

Chapter

5

Recommended Mitigation Measures

5.1 Introduction

5.1.1 General Background

Conservation work, particularly in some oil palm plantations is a reality. Areas that are not conducive for oil palm are kept as either forest or wetland to provide habitat for wild animals and birds. In some cases, predatory animals such as cobra, owls and leopard cats thrive in these areas and help control the population of rats and squirrels in oil palm plantations.

Green tagging is vital in agro-based industry. Consumers in Europe are concerned over the global environment and will only support the purchase of commodity derived from areas practicing sustainable agriculture. Conservation activities in oil palm plantations can give positive influence to consumers in Europe and other developed countries.

Documents relevant in devising the recommended mitigation measures for this SEIA include the previous SEIA^{5a} for the proposed ITP plantation, which covers the whole Project area and the EIA^{5b} for the on-going Kalabakan-Sapulut road construction as well as their approval conditions issued by the Environment Protection Department, Sabah. It is also important to highlight that there is already on-going compliance monitoring conducted for the above mentioned activities. The consultant has also tried to investigate the existing mitigation measures practiced on ground and re-emphasise where necessary.

5.1.2 Key Mitigating Measures

This section discusses the key mitigating measures recommended to minimize or alleviate the adverse impacts discussed in **Chapter 4**. It also includes, to some extent, recommendations for environmental management related topics. However, the undertaking of these measures by the Project Proponent will depend upon the overall assessment and through consultation with the Environment Protection Department (EPD).

The key and common mitigating measures identified from the assessment can be categorized under the following main topics and they are:

^{5a} Special Environmental Impact Assessment (SEIA) for the Proposed Sino-Malaysia JV Forest Plantation At Kalabakan and Gunung Rara Forest Reserves, Tawau District, June 2002.

^{5b} Environmental Impact Assessment for the Projek Membina Jalan Sapulut-Kalabakan, Sabah, October 2002.

1. Soil Erosion, Water Quality and Hydrology
 - o Preservation of Riparian Reserve;
 - o Protection of Steep Area;
 - o Water Yield Management;
 - o Reduction on Potential Flood Levels; and
 - o Protection of Water Quality from Sediments.
2. Flora and Fauna Ecology
 - o Protection of Sensitive/High Risk Areas
 - o Wildlife Management
 - o Flora Management
3. Forest Harvesting and Plantation Operation Management
 - o Reducing the Land Area Disturbed
 - o Phased Logging and Clearance
 - o Biomass Management
 - o Fire Prevention and control
 - o Pests and Diseases Management
4. Socio-Economic Consideration
 - o Provision of Employment Opportunities
 - o Protection of Water Resources and Supply
 - o Protection of Worker's Safety and Health
 - o Reducing Dust Problems
 - o Preservation of Landscape and Ecotourism Opportunities
 - o Staff Training
5. Abandonment

Sections 5.2 thru **5.6** discuss the individual measures to be taken in relation to the issues mentioned in the list above and in that order. **Section 5.7** summarises the recommended measures in an operational manner.

5.2 Mitigation Measures for Soil Erosion, Water Quality, Hydrology and Aquatic Resources

5.2.1 Preservation of Riparian Reserve

The preservation of riparian reserve is to serve as:

- o **Soil erosion control measures, water quality, hydrology and aquatic resources.** Provision of adequate riparian reserve preserves will contribute positively to the protection of quality and quantity of water to downstream communities such as Kg. Kalabakan and Kg. Brantian. These communities are dependent on watersheds of Sg. Kalabakan and Sg. Brantian for drinking water and fishing; and the riparian reserve can further prevent downstream siltation and flooding. In realizing the importance of riparian reserve, it is worth noticing that the 5-km Sg. Kuamut is already excluded from this Project area by the Project Proponent.
- o **Wildlife and forested corridor network.** It provides a corridor for animals to move in search for food and serve as temporary refuge. In addition, maintaining the buffer belt along the main rivers will also form a network of forested corridor between two habitats. This is possible for example by joining the river buffers in BW 3/02, BW 10/02, BW 10/01, BW12/04, BW12/01 and BW 12/03 forming the linkage with Sg. Imbak and the forest in the north. This will be further discussed in **Section 5.3.1**.
- o **Protection of riverine biodiversity and aquatic resources.** Most of the trees and plants along the rocky rivers in the area have adaptive morphological features to ensure their survival, which is otherwise sensitive to logging and clearing activities. Meso- and microclimatic changes due to openings of canopy will cause the loss of the epiphytic flora on these trees and plants. Inadequate or removal of the riparian reserve could damage their protective role.

In the previous approval conditions for the SEIA, the designated riparian reserves are as follows:

River/Stream	Riparian Reserve (x2)
Sg. Kuamut within the plantation area	1000 m
Sg. Kuamut within the NFM area	100 m
Sg. Brantian	200 m
Sg. Kalabakan and its tributaries, Sg. Anjeranjermut and Sg. Tiagau	100 m
All other rivers	30 m

With the proposed development for OPP and ITP, the riparian belts have to be revised as shown in **Table 5.2.1** and **Figure 5.2.1** to **Figure 5.2.2**.

Table 5.2.1: Recommended Riparian Reserve for the Proposed OPP Plantation

Stream Width	Minimum width of Riparian Reserve (x2)
<3m	5 m
>3m – 20 m	30 m
>20m (Sg. Tiagau)	100 m
Special consideration:	
Sg. Brantian (up to the VJR) ^{5c}	250 m
Sg. Kalabakan & Sg. Anjeranjermut ^{5d}	1000 m
To be maintained:	
Sg. Kuamut	5 km

Note: In the case where "high risk" area is located adjacent to the river, the width of the riparian reserve should be 1.5 times bigger than the above recommendation (or whichever is bigger) (see **Figure 5.2.1 to **Figure 5.2.2**).*

To further ensure that soil erosion is kept to the minimum, in addition to the buffer belts it is recommended that other measures be enforced:

- o Boundaries of the riparian reserves (see **Figure 5.2.1** to **Figure 5.2.2**) should be CLEARLY demarcated on maps and marked with highly visible, indelible means (e.g. paint) in the field. See signboard erected at the field in **Plate 5-1**.
- o If tractors are used for clearing, they should be small size and equipped with brush rake in place of earth moving blade, in order to minimize soil disturbance and compaction. The brush rake should be moved above the ground surface without touching the ground to prevent any soil disturbance and forming of rill erosion.
- o In reopening old skid trails, the layer of accumulated litter and matted roots should be retained in order to reduce erosion and compacting of soils.
- o Table drains, culverts and other drainage structures such as those needed to channel run-off water to road-side filter strips (see **Plate 5-2**) prior to entry into streams should be installed concurrently with road construction.
- o Table drains should be seeded with grass to prevent erosion of drainage banks and to prevent formation of erosion channels.
- o Road grade should not exceed 15% (8 degrees).
- o Roads should not cross main streams unless appropriate crossing structures (e.g. culverts or bridges) are built.
- o Blading off is not encouraged and it should only be allowed if damage is minimal and subsequent drainage and repair is possible.

^{5c} A minimum reserve of 250m (x 2 for both banks) should be kept for Sg. Brantian (see **Figure 5.2.1**) within the Project area as a refuge for proboscis monkey because this group of animal will not survive with small riparian reserves as their diet is quite specific. In order to ensure the protection of this species, it is important to preserve the riparian reserve for Sg. Brantian in such a way that it stretches like a 'green finger' all the way down to the mangrove estuary and it is crucial for all relevant authorities, developers or landowners that they must also maintain the required riparian reserve south of the project area.

^{5d} The Kalabakan and Anjeranjermut rivers riparian reserve must be enlarged, as they are strategically located along the Kalabakan-Sapulut road. It is now recommended that the reserve for these rivers to be 1000 meters from both side of the river bank as they flow in parallel with the Kalabakan-Sapulut road.

- o Table drains should be provided and roads should be appropriately cambered, crowned, insloped or outsloped as appropriate to the circumstances to ensure water drains from road surfaces.
- o Avoid pushing excess spoil into gullies and the edges of road embankments during road maintenance. Spoil should be compacted “*in situ*”, or transported to disposal sites away from the road, thus minimizing erosion of roads and sedimentation of waterways.
- o Provide filter strips^{5e} along the roadsides to help to reduce siltation of river systems and to prevent an increase in the intensity and frequency of peak flows into the river system downstream of the land clearing activities (Refer **Plate 5-2**). This has been recommended in the SEIA 2002 but was not adopted.

Filter strips are strongly recommended. The size, shape and locations of filter strips have to be determined based on the road alignment but for effective filter strips, the following details are recommended:

- Filter strips together with contour lines, drainage system (river system and road drainage), road and skid trail network be shown on maps for each region in the scale of 1:25,000 and the maps should be submitted together with the detailed design of the drainage and the road-side filter strips as part of the detailed forest plantation management plan.
- Filter strips should be designed and dimensioned to withstand a 1:10 year peak flow with minimal local erosion and mass calving.
- Discharge from road drainage should be introduced to filter strips using weep drains or infiltration fields to prevent soil erosion.
- Filter strips should not be located in:
 - o Areas with ground slope of more than 15 degrees and less than 3 degrees;
 - o Areas with unsuitable soil for filter strips. The type of soil is considered unsuitable if the thickness is less than 0.3 m;
 - o Areas where the average infiltration rate of the water saturated soil is less than 30 mm/h;
 - o Areas where the soil shows a water restricting layer at a depth of less than 0.6 m;
 - o Areas where the soil is of similar type; or if the soil shows any indication of permanent wetness.
 - o Areas with high risk of land slide occurrence;
 - o Areas with springs or perched ground water;
 - o Areas at the head of rivers and creeks; or
 - o Areas within a zone of convergence flow lines (slope gradients).

