0
	Pensiangan	4	0.0	0.0
	Total	11,493	100.0	1.4
Sabah		843,952		100.0

Source: Report on Crop Hectareages in Sabah 1997 (DOA 99/1).

1.2 Legal Requirements

Effective September 1999, Environmental Impact Assessment (EIA) is a mandatory requirement for oil palm plantation development activities in Sabah under the *Conservation of Environment Enactment 1996* and the *Conservation of Environment (Prescribed Activities) Order 1999*. Oil palm plantation development is a Prescribed Activity, which requires an EIA approval prior to project commencement. It falls under the following category:

Section 1: Agricultural Development

Paragraph (i): development of agricultural estates or plantations covering an area of 500 hectares or more – (a) from land under secondary or primary forests; (b) which would involve the resettlement of 100 families or more; or (c) which would involve modification in the use of the land;

Paragraph (ii): conversion of mangrove swamps and other wetland areas into agricultural estates having an area of 50 hectares or more; or

Paragraph (iii): development of agricultural area adjacent to any conservation area, park or sanctuary declared under any written law.

Failure to observe this directive, the authority, body or person in default shall be guilty of an offence and shall, on conviction, be liable to a term of imprisonment for 5 (five) years and a fine of RM50,000.00 (Malaysian Ringgit fifty thousand only).

1.3 Approving Authorities, Administration & Licensing

Environmental

Any person who intends to undertake oil palm plantation development activities in the State of Sabah shall submit to the Director of the Environmental Conservation Department (ECD) an ***EIA Report*** for approval. The Department contact is:

The Director
Environmental Conservation Department
Tingkat 2 & 3, Wisma Budaya
88000 Kota Kinabalu, Sabah

Attention: Environmental Assessment Section
Tel: 088-251290/1
Fax: 088-238120
E-mail: jkas@sabah.gov.my
Homepage: *www. sabah. gov.my/jkas*

Agricultural Policy

Oil palm is one of the important commodity crops in Sabah. The Sabah Agricultural Policy (1992 – 2010) states that:

Section 10. Commodity Policy

Item 10.1.1 Oil Palm – To maximise returns from palm oil, production will be increased through expansion, productivity improvement, and upgraded efficiency particularly in the smallholders subsector. The adoption of automation and intensified mechanisation will be encouraged to increase productivity and efficiency and as a long term solution to the problem of labour shortage. Milling, bulking installation and refining facilities will be upgraded, expanded and increased to cater for increase production. Downstream processing to produce locally manufactured value-added palm oil products, such as oleo-

chemicals, will be encouraged to ensure a balanced and sustained growth of the industry. Environmentally friendly methods of oil palm cultivation, production and processing will be promoted.

Oil palm cultivation is not only meant to meet investors' and developers' economical benefits but also fulfil the State's socio-economic interest. Environmentally friendly methods of oil palm cultivation is clearly emphasised in the Policy.

Note: ***Sabah Agricultural Policy (1999 - 2010)*** is currently at the final stage of preparation (**ECD will obtain from Agriculture Dept.**).

Purpose of oil palm plantation development

Oil palm plantation in the State of Sabah is carried out mainly for production of large quantities of high quality fresh fruit bunches (FFB) for the purpose of producing crude palm oil (CPO), palm kernel oil (PKO) and other products that generate income for the developer, the state of Sabah and Malaysia as a whole.

Application Procedures

Effective September 1999, land applications for oil palm plantation development activities in the State of Sabah are subject to the requirements of an EIA. The application procedure for developing an oil palm plantation begins with the application for land as shown in Figure 1.1. The procedure is summarised as follows:

- Application shall be made in writing to the Assistant Collector of Land Revenue (ACLR)

- The ACLR shall refer the application to the Land Utilisation Committee (LUC) for technical comments. Permanent members of the LUC are Director or Deputy Director of LSD (Chairperson), District Surveyor, Department of Agriculture (DOA), Forestry Department, Department of Irrigation and Drainage (DID), Fishery Department and community leaders. Community leaders and surveyors will ensure that the land is available and unencumbered. DOA will give a technical comment in terms of land suitability for the purpose of oil palm cultivation. DOA will also consider the proposed Agriculture Development Plan (ADP) to be implemented by the applicant and make recommendations to ACLR. The recommendations do not bear any regulatory weight but if applied by the Enforcement Section of the LSD under the regulations stipulated in the Land Code, the recommendations might be used to prosecute any breach of the requirements under the Code

- The application is then forwarded to the Director of LSD who will then forward it to the Secretary of Natural Resources for approval by the YAB Chief Minister

- The approved application is returned to the Director of LSD who will direct the ACLR to make an offer to the applicant and a Draft Land Title is subsequently issued

- The applicant, already obtained the Draft Land Title, then carry out an EIA (if it is a prescribed activity) until its approval by the ECD, which will assist in determining the exact area of the oil palm plantation. In order for the boundary of the oil palm plantation be finalised and the development to commence, an EIA must be prepared and the Agreement on Environmental Conditions must be signed between the Project Proponent and the ECD

- Upon approval of the EIA by the ECD, the applicant then approach the District Surveyor to establish the Registered Survey Paper (RSP) through the service of a Registered Surveyor who will then produce the Draft Survey Plan (DSP)

- The DSP will be reviewed and checked by the District Surveyor before the Plan as well as the survey data are submitted to the LSD for official registration

- Upon completion of the tasks required by LSD, the Land Registrar will issue the lease to the applicant and the Final Title is produced.

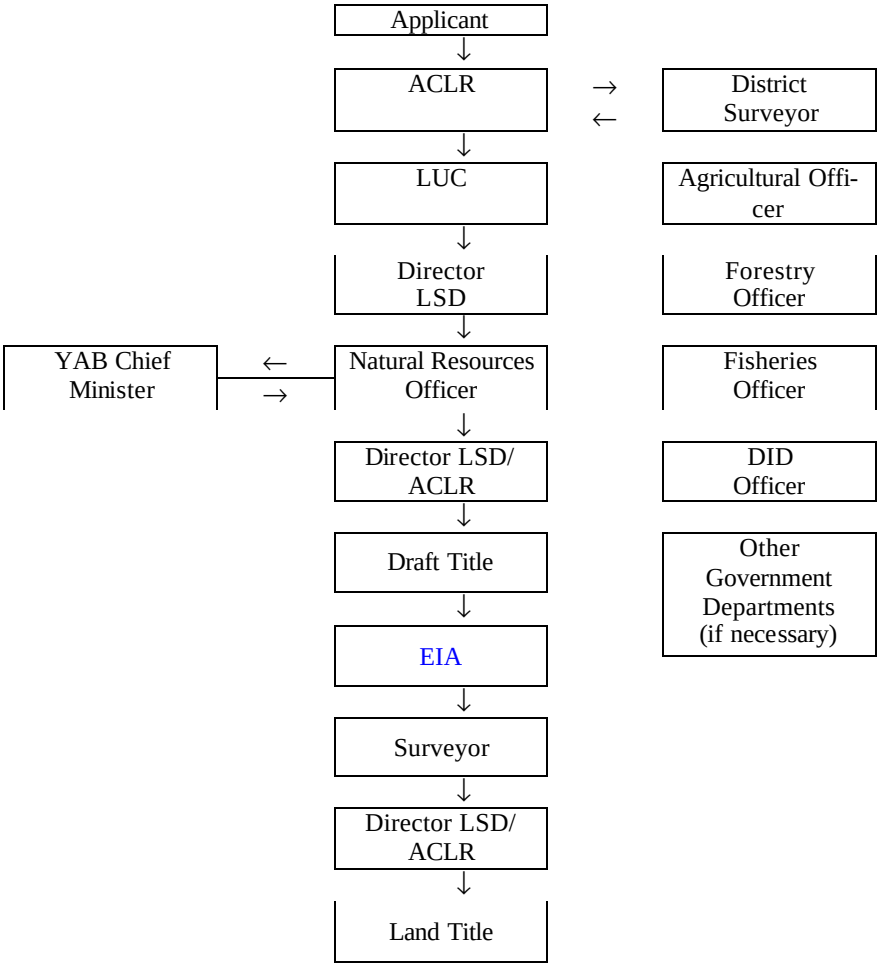

Figure 1.1: Application Procedures for oil palm plantation development in Sabah (Details in Annex 1.1).

1.4 Typical Project Activities

Operations

Typical oil palm plantation development operations may involve six main stages, namely; (i) pre-development, (ii) nursery establishment, (iii) site preparation, (iv) field establishment, (v) maintenance and harvesting, and (vi) re-planting/abandonment.

- Pre-development - this stage involves the conduct of feasibility studies, application/acquisition of land, preparation of EIA, and survey of boundary and plantation blocks

- Nursery establishment – normally one ha nursery will cater for a planting area of 100 ha. This stage will prepare high quality seedlings for field planting when the plantation proper site has been developed

- Site preparation – normally the existing vegetation is cleared and removed to enable earthworks (particularly terracing & drainage works). Cover crops will be planted and maintained

- Field establishment – field lining and holing will be carried out. Suitable seedlings from the nursery will be transplanted on prepared planting field

- Maintenance and harvesting – planted palm trees are maintained by manuring and control of diseases, weed and pests. Harvesting will normally commence within 2.5 to 3 years after field planting

- Re-planting/abandonment - after completion of the productive life span (20 to 25 years), decision will be made on either to replant or abandon the oil palm plantation.

