

Forest Management Plan 2

1st January 2005 – 31st December 2014

DERAMAKOT FOREST RESERVE FOREST MANAGEMENT UNIT NO. 19



SABAH FORESTRY DEPARTMENT



SABAH FORESTRY DEPARTMENT

Forest Management Plan 2

DERAMAKOT FOREST RESERVE FOREST MANAGEMENT UNIT NO. 19 SANDAKAN

Period 1st January 2005 – 31st December 2014

Approved by:

SAM MANNAN
Director of Forestry

Dated:11.05.2005

This Forest Management Plan is prepared by:

The Forest Management Plan Division in collaboration with the GIS Section, Forest Engineering Division, Forest Protection Division, Deramakot Forestry Officer, Natural Forest Management Section (Forest Research Center, Sepilok) and Monitoring & Control Division, under the supervision of the Director of Forestry.

Dated: 11.05.2005

Approved by:

**(SAM MANNAN)
DIRECTOR OF FORESTRY DEPARTMENT
SABAH, MALAYSIA**

Dated: 11.05.2005

Table of Contents

Table of Contents		Page
<i>Table of Contents</i>		i
<i>List of Abbreviations</i>		iv
<i>List of Tables</i>		v
<i>List of Figures</i>		vi
<i>Appendices</i>		vi
<i>Executive Summary</i>		vii
PART I - INTRODUCTION		1
1.0	Background	1
1.1	Legal Authority and Period of Operation	2
1.2	Policy Statements	2
1.3	Management Objectives	3
1.4	Legal Framework and Management Guidelines	4
1.5	Management Constraints	5
PART II - GENERAL INFORMATION		6
2.0	Name, Location and Legal Status	6
2.1	Physical resources	7
	2.1.1 Climate	7
	2.1.2 Topography	9
	2.1.3 Hydrology	10
	2.1.4 Managerial Implications of Topography and Hydrology	10
	2.1.5 Geology, Rock and Soil	10
	2.1.6 Managerial Implications of Geology and Soils	11
	2.1.7 Vegetation Types	11
	2.1.8 Wildlife Resources	11
	2.1.9 Managerial Implications of Wildlife Relationships With Natural Forests	13
2.2	Infrastructure	14
	2.2.1 Buildings	14
	2.2.2 Forest Roads	14
2.3	Manpower	15
2.4	Socio-Economic Aspects	16
	2.4.1 Population	16
	2.4.2 Infrastructure	17
	2.4.3 Economic Activity	18
	2.4.4 Land Property	19
	2.4.5 Impact on Forest management	19

2.5	Past Management		20
	2.5.1	Planning	21
	2.5.2	Past Production	21
	2.5.3	Silviculture	22
	2.5.4	Environmental Issues	23
	2.5.5	Forest Protection and Security	23
	2.5.6	Managerial Implications of Forest Protection and Security Issues	24
PART III - FOREST RESOURCE BASE			25
3.0	Forest Stratification		25
3.1	Forest Inventory		26
3.2	Yield Regulation		26
3.3	Annual Allowable Cut		26
3.4	Forest Recreation		31
	3.4.1	Introduction	31
	3.4.2	Natural Attractions of DFR	31
	3.4.3	Potential Products	32
	3.4.4	Management Implications	32
3.5	High Conservation Value Forests (HCVF)		33
	3.5.1	Introduction	33
	3.5.2	Definition of HCVF	33
	3.5.3	Identified HCVFs in DFR	34
	3.5.4	Rationale	34
	3.5.5	Distribution of HCVFs in DFR	35
	3.5.6	Management Implications	37
PART IV - MANAGEMENT PRESCRIPTIONS			38
4.0	Forest Zoning		38
4.1	Conservation Area		39
	4.1.1	Management Objectives	39
	4.1.2	Focus of Management	39
4.2	Timber Production		39
	4.2.1	Net Timber Production Area	39
	4.2.2	Management Objectives	40
	4.2.3	Forest harvesting and Schedule	41
	4.2.4	Continuous Forest Inventory (CFI)	42
	4.2.5	Timber Stand Improvement	42
	4.2.6	Forest restoration	43
4.3	Ecotourism and Forest recreation Opportunities		44
	4.3.1	Objectives	44
	4.3.2	Definitions	44

	4.3.3	Basic requirements for Forest Recreation in DFR	45
	4.3.4	Implementation	49
	4.3.5	Work Plan	49
4.4	Managing HCVPs in DFR		52
	4.4.1	Biological and Ecological Category	52
	4.4.2	Areas Sensitive to Disturbance	53
	4.4.3	Cultural, Ecological, and Economic Significance	54
	4.4.4	Monitoring HCVPs	55
4.5	Community Forestry		55
	4.5.1	Introduction	55
	4.5.2	Community Forestry Objectives	56
	4.5.3	Strategies	56
4.6	Infrastructure Management		58
	4.6.1	Roads	58
	4.6.2	Buildings and Basic Facilities	59
4.7	Forest Protection		61
	4.7.1	Control of Boundaries	61
	4.7.2	Forest Encroachment by Local Communities	61
	4.7.3	Soil Protection and Watershed Management	62
	4.7.4	Wildlife Protection	63
	4.7.5	Fire Protection	63
4.8	Research and Development (R&D)		64
	4.8.1	Introduction	64
	4.8.2	Focus for R&D in DFR	65
4.9	Manpower requirement		68
PART V - BUDGET AND COST PROJECTION			72
5.0	Introduction		72
5.1	Estimated Cost and Revenue		72
5.2	Financial Analysis		72
5.3	Results of Financial Analysis		73
	5.3.1	Returns on Investment	73
	5.3.2	Sensitivity Analysis	74
PART VI - EIA AND FOREST MANAGEMENT STANDARDS			75
6.0	Environmental Impact Assessment		75
6.1	Management Standards		75
6.2	Manpower Requirement		75
PART VII - IMPLEMENTATION AND MONITORING			81
7.0	Responsibility for Implementation		81
7.1	Monitoring and Auditing		81
	7.1.1	Internal	81

	7.1.2	External	81
7.2	Reporting		82
	7.2.1	Responsibility	82
	7.2.2	Reporting Frequency	82
	7.2.3	Reporting Formats	82
7.3	Compartment Register Book		82
7.4	Review		82

List of Abbreviations

AAC	Annual Allowable Cut	HCVF	High Conservation Value Forest
ADFO	Assistant Deramakot Forestry Officer	HQ	Head Quarters
a.s.l	above sea level	ITTO	International Tropical Timber Organization
AWP	Annual Work Plan	Kg.	Kampung
CERKU	Centre for Ecological Research Kyoto University	MC&I	Malaysian Criteria & Indicators
CFI	Continuous Forest Inventory	mm	millimeter
CHP	Comprehensive Harvesting Plan	NFM	Natural Forest Management
Cpt.	Compartment	NGO	Non-Governmental Organization
dbh	diameter at breast height	NTFP	Non-Timber Forest Products
DFO	Deramakot Forestry Officer	PACOS	Partners of Community Organizations
DFR	Deramakot Forest Reserve	PCT	Potential Crop Tree
EIA	Environmental Impact Assessment	R&D	Research & Development
FMP	Forest Management Plan	RIL	Reduced Impact Logging
FMU	Forest Management Unit	SFD	Sabah Forestry Department
FR	Forest Reserve	Sg.	Sungai
FSC	Forest Stewardship Council	SFM	Sustainable Forest Management
GIS	Geographic Information System	TSI	Timber Stand Improvement
Ha	Hectare	VJR	Virgin Jungle Reserve

List of Tables

Tables No.		Page
Table 1	DFR Monthly Total Rainfall for 2002 and 2003 (in mm)	7
Table 2	Rainfall Record of Tangkulap Weather Station showing the average monthly rainfall (in mm) from the year 1991 to 2000	8
Table 3	Road Classification in DFR	15
Table 4	Condition of access road in DFR	15
Table 5	General information of the villages	17
Table 6	Infrastructure available in the villages surveyed	18
Table 7	Economic activities and land property of the villagers surveyed	20
Table 8	Forest strata for DFR as interpreted from aerial photographs 1:17,500 scale	25
Table 9	Inventory results showing number of sound commercial trees ^{ha} - ¹ and their volume in m ³ ha ⁻¹ (given in parenthesis) for individual compartments in DFR	27
Table 10	Calculation of annual allowable cut for the planning period 2005-2014	31
Table 11	Land use classification based on forest functions in DFR	38
Table 12	Net Timber Production Area in DFR	40
Table 13	Harvest schedule for the planning period 2005 - 2014	41
Table 14	Schedule and selected compartments for CFI for the planning period 2005-2014	42
Table 15	Schedule of TSI treatments for the planning period 2005 - 2014	43
Table 16	Forest restoration program 2007 - 2011 in DFR	43
Table 17	Work Plan for Forest Recreation Development in DFR	50
Table 18	Road planning in DFR (2005 - 2014)	60
Table 19	Ground and river patrols for boundary control and surveillance	62
Table 20	Guidelines for mitigating the impact on wildlife populations	64
Table 21	Manpower requirement in DFR 2005-2014	71
Table 22	List of Management Standards	76
Table 23	Mitigation of environmental impact of forest management activities	78

List of Figures

Figures No.		Page
Figure 1	Location of Deramakot Forest Reserve	6
Figure 2	Rainfall Pattern at DFR	8
Figure 3	DFR local rainfall in relation to statewide rainfall distribution	9
Figure 4	Organization Chart of Deramakot District Forestry Office 2004	16
Figure 5	Location of Kampung at the vicinity of DFR	17
Figure 6	DFR social forestry committee structure	57
Figure 7	Organization Chart of Deramakot District Forestry Office 2005-2014	70
Figure 8	10 - year plan (2005-2014) costs breakdown for DFR	73

APPENDICES

Appendix 1	Slope Map of DFR
Appendix 2	Topography Map of DFR
Appendix 3	Soil Association Map of DFR
Appendix 4	Harvested Compartments (1995-2004)
Appendix 5	Silviculturally Treated and Enriched in DFR (1996 - 2004)
Appendix 6	Stratum Map of DFR
Appendix 7	Distribution of HCVF in DFR
Appendix 8	Forest Function of DFR
Appendix 9	Harvesting Compartments (2005-2014)
Appendix 10	Timber Stand Improvement Treatments Compartments (2005 - 2014)
Appendix 11	Forest Restoration Program (2007 - 2011)
Appendix 12	List of Compartments
Appendix 13	Financial Analysis of SFM in DFR (2005-2014)

Executive Summary

This second 10-Year Forest Management Plan (FMP) is prepared as a further guide on forest management in Deramakot Forest Reserve (DFR) from January 1, 2005 to December 31, 2014. The plan is an adaptation and continuation of planning processes that have been in place since the first FMP. The DFR FMP 2 is divided into seven (7) parts. Part I is the introduction, Part II prescribes the general information of DFR, Part III describes the forest resource base, whereas, Part IV provides the medium-term direction for forest protection, harvesting, timber stand improvement, continuous forest inventory (on selected compartments only), forest restoration, forest recreation and ecotourism, community forestry, Research and Development, and managing high conservation value forests. Part V highlights the budget and cost projection of managing DFR during the plan period. Part VI prescribes the EIA and forest management standards, while the last part, which is Part VII, prescribes the responsibility, as well as, monitoring and auditing of sustainable forest management implementation in DFR.

The total number of compartments in DFR is 135, that is, 17 compartments have been set aside for conservation/protection (3,473 ha) and 118 compartments (51,610 ha) for natural forest management (NFM). However, the net production area is approximately 42,789 ha, whereas, the total protection area has increased to 11,355 ha or 21% of the total area of DFR. Forest harvesting is confined to the net production area of 42,789 ha. There are 2 small sub-compartments (18 ha) within the NFM area, which have been designated for the local communities. These areas are to be developed under the community forestry program, which is prescribed in Chapter 4.5.

The long-term objective of natural forest management (NFM) in general, is to sustain production of high value timber based on the AAC limit while maintaining a high degree of species and structural diversity. For this planning period, the annual allowable cut (AAC) is set at 17,600 m³, and the total harvest for the entire planning period should not exceed 176,000 m³. It is also anticipated that 1,600 m³ (or 9% of the AAC) can be obtained from the logging residues annually. Twenty-five (25) compartments covering an area of about 11,026 ha are scheduled for harvesting during the planning period. Forest harvesting will be carried out based on reduced impact logging (RIL), which is eco-friendly.

Efforts will be focused on improving the growing stock through timber stand improvement (TSI) and forest restoration programs. During the planning period, TSI treatments will be maintained at 10,000 ha, that is, an average of 1,000 ha per year, while 2,000 ha involving 5 compartments in the southern part of DFR are to

be restored within 5 years through a forest restoration program using indigenous species subject to the availability of funds.

An essential part of yield regulation is the permanent monitoring of the growing stock by repeated inventories or by the use of permanent plots. A permanent monitoring and control system will be established during this management planning period, and repeated inventories will be carried out as a routine management activity. The target is to resample 5 compartments every year.

Given that the original purpose of applying sustainable forest management in DFR was to create a model for multiple-use forestry, there is potential within this management plan period to expand the present functions of the DFR to develop alternative forest uses, such as, forest based recreation and tourism. Therefore, the key step to be undertaken within this management period is to develop recreation and tourism within DFR and maximise economic, social and environmental benefits from this area. To commence forest recreational activities in DFR, there are many basic requirements, which also need to be taken into consideration and/or put in place for these activities to function. Within the FMP period, these requirements will either need to be planned in detail separately or planned for in combination with the various proposed forest recreational activities respectively. This includes roads and access, accommodation, food and beverage provision, transport services, water and electricity supply, telecommunications, waste disposal, safety regulations and emergency procedures, information and interpretive services, and promotions.

High conservation value forests are also prescribed in the plan. There will be a need to focus on the implications for management, to ensure that the high conservation values that have been identified in DFR (biological and ecological category, areas sensitive to disturbance, and cultural, ecological, and economic significance) are maintained or enhanced. This process also needs to be closely integrated with a monitoring program.

At present, the main and secondary roads within DFR are still usable. However, sections of these roads require regular maintenance and/or the upgrading of problem sections. For this reason, road maintenance and upgrading problem sections (such as log-culverts, log-bridges and steep sections) are highlighted as the number one long-term priority infrastructure strategy to be put in place, in order to have good access to DFR and to facilitate the development of forest recreation and tourism in DFR. Similarly, the development of appropriate office space and accommodation will be necessary in DFR due to its remoteness from urban populations. Also, the provision of adequate and good quality water supply and electricity will be some of the fundamental steps to be put in place for the development of expanded facilities for DFR.

Many commitments in the Sabah Forestry Department strategic directions outline the need for greater scientific knowledge and technological innovation in the forestry sector. Structuring Research and Development enables experts from diverse disciplines, to focus on complex problems and supports the development of more integrated techniques and approaches to resource management. The Forest Research Centre (FRC) in Sepilok will combine their expertise and resources to look at a wider spectrum of issues associated with sustainable development in DFR especially those of the forest itself. In this DFR FMP 2, various research projects have been prescribed, which are to be carried out during the plan period.

A proper long term budgeting plan can help to alleviate an unnecessary escalation of expenses and not to erode potential revenue from a given resource annually. It also allows operational planning to be made in the least costly way and to ensure the project's operations remain viable. For this purpose, a budget plan and estimated revenue which consider the various cost centres and the main activities of the DFR operations and new investments that are considered necessary for the next 10 years, has been prepared. A total of RM 64.33 million is estimated to be required to run the operations of DFR for the next 10 years, while generated revenue is projected to be at RM 83.32 million. The estimated net revenue is RM 18.98 million at current prices.

Executive Summary

This second 10-Year Forest Management Plan (FMP) is prepared as a further guide on forest management in Deramakot Forest Reserve (DFR) from January 1, 2005 to December 31, 2014. The plan is an adaptation and continuation of planning processes that have been in place since the first FMP. The DFR FMP 2 is divided into seven (7) parts. Part I is the introduction, Part II prescribes the general information of DFR, Part III describes the forest resource base, whereas, Part IV provides the medium-term direction for forest protection, harvesting, timber stand improvement, continuous forest inventory (on selected compartments only), forest restoration, forest recreation and ecotourism, community forestry, Research and Development, and managing high conservation value forests. Part V highlights the budget and cost projection of managing DFR during the plan period. Part VI prescribes the EIA and forest management standards, while the last part, which is Part VII, prescribes the responsibility, as well as, monitoring and auditing of sustainable forest management implementation in DFR.

The total number of compartments in DFR is 135, that is, 17 compartments have been set aside for conservation/protection (3,473 ha) and 118 compartments (51,610 ha) for natural forest management (NFM). However, the net production area is approximately 42,789 ha, whereas, the total protection area has increased to 11,355 ha or 21% of the total area of DFR. Forest harvesting is confined to the net production area of 42,789 ha. There are 2 small sub-compartments (18 ha) within the NFM area, which have been designated for the local communities. These areas are to be developed under the community forestry program, which is prescribed in Chapter 4.5.

The long-term objective of natural forest management (NFM) in general, is to sustain production of high value timber based on the AAC limit while maintaining a high degree of species and structural diversity. For this planning period, the annual allowable cut (AAC) is set at 17,600 m³, and the total harvest for the entire planning period should not exceed 176,000 m³. It is also anticipated that 1,600 m³ (or 9% of the AAC) can be obtained from the logging residues annually. Twenty-five (25) compartments covering an area of about 11,026 ha are scheduled for harvesting during the planning period. Forest harvesting will be carried out based on reduced impact logging (RIL), which is eco-friendly.

Efforts will be focused on improving the growing stock through timber stand improvement (TSI) and forest restoration programs. During the planning period, TSI treatments will be maintained at 10,000 ha, that is, an average of 1,000 ha

per year, while 2,000 ha involving 5 compartments in the southern part of DFR are to be restored within 5 years through a forest restoration program using indigenous species subject to the availability of funds.

An essential part of yield regulation is the permanent monitoring of the growing stock by repeated inventories or by the use of permanent plots. A permanent monitoring and control system will be established during this management planning period, and repeated inventories will be carried out as a routine management activity. The target is to resample 5 compartments every year.

Given that the original purpose of applying sustainable forest management in DFR was to create a model for multiple-use forestry, there is potential within this management plan period to expand the present functions of the DFR to develop alternative forest uses, such as, forest based recreation and tourism. Therefore, the key step to be undertaken within this management period is to develop recreation and tourism within DFR and maximise economic, social and environmental benefits from this area. To commence forest recreational activities in DFR, there are many basic requirements, which also need to be taken into consideration and/or put in place for these activities to function. Within the FMP period, these requirements will either need to be planned in detail separately or planned for in combination with the various proposed forest recreational activities respectively. This includes roads and access, accommodation, food and beverage provision, transport services, water and electricity supply, telecommunications, waste disposal, safety regulations and emergency procedures, information and interpretive services, and promotions.

High conservation value forests are also prescribed in the plan. There will be a need to focus on the implications for management, to ensure that the high conservation values that have been identified in DFR (biological and ecological category, areas sensitive to disturbance, and cultural, ecological, and economic significance) are maintained or enhanced. This process also needs to be closely integrated with a monitoring program.

At present, the main and secondary roads within DFR are still usable. However, sections of these roads require regular maintenance and/or the upgrading of problem sections. For this reason, road maintenance and upgrading problem sections (such as log-culverts, log-bridges and steep sections) are highlighted as the number one long-term priority infrastructure strategy to be put in place, in order to have good access to DFR and to facilitate the development of forest recreation and tourism in DFR. Similarly, the development of appropriate office space and accommodation will be necessary in DFR due

to its remoteness from urban populations. Also, the provision of adequate and good quality water supply and electricity will be some of the fundamental steps to be put in place for the development of expanded facilities for DFR.

Many commitments in the Sabah Forestry Department strategic directions outline the need for greater scientific knowledge and technological innovation in the forestry sector. Structuring Research and Development enables experts from diverse disciplines, to focus on complex problems and supports the development of more integrated techniques and approaches to resource management. The Forest Research Centre (FRC) in Sepilok will combine their expertise and resources to look at a wider spectrum of issues associated with sustainable development in DFR especially those of the forest itself. In this DFR FMP 2, various research projects have been prescribed, which are to be carried out during the plan period.

A proper long term budgeting plan can help to alleviate an unnecessary escalation of expenses and not to erode potential revenue from a given resource annually. It also allows operational planning to be made in the least costly way and to ensure the project's operations remain viable. For this purpose, a budget plan and estimated revenue which consider the various cost centres and the main activities of the DFR operations and new investments that are considered necessary for the next 10 years, has been prepared. A total of RM 64.33 million is estimated to be required to run the operations of DFR for the next 10 years, while generated revenue is projected to be at RM 83.32 million. The estimated net revenue is RM 18.98 million at current prices.

PART I: INTRODUCTION

1.0 Background

The concept of sustainable forest management (SFM) has drawn together an impressive coalition of interests, which find common ground in affirming that forests should be managed to meet the needs of both present and future generations. The Sabah Forestry Department (SFD) actively supports this concept through its involvement in international forestry discussions and cemented its commitment to forest resource management based on SFM principles in 1989 when Deramakot Forest Reserve (DFR) was chosen as a model for a well-managed forest in Sabah. In 1995, the first 10-Year Medium Forest Management Plan (1995 - 2004) for DFR was prepared and implemented. Subsequently, the SFD was awarded a certificate by the FSC in 1997 on forest management practices in DFR, which fulfilled the requirement of a well-managed forest. The certificate expired in August 2002 and was renewed in February 2003 for another 5-year period.

This second 10-Year Forest Management Plan (2005 - 2014) is prepared as a further guide on forest management in DFR. The plan is an adaptation and continuation of planning processes that have been in place since the first Forest Management Plan (FMP). The management of DFR has continued to evolve over time in response to experiences gained and to changes in society's values. The planning processes include strategic and operational plans, analysis, standards, monitoring and public review. The results of the final review of the SFD's effectiveness in management performance, against the objectives, prescriptions, implementation schedules and budgets and the public participation processes over the past eighteen months, constitute the platform for the preparation and completion of this second FMP. Changes in the numbering of the compartments were made for easy reference. One new compartment was included, that is, a protection compartment - a small reduction in production area. However, the annual allowable cut (AAC) has increased to 17,600 m³ from 15,000 m³ at the 1st plan's mid-term review. This is based on the inventory results carried out in every production compartment.

The SFD believes that in order to work effectively and maintain its reputation as a leader in practicing SFM, this plan has to prescribe more strategic directions and effective approaches as compared to the first FMP. Forest recreation and tourism have been considered as new focuses in the management of the area, and an enhancement of the current utilization of DFR. In addition, research and development (R&D) have been emphasized during the planning period due to the many commitments in the strategic directions outlining the need for greater

scientific knowledge and technological innovation in the forestry sector. The Forest Stewardship Council (FSC) Principles as the framework for measuring and assessing Deramakot's progress, as a well-managed forest, would provide further coherent direction for SFM in DFR.

1.1 Legal Authority and Period of Operation

The plan is called the "Ten-Year Forest Management Plan II for Deramakot Forest Reserve". It is the intent of this plan that all forest resources and services within DFR (FMU 19) are managed on a sustained yield basis for total optimization of economic, social, and environmental benefits to the State by the SFD under the authority of the Sabah Chief Minister. The Deramakot District Forestry Officer will administer this FMP. The term of this plan will be ten years commencing on 1st January 2005 and concluding on 31st December 2014. The plan will be reviewed in the year 2009.

1.2 Policy Statements

As a pioneer of SFM in Sabah, the SFD is committed towards protecting the future of DFR as a well-managed forest. While the primary responsibility of managing the DFR rests with the SFD, a number of governmental and non-governmental agencies and local communities, also have an interest on it's management. The key agencies are the Wildlife Department, Drainage and Irrigation Department, and non-governmental organizations (NGOs) such as WWF Malaysia and Partners of Community Organisations (PACOS). The emphasis on environmental issues has also necessitated closer relationships with stakeholders such as the Environmental Protection Department and the local communities. The SFD, throughout its operations in DFR, would adhere to the basic criteria of sound forest management, by ensuring that SFD's activities will be environmentally appropriate, socially beneficial and economically viable.