^{5e} Filter strips are undisturbed natural vegetation along the sides of the main forest road. It serves to trap run-off prior to entry into stream.

- o If establishment of filter strip is not possible at certain area, the use of silt traps^{5f} is encouraged at all drainage outlets, prior to discharge into streams to reduce suspended sediment loading. Maintain and empty silt traps regularly to avoid clogging. Do not dispose silt from silt traps adjacent to the silt traps, rivers, streams, creeks or any drainage.
- o Machinery should, as far as possible, avoid operating in the streams during construction.
- o All culverts should have a cut-off wall to prevent erosion under the pipe.
- o The head and outlet walls of culverts should be stabilized with log- or stone-pitched walls.
- o Culvert gradients should ideally be 1-3%.
- o Contractors shall, during rehabilitation work, ensure that proper drainage is installed in order to reduce soil erosion and runoff.
- o Bark and landing debris should be dispersed evenly across the landing to assist in stabilization.
- o Since there is still on-going timber extraction operations in some of the Project area, it is important to carry out the following upon completion of this operation:
 - Rehabilitate unused or abandoned stumping points if planting has not commenced. These should be slightly tilled and immediately covered by planting indigenous fast-growing creepers or cover with unused or discarded tree bark (from the landings) to reduce surface erosion.
 - The landing site, for example in **Plate 5-3** to be rehabilitated shall be cleaned from non-biodegradable material and all solid waste shall be removed, including oil/fuel drums and steel wire.
 - Silvicultural treatment on disturbed area especially localized steep area shall be carried out to sustain future regeneration.
 - Install cross-drains in on abandoned roads, skid trails, landings, etc. with slopes >10% (5 degrees) to ensure water runoff is channelled off the road and into surrounding forest.
 - Cross drain spacing should be proportional to the slope of the road i.e. steeper gradients have more frequent cross drains. Generally "cross-drains" on roads of moderate slope (10%) should be spaced at 30-50 meter intervals. Cross drains prevent soil erosion and loss of culverts and bridges, preserving skid-trails, roads and landings for use in future selective harvesting operations.
- o Removal of biomass should be carried out during suitable time period (month of the year), proper methods (such as partial mechanization method) and procedures and selection of machineries to reduce unnecessary surface erosion.
- o If tractors are used for clearing, they should be small size and equipped with brush rake in place of earth moving blade, in order to minimize soil disturbance and compaction.

^{5f} Design in accordance with the "Guidelines for prevention and control of soil erosion and siltation in Malaysia" published by the Department of Drainage and Irrigation, Malaysia, if possible.

5.2.2 Soil Protection – Terracing and Anti-Erosion Bunds

It is generally recommended that land slopes between 12° to 20° should be terraced for oil palm cultivation. Terraces will result in better field, improved access, water retention etc. The advantages and proper way of constructing terraces are elaborated further in **Annex B1.4.1**.

Similarly, anti-erosion or stop bund helps to stop excess water running freely away and hence prevent soil erosion and conserve water. Anti-erosion bund comprises the digging of discontinuous silt pits along the contour, an un-dug section being left every few metres to stop water actually running along them. The excavated earth is used to erect a continuous earth bank, or bund. See further details in **Annex B1.4.1**.

5.2.3 Protection of Steep Area

A total of 6,159 ha of the proposed total Project site of 109,600 ha is considered steep slopes. See **Figure 4.3.1**. Based on the site inspection in November 2004, most of the steep ridges in BW1/00, BW4/00(A), BW9/00 and BW9/03 are seriously logged using the conventional method. See **Plate 5-4** and **Plate 5-5**.

The high-risk area, apart from being prone to erosion and have poor regenerative capability, also possesses certain ecological functions. The followings are the suggestions for exclusion of such areas, besides fulfilling the legislative requirements.

- o **Flora Conservation.** Normally, the area above 900 m (or ~2,700 ft) has different vegetative types as compared to the lower elevation. Based on site observation, the steep ridges in BW 1/01, BW 2/01 and BW 3/01 are recommended for protection. See **Figure 5.2.2** and **Plate 5-6**. These areas, owing to the steep terrain and soil types are habitats of many endemic species that do not regenerate easily (Kiew, 1983 & 1988). Thus, marking of these areas on the map clear demarcation on the ground where trees at the boundary are clearly marked with red paint on their trunks are crucial.
- o **Ecological Protection.** The montane forest at high elevation (>900 m) has poor regenerative properties due to the climatic condition, difficult terrain and soil types, which are ecologically very delicate. For this reason, the prohibition of logging and protection of the whole ridge at BW 9/00), with its highest peak Gunung Nakopan at 1,312 m or 3,998 ft, is highly recommended (see **Figure 5.2.1** and **Plate 5-7**).
- o **Natural Corridor.** The steep ridges are the natural link to the forest outside the proposed Project Site. These ridges include those that are along BW 9/00, BW 9/03, BW 9/02, BW 3/00, BW 2/99 and BW 4/00(A). See **Figure 4.3.1** and **Figure 4.3.2**. They must be protected and managed accordingly so that animals can use them as refuge and as migratory pathway. The long-term survival of animals is affected when isolated for a long period through fragmentation of forest. This will be further discussed in **Section 5.3.1**.
- o **Wildlife Temporary Refuge.** As some wildlife do take refuge within the patches of forest on steep ridges, it is recommended steep hill and ridges i.e. 25 degree slope or higher be excluded. This is especially crucial during the salvage

harvesting and land clearing stages when large amount of trees are felled and arboreal as well as ground animals will need these belts to move away to new shelters. Eagles and hornbills prefer trees on high ridges for nesting. These belts will eventually be the only sources of shelter and food for the animals when the plantation is established. They are also natural barrier to poachers.

5.2.4 Water Yield Management

Baseflow is groundwater flow that enters the stream or river by way of deep sub-surface flow below the main water table, and is affected by the net effect of changes in evapotranspiration and rainfall infiltration opportunities following forest removal. If the infiltration rates, after the catchment disturbance have reduced to the extent that increases in surface storm runoff during rainfall exceed the gain in baseflow associated with lower evapotranspiration loss, then diminished dry season flow will occur and the river will eventually dry up. Conversely, if soil infiltration capacity is maintained, increase in dry season flow can be expected, as the soil water storage is already higher than before forest removal.

Therefore, appropriate mitigating measures would include:

- o Using standard reduced impact logging techniques as applicable to land clearing, i.e. those techniques aimed at reducing soil damage. Such techniques include, but are not limited to: Winching rather than direct dragging, skidding on top of debris, pre-planned skid tracks, use of light machinery, limitation to work during drier periods, commence planting soon i.e. not later than 3 month after site clearing.
- o Development or land clearing should be spread over different sub catchments instead of concentrated in one big catchment. This is to help in reducing total water loss and sediment yield. For example, in Yayasan-Melaka JV, the division of planting plot could follow the sub-catchment boundaries to reduce the impacts (see **Figure 5.2.3**).

5.2.5 Reduction on the Flood Levels

As mentioned in the assessment of potential impacts from the OPP and ITP Project in **Chapter 4**, no significant threat of neither floods nor droughts due to this development is foreseen. The increase in flood levels as assessed is expected to be short term and temporary. However, to increase the infiltration capacity and reduce runoff volume and flood peak downstream, the following is strongly recommended:

- Proper management practices. This encompasses aspects of land clearing and site preparation and it is further discussed in **Section 5.4.1**.
- Development of the Project area in phases. There must be a detail map showing the development in phases. This is further discussed in **Section 5.4.1**.
- Planting of cover crops and secondary vegetation immediately after clearing and maintaining adequate streamside buffer strips, also known as riparian reserve (refer to **Section 5.2.1** above).

5.2.6 Protection of Water Quality from Sediment Yield

In addition to the riparian reserve or buffer zones recommended in **Section 5.2.1**, the recommended mitigating measures to reduce the potential impacts due to sedimentation are as follows:

- o Develop the proposed oil palm plantation in different phases as shown in **Table 2.3.1** and scheduled over drier period or months as well as development in different sub-catchments (see **Figure 5.2.3**).
- o Roads must be carefully laid out, preferably following the contour and must be far enough from stream.
- o Clearing should be done parallel to contour lines, starting from high to low ground.
- o Install cross drains for minimising overland flow.
- o Timing of road construction or road upgrading to conform to periods of less rainfall and allowing sufficient time for earthworks to stabilise.
- o Using the appropriate machineries in the land clearing to minimize disturbance to the soil.
- o All clearing, grading and stabilization operations would be done before starting the next phase.
- o Where possible, the stages of development should be from the high to low grounds, so as to take advantage of the present vegetation to act as silt and runoff barriers.
- o Reduce the duration of land exposure to natural elements i.e. reduce the time between land clearing and tree establishment (maximum 3 months interval).
- o No person shall carry out any tree felling, building or structures erecting and other works within the buffer strips.