Current Practice

A project flow diagram for a typical activities related to oil palm plantation development is shown in Figure 1.2.:

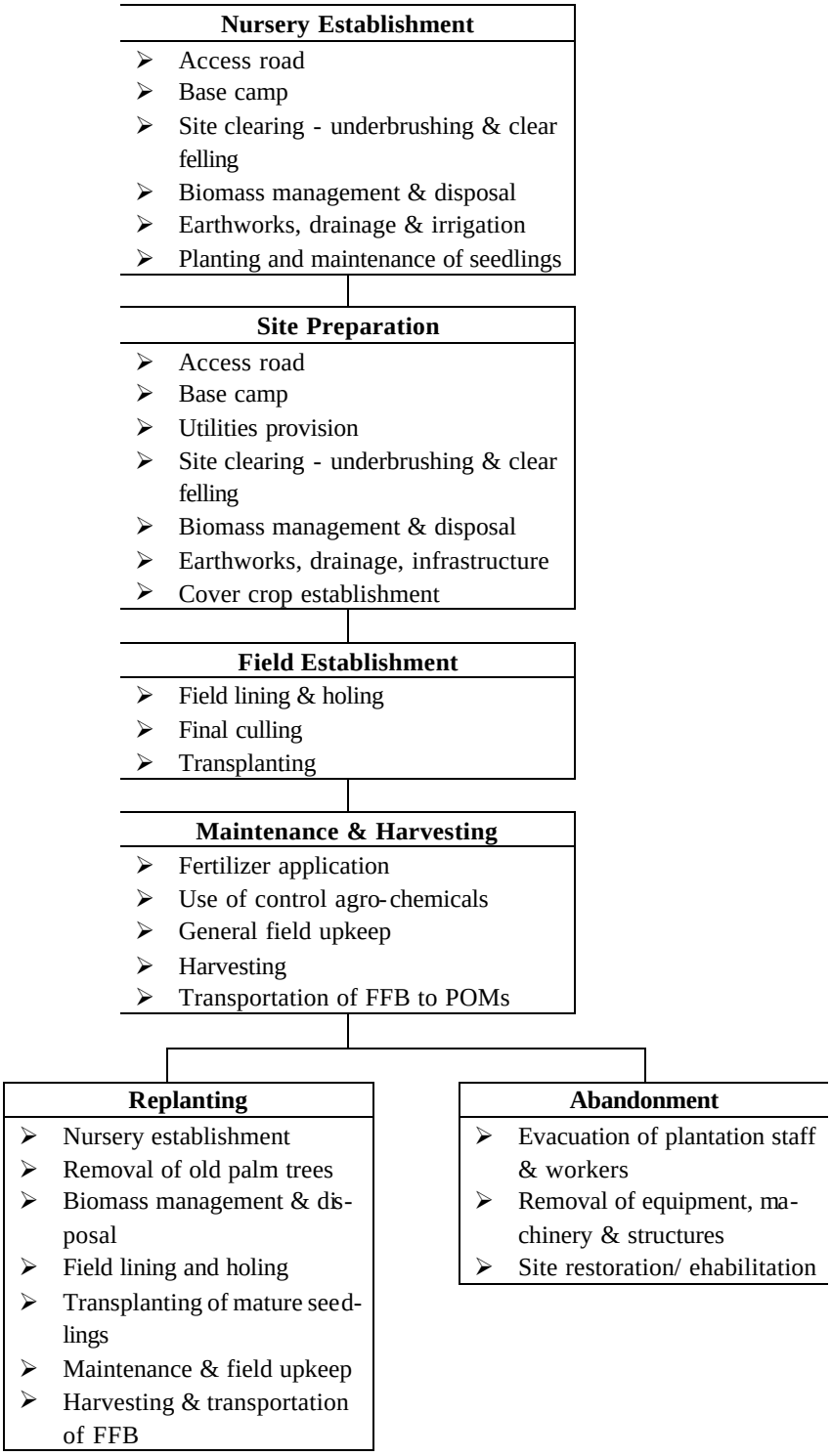

Figure 1.2: Flow Diagram of Typical OPP Development Activities

1.5 Key Stakeholders

Stakeholders

Key stakeholders in activities involving oil palm in Sabah include:

- *Oil palm plantation developers* - to carry out oil palm planting and to supply FFB to palm oil mill, either as company or private individual/smallholders
- *Palm oil mill operators* - to obtain FFB from oil palm planters to produce palm oil
- *Oil palm planters association (EMPA)* - a group of oil palm cultivating companies and organisations for East Malaysia
- *Department of Agriculture (DOA)* - to review and comment on the plantation development plan and land/soil suitability for oil palm cultivation
- *Department of Irrigation and Drainage (DID)* – to comment on potential concern over hydrology and drainage issues in relation to the oil palm plantation development
- *Environmental Conservation Department (ECD)* – to approve EIA to commence activities for oil palm plantation development within the State
- *Land & Surveys Department* (LSD) – to issue a Land Title to develop oil palm plantation within the State
- *Malaysian Palm Oil Board (MPOB)* – a new statutory body established on 01st May 2000 pursuant to the Malaysian Palm Oil Board Act 1998 (Act 582). PORLA and PORIM have cease to exist since then as the two bodies are merged into MPOB. The main roles of MPOB are to promote and develop the oil palm industry in Malaysia as well as developing national objectives, policies and priorities for the orderly development of the industry.

2 Environmental Impacts

What are the main environmental impacts?

Steps	*Activities*	*Issues*
Step 1	Assessment of Impacts	Key environmental impacts include: • Ecological impacts due to land development • Soil erosion due to land clearing • Air pollution due to open burning • Water pollution due to usage of agro-chemicals
Step 2	Mitigation Measures	
Step 3	Monitoring	

The purpose of this chapter is to outline procedures that can help identify the environmental impacts associated with the development of an oil palm plantation. Methodologies are suggested for evaluating the scale and extent of the impact.

2.1 Impact Assessment based on site characteristics

Definition

The environmental assessment for oil palm plantation development activities will basically based on the size and sensitivity of their locality. Size and sensitivity of the project are defined in Table 2.1 and Table 2.2:

Table 2.1. Project size definition

Size	Area (inclusive of adjacent lands for oil palm plantation)
Small	Less than 500 ha
Medium	500 to 5000* ha
Large	More than 5000 ha

* As a rule of thumb, a planted area of at least 5000 ha justifies the establishment of a palm oil mill

Table 2.2. Project sensitivity definition

Sensitivity	Locality
Normal	Anywhere not listed as 'sensitive'
Sensitive	Riparian reserve; gazetted conservation areas; high risks erosion sites; flood plains; mangrove swamp/forest; water supply catchment and intake point

2.2 Key Environmental Impacts

Key Impacts

The key adverse environmental impacts of oil palm plantation development activities are:

1. ***Ecological impacts*** due to loss of habitats for diverse species of flora and fauna as a result of land development
2. ***Soil erosion*** due to land clearing resulting impacts to water quality and hydrology (flood)
3. ***Air pollution*** due to open burning for biomass disposal
4. ***Water pollution*** due to usage of agro-chemicals.

Additional Impacts

Additional adverse environmental impacts of oil palm plantation development activities are:

1. ***Biomass generation*** from site clearing and field maintenance
2. ***Pest infestation*** due to the presence of degraded biomass
3. ***Traffic and transportation impacts*** particularly when harvesting
1. ***Water pollution due to sewage generated*** from workers' population.

2.2.1 Ecological impacts due to land development

Impacts

Locality and site preparation activities are the two main aspects that contribute to the ecological impacts of an oil palm plantation development. Location of a proposed plantation that is within areas classified as ecologically "sensitive" may result in inadvertent clearing and subsequent removal and extinction of ecologically important habitats and species. Site clearing for access road, nursery and the oil palm plantation can directly damage the habitats for a broad range of terrestrial flora and fauna species as well as indirectly affecting the aquatic ecosystem relevant to the affected site.

Table 2.5: Summary of EIA Matrix on Ecological Impacts for Oil Palm Plantation Development Activities

Key Environmental Impacts	Possible Cause	Typical Effects
Ecology	➢ Clearing for construction of access road ➢ Clearing for establishment of base camp ➢ Site clearing for the plantation proper	➢ Loss of habitats for ecologically important species of flora and fauna

Habitat Destruction

Land based. The establishment of an oil palm plantation will inevitably lead to clearing of almost the entire affected area. Such activity would result in loss of natural terrestrial habitats and cause certain degree of disturbance or ecological imbalances, depending on the existing ecological state of the affected area. The impairment can probably cause unfavourable conditions for the survival of the wildlife. Some animals particularly small ones need specialised habitats and are sensitive to environmental changes or significant loss of very productive niches, which in turn threaten their survival.

Removing the existing vegetation will significantly reduce the breeding ground of some important mammal pests of oil palms. The examples are monkeys, rodents, wild boar and porcupine. Bird population will be affected at minimal level as they can easily relocate to adjacent areas to set up their new resident.

Aquatic based. The complete clearing of forested area may temporarily cause problems in terms of water flow, surface erosion, sediment delivery to streams and poor water retention. The problems could further cause deteriorating water quality. However, the degradation is predicted to be restored after the establishment of the mature oil palm plantation. The biological resources that come about through the establishment of the plantation may significantly at least replace some important ecological roles of the former ecosystem.

Lost of species

The proposed oil palm plantation might result in loss in plant resources, which have been locally identified of their economic, commercial and ethnobotanical importance. Ecological status may also need to be ascertained even though the loss of certain protected plants may be relatively insignificant in terms of plant conservation if that particular plant species is not included in the IUCN Red Book. However, the presence of any endemic species should be highlighted.

The complete clearing of vegetation means destruction of breeding sites of birds and small mammals. Those affected animals are expected to move to the adjacent area for their new homes. During the plantation establishment, animals such as rats, porcupines or wild pigs will have sufficient foraging materials particularly the young shoots of the planted palms and most herbaceous plants that infested the opened space. As soon as the palms start to fruit, rodents and squirrels will continuously visit this area to feed on the oil palm fruits available.

Improper clearing may cause some mammals such as slow moving species to be trapped (due to inadequate time to abandon the cleared site) and killed. Highly mobile animals such as birds, monkeys, bearded pigs and deers could quickly move into adjacent sites for refuge and re-establishment of their habitats.

Assessment methods

Site assessment

It is important before any plantation is developed a habitat map over the entire site is produced to ascertain the ecological importance of the project site. The map can be derived from an aerial photograph or satellite imagery, the latter is more preferred as the information can be as recent as possible. Ground validation will be necessary to confirm the interpretation derived from those remote sensing methods. Ground validation may also be used to determine other ecological features such as breeding ground, migratory routes or temporary homes for migratory species. Cross-referencing with agencies such as World Wildlife Fund (WWF) will give some additional details to the findings.