The SFD's Policy Statements are as follows:

- DFR will be managed under sound forest management practices in accordance with the FSC Principles and the biological, social and economic principles defined by the International Tropical Timber Organisation (ITTO), Malaysian Criteria and Indicators (MC&I), and in conformity with the existing State forest policies, environmental policies, legislation and regulations.
- The SFD would maintain and enhance the high conservation value forests (HCVF), biodiversity, wilderness, soil, and water resources that are

ecologically justified, technically and financially feasible within the framework of the SFD's regular operations.

- The SFD would continue to demonstrate to all relevant stakeholders, national, and international clients, on its efforts towards quality environmental management in DFR. Our internal and external auditors shall monitor this.
- Every effort would be undertaken by the SFD to optimize economic returns to the State on a long-term basis by maximizing utilization, efficient use of raw materials from DFR, and good marketing strategies of DFR's ecotourism potentials.
- On the social aspect, the SFD would continue to provide job opportunities and socio-economic development activities, particularly to the local communities living adjacent to DFR, so as to improve their living standard.
- The SFD would escalate research and development (R&D).

1.3 Management Objectives

The overall goal of the SFD in managing DFR is to have a multiple-use forest for economic, social and environmental purposes. The long-term objectives are as follows:

- To sustain production of high value timber based on an annual allowable cut (AAC) of 17,600 m³ and reduced impact logging (RIL) while maintaining a high degree of species and structural diversity.
- To carry out silvicultural tending (10,000 ha) during the plan period, in areas where sufficient natural regeneration and potential commercial species are present for the purpose of liberation and enhancement of their growth performance.
- To restore 2,000 ha during the plan period, in the southern part of DFR where stand stockings are absent or inadequate by using indigenous species, subject to financial constraints.
- To integrate all forest operational activities within the concept of conservation and protection so as to reduce the impact to the environment from fire and unauthorized encroachment by third parties.

- To maintain the ecosystem diversity at all levels for wildlife habitats, education, research, and eco-tourism purposes.
- To develop recreation and tourism within DFR and maximise economic, social and environmental benefits from them.
- To maintain and enhance HCVFs sites.
- To involve and increase the participation of the local communities in forestry activities particularly, social forestry activities in areas or compartments, which have been designated for them.

1.4 Legal Framework and Management Guidelines

Laws and regulations on forest legislation are the legal instruments, which are necessary in the implementation of the objectives of a forest policy. Forest legislation reflects the principles of sustainability in order to support implementation of forest policy. Management guidelines, on the other hand, provide advice and promote more extensive application of forest management practices. In this context, the following are the legal frameworks and management guidelines, which the SFD would refer to:

- | | | | |
|-------|---|--------|----------------------------------|
| i. | State Forest Policy, 1954; | xi. | Biodiversity Enactment, 2000; |
| ii. | Forest Enactment, 1968; | xii. | Environmental Quality Act, 1974; |
| iii. | Forest Rules, 1969; | xiii. | MC&I; |
| iv. | Environmental Protection Enactment, 2002; | xiv. | FSC Principles; |
| v. | Park Enactment, 1984; | xv. | RIL Guidelines, 1998 |
| vi. | Wildlife Conservation Enactment, 1997; | xvi. | Sabah Labour Ordinance; |
| vii. | Land Ordinance, 1930; | xvii. | The Employment Act; and |
| viii. | Water Resources Enactment, 1998; | xviii. | Health and Safety Regulations. |
| ix. | Cultural Heritage (Conservation) Enactment, 1997; | | |
| x. | Sabah Conservation Strategy, 1992; | | |

1.5 Management Constraints

The plan is subject to the following management constraints:

- Low growing stock, many hollow trees, and heterogeneous stand conditions;
- Low fertility and high erodability;
- Risks of forest fire from oilpalm development adjacent to DFR; and
- Financial outlays.

PART II: GENERAL INFORMATION

2.0 Name, Location, and Legal Status

This management plan is prepared for DFR, which is a Class II Commercial Forest Reserve covering an area of 55,083 ha. DFR is within FMU 19, located in the central part of Sabah. It is situated between Longitude $117^{\circ} 20' E$ and $117^{\circ} 42' E$ and between Latitude $5^{\circ} 19' N$ and $5^{\circ} 20' N$ (see Figure 1). DFR has been administered as a forest reserve since 1961, and in 1984, it was re-constituted as part of the permanent forest estate as a Commercial Forest Reserve.

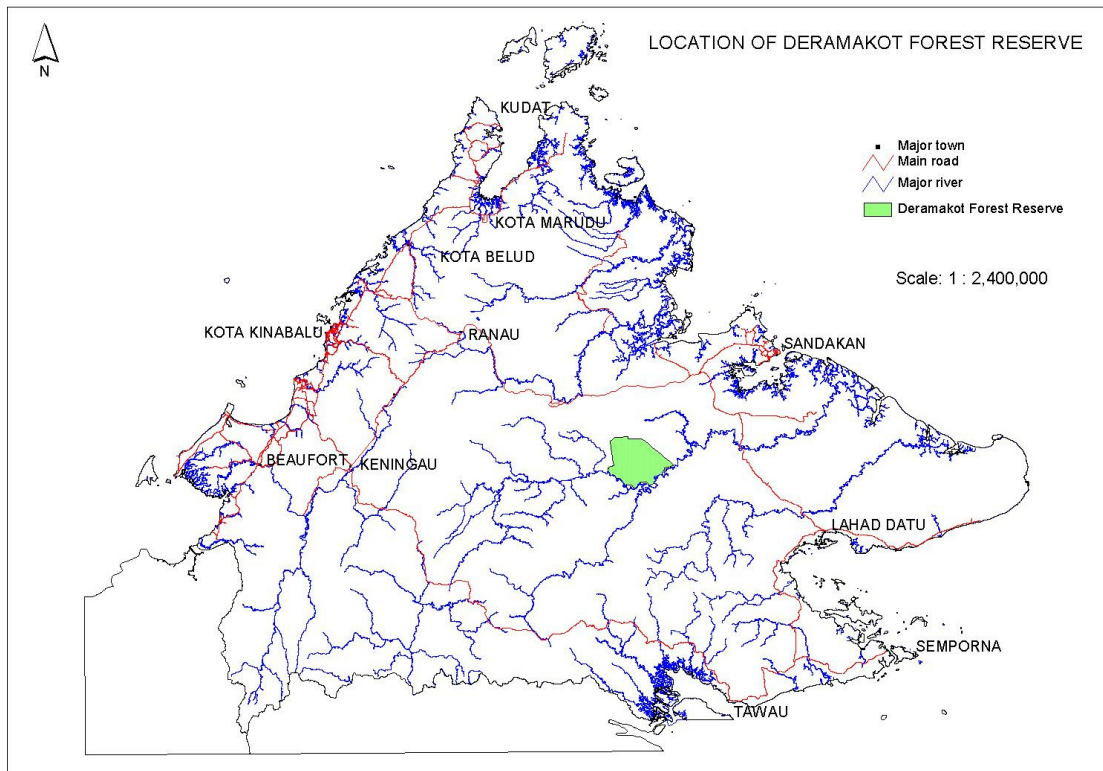


Figure 1: Location of Deramakot Forest Reserve

2.1 Physical Resources

2.1.1 Climate

Rainfall

DFR generally experiences an equatorial climate characterized by warm and humid weather all year round. In spite of its interior location, it has a total annual precipitation of between 3,842.8 mm and 4,888.5 mm (see Table 1). However, its monthly rainfall shows a very distinct variation that ranges from 78 mm to 1,103 mm. On the other hand, illustration of rainfall pattern in Figure 2 does not indicate a clear seasonal variation of rainfall due to the fact that the rainfall deficit in the drier months is offset by the abundance of rainfall in the following month.

Table 1: DFR Monthly Total Rainfall for 2002 and 2003 (in mm)

Month	Year	
	2002	2003
January	827.7	36.0
February	193.2	454.0
March	180.0	06.0
April	363.0	114.8
May	589.0	78.0
June	441.0	56.0
July	328.6	91.0
August	517.7	41.0
September	435.0	91.0
October	629.3	43.0
November	198.0	229.0
December	186.0	1,103
Total	4,888.5	3,842.8

Meanwhile, 10-year rainfall data collected by the Meteorological Services Department, at their weather station at Tangkulap, which is situated adjacent to DFR, showed an annual rainfall range of between 1,777.5 mm to 3,708.0 mm (see Table 2).

On a statewide basis, rainfall distribution trends drawn from 30-year rainfall data collection in 26 Meteorological Services Department stations, showed that DFR is located within the highest rainfall range of between 3,000 mm to 3,500 mm a year (see Figure 3).

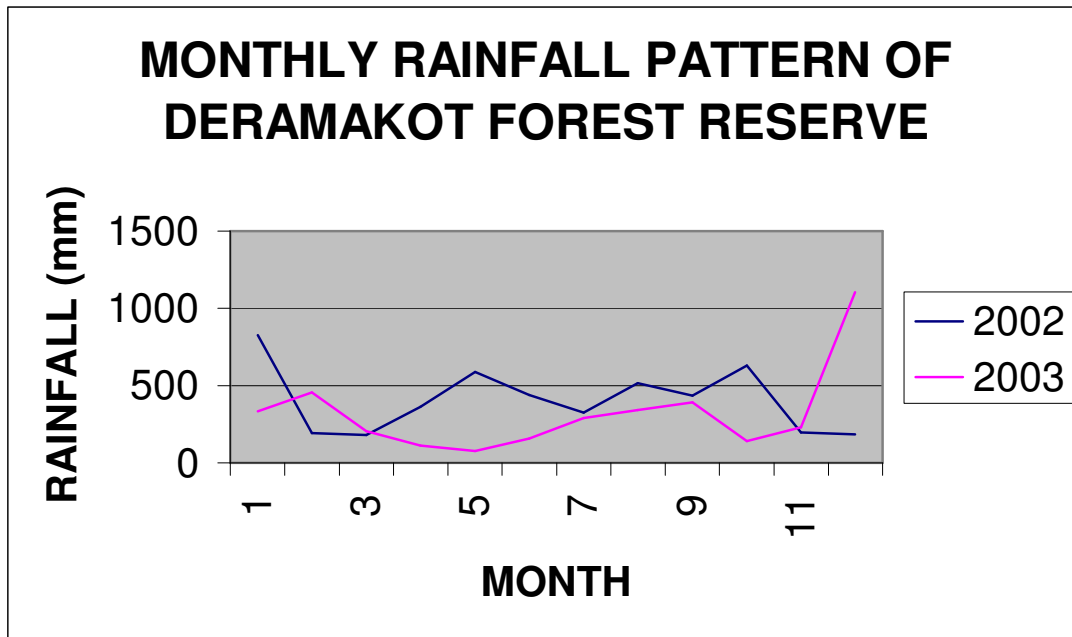


Figure 2: Rainfall Pattern at DFR

Table 2: Rainfall Record of Tangkulap Weather Station showing the average monthly rainfall (in mm) from the year 1991 to 2000.

Year	MONTH												Total
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec	
1991	54.0	207.0	4.0	02.5	82.0	47.0	65.0	34.5	49.0	13.5	529.5	380.0	3708.0
1992	28.5	92.5	56.5	24.0	131.5	*	133.0	212.5	325.5	296.5	163.0	314.0	1777.5
1993	195.0	234.0	288.0	204.5	60.5	124.5	317.0	172.0	253.0	298.5	334.0	352.5	2833.5
1994	157.5	213.5	181.0	187.0	280.0	266.0	135.0	354.5	246.5	210.5	164.5	272.0	2668.0
1995	326.0	248.0	172.5	42.0	342.0	388.0	760.3	411.7	249.0	342.0	168.0	331.0	3280.5
1996	501.0	572.5	95.5	235.5	361.5	190.5	140.5	196.0	186.0	443.5	123.0	412.5	3458.0
1997	250.5	463.0	142.5	93.0	257.5	37.5	163.0	342.0	127.3	403.0	172.0	230.5	2682.5
1998	114.0	43.5	33.0	34.0	109.5	138.0	204.0	289.0	207.3	253.5	396.0	149.5	1971.5
1999	211.5	381.5	281.0	384.0	554.5	194.5	145.0	405.0	191.5	240.5	180.5	294.5	3464.0
2000	440.0	230.0	490.0	350.0	430.0	200.0	250.0	40.0	90.0	290.0	130.0	300.0	3240.0

Though DFR falls within the *isoline* that receives the highest rainfall, it is still subject to forest fire risk when a prolonged dry season occurs. For instance, when El Nino, a weather phenomenon that causes extreme dry spells, hit South- East Asia in 1982/83, DFR was severely affected by forest fires particularly in the degraded areas, in the south.

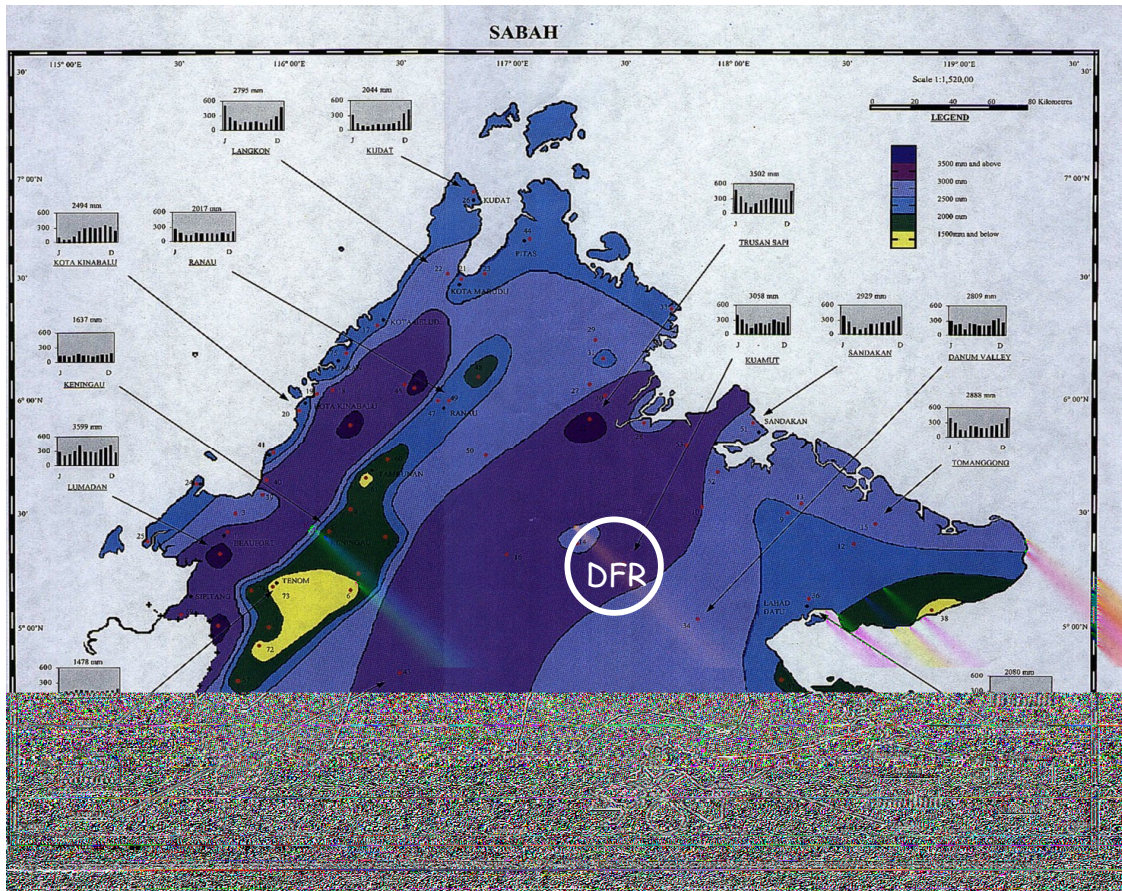


Figure 3: DFR local rainfall in relation to statewide rainfall distribution

Temperature

DFR has an average annual temperature of about 27 °C with average maximum and minimum temperatures of 31 °C and 23 °C respectively.

2.1.2 Topography

DFR is located on land with elevations of 200m rising to a maximum of 1,079m above sea level (a.s.l). A large part of the area is on elevation ranging from 250m to 700m a.s.l (see Map in **Appendix 1**). The landforms are mainly undulating (71% of the area) with slopes varying from 6° to 24°. The higher elevation and steep slopes (>25°), which cover 5% of the area, are mostly located on the southeast and southwest of the reserve. The rest of the reserve (approx. 24%) is flat (< 5° slope).

2.1.3 Hydrology

There are five main rivers in DFR. These are Sungai Rawog Besar, which is located to the North, Sungai Tabalin Besar to the East, Sungai Tangkulap Kecil to the West, Sungai Balakung and Sungai Deramakot both to the South. All these rivers are flowing/draining south into the Kinabatangan River and form part of the Kinabatangan drainage system (see Map in **Appendix 2**).

2.1.4 Managerial Implications of Topography and Hydrology

The Hydrology Section of the Forest Research Centre has carried out hydrological studies in DFR since 1998. The studies focused on assessments of the effects of logging (based on RIL techniques) on stream/river water quality in Compartments 61 (68)¹, 36 (51), 53 (63), 18 (12), and 34 (40). Based on the results of the assessment, it shows that, overall, there is no significant difference in water quality in terms of the following parameters:

- > Turbidity
- > PH
- > Suspended solid
- > Dissolved oxygen
- > Temperature
- > Color
- > Total dissolved solid
- > Electrical conductivity

The research results also showed that the RIL system practiced in DFR does not show a significant impact on water pollution in DFR.

2.1.5 Geology, Rock and Soil

The geology of DFR is dominated by tertiary sedimentary formations. The most prominent rock types are red and purple silt (mud) and sand stone. Smaller patches of ultra basic rocks like serpentinite are also reported. The big valleys of the Rawog and the Lokan Rivers are made up of old alluvial deposits. Gravel and stone beds are found along the banks of both rivers to respectable depths. The soils derived from these rocks are infertile with limited stocks of plant-available nutrients.

Acrisols comprise 91.1% in DFR while 6.9% are made up of Leptosols and other soil types (see map in **Appendix 3**). Leptosols found on steep slopes are shallow, limiting root penetration. Generally these soils are dry due to high rock content. The Soil Families found (Kapilit, Paliu and Lithosols) are among the most impoverished in terms of plant-available nutrients. More than 99% of the soils in DFR have less than

¹ Numbers in brackets indicate the old compartment numbers.

5,000 kg/ha of exchangeable macro-nutrients and can be classified as poor to very poor.

2.1.6 Managerial Implications of Geology and Soils

Acrisols developed on old land surfaces and prolong weathering lead to a general loss of nutrients. Moreover, they are easily erodable. These two factors are the major serious limitations to any type of land management.

Since Leptosols found on steep slopes limit root penetration, and they are dry due to high rock content, logging is restricted in these areas because erosion may wash away the already thin soil layer. Approximately 85% of the area is affected by erosion. More than 71% show only slight erosion with no formation of rills and gullies. However, the RIL logging adopted in DFR would reduce the occurrence of compaction in the area.

2.1.7 Vegetation Types

The lowland dipterocarp forest of DFR belongs to the *Parashorea tomentalla/Eusideroxylon zwageri* Forest Type, which is dominated by *Parashorea* (20%), and its principal associate species are *Shorea leptoclados*, *Dryobalanops lanceolata*, and *Dipterocarpus caudiferus*. Together, these four dipterocarps account for about 40% of the large trees (> 50 cm dbh).

2.1.8 Wildlife Resources

Forest Habitat

Evaluation of wildlife habitat in DFR is based on data gathered during the management inventory of the area. In general, DFR provides good wildlife habitats because 71% of its landscape is undulating with slopes $6^\circ < 24^\circ$ and 24% is flat (< 5° slope). This condition provides better habitat contiguity and long-term prospects for viable populations of wildlife in DFR. Elephants (*Elephas maximus*) and Tembadau (*Bos javanicus*) appear to use the generally flatter parts of north DFR and a small portion at the southern part especially near Kg. Balat. Elephant's range in the area extends from the Pinangah hills in the west through parts of the Tangkulap Forest Reserve (west of DFR), into Segaliud Lokan Forest Reserve (SLFR), stateland and the Lokan VJR (east of DFR). Most boundaries of these forest reserves to the north are shared with oilpalm plantations. Orang-utans (*Pongo pygmaeus*), on the other hand, are fairly widespread in DFR but significantly higher in the southern part (disturbed habitat: stratum 3). Nest concentration is

low in strata 4 and 5 and is intermediate in the northern part (stratum 2). Nests are commonly built in Laran and Binuang trees, which grow along streams.

Wildlife Diversity

A brief wildlife survey in DFR carried out by the Forestry Department in 1994, revealed that DFR harbored remarkable wildlife diversity, including significant populations of highly endangered species such as the orang-utan, the tembadau and the Asian elephant. It was reported that there were at least 75 species of mammals (excluding bats), 220 species of birds and over 100 species of reptiles, amphibians and fish. Among mammals, primate diversity is relatively rich. Orang-Utans are found through out the area, while gibbons (*Hylobates muelleri*) are heard calling frequently. Two sympatric colobines (proboscis monkey and the maroon langur) are found in Sungai Lokan.

The Asian elephant (*Elephas maximus*) occurs in the entire area and its range extends to the adjoining reserves. Tembadau (*Bos javanicus*) together with large populations of sambar deer (*Cervus unicolor*) and bearded pig (*Sus barbatus*) occur in the flat areas where grass is more prolific. The most common large carnivore is the Malay sun bear (*Helictes malayanus*). Clouded leopards are also found in DFR. Small carnivore diversity found in DFR includes the leopard cat, marbled cat, Malay badger, yellow-throated marten, several species of civet and smooth otters.

Six species of hornbill found in Sabah are also found in DFR. Large flocks of rhinoceros hornbill (*Anthracoceros coronatus*) have been sighted. The Rawog River is part of the last undisturbed breeding grounds for the estuarine crocodile (*Crocodylus porosus*).

In 1999, the SFD consultants (Dr. Isabelle Lackman-Ancrenaz and Marc Ancrenaz) carried out a reconnaissance survey in DFR to corroborate the above findings. Qualitative assessment was carried based on seven components (Footpath Monitoring, Night Roadside Monitoring, Riverside Monitoring, Saltlick Monitoring, Elephant Monitoring, Orang-Utan Aerial Survey, and Opportunistic Observations). The results of the survey show that:

- Different cervid species living in DFR are mostly solitary individuals. However, it is possible to encounter groups of small size at certain places like natural mineral sources. They are most common in degraded habitats and gently sloping terrain. They are mostly seen along roads, skid trails and skyline corridors.

- The bearded pigs are widespread in DFR, and migrations occur according to fruit availability and season. Their population in DFR appears to be high.
- Tembadau population (< 50 individuals) in DFR consists of several small groups (females and their young: 5-10 individuals) and solitary males. They are attracted to natural saltlicks (up to 11 individuals together).
- A population of approximately 100 individuals of elephants exist in DFR. Groups usually contain between three and forty individuals. Groups split and merge, but usually contain one or more adult females with young of both sexes and various ages.
- A population of a few hundred Orang-Utans live in DFR. Significantly high number of nests was sighted in the southern part of DFR (disturbed habitat). This is because fruit productivity is higher in degraded habitats than in more intact forests. Orang-utan nest counts carried by the SFD with assistance from the Sabah Wildlife Department from 1999 to 2002 (based on aerial surveys) indicated that there was an increase of nest numbers from 1.4 individuals per km² in 1999 to 1.8 individuals per km² in 2002.
- Avifauna found in DFR is very rich and diverse. Globally threatened bird species found within DFR include hornbills, Storm's stock, Malaysian Peacock-pheasant, crested fireback, etc.

Based on the survey results, it was reported that animal biodiversity in DFR is high compared to other similar habitats found in Sabah. Further information can be referred to in Chapter 4.4.

2.1.9 Managerial Implications of Wildlife Relationships With Natural Forests

For large mammal populations, habitat contiguity in the form of natural forest cover is critical in determining the long-term prospects of viable populations. A rule of thumb of area required for large mammal population viability, for example, elephants, is approximately 70,000 - 100,000 ha. DFR is fortunate because it shares a common boundary with Segaliud Lokan FR (on the east) and Tangkulap FR (on the west), which provide better habitat contiguity. The RIL method, which is practiced in DFR, showed no significant impact on the reduction of the wildlife populations in DFR. This eco-friendly harvesting practice will be continued in DFR. However, more effective monitoring and controlling during logging operations will be carried out to ensure that the intensity of logging and harvesting method conforms with the prescriptions as prescribed in this plan.