5.3 Wildlife and Aquatic Ecology

5.3.1 Protection of Sensitive Areas

Based on the assessment, there are a few areas within the proposed Project area that are recommended to be conserved as natural forest and be excluded from the OPP and ITP:

- **Hill Ridges above 650 m and over 25 degrees.** The ridge along BW9/00 within BWIIC forms a link with the river buffers of Sg. Anjeranjermut and Sg. Kalabakan together with the neighbouring ridges and westwards to the protected area of Maliau Basin (**Figure 5.2.1** and **Plate 5-6**). For BW9/03 the steep areas marked out in the harvesting plan should be linked with the river buffers in the north with Sg. Kalabakan while in the south with Sg. Anjeranjermut. Similarly, steep ridges

of G. Tampilat marked out in BW9/02 can be linked with Sg. Kalabakan in the north and the forested area south. In addition to the protection of plant diversity in this area, this is the main approach road to the Maliau Basin Conservation Area, which attracts many nature tourists. With the maintenance of the natural vegetation the drive to the conservation area will be more aesthetic pleasing not like the oil palm plantation just outside the Project site. There is also a deep beautiful gorge next to this main road formed by Sg. Anjeranjermut next to BW9/01 (see **Plate 5-9**) and the mud volcano could form very scenic stops for travelers. The system of road buffer from Luasong to Sg. Kuamut main road should be the standard for all other main access roads. See **Plate 5-10**.

The second important area with potential of high level of endemic plants is on the central part of Benta Wawasan I. This includes BW1/01, BW2/01 and BW3/01 with ridges above 650m. Protecting all the area above 650m will form a continuous belt with the northern forest area under natural forest management (**Figure 5.2.1**). This together with the river buffers of Sg. Geminchau and a tributary of Sg. Imbak will form an efficient corridor from the south to the north. See **Plate 5-7**. Steep sites within these coupes have been identified in the harvesting plans but they are isolated and not linked to each other thus not providing the optimum benefit.

The third important link will be along the buffer belt of Sg. Brantian (BW3/00) towards the Brantian-Tatulit VJR. See **Plate 5-11**. Continuing with the ridges above 500m towards the northern coupes of BW2/99 and BW4/00(A) will link up with the natural forest area contiguous with the Danum Valley Conservation Area (**Figure 5.2.1**). The ridges along this belt are still covered with good vegetation. In addition to the ridge top vegetation, this area has been documented with many nesting trees of the Orangutan (**Plate 5-12**). Smaller links could also be formed using road, other river buffers and steep areas. Examples are the link formed by joining the Ulu Napagon VJR to river buffers to the north and east, while the southern steep area of BW2/02 could be linked with similar sites of BW14/01. This network of corridors will be an essential component for maintaining part of the biological diversity in the Project site.

- **Mud Volcano / Salt Licks.** The mud volcano and salt licks are found in coupe BW 9/99. The SEIA 2002 has recommended a buffer of 2,370 ha around the site that links to the Luasong Forestry Project. Another mud volcano is located in the SUAS project area. Mud volcano and salt licks are used regularly by wild animals to supplement their mineral intake. Many animals are drawn to this site.

In 2001, elephants were found using the mud volcanoes. However, the November 2004 ground survey and interviews with workers indicate that elephants have not been seen in this area for a long time. The Kalabakan-Sapulut road will also be upgraded into a highway, which will require a good system of managing wildlife in this stretch as mud volcanoes attract animals.

In view of this new development, it is now proposed that the mud volcano and salt licks be incorporated into the 1000-meter riparian reserve involving the Kalabakan and Anjeranjermut rivers, and the Kalabakan/Sapulut road.

- **Virgin Jungle Reserves (VJRs).** There are two prominent VJR associated with the proposed project site. The Brantian-Tatulit VJR (see **(Plate 5-11)**) is engulfed within Benta Wawasan I while Ulu Napagon VJR is located west and outside of Benta Wawasan I.

VJRs serve as water catchment areas and home to wildlife. In this particular instant, the VJR serves as a temporary refuge for wildlife escaping from land clearing activities. To ensure survival of these VJRs following the clearing of the land for oil palm and industrial tree plantations, a 100m buffer must be maintained. This is to reduce the edge effect on the trees at the edge of the VJRs. This impact of forest edge on vapour pressure deficit (VPD) and soil moisture due to clearing had been documented at a distance of 100m (Kapos, Wandelli, Camargo & Ganade, 1997). In the SEIA 2002, a 100-meter buffer zone is recommended for VJRs. This recommendation is upheld. It was observed that a road had been constructed on the western edge of Brantian-Tatulit VJR and the vegetation on this slope had been damaged.

To make the VJRs more effective in providing a refuge for the animals, they should be contiguous with forested areas. This linkage will provide a corridor for animals to forage for food outside the limited constraint of the VJRs. This continuity will also ensure that there will be sufficient genetic exchange within the plants with those of the surrounding forest.

The plantation management must be continuously vigilant against hunting and illegal logging in the VJRs and the forested corridors. All the boundary of VJRs and corridors must be clearly marked and shown to the contractor on the ground as well as on harvesting maps.

- For the protection of the ongoing **INIKEA Project**, a buffer of 1 km is prescribed to prevent any edge effect on the project and to avoid encroachment.
- The system of 100m-road buffer from **Luasong to Sg. Kuamut** main road (**Plate 5-10**) should be the standard for all other main access roads.

5.3.2 Establishment of *In-situ* and *Ex-situ* Conservation Programme

Although undergoing salvage logging, it is strongly recommended that in-situ conservation programmes be implemented to sensitive sites. These are Coupes BW1/00, BW9/00 and BW9/03. This could be through the establishment of VJRs under the management of Sabah Forestry Department or the plantation management. Inventory of the flora and fauna could be initiated and a genetic conservation programme established. These sites will be important seed source for the rehabilitation stage when the plan to revert to natural forest is implemented.

With the clearing of a large tract of forest for plantation establishment, genetic resources and species will be lost. To reduce this impact an ex-situ conservation plan is strongly recommended. Rare and unique plants are to be collected and established

within a suitable site of the Project Area. This approach will reduce the severe impact of localized loss of species and genetic traits gained by these flora plants. The management of the plantation should put its resources into this establishment and maintenance. As the area with terrain above 20 degrees will not be established with oil palm enrichment planting should be carried out using indigenous timber species. Planting stocks could be established through seedlings sourced from the protection and conservation areas mentioned above. During gregarious flowering of the Dipterocarp trees large amount of seeds could be procured from the residual trees in these sites and established in the forest nurseries for propagation. This ensures that these areas will have a good stock of timber species in 30 to 40 years.

5.3.3 Forest Rehabilitation Programme

As it is projected that the oil palm plantation is to be for only one rotation the plantation area could be reforested through tree plantation using more indigenous species so as to create a forest condition. The approach could be adopted from that carried out by the Forest Research Institute Malaysia (FRIM) at Kepong in the late 1940s where 600 ha of degraded land planted with agricultural crops were reestablished with a diversity of indigenous forest tree species. After 60 years the trees had reached the height and diameter close to that of the primary forest. Understorey species had also recolonized the plantation with seed sources from the neighbouring forest.

Activating anti-poaching exercise is also part of the conservation effort. Wildlife must not only be protected but also encouraged to re-colonize these sensitive areas. Conservation also involves wildlife rescue and relocation exercises. One of the daunting conservation efforts is in addressing the human-animal conflict.

Hence, it is recommended that a proper rehabilitation programme should be drawn up at an early stage during the plantation development so that appropriate guidelines are laid and adhered to.

5.3.4 Protection of Special Sites

Retaining the proposed wildlife corridor linking Maliau Basin to Danum Valley. Davies & Payne (1982) indicated that a continuous population of at least several tens of individuals is needed to ensure that a species does not die as a result of inbreeding, diseases or disturbances including hunting. It is estimated that an area of between 50 to 6,000 km² is required to sustain such population of birds and large mammals respectively.

With the proposed oil palm development, the displacement of wildlife is obvious while some may perish in the process. Directional felling is vital. Rescue and relocation exercise is necessary. Poaching must be in controlled immediately. For the long term, displaced wildlife will seek refuge in forestland outside the OPP project. Thus, a wildlife sanctuary⁵⁹ within the concession must be provided for. Yayasan Sabah Concession Area is about 1 million hectare. There are two important conservation areas within the concession namely the Danum Valley Conservation Area (43,800 ha)

⁵⁹ A sanctuary means an area where wildlife is confined with a certain degree of protection.

and Maliau Basin Conservation Area (58,840 ha). A third conservation area has been identified and proposed, which is the Imbak Canyon Conservation Area covering an area of about 30,000 hectares. See location of these conservation areas in **Figure 4.4.1**. It is therefore recommended that the proposed wildlife sanctuary comprise all the three conservation areas and areas outside these conservation areas. Except for the area outside these conservation areas and the area proposed for OPP and ITP, the other area is to be managed under natural forest. In this sense, areas that are appropriate can be selectively logged using the best logging practices and sustainable forest management. Such areas will continue to be conducive and relevant to wildlife.