The site assessment should be able to provide sufficient facts to establish an inventory that will contain the following:

- **Step 1:** Regional habitat and land use development (present and future)
- **Step 2:** Distribution of habitats within the project site – particular highlights on areas of ecological importance such as breeding ground, migratory routes, etc.
- **Step 3:** Lists of flora and fauna species (including their types and number) known and verified/validated to be present in those habitats. Selected indicator species may be used
- **Step 4:** Determine the status of the species i.e. ecologically (rare, endangered, endemic, common – locally and global), and legally (not protected, protected, totally protected, endemic)
- **Step 5:** General assessment to encompass the magnitude and extent of impacts
- **Step 6:** Assessment of impacts based on different scenarios e.g. alternative mitigation (e.g. zoning, phasing), or with/without mitigation.

2.2.2 Soil erosion due to land clearing and development

Impacts

When site clearing is carried out, removal of the protective vegetation cover and disturbance to soil surface will inevitably bring about soil erosion. The activities that bring about soil erosion for oil palm plantation development are tabulated in Table 2.6.

Table 2.6: Summary of EIA Matrix on Soil Erosion Impacts for Oil Palm Plantation Development Activities

Key Environmental Impacts	Possible Cause	Typical Effects
Soil Erosion	➢ Clearing and earthworks construction of access road ➢ Clearing and earthworks establishment of base camp ➢ Site clearing and earthworks for the nursery proper ➢ Site clearing and earthworks – terracing, drainage works, infrastructure	➢ Reduction in arable soil from plantation area ➢ Elevated TSS content and turbidity in waterways downstream ➢ Reduction in channel capacity of waterways due to sedimentation leading to potential localised floods

Factors influencing soil erosion

Under natural conditions the dominant factors controlling soil erosion are the erosivity of the eroding agent, which in the case of Sabah, will principally refer to:

- Rain
- The erodibility of the soil
- The slope of the land
- The nature of the plant cover.

These four issues are important for defining the project location. For at specific project the key soil erosion issues relate to:

- The project location
- The area of land exposed to erosion
- The period of exposure.

Increased rates of erosion occur when there is disturbance of the tree canopy and litter layer, resulting in increased exposure of the soil surface. Once exposed, erosion takes place through a sequence of process starting with the detachment of soil particles by rainfall splash, progressing onto sheet, rill and gully erosion. Sheet erosion takes place when water flows over the surface of compacted ground. Topographic irregularities often lead to the concentration of surface water flow in micro-channels called rills. Gullies form where rills increase in depth. In undisturbed forests, both splash and sheet erosion produce low volumes of sediment but will produce substantial amounts of sediment after the soil is bared. Intensive rilling and gullying is a sign that large volumes of soil material have been eroded from the site. Mass wasting or landslides often associated with poorly constructed and maintained roads may also supply significant volumes of sediment and remain potentially active well after the initial disturbance. Often there is a progression from one form of erosion to another, the significance being that sheet erosion is easier to mitigate than rill, and rill easier to mitigate than gully.

Eroded soil once mobilized becomes available for transport through the drainage system.

Assessment methods

Site Assessment

For all oil palm plantation development activities it is important to assess and identify sites that may fall into high erosion risk areas (Table 2.7).

Table 2.7. Assessment Method for Soil Erosion

Activity	Predictive Technique	Evaluation Criteria
All size & normal	Site assessment	High erosion risk areas
All size & sensitive	Site assessment / computer modelling	High erosion risk areas

The impact analysis should focus on identifying potential areas of erosion hazard. A suitable approach would be to analyze thematic data layers based on the factors that control erosion, i.e. slope, rainfall, vegetation cover and intended sites of disturbance i.e. location of roads and other clearings. Additional layers should include all perennial streams and catchment boundaries. Subsequent overlay analysis of these factors will help identify site suitability at a reconnaissance scale of mapping, based on erosion hazard. Sites that indicate a high hazard level may require additional attention and investigation.

If a soils map is not available and an assessment is based on slope and rainfall alone, but a high hazard is indicated, this could merit the initiation of a soil survey in these risk areas to further assess the overall soil erosion risk.

Although GIS is well suited for overlay analysis, manual methods may also be employed. Careful consideration should be given to the type of data to be included, as it must contribute towards the hazard assessment.

Data requirements

The assessment of erosion hazard is a specialised form of land resource evaluation, the objective of which is to identify areas of land that will be threatened by excessive soil loss. The assessment aims at dividing a land area into regions of similar erosion hazard as a basis for planning soil conservation work.

Although the rate and amount of soil erosion under undisturbed conditions is controlled by a number of known factors, the impact of the disturbance will override these. This therefore requires the identification of road and drainage networks and other land clearings indicated in the plantation development plan. A comprehensive assessment should therefore consider the flowing data layers:

- **Elevation and slope.** Topographical data should be abstracted from the available 1:50,000 map sheets. If larger scale 1:25,000 data is available this may be used or at least reported that it is available

  Elevation data is required to derive slope distribution within the study areas. A minimum data requirement is that slope is captured from topog-

raphic data from the 1:50,000 scale maps using the minimum contour interval spacing available, which on most map sheets is 100 feet. Once data on elevation has been captured it is preferable to utilise computerised methods to determine slope and several commercial software packages are available to carry out this. Details of the software and the basic principles of the derivation should be presented with the slope map

Digitally derived slope maps captured from 1:50,000 topographic maps provide a general assessment of the distribution of steep land. However, due to the wide interval spacing, important local topographic variation may be missed, therefore the local erosion risk may be underestimated

- **Rainfall distribution.** Average annual rainfall must be projected over the project location in the first instance by extending available isohyetal data and presented at the same 1:50,000 base map scale as slope. If more appropriate rain data is available i.e. data available from agricultural stations, research stations, DID etc., this data should be incorporated and used for the assessment

  Soil loss is closely related to rainfall volumes and intensity, partly through the detaching power of raindrops striking the soil surface and partly through the contribution of rain to runoff. This applies particularly to erosion by overland flow and rills for which intensity is generally considered to be the most important rainfall characteristic. Although antecedent conditions may have some influence on rates of erosion, in general rates will increase with increased intensities. The most suitable expression of the erosivity of rainfall is an index based on the kinetic energy of the rain. Thus the erosivity of a rainstorm is a function of its intensity and duration. A spatial map of an erosivity index derived from rainfall intensity measurements extrapolated over the project site would be an important additional layer of information. However, it is recognised that the distribution of recording gauges maybe limited

  In general, high intensity rainfalls occur frequently throughout Sabah and are capable of producing powerful erosive events. Higher annual rainfall totals would normally indicate a greater chance that such events will occur. In general, the eastern seaboard of Sabah is drier than the rest of the state

- **Drainage.** River systems as represented on the National 1:50,000 maps should be digitally presented as a separate data layer. However, during interpretation it should be borne in mind that the representation of streams on maps is notoriously subjective and is dependent upon a range of factors including the technique used to abstract and transfer data from the original air photographs. In the absence of ground truthing it is difficult to gauge how representative the stream networks are. This is particularly so for forested catchments where drainage is often inferred from topographic relief as determined from canopy vegetation. Again map scale is important. Small streams represented on large-scale maps will not necessarily be represented on smaller scale maps. A first order stream sustains perennial flow under normal climatic conditions. Zero order streams contain inter-

mittent storm based ephemeral flow. At the 1:50,000 scale it is probable that most drainage lines recorded as 1st order are in fact 2nd or in some cases even 3rd. In addition, some of the larger may have switched or altered course considerably. Therefore this information should be taken as indicative and not absolute

- **Vegetation.** Available data on vegetation cover, habitat and/or current land-use should be presented on the same 1:50,000 scale. If current information is not available this data may be mapped for larger size projects from a SPOT satellite image or by site visits for smaller projects

  In the context of soil erosion, vegetation acts as a protective layer or buffer between the atmosphere and the soil, absorbing some of the energy of falling raindrops, running water and wind. The below ground root system also contributes to the mechanical strength of the soil. So plant cover can play an important role in reducing erosion provided that the cover extends over a sufficient proportion of the soil surface. Overall forests are the most effective but a dense cover of grass or other herbaceous growth may almost be as efficient and quicker to establish. For adequate protection at least 70 per cent of the ground surface must be covered but reasonable protection can be achieved with 40 per cent cover. However, as it will be the removal of vegetation that increases the hazard, all clearings to accommodate road and drainage network as well as plantation complex for workers' housing and management offices should be overlain on this layer

- **Soil.** Erodibility defines the resistance of the soil to both detachment and transport. Although a soil's resistance to erosion depends in part on topographic position, slope steepness and the amount of disturbance, errodibility varies with soil texture, aggregate stability, shear strength, infiltration capacity and organic and chemical content. Given the inherent difficulties associated with determining any one of these factors - a thematic layer should be constructed using available soils data, preferably at a scale of 1:50,000 or the largest scale available. It may be that if a site is identified as potentially having a high erosion hazard, more data or an additional survey will be requested

  If additional information is requested, the survey adopted should be an internationally accepted procedure (e.g. FAO guidelines for soil description) or should follow the recommendations of the Department of Agriculture. This procedure should refer to existing topography, geology, soils and relevant work in the area, which in turn assists in deciding the level of groundwork and coverage required

  Observable properties such as soil depth, particle size distribution, texture, structure and stoniness should be recorded using the FAO guideline for soil description

  The soils of Sabah have been described down to the Family level. A soil family is a unit of classification defined specifically by the type of parent material, which in Sabah has been quite broadly classified. The soil parent

materials for example would be, sedimentary, intrusive igneous and crystalline basement rocks. For the existing soils map of Sabah, soil associations have been mapped at a scale of 1:250,000. A soil association is not a classification unit but has been adapted to enable mapping based on landform classes, dominant soil units and characteristic vegetation. This mapping level is broad and may be used for the initial assessment

Geological data is useful as the parent material from which the soil develops determines soil texture. In general large particles are more resistant to transport because of the greater force required to entrain them and fine particles are also resistant to detachment because of their cohesiveness. The least resistant particles are silts and fine sands

It should be borne in mind that following disturbance, the properties of most soils are changed so dramatically that often there is little relationship to the original data and survey results

- **Schedule and phasing of operations.** The schedule and phasing of operations should be clearly stated and when possible represented in a spatial format. If the project will eventually result in forest clearance, information on the time lag between logging, clearing and conversion to the alternative land-use is required.