2.2 Infrastructure

2.2.1 Buildings

A base camp is located at the northern part of Compartment 54 (formerly known as Compartment 60). It consists of 9 Detached Living Quarters, 2 Guesthouses, an Office with a conference room, a Workshop, a Nursery, and Recreational and Camping Grounds. Two Guard Posts are in place in Kg. Balat and Sg. Liningkon. An additional junior staff house is located in Compartment 14 (formerly known as Cpt. 16). There is one outlying building known as the "white house" in Compartment 4.

The base camp is equipped with:

Generator sheds with 2 Yanmar 40 KW and 1 Lister 60 KW generators
Water tank (22,300 litres)
Pump house with 15 HP electrical pump
4,000 gal diesel tank
Store room

Equipment:

- Machineries - 6 tractors/bulldozers (2 non-servicable); 2 Excavators (1 non-servicable); 1 Vibrating Compactor; 1 Motor grader; 1 Backhoe; 3 Dump Trucks; and 3 Skylines (1 non-servicable).
- Vehicles - 4 Toyota Hilux Double Cabin; 5 Toyota L/C Pick Up; 1 Nissan Patrol Pick Up; 1 Isuzu Invader Double Cabin.
- Boats - 2 Fiberglass Launch 25'ter; 3 Fiberglass Boat 15'ter; 3 Yamaha Outboard Engines.
 - These boats are placed at Kg. Balat and Sg. Liningkong guard posts.

2.2.2 Forest Roads

In general, the basic road network in DFR has improved and is in a better condition since 1997, that is, after DFR was certified by FSC as a well-managed forest. The main road is from Tangkulap FR passing through the Base Camp to Kg. Balat. It has a total distance of approximately 72 Km. In addition, there is a total of 127km of secondary and feeder roads (see Table 3). The majority of the operational road networks have been constructed during logging operations. The main and secondary roads are regularly maintained by the SFD using the machineries it has as listed. The present conditions of the access road in DFR are shown in Table 4.

Table 3: Road Classification in DFR

Forest Road Type	Length (km)	Density (%)	Density (m/ha)
Main Road	72	0.0897	0.8968
Secondary Roads	75.12	0.1091	1.3638
Feeder Roads (comprises of 16 Compartments)	51.97	0.0043 (average)	0.0719 (average)

Table 4: Condition of access road in DFR

Name / Location	Length	Present Condition
Balat Road	32km	Two bridges collapsed, one major landslip, but still passable
Rawog-Segaliud Lokan Road	23km	Four bridges collapsed, one collapsed wood culvert, Unpassable after the white house.
Rawog-Tangkalap Estate Road	11km	One bridge collapsed, two wood culverts collapsed, passable
Compartment 29 Road	9km	One bridge collapsed, one wood culvert collapsed, one major landslip, passable
Karis-Karis Road (to Kg. Tulang ²)	19km	One bridge collapsed, unpassable (not recently surveyed)
Tangkalap Kecil-Tulang ² Road	32km	One bridge collapsed, unpassable (not recently surveyed)

2.3 Manpower

DFR was under the jurisdiction of the Sandakan District Forestry Officer from 1995 to 1998. However, from 1999 onwards, DFR was placed under the Deramakot District Forestry Officer, a new DFO, based in Deramakot Base Camp. The current strength of DFR personnel is as follows:

DFO	:	1	Driver + Authorized Driver	:	1
ADFO	:	1	Labourer	:	32
Forest Ranger	:	4	Heavy Machinery Operator	:	3
Forester	:	3	Mechanic	:	1
Boatman	:	2			

The majority of the staff (44) is attached at the base camp. The organizational set-up of Deramakot Forestry Office in 2004 is depicted in Figure 4.

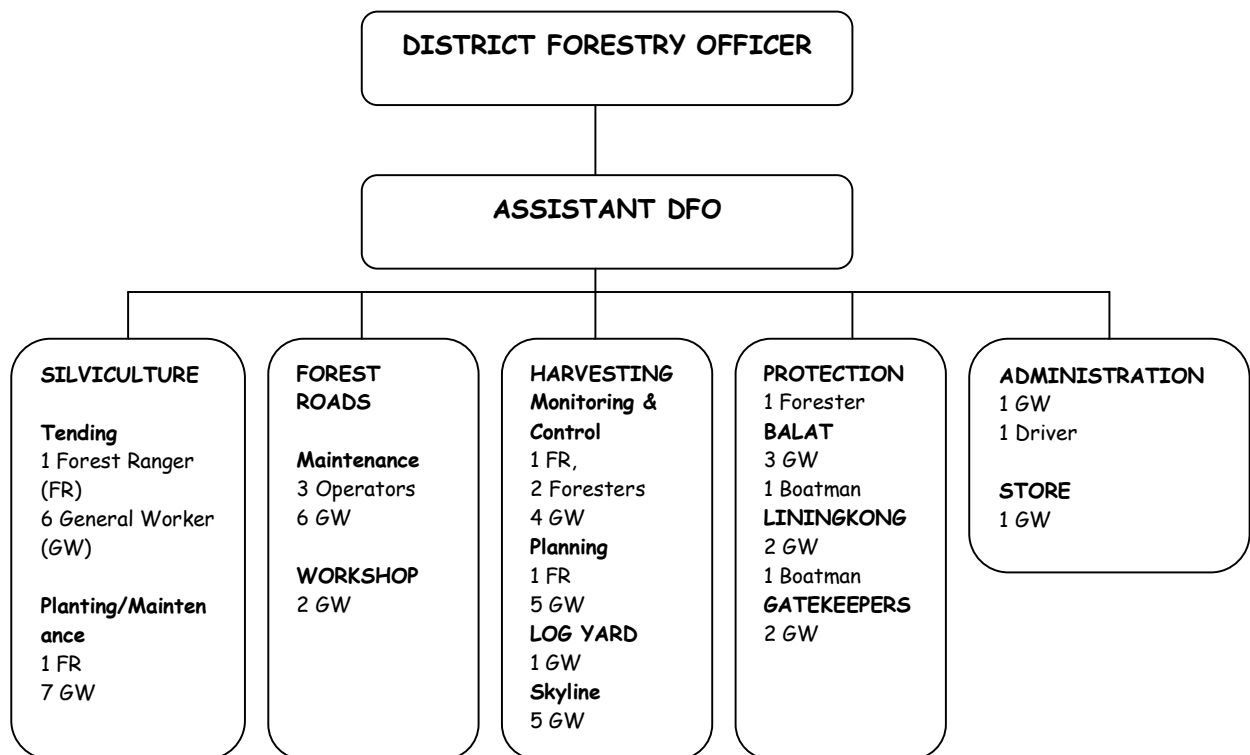


Figure 4: Organization Chart of Deramakot District Forestry Office in 2004

2.4 Socio-Economic Aspects

2.4.1 Population

There are no villages located inside DFR. Villages are only located along the Kinabatangan/Millian River on the southern part of DFR. The social baseline surveys were carried out in 5 villages due to their close proximity with DFR. These villages are Kg Balat, Kg Desa Permai, Kg Tulang Tulang, Kg Tangkong and Kg Kuamut. Figure 5 shows the distribution of these villages.

Kg Kuamut is the most populated village, possibly due to its long existence, since 1824 followed by Kg Balat, which has been in existence since 1920 (Table 5). The other three villages were established in the 1980s. Some of the villagers in Kg Desa Permai were ex-Kg Pagar occupants, whose village is now abandoned. Almost all of the villagers are of the Sungai ethnic group. However, some Kadazan, Murut, Dusun, Bugis and Timor ethnic groups are also found, mainly through mixed marriages. The communities appear to adopt a one village-one religion concept. Islam is the major religion for Kg Balat, Kuamut and Desa Permai, while Kg Tangkong and Tulang-Tulang adopt Christianity. Education wise, only Kg Kuamut shows the

highest literacy rate of more than 50%. The rest of the respondents in other villages scored less than 25%.

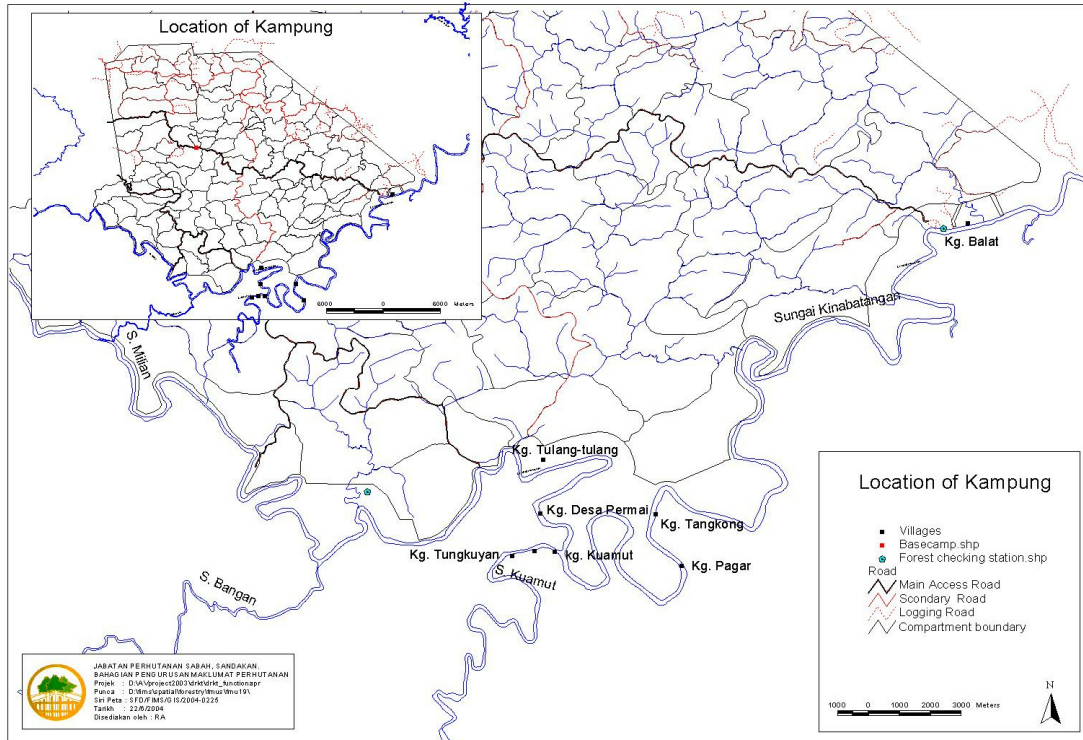


Figure 5: Location of Kampung at the vicinity of DFR

Table 5: General information of the villages

Village	Number of Households	Population	Major Religion	Year Established	Ability to Read (%)
Kg. Balat	44	230	Islam	1920	<25
Kg. Tangkong	12	75	Christian	1985	<25
Kg. Kuamut	128	269	Islam	1824	51-75
Kg. Desa Permai	12	110	Islam	1975	<25
Kg. Tulang-Tulang	22	100	Christian	1973	<25

2.4.2 Infrastructure

Amongst the 5 villages surveyed, Kg. Balat is considered the most "advanced" village with most of the basic infrastructure available (Table 6). Telecommunication wise, the village is very near the Balat Forest Checking Station, where a satellite telecommunication set is available. This village also enjoys clean and continuous

gravity water supply from Compartment 112 nearby. Kg. Kuamut is the largest village and has the most number of Government offices. It is the center for Mukim Kuamut. It is the only village that has a clinic. Kg. Tulang-Tulang has the least infrastructure and is the poorest amongst all.

Residents of Kg Desa Permai and Kg. Tulang-Tulang have been requesting SFD to repair the Karis-Karis road, which links the villages to the DFR Base Camp and Telupid/Sandakan. However, due to cost and operational priorities elsewhere, the SFD has not been able to re-establish the old road. River is the main mode of transportation and every household owns at least one small paddleboat. For a one-way trip to Bukit Garam (3 hrs by 30 HP boat from Kuamut), one has to pay RM35.00 - RM50.00 depending on weight and the bulkiness of their goods. Renting a boat to Bukit Garam would cost RM200.00 -RM500.00.

2.4.3 Economic Activity

The villagers are in majority, subsistence farmers. Only a few are working in government agencies because finding employment in government agencies has been difficult. Unemployment becomes more serious due to the absence of logging companies nearby. More and more youngsters and middle-aged villagers immigrate to towns looking for proper employment, resulting in an energy-drain of the villages.

Table 6: Infrastructure available in the villages surveyed

Infrastructure	School	Clinic	Religious Building	Road	Meeting Hall	School Library	Water Supply	Electricity Supply
Village								
Kg. Balat	✓		✓	✓	✓	✓	✓	
Kg. Tangkong	✓		✓		✓			
Kg. Kuamut	✓	✓	✓		✓	✓		
Kg. Desa Permai	✓		✓		✓			
Kg. Tulang-tulang			✓		✓			

The main economic activities of the local communities are timber salvaging or "cultural harvesting", fishing and to a lesser extent, hunting, rattan collection, fruit and vegetables farming. Rattan is collected in DFR by the local communities in Kg. Balat and sold to a middleman. Fruit is a common perennial crop sold to a nearby market. Conceptually, all villagers would sell any perennial or annual crops available, but they are restricted by market accessibility.

The local communities still depend on nearby forests to get their supply of timber, rattan, firewood, wild vegetables, fish, wild animals, wild fruits, medicinal plants and others. Primarily, they are for own consumption, except for timber and rattan. To these communities, the latter two forest products are essential for their life sustenance. Together with other home (e.g. bread, etc.) and farm (e.g. hill rice, corn, durian) products, they are sold to logging companies, SFD staff at Balat Forest Checking Station, Kg Kuamut or at Bukit Garam.

2.4.4 Land Property

On the average, the local communities in Kg. Kuamut and Kg. Tulang-Tulang own approximately 6.0 ha of land each (Table 7), while those from the other 3 villages have less than 2 ha. However, all the local communities in Kg. Desa Permai have managed to secure Native Titles on their lands, whereas, about 18% and 5% of the villagers in Kg. Balat and Kg. Tulang-Tulang respectively, have managed to secure Native Titles on their lands. However, the villagers in Kg. Tangkong, are yet to get their land titles.

2.4.5 Impact on Forest Management

Since time immemorial, DFR has been one of the better forests for the local communities to collect minor and even major forest products. The timber boom in the eighties and early nineties has made these communities largely dependent on timber alone as their main source of income. They received good salary working for logging companies, and for some enterprising individuals, they have made quite a good fortune by becoming loggers themselves. Farming for food was not common at that time, since they could purchase almost everything from the money they earned from working for the timber companies. Unfortunately, this source of income was not sustainable because logging operations in the area have long being stopped. Thus, some of the local communities have turned to DFR to continue their habit for quick cash, prompted by several unscrupulous log buyers.

Despite regular patrolling along the southern border of DFR, illegal loggers still managed to encroach and carried out their illegal activities in DFR. This has prompted the SFD to increase surveillance along the Kinabatangan River in order to ensure that illegal encroachment in DFR will not occur. This problem has been largely alleviated if not eliminated. Meanwhile, all Heads of Villages have asserted that since DFR is part of their "ancestral land", they should be given permission to enter DFR freely to collect minor forest produce, such as fish, medicinal plants and so on. Within the DFR Compartment 109 near Kg Balat, there are two small land areas protruding towards the Kinabatangan River. These lands are actually part of DFR, which cut across the riparian reserve as access to the river. Since there was

no proper marking of the boundary on the ground, villagers had occupied these lands for planting rattan and hillrice. Efforts will be undertaken, however, to develop and restore these areas with the local communities' participation through social forestry activities (see Chapter 4.5).

Table 7: Economic activities and land property of the villagers surveyed

Economic Activities	Average land area (ha)	Land Ownership *		Type of Crops Marketed		Employment		Use of Forest	
		Type *	Household (%)	Perennials **	Annuals ***	Govt (No.)	Company (No.)	Type ****	Use *****
Kg. Balat	2	3	18	1, 2	1,2,4	8	-	1,2,3,7	1,2
Kg. Tangkong	1.2	2	100	1	1,2,3	2	-	1,3,4,5,6,	1
Kg. Kuamut	6.0	1	70	1	1,2,3,4	8	-	1,2,3,4,5,6,	1,2,3,
		3	30			-	2		
Kg. Desa Permai	1.2	3	100	1	1,4	3	-	1,2,3,4,5,6,7	1,2,3
Kg. Tulang-Tulang	6.0	1	5	1	1,2	-	1	1,2,3,5,6,7	1

Note:

* 1: No Land Title, 2: Land Application, 3: Native Title

** 1: Fruit trees, 2: Rattan

*** 1: Vegetables, 2: Corn, 3: Tapioca, 4: Sweet Potato

**** 1: Timber, 2: Rattan, 3: Firewood, 4: Wild vegetables, 5: Fish, 6: Wild animal, 7: Medicinal plants

***** 1: Own use, 2: Sell, 3: Own use & sell

2.5 Past Management

Conventional logging commenced in DFR in 1956 under the Special License of United Timbers. The Company ceased operations in 1976, but at the same year, another license was issued to Seranum Sdn. Bhd. covering an area of 945 ha. In the following year, another area of 1,204 ha was given to Lai Fook Kim (Brothers). By

the end of 1979, there were 5 Special Licenses issued in DFR, which covered approximately 16,914 ha.

Elopura Maju was given the balance of virgin forests at the north-eastern part of DFR in 1979. In 1987, a Special License was issued to Abadi Mewah Sdn. Bhd., and an annual license to Syarikat Jaimi Sdn. Bhd. for relogging.

Reduced Impact Logging (RIL) was started in DFR by the SFD in 1995. As of September 2004, the total net area harvested under RIL was approximately 5,127 ha, which covered 16 Compartments (see Map in **Appendix 4**). These compartments are 54, 59, 50, 61, 51, 38, 29, 35, 31, 30, 22, 53, 32, 18, 34 and 55 (up to Sept. 2004).

2.5.1 Planning

Prior to 1976, the Special License served as a simple working plan based on area control. The area was divided into working blocks, whereby, a block is worked as an annual coupe. The silvicultural system used was the selective system. In this system, the felling diameter limit for all commercial tree species was 60 cm dbh. Upon the completion of logging, the coupe area was closed after a "closing inspection report" was prepared by the DFO. This was normally followed by silvicultural treatment.

In 1976, logging by area control was abandoned, and previously logged areas were re-logged. Silvicultural operations after logging were also stopped in 1977. By 1995, DFR was managed by the SFD based on a forest management plan (FMP), which was thoroughly prepared with a well-coordinated operational program.

2.5.2 Past Production

Timber production rose from 74,065 m³ in 1961 to a peak of 467,757 m³ in 1973. Total production for the period 1961 to 1975 was 3,161,348 m³. Based on available production figures related to DFR, the average production from 1959 to 1968 was 109 m³/ha.

When SFM was implemented in DFR in 1995, the annual allowable cut (AAC) was calculated at 20,000 m³. However, the results of the mid-term review, which was carried out in 1999 showed that, the SFD had achieved the area target to be harvested but the harvest volume was far short from the target. As a result, it was recommended in 1999 that the AAC within the balance area of 3,487 ha, be reduced to 15,000 m³ until year 2004, while the harvesting intensity is to be increased to 25 m³/ha (i.e., maximizing harvest/ha). As a result of this, a total net

area of 5,127 ha (up to November 2004) comprising 16 compartments was harvested (see **Appendix 4**). The total yield over the 10-year planning period was approximately 118,675 m³. Average yield over the net harvested area was about 23 m³ha⁻¹.

2.5.3 Silviculture

Prior to 1995, four different types of silvicultural treatments were prescribed in DFR. These were:

First Silvicultural Treatment: climber cutting and tree marking for retention before felling.

Second Silvicultural Treatment: LSM (linear sampling milliacre survey), climber cutting and poison girdling

Third Silvicultural Treatment: LS $\frac{1}{4}$ (linear sampling quarter-chain survey), climber cutting and poison girdling

Fourth Silvicultural Treatment: LS $\frac{1}{2}$ (linear sampling half-chain survey), climber cutting and poison girdling.

The first silvicultural treatment was carried out 2 years before felling, whereas, the second silvicultural treatment was done immediately after logging. The third and fourth silvicultural treatments were done 5 years and 10 years after logging respectively. Records showed that the total area treated during the 2nd, 3rd and 4th silvicultural treatments were 31,557 ha, 8,604 ha and 8,217 ha respectively.

From 1996 to 2004, two types of silvicultural measures were prescribed in the medium-term FMP. These measures were stand tending and enrichment planting. Stand tending encompasses the tending of regeneration (trees 1.5 m height - 5 cm dbh) established in gaps by cutting climbing bamboo and removing non-commercial competitors in their immediate vicinity and liberation of potential crop trees by removing trees which directly compete for light. Enrichment planting (using indigenous species) was carried out by planting the seedlings in lines or in clusters of 3-5 seedlings. The total area silviculturally treated from 1996-2004 was approximately 8,022.45 ha comprising 14 compartments (see map in **Appendix 5**). The total area planted by enrichment planting was 1,147.85 ha. This activity was discontinued in 2002 due to the high cost involved, high mortality rate (15%) and ground assessment revealed that stand-tending alone was sufficient due to good natural regeneration.

2.5.4 Environmental Issues

Conventional logging practices are often highly destructive to the forest ecosystems. Heavy machinery can compact the soil and destroy vegetation while high-volume harvesting can contribute to erosion, and reduce species diversity and the regenerative capacity. Excess organic debris can make forests more vulnerable to destruction in the event of fire. Therefore, forest harvesting in DFR is based on the Reduced Impact Logging (RIL) technique, as a matter of policy.

Since DFR was certified by the FSC as a well managed forest in 1997, the SFD has given priority to training and research to quantify environmental effects of reduced-impact logging (RIL) particularly on the effects of logging road construction and timber harvesting activities on stream water quality. The training focused on:

- **Road engineering** - Road engineering involves the specification of design standards and the actual engineering, design, field layout, construction and maintenance of forest roads. It also includes subsidiary structures such as small scale and low cost bridges and culverts. Properly designed and constructed roads can improve the efficiency and safety of transport and minimize soil erosion.
- **Felling** - The SFD staff are trained in improved felling (such as directional felling) and crosscutting techniques. Safety and health aspects of forest work are also highlighted during the course.
- **Extraction** - Timber extraction is a complicated operation that can inflict substantial damage to the forest. The SFD staff and workers were trained in the planning of skid trails and practical implementation of efficient extraction techniques. This is very important in order to optimize extraction productivity and to minimize damage to the forest.

The research results carried out in DFR demonstrated that environmental damage could be minimized through the use of site-sensitive harvesting techniques. Among the findings, it has been shown that RIL methods can reduce impacts to the soil from heavy logging machinery of between 9% and 13%. The result also showed that the amount of damage to the soil and to advanced regeneration was reduced by about 50 % relative to conventional logging. Being a research project, the EIA requirement in DFR was exempted by the Environmental Protection Department.

2.5.5 Forest Protection and Security

Forest protection and security cannot be planned and effectively implemented in the absence of a permanent forest estate. In the case of DFR, it was re-

constituted as a Commercial Forest Reserve in 1984, which is a commitment by the State government to defend the permanent forest estate based on secure, long-term land tenure for forest users. The forest management system in DFR sets the standards and regulations, as well as, procedures for effective forest protection, particularly in the protection or conservation areas and enforced, a systematic control, with good enforcement of laws and policy.

Permanent definition and subsequent surveying of boundaries were carried out in DFR. In addition, DFR was zoned according to land use. Zoning is used to identify activities that are acceptable or prohibited, subject to some form of regulations and procedures. This has contributed to the effective protection of DFR from fire, encroachment and illegal logging. Besides, the presence of a firm and lasting commitment and appropriate plan and monitoring action by the DFO and his staff have effectively protected DFR from potential threats and activities that might impair the achievement of SFM in the area.

2.5.6 Managerial implications of forest protection and security issues

In DFR, appropriate land tenure policies, contracts, supervision, and regulation, are already in place. Environmental protection had been implemented strictly without compromising environmental values. However, forests provide substantial public-good services, implying that a high degree of stakeholders' involvement is both inevitable and desirable. In view of the overall resource constraints facing the SFD, the SFD must collaborate with other stakeholders, particularly the local communities to work toward forest protection particularly, against the threats from fire and illegal logging.