However, within this concession area there may be other area that has great potential and has not been identified as conservation area. Thus, YS as a whole must continue to seek areas of potential within its concession. This is in line with YS reputation and strength in research and conservation work worldwide. In a nutshell, the future of wildlife within SF concession depends on these conservations areas, while they continue to use the logged forest for foraging and migration.

The proposed wildlife corridor^{5h}, measuring approximately 210,000 ha (**Figure 4.4.1**) links YS concession area down south to the Kalimantan border. From an aerial survey, the area is still under forest despite the logging activity. See **Plate 5-13**. There are two ways to manage this wildlife corridor. First is to allow herd of elephants to forage and migrate between Sabah and Kalimantan. In this case the government of Sabah must continue to manage the forest south of Maliau Basin conservation area and towards the Kalimantan border under natural forest. Converting them into oil palm and industrial tree plantations will cut off this foraging and migration route. Second is to manage the elephants in Sabah and Kalimantan as two separate entities. In this case, herds in the northeast Kalimantan are encouraged to propagate and utilize the forest without crossing into Sabah. The issue of genetic diversity is negligible as capture and relocation of elephants can be done effectively.

5.3.5 Wildlife Protection

In terms of wildlife management, the following are the recommended mitigating measures:

- o It is recommended that proper sanitation to be provided as human gastrointestinal parasites and pathogens can be spread to wildlife via water.
- o It is also recommended that no hunting permits should be issued for the Project ITP area as well as YS Management Area.
- o The Project Proponent or their contractors must, in accordance with Section 38 of the Wildlife Conservation Enactment, inform the Wildlife Department Sabah one month prior to the Project commencement. Based on ground surveys in November 2004, there was a very low presence of wildlife within the project site. Few orangutan nests were spotted at BW5/98, which is adjacent to the Brantian-Tatulit VJR. The elephants were observed outside the Project site.

^{5h} A wildlife corridor is defined as an area connecting one forest entity to another forest entity to allow for wildlife migration or movement in search of food.

One YS staff mentioned that he has relocated three giant forest tortoises. Other than this there is no other activity pertaining to rescue and relocation. This operation may be irrelevant at the present time as salvaging, clearing and planting is in progress and that, not much wildlife is detected. Nevertheless, YS Group must liaise with the Wildlife Department Sabah on this issue.

- o There should be strictly no hunting within the plantation area and coupes as well as the surrounding area. The Project Proponent and their contractors must set up security gates on roads leading into all the coupes. See existing signboard for the security gate in **Plate 5-14**. Security gates must also conduct search for weapons, trapping materials and carcasses when vehicles enter or leave the Project site.
- o Contractors must prohibit hunting and trapping by their own people.
- o In order to minimize impacts to wildlife, felling of trees must be conducted gradually on a block-by-block method, and heading towards forested areas. This is to ensure that the mobile animals have the time and space to escape and seek refuge at the nearby forest. To enable wildlife to seek refuge at the surrounding forest areas, it is strongly recommended that the recommendation of SEIA 2002 on directional felling is strictly adhered to. It is again recommended that phased directional implementation as per recommended in SEIA 2002 be strictly followed and more so for areas undergoing salvaging operation. This will allow wildlife to move to forested areas in the north to Danum Valley and Kuamut river buffer zone and Luasong Forestry area for Benta Wawasan I. For Benta Wawasan IIC, the recommended directional implementation allows the animals to move towards the forest areas of Luasong Forestry area, INIKEA, SUAS and the wildlife corridor. Of concern will be BW5/98 where orangutan nests have been observed. Any clear felling activity must allow migration of orangutan to the Brantian-Tatulit VJR.
- o In the event that any wildlife is trapped or hurt during logging and land clearing operations, the Wildlife Department must be informed and for translocation may be taken. The Project Proponent should allocate fund for such translocation.
- o Hunting dogs should be banned from the camp sites.

5.4 Forest Harvesting and Plantation Operation Management

5.4.1 Minimization of Land Area Disturbance

During the land clearing and site preparation, the following control measures should be considered to minimize disturbance:

- o The project implementation is staggered into 5 phases of 500 ha to 7,500 ha. This will alleviate the impact due to drastic change of the environment and reduce the magnitude and impact to manageable levels.
- o Commence planting soon (e.g. within 3 months) after site clearing.
- o Prior to felling, the areas should be surveyed to identify and delineate areas that exceed the maximum slope limit for oil palm and ITP plantations, as discussed in **Sections 4.3.1, 5.2.1 and 5.2.2** and **Figure 5.2.1** to **Figure 5.2.2**. These areas,

which should have been identified in the present commercial timber harvesting operations, should also be delineated on maps and in the field and excluded from all OPP and ITP development.

- o In clearing logged over forest and secondary regrowth for planting oil palm, the best method is using bulldozers (e.g. Caterpillar D6 or D8) as it is fast, efficient and economical. Clearing by hand is outmoded slow and inefficient and not suitable for developing large parcels of land as in Benta Wawasan I and IIC. The undergrowth is first slashed and all standing timber felled. Any regrowth from stumps is later poisoned, using 20% c.p trichlopyr in diesel oil.
- o Occasional rows can be cleared to 6m to serve as fire breaks in case of accidental fire, dividing the area into fire control block of about 10 ha.
- o Areas that cannot be planted within 3 months of clearing, and areas of unstable soil or local steep areas should be planted with legume inter-row crops to assist in stabilizing the site and preventing erosion. Legume inter-row cropping also helps to improve the structure of the top soil, recycle other nutrients and reduce leaching losses significantly. The benefits of a legume inter-row cover are presented in **Annex B1.4.2**.
- o Do not remove stumps, roots, small wood residues, soil, etc. i.e. clear only the above ground biomass, obtain clear planting spots*. (*approximately 1,400 per hectare)
- o In terms of infrastructure development, it is important to:
 - Keep the main forest roads and secondary roads to 6 m or less in width.
 - Use the old skid trails for access to plantation. They should not exceed 4 m in width.
 - Keep the total area for roads, skid trails and landings of about 12 % or less in the designated planting area.
 - Reuse old campsites, if possible and the camp area should not exceed 0.4 ha (50 m x 80 m) in size.
- o For establishment of forest plantations on slopes from 20 to 25 degrees slope, i.e. the areas designated for industrial tree plantation (about 12% of the Project Area or 13,000 ha – see **Table 3.3.2**), the following mitigating measures should be adopted:
 - Manual site clearing, consisting of felling residual trees, cutting them into small-sized pieces and piling in windrows between rows of planted trees.
 - Maintain natural ground cover vegetation and bushes with a height up to 0.5 m.
 - Use tractor equipped with rear-mounted ripper attachment, to break up heavily compacted areas—roads, landings, skid-trails—in order to ensure tree growth on these areas. Cover crops shall be planted immediately after ripping to reduce soil erosion.

5.4.2 Control of Soil Compaction

In order to minimise soil compaction and the associated loss of permeability, which leads to limited plant growth, which again may lead to sheet erosion it is recommended to follow closely the relevant procedures for land clearing and plantation management.

These procedures, for which standard guidelines are issued from national as well as international forestry institutions, all aim at reducing the area subjected to compaction by heavy machinery and subsequent alleviating the problems by deep tillage if they occur.

In short, the procedures include pre-planned skid tracks, choice of light machinery, extensive use of winches and keeping a layer of debris on the skid tracks. Rehabilitation of compacted or barren soil is advocated to be done through the afore mentioned deep tillage and/or propagation of hardy cover crops.

5.4.3 Soil Organic Matter

In order to maintain a high level of organic matter in the soil, on-site natural decomposition of all un-commercial debris is recommended. The use of organic compost from mill waste and EFB is part of this recommendation.

Recent experience, e.g. in the nearby FMU 25 has shown positive results from planting forest species in the debris, thus maintaining an even layer of organic matter over the area.

In addition, zero burning method of land preparation where cleared vegetation is left in the interrows to decompose to enrich the soil with organic matter and recycle plant nutrients should be encouraged.

5.4.4 Managing Human-Animal Conflict

Elephants

The Project Proponent must quickly establish electric fencing around the proposed Project site. The eastern part of Benta Wawasan I and southern part of Benta Wawasan IIC are unlikely to face this problem. However, it is difficult to predict where and when the elephant will strike. A reliable elephant control unit that will monitor the animal movement. The Project Proponent must allocate fund and be ready to install electric fence if elephant problem appear to be serious concern.

Orangutan

Orangutans can be captured and relocated easily. They are fully protected under Schedule I, Part I of the WCE 1997. Killing of orangutans can lead to upon conviction a mandatory jail term of 6 months and not more than 5 years. Only patrolling to detect these animals and subsequent physical chase may discourage the Orangutans from raiding the plantation and thus avoid the potential conflict.

Wild Pigs

Short-term control has been attempted by scaring the pigs, using crackers which sound like gunshots. These are made from potassium chlorate and arsenic orange ($\text{FeS}_2 + \text{FeAs}_2$) placed on posts and activated by an encroaching pig.

Apart from physical protection by fencing whole areas or individual crop trees only hunting is left in the management of the wild pigs. In a properly managed plantations and good conservation practices, wild pigs can bring extra revenue to the management. Hunters can come to shoot pigs for a fee at the same time help in controlling the pig population.