Computer Modelling

Computer or manual modelling does offer opportunities to determine the potential risk of soil erosion for any particular area planned for oil palm plantation development. The modelling will involve a two-stage evaluation, namely slope classification and determination of potential soil erosion rate. The amount of soil loss can be estimated by multiplying the erosion rate the corresponding area and also the exposure duration:

Total soil loss = summation of [Erosion rate x area x exposure duration].

To reflect worst-case scenario, the maximum amount is taken into the calculation e.g. for the range of 50-100, the 100 t/ha/yr is taken instead of 50 t/ha/yr.

Computer modelling with incorporation of GIS capabilities will enable accurate estimation of soil erosion with an option to be able to simulate variety of scenarios, which are very much similar to the expected condition when the project is implemented. Input data should be closely scrutinised so that the results obtained are indicative enough for the proposed project.

The slope map may be generated from the topographic map at a scale of 1:10,000 with contour interval of 25 feet (preferably) or if non-existent, the 1:50,000 topography map with 50-feet contour intervals may be used. The map generated should be able to indicate areas according to their slope classification, namely flat, undulating, steep and very steep. The capability to generate three-dimensional perspective views of the project area should enhance understanding on the slope classes within the site. The slope distribution within the project area is then tabulated.

Soil loss is the soil moved off a particular slope or field. Based on the erosion rate determined in the slope map, the crude estimation of soil loss under existing condition, during project development, and after full planting and establishment of cover crops are tabulated.

Evaluation Criteria

Criteria used for environmental assessment should be based on the following:

Hazard assessment map. For larger projects, the overall assessment of soil erosion hazard should include overlay analysis incorporating the above data layers. For smaller projects, the requirements include the assessment of slope and drainage. The resulting hazard map should identify isolated areas of high erosion hazard i.e. single hill slopes or regions of high erosion hazard, i.e. a range of collection of steep regions with high erosion hazard.

Soil erosion rate may be evaluated with the DOE criteria as follows:

Soil erosion rate, t/ha/year	Risk Classification
< 50	Low
50 – 100	Moderate
100 – 150	High
> 150	Critical

Soil loss during different stages of the project i.e. comparison between the condition before development, during site preparation and complete cultivation of oil palm.

It should be emphasised that soil loss relates to loss of arable land and thus not only reduce soil fertility but also pollute the environment. Soil erosion modelling should be geared to determine that soil loss can be minimised.

Example. As the northern location of the project site is located on very steep areas and thus having high soil erosion risk when developed, it is suggested that the area is clearly marked for exclusion from the oil palm plantation development.

Soil loss modelling results show that with phased development, soil loss can be reduced as much as 60% from the amount it would be if the entire plantation is developed all at once. The results also show that during development, soil loss is estimated to be 50 times higher compared to the existing condition. However, with completion of field planting and establishment of cover crop, soil loss is estimated twice as much as those under existing condition.

Water pollution due to soil erosion

Soil Erosion

Eroded soil as a result of oil palm plantation development will be deposited in the waterways once the transport energy is completely exhausted. The projected soil loss analysis will indicate the severity of the soil erosion. The washing of

surface runoff laden with eroded soil particles will increase the Total Suspended Solids (TSS) and turbidity of the receiving water bodies, which in turn will affect the aquatic life therein. As more and more eroded soil being deposited in the waterways bed, channel capacity will be greatly reduced as discussed in the following section. Reduction in DO level is one of the indicators that may be attributed to poor channel capacity. Soil loss to the streams or rivers is expected to reduce as time progresses when palm trees mature and ground vegetation establishes and grows.

Hydrology and drainage impacts due to soil erosion

Impacts

During site preparation stage, the development of the area for oil palm plantation is expected to drastically change the existing characteristics of the area since the area would be cleared off its vegetation cover.

Clear felling will inevitably disturb the soil surface and the remaining vegetative cover. This has implications for site hydrology, which need to be appreciated to understand other associated impacts.

When vegetation is removed the hydrological cycle is altered as water that would have been returned to the atmosphere by means of plant transpiration processes, under undisturbed circumstances, now remains within the soil layer. The impact or additional volume of water retained, increases approximately in proportion to the amount of vegetation removed, therefore the greater the amount of vegetation removed, the greater the hydrological impact. Absence of vegetation also allows a greater proportion of direct rainfall to reach the forest floor. The additional rainfall and reduced rates of evapotranspiration translate into increased volumes of water leaving the catchment.

When the amount of disturbed and compacted surfaces are high there will be an accompanying increase in the fast routing of surface runoff or the stormflow component of the streamflow. However, most of the additional water drains more gradually through the soil, contributing to the slower baseflow component of hydrological routing.

Although it is popularly reported that deforestation results in an increased incidence of flood, however, it must also be borne in mind that floods are a natural hazard, particularly in areas that receive heavy rainfall. The speed at which water runs off into a river system determines the height and duration of a flood. Again the changes in volume and timing of storm runoff will be approximately proportional to the extent and amount of reduction in vegetation cover.

Monitoring for any form of hydrological impact requires long term instrumentation of catchments as the natural flow conditions, ranges and responses of a river system needs to be established and documented before any changes can be attributed to the treatment changes e.g. clear felling for plantation. Within the framework of an EIA study, such experiments are not normally feasible, nor indeed necessary. Although care must be taken when extrapolating results from one catchment to another, it will be necessary to draw upon experiences and results from relevant examples. Acknowledging that removing vegetation does

alter streamflow volumes and timing should form the core of the impact statement and mitigation measures should be planned accordingly.

Removal of the protective vegetation cover will not only result in increased surface runoff due to reduced infiltration rate but also soil erosion from cleared surfaces. Eroded soil particles will result in sedimentation of waterways i.e. their channel capacity is reduced. Increased surface runoff coupled with reduced channel capacity will result in flooding within that catchment. The low-lying as well as waterlogged areas e.g. floodplains may experience flooding during storm events or monsoon seasons.

Table 2.6: Summary of EIA Matrix on Hydrology and Drainage Impacts for Oil Palm Plantation Development Activities

Key Environmental Impacts	Possible Cause	Typical Effects
Hydrology and Drainage Impacts	➢ Site clearing resulting in increased surface runoff and reduced channel capacity of waterways	➢ Flood incidents downstream of the project site

Site assessment

Step 1: Demarcation of water catchment. Clear demarcation of the hydrological boundary is important to determine the hydrological impact of the proposed plantation. It is preferable that plantation areas are demarcated based on this basis to facilitate control on flooding and water pollution within the catchment (and sub-catchments).

Step 2: Historical floods data. Flood history of the area may be obtained from the DID as well as interviewing the locals, if available. Site survey would also help to visually determine the signs of flooding, particularly at flood prone area, e.g. by water marks on the river banks or vegetation nearby.

Step 3: Flood risk area. Another aspect that needs to be determined is the area within the main catchment that is affected by the proposed plantation development. If the proposed plantation occupies the majority of the main catchment area, change in soil cover, particularly removal of vegetation cover during site clearing, will result in significant hydrological change to that catchment. This approach may be used as a quick check on the significance of the flooding effect resulting from the proposed plantation.

Site Survey

Site survey should be carried out to determine the flow of the waterways within the catchment as well as recording on the water level. Ideally long term data from local gauging station will provide a profound insights on the existing hydrological pattern relevant to the project site. Landuse of the area particularly downstream portion of the catchment must be determined, especially human settlements and other related structures (e.g. houses, properties) and features (e.g. burial sites, farms). Information of the landuse will assist in establishing the map for flood risk area.

Computer Modelling

Computer modelling may be used to simulate the hydrological changes as a result of oil palm plantation development, particularly for large plantation (more than 5,000 ha in area). It can also be used to assess the various extent of impacts as a result of different scenarios which could be the several development options that may be considered for implementation. Data obtained through site survey may be used to calibrate the model which will increase the reliability of the findings. However, the following aspects must be considered when computer modelling is resorted to for impact assessment:

- The model must be well tested and approved for use by the National Hydraulic Institute of Malaysia (NAHRIM)
- The acknowledgement of the limitations of the model for the intended purpose
- Inherent assumptions and simplications incorporated in the model
- Assumptions that were considered in the modeling exercise.

Evaluation Criteria

Flood impact as a result of the oil palm plantation development may be assessed based on the following criteria:

- Surface runoff increase that may result in flooding of any land exceeding the natural water level rise regardless of its duration is unacceptable
- Inundation of human settlements (villages), properties and features is unacceptable.

2.2.3 Air pollution due to open burning of biomass

Impacts

Generation of biomass during site clearing will traditionally be followed by massive burning. In the very near past, this practice had resulted in a regional transboundary haze incident. Even though it is the easiest means to significantly reduce the biomass volume, due consideration on the regional impacts of open burning will make it less preferred. Activities in oil palm plantation development that result in air pollution are tabulated in Table 2.5.

Table 2.6: Summary of EIA Matrix on Air Pollution Impacts for Oil Palm Plantation Development Activities

Key Environmental Impacts	Possible Cause	Typical Effects
Air Pollution	➢ Biomass management and disposal through open burning	➢ Elevated ambient TSP that may develop into regional haze episode

Assessment methods

Step 1: Biomass estimation. Site survey will be used to ascertain the estimated amount of biomass to be disposed. The determining factors would be the size of the area and the extent of vegetation cover therein.

Step 2: Determine magnitude of the problem. Regional factors such as season, wind pattern and proximity with other plantations practicing open burning for biomass disposal may need to be ascertained as appropriate timing of burning may facilitate a good burn and at the same time minimise air pollution impact. Consideration of the regional factors will enable classification of the area in terms of air pollution risks.