PART III - FOREST RESOURCE BASE

3.0 Forest Stratification

Based on the visual photo interpretation of aerial photographs (scale 1: 17,500), the entire DFR was classified into 5 different forest strata. Such an assessment of DFR is intended to provide an overall impression of forest quality and timber stock at a landscape level. The criterion for stratification is the number of trees ≥ 60 cm dbh (Table 8) as interpreted from crown size. This approach to forest stratification is a standard method used by the SFD mainly to provide a quick assessment of the commercial potential of a forest area and to aid in identifying areas suitable for timber harvesting. The map in **Appendix 6** shows the forest stratum map for DFR that was interpreted from aerial photographs taken in 2001. More than half (54%) of DFR is classified as 'poor' forest, while only about 5 % of the reserve comes close to the stocking level of a primary forest.

Table 8: Forest strata for DFR as interpreted from aerial photographs 1:17,500 scale

Stratum	Forest Description	Number of trees ha ⁻¹ ≥ 60 cm dbh	Area (ha)	% of total area
1	Good forest	> 16	2,688	4.9
2	Moderate forest	9 - 16	12,044	21.8
3	Poor forest	5 - 8	29,723	54.0
4	Very poor forest	0 - 4	10,470	19.0
5	Shrubs/grassland		75	1.3

3.1. Forest Inventory

An inventory of timber resources was carried out over a period of 9 months, from October 2002 to July 2003, covering all production compartments in DFR. The inventory involved 5 teams and a total cost of about RM 220,000. This cost included basic field equipment, field allowances and transportation.

The inventory method used plots arranged continuously along a linear strip. All trees > 40 cm dbh were enumerated on 10 x 20 m plots along the strip, while PCTs were selected within a nested 10 x 10 m plots. Each compartment was inventoried independently, resulting in stand and stock tables for individual compartments. The results of the inventory are provided in Table 9.

3.2 Yield Regulation

The main purpose of yield regulation is to determine an AAC or prescribed annual yield for the planning period. For this, growth projections of the inventory data were made to determine when a compartment is likely to yield an economic harvest. Although the management-planning period spans over a period of 10-years, growth projections were made for one cutting cycle, in order, to ensure that harvesting is sustainable over the long-term. For the purpose of yield regulation, a 40-year cutting cycle is assumed for this management plan, and a minimum economic cut of $45 \text{ m}^3\text{ha}^{-1}$ is used to determine when a compartment is adequately stocked to justify a harvest. This translates to about 9 extracted trees ha^{-1} of trees between 60 cm to 80 cm dbh. Therefore, a compartment is considered ready for harvest when it has 9 trees ha^{-1} in this size class that may be extracted. However, the standard used in Table 9 is 15 trees. This is because experience from the previous planning period showed that only about 60% of trees marked for harvesting are actually removed due to defects and operational constraints. Taking this into account, a stand will need to be stocked with at least 15 trees to get 9 extractable trees ha^{-1} .

Table 9 provides a ranking of compartments according to the year that they are expected to be ready for harvesting. The varying years compartments are ready for harvesting, reflects the heterogeneity of stocking conditions from one compartment to another, which is typical of a logged-over forest like DFR. The numbers in column 8 indicate the year the compartment is expected to be ready for harvesting. The number '1' indicates that the compartment may be harvested in the current year (i.e. the year the inventory was conducted), while '2' indicates that the compartment may be harvested in the following year, and so on. The number 40 + indicates that the compartment is not likely to yield an economic harvest within a cutting cycle of 40 years, and prospects for natural regeneration is uncertain. For these compartments, some form of restorative intervention would have to be considered.

3.3 Annual Allowable Cut (AAC)

Following the standard approach to area-control yield regulation, the next step is to consider the total area available for harvesting during the period of one cutting cycle. Dividing this area by the number of years in the cutting cycle would give the average size of forest area that may be harvested each year. From growth projections for all production compartments, 86 compartments covering a total area of about 36,695 ha may be harvested over the entire 40-year cutting cycle (Column 9, Table 9). Dividing this area by 40 years, would give a gross annual allowable harvest area of about 917 ha.

Table 9: Inventory results showing number of sound commercial trees ^{ha⁻¹} and their volume in m³ha⁻¹ (given in parenthesis) for individual compartments in DFR

Compartment	Block	Size (ha)	40 - 60cm	60 - 80cm	80 - 120cm	> 120cm	Year ready for harvest	Year scheduled for harvest
87		460	5.7	18.5 (77.0)	2.2 (16.9)	0.3 (4.3)	1	11
48		263	7.1	17.7 (75.3)	1.2 (9.1)	0.4 (4.8)	1	4
62		333	18.1	12.1 (50.9)	2.9 (20.5)	0.3 (4.6)	1	3
85		580	8.0	10.8 (44.2)	3.1 (20.9)		1	1
49		501	7.8	12.1 (52.2)	2.2 (15.2)	0.1 (1.9)	1	4
57		557	6.8	9.6 (39.0)	2.6 (11.2)	0.3 (1.8)	1	1
42		255	10	9.1 (37.5)	3.9 (25.8)	0.1 (1.3)	2	4
56		339	12.2	10.9 (44.6)	1.8 (9.0)		2	2
33		451	3.3	11.9 (48.2)	1.3 (7.2)	0.6 (7.3)	2	2
1		510	4.7	11.3 (47.5)	2.0 (14.3)	0.5 (7.1)	3	3
76		554	6.1	6.5 (28.2)	4.8 (34.3)	0.2 (3.2)	3	5
28		474	3.6	11.6 (50.5)	1.5 (10.7)	0.1 (1.4)	3	6
63		500	8	11.0 (46.2)	1.0 (6.2)	0.1 (1.3)	5	5
60		582	13.3	9.7 (41.2)	2.0 (12.3)		5	7
43		493	5.8	11.2 (46.4)	1.4 (9.4)	0.1 (1.0)	6	6
47		375	5.3	10.4 (43.6)	0.7 (5.6)		7	12
104		178	8.8	9.1 (39.2)	1.3 (9.2)		7	8
25		298	6.1	9.2 (39.0)	1.9 (13.4)		8	9
77		591	11.2	6.3 (26.8)	2.4 (17.6)	0.1 (1.4)	8	7
108	A	150	4.8	11.4 (47.3)	1.4 (10.9)	0.2 (2.2)	8	11
72		503	4.9	11.0 (47.8)	0.6 (3.6)		8	8
4		399	5.7	4.4 (19.6)	4.6 (34.6)	1.5 (22.8)	9	12
7		480	6.6	10.1 (41.1)	1.3 (8.9)		9	10
107		704	5.9	9.2 (38.2)	1.4 (8.9)	0.1 (0.7)	10	10
11		666	6.9	8.8 (37.3)	1.2 (8.5)		10	9
71		512	7.8	9.2 (38.9)	0.8 (5.9)		11	8
27		425	5.6	9.4 (39.0)	0.1 (0.9)		11	9

Table 9 - Continue

Compartment	Block	Size (ha)	40 - 60cm	60 - 80cm	80 - 120cm	> 120cm	Year ready for harvest	Year scheduled for harvest
20		840	10.2	6.2 (26.0)	2.0 (15.3)	0.2	12	10
52		174	12.8	4.8 (19.7)	2.1 (15.4)	0.2	12	13
74		383	8.2	5.2 (23.1)	1.8 (12.8)		13	13
86		362	4	8.3 (35.2)	1.8 (13.3)		13	13
117		449	9.6	4.4 (19.5)	2.1 (17.3)	0.5	14	14
114		413	10.6	7.1 (29.0)	0.1 (0.7)		14	14
3		257	10.3	6.7 (28.3)	1.4 (9.1)		15	15
64		413	8.6	4.0 (17.0)	2.2 (15.7)	0.1	15	15
2	A	179	10.4	6.5 (27.8)	1.4 (9.0)		16	15
105		550	9.4	5.4 (23.0)	0.6 (4.0)		16	16
9		564	12.6	4.6	0.2		17	18
60		582	13.3	2.7			17	18
50 *		592	7.3	12	5.1	0.5	18	19
16		550	5.8	6.7	1.5		19	19
54 *		661	9	5.4	1.4	0.1	19	20
97		319	9.4	5.1	0.1		19	21
61 *		505	15	7.3	3.2	0.2	20	21
51 *		315	14.7	6.9	3.3	0.3	20	22
8		320	4.5	3	3.9	1	20	22
53 *		329	7.8	8.1	5.3	0.3	21	22
31 *		431	17.4	6.9	0.8		22	23
29 *		440	6	14	1.4	0.6	22	23
24		338	2.9	8.4	1		22	24
101		549	4.1	7	0.9		22	24
26		305	6.1	7.6			22	25
35 *		429	8.1	4.1	2		22	25
96		480	9.4	3.9			22	26
30 *		410	7	16	1.6	0.2	23	26
22 *		732	6.3	9.8	2.3	0.5	23	27
32 *		701	12.2	10.2	1.4		23	28
83		151	8.1	6.5	0.2		23	28
38 *		384	9	10.5	5.2	1.1	23	29
44		450	5	5.3	1.6		24	29
12		296	4.9	5.4	1.3	0.3	24	30
91		370	10.1	3.4			24	30
55 *		291	13.8	6.1	1.7		25	30
34 *		770	7.4	7.5	4.3	0.2	25	31
112		416	6.3	3.9	1.4		26	32

Table 9 - Continue

Compartment	Block	Size (ha)	40 - 60cm	60 - 80cm	80 - 120cm	> 120cm	Year ready for harvest	Year scheduled for harvest
65		392	6.1	2.6	0.9	0.4	26	32
121		573	1.5	4.3	2.9	0.5	27	33
89		466	9.4	2.1			27	33
95		359	3.9	5	1.4		28	34
88		635	3.8	5.5	0.8		28	34
19		545	6	4	0.3		28	35
23		381	2.7	2.2	2.9	1.1	30	35
21		369	4	3.8	1.3		30	36
78		341	9.1	4.1			30	36
100		340	2.4	4.1	1.1		33	36
59 *		400	8.5	3.4			33	37
93		131	2.6	3.3	1.4		34	37
2	B	218	17.3	1.9	3.8		35	37
79		345	2.6	3.7	0.9		36	38
67		328	7.5	2	1.6		36	38
10		359	7.8	2.1			37	39
66		497	2.8	5.1	0.5		38	39
98		452	1.8	3.3	0.8		38	40
70		627	3.4	3.3	1.3		40	40
90		355	3.2	2.7	0.4		40+	
73		171	5.5	2.6	1.9		40+	
106		454	2.7	3.2	0.8		40+	
15		191	3.1	2.5	0.8		40+	
7		600	2.4	2.7	0.6		40+	
4		330	3.9	2	0.6		40+	
84		315	2.4	3	1.1		40+	
69		490	2.8	4.1	0.1		40+	
99		509	2.8	2.3	0.7		40+	
111		496	2.9	1.8	0.9		40+	
58		443	5.7	2.2	0.5	0.1	40+	
13		608	6.8	2	0.4		40+	
120		335	2.3	0.2			40+	
125		358	7.8	2.3			40+	
126		535	7.1	2	0.1		40+	
68		234	1.5	1.8	0.2		40+	
109		265	5.3	0.7	0.7		40+	
124		375	5.6	0.7	0.7		40+	
6		308	5.3	1.4	0.2		40+	

Table 9 - Continue

Compartment	Block	Size (ha)	40 - 60cm	60 - 80cm	80 - 120cm	> 120cm	Year ready for harvest	Year scheduled for harvest
46		312	7	1.1	0.3		40+	
133		453	1.4	1.1	0.3		40+	
128		566	3.9	1.4			40+	
127		473	4.5	1.3			40+	
135		669	0.6	0.6	0.4		40+	
5		466	6.4	0.4	0.3		40+	
45		315	7.3	0.6	0.2		40+	
122		870	1.5	0.7	0.1		40+	
131		216	2.3	0.7			40+	
132		438	1.3	0.2	0.2		40+	
134		289	3.6		0.2		40+	
130		333	1.8	0.2			40+	
129		444	2	0.1			40+	
5		466	0.7				40+	
123		499	2.8				40+	
108	B	319	3.1				40+	

Note: Compartments are ranked in ascending order according to the year it is projected to be ready for harvest. In the first column, '*' indicates compartments harvested in the previous planning period (1995-2004).

The next step is to identify compartments or combinations of compartments that would add up to approximately this size and to schedule their harvest such that harvesting may be carried out sustainably throughout one cutting cycle. This schedule is shown in Column 9, Table 9. The schedule demonstrates that harvesting can be sustained continuously throughout one cutting cycle.

Twenty-five (25) compartments covering an area of about 10,759 ha are scheduled for harvesting in the planning period 2005 - 2014. Assuming that the net harvestable area is 48 % of the gross harvestable area - calculated average proportion from the previous planning period - and the minimum economic cut, i.e., 40 m³ha⁻¹ is taken as the average yield per hectare, then the AAC is calculated as 17,600 m³ (Table 10). Therefore, for this planning period the annual allowable cut is set at 17,600 m³, and the total harvest for the entire planning period should not exceed 176,000 m³.

Table 10: Calculation of annual allowable cut for the planning period 2005-2014

Average Gross Annual Harvestable Area (ha)	Average Net Annual Harvestable Area (ha)	Average Estimated Yield (m^3ha^{-1})	Annual Allowable Cut (m^3)
917	440	40	17,600

3.4 Forest Recreation

3.4.1 Introduction

The traditional emphasis of forest management in DFR has focussed on timber production. In this respect, the land use of the area has typically addressed only two types of zoning (by compartments) - timber production and protection. Given that the original purpose of applying sustainable forest management in DFR was to create a model for multiple-use forestry, there is potential within this management plan period to expand the present functions of the DFR to develop alternative forest uses, such as, forest based recreation and tourism.

DFR has abundant land resources (more than $550km^2$), pristine forests, rivers and lakes, which provide a suitable setting for forest based recreation and tourism. The present compartment-based cycle of harvesting, and the FMP process (being implemented within this FMU) provides the opportunity to develop compatible resource uses in a systematic and organised manner. The inclusion of forest recreation and tourism will enhance and strengthen sustainable forest management, create greater public awareness and appreciation, provide additional business opportunities (strengthening the local economy), and in particular enhance the revenue generation potential of DFR. In short, it fulfils the overall goal of creating a multiple-use forest for economic, social and environmental purposes.

3.4.2 Natural Attractions of DFR

Identifying the natural features that are significant is one of the fundamental steps in the development of any tourism or forest recreation area. This is important to keep in mind because it will give rise to the "purpose" of the development, giving direction to the design of facilities, services and activities provided. In addition to this, the natural significant features (or attractions) will give rise to what overall experience (or take home message) is to be portrayed, and guide the design of interpretation (or "communication message") to be promoted to attract visitors to the site.

The possible attractions of DFR include lowland dipterocarp forest, extraordinary large trees, wildlife and birdlife, rivers, lakes, limestone caves, and scenic vistas. The details of these attractions can be found in a report entitled "Preliminary

Assessment of Forest Recreation & Ecotourism Potential for Deramakot Forest Reserve", which was written by Martin P Vogel (SFD Consultant). It should be noted that this list is general and includes only the highly visible "flagship attractions" of the area. There are possibly many other interesting, special, and significant features that "stand out" in Deramakot, not yet included in this list. This list is not meant to be exhaustive and with detailed scientific exploration, many additional draw-cards could be uncovered.

3.4.3 Potential Products

The potential products, which are suitable for development within DFR, include wildlife observation & photography, sport fishing and recreational angling, canoeing and kayaking, and long distance trekking. It is important to keep in mind that:

- Each of the products will require individual detailed planning to ensure the appropriate design and placement of facilities, and appropriate mechanisms are put in place for the management and marketing of these products.
- For the purposes of this FMP, it is envisaged that the detailed planning necessary for each suggested product is within the scope of the next 10-year period of implementation of the FMP. In this respect, detailed planning might find that these products are not feasible, and/or alternative products are more appropriate. For this reason, this list is not meant to be definitive, but merely outline a preliminary list of the potential products to direct the initial detailed investigation and planning activities.
- There is a broad scope for integration of forest based recreation activities and tourism with the other present ongoing harvesting activities within the reserve. This list is meant to outline the preliminary requirements so that the management of other activities (namely harvesting) can be cognizant of the proposed products and work in the short-term and long-term towards ensuring compatibility between these activities.

3.4.4 Management Implications

Planning for the management of DFR and its surrounding should take into consideration the potential for developing ecotourism activities in the area. A comprehensive study to evaluate the tourism potential of DFR was carried out. Suitable areas for development of ecotourism activities were identified. However, a proper zoning process for all ecotourism sites as mentioned in this plan will not be feasible.

There is already good models demonstrating how careful management and operations practices aimed at maintaining high service standards will continue to attract visitors and ensure on-going profitability. High environmental standard is

becoming increasingly valuable in the market place. In view of this, an explicit management and operations strategy is needed in DFR. In general, the strategy should seek to improve the quality of the tourist experience and the socio-economic contributions of tourism, while maintaining the physical resource base.

3.5 High Conservation Value Forests (HCVF)

3.5.1 Introduction

In 2003, the SFD revised its first DFR FMP by incorporating HCVFs. The HCVF concept focuses on the values, which make the forest important in a particular social, biological, cultural and geographical context. It is these values, which must be identified and protected. For instance, if the identified conservation value is the highly endangered Orang-Utan, then the forest in which these Orang-Utans live becomes a high conservation value forest and management activities in that forest must protect Orang-Utans. Similarly, if the high conservation value identified is the sacred burial area of an indigenous people, then the forest containing the burial sites becomes an HCVF and management within that forest must protect the burial sites.

3.5.2 Definition of HCVF

High Conservation Value Forests, as defined in this plan, are those forests that possess one or more of the following attributes:

- Forest areas or compartments having high biodiversity values (e.g. areas of high *endemism*, areas known to support endangered species, areas rich in wildlife);
- Forest areas or compartments that may provide representative samples of natural populations in their undisturbed form (e.g. pristine forest);
- Forest areas or compartments that may provide basic environmental services and are sensitive to disturbance (e.g. watersheds, areas on steep slopes, areas sensitive to soil erosion); and
- Forest areas or compartments fundamental in meeting the basic needs of local communities (e.g. subsistence, protein, medicines, building materials, and clean water) and/or critical to local communities' cultural integrity (e.g. areas of cultural and ecological significance).

The first three attributes are classified under the biological and ecological category, whereas, the last attribute is under basic needs of the local communities.

3.5.3 Identified HCVFs in DFR

Given the above definition, the Sabah Forestry Department in consultation with experienced SFD field staff of DFR, relevant government agencies, NGOs (WWF Malaysia and PACOS), and the local communities, has made an assessment to determine the presence of the HCVF attributes in DFR. In addition, WWF Malaysia also conducted their one-month HCFV field survey in DFR in 2003. Based on the assessment results, the identified HCVF attributes were:

- Forest areas having high biological and ecological values;
- Watersheds and areas with steep slopes; and
- Areas of ecological and economic significance to local communities.

3.5.4 Rationale

Deramakot FR is geographically divided into 3 parts. They are: Deramakot North, which is generally flat and gentle terrain, with pockets of wetland areas or fresh swamp forests, Deramakot Central, which is generally hilly, and Deramakot South, which is a mixture of fragmented limestone hills and wetlands. Each of these forests contains some unique species, which have adapted only to the conditions found therein. These forest types also have certain genetic and species diversity that maintain (i) the potential for ecological resilience and resistance and (ii), provide refuge for forest-dwelling species when disturbance occurs.

The HCVFs that meet the basic needs of the local communities were identified based on close consultation with the local communities. A preliminary assessment was used to identify where the value(s) occurred in DFR. Site visits to the local communities living in the vicinity of DFR (especially Kg. Balat, Kg. Desa Permai and Kg. Tulang-Tulang) were conducted. Consultations through dialogues and discussions with them pertaining to the presence of high conservation values were held. A large part of the local communities' protein is from hunting and fishing. The only source of good quality water supply is from DFR. With the information gathered, the HCVFs for local communities in DFR were identified and mapped (see map in **Appendix 7**). Nevertheless, full assessment to determine the size of the areas and whether they are actually present in DFR, requires further consultation and joint site assessments.

3.5.5 Distribution of HCVFs in DFR

The sites of these HCVFs having the above attributes can be referred to as per Figure 11. Not all of the attributes mentioned above are being fully assessed and mapped in this plan. There are still some information gaps at the western and eastern central parts of DFR that need to be addressed. They would, however, be identified (including size of the areas) and mapped during the preparation of the Comprehensive Harvest Plan (CHP), which is more detailed and accurate.

Forest areas having high biological and ecological (biodiversity) values

In Deramakot North, Compartments 17, 18, 19 and 20 are recognized to have mixed peat swamp forests. The most localized species found here is the Kapur paya (*Dryobalanops rappa* Becc.) species. The species is gregarious in nature, but after the previous logging, is now in pockets at the edge of shallow peat swamps, or scattered on sandy hillsides and ridges.

The Upper Rawog Besar River (Cpts 12, 13, 14, 26, 25 and 24) has been relatively untouched, and is recognized to have a high concentration of fresh water fishes and particularly, the much sought after fish, locally known as *Polian* and *Kalui*. Their abundance has attracted crocodiles (*Crocodylus porosus*) into these areas and the areas have become the crocodiles' safe breeding ground.

The wide range of compartments (north and south of DFR) that physically connect DFR with Segaliud Lokan FR (east of DFR) and Tangkulap FR (west of DFR), are fairly low ground and thus, become the wildlife (elephants and also wild ox) corridors. Co-incidentally, at the northern corridor, there are saltlick areas located in Cpt 9 and at the southern corridor, which are located in Cpts 108, 88 and near 120 (at the mouth of Sg. Deramakot), the northern part of Kg. Balat, western part of Malubuk River, and the eastern part of Kg. Tangkong. These are usually wetland areas or swamp forests where concentration of animals increases during the dry season. However, saltlicks are also reported to occur in Cpt. 49 and 63 in Deramakot Central.

Elephants (*Elephas maximus*) are found almost everywhere inside Deramakot, but commonly spotted along Masirom Road (Cpt. 61 to Cpt. 117), Karis-Karis Road (Cpt. 77 to Cpt. 134), Tangkulap Road (Cpt. 18 to the junction of Tung Hup Road), Batuk Road (Cpt. 16 & 21) and in the south, along the Kinabatangan River. Elephants are commonly sighted along these roads because they use the road network as one of their trails to reach other sub-habitats (compartments), which are considered as HCVFs. Spotting elephant tracks is possibly easier using helicopters during the dry season, when elephant food such as rattan, *Barau* and many kinds of climbers dry

faster. Our Border Patrol Unit has seen a large herd of elephants crossing the wide Kinabatangan River near Sg. Liningkong and at another point, between Sg. Malua Kecil and Sg. Malubuk.

Orang-Utan (*Pongo pygmaeus*) nests have been seen frequently all over Deramakot, but higher concentrations are found along Upper Deramakot River (Cpts. 99, 120 & 121), along Masirom Road (Cpts 61 to 109) and Liningkong (Cpt. 135). They mainly nest on Binuang (*Octomeles sumatrana*) and Laran (*Antocephalus cadamba*) trees, both pioneer species.

Tracks of Wild Ox (Tembadau - *Bos javanicus*) have been observed at Ulu Liningkong River (Cpts. 127 & 128), Tangkulap Kecil River (Cpts. 84 & 85), Masirom Road near Km 20 (Cpts. 104 & 103), in the north at Cpts. 18 and 22 and nearby compartments.

Proboscis monkeys (*Nasalis larvatus*) are usually seen along the banks of the Kinabatangan River during low water level in April to June. They forage in small groups at some common points from Sg. Arawon to Batu Api (15-18 per group), at Kalang-Badan (6-7 per group) and from Sg. Liningkong to Sg. Bangan (approx. 30 per group).

Watersheds and areas with steep slopes

These areas are commonly known as "exclusion areas" and/or "unloggable areas" within the production areas. These areas are set aside and to remain undisturbed due to its steepness, which is in excess of 25° over a contiguous area exceeding 2 hectares, or rocky areas. Since these areas are small in size, plotting/marking these areas on maps can only be done during the stock/harvest tree mapping process.