Porcupines

To overcome this plantations management puts galvanized zinc collars around the palms. This is an effective method. To capture porcupine, the technique is to put some food (sweet potatoes) in the nylon fertilizer's bag. The animal enters the bag only to get its spikes stuck to the bag when retreating backward.

Porcupine is protected under Schedule II of the WCE 1997. A permit can be obtained from SWD to hunt or kill them.

5.4.5 Biomass Management

The total biomass that is expected to be generated from the oil palm plantation development is estimated to be approximately 14.8 million tonnes following salvage logging, 880,000 tonnes following harvesting and 8 million tonnes at the end of the 30-year cycle. The industrial tree plantation development, on the other hand is expected to generate a total of approximately 2.4 million tonnes of biomass.

The plant biomass should be fully utilized before removal or windrowed. Logs can be used for on-site or local construction.

Unfortunately, there is at present no pulp mill in Sabah that could utilise the remaining biomass or part thereof. Neither will the biomass from a land clearing constitute any suitable resource for export of chips. The only management option on larger scale is thus natural decomposition, which will release nutrients slowly to the benefit of the new crops.

During clearing, the biomass may also function as cushion against skidding and other transport by being allowed to cover trails and other transport ways.

Oil Palm Waste Products

For this development, the Project Proponent has proposed to use the concept of composting. The concept is to convert or utilize all the mill waste products to give zero waste – zero discharge to the mill using AsiaGreen compost system.

Compost produced from the system is applied back into the oil palm field as a source of nutrients, and organic matter.

The compost will provide saving from reduction in inorganic fertilizer inputs, provide more balance fertilizer inputs, and more sustainable agriculture as organic matter is introduced into the soil.

The mill with zero waste discharge will be environmental friendly and the estate with less inorganic fertilizer inputs will also be more environmental friendly. See **Chart 5-1** for the composting process.

5.4.6 Fertiliser Application and Pests and Diseases Management

In fertilizer application and pests and diseases management, the following must be observed:

- Correct timing of application

Fertilizers, pesticides and weedicides should not be applied during the wet season or before a downpour as this will result in surface run-off. This will reduce unnecessary loss which but also contribute to minimising pollution of the environment. Spraying should avoid windy conditions.

- Split application of fertilizers

Fertilizers should be applied in split doses according to crop requirement for more efficient uptake and reduce loss through volatisation, surface run-off and water leaching.

- Judicious use of pesticides

Frequency, dosage and timing of chemical application should be closely monitored. The volume of spraying solution can be reduced by use of Controlled Droplet Applicator (CDA), Very Low Volume (VLV) or Ultra Low Volume (ULV) applicator. Trunk injection is an alternative to consider as it has practically no impact on the environment. See **Plate 5-15**.

Chemicals used should be approved by the Pesticide Board. More environmentally friendly chemicals should be chosen. Avoid more persistent or non-biodegradable chemicals. Less toxic insecticides and specific target pesticides are preferred over broad spectrum ones to avoid killing predators and parasites. Biological formulations, such as *Bacillus thuringiensis* (Bt) and organic compounds (e.g. neem) should be preferred over synthesised chemicals.

Chemicals for pest and disease control should be judiciously applied when the outbreak has reached threshold level. Whenever possible biological method of control should be considered. Host plants of natural enemy of pests should be encouraged or conserved to build up their population. In some cases, e.g. in controlling bag worm, hand picking the pest in the nursery may be possible.

Integrated Pest Management (IPM) is defined by Oudejans(1991) as: "A pest management system that, in the context of the associated environment and the population dynamics of the pest species, utilizes all suitable techniques and methods in as compatible a manner as possible and maintain the pest population at levels below those causing economic injury". In IPM, the biological and ecological understanding serves as a platform for the choice and correct use of the physical, cultural, chemical and biological control methods.

Biological control is currently gaining much acceptance and is slowly becoming an important component in IPM programmes in oil palm plantations.

Biological control of weeds

For weedicides circle weeding is done in preference to blanket spraying. Maintaining a selective ground cover in the inter-rows reduces cost, and provides host plants for predators to thrive.

Animals can also be used in biological weed control. Studies in Malaysia showed that sheep browsing could be used effectively at a stocking rate of 15 to 17 ewes/ha in immature palms infested with *Asystasia*. Sheep grazing can eradicate *Asystasia*, *Mikania*, *Mimosa*, *Imperata* and ferns, also showing good profitability, with one estimate of 56%. Controlled grazing with cattle, rotating them between plots at intervals of 90 to 120 days, does not eliminate the need for palm circle weeding or selective weeding for noxious weeds, but reduces weeding frequency. In one long-term evaluation, weeding costs were reduced by about 30%, with labour requirement 39% less. However, use of sheep or cattle in this way is not commonly practiced in Malaysia. If inclusion of these animals is to be considered, the practice must be taken seriously and done properly to be effective and without endangering yield from the main crop. This applies particularly to over-stocking and use of controlled, systematic grazing.

Biological control of small mammalian pests

Predators of small mammals such as snakes and barn owls should be protected. Experience gained in Klias Estate/Settlement Scheme, Sabah indicated that barn owls (*Tyto alba*) can be successfully introduced to areas outside Peninsular Malaysia. Rat attacks on FFB were significantly reduced to an acceptable level after the introduction of the birds without the need to carry out poison baiting. The owls are well adapted to the new environment and are multiplying as indicated by 50 to 60% occupancy of nest boxes built for them.

The role of barn owls in rat control is very important as an environmentally friendly biological control method which avoids poison baits that will contaminate the environment and kill other natural wildlife predators which feed on the dead rats.

The bird is readily accepted by the people as they do not prey on domestic animals such a chicks kept by kampung folks. Their impact on other natural predator needs to be monitored.

It is important to note that no new animal species should be introduced into the area without the sanction and guidance from the Sabah Wildlife department.

Integrated pest control or biological control methods will reduce the use of poisonous pesticides.

However, where use of agrichemicals is unavoidable, they should be stored properly whereby storage facilities should be built. The store should be sited away from drains, streams, rivers and other water bodies to avoid water contamination.

Other non-specific pest and diseases management include maintenance of areas of natural vegetation to be maintained next to plantation. This would serve as a green belt for ecological balance by being a reservoir of natural enemies to combat insect pest outbreaks. The riparian reserves and other buffers mentioned in the earlier sections will also serve this purpose.

5.4.7 Fire Prevention and Control

The Project Proponents should adopt the following precautionary measures, aimed at minimising fire risk.

- o Each plantation area should form a forest fire team consisting of permanent project staff. This team will be responsible for planning and implementing all aspects of fire prevention, detection and suppression. Besides, this team should be well-equipped, trained and mobile in constant state of readiness to suppress fires quickly before the impact covers large areas.
- o All project staff and workers, as well as local community leaders, should be made aware of their responsibilities related to fire safety by participating in regular training exercises and demonstrations. Besides, it is advisable to conduct regular public awareness campaigns in settlements within and adjacent to Project area.
- o Control public access to oil palm and forest plantation areas. Use of gates to close roads leading to non-active areas is recommended. In the event of fire, the site should be closed to public and all operations in the forest should be curtailed.
- o Employ topographic features as planting block boundaries. Stream beds, ridges, etc. are easier to control spread of fire than straight line boundaries. The same topographic features are used for marking logging coupes and blocks (see **Sections 5.2.3 and 5.2.5**).
- o Develop and maintain fire-breaks (50-m wide strips of natural forest or permanent green, non-flammable ground cover) around the perimeter of plantation area. Firebreaks should follow natural topographic features (ridge-top, stream), or forest roads, to stop the spread of fires from one cluster of planting blocks to another. For example, the protected forest on the ridges from the Brantian-Tatulit VJR northwards to BW1/00 together with the riparian reserve along Sg. Brantian will be the first break in Benta I area (see **Figure 5.2.1**). Another break will be the ridge area above the 650-m elevation in BW2/01, BW3/01 and BW4/98 and the riparian reserve of Sg. Geminchau (see **Figure 5.2.1**). The river reserves of Sg. Kalabakan and Sg. Anjeranjermut will form breaks between the northern and southern part of Benta IIC. Sg. Kuamut will be the natural barrier separating the Project area from forested areas to the north. Firebreaks should be accessible to facilitate access by fire fighting equipment and personnel.
- o Provide the following equipment and facilities at each of the administrative plantation areas.
 - Permanent Water Supply Points such as streams and rivers with vehicle access and selected water holes with helipads for aerial fire fighting.
 - Mobile Water Tankers - Two 500-liter slip on water tanks, pump and hose reel units which can be fitted onto a normal forest pickup truck. Two 6,000 litre

mobile water tanks which may be towed by a 4-wd tractor and which is also fitted with a pump, suction hose and hand tools.

- Vehicles fitted with radios or telephones for normal plantations duties. Appropriate hand tools such as fire axes, shovels, hoes (cangkul), beaters, back-pack sprayers, etc.

5.5 Socio-Economics Consideration

5.5.1 Foreign Workforce

The recommended control measures to address the impacts that may be created by foreign workforce are (refer to **Section 5.2** also):

Employment

The Local Authority and the Project Proponent will encourage local recruitment, as this will reduce costs to the contractor. For all employment issues, the Project proponent shall cooperate with government agencies to ensure all legal aspects of employment are upheld by himself as well as by his (sub)contractors.