Step 3: Assess different scenarios. Among the scenarios that can be considered are burning, non or zero burning, phased and one-time burning, etc.

Biomass generation

Impacts

Site preparation and field maintenance are the two main activities that have the potential to result in generation of large quantities of biomass.

Site clearing comprises activities such as underbrushing and clear felling that generate biomass in the form of re-useable/marketable timber and vegetative wastes. Field maintenance will basically result in generation of manually removed weeds as well as vegetative wastes from pruning exercise. Traditionally, the vegetative wastes will be burned on site (that had caused haze problems regionally and internationally).

Table 2.4: Summary of EIA Matrix on Biomass Generation Impacts for Oil Palm Plantation Development Activities

Environmental Impacts	Possible Cause	Typical Effects
Biomass Generation	➢ Clearing for construction of access road ➢ Clearing for establishment of base camp ➢ Site clearing for the nursery proper ➢ Site clearing for the plantation proper ➢ Final culling of seedlings ➢ General field upkeep – weed eradication, palm pruning ➢ Removal of old palm trees	➢ Biomass generation that need to be properly managed

Biomass Generation

Site clearing will inevitably result in generation of biomass, which needs to be removed from the project site to enable terracing and other works to proceed. In the past, burning and re-burning of dried biomass had been practised on the grounds that it was the easiest and economical means of disposal. However, with the occurrence of transboundary haze problems experienced by the nation in 1997 as a result of widespread open burning for land development locally

and in neighbouring countries, zero burning disposal methods have been seriously considered and at certain areas, had been implemented with varying degree of success as well as challenges.

Biomass Estimation

Prior to implementing zero burning method, it is a good practice to estimate the total biomass volume of every vegetation types within the oil palm plantation area meant to be cleared. This information may assist in determining the requirement for land area and sorting/recovery of re-useable biomass that can be achieved for successful implementation. One of the estimation methods applicable was developed by Kato (1987), which enumeration method for the species inventory was developed by Soepadmo (1987). Application of these two methods will enable the ecological importance of plant species and the estimated above-ground biomass to be ascertained.

Biomass Disposal

After undergoing sorting and recovery of re-useable biomass, the leftover biomass from clearing activities, which is basically vegetative wastes, could be disposed off by adopting the zero burning technique. Zero-burning technique is a method of land clearing whereby the remaining tree stands are felled and chipped into smaller pieces and left *in-situ* to decompose naturally or used as mulch for young palms. Zero burning enhances the soil organic matter status, thus help to restore and improve the fertility and physical status of soils. Large quantities of plant nutrients are recycled in the soil through decomposition of crop residues. With the recycling of plant nutrients, the inputs of inorganic fertilisers could be reduced.

However, this method is not without its disadvantages; one of it is that termites may proliferate in the rotting wood material and the other is that plant diseases may be not be fully eliminated (i.e. the diseased parts of the plant or plants are not removed or eliminated). Controlled application of pesticide may eradicate these problems.

Site assessment

Findings from ecological site survey particularly flora inventory will be used to determine the amount of biomass to be managed. Substantial reduction in the amount of biomass to be disposed off can be achieved if sorting can be carried out to segregate re-useable timber from vegetative wastes that will undergo zero burning method of disposal.

2.2.4 Water pollution due to use of agro-chemicals

Impacts

Water pollution for the proposed oil palm plantation development can be mainly due to usage and application of agro-chemicals such as fertiliser and pests control.

Usage Of Chemicals

Deterioration in water quality of waterways or water bodies within the catchment of the proposed plantation will mainly be in the form of chemical infiltration from the application of fertilisers and usage of agro-chemicals such as pesticides and weedicides.

Fertilisers Application

The application of artificial fertilisers can lead to a marked increase in the nutrient concentrations of water draining from the fertilised areas. The main

elements compounded in fertilisers are Nitrogen (N), Potassium (K), phosphorus (P) and magnesium (Mg). Fertilisers find their ways into the natural water sources via a few processes:

- They are being eroded away together with the surface soil and washed into the watercourses
- Leaching conveys soluble compounds into the groundwater
- Runoff carries both soluble and insoluble compounds into surface water sources.

N and P will have significant impact on water quality. N is mainly supplied bound in the forms of ammonium and / or nitrate compounds, and urea. Both ammonium compounds and urea are eventually converted into nitrate in the soil under well-drained condition. Nitrate, being soluble in water, will easily find its way into the water sources if precautions are not taken. Nitrate promotes undesirable growth of aquatic micro flora in watercourses.

P in the form of phosphate has the same euthrophication effect in surface water as nitrate, causing excessive wanton growth of algae, stopping sunlight from reaching aquatic life in deeper water. However, phosphate is less mobile than nitrate. Therefore, leaching loss of phosphate is small. Loss is mainly through runoff and soil erosion.

Fertilisers, if applied at the correct rates and evenly distributed over the ground surface during fine weather conditions should not pose environmental hazards as they are readily absorbed by plant roots. Some surplus that is not taken up by the roots would become absorbed or be converted into more insoluble forms within the soil environment and be released slowly, thereby posing no pollution hazards. Excessive and inappropriate applications will however create the potential for significant environmental impacts.

Pesticides/Weedicides

In oil palm plantations, use of pesticides is minimal. Biological control methods have been proven to be quite effective (e.g. upkeeping plantation owl and snake populations). Under this scenario, impacts from this source will not be of great concern.

Excessive levels of chemicals in the watercourses can seriously affect aquatic life and freshwater supply. **A newspaper clipping on the adverse impact of excessive agrochemicals is attached in Annex 2.3 (will be attached if the clipping is found/available).**

Assessment methods

Step 1: Baseline water quality data. Water monitoring of waterways within the catchment or catchments that are relevant to the proposed plantation will have to be carried out to assess their baseline quality. Collection and analysis of water samples shall be carried out as follows:

- Sampling location to be marked on the base map

- Sample collection exercise is supported with photographs
- For every waterway, three sampling locations should be identified: first at the upstream project boundary, second at mid-stream, and third at downstream project boundary. If there are more than one waterway, each tributaries shall have three sampling locations, however, a location may be shared by more than one waterways
- One of the sampling days should be conducted during of immediately after a rain event of magnitude of >20 mm or high tide period
- In-situ monitoring for Dissolved Oxygen (DO) shall be carried out using calibrated DO meter
- Samples to be analyzed by an accredited laboratory for Total Suspended Solids (TSS), turbidity, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand for 5-days (BOD_5), Fecal Coliform Count, Oil and Grease and agro-chemicals depending on the types being used by the plantation.

Step 2: Establishment of a map indicating areas at risk. Land use map should be prepared to determine the environmental features within the catchment relevant to the proposed plantation. The map will also identify areas that may be potentially at risk due to usage of agro-chemicals in the plantation. The following features shall be clearly marked on the map (but not limited to):

- Human settlements
- Water intake points and treatment plants
- Other sources of pollutants e.g. monsoon drain from a highly populated area, etc.
- Other features of importance.

Step 3: Risk assessment based on topography – flat, undulating, steep and very steep.

Step 4: Risk assessment based on soil types. Different soil types will have different erosivity.

Step 5: Risk assessment based on usage of agrochemicals. Different amount and properties of agrochemical will give different scenarios of pollution impacts.

Environmental assessment will be based on the following criteria:

- Site characteristics – land use map will be useful to determine land use compatibility in terms of water quality conservation

- Modeling results to indicate contribution of pollutant from the plantation and comparison with the ECD-approved limit as well as the baseline level.

2.3 Additional Impacts

2.3.1 Pest Infestation

Impacts

Pest infestation may become an environmental concern particularly when it has developed throughout the entire plantation. There are two types of pests, namely vertebrates and invertebrates. Vertebrate pests normally consist of rats, porcupines, squirrels, monkeys, pigs, elephants and birds, whereas invertebrate pests are nematodes, ants/termites, slugs/snails, grasshoppers, wasps/bees, beetles (leaf miner, weevils, cockchafers), oil palm bunch pests, sucking insects, and leaf-eating caterpillars (Turner & Gillbanks, 1974). This incident comes about when large amount of biomass is left on site to degrade naturally i.e. zero burning method. Not only growth and production of palm trees will be severely affected, intervention by using extra amount of pesticides will be necessary, which in turn may be a cause of water pollution.

The presence of large quantities of biomass will also provide shelter for certain pests such as rodents, which will forage on available palm fruits and thus creates the necessity to provide some form of control such as chemical or biological. Again, chemical control may become a source of water pollution.

Table 2.14: Summary of EIA Matrix on Pest Infestation Impacts for Oil Palm Plantation Development Activities

Environmental Impacts	Possible Cause	Typical Effects
Pest Infestation	➢ Biomass management and disposal by means of windrowing or zero burning method	➢ Infestation of pests that may develop into a stage where seedlings growth and crop production will be severely affected

Site assessment

Site visits to the plantation at the different stages of plantation development should gear also to establish a baseline level of pest threats. Over time, site visits should take note on the number of known pests present as well as the physical condition of the palm trees to identify any irregularities or signs of pest infestation.

Evaluation Criteria

Pest infestation may be assessed based on the following criteria:

- Comparison between the current number of pests and the baseline i.e. prior to plantation development

- The effect of pest infestation to the palm trees (affected growth, damage to trees, reduction in yield, etc.) as well as other components of the plantation (e.g. increase scavenging by rodents).

2.3.2 Traffic and Transportation

Impacts

Traffic and transportation activities within and due to the plantation result in dust and noise pollution as well as addition to the existing traffic volume. Traffic associated with oil palm plantation ranges from motorcycles for field workers/supervisors, to transporting vehicles such as tractor-trailer combination and lorries. Significant traffic and transportation impacts take place during maintenance and harvesting stage i.e. transporting collected fresh fruit bunches (FFB) to the palm oil mills.

2.3.3 Water pollution due to sewage generation

Impact

Sewage will normally be generated by people at the project site during site preparation and field maintenance stages. Improper treatment of sewage will result in elevated COD, BOD and microbiological contents of the waterways.