Areas of cultural, ecological and economic significance to local communities

Several important sites have been identified as important to the local communities. These are:

Hunting ground/fishing sites - The local communities derive a large part of their protein from hunting and fishing in the forest. Hunting is carried out once to twice a month using traditional methods (using spear and dogs). Hunting grounds are located along the Kinabatangan and Kuamut River. At Kg. Tangkong, the hunting ground site is along the Malubuk River up to the hill site at the eastern part of the village. Fishing is largely carried out in the Kinabatangan River.

Water supply - The pipe water gravity for the local communities in Kg. Balat, is sourced from the Goigob River located in Compartment 112. Other forests or compartments (Cpts. 67, 88, 108, 110, 119, 123, 124, 131, 132, and 135) have been identified and recognized by the communities as having social and economic values, particularly for the collection of non-timber forest products (e.g. food plants, honey, meat, and mushroom), traditional medicines and economic plants, such as rattan.

Ecotourism and historical value - Beautiful waterfall sites are located at the Sangitan River and at Ulu Arawon River (Cpt. 116, approximately 1.5 km from Sg. Bas-Bas, near Deramakot River). There is a wonderful waterfall formation locally known as "Airterjun Lubang-Tujuh". Limestone caves have been identified at Bukit Togunob (near Arawon River - Cpt 116) and another at Sg. Tangkulap Kecil. It was reported by the local communities that some edible birdnests are found in these caves. Sites of coffin caves have been identified at Serupi and Sg. Milian west of kg. Tulang-Tulang. The latter is considered to have some historical value.

Wildlife observation sites - The local community has identified Malubuk River and Sangitan River as potential wildlife observation sites. Proboscis monkeys and birds are the main attraction.

There are more spectacular eco-tourism sites on the other side of the Kinabatangan River, especially those at Sg. Kuamut and Sg. Bangan. Together with the various eco-tourism areas that Deramakot can offer, they could become a very interesting nature-education cum adventure package for domestic and international tourists.

3.5.6 Management Implications

DFR and the surrounding land area have played an important role in the shaping of the present Kinabatangan River. The history of the area is of high significance and should be an important tourism attraction. Historical aspects of DFR (in particular the caves found in DFR) and surrounding areas have been considered, and to be zoned, once proper identification is completed. Given the biodiversity of wildlife, DFR has great potential to become an attraction for tourists.

PART IV - MANAGEMENT PRESCRIPTIONS

The previous chapters of this plan described the basic information and resource base, which have direct relevance to the management of DFR. In this chapter, specific management prescriptions are directly related to achieve each of the management objectives listed in Chapter 1.3.

4.0 Forest Zoning

DFR (FMU 19) has been re-zoned and divided into 135 compartments using geographical features where available (see map in **Appendix 8**). The list of compartments with their respective functions can be found in **Appendix 12**. The relevant land use or function has been ascribed to these compartments based on site degradation risks, actual growing stock conditions, potential for water catchment, and socio-economic requirements, particularly for those residing in Kg. Balat. Table 11 provides a summary of the land use classification of DFR.

Table 11: Land use classification based on forest functions in DFR

Total Area (Ha)	Forest Function			
	Conservation (Ha)	Production (NFM) (Ha)	Community Forestry (Ha)	Recreation/ Ecotourism (Ha)
		Cable Crane and Ground Skidding Combined		
55,083	3,473	51,592	18	0
%	6.31	93.66	0.03	0

Conservation: Slopes > 25° (e.g. protection of water resources)
Slopes < 25° (e.g. HCVFs)

Production: Slopes ≤ 25°

Community Forestry: Areas adjacent to human settlement
Suitable for community based land-use

Recreation: Areas suitable for all sorts of recreation or eco-tourism

From Table 11, it is noted that approximately 3,473 ha in DFR are designated as protection or conservation areas. The designated conservation compartments comprise mostly hilly terrain with slopes above 25°. A gross area of 51,592 ha or 93.7% is set aside for production, while the "two legs", [compartments 109 (A) and (109 (B))] located in the south - east of DFR, have been designated for community needs. Areas identified for recreation/ecotourism and HCVFs are located in the

protection and production areas. These areas have not been specifically set- aside but they will be protected during the harvesting operations.

4.1 Conservation Area

4.1.1 Management Objectives

There are 17 compartments with a gross area of 3,473 ha that have been designated for protection/conservation (see map in Appendix 7). In addition, another 7,882 ha are within the production area (Table 12). Therefore, the total protection area in DFR is 11,355 ha or 21% of the total area of DFR. The main objective of managing the area is to prevent site degradation caused by logging in this steep area, which contains most of the slopes above 25°. The protection of this area is fundamental to the management of the water catchment areas of the Kinabatangan River. The secondary objective is to manage this area together with the production area to protect and conserve whole ecosystems to maximize the protection and conservation afforded for forest resources, soil, water and bio-diversity of both flora and fauna.

4.1.2 Focus of Management

Management will be confined to boundary protection and the prevention of any activity, which disturbs the natural succession of the existing vegetation and wildlife populations, in particular fire, illegal encroachment, logging and hunting (see Chapters 4.4 - 4.7). The values for ecotourism have been assessed and its management can be referred to in Chapter 4.3. Riparian reserves of 30 m wide on each side of the permanent watercourses will be protected in all compartments within the production area. A separate Forest Protection Plan has been prepared and is currently being implemented in DFR.

4.2 Timber Production

4.2.1 Net Timber Production Area

Not all areas within the production area are for timber production. Therefore, the net timber production area is derived by deducting permanent infrastructure (roads, buildings), riparian reserves and swamps/lakes from the gross production area. This is shown in Table 12.

Table 12: Net Timber Production Area in DFR

Area Designation	Area (ha)
Gross Production Area	51,592
Less: Permanent Infrastructure	921
Riparian Reserves *	3,550
Slope > 25°	4,332
Net Timber Production Area	42,789

* Riparian Reserves - areas on 30m wide along both sides of the permanent watercourse measuring not less than 5m in width and swamps.

From Table 12, the net area for timber production is expected to be approximately 42,789 ha.

Forest harvesting is confined to the net production area of 42,789 ha. There are 118 compartments, which have been designated for timber production. Prior to harvesting, the timber resources have been assessed of its stocking level through aerial photographs and forest inventory (see Chapter 3.1).

4.2.2 Management Objectives

The long-term objective of natural forest management (NFM) in general is to sustain production of high value timber based on the AAC limit while maintaining a high degree of species and structural diversity. Considering the importance of forest resource sustainability and timber quality, emphasis within this planning period is given to the improvement of growing stock based on the following regimes:

- **Natural regeneration** - these are the areas whereby the forest stockings are still high and the resources are to be managed sustainably.
- **Silviculture inputs** - the harvestable stock in these areas may be low, but existing growing stock is high. These areas require various levels of silvicultural measures before the forests could be restored of its sustainability.
- **Forest Restoration** - these are the areas where there is no or insufficient natural regeneration and needs to be restored by planting with indigenous tree species.

4.2.3 Forest Harvesting and Schedule

Forest harvesting will be based on an area-control yield regulation and the AAC of 17,600 m³. During the tenure of this FMP, logging will be permitted only in compartments as listed in Table 13.

Twenty-five (25) compartments covering an area of about 11,026 ha (gross) are scheduled for harvesting during the planning period 2005–2014 (see **Table 13** and map in **Appendix 9**). The total gross area to be harvested each year ranges in size from 967 ha to 1,477 ha. The estimated average gross total volume of standing timber available in the compartments to be harvested annually is approximately 63,000 m³, whereas, the annual average net production is expected at 17,600 m³, which is a conservative figure. The expected log residues extracted annually will be 1,600 m³, that is, 9% of the expected net production.

Forest harvesting will be carried out based on reduced impact logging (RIL), which is eco-friendly. For difficult terrain area, harvesting will be a combination of skyline-ground skidding methods. The SFD's trained contractor will carry out the logging operations, while the staff of the SFD will do the preparation of the Comprehensive Harvesting Plan (CHP).

Table 13: Harvest schedule for the planning period 2005 - 2014

Year	Cpt No.	Area (Ha)	Total Area (Ha)	Estimated Volume (m ³)
2005	57and 85	557and 580	1137	13,196.5
2006	56 and 33	339 and 451	790	12,942.5
2007	1 and 62	55 and 333	887	20,408.2
2008	42, 48 and 49	255, 263 and 501	1,019	16,694.1
2009	63 and 76	500 and 554	1,054	18,938.3
2010	60 and 77	582 and 591	1,173	17,623.0
2011	71, 72 and 104	512, 503 and 78	1,193	19,796.9
2012	28 and 43	474 and 493	967	19,259.4
2013	11, 25 and 27	666, 298, and 425	1,389	15,375.7
2014	17 and 20	557 and 840	1,417	21,240.9
Total			11,026	175,475.41

4.2.4 Continuous Forest Inventory (CFI)

An essential part of yield regulation is the permanent monitoring of the growing stock by repeated inventories or by the use of permanent plots. The main purpose is to check the actual growth and development of the growing stock, against the projected growing stock, in order to avoid any serious discords between what is planned and what can actually be achieved. If large discrepancies are found between actual and projected development of the growing stock, then adjustments will have to be made with regard to the harvest scheduling.

A permanent monitoring and control system will be established during this management planning period, and repeated inventories will be carried out as a routine management activity. A portion of the former inventory lines of each compartment will serve as permanent inventory lines, and will be repeatedly inventoried every 5 to 10 years. The target is to resample 5 compartments every year. An important benefit of continuously updating inventory data in this manner is that it will make it unnecessary to carry out a major inventory for the entire FMU for every new planning period. Table 14 provides a schedule for the re-enumeration of selected compartments for the 10-year planning period.

Table 14: Schedule and selected compartments for CFI for the planning period 2005-2014

Year	Compartments To Be Inventoried	Year	Compartments To Be Inventoried
2005	10, 34, 52, 55, and 74	2010	16, 26, 50, 63, and 76
2006	17, 47, 57, 64, and 85	2011	28, 43, 54, 61, and 97
2007	14, 33, 56, 86 1, and 17	2012	8, 51, 53, 60, and 77
2008	1, 9, 62, 105, and 114	2013	24, 31, 71, 72, and 104
2009	42, 48, 49, 64, and 74	2014	11, 25, 27, 29, and 101

4.2.5 Timber Stand Improvement

Timber stand improvement (TSI) in the context of this plan refers to the cutting of climbing bamboos and woody vines, as well as, the selective liberation of PCTs by girdling weedy trees that impede their growth. TSI is generally prescribed as a post-harvest treatment. Therefore, all compartments, which are harvested during the planning period, will also be treated. In the present planning period, TSI treatments will be maintained at 10,000 ha, that is, an average of 1,000 ha per year, covering 23 compartments. Table 15 and map in **Appendix 10** provide the schedule for TSI treatments for the 10-year planning period.

Table 15: Schedule of TSI treatments for the planning period 2005 - 2014

Year	Compartment No.	Size (Ha)	Year	Compartment No.	Size (Ha)
2005	34 and 55	1,000	2010	63 and 76	995
2006	57 and 85	1,102	2011	60 and 77	1,145
2007	33 and 56	774	2012	71, 72 and 104	1,130
2008	1 and 62	840	2013	28 and 43	951
2009	42, 48 and 49	992	2014	11, 25 and 27	1,293
Total					10,222

4.2.6 Forest Restoration

Over the 10-year planning period, an area of about 2,000 ha involving 5 compartments in the southern part of DFR are proposed to be developed through forest restoration program using indigenous species. These compartments are 108, 122, 123, 124, and 134 (see Table 16 and map in **Appendix 11**). All these compartments have been determined to have very poor standing stocks, and are not expected to yield an economic cut within one cutting cycle of 40 years.

Table 16: Forest restoration program 2007 - 2011 in DFR

Year	Compartments To Be Restored	Net Area To Be Restored (ha)
2007	108	400
2008	122	400
2009	124	400
2010	123	400
2011	134	400
Total	5	2,000

Due to the proximity of these compartments to village communities living along the Kinabatangan River, every effort will be made to engage these communities in the planting operations. It is expected that the restoration program in these compartments will also prevent boundary encroachment in the south.

The species being considered for planting are fast-growing indigenous species such as, Laran (*Anthocephalus cadamba*), Biniang (*Octomeles sumatrana*), and Sepat (*Mytragyna speciosa*). The cost of the forest restoration works, including the cost

of maintenance for a 5 - year period is estimated at RM 3,000 ha⁻¹. The annual target for the forest restoration development is 400 ha yr⁻¹. The forest restoration works will begin in 2007, subject to the availability of funds, which the SFD has applied from the Federal Government under the 9th Malaysia Plan.

4.3 Ecotourism and Forest Recreation Opportunities

The key step to be undertaken within this management period is to develop recreation and tourism within DFR and maximise economic, social and environmental benefits from this area. By doing so, it will help to improve the "image" of the SFD from the public as being a "sleeping giant" on ecotourism development.

4.3.1 Objectives

- To provide recreational & educational opportunities in the natural forest environment;
- To define, plan and support the development of recreational & educational opportunities within DFR;
- To make DFR as a tour destination, which creates income generation opportunities and generate revenue for the State; and
- To promote community-owned based ecotourism for the adjacent local communities.

4.3.2 Definitions

"Nature Based Recreation" and "Forest Based Recreation" are synonymously referred to in the context of this plan, and are defined as any specific activity in the natural/forest environment that is "not regarded as work", but regarded as an outdoor leisure activity, hobby or pursuit. To name a few, this would include; walking, hiking, picnicking, sightseeing, swimming, relaxing in nature, bird watching, camping, fishing, climbing and so on. This list is inexhaustible and viewed also to encompass "hard-core adventure pursuits" and "outdoor sport activities" such as trekking, orienteering, rock-climbing, etc.

"Ecotourism" is defined as tourism to natural areas that enhances the conservation of the area, provides benefits to local populations, and appropriate interpretation of the environment to enhance the visitor's experience. For the purpose of this FMP, the terms "tourism", nature based recreation, and ecotourism, will be used synonymously and interchangeably. This is because the focus of "tourism" and "recreation" within DFR is primarily "**nature based**" and at the same time, bound to fit in with the "**principle of sustainability**" (in line with the principles and policy of SFM), which by default meets the basic definition of "ecotourism".

"Environmental Education" and "Nature Education" are referred to synonymously in the context of this plan, and defined as "education about the environment - in the

environment". Environmental Education (EE) is regarded as a specific activity targeted at students with specific learning objectives, and is based on a standard curriculum within the education system or related co-curriculum student/teacher activity. For the purpose of this FMP, Environmental Education (EE) is considered to be a special interest outdoor activity, which typically involves, or is based on, a number of nature based recreation activities. For this reason, EE will be treated as a special interest nature based recreational activity, with planning needs following similar requirements as other nature based recreational activities.

The natural features of DFR as mentioned in Chapter 3.4.4 are significant and attractive enough to lure visitors for sightseeing, or other special interest activities within DFR. These natural features can be developed as sights of significance, to function as attractions for visitors who simply want to observe or witness the phenomena. In addition to this, these natural features can form the backdrop to develop recreation activities, whereby the activities, also function as a major part of the attraction of the area.

4.3.3 Basic Requirements for Forest Recreation in DFR

For forest recreation and tourism activities to take place within DFR, there are some basic supply side requirements that should be put in place for these activities to be developed. These include: access, the availability of transport services, accommodation at site, the supply of food & beverages, basic amenities (water & electricity supply, sewerage treatment, and waste disposal), safety regulations and emergency procedures (e.g. access to medical attention), telecommunication facilities for operations (or in case of emergency), as well as information (interpretive) and promotional materials.

This section will outline in brief the basic requirements for forest recreation to be developed within DFR. These basic requirements need to be in place, irrespective of whatever forest recreational activity, arises as the most appropriate. They will act as a guiding framework for forest recreational development over the next 10-year management period, whereby actions and strategies to achieve these requirements will be outlined in the implementation plan (and annual work plans). This should ensure that the key elements in forest recreation are studied in detail and incorporated into the detailed development planning process.

Access, Roads & Trails

One of the strengths of DFR, which sets it apart from other forest based recreation and tourism destinations in Sabah, is the good quality all season road access and the existence of a network of secondary roads and trails within the reserve. For an area of the size of DFR (over 550km²), the existence of a variety of world-class natural attractions is meaningless without available road access.

Roads and trails are the key to the success of forest based recreation and tourism within DFR. The present road access sets this reserve apart from other forest based recreation and tourist destinations in Sabah such as Mt Kinabalu, Meliau Basin, Danum Valley, and the Lower Kinabatangan Wildlife Sanctuary whereby, vehicles access is limited to the fringes of the reserves.

A variety of access related facilities would need to be put in place to provide a platform for activities in the area (eg shelters, rest-stops, car parks, and signage). These elements are more appropriately covered in detail in the development plans. However, their importance should not be forgotten for future management of forest recreation in DFR.

Accommodation, Transport, Food & Beverage Provision

The development of appropriate accommodation will be integral to the success of forest recreation & tourism within DFR because of its remoteness and its distance from urban populations & basic tourism infrastructure (e.g. hotels). Appropriate accommodation should include permanent and organised campsites for visitor target groups such as school students. Accommodation should be designed to enhance the visitor's experience of the forest environment and put in place steps to minimise impact on the environment, for example, follow eco-design principles. If appropriately designed, the accommodation can become an attraction by itself.

Transport, accommodation and food & beverage services are fundamental to the supply of forest recreation and tourism. In the Sabah context, these services are typically privatised and operated by commercial hoteliers and/or tour operators. In the case of DFR, the detailed planning stage of product development need to be undertaken to investigate the advantages and disadvantages of privatising both service and facilities concessions. Detailed planning stage of product development studies would also be undertaken to investigate the economic feasibility of forest recreation and tourism activities, the start-up and hidden costs of operating in this remote area, and the long-term revenue generation potential.

Basic Amenities

The provision of adequate water supply and electricity supply will be one of the fundamental steps to be put in place for the development of expanded facilities for recreationists and tourists to DFR. The inadequacy of these basic amenities is one of the main limiting factors to dispersing the development of recreation facilities to the more picturesque locations within DFR, other than the operations centre at the base camp. Even so, for the early stages of recreational development, these amenities (and hence facilities) are centralised to reduce start-up costs.

The detailed planning and implementation for water & electricity supply is done at an early stage of this planning period. Similarly, with waste disposal and sewerage treatment, detailed planning would be carried out to ensure that an increase in

human-traffic in the area does not lead to adverse long-term impacts on the natural environment. Prevention of adverse environmental impacts should be made a top priority for the SFD's planners of facilities and activities within DFR with the provision of tertiary sewerage treatment, composting toilets and removal of all solid wastes from the area as a standard protocol or long-term goal.

Emergency Procedure & Medical Treatment

Safety and security should always be a first priority particularly in a very remote location such as DFR. There are various risks associated with outdoor recreational pursuits. However, these factors combined with hostile wildlife, other local environmental risk factors, poor planning, and lack of preparation, is a sure cocktail for disaster. The risks involved should not deter recreational activities going ahead. However, any recreation and tourism development in DFR should be accompanied by a detailed risk assessment. The point of this exercise is to put in place mechanisms and management strategies that reduce the risks, prevent accidents before they happen, and prepare contingencies in the event of a disastrous situation.

Risk assessment processes are to be established as a standard procedure. In the start-up phase, before any further ground breaking development goes ahead, this needs to be investigated once the detailed planning is completed. Periodic risk assessment should also be followed on an on-going regular basis in the future. A large part of risk reduction, accident prevention and contingency strategies will be the management of personnel, service providers and out-fitters. There should be an appropriate education and training of all staff associated with work within DFR, particularly front-liners handling visitors and recreationists.

Telecommunications

Adequate telecommunications will be an essential prerequisite for the management of recreational and tourism activities within a vast remote area such as DFR. At present VHF radio has already been established for use within DFR, and has proven to be successful for communicating within remote compartments of the reserve. The VHF radio facilities, repeater stations, and mobile units will be maintained and upgraded to reduce potential problems with the radio network. Simple steps such as purchase of lightning proof equipment should be put in place to avoid failure of communications at a critical time. Staff should be appropriately trained in handling radios, and regular (weekly) radio system checks established and put into practice.

Information (Interpretation)

Information, communication & interpretation (all used synonymously) are a key component in enhancing the visitor's experience at Deramakot. This includes providing information about places to go, things to do, activities and choices. It also includes directional information, signages, maps and information to orientate the visitors so that they are not lost, but immediately orientated and given a sense of

security of being taken care of. It provides basic guidelines to appropriate behaviour, along with do's or don'ts where necessary - e.g. to ensure visitor safety. It also includes information about the interesting and significant features in DFR (interpretation) so that visitors understand and appreciate what they are observing or experiencing. It should also involve information about the management and organisation, to raise awareness about policy, principles, and programs- e.g. SFM or conservation efforts.

An interpretation plan (or communications plan) would be prepared after the detailed development plans are completed to outline all the necessary communications elements necessary, and ensure that communications are coordinated, thematic and portray the overall mission and image of the SFD. An appropriately designed and located interpretation centre would add value to the visitor's experience within DFR, and is considered imperative to communicating the uniqueness, significance and "take home message" to visitors to the reserve. An interpretation centre can also provide directional information, safety information, promote certain activities, and create awareness of appropriate visitor behaviour within the reserve.

Properly designed and located "observation platforms" should be put in place to enhance the visitor's experience of the natural setting by offering a "birds eye view" of a particular landscape, scenic vista, or natural phenomena (in the case of wildlife observation towers). This is understood in the context of this plan to be an extension of the Interpretation Centre in FRC. This is an appropriate low-impact development that would enhance the visitor's experience, becoming an attraction in itself. Of particular potential within DFR are wildlife observation platforms (or hides) appropriately located near one or more of the numerous saltlicks.

Promotional Materials

Promotional materials such as brochures, posters, flash-clips, and web-sites will eventually need to be put in place. This needs to be planned appropriately, with budget allocations assigned for this purpose. Marketing plans should be a mandatory part of the detailed development plans or alternatively part of the overall communications (interpretation) plan. This should outline all available marketing vehicles, and steps to establish contacts with domestic and foreign agents, wholesalers and government promotional bureaux, special interest groups, clubs, schools, societies and so on. In the long term, all avenues should be addressed including merchandising products such as souvenirs, T-shirts, hats, post-cards, screen-savers and any other gimmicks to popularise the recreational and tourism activities within the reserve.

Service Providers (Tour Operators - Outfitters)

Some aspects of the development and operations of forest recreation and tourism will eventually be contracted out to private companies. The detailed study would be

undertaken to establish appropriate protocols, procedures, guidelines and standards established and put in place before facilities, services or concessions are handed to private firms. Realistic fees would be established within marketable parameters in order to provide adequate revenue generation, as well as, incentives to private operators, to do the job properly.

4.3.4 Implementation

Summary

For forest recreation and tourism to be developed within DFR, further detailed investigation and planning is essential. In this respect, it is important that detailed studies are initiated from the outset, with development plans and guidelines put in place throughout the management plan period. It will be important within the FMP period to plan in detail the visitor management concept, zone activities, and outline the theme of forest based recreational development in DFR. This will ensure appropriate development will be undertaken, that fits with the overall "image" chosen for the area, and give rise to detailed regulations and guidelines for these activities to proceed within DFR.

At present the specific forest recreational activities and associated developments to be targeted within the FMP period are not specified. This is because further investigation is necessary to ascertain the respective feasibility of each proposed forest recreational activity and their detailed requirements. Each of the proposed activities will be planned in detail, and discussed at length before their final implementation goes ahead. Even so, a preliminary list of potential recreational activities is suggested to include; wildlife observation, recreational fishing, hunting, long-distance trekking, and canoeing. This preliminary list will form the basis of detailed investigation and planning for the initial FMP period.

To commence forest recreational activities in DFR, there are many basic requirements, which also need to be taken into consideration and/or put in place for these activities to function. Within the FMP period, these requirements will either need to be planned in detail separately or planned for in combination with the various proposed forest recreational activities respectively. This includes roads and access, accommodation, food and beverage provision, transport services, water and electricity supply, telecommunications, waste disposal, safety regulations and emergency procedures, information and interpretive services, and promotions.