- Where possible, locals should be given the priority for employment. A more attractive and competitive employment scheme may attract the local to take up employment in the Project (e.g. more attractive daily rate, staff benefits such as insurance, leave, traveling allowance, accommodation, staff loan, etc.).
- Where skills are lacking, specific training should be given (e.g. plantation management, operating of machinery and equipment).
- Employment of foreign labours must be through proper channel with proper documentation in compliance with the Immigration and Labour Rules and Regulations and monitoring of these workers must be strictly enforced. A clause of this requirement must be stated in the contract document between the Project Proponent and their contractors and sub-contractors.
- Proper repatriation program should be instituted at the end of the contract to ensure smooth and legal departure. This would also help to mitigate against possible squatting problems.
- All workers must go through medical check up before being employed with special emphasis on communicable or infectious diseases especially malaria, other mosquito-borne disease and tuberculosis (TB) upon employment and consequently every six months. This is particularly important for all foreign workers. The risk of foreign workers bringing in malaria and TB into the Project area is high. Suspected persons should not be employed and should be directed to the relevant health authorities for further action. The same should be applied for suspected sexually transmitted disease (STD) carrier.
- The Project Proponent shall provide medical facilities within the plantation to avoid overcrowding in the local medical centre.

Security

- Employee base camp should not be located nearby any local settlements in the area and provided with all the necessary infrastructure and facilities to avoid pressure on existing infrastructure, utilities and amenities of the area.
- Draft environmental specifications for contractors, ensuring that work-site camps, construction works, and the lifestyles of their workers do not have any negative impacts on the social, cultural and economic activities of nearby communities.
- The Project Proponent shall co-ordinate with the Police, Army, Immigration Department and other relevant government departments in monitoring activity in these camps and area near the Sabah/Indonesia border.
- Setting up of checkpoints at strategic location and regular patrolling by the army or police would help to monitor any illegal activities in the area.

Camp Hygiene

- Camp should be located at least 40 meters from the nearest stream/rivers.
- Camps must be supplied with potable water obtained from running streams, rainwater or wells.
- Water storage tanks should be properly screened to prevent the breeding of mosquitoes.
- To further prevent mosquito-related diseases, the workers' quarters should be adequately covered with protective netting at the windows and other ventilation open spaces or corridors.
- Camp areas should be well drained so that water does not pond or create mosquito breeding areas.
- Sewage should be discharged so it does not enter the catchment of drinking water supplies/intakes, into a stream or into the stream at any point where it may cause health risk to camp personnel or nearby communities.
- Provide refuse disposal areas at least 30 meters from any waterbody or stream/river. Cover with soil at least once a week.

5.5.2 Infrastructure, Facilities and Amenities

The Project Proponent and its contractors shall ensure that proper base camps equipped with all the basic infrastructure, facilities and amenities is available for its workforce to avoid putting pressure and disruption of the existing infrastructure, facilities and amenities of Kalabakan. These may include but not limited to water supply, power supply, medical clinic, school (where appropriate), fire protection services, security services, transportation, spiritual facilities and recreational.

5.5.3 Water Resources Degradation and Siltation

- Good site development practices e.g. conservation of riparian reserves, soil erosion minimisation, etc., would help to minimise adverse impacts on river water quality otherwise alternative water supply should be considered.
- Skid/storage tank, if any, must be constructed on stable ground with bunding and sited at least 50 m away from any waterway.
- The Project Proponent shall cooperate with the communities and local authorities on solving water supply issue of the directly affected communities. This may include identification of sub-catchment for protection, alternative water supply or modification to its operation and development practices.
- Water quality monitoring of affected rivers shall be carried out by the Project Proponent on a regular basis to ensure that the implementation of Project do not contribute further to the pollution.
- The Project Proponent will work with the Health Department and Environmental Protection Department to protect against bacterial and viral contamination of surface waters.

5.5.4 Impact on Community Use of Forest Resources

- o Prohibits workers of the plantation from hunting activities either within or outside the Project site. The use of *tuba*, insecticides or explosive for poisoning fishes should be strictly prohibited at the affected rivers within and at the surrounding estate areas. Workers caught using this technique will face severe fine such as immediate termination of their employment and work permits for the contract workers.

5.5.5 Reducing Dust Problems

- o **Within** the Project area:
 - Ensure efficiency of engine. Vehicles should be well maintained to reduce exhaust smoke emissions. Where possible, diesel vehicles should have green engine, which emits cleaner exhaust.
 - Gravelling or bitumenising of roads around the plantation office, village and living quarters would reduce the dust problem.
 - Introduce tree-covered buffer zone around plantation village to reduce dust in the dwelling area.
- o **Outside** the Project area:
 - The Project Proponents should inform the logging truck drivers to reduce their speed when approaching the Luasong Forestry Centre, Kg. Fajar Harapan Luasong and other human settlements to reduce dust generation.

During the dry season, the stretch of road crossing the LFC shall be wetted to reduce dust polluting the air, if possible.

- Install road sign and establish speed humps near the settlement areas (at the entry points) and impose speed limit of 20km/hr on plantation roads to reduce churning up of dust.
- Re-adopt the use of washing trough before entering the LFC settlement area.

5.5.6 Preservation of Landscape and Ecotourism Opportunities

Since the proposed OPP and ITP development do not directly affect the Danum Valley and Maliau Basin Conservation Areas in terms of their conservation plans, no mitigating measure is necessary. However, to maintain the aesthetic value of the natural forest en-route to Maliau Basin and to mitigate the loss of otherwise attractive landscapes, it is recommended that in the interest of domestic as well as international tourism:

- o A 1000-m green belt on both sides of the Kalabakan-Sapulut road, Sg. Anjeranjermut and Sg. Kalabakan is protected from Benta IIC towards Maliau Basin.

To further complement the Maliau Basin tour, it is suggested the following features along the route be conserved:

- o The deep beautiful gorge (see **Plate 5-8**) next to the Kalabakan-Sapulut road formed by Sg. Anjeranjermut, specifically at the boundary of BW9/00 and BW9/01, together with the residual forest patches along the road can provide an initial introduction to tropical forest, with backdrop of G. Luis on the south and the hilly ridge forest of BW9/01. Scenic stops could be constructed and educational signs are prepared to educate the tourists or to have a break.
- o A unique mud volcano / salt spring near to BW9/01 and BW9/00 are protected (see **Section 5.3.1**). A path of 1-m width leading to the site is proposed to allow visitors access. However, the number of tourist to this mud volcano should be restricted to protect the animals' access to the area.

5.5.7 Road Safety

It is envisaged that Kalabakan area will be the focal point for products harvested from the plantation areas (timber or oil palm), thus it is recommended that:

- o Proper traffic signboard be erected at appropriate spots e.g. at T-Junctions, approaching settlement areas, base camps, stream crossings, corners, etc.
- o Establish speed limit along the main road especially near the settlement areas (at entry points).
- o No transportation of logs or FFB shall occur after 6 p.m. (dusk) and before 6 a.m. (dawn) to reduce risk to the general public when visibility is poor and to ensure a period of tranquillity for both humans and wildlife.

- All drivers should observe proper traffic signalling during transportation of logs or FFB to allow lighter vehicles to pass/overtake, etc.
- Transportation is prohibited during rainy days to reduce the risk of accidents and further road damage.
- If any section of the road to the site is subjected to damage by the transportation vehicles, repair work should be done immediately.
- Any public complaints must be investigated and appropriate steps taken to settle them as soon as possible.

5.6 Project Abandonment

In case of abandonment, the Project Proponent will be responsible to ensure that the cessation of the Project would be carried out in a responsible manner and a rehabilitation plan would be prepared to ensure the restoration of the environment and safe disposal of any waste remaining.

The purpose of the rehabilitation programme is to restore the Project site to render it stable enough so as not to become a source of environmental repercussions in the future as well as minimising aesthetic and visual impacts. It is also meant to prepare the area for other development or maintained as natural forest. However, the ability of reverting back to the forest condition will depend on the stage when work on the Project is stopped. Following re-entry logging opportunity for natural succession to regenerate can still occur as there are still some residual trees of the original vegetation. Salvage logging will, however, create a greater impact as all trees over 25cm diameter are removed resulting in large openings that change the environment that is conducive to the more shade tolerant species. Once land clearing is started reverting back to forest condition with the origin species will not be possible. Artificial regeneration by planting with appropriate species will create a forest environment over a long period.

Some of the rehabilitation programme proposed for this Project includes:

- Revegetation of cleared areas with fast growing indigenous shrubs and grass.
- Remove all wooden bridge or install blockage into all the logging roads to discourage hunting or unauthorized personnel from entering into the Project area or Yayasan Sabah Management area.
- Remove all the base camps and workshops. All waste remaining must be disposed off safely.
- Re-establish native vegetation to enable the formation of a new ecological equilibrium of the area.
- All remaining structure, machinery and equipment should be removed. Waste generated from the demolition of structure should be properly disposed off or buried.

5.7 Operational Summary

While the sections above looks at mitigating and environmental management issues seen from the point of view of benefits, this section will summarize the recommendations according to the Project planning sequence and activities in the

field. Detailed argumentation for each of the recommendations below is included at relevant places in the text above.