2.3.4 Pollution from Hazardous Materials

Impact

Use and storage of hazardous materials such as used lubricants from the workshop and agrochemicals from the store may bring about potential pollution to the environment, particularly surface water quality. Appropriate storage area and proper disposal should be able to prevent possible spillage and inadvertent pollution.

2.4 Baseline Data Requirements

Before any potential environmental impacts of an oil palm plantation development activities can be properly assessed, it is necessary to have a profound understanding on the condition of the existing environment. This entails the necessity to obtain high-quality baseline data for both terrestrial, aquatic and atmospheric environments. Field surveys and measurements, together with laboratory analyses will be required to complement existing data collated. *Details for each individual EIA in terms of environmental characteristics, parameters and locations shall be determined during the scooping exercise with active participation by ECD.*

The following data should normally be collected:

Table 2.17. Baseline data

Environmental Characteristics	Examples of appropriate data	Sampling Point
Ecology	Habitat distribution Species inventory with classification into legal and ecological status	Sampling location to represent the overall project site

	Above ground biomass	
Hydrology	Flow and water level – for dry and wet season	All waterways within the catchment, one each for upstream and downstream boundary
Air Quality	TSP level	At any location within the project site, preferably at the proposed residential/populated area
Soil Erosion	Soil type	Distribution to represent the overall project site
Water Quality	In-situ result for DO Laboratory analysis for BOD, COD, TSS, TDS, Oil & Grease, Fecal Coliform Count	All waterways within the catchment; one each for upstream and downstream boundary
Land use	Human settlements Structures – water intake points, water treatment plant, etc. Features – farms, burial ground, etc.	Within the catchment affected by the oil palm plantation
Topography	Terrain Slope classification (map)	The overall project site including areas relevant for impact assessment

3 Mitigation Measures

What are the main mitigation measures?

Steps	*Activities*	*Issues*
Step 1	Assessment of Impacts	
Step 2	Mitigation Measures	Key mitigation measures include: • Demarcation of water catchment • Zoning of plantation area • Phasing • Controlled and Zero burning • Soil conservation practices
Step 3	Monitoring	

The purpose of this chapter is to assist in determining possible preventive, remedial or compensatory measures for each of the adverse impacts evaluated as significant.

Mitigation will consist of a number of related actions, many of which may consist of no more than ensuring effective management and control of site operations. Mitigation measures can take many forms, including the following:

- Preventive - to be addressed during the pre-feasibility study and land application including site selection; exclusion of areas identified as having high environmental risks e.g. soil erosion and flooding, plantation layout particularly for drainage system and road network; provision of buffer zones, and alternatives for development method

- Control - to be addressed during development and operational phases and related to working practices such as implementing zero burning method instead of open burning, provision of perimeter drains and silt traps, controlled fertiliser application and usage of pesticides, and establishment of cover crops at cleared areas.

- Compensatory - whereby it is recognised that there will be an impact and that some compensation for the loss is to be made. This could include a specific contribution towards local conservation.

This chapter covers (i) identification of the major mitigation measures for the key environmental impacts, (ii) elaboration on implementation methodologies to be used to help minimise or eliminate the impacts, and (iii) description of other mitigation measures, including secondary rehabilitation measures.

3.1 Key Mitigation Measures

Key Measures

Key mitigation measures for oil palm plantation development activity include:

1. **Demarcation of water catchment** that will serve as the boundary for the plantation area

2. **Zoning of plantation area** to exclude areas having high environmental risks as well as natural habitats with significant environmental importance

3. **Phasing** in developing and operating the oil palm plantation

4. Practice **controlled burning (first time clearing)** and **zero burning (replanting)** to reduce and eliminate air pollution problem.

5. Implement **soil conservation practices** when developing the plantation, which include access road alignment, stream crossings, maintenance of waterways and soil compaction.

Additional Measures

Other additional mitigation measures include:

- Optimum usage and timely application of agro-chemicals
- Chemical used for pest control
- Sanitation facilities
- Occupational safety and health.

3.2 Demarcation of water catchment

Impacts mitigated

Demarcation of water catchment relevant to an oil palm plantation, which will then be adopted as the boundary will assist in mitigating the following potential impacts:

- Flood – exclusion of floodplains from being developed will prevent inundation of other areas (as a result of reduced area to temporarily regulate excess surface runoff previously taken care of by the flood plains) as well as monetary loss due to damage related to flooding

- Water pollution due to soil erosion and contamination from agrochemicals. Early acknowledgement of any catchment for potable water supply will prevent pollution of the catchment that in turn affecting human population depending on it.

When water catchment boundaries are considered in determining plantation boundary, environmental impacts and their related control/mitigation measures can be focussed on the Project Proponent residing in that particular catchment. This will facilitate enforcement as well as clearly defining the spatial responsibility of the Project Proponent.

Boundary demarcation

Normally boundary demarcation will be based on adjacent pieces of land and it is noted that the boundary alignment more often than not does not follow the local topography pattern. This condition will make it difficult in terms of controlling environmental impacts since the sources of the problems e.g. water pollution and floods would be within other people's land although located within the same catchment. In other words, topographical aspects should be taken into consideration when setting up project boundary as environmental impacts tend to linger within a catchment regardless of the administrative boundaries.

Boundary demarcation should facilitate adequate control of potential environmental impacts. This is can be achieved when/if topographical aspects of the region are given due consideration for boundary demarcation of the plantation.

Implementation

The proposed oil palm plantation area shall be checked for acceptability by the following methods:

- Map of the proposed plantation overlay onto the topography map at least at 1:50,000 scale or larger, that indicates boundaries for water catchment found within or relevant to the project site

- Adjustments of the project boundary may be necessary to follow the water catchment boundary in order to ensure full control of the potential impacts by the project proponent (i.e. the sources of pollution and impact receivers are well defined and can be easily identified due to the activities by the project proponent) and also facilitate enforcement by ECD (i.e. the contributor can be quickly identified and made to assume full responsibility for clean up works and/or improving mitigation measures).

Photo 1: The effect of developing oil palm plantation on flood plains – flood water goes overbank and inundates oil palm trees. Prolonged inundation may result in death of the trees (change to Kinabatangan flood plain picture).

3.3 Zoning of Plantation Area

Impacts mitigated

Zoning of plantation area will assist in mitigating the following potential impacts:

- Ecology – buffer zones and riparian reserves within the plantation area will provide evacuation corridor and sanctuary for mobile fauna. In the long run, these excluded areas will at least provide habitats for most of the original species prior to the plantation development thus preventing their extinction. Buffer zones planted with non-fruiting vegetation such as *Acacia mangium* can deceive mobile pests from moving into the plantation area for food

- Soil Erosion – zoning of the plantation area will enable exclusion of high erosion risk areas from being developed. This particularly involves very steep slopes as well as areas with soils that are easily eroded (i.e. high erosion rates) within the project site

- Water Pollution – riparian reserves will serve as natural filters for surface runoff from the plantation areas. The reserves will also play a major role in protecting the banks of the waterways from channel erosion.

Zoning of plantation area will culminate three main zones namely buffer zones, riparian reserves and sensitive sites.

Buffer zones

The impacts of oil palm plantation development in terms of ecology, soil erosion and water pollution can be minimised if not eliminated by the provision of buffer zones between the plantation site and its surrounding area.

The following criteria can be considered for implementation:

- Buffer zone between plantation area and national parks as well as other ecologically sensitive sites for the protection of natural habitats as well as clearly demarcating the plantation and the national park

- Elephant ditch for areas known to be susceptible to elephant attacks (***Photograph will be obtained from Tony Greer***)

- For "jungle islands" that had been excluded due to high erosion risk, no additional buffer is recommended besides the area having a gradient of 25º or more. Vegetation in these areas should be left intact.

Riparian Reserves

The impacts of oil palm plantation development in terms of ecology, soil erosion and water pollution can be minimised if not eliminated by the provision of riparian reserves for all waterways affected by or related to the plantation.

The following criteria can be considered for implementation:

- Riparian reserves of 20-m width at both banks of waterways within the plantation area shall be provided

- No clearing nor erecting of any structure shall be carried out within these reserves.

Sensitive Sites

The selection of a location for oil palm plantation is primarily based on the availability of land for the purpose i.e. the land is unencumbered nor gazetted for specific purposes such as forest reserve, national parks etc. Sensitive sites comprise the areas as listed (but not limited to) in Table 2.2, which include environmentally sensitive areas (high erosion risk due to factors such as topography and soil types, flood plains, mangrove swamp/forest, etc.) as well as areas already set aside as part of the environmental conservation strategy e.g. riparian reserve, national parks, protected forests, water catchment for potable water supply, etc.

After a piece of land is confirmed to be available, the secondary criteria for site selection would be based on the physical characteristics of the site. During the feasibility study stage, is important to determine that the proposed site is physically viable to be developed and environmentally acceptable. Any sensitive sites encountered within the proposed plantation site should be excluded from being developed.

Implementation

Based on the environmental assessment, areas that can be developed into oil palm plantation should be clearly identified on a map. The following can be used as examples of zoning for oil palm plantation development activities:

- Each oil palm plantation should allocate strip of land fringing any ecologically sensitive areas (e.g. national parks, etc.) that will be planted with non-fruiting vegetation (if not readily available) or provided with other physical barriers such as elephant ditch to prevent encroachment by pests. LSD may consider a slightly lower or abolishment of premium on land designated for this purpose (*Check with LSD*

- High erosion risk areas shall be excluded from being developed

- All waterways within the plantation *having a width of 3 m or more as well as areas with high erosion risk located near the existing waterways* shall be allocated with the 20-m wide riparian reserve.