4.3.5 Work Plan

Deramakot Forest Reserve has already been a testing ground for new theories and practices of harvesting and SFM. It has already proven to be a workable solution to the provision of economic, social and environmental needs. Forest recreation and tourism can be considered as the next step in the management of the area, and an enhancement of the present utilization of DFR.

This section will outline the work necessary to be carried out within this FMP period (see Table 17). This work plan provides some basic indicators for monitoring of the development throughout the 10-year implementation period.

Table 17: Work Plan for Forest Recreation Development in DFR

Management Activity	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Detailed Studies & Planning										
Detailed investigation initiated from the outset										
Detailed development plans drawn-up										
Outline the visitor management concept										
Define the zones for activities										
Outline the theme & overall "image" for DFR										
Define detailed regulations and guidelines										
Detailed Studies & Planning										
Monitoring to ensure appropriate development										
Mid-term Review of Planning & Development										
Basic Requirements										
Roads & Access										
Accommodation										
Food & Beverage Provision										
Transport Services										
Water & Electricity Supply										
Telecommunications										
Waste Disposal										
Safety Regulations & Emergency Procedures										
Information & Interpretive Services										
Human Resource Development & Training										
Promotions										
Review that all Basic requirements in place										

Table 17 - Continue

Management Activity	Year									
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Wildlife Observation										
Ascertain feasibility & detailed requirements										
Detailed Planning										
Workshop & discussion before implementation										
Tender out activity concessions										
Promote the activities										
Operation										
Recreational Fishing										
Ascertain feasibility & detailed requirements										
Detailed Planning										
Workshop & discussion before implementation										
Tender out activity concessions										
Promote the activities										
Operation										
Long-Distance Trekking										
Ascertain feasibility & detailed requirements										
Detailed Planning										
Workshop & discussion before implementation										
Tender out activity concessions										
Promote the activities										
Operation										
Canoeing										
Ascertain feasibility & detailed requirements										
Detailed Planning										
Workshop & discussion before implementation										
Tender out activity concessions										
Promote the activities										
Operation										

4.4 Managing HCVFs in DFR

Identification of HCVFs is the first stage of the process. There will be a need to focus on the implications for management, to ensure that the HCVs that have been identified in DFR, are maintained or enhanced. This process also needs to be closely integrated with a monitoring program

4.4.1 Biological and Ecological category

Kapur paya species - Maintaining and enhancing the productive sites of Kapur paya species in compartments 17, 18, 19 and 20 are essential. Practical steps that would be taken are as follows:

- The SFD in consultation with specialists such as, Ecologists and Botanists from the Forest Research Centre, Sepilok would undertake ground studies of the areas including compiling all relevant, available baseline information pertaining to the species. Any threat to the HCV, posed by harvesting operations, will be identified. The constraints of these threats on harvesting operations are also to be examined. This will be an on-going process;
- Specific sub-compartment boundaries and sizes, sufficient to maintain the Kapur paya, are to be defined and delineated and later, to be mapped;
- The species are to be protected from being logged. The sub-compartment boundaries where necessary, will be marked with yellow paint and notices will be displayed on site; and
- Forest restoration activities will be implemented, if deemed required.

Wildlife habitats - There is always a growing interest in conserving wildlife in DFR. Therefore, promoting practical actions along the following lines can promote effective wildlife conservation in DFR:

- The identified saltlick areas and the surrounding forest habitats in Cpts. 9, 49, 108, 63, 88, and near 121 (mouth of Sg. Deramakot) will be protected from logging. Close supervision will be carried out during logging. Hunting shall not be allowed in the area. Markers and notices in the areas will be displayed.
- Close supervision will be carried out during logging operations in Cpts. 12, 13, 14, 24, 25 and 26 to ensure that the operation conforms to work procedures and follows the RIL guidelines or harvesting lay out plan. Besides that,

fishing will be strictly prohibited along the Rawog Besar River that falls within these compartments. Notices in the areas will be displayed.

- All forms of disturbances, however temporary, displaces animals from parts or all of their territories/habitats. The more extensive and prolonged the disturbance, the greater the chances that animals in an area, will become over crowded and their populations declining owing to social pressure, limitations on food supplies and space, and impaired reproductive ability. In order to minimize these effects, SFD will have to ensure that corridors connecting refuges as shown in the map in **Appendix 7** will be provided to allow free movement of animals in either direction. This means, logging operations will be minimal and will not take too long within the wildlife corridors, particularly in Cpts. 12, 14, 34, 55, 86, 88, 110, 119, 123, 124, 131, 132, and 135, which are classified to have higher value for the HCVF.
- Certain stand-level habitat features (e.g. riparian zones) will be maintained and protected as far as possible in a natural state so that their habitat and food sources will not be modified or removed.
- The size, frequency, and intensity of natural disturbance patterns and the current level of effective connectivity between habitat types found within DFR will be mapped and/or described.
- The existing systematic monitoring program for the wildlife in DFR will be continued.

4.4.2 Areas sensitive to disturbance

- In areas less than 2 ha in size with slopes of more than 25°, felling of commercial trees can only be allowed, if the log skidding operations by tractors can be performed, without construction of skid trails (unless they are old skid trails) inside the steep areas.
- Areas with slopes above 25°, which are more than 2 ha in size will be identified and marked/plotted on the CHP. These areas cannot be determined more accurately through map reading due to inaccurate contour lines. Therefore, they will be determined by actual slope reading collected in the field. No skidding is allowed in such areas, unless there is an approval from the District Forestry Officer, based on skid trail alignments prepared during the planning stage. Strict supervision and constant monitoring, however, must be exercised.

- "RIL Enclaves" or areas with slopes $<25^\circ$ surrounded by steep slopes $>25^\circ$ must be marked/plotted in the CHP. Harvesting is permitted but must be authorized by the District Forestry Officer provided factors such as soil conditions and weather are at a safe level. Strict supervision and monitoring on the ground during harvesting operations will be exercised by the officer-in-charge.

4.4.3 Cultural, ecological, and economic significance

- Communities living adjacent to DFR where the identified social and cultural HCVs apply will be further described. The relationship of each community with each of the identified HCV is also to be described.
- Logging will be integrated with minor forest product harvesting in the same area of forest. Such integration can be achieved with good logging practices and by establishing good relations with local people. Much incidental forest damage can be avoided simply by following RIL guidelines and good forestry practices.
- Harvest planning for wood production in the identified compartments will be dispersed so that adjacent or nearby compartments are at different stages of recovery following harvesting. By minimising forest fragmentation, greater species diversity is likely to be maintained and the risk of loss of NWFP species is minimized.
- SFD shall develop trust, foster understanding and productive communication and collaboration with the local communities particularly on the issues of NTFPs. A plan will be developed for continuous consultation with the community.
- Local communities are to be encouraged to be actively associated with forest resource management, including managing NTFPs. This means that, local communities will be invited and encouraged to work with SFD Forestry Officers on pre- and post-harvest assessments to ensure that NTFP species are properly considered. The aim is to provide continuing access to NTFPs by local communities having a traditional dependence on them.
- Isolated patches of forest areas, which have major social or cultural significance, will be further identified and mapped simultaneously with the stock mapping or harvest tree marking activity. Collaboration with the community is essential in this exercise. Building of roads through these areas will be limited.

4.4.4 Monitoring HCVs

The purpose of monitoring is to make sure that any changes in the identified HCVs are noticed. This allows action to be taken if the change is negative.

Key components of monitoring programs and indicators are the following:

i. Biological and ecological HCVs

- Kapur paya species would be monitored at least once every 3 years to determine whether the status of the species within the identified HCVFs (or Compartments) has changed.
- Status of representative habitat and specific wildlife population trends are to be monitored annually.
- Habitat survey results will be analysed annually.

ii. Basic services, social and cultural HCVs

- Harvesting operation in DFR will be closely monitored if it is affecting each identified HCV by checking incidence of landslides and water flow data. This is to be done annually.
- The identified HCVs will be monitored in collaboration with the local communities to ensure that they are intact.

4.5 Community Forestry

4.5.1 Introduction

Recently, community forestry has emerged as a major new area of development assistance to the local communities. Encouraging local communities to grow trees themselves - on their own farms and around their villages - is seen as an essential part of the strategy needed to combat the problems of forest encroachment and loss of trees and forest cover.

A variety of program approaches have been devised. Community participation has been sought as a means of widening the range and distribution of benefits, and involving landless people and the poor. Despite some success, there are obstacles to local participation. One encountered constraint in the context of DFR, is where people have no rights to land, and cannot be sure that they will derive the benefits

from any trees they plant. Therefore, it is quite pointless for them to make the long-term investment of effort and resources required. Nevertheless, the SFD will implement programs that can incorporate measures, which provide the local communities some security of tenure of the two compartments set aside for them.

4.5.2 Community Forestry Objectives

The objectives are:

- i. To integrate the communities living within the vicinity into the forest management activities of DFR.
- ii. To develop program approaches to a sustainable use of forest resources while improving the standard of living of the local communities through a management concept, in which the local communities play the main part in the management of the community compartments set aside to them and directly benefit from it.
- iii. To foster goodwill, understanding and mutual respect between the DFR staff and the communities, particularly on forest protection.

4.5.3 Strategies

All social forestry activities will be managed through a specially formed committee - the Deramakot Forest Reserve Social Forestry Committee. The structure of the committee is shown in Figure 6. The terms of reference of this committee, which provides a framework of authorities and function on the members in the committee is already in placed.

The Chairman will report directly to the Director of Forestry and any meeting minutes will be made known to the respective District Officer and State Assemblyman.

Workforce in Forest Operation

The local participation in any forest activities in DFR during the FMP1 was poor due to difficulties in hiring them and the problem of absenteeism. However, with the formation of the committee, it will facilitate the SFD to select and recommend suitable candidates should there be a vacancy as skilled or general workers in any forest operations in DFR, such as boundary maintenance, forest harvesting, silviculture, forest restoration, road maintenance or forest protection.

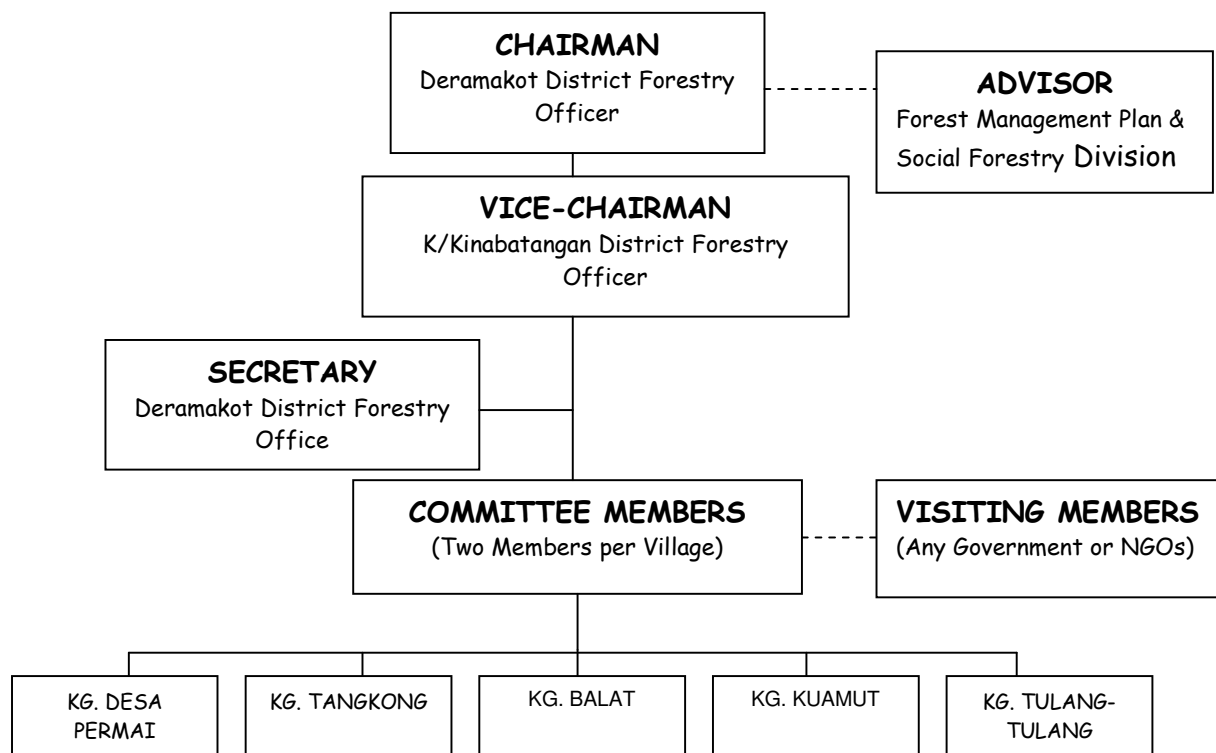


Figure 6: DFR social forestry committee structure

Joint Forest Management

Currently, there are 3 compartments partly utilized by the Kg Balat community. Compartment 97 is a watershed area for Sg Goingob, which is the source of gravity water supply for Kg Balat. This compartment is re-zoned as a Protection Compartment. There is no impending problem other than the need for constant maintenance on the gravity water system. However, there are at least three eco-tourism points along Sg. Goingob that can be developed as a source of income to the village, and coupled with home-stay programmes, it will present a perfect treat to culture and nature loving tourists.

The other 2 compartments are located at the 'Deramakot Legs' - a small area protruding to the Kinabatangan River, previously gazetted as forest roads. The *leg* nearest to the Balat Forestry Checking Station is Compartment 109 (A), and currently some local communities have planted the area with rattan. The other *leg* is located at the east-end of Kg Balat, which is Compartment 109 (B) and currently used for hill rice cultivation by 2-3 villagers only. Efforts will be undertaken to secure and regularize these *legs* and then to improve their ecological condition through social forestry activities. Since the villagers of Kg Balat are interested in farming non-timber forest products, these areas will be developed based on the

agroforestry concept by planting a mixture of rattan, forest fruit trees, medicinal plants, bamboo and others.

Forest Restoration

Forest restoration activities have been planned to restore 5 compartments within the natural forest management area, which are located at the southern part of DFR (see Chapter 4.2.6). The local communities will be given the opportunities through forestry contracts or labour in this program.

Small-scale Forest Based Industries

Handicraft making and woodcarving are some of the cultures inherited by the *Orang Sungai*. Their products are ranging from baskets, hats, mattresses, fish-trap to various kitchenwares. Therefore, efforts will be taken in collaboration with PACOS, Community Development Unit and other relevant agencies to encourage and to promote the local communities to establish and operate small-scale industries on wood products. The local communities are also encouraged to plant materials, such as rattan, bamboo, long-grass, hardwoods and others in the compartments assigned to them. Majlis Amanah Rakyat (MARA) will be invited to play the role of providing industrial advisory services, financing and training. They may also handle the marketing of the products.

Although medicinal plants such as *tongkat ali*, *kacip fatimah*, *medang tiga urat*, *medang sasi* and so on, are abundant in DFR, further consultation and research will be required on the readiness and capacity of the local communities to venture on these endeavors.

4.6 Infrastructure Management

4.6.1 Roads

At present, the main and secondary roads within DFR are still usable. However, sections of these roads require regular maintenance and/or the upgrading of problem sections. For this reason, road maintenance and upgrading problem sections (such as log-culverts, log-bridges and steep sections) are highlighted as the number one long-term priority management strategy to be put in place, in order to have good access to DFR and to facilitate the development of forest recreation and tourism in DFR.

Road construction and maintenance works will be carried out in accordance to RIL guidelines. The main road will be maintained at a density of 7m per hectare with a

maximum gradient of 10%. They have a 20 m right of way and a surface width of 10 m. The thickness of gravel is 15 cm. Secondary roads are maintained at a density of 14 m per hectare with a maximum gradient of 12%. They are 8 m wide with 6 m graveled to 10 cm thick.

The construction of new roads will be kept to a minimum to reduce costs, as well as, to lower the environmental impact on DFR as a whole. Where necessary, old skid trails will be used. The program to construct, upgrade, improve and maintain existing roads during the plan period is shown in Table 18. Feeder road maintenance will be carried out at least six months ahead of forest harvesting scheduled in the respective compartments.

Given that road construction and maintenance are some of the major cost hurdles to overcome, skills will be developed "in-house" (within the SFD) to build and maintain roads, bridges, culverts and drainage. Considerable attention will also be focused on R&D on alternative cost-effective methods of permanent bridge construction.

4.6.2 Buildings and Basic facilities

The development of appropriate office space and accommodation will be necessary in DFR due to its remoteness from urban populations. Similarly, the provision of adequate and good quality water supply and electricity will be some of the fundamental steps to put in place for the development of expanded facilities for DFR.

The following buildings and basic facilities will be constructed:

- 1 unit extension office for GIS and First Aid; to be constructed in 2006.
- 1 unit Rest House (6 rooms); to be constructed in 2008.
- 1 unit Rest House (3 rooms); to be constructed at Kg. Balat in year 2009.
- 1 unit Visitor Centre.
- 1 unit Multipurpose Hall.

Table 18: Road planning in DFR (2005 - 2014)

Year	Road ID	Location	Distance (km)	Purpose
2005	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 1		6	Maintenance
	SR 1A		15.7	Repair, Maintenance
	FR	C61	6.78	Repair, Maintenance
	FR	C47	9.02	Repair
2006	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 1		6	Maintenance
	FR	C69	6.66	Repair
	FR	C1	11.08	Repair
2007	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 3		10	Repair, Maintenance
	FR	C46	5.1	Repair
	FR	C58	10.02	Repair
	FR	C53	5.26	Repair
2008	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 2		8	Repair, Maintenance
	FR	C76	10	Repair
	FR	C99	11.08	Repair
2009	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 2		3.5	Repair
	FR	C74	11.64	Repair
	FR	C89	11.82	Repair
2010	MR 1		19	Maintenance
	MR 2		29	Maintenance
	FR	C66	10.24	Repair
	FR	C70	10.06	Repair
	FR	C79	3.56	Repair
2011	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR8		22	Repair, Maintenance
	FR	C30	9.48	Repair
	FR	C39	9.86	Repair

Table 18 (Continue)				
Year	Road ID	Location	Distance (km)	Purpose
2012	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 1		6	Maintenance
	SR 1B		16	Repair, Maintenance
	FR	C11	13.32	Repair
	FR	C21	5.96	Repair
	FR	C23	8.5	Repair
2013	MR 1		19	Maintenance
	MR 2		29	Maintenance
	SR 1		6	Maintenance
	FR	C15	11.54	Repair
	FR	C27	16.8	Repair
2014	MR 1		19	Maintenance
	MR 2		29	Maintenance

Note: MR - Main Road; SR - Secondary Road; FR - Feeder Road

4.7 Forest Protection

4.7.1 Control of Boundaries

An important requirement of long-term sustainable management is the security of DFR. DFR is porous in the west where it shares a common boundary with Tangkulap FR, and in the south along the Kinabatangan River. Two outposts are emplaced in Kg. Balat and Sg. Liningkong as a deterrent against illegal logging and also the prevention and control of forest fires during the drought season through a systematic mobilization of ground and river patrols as indicated in Table 19.

4.7.2 Forest Encroachment by Local Communities

At present, there are no human settlements within DFR except those along the Kinabatangan River, which are outside DFR. Regular dialogues with them via the Southern Deramakot Community Forestry Committee will be conducted. Community forestry programs will be implemented by the local communities in compartments [109(a) and 109(b)] in collaboration with the SFD. Employment opportunities for the local communities in forest operations particularly in forest restoration program will be provided. By incorporating the local community into the forestry activities,

the SFD hopes to secure the cooperation of the community in controlling encroachment into DFR for cultivation, settlement and prevention of fire.

A Daily Patrol Record for forest encroachment is currently emplaced in DFR. The SFD will continue to control all access points and patrol the area. The movements of the local communities will not be impeded in any way.

Table 19: Ground and river patrols for boundary control and surveillance

Guard Post	Area of Surveillance (Coverage)	
	Main River	Tributary
Kg. Balat	Sg. Kinabatangan	Tabalian Besar; Tabalian Kecil Deramakot; Balat; Arang; Arawon; and Goingob
Sg. Liningkong	Sg. Kinabatangan Sg. Milian	Ragu-Ragu Besar; Ragu-Ragu Kecil; Tiu-Tiu; Kara-Kara; Liningkong; Tangkulap Kecil; Kukon; Baka; Karis-Karis; and Kalang Badan
Base Camp	Northern/Eastern/Western Boundary of DFR	

4.7.3 Soil Protection and Watershed Management

There are 19 compartments or 6% of DFR, which have slopes greater than 25° that have been designated as protection/conservation areas. Logging will be prohibited in these compartments. Apart from these designated compartments, riparian reserves of 30 m wide on each side of the permanent watercourses within the production areas will be protected during harvesting operations.

All road constructions must follow the road specifications set in the Reduced Impact Logging (RIL) Guidelines, as well as, the Pre-Harvest Planning Standard of Procedure for tree harvest mapping and road alignment, which is available in DFR. All areas to be harvested will have a CHP. Areas having high site degradation risks will be demarcated on the CHP, as well as, on the ground. Other mitigation measures are already prescribed in Chapter 6.7.2.

4.7.4 Wildlife Protection

The wildlife monitoring system is already in-placed and being implemented in DFR. Besides, the measures as prescribed in Chapter 4.7.1, Table 20 provides the mitigating practices to be adopted to lessen the impact of forestry operations on the wildlife population. It is important to remind all forest visitors by erecting signboards to highlight the banning of illegal hunting and poaching activities, the prohibition of fishing, fish poisoning and bombing, and its penalties or fines as prescribed under the relevant laws. Steps are also to be taken to formulate action plans and strategies, both short and long term, which aim at improving the wildlife stocking and its value in the forest. This will be done during the mid-term period of this plan.

4.7.5 Fire Protection

A **Forest Fire Management Plan** has been developed separately for DFR. The plan is comprehensive and currently being implemented to effectively protect the forest from fires, which may occur due to the agricultural land clearing adjacent to DFR. Amongst others, the plan specifies the following:

- Fire Management Map with a scale 1: 50,000;
- Fire Prevention Plan;
- Fire Preparedness Plan;
- Fire Management Zones - access routes by vehicle, road and track network;
- Location of existing water points;
- Equipment resources statement and specifications for procurement of new equipment; and
- Fire Management Organization.

Table 20: Guidelines for mitigating the impact on wildlife populations²

ACTIVITY	NEED COORDINATION TO	DESIRABLE PRACTICE
1. Road construction & maintenance	<ul style="list-style-type: none"> • Protect riparian reserves & travel ways • Maintain down-and up-stream access of aquatic fauna • Prevent sediment from reaching streams 	<ul style="list-style-type: none"> • Use bridges or open-bottom culverts to cross streams • Stop construction in rainy season • Minimize road width and "timbang matahari" • Do not remove spawning gravel from stream beds
2. Conversion (Plantation Establishment)	<ul style="list-style-type: none"> • Protect riparian reserves • Apply low-impact conversion methods • Establish linear reserves 	<ul style="list-style-type: none"> • Clearing should progress towards wildlife protection areas • No burning
3. Felling	<ul style="list-style-type: none"> • Improve structural diversity (e.g. relic trees with holes for breeding of birds) • Retain riparian vegetation to provide shade & prevent temperature fluctuations that is harmful to aquatic life • Retain riparian vegetation to provide stream bank stability 	<ul style="list-style-type: none"> • Adhere strictly to tree marking rules • Protect food plants of value to wildlife • Pre-lay skid trails & maximize use of LDCCS* • Demarcate riparian buffer strips • Fell trees up-slope away from streams and buffers
4. Yarding	<ul style="list-style-type: none"> • Prevent damage to stream channel and minimize erosion 	<ul style="list-style-type: none"> • Do not yard across streams and maximize use of LDCCS
5. Pesticide application	<ul style="list-style-type: none"> • Prevent contamination of water and vertebrate populations 	<ul style="list-style-type: none"> • Use require application rates • Refrain from aerial spraying within 500 m or hand application within 30 m of streams • Do not spray during periods of heavy predation by insectivorous animals
6. Water management	<ul style="list-style-type: none"> • Protect streams from logging contamination (fuel & lubricants) 	<ul style="list-style-type: none"> • Do not yard across streams and maximize use of LDCCS

Note: * LDCCS refers to Long Distance Cable Crane System

²Source: Chai, D.N.P., Forest Management Plan: Forest Management Unit No. 19.