While the sections below may include some recommendations exceeding above requirements, these requirements remain in force as minimum requirements and are part of the mitigating measures recommended by this assessment.

5.7.1 Areas to be excluded from plantation development

Boundaries between areas to be developed for oil palm or industrial tree plantation and areas to be excluded and/or protected otherwise must be clearly marked on operational maps as well as in the field.

It is the responsibility of the Project Proponent to ensure his workers and sub-contractors are fully aware of these boundaries and understand their implications.

5.7.1.1 Areas of altitude exceeding 900 m a.s.l.

For the purpose of soil and water protection as well as preserving biotopes and refuges for wildlife, all areas exceeding an elevation of 900 m a.m.s.l. shall be excluded from plantation development including infrastructure such as roads, storage facilities and buildings. The prohibition of forestry or development activities and protection of the whole ridge at BW 9/00), with its highest peak Gunung Nakopan at 1,312 m or 3,998 ft, is thus recommended (see **Figure 5.2.1** and **Plate 5-7**).

No activities shall take place within areas exceeding 900m a.m.s.l.

5.7.1.2 Slopes exceeding 25⁰

Slopes exceeding 25⁰ are all excluded from forestry or plantation development under Sabah legislation. This exclusion has been repeated in the permit for plantation development for this Project by the Sabah Department of Forestry. The protection of steep slopes will to some extent also serve as ecological reserves.

The steep ridges in BW 1/01, BW 2/01 and BW 3/01 are recommended for protection as one, contiguous or interlinked zone. See **Figure 5.2.2** and **Plate 5-6**.

The ridge protection along BW 9/00 and BW 9/02 should be contiguous to allow for the establishment of a wildlife corridor.

The ridge protection along BW 2/99, BW 3/00, and BW 4/00(A) should be contiguous to allow for the establishment of a wildlife corridor linking Danum valley to the Brantian-Tatulit VJR.

No development activities shall take place within areas exceeding 25⁰ slope.

5.7.1.3 Riparian reserves

For the purpose of protection of water quality and quantities, river banks and biodiversity riparian reserves are proposed as listed in **Table 5.7.1** below.

Table 5.7.1: Recommended Riparian Reserve for the Proposed Oil Palm Plantation

Stream Width	Minimum width of Riparian Reserve (x2)
<3m	5 m
>3m – 20 m	30 m
>20m (Sg. Tiagau)	100 m
Special consideration:	
Sg. Brantian (up to VJR)	250 m
Sg. Kalabakan & Sg. Anjeranjermut	1000 m
To be maintained:	
Sg. Kuamut	5 km

Note: In the case where “high risk” area is located adjacent to the river, the width of the riparian reserve should be 1.5 times bigger than the above recommendation (or whichever is bigger) (see **Figure 5.2.1 to **Figure 5.2.2**).*

The table above has taken the recommendations from the SEIA 2002 into consideration but has been revised in accordance with new experience.

No activities shall take place within the riparian reserves other than road crossings when necessary.

Watercourses and protected areas shall at all times be kept clear of logging debris and other material brought into these areas by water, gravity or other means.

5.7.1.4 Wildlife corridors

Wildlife corridors are proposed established by:

- Joining the river buffers in BW 3/02, BW 10/02, BW 10/01, BW 12/04, BW 12/01 and BW 12/03 forming the linkage with Sg. Imbak and the forest in the north.
- The forest link between INIKEA and SUAS to the wildlife corridor and Maliau Basin must be maintained and managed as natural forest.

The wildlife corridors shall be kept under natural forest management. Normal sustainable forest management practices are possible within these areas.

5.7.1.5 Roadside buffers

The system of 100m-road buffer from **Luasong to Sg. Kuamut** main road (**Plate 5-10**) should be the standard for all other main access roads.

5.7.1.6 Boundary buffers

- A boundary buffer of 100 m, excluded from all activities, is proposed along the VJRs. Such buffer may overlap with riparian reserves but does not replace these, e.g. the 250 m river buffer at the Brantian river.
- The boundary to the Kuamut river and its 5 km buffer zone is assumed permanent and excluded from this development area.

5.7.1.7 Mud-volcanoes and salt licks

It is proposed that the mud volcano and salt licks be incorporated into the 1000-meter riparian reserve involving the Kalabakan and Anjeranjermut rivers, and the Kalabakan/Sapulut road. This proposal is a revision of the proposal made in the SEIA 2002.

5.7.1.8 Archaeological and cultural sites

While no archaeological sites or sites of specific cultural value have been identified within the Project area during this SEIA, such sites shall be reported to the Sabah State Museum if discovered during Project development. The Project Proponent shall in such case cooperate with the Museum in order to install protective measures as requested.

5.7.2 Environmental management or mitigating measures during Land Clearing

The development plan approved by the Sabah Forestry Department permits clearing of slopes 0-25 degrees for the purpose of oil palm development on slopes 0-20 degrees only and for the purpose of industrial tree planting on slopes 20-25 degrees only.

5.7.2.1 Phased and directional development

The phased development as proposed by the Project Proponent is recommended to be further developed so that clearing shall follow natural sub-catchment boundaries and be worked in a sequence that will allow wildlife to leave the area and take refuge in suitable areas.

5.7.2.2 Pre-clearing methodologies

Upon completion of timber extraction, following activities should be implemented:

- Rehabilitate unused or abandoned stumping points if planting has not commenced. These should be slightly tilled and immediately covered by planting indigenous fast-growing creepers or cover with unused or discarded tree bark (from the landings) to reduce surface erosion.

- The landing sites, for example in **Plate 5-3** to be rehabilitated shall be cleaned from non-biodegradable material and all solid waste shall be removed, including oil/fuel drums and steel wire.
- Install cross-drains in on abandoned roads, etc. with slopes >10% (5 degrees) to ensure water runoff is channelled off the road and into surrounding forest.
- Cross drain spacing should be proportional to the slope of the road i.e. steeper gradients have more frequent cross drains. Generally "cross-drains" on roads of moderate slope (10%) should be spaced at 30-50 meter intervals. Cross drains prevent soil erosion and loss of culverts and bridges, preserving roads for future use.

5.7.2.3 Land clearing methodologies

- Clearing work shall within the clearing blocks progress from the highest areas towards lower ground
- Mechanical clearing may be allowed provided light tractors are used. It is important that dozer blades be kept above ground level in order to leave top soils as intact as possible. Should this prove to be impossible, earth moving dozer blades shall be replaced with appropriate rakes or other specialised clearance attachments.
- Minimum clearance shall be carried out, i.e. only major debris shall be windrowed whereas minor debris, roots and broken stumps shall be left in place for natural decomposition to the extent plantation development can still take place.
- In areas for industrial tree plantation planting in thick debris shall be attempted.
- Obnoxious re-growth from larger stumps may be poisoned later, using 20% c.p trichlopyr in diesel oil.
- Areas cleared for vegetation and debris shall immediately be planted with leguminous cover crops. This requirement is valid for all areas, both areas designated for oil palm development and areas designated for industrial tree plantation
- For areas designated for industrial tree plantation maintain natural ground cover vegetation and bushes with a height up to 0.5 m.
- Dominant drainage paths on cleared areas shall be rehabilitated with fast growing creeper plants to prevent formation of soil erosion channels.
- Use tractor equipped with rear-mounted ripper attachment, to break up heavily compacted areas—roads, landings, skid-trails—in order to ensure tree growth on these areas. Cover crops shall be planted immediately after ripping to reduce soil erosion.

5.7.3 Infrastructure Development

5.7.3.1 Roads and trails

Gradient

- Road grades should not exceed 8° (15%) in order to avoid excessive surface erosion.

Filter strips and other drainage considerations

- Filter strips along the roadsides should be reserved to help to reduce siltation of river systems and to prevent an increase in the intensity and frequency of peak flows into the river system downstream of the land clearing activities (refer **Plate 5-2**). The exact size, shape and locations of filter strips have to be determined based on the road alignment but for effective filter strips, the following details are recommended:
 - Filter strips together with contour lines, drainage system (river system and road drainage), road and skid trail network be shown on maps for each region in the scale of 1:25,000 and the maps should be submitted together with the detailed design of the drainage and the road-side filter strips as part of the detailed forest plantation management plan.
 - Filter strips should be designed and dimensioned to withstand a 1:10 year peak flow with minimal local erosion and mass calving.
 - Discharge from road drainage should be introduced to filter strips using weep drains or infiltration fields to prevent soil erosion.
 - Filter strips should not be located in:
 - Areas with ground slope of more than 15 degrees and less than 3 degrees;
 - Areas with unsuitable soil for filter strips. The type of soil is considered unsuitable if the thickness is less than 0.3 m;
 - Areas where the average infiltration rate of the water saturated soil is less than 30 mm/h;
 - Areas where the soil shows a water restricting layer at a depth of less than 0.6 m;
 - Areas where the soil is of similar type; or if the soil shows any indication of permanent wetness.
 - Areas with high risk of land slide occurrence;
 - Areas with springs or perched ground water;
 - Areas at the head of rivers and creeks; or
 - Areas within a zone of convergence flow lines (slope gradients).
 - If establishment of filter strip is not possible at certain area, the use of silt traps is encouraged at all drainage outlets, prior to discharge into streams to reduce

suspended sediment loading. Maintain and empty silt traps regularly to avoid clogging. Do not dispose silt from silt traps adjacent to the silt traps, rivers, streams, creeks or any drainage.