The above example can be implemented as follows:

- Measure the width of the buffer strip from boundary of the national park. The width of this strip should be determined by the ecologist. This strip should be planted with non-fruiting trees if not readily available or excavated to form the elephant ditch as per dimension specified by the Wildlife Department

- Measure the width of the riparian reserve from edge of the vegetated bank towards the plantation area. This reserve should not be less than the 20 m from the highest water mark. No activities shall be carried out herein

- Measure the gradient of a particular slope within the plantation site. Mark any area that has the slope gradient of 25º or more
- Use of flags and poles to mark the area that can be developed into the oil palm plantation
- Post proper signs and inform site clearing supervisors and contractors of the area that can be developed as well as those to be left aside/intact
- Map the final distribution of areas within the plantation that have been developed or conserved.

3.4 Phasing

Impacts Mitigated

Phasing of oil palm plantation development and operation will be able to minimise or eliminate the following impacts:

- Ecology - phasing of development activities will allow some time for mobile fauna to seek refuge in adjacent similar habitats or establishing new ones nearby
- Biomass generation - phased development will generate biomass at a volume that is more manageable if compared to the volume that resulting from total site clearing. Salvaging/recovery of useable biomass (after sorting) can significantly reduce the volume that has to be disposed off
- Floods - Phasing of the development into smaller phases will result in only manageable plantation area being developed at any one time, thus the impacts can be easily identified and controlled. Flood impact would be much less if the entire plantation area is sub-divided into a few smaller phases as the amount of rainwater that can become surface runoff at any one time will be reduced.

Phasing

The basic principle of carrying out phased development is to have smaller areas at any one time that will result in much less adverse impacts. It is achieved by dividing the entire project area into smaller areas that will be developed in different times and thus resulting much less impacts to the environment. Some developers incorporated this approach due to financial constraints, however, achieved additional benefits through less or minimal environmental impacts that need to be addressed.

Implementation

Phasing in the development of an oil palm plantation shall be implemented as follows:

- The entire plantation area is sub-divided into smaller development blocks e.g. less than 500 ha each
- Commencement dates for the blocks are determined

- If more than one block are required to be developed at any one time, the area where site clearing works commence should be separated so that the areas exposed at any one time are broken into discrete patches of cleared and still vegetated blocks

- Map the different phases of the plantation with indicative dates of commencement.

3.5 Zero burning

Impacts Mitigated

Zero burning practiced during the development stage of an oil palm plantation e able to minimise or eliminate the following impacts:

- Air Pollution - no open burning but resort to zero burning technique such as windrowing and chipping of vegetative wastes to undergo on site natural decomposition (on site stacking).

Photo 2: Pruned fronds disposed on site for natural decomposition.

Controlled burning

If by any chance open burning is allowed, particularly for first cycle development as the biomass volume would not be effectively disposed through natural decomposition, the air pollution impact may be minimised by limiting the area per burning session. Based on past experience, ease of control and acceptable level of air pollution due to burning activity can be achieved by only allowing 50 ha of fully dry biomass to be burned at any one time. Adjacent farms may have to negotiate on their respective burn area in order not to exceed the above hectareage for the region.

Zero burning

Although mass burning of biomass is common in the past, haze incidents that had developed into a state of emergency resulted from such practice should provide a valid reason to seriously consider an alternative that can deliver the task.

Zero-burning technique is a method of land clearing whereby the remaining tree stands are felled and left *in-situ* to decompose naturally or used as mulch for young palms. Zero burning enhances the soil organic matter status, thus help to restore and improve the fertility and physical status of soils. Large quantities of plant nutrients are recycled in the soil through decomposition of crop residues. With the recycling of plant nutrients, the inputs of inorganic fertilisers could be reduced. With zero burning, the decomposing debris would enrich the underlying soil (substitute for the applied inorganic fertilisers) and less erosion thereby resulting in better conservation of the natural soil resources and consequently lesser water pollution and siltation of waterways.

Photo 3: Vegetative wastes from site clearing may be left on site (preferably properly stacked) to degrade naturally instead of being burnt

The plant biomass must be stacked properly in order to avoid possible obstructions during operations. Improper stacking may cause obstruction to plantation transportation and become potential nest and breeding grounds for rodent pests. The plant residues provide suitable and sufficient resource for termites to establish their population beyond economic threshold.

Windrowing. The windrow is a process whereby vegetative wastes are stacked in the interrows for natural decomposition to take place. Windrowing conserves the chemical nutrients in the vegetative wastes and enhances the soil nutrients or organic matter status.

Zero burning techniques should be further refined so that it can become more feasible and viable to be implemented, particularly the problems related to harbouring of plantation pests within piled vegetative wastes that eventually attack the palm trees and fruits.

Photo 4: Elevated TSP - typical effect of open burning for biomass disposal.

Implementation

Controlled burning shall be implemented as follows:

- **Step 1:** Demarcate burning areas into smaller plots of about 50 ha each for one burning session
- **Step 2:** Provide a fire belt comprising 40-m wide unfilled trees for areas adjoining existing planted land
- **Step 3:** Control the direction and coverage of burn.

Zero burning shall be implemented as follows:

- **Step 1:** The trees are felled and underbrushes are cleared
- **Step 2:** Felled trees and cleared underbrushes are formed into windrows, arrangement of vegetative wastes in rows following the dominant local wind direction, to facilitate natural decomposition of stacked wastes.

3.6 Soil Conservation Practices

Impacts Mitigated

Soil conservation practices will minimise or eliminate soil erosion impact within the plantation that will in turn prevent related impacts such as water pollution due to high TSS content in stream water.

Soil erosion impact can be mitigated by implementing three types of practices, namely agronomic measures, soil management and mechanical measures (Mor-

gan, 1986). The summary on the approaches to soil conservation practices and soil conservation strategies for cultivated land are given in **Annex 3.1**.

Photo 5: Rapid establishment of cover crops will prevent further erosion of cleared areas within the plantation

Photo 6: Establishment of cover crops at areas not meant for further development will significantly reduce eroded soil on site.

Implementation

A major step towards the overall mitigation of physical impacts is in recognising potential hazard sites and the subsequent zoning of activities.

Provision of hill/ steep land reserves

From the results of the hazard assessment the project site should be zoned according to the erosion hazard assessment. Areas comprising significant regions of high risk will need to be either excised from the project plan or marked for development with particular care. If there are isolated steep areas the decision may be taken to progress with the development but with care. However, if the steep lands area is extensive, maybe coinciding with an ecologically important area, then a decision has to be made as to whether or not the area should be excised.

The hazard assessment map may be used to plan the plantation road and drainage networks, riparian reserves and location of necessary watercourse crossings. If the clearing operations plan has already been made, this may be overlain on the hazard map and mitigation measures planned accordingly.

Intensive-clearing styles of conversion should be restricted to low risk gentler terrain, generally in the lower parts of catchments.

Thereafter the key mitigation measure is to minimise ground disturbance during clearing and site development operations. Mitigation measures should focus on reducing the land area disturbed, reducing the time of soil exposure after disturbance and provision of river reserves.

Use existing access road

The key mitigation measure of reducing the area of disturbed land may be achieved by minimising fresh clearing for access roads through improvement and use of existing timber tracks within the area. Access road during nursery establishment and site preparation stages should be based on available existing logging tracks in order to minimise or prevent fresh clearing of vegetation. This approach will also reduce the cost for site development as the only cost that is necessary is for upgrading of these existing access roads.

Reducing time of soil exposure after disturbance

The forest conversion schedule should minimise the time between harvesting, conversion and planting, thus minimising the period of exposure and increased erosion risk. Large exposed areas should be re-vegetated with fast growing species such as *Centrosema pubescen*, *Calapogonium caerulum*, *Calapogonium muconoides*, *Pueraria phaseoloides* and *Pueraria javanica*. Ground cover not only protects against soil erosion but if leguminous plants are used they may also enrich the soil through their nitrogen fixing abilities. Exposed areas where planting of cover crops is not favourable (e.g. road sides) may be compacted as soil in large particles are more resistant to transport by erosive agents because

of the greater force required to entrain them. Compaction or other soil management practices may be implemented to reduce as much as possible detachment of soil particles.

Provision of riparian reserves

In accordance with Water Enactment all permanent watercourses are to maintain a riparian reserve of at least twenty metres from the top of each riverbank. If a GIS is being used for analysis the river reserve maybe generated on the drainage map. The reserves are to be clearly identified and marked by survey teams before clearing and site development operations commence. If the area has previously been cleared the reserve must still be established through replanting with indigenous trees and vegetation. The irregular terrain may complicate demarcation of the reserve strip in the field, particularly for smaller rivers in steeper terrain but the reserve must be identified and maintained. At no time must a vehicle or tractor enter a riparian reserve or cross a perennial stream unless provision to do so has been made i.e. culvert or bridge. If selective harvesting of timber is carried out prior to plantation development, logs may be extracted from the reserve but machinery is not allowed to enter the reserve to extract the log. The log must be winched from outside of the reserve. Accordingly, logs harvested within the reserve must be felled away from the river. Access to felled logs must be along a planned route avoiding the marked drainage system. Many of the physical impacts of clear-cutting can be minimised by the provisions of buffer zones along riverbanks, streams, adjacent conservation areas and roads.

The purpose of maintaining riparian reserves along rivers is to minimize the amount of sediments entering river system, minimize erosion of riverbanks and minimize destruction of riparian habitat. In addition the reserves maintain aesthetic scenes along roads and provide refuge for some mobile wildlife. According to Payne (1997), biological control of rats might be achievable by leaving about 5% of plantation land under forest in the form of reserves (riparian and hill/steep land)

Provision of surface runoff control measures

Drainage system for effective conveyance of surface runoff away from disturbed areas will minimise the extent of erosion. For plantation planting field, roadside drains may play this function and riparian reserves provided will further retain direct discharge of eroded soil particles into the waterways. However, for areas that were cleared for the plantation complex, a sedimentation pond that corresponds to at least 5 to 15% of the total cleared area may be constructed to retain the surface runoff and allow for sedimentation of eroded soils prior to discharge into existing waterways.

Provision of stream crfossings

As far as possible, crossings should be provided where natural waterways within the oil palm plantation are affected. This approach will prevent occurrence of flash flooding as well as ensuring smooth conveyance of surface runoff. Use of available logs on site (during site preparation stage) to construct temporary crossings can further justify the need to sort and recover useable biomass generated.