4.8 Research & Development (R&D)

4.8.1 Introduction

Science plays a fundamental part in efforts to achieve sustainable forest management, dealing with forest resources, as well as, their harvesting and processing. Forest management in Sabah is becoming increasingly complex, and information demands are multiplying. Concerns traditionally related to timber yield and economic benefits have expanded to include a host of non-timber objectives, from preserving natural habitats and recreational values, to meeting the distinctive needs of forest-based communities.

Many commitments in the SFD strategic directions outline the need for greater scientific knowledge and technological innovation in the forest sector. In particular, the SFD must increase its understanding of the impacts of human and natural disturbances on forest ecosystems, develop appropriate forest management tools and techniques, and enhance the forest sector's international competitiveness. Structuring research and development in this way, enables experts from diverse disciplines, to focus on complex problems and supports the development of more integrated techniques and approaches to resource management. This process brings in various disciplines in the natural and social sciences, as well as, traditional knowledge.

The Forest Research Centre (FRC) in Sepilok will combine their expertise and resources to look at a wider spectrum of issues associated with sustainable development in DFR especially those of the forest itself.

4.8.2 Focus for R&D in DFR

Research Projects on Tropical Forest Disturbance and Recovery

A Memorandum of Understanding between FRC and Centre for Ecological Research, Kyoto University (CERKU) was signed on March 17, 2003 to work on 'Tropical forest disturbance and recovery' in DFR. In this respect, a laboratory is to be built in DFR base camp by CERKU to facilitate the on-going research in Deramakot under this programme. Research projects under this theme are:

- i. Sustainability of biomass and floristic composition in Reduced-Impact Logged (RIL) forests;

- ii. Comparative analysis of the nutrient loss between a lightly logged versus an intensively logged forest in Deramakot Forest Reserve;
- iii. Effect of forest management on the diversity and community structure of the soil fauna in the Deramakot Forest Reserve;
- iv. Assessment of forest-use impact on insect biodiversity in tropical lowland rain forests of Sabah;
- v. A study on the abundance of seed dispersing animals and its effects on forest ecosystems;
- vi. Study on the ecology of ground herbivores and their role in tropical forest ecosystem: Check of ground herbivores by camera trap and direct observation in Deramakot; and
- vii. Economic evaluation on forest ecosystems under different utilization.

A project on soil beetles is also to be carried out and to be incorporated under the Intensified Research in Priority Area (IRPA) programme funded by of the Ministry of Science Technology and Innovation (MOSTI).

The FRC researchers in collaboration with the researcher(s) from CERKU, JAPAN carry out the research projects. CERKU researchers would have to be independent in most circumstances.

Research Projects on Impact of Forest Harvesting

The research projects carried out by FRC are conducted under the RMK 8 and to be extended after 2005. List of studies and objectives of the projects under the RMK 8 in DFR are:

Study 1 *Effects of two minimum diameter-cutting limits on timber yield, residual stand damage and regeneration in a lowland logged-over mixed dipterocarp forest in the Deramakot Forest Reserve (DFR), Sabah*

Objectives:

- To describe the forest structure of the study area before, after and several years after the logging
- To compare the level of logging damage to the residual trees between two cutting regimes,

- To compare timber yield between two cutting regimes
- To assess the mortality and regeneration of the forest after logging under two cutting regimes

Study 2 *Impact of forest harvesting on soil and leaf-litter beetle assemblage at Deramakot Forest Reserve in Sabah*

Objectives:

- To document the soil and leaf-litter beetle assemblage at the Deramakot Forest Reserve.
- To compare the species richness, abundance and species composition of the soil and leaf-litter beetle assemblages at different sites (before and after logging) at the Deramakot Forest Reserve.
- To investigate the impact of forest harvesting at different diameter cutting limits on the soil arthropods, with special reference to beetles.
- To investigate the impact of forest harvesting on beetle diversity at slopes of various degrees.
- To investigate the re-colonisation of the beetle assemblages at various logged sites over a period of time.

Study 3 *The effect of forest harvesting at different slope on soil erosion in Deramakot Forest Reserve*

Objective:

- To quantify the magnitude of soil loss by means of soil erosion if harvesting is carried out in different slopes and at different cutting limits and to make recommendations on the acceptable slope limit for harvesting.

Study 4 *The effects of different forest treatments on stream hydrology, water quality and quantity in Deramakot Forest Reserve*

Objectives:

- To understand the stream water hydrographic characteristics, which was affected by different forest cutting limits before, during and after logging.
- To monitor the changes of water quality due to logging

activities before, during and after logging.

- To study the direct effect of harvesting activities in certain areas within the logging areas specifically on sedimentation.
- To determine the duration in which the situation will be reverted back to normal condition after logging activities had stopped particularly on water quality.

Study 5 *Quantification of nutrient loss under reduced-impact logging: a comparative analysis between different logging intensities*

Objectives:

- To describe the major components or pathways of nutrient loss caused by logging.
- To quantify the amount of losses under the various components.
- To compare the nutrient losses under the different logging intensities.
- To estimate how long the forest can recover from the disturbances, in terms of nutrient replenishment.

Study 6 *Wood quality in relation to diameter sizes of trees*

Objectives:

- To determine the wood density of various size (DBH) of trees (selected species).
- To determine the proportion of heartwood and sapwood of various size (DBH) of trees (selected species).
- To determine the occurrence of juvenile wood of various dbh sizes of selected tree species.

Besides the two main programmes, University Malaysia Sabah (UMS) students from the School of International Forestry also occasionally visit Deramakot to conduct short-term research or fieldworks.

FRC will also submit a proposal to study carbon sequestration in relation to RIL and biodiversity, to ITTO. If this materializes, it will be in collaboration with UMS, Forest Research Institute of Malaysia (FRIM) and DIWPA (Diversitas in Western Pacific and Asia).

Other R&D in DFR will focus on the following:

- i. Information on wildlife in terms of their population, habitat requirements and the impact of management activities;
- ii. Information for forest management decisions particularly in the determination of AAC based on data obtained from plots established within the SFMLA area;
- iii. Growth performance of trees that have been silviculturally treated; and
- iv. New studies directed at expanding knowledge on biodiversity amongst plants and animals within DFR.

Research aimed at meeting these challenges will be coordinated amongst research institutions and from other suitably qualified agencies and from individuals. FRC and other institutions may provide funding from year to year.

4.9 Manpower Requirement at DFR

The management of DFR requires people trained in forestry and engineering. Experienced professionals in HQ will be directly involved in the management of DFR as a whole, while the Research Officers in FRC will be responsible in R&D. The DFO and the ADFO will be responsible for the operational works in the field. An officer in HQ will carry out accounting and auditing works. The organization chart and the required strength of staff for DFR during the plan period are shown in Figure 7 and Table 21 respectively.

Utilizing contractors, particularly in forest restoration, silviculture, harvesting and other field operations, can achieve greater efficiency. Therefore, the SFD will continue to contract out to qualified contractors forest related activities in DFR. The contractors are required to give priority to recruit local communities living around DFR. These contractors would only be allowed to recruit labour elsewhere if the labour around DFR proves inadequate.

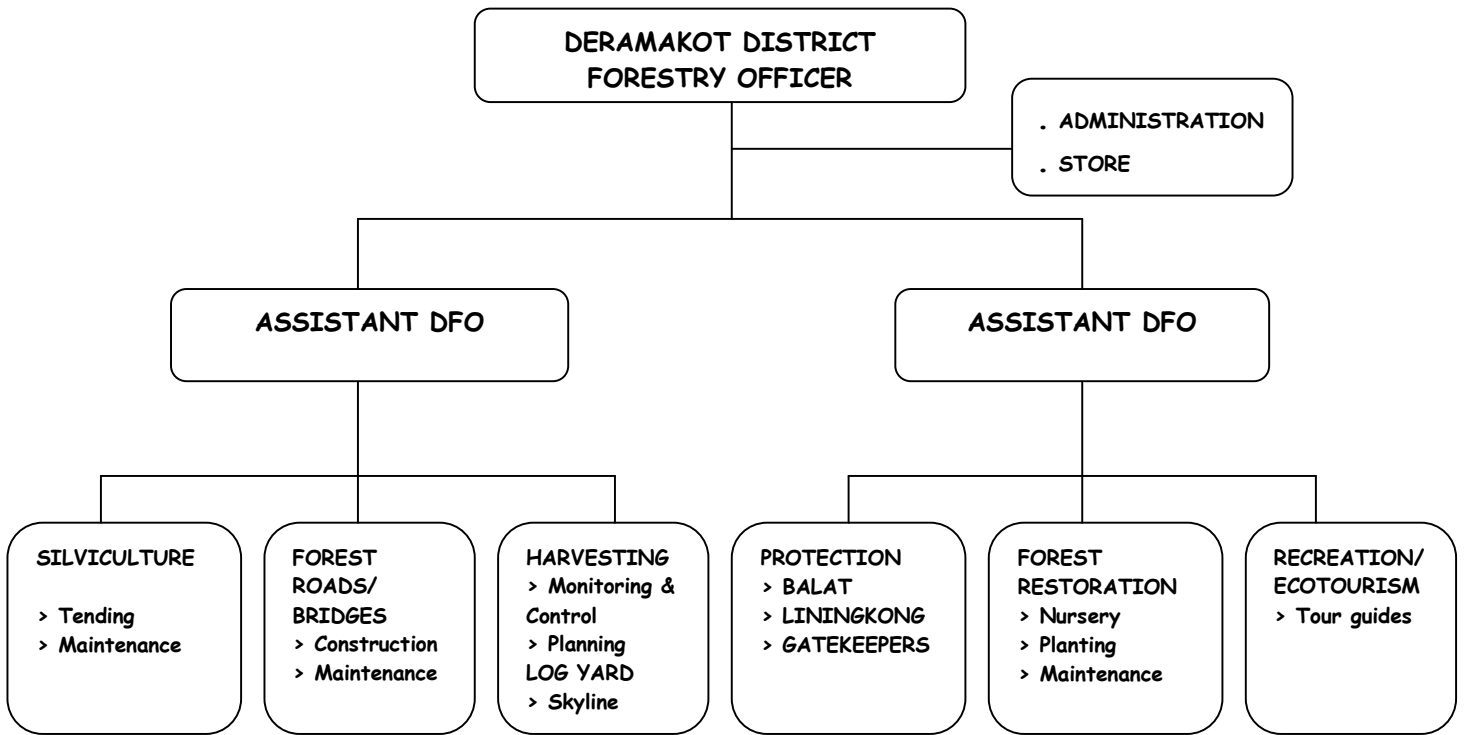


Figure 7: Organization Chart of Deramakot District Forestry Office 2005-2014

Table 21: Manpower requirement in DFR 2005-2014

Forest Activities	Position	Year									
		1	2	3	4	5	6	7	8	9	10
Forest Management	DFO	1	1	1	1	1	1	1	1	1	1
	ADFO	1	1	1	1	1	1	1	1	1	1
Silviculture	Forest Ranger	1	1	1	1	1	1	1	1	1	1
	Forester	1	1	1	1	1	1	1	1	1	1
	General Worker	6	6	6	6	6	6	6	6	6	6
Harvesting • Planning - CHP • Monitoring • Skyline	Forest Ranger	2	2	2	2	2	2	2	2	2	2
	Forester	5	5	5	5	5	5	5	5	5	5
	General Worker	22	22	22	22	22	22	22	22	22	22
Forest Restoration Nursery	Forest Ranger	1	1	1	1	1	1	1	1	1	1
	Forester	1	1	1	1	1	1	1	1	1	1
Forest Protection	Forester	2	2	2	2	2	2	2	2	2	2
	Boat men	2	2	2	2	2	2	2	2	2	2
	Gate Keeper	2	2	2	2	4	4	4	4	4	4
	General Worker	6	6	6	6	6	6	6	6	6	6
R&D											
Eco-tourism	ADFO	1	1	1	1	1	1	1	1	1	1
	Forester Ranger	1	1	1	1	1	1	1	1	1	1
Community Forestry	Forest Ranger	1	1	1	1	1	1	1	1	1	1
	Forester	1	1	1	1	1	1	1	1	1	1
	Committee Member										
	HQ										
Construction and Maintenance - Roads and Bridges	Forest Ranger	1	1	1	1	1	1	1	1	1	1
	Forester	1	1	1	1	1	1	1	1	1	1
	Operator	8	8	8	8	8	8	8	8	8	8
	General Worker	6	6	6	6	6	6	6	6	6	6
CFI or PSP	Same set up as in "Silviculture"										
Administration	Forest Clerk	1	1	1	1	1	1	1	1	1	1
	Typist/Filing	3	3	3	3	3	3	3	3	3	3
Store: Fuel/Lubricant/ Hardware/Genset/Water Pump	Store Keeper	2	2	2	2	2	2	2	2	2	
Workshop	Mechanic	2	2	2	2	2	2	2	2	2	2
	General Worker	1	1	1	1	1	1	1	1	1	1
Landscaping Garbage Disposal Eco/Management Trail Maintenance	General Worker	4	4	4	4	4	4	4	4	4	
TOTAL		86	86	86	86	86	86	86	86	86	86

Note: Year 1 starts in 2005

PART V - BUDGET AND COST PROJECTION

5.0 Introduction

A proper long term budgeting plan can help to alleviate an unnecessary escalation of expenses and not to erode potential revenue from a given resource annually. It also allows operational planning to be made in the least costly way and to ensure that the project's operations remain viable. For this purpose, a budget plan and estimated revenues which consider the various cost centres and the main activities of the Deramakot Forest Reserve operations and new investments that are considered necessary for the next 10 years, has been prepared as in **Appendix 13**.

5.1 Estimated Cost and Revenue

A total of RM 64.33 million is estimated to be required to run the operations of the Deramakot Forest Reserve for the next 10 years, while generated revenue is projected to be at RM 83.32 million and net revenue at RM 18.98 million at current price. As indicated in Figure 8, the main cost components will be the harvesting operation estimated at 36.8% of the total cost, followed by the general administrative cost at 18.8%, forest restoration at 15.5% and acquisition of new machineries at 9.1 %. Logging road cost is estimated at 8.3 % following the approach to use only existing or old roads as much as possible and to avoid unnecessary construction of new roads, and by sequencing the compartments to be harvested as close as possible in a year or for future years as to reduce the maintenance costs of roads.

5.2 Financial Analysis

A financial analysis using the discounted cash flow method has been used to support and to predict the viability of the Deramakot Forest Reserve operation in the next 10 years. For the purpose of this analysis a number of assumptions have been used as follows:

- (i) The timber volume to be harvested is based on inventory data and it is assumed that only 30% of the stand stock can be harvested.
- (ii) Revenue is generated from the sales of logs, logging residues and ecotourism products.
- (iii) The log price is based on the average bidding price of logs auctioned between the years 2002-2004, adjusted to 2004 prices (Consumer Price Index (CPI) 2004=100).

(iv) A discount factor at 4% and 7% are assumed, as this project is a government project.

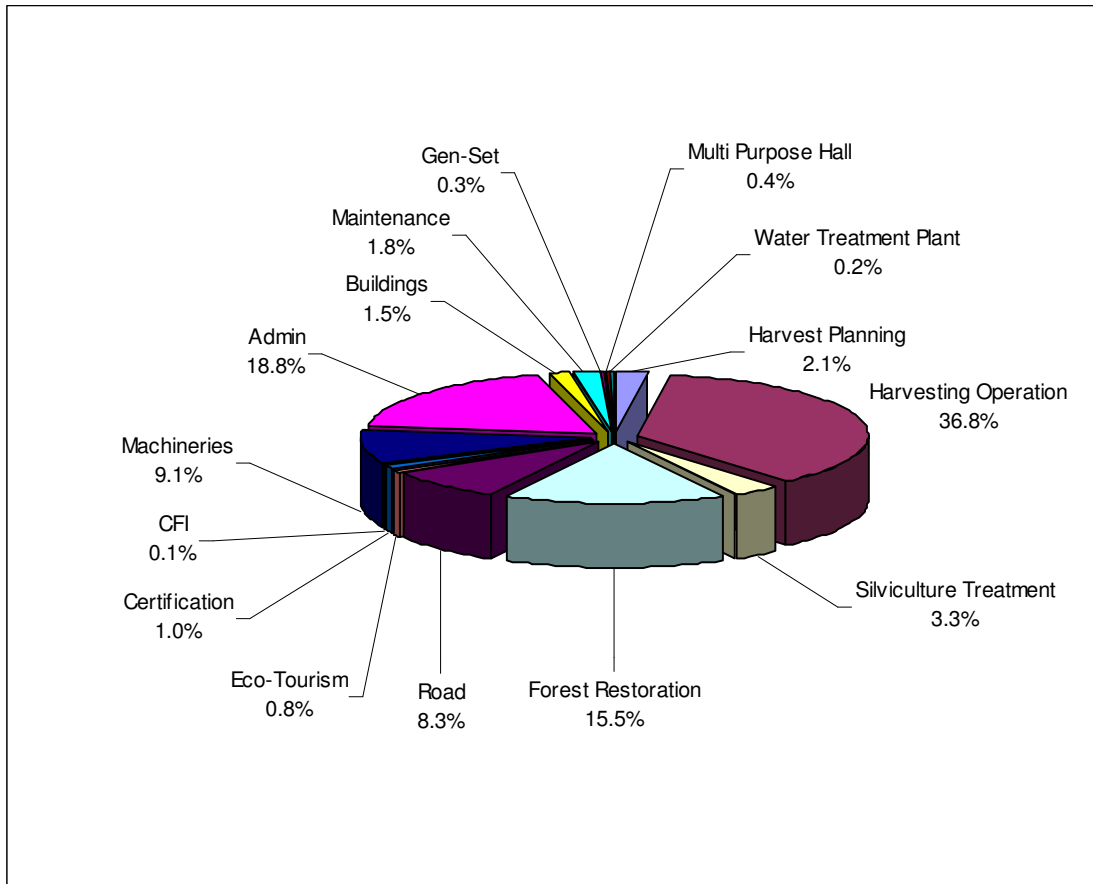


Figure 8: 10 - year plan (2005-2014) costs breakdown for DFR

5.3 Results of Financial Analysis

The financial analysis project's worth is measured in terms of Net Present Value (NPV), Internal Rate of Return (IRR) and Benefit Cost Ratio. Sensitivity analysis was also conducted to examine changes in returns with possible changes in the main variables.

5.3.1 Returns on Investment

Based on the estimated cost of operations, new investment, the projected prices of log and log volume that can be extracted, the operation in Deramakot for the next 10 years shows that it is viable and that positive returns will be generated annually

beginning year 1 (2005), mainly because most of the necessary initial heavy capital investment for the Deramakot project had already been made in the initial phase of implementation of the Deramakot Sustainable Forest Management Project. The computed Net Present Value (NPV) for the project at 4 % interest rate is RM **14,604,035** while at 7 % interest rate the NPV is RM **12,183,398**. The cost benefit ratio at 4 % is 1.28 implying that for every Ringgit invested, RM 1.28 returns can be expected, while at 7 % interest rate, the cost benefit ratio is slightly reduced to 1.27. The results however assume that all new investments are implemented as planned and that all compartments are also harvested as scheduled.

5.3.2 Sensitivity Analysis

A sensitivity analysis has been computed for a different range of scenarios which can seriously affect the returns of investment namely on a possible decline in projected log prices, a decline in the actual log volume extracted and an increase in the operational cost at both 4% and 7% interest rates respectively. The computed results show that the viability of the project is sensitive to fluctuation in the projected timber price, reduction in timber volume harvested and an increase in the operational cost at both 4% and 7% interest rates respectively. At both 4% and 7% interest rates, any combined changes in the operational costs and a decrease in timber prices beyond 15% will make the project not viable. Similarly any combined reduction in the volume extracted and timber price decrease at 20% will make the project not viable. The details of returns by varying the percentage changes in costs, log prices and log volumes is also shown in **Appendix 13**.

PART VI: EIA AND FOREST MANAGEMENT STANDARDS

6.0 Environmental Impact Assessment

The forest management system in DFR is on an experimental basis and thus, exempted from having to obtain an EIA by the Environmental Protection Department. Nevertheless, the forest management system in DFR fully meets the ecological and socio-economic requirements of an Environmental Impact assessment (EIA) mandated by the *Conservation of Environment (Prescribed Activities) Order 1999*. The forest management system also has been assessed under the QUALIFOR Programme and was certified by FSC as fulfilling all the requirements of a well-managed forest. The SFD is committed to maintain this reputation and, therefore, will continue to safeguard and protect the ecology and all the forest functions and services for society by implementing the eco-friendly harvesting approach. All management operations including the development of forest restoration undertaken in DFR will fully meet the EIA requirements.

6.1 Management Standards

All forestry operations undertaken in DFR under this plan will adhere to pre-defined standards (see Table 22) and the following Standards of Procedures, which are available in DFR:

- Pre-Harvest Planning (Tree Harvest Mapping & Road Alignment);
- Post-Harvest (Closing Inspection); and
- Disposal of Solid/Non-Solid Waste.

6.2 Environmental Mitigation

In the process of implementing the various activities as prescribed in this plan, some mitigation measures will have to be undertaken in order to safe guard the environment in DFR. Table 23 summarizes the environmental mitigation measures, which are relevant to the area.

Table 22: List of Management Standards

ACTIVITY	ASPECT	INDICATOR	STANDARD
Forest Zoning	1. Forest functions 2. Management restrictions	-1:50,000 scale functional compartment map -Topography -Soil -Stand -Wildlife	-Land-use planning according to ecological restrictions and society needs -Slope Classification based on terrestrial surveys -Site Classification -Refer to ASSESSMENT OF SILVICULTURAL STATUS -According to Sabah Conservation Strategy
Assessment of Silviculture Status	1. Structural diversity 2. Species composition	-Diameter distribution -Diversity index	-Number of immature and mature commercial trees and regeneration is adequate to maintain the forest's ability to self-regulation and economic productivity -Ratio of diversity indices of managed and virgin forests
Yield Regulation	1. Total timber stocks 2. Productivity 3. Timber yield	-Number of trees and volume/ha -Volume increment (v/ha/a) -AAC	-SE of standing commercial timber volume derived from terrestrial sampling inventories -Representative for the actual forest condition of the FMU -Based on scientifically proven growth parameters -AAC < annual commercial volume increment -AAC derived from harvesting/growth simulations
Forest Tending	1. Type 2. Intensity 3. Operational	-Tree size class subject to tending -Number of trees removed -Type of equipment or chemical used	-Liberation/release by removing immediate competitors only -Minimum intervention -Trees which cannot be removed mechanically are to be treated with bio-degradable chemicals

Table 22: List of management standards (contd.)

ACTIVITY	ASPECT	INDICATOR	STANDARD
Timber Harvesting	1.Tree selection	-Tree size -Number -Species -Location	-Diameter limits -Maximum gap size and reserve growing stock -Species list -Tree marking exclusively on production sites -Ratio of crop tree number pre-felling/post felling
	2.Felling	-Residual stand damage	-Ratio of tree Number pre-yarding/post-yarding
	3.Yarding	-Area losses (%)	-Ratio of pre-harvesting/post-harvesting net production
Forest Conversion	1.Pre-conversion site and stock condition	-% of area disturbed -Soil fertility -Slope gradient -Diameter distribution	-Area assessment based on field survey
	2.Conversion planning	-See above	-Conversion only, if the forest cannot regenerate naturally in acceptable time frames
	3.Type	-Site preparation method -Species selection	--Operation according to "Planting Manual
Road Construction	1.Loss of area	-Road density -Gradient	-Opening-up according to technical requirements of harvesting system
	2.Road quality	-Width -Drainage system -Bridge conditions	-Construction and maintenance according to Guidelines for road constructions as specified in RIL Guidelines
Protection	1.Forest fires	-Forest losses (ha)	-Operations according to Fire Prevention Plan
	2.Pest & Diseases	-Forest losses (ha)	-Early warning system
	3.Wildlife habitat	-10 year work area (ha) -Protection area	-Forest tending according to "Silviculture Guidelines" - $\frac{3}{4}$ of total area unaffected by management at any one time
	4.Watershed management	-Erosion rates (t/ha/a)	-According to Nature Conservation Framework Plan -Covered by Standards for "Forest Zoning" and "Road Construction"

Table 23: Mitigation of environmental impact of forest management activities

Forest Function	Activity	Objective of Mitigation	Mitigation of Impact
PROTECTION	Watershed management	Reduction of accelerated run off and sedimentation	<ul style="list-style-type: none"> • Forest zoning by forest function • Delineation of protection compartments according to management restrictions • Natural forest management: no clear felling, long harvesting cycles, natural regenerations • RIL • No ground skidding across streams • Alignment of roads away from key habitats • Road constructions during dry season only • Stabilization of road banks
	Wildlife protection	Minimum disturbance of habitats of endangered mammals	<ul style="list-style-type: none"> • Forest zoning • NFM • Road construction and harvesting according to standards given above

Table 23: Mitigation of environmental impact of forest management activities (contd.)