- Table drains, culverts and other drainage structures such as those needed to channel run-off water to road-side filter strips (see **Plate 5-2**) prior to entry into streams should be installed concurrently with road construction.
- Table drains should be provided and roads should be appropriately cambered, crowned, in-sloped or out-sloped as appropriate to the circumstances to ensure water drains from road surfaces.

Spoil/Maintenance

- Excess spoil should not be pushed over the edges of road embankments during road maintenance. Spoil should be compacted "*in situ*", or transported to disposal sites away from the road, thus minimizing erosion of roads and sedimentation of waterways.

5.7.3.2 Bridges and culverts

- Roads should not cross water channels such as drains, streams or rivers unless proper crossings such as culverts or bridges are installed.
- Machinery should, as far as possible, avoid operating in the streams during construction.
- All culverts should have a cut-off wall to prevent erosion under the pipe.
- The head and outlet walls of culverts should be stabilized with log- or stone-pitched walls.
- Culvert gradients should ideally be 1-3%.

5.7.3.3 Camps, workshops and service installations

Riparian reserves must be respected within camps.

It must be ensured all inhabitants have access to pit latrines or latrines that are deemed safer, e.g. septic tanks. Such latrines must be constructed not less than 20 m from riparian reserves.

Oil, grease and fuel must be stored at areas protected against leakage not closer to any protected area or buffer zone than 50 m.

5.7.4 Hunting

It is proposed that it becomes a standard condition for employment to refrain from hunting unless this is part of project activities, i.e. wildlife control. Also, staff shall be

banned and keeping of hunting dogs in the camps. Hunting dogs presently in the area shall be removed.

As a result, it is recommended the Sabah Wildlife Department refrains from issuing hunting permits contravening these recommendations.

5.7.5 Operation and management of oil palm plantation

5.7.5.1 Planting

- Planting shall take place not more than 3 months after clearing the areas.

5.7.5.2 Terracing

- It is generally recommended that land slopes between 12° to 20° should be terraced for oil palm cultivation. Terraces will result in better field, improved access, water retention etc.

5.7.5.3 Use of agrochemicals

The Project Proponent should adopt and publish a policy of minimizing the use of agrochemicals by:

- As far as possible using integrated pest management (IPM), which in many cases replaces synthetic pesticides with organic compounds, natural predators or other natural agents that controls pest populations, e.g. parasites and virus.
- Refrain from systematic and periodic application of pesticides, but restrict the use of pesticides to controlling actual, identified pests and diseases.
- The use of split application of fertilizers.
- Train staff in correct application of agrochemicals including issues such as correct timing (climatic and biological factors), dosage, and means of application, safety regulations.
- In case there is a choice, prefer biological and organic means and formulations over synthetic chemicals.
- Storage facilities for agrochemicals shall strictly follow government guidelines

It is further suggested, the Project Proponent experiments with the use of large herbivores such as cattle, sheep and goats for the control of weeds.

5.7.5.4 Nursery operation

Irrigation systems shall be designed so excess water containing fertilizers or other agro chemicals do not flow into the natural waterways.

5.7.5.5 Waste management

For this development, the Project Proponent has proposed to use the concept of composting. The concept is to convert or utilize all the mill waste products to give zero waste – zero discharge to the mill using AsiaGreen compost system.

Compost produced from the system is applied back into the oil palm field as a source of nutrients, and organic matter.

The compost will provide saving from reduction in inorganic fertilizer inputs, provide more balance fertilizer inputs, and more sustainable agriculture as organic matter is introduced into the soil.

The mill with zero waste discharge will be environmental friendly and the estate with less inorganic fertilizer inputs will also be more environmental friendly. See **Chart 5-1** for the composting process.

Scheduled waste

Scheduled waste such as agrochemicals, pesticides, paints and solvents shall be stored and disposed of in accordance with Department of Environment regulations and to the satisfaction of the local authorities.

Fuel, Oil and grease

Fuel, oil and grease may neither be stored nor disposed of closer than 50 m to riparian reserves or other protected areas such as conservation areas and water catchments. All possible precautions shall be taken to avoid any spillage or seepage of such substances into waterways, however small.

Other 'mechanical' waste

Non-toxic waste from workshops and other discarded mechanical parts, incl. steel wire shall, if not disposed of legally outside the concession, be buried not less than 0.5 metres underground and not less than 30 m from protected areas such as riparian reserves, conservation areas and water catchments.

Human waste

Human waste may not be disposed of in waterways.

All permanent and semi-permanent camps shall be provided with pit latrines as a minimum. Such latrines may not be closer than 20 m to riparian reserves and may not be constructed within protected areas such as conservation areas and water catchments.

Other domestic waste

Domestic waste shall, if not removed from the concession area, recycled or composted, be collected in pits. The waste shall be covered with minimum 30 cm earth once a week. The pit shall not be filled closer than 75 cm to the soil surface.

Pits for domestic waste shall be at least 30 metres from riparian reserves and may not be constructed within protected areas such as conservation areas and water catchments.

5.7.6 Operation and management of industrial tree plantation

5.7.6.1 Planting

Planting shall take place not more than 3 months after clearing the areas.

5.7.7 Fire prevention and Control

The Project Proponent should adopt the following precautionary measures, aimed at minimizing fire risk.

Each plantation area, whether industrial tree plantation or oil palm plantation, should form a forest fire team consisting of permanent project staff. This team will be responsible for planning and implementing all aspects of fire prevention, detection and suppression. Besides, this team should be well-equipped, trained and mobile in constant state of readiness to suppress fires quickly before the impact covers large areas.

All project staff and workers, as well as local community leaders, should be made aware of their responsibilities related to fire safety by participating in regular training exercises and demonstrations. Besides, it is advisable to conduct regular public awareness campaigns in settlements within and adjacent to project area.

Control public access to oil palm and forest plantation areas. Use of gates to close roads leading to non-active areas is recommended. In the event of fire, the site should be closed to public and all operations in the forest should be curtailed.

Employ topographic features as planting block boundaries. Stream beds, ridges, etc. are easier to control spread of fire than straight line boundaries. The same topographic features are used for marking logging coupes and blocks (see **Sections 5.2.3 and 5.2.5**).

Develop and maintain fire-breaks (50-m wide strips of natural forest or permanent green, non-flammable ground cover) around the perimeter of plantation area. Firebreaks should follow natural topographic features (ridge-top, stream), or forest roads, to stop the spread of fires from one cluster of planting blocks to another. For example, the protected forest on the ridges from the Brantian-Tatulit VJR northwards to BW1/00 together with the riparian reserve along Sg. Brantian will be the first break in Benta I area (see **Figure 5.2.1**). Another break will be the ridge area above the 650-m elevation in BW2/01, BW3/01 and BW4/98 and the riparian reserve of Sg. Geminchau (see **Figure 5.2.1**). The river reserves of Sg. Kalabakan and Sg. Anjeranjermut will form breaks between the northern and southern part of Benta IIC. Sg. Kuamut will be the natural barrier separating the Project area from forested areas to the north. Firebreaks should be accessible to facilitate access by fire fighting equipment and personnel.

Provide the following equipment and facilities at each of the administrative plantation areas.

- Permanent Water Supply Points such as streams and rivers with vehicle access and selected water holes with helipads for aerial fire fighting.
- Mobile Water Tankers - Two 500-liter slip on water tanks, pump and hose reel units which can be fitted onto a normal forest pickup truck. Two 6,000 litre mobile water tanks which may be towed by a 4-wd tractor and which is also fitted with a pump, suction hose and hand tools.
- Vehicles fitted with radios or telephones for normal plantations duties.
- Appropriate hand tools such as fire axes, shovels, hoes (cangkul), beaters, back-pack sprayers, etc.

5.7.8 Scenic changes

To mitigate the loss of scenic values en route to the Maliau Basin, the deep gorge next to the Kalabakan-Sapulut road formed by Sg. Anjeranjermut, specifically at the boundary of BW9/00 and BW9/01, together with the residual forest patches along the road should be preserved and promoted to provide an initial introduction to tropical forest, with backdrop of G. Luis on the south and the hilly ridge forest of BW9/01. Scenic stops could be constructed and educational signs are prepared to educate the tourists or to have a break.

Also, the mud volcano / salt spring near to BW9/01 and BW9/00 should be protected (see **Section 5.3.1**). A path of 1-m width leading to the site is proposed to allow visitors access. However, the number of tourist to this mud volcano should be restricted to protect the animals' access to the area.

5.7.9 Abandonment

In case of abandonment, the following mitigation measures should be observed:

- Revegetation of cleared areas with fast growing indigenous shrubs and grass.
- Remove all wooden bridge or install blockage into all the logging roads to discourage hunting or unauthorized personnel from entering into the Project area or Yayasan Sabah Management area.
- Remove all the base camps and workshops. All waste remaining must be disposed off safely.
- Re-establish native vegetation to enable the formation of a new ecological equilibrium of the area.
- All remaining structure, machinery and equipment should be removed. Waste generated from the demolition of structure should be properly disposed off or buried.

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Table

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