Photo 9: Temporary crossing that blocks the waterway

3.7 Additional Mitigation Measures

3.7.1 Optimum usage and timely application of agro-chemicals

Agro-chemicals

Excessive usage and untimely application of agro-chemicals can not only result in higher operating cost but also elevated level in surface water system. Manuring/fertiliser application should be based on the palms requirements (i.e. through foliar sampling and analysis). Use of pesticides, weedicides and the like should be minimised and limited to serious cases of infestation and priority should be given to biological control and manual weeding.

Photo 7: Manuring control.

In brief, for pest control as far as possible use of agrochemicals should be taken, as the last resort and biological control should be given priority. If use of agrochemicals is inevitable, controlled usage should be implemented with emphasis on the amount and timing of application.

3.7.2 Pest Control

When carrying out zero burning method for biomass disposal, pest (particularly rats and possibly termite) infestation may become an important concern. This problem may be mitigated by:

- Providing breaks within the alignment of the biomass windrows to prevent any potential for extensive infestation
- Controlled usage of pesticides, particularly when infestation is extensive.

Photo 8: An example of a pest (rat) attack on palm fruits.

3.7.3 Sanitation Facilities

Improper sanitation facilities may lead to disease outbreak (either air-borne, water-borne or vector-borne). Adequate sanitation facilities include:

- Toilets with septic tanks that are maintained regularly to ensure their effectiveness
- Domestic waste disposal system that is capable of ensuring proper disposal, prevention of scavenging by rodents and other scavengers.

It is very important that the proponent allocates sufficient funds for providing the above facilities adequately for the plantation population.

3.7.4 Maintenance of Waterways

Waterways on site should be clear from any blockages either in the form of vegetative wastes or elevated channel bed. Removal and proper disposal of blocking materials should be incorporated into the plantation work schedule to ensure smooth conveyance of surface water and prevention of flash flood on site.

Photo 10: Vegetative waste that blocked a waterway.

3.7.5 Occupational Safety and Health

Activities within the plantation are mainly carried out by the workers and they are the ones who will be exposed to occupational health and safety hazards. In order to minimise these hazards, the following mitigation measures should be implemented:

- Workers should be given proper and adequate training in machinery handling and safe working procedures
- Personnel protective apparels such as safety boots, gloves, respirators (especially for pesticide application) should be provided in terms of suitability and adequacy
- Traffic signage at strategic locations within the oil palm plantation should be provided, particularly during harvesting stage when traffic volume is higher than any other stages.

Photo 11: Workers involved in application of agro-chemicals should be provided with adequate PPE.

3.7.6 Management of Hazardous Materials

In the operation of an oil palm plantation, there are two types of materials that are of environmental concerns, namely the agrochemicals (pesticides and fertilisers) and oil/grease wastes. Both materials can be a source of significant water pollution.

Agrochemicals pollution may arise from improper storage and mishandling where spillage may result in introduction of these substances into nearby and surrounding waterways. Pesticides may lead to poisoning of aquatic lives or even human beings. Fertilisers may result in eutrophication of affected waterways.

Oil and grease wastes come about from storage and mishandling of used lubricants or other petrochemical products such as fuel and fuel enhancers.

The following measures may be implemented to minimise potential environmental pollution arising from theses materials:

- Agrochemicals – proper storage and handling, used containers to be returned to suppliers or collected for proper disposal – they should never be re-used for domestic purposes
- Used lubricants – collected for reuse and/or disposed off as scheduled wastes
- Fuel dispensing to be carried out at bunded area and by trained and experienced personnel to prevent spillage
- Containers for fuel and fuel enhancers to be collected and properly disposed off.

4 Monitoring

What type of environmental monitoring is required?

Steps	*Activities*	*Issues*
Step 1	Assessment of Impacts	
Step 2	Mitigation Measures	
Step 3	Monitoring	Environmental monitoring includes: • Compliance monitoring • Impact monitoring.

This chapter includes the following:

- Monitoring requirements to ensure compliance of the recommended mitigation measures
- Procedures for monitoring residual environmental impacts.

4.1 Compliance monitoring

Mitigation measures can only take effect if they are properly implemented. The level of implementation may vary in accordance to the commitment made by the project proponent to comply with the mitigating measures. To enable compliance monitoring to be carried out, the project proponent should provide the information tabulated in Table 4.1.1. The details will be specified in the Agreement on Environmental Conditions (AEC) between the Project Proponent and the ECD.

Table 4.1.1. Compliance Monitoring

Monitoring	Item
Demarcation of water catchment	Site location map overlay onto topography map showing boundaries of water catchment found within the project site
Zoning of plantation area	Placement of flags and poles that will mark areas to be developed and conserved within the plantation Mapping of plantation area to record areas developed as well as conserved

Phasing	Layout plan and development schedule
Zero burning	Layout plan and development schedule that specifies zero burning is practiced Photographs showing implementation of zero burning with a map indicating locations of the photos taken
Soil conservation practices	Layout plan indicating areas where cover cropping is implemented as well as areas not suitable to do so

4.1.1 Demarcation of water catchment

Based on the flow chart on the land application procedure in **Figure 1.1**, the project proponent, upon issuance of the Draft Land Title, should carry out an EIA study for submission to and approval by the ECD. The findings in the EIA shall be used to determine the final plantation boundary that has taken into consideration the water catchments relevant to the proposed plantation. This will assist in a better control of environmental impacts with regards to preventive measures as it can be certained that the impacts will be contained within specific water catchment thus the parties responsible can be quickly identified and mitigation/control measures implemented.

The project proponent should provide the ECD with a layout plan showing the boundaries of water catchment within the plantation and the proposed project site boundary that will be used by the LSD to issue the Final Land Title to the Project Proponent.

4.1.2 Zoning of plantation area

The project proponent should provide the following:

- A layout plan showing areas that are classified as environmentally sensitive, ecologically important, socio-culturally significant and provisions for buffer zones and riparian reserves are clearly marked

- A layout plan showing placement of flag poles indicating different zones of the plantation during site development

- Re-mapping of the entire plantation area upon completion of site development of every phases of the plantation.

The updated plantation zoning map should be submitted to ECD upon completion of any new development phases or as per AEC.

4.1.3 Phasing

The project proponent should provide the documented development procedures that specify phasing of the development. The information should be submitted to ECD upon completion of any new development phases or as per AEC.

4.1.4 Zero Burning

The project proponent should provide the record on practice of zero burning methods, which is supported with photographs. The information should be submitted to ECD upon completion of any new development phases or as per AEC.

4.1.5 Soil Conservation Practices

The project proponent should provide records on implementation of soil conservation practices – supported with photographs – after completion of new phases or as per AEC.

4.2 Impact Monitoring

If environmental assessment shows that the project may result in significant residual impact to the environment, the information that should be provided by the project proponent to ECD for impact monitoring purpose is as presented in Table 4.2.1.

Table 4.2.1. Impact Monitoring

Monitoring	Item
Ecology	Report on the impacts on the intended species within the zoned areas
Soil erosion	Elevated TSS and turbidity in waterways
Flood	Records on occurrence of localized flooding on site and downstream
Water quality	Total suspended solids (TSS), pesticides, fertilisers

Impact monitoring will serve as the "red flag" whereby any monitoring components exceeding the stipulated limit for their respective parameters will be taken as an indication that the mitigation measures for those particular aspects are either ineffective, defective or not in place. Such findings may be used to enforce proper implementation of mitigation measures.

4.2.1 Ecology

The effectiveness of mitigation measures for ecological impacts can be determined by monitoring the extent of ecological impacts on the species intended to be conserved within the zoned areas. Adequate and effective buffer zones will clearly demarcate the plantation and the national park; whereas riparian reserves can provide sanctuary for mobile fauna as well as establish new habitats for displaced species.

Methodology

Impacts on the species intended to be conserved within the zoned areas will be identified by determining the changes that take place within that particular species.

Indicators

Changes within a particular species can be ascertained by determining variations in terms of population size (increase, remain, decrease) and growth

condition (good, retarded, normal, etc.). The baseline data will serve as the yardstick to ascertain the extent of changes taking places.

4.2.2 Soil Erosion

If environmental assessment indicates that the oil palm plantation may result in soil erosion on site, periodical monitoring should be carried out for signs of soil erosion on site as well as water quality deterioration that could be attributed to the soil erosion.

Methodology

Visual inspection of soil erosion incidence within the plantation area. Variations in the level for soil erosion indicators, particularly TSS and turbidity in water quality of waterways relevant to the plantation, will have to be determined.

Indicators

Physical appearance on site - photographs of these erosion incidences gully, sheet, etc. shall be included in the report. Test results and assessment shall be reported and submitted to ECD as per AEC.

4.2.3 Flood

If the environmental assessment indicated that there could be a potential for flooding to occur as a result of the oil palm plantation development, monitoring for flood incidents shall be carried out.

Methodology

Impact monitoring for floods may be carried out as follows:

- Install water level gauges at three locations along the main waterway of the plantation i.e. upstream, mid-stream and downstream
- Recording of water level monthly by the project proponent
- Submission of the flood record to ECD.

Photographs of these gauges as well as the extent of flood (if any) shall be included in the report. The report shall be submitted to ECD as per AEC.

Indicators

Inundation of areas having high risk for floods.

4.2.4 Water quality

Soil erosion, use of agro-chemicals and other on site activities will inevitably affect water quality of waterways within the oil palm plantation.

Methodology

The impact monitoring of water quality can be carried out by determining the changes in water quality of waterways relevant to the oil palm plantation. This can be achieved by taking water samples at locations that are representative of the site's condition, which will be determined and agreed by ECD. Report on the variations to be submitted to ECD as per AEC.

Indicators

Water quality changes for waterways relevant to the oil palm plantation can be ascertained by determining variations between the existing water quality and the baseline data. Parameters that should be determined are TSS, turbidity, dissolved oxygen, pH, Biochemical Oxygen Demand, Chemical Oxygen Demand, Oil and Grease, Agro-chemicals.