Forest Function	Activity	Objective of Mitigation	Mitigation of Impact
PROTECTION	Fire control	Reduction of fire hazard	<ul style="list-style-type: none"> • Fire management plan for the forests based on prevention, detection and suppression
	Pest & disease control	Prevention of contamination of soils and vertebrate fauna with pesticides	<ul style="list-style-type: none"> • Application of bio-degradable pesticides • Restriction of use only during non-breeding season of insectivorous animals • Restriction of use to production compartments only <p>Safe disposal of waste</p>
TIMBER PRODUCTION	Forest tending (Silvicultural operation)	Minimum disturbance of natural succession and bio-diversity	<ul style="list-style-type: none"> • Elimination of immediate competitors of commercial trees only • No eradication of weeds; only liberation of commercial regeneration • Use of bio-degradable chemicals
	Rehabilitation (Enrichment planting)	Minimum disturbance of natural succession and bio-diversity	<ul style="list-style-type: none"> • Removal of vegetation only along planning lines • Planting of indigenous timbers/high value exotics

Table 23: Mitigation of environmental impact of forest management activities (contd.)

Forest Function	Activity	Objective of Mitigation	Mitigation of Impact By
Conversion to industrial tree plantation	Reduction of accelerated soil erosion and safeguarding minimum water quality	<ul style="list-style-type: none"> • Forest zoning according to site suitability (slope, depth, nutrients) • No blading of top soil • Prescribed burning • No terracing • Apply slow-release fertilizer 	
TIMBER PRODUCTION	Harvesting	Safeguarding of future forest stands at compartment level	<ul style="list-style-type: none"> • Felling of trees based on silvicultural tree marking • Directional felling • Employment of low impact yarding systems
	Road construction	Reduction of accelerated soil erosion	<ul style="list-style-type: none"> • Minimizing road density by employment of LDCCS • Road gradient, width, drainage system and stabilization of banks according to minimum standards
COMMUNITY NEEDS	Community forestry	Prevent encroachment	<ul style="list-style-type: none"> • Awareness campaigns • Provision of employment through long-term forest operations • Issuing of licences for timber felling and hunting according to management plan
RECREATION/ ECOTOURISM	Conversion of forest for recreation	Minimum disturbance of natural succession and bio-diversity	<ul style="list-style-type: none"> • Conserving the forest and forest resources for recreational; purposes with minimum disturbances to the natural habitat

PART VII: IMPLEMENTATION AND MONITORING

7.0 Responsibility for Implementation

The DFO is responsible for the implementation of the activities as prescribed in the FMP and are further described in the Annual Work Plan (AWP). The DFO is also responsible to submit progress reports to HQ once in three months.

7.1 Monitoring and Auditing

7.1.1 Internal

Regular internal monitoring and control of all forest operations will be carried out by the DFO to ensure compliance and early recognition of problems and to take meaningful corrective action immediately. This is an essential practical aspect of forest management that forms the basis for compliance and transparent accountability of operational activities.

The SFD at HQ and FRC level would carry out periodic and continuous formal and systematic internal auditing to be carried out by experienced forestry officers who are specialized in one or more of the following fields of forestry:

- > Forest Management
- > Silviculture Management
- > Social Forestry
- > Economics
- > Timber Harvesting
- > Forest Restoration Management
- > Forest Protection

7.1.2 External

DFR has been assessed as a well-managed forest under the FSC system, and is certified under the QUALIFOR Program. The Société Générale de Surveillance (SGS), which is an international inspection organization, is responsible to carry out surveillance, inspection and assessment of SFM implementation in DFR under the FSC system. This is done every six (6) months, so that continued compliance with the QUALIFOR Program requirements can be verified.

7.2 Reporting

7.2.1 Responsibility

The information generated by a monitoring system is to be reported regularly by the DFO to HQ. Reporting should be both written and oral, in order that specific problems, unexpected achievements or any other aspects of management can be discussed and any necessary action that is required can be taken quickly. The DFO should summarize each periodic report and transmit the findings and recommendations to HQ.

7.2.2 Reporting Frequency

The frequency of reporting should be related to the nature of the topic being reported on. Reporting should be at least monthly, weekly or even daily, in case of timber harvesting where close control of output, location of logging and trees being cut should be followed closely. If logistics and staff are not readily available, reports can be prepared quarterly or annually depending on the sensitivity of the key topics.

7.2.3 Reporting Formats

A convenient way of reporting achievements for many forest operations is to use a tabular format that summarizes operational prescriptions on one side of the form and operational achievements on the other. Photos and maps are to be included in the report.

7.3 Compartment Register Book

This serves as a permanent record of site and stand condition, management prescriptions and activities undertaken in each compartment. The Register Book for DFR is in place and updated regularly.

7.4 Review

This medium-term FMP will be reviewed in 2009. The review process provides for the refinement of management prescriptions and zoning scheme in response to new information or changes in the SFD and/or government policies, technology and market conditions. However, any refinement or changes to the plan should not be disruptive to planning and operations.

During the mid-term review, the following aspects shall be considered:

- Comparison between the actual work done and achievement against the target on harvesting, silviculture and restoration activities;
- Improvement on forest resources through the assessment of permanent sampling plots;
- Evaluation on the conservation of the forest in terms of soil, water and wildlife protection; and
- Evaluation of the results of R&D and the progress and quality of work carried out so far.

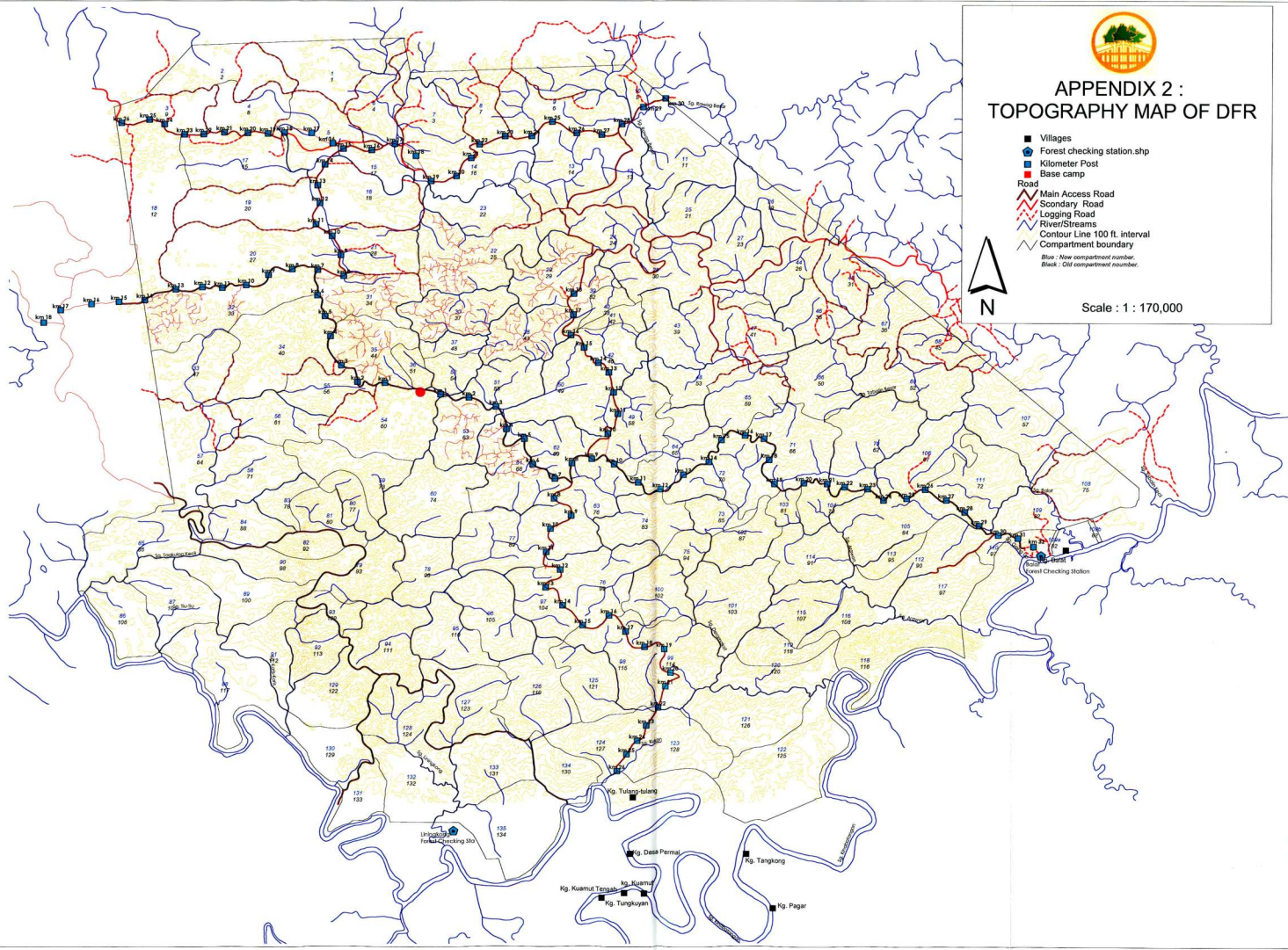


APPENDIX 2 : TOPOGRAPHY MAP OF DFR

- Villages
 - Forest checking station.shp
 - Kilometer Post
 - Base camp
 - Road
 - ▲ Main Access Road
 - ▲ Secondary Road
 - ▲ Logging Road
 - ▲ River/Streams
 - ▲ Contour Line 100 ft. interval
 - ▲ Compartment boundary
- Blue : New compartment number.
Black : Old compartment number.



Scale : 1 : 170,000





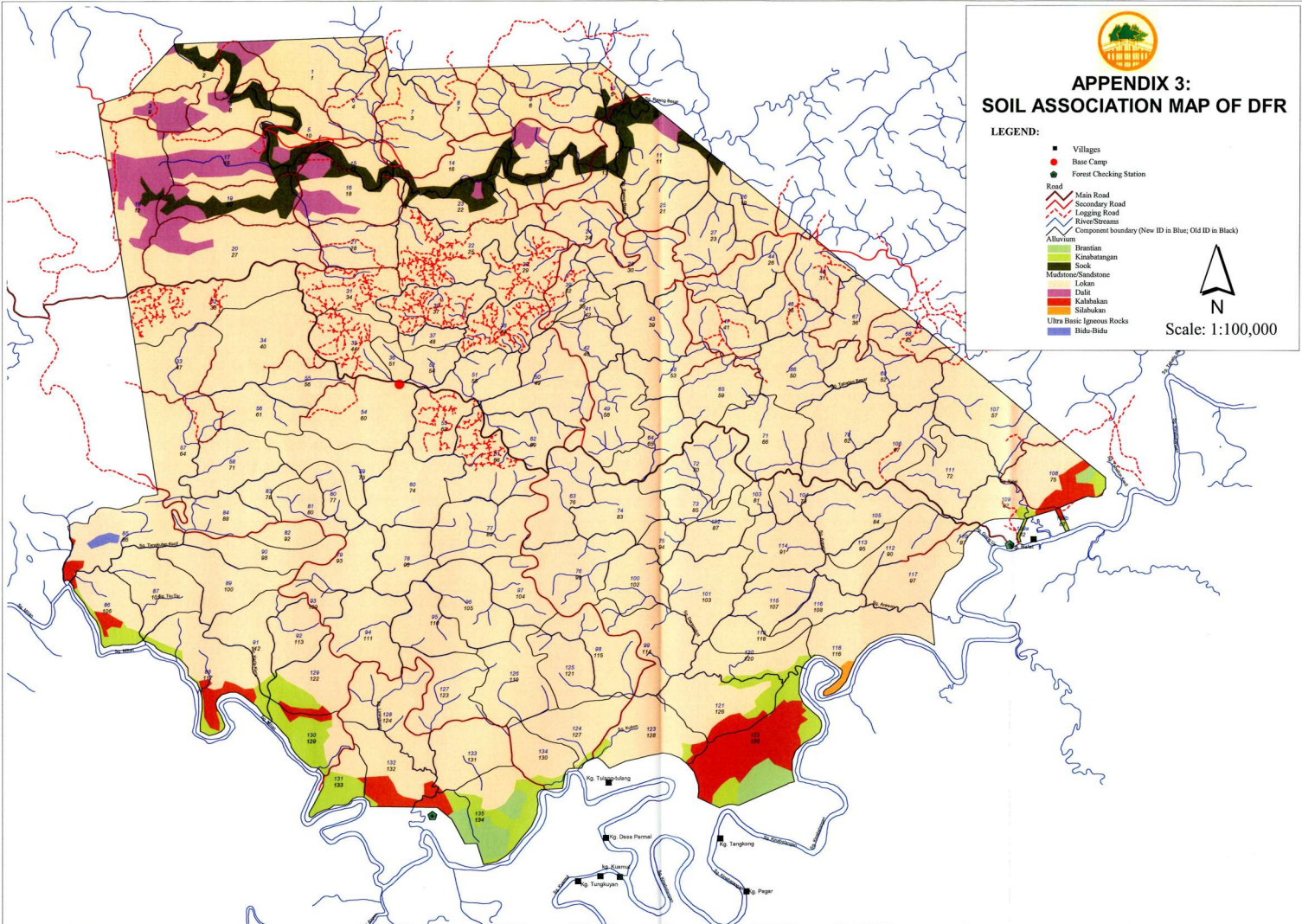
APPENDIX 3: SOIL ASSOCIATION MAP OF DFR

LEGEND:

- Villages
- Base Camp
- Forest Checking Station
- Road
 - Main Road
 - Secondary Road
 - Logging Road
 - River/Stream
 - Component boundary (New ID in Blue; Old ID in Black)
- Alluvium
 - Brantim
 - Kinabatangan
 - Sook
- Mudstone/Sandstone
 - Lokan
 - Dulu
 - Silabukan
- Ultra Basic Igneous Rocks
 - Batu-Batu

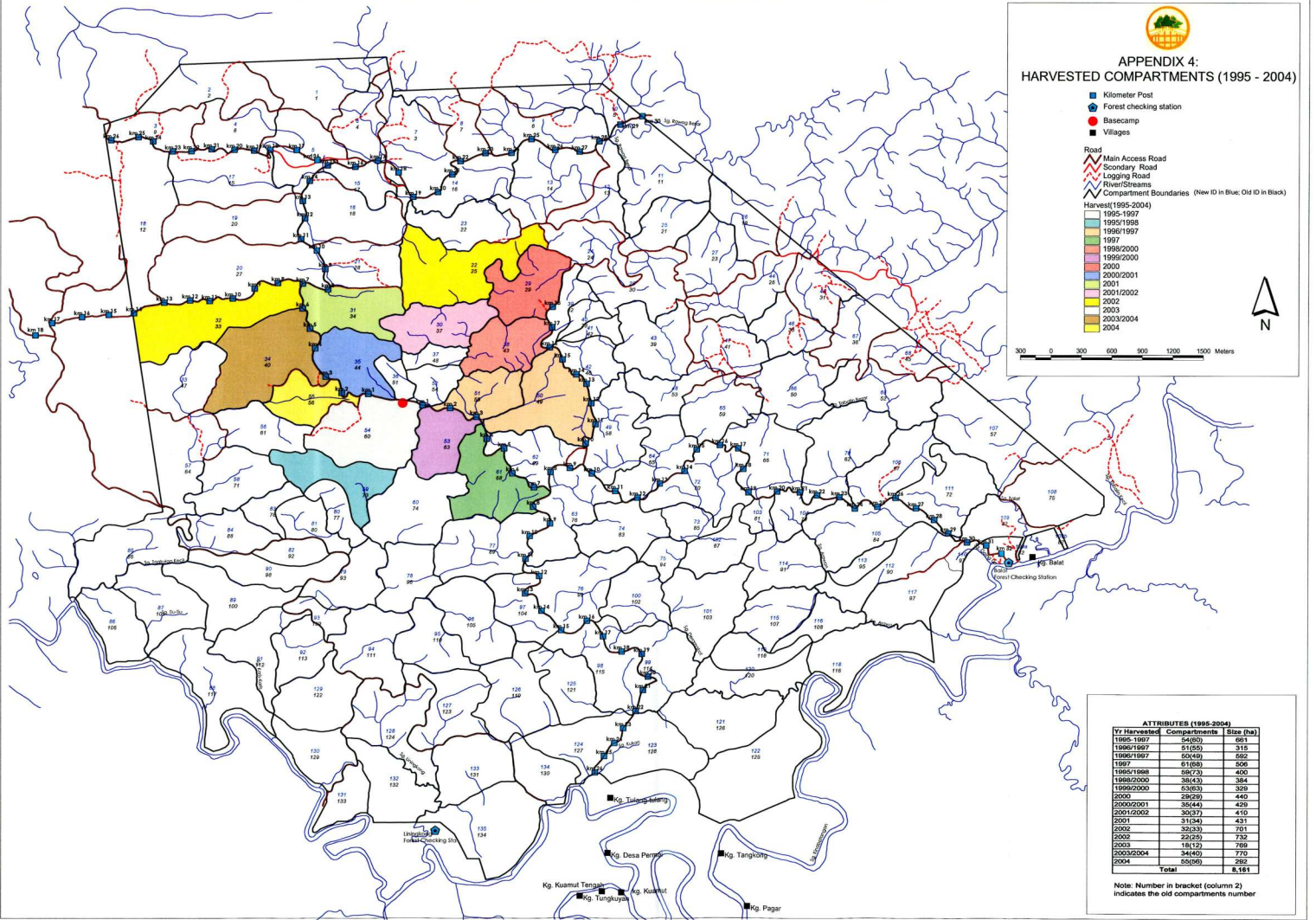
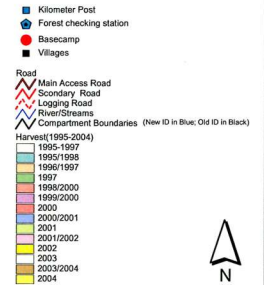


Scale: 1:100,000





APPENDIX 4: HARVESTED COMPARTMENTS (1995 - 2004)



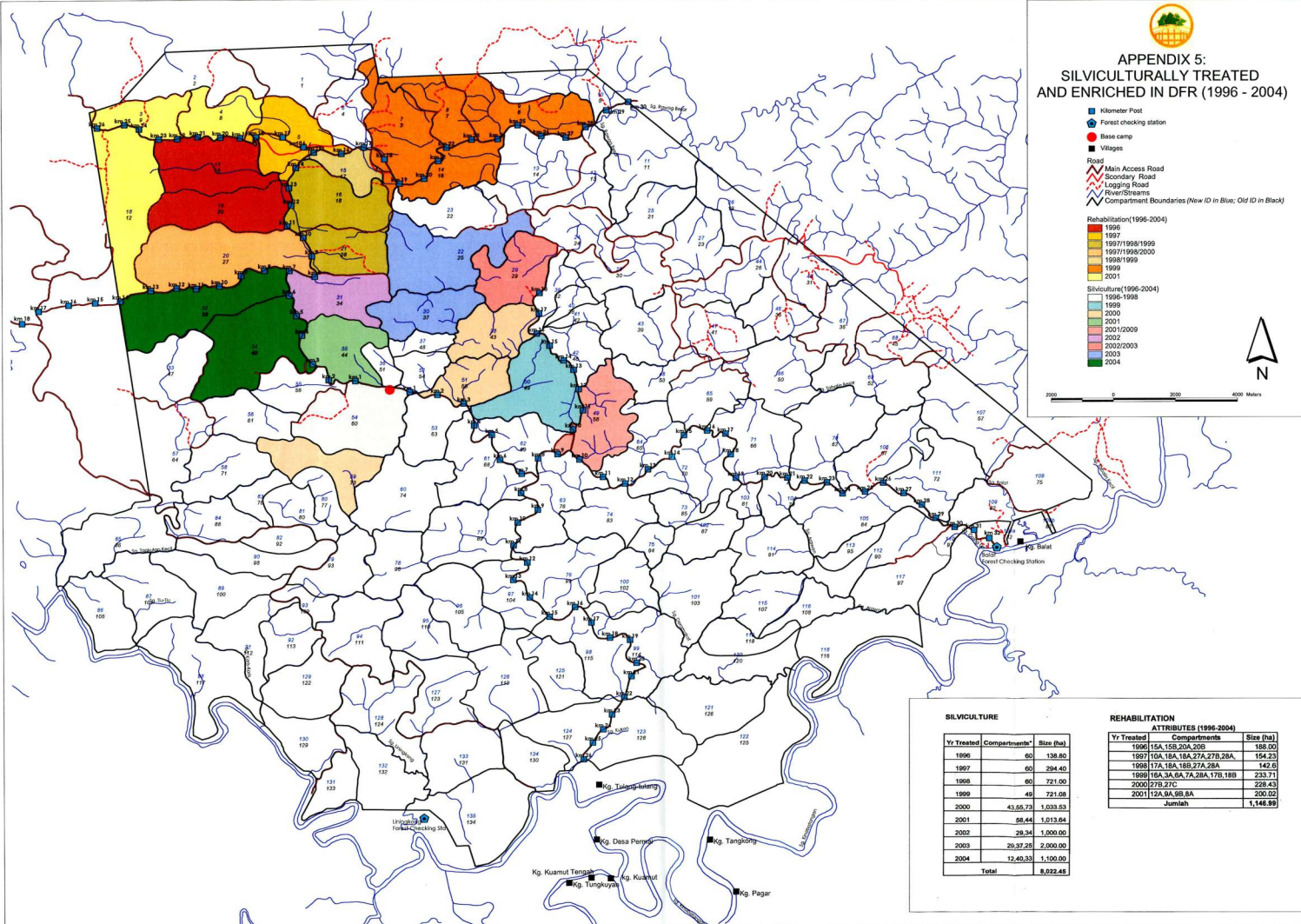
ATTRIBUTES (1995-2004)

Year	Harvested Compartments	Size (ha)
1995-1997	54(02)	651
1996/1997	51(25)	315
1996/1997	50(49)	262
1997	61(85)	506
1998/1998	52(23)	453
1998/2000	38(43)	384
1999/2000	53(35)	329
2000	29(25)	440
2000/2001	35(44)	429
2001/2002	32(27)	410
2001	31(34)	431
2002	33(33)	761
2002	22(25)	732
2003	18(12)	766
2003/2004	34(40)	770
2004	25(26)	292
Total		5,351

Note: Number in bracket (column 2) indicates the old compartment number



APPENDIX 5: SILVICULTURALLY TREATED AND ENRICHED IN DFR (1996 - 2004)



SILVICULTURE

Yr Treated	Compartments*	Size (ha)
1896	60	138.80
1997	60	294.40
1998	80	721.00
1999	49	721.08
2000	43,65,73	1,033.53
2001	58,64	1,013.64
2002	29,34	1,000.66
2003	30,37,25	2,000.00
2004	12,40,83	1,100.00
Total		8,022.45

REHABILITATION

ATTRIBUTES (1996-2004)		
Yr Treated	Compartments	Size (ha)
1996	15A,15B,20A,20B	155.00
1997	10A,18A,18A,27A,27B,28A	154.23
1998	17A,18A,18B,27A,28A	142.0
1999	15A,3A,6A,7A,20A,17B,18B	233.71
2000	27B,27C	238.43
1999	12A,9A,9B,8A	200.02
Jumlah		1,146.99



**APPENDIX 6:
STRATUM MAP OF DFR**
(Based on aerial photo interpretation
acquired in 2001)

Legend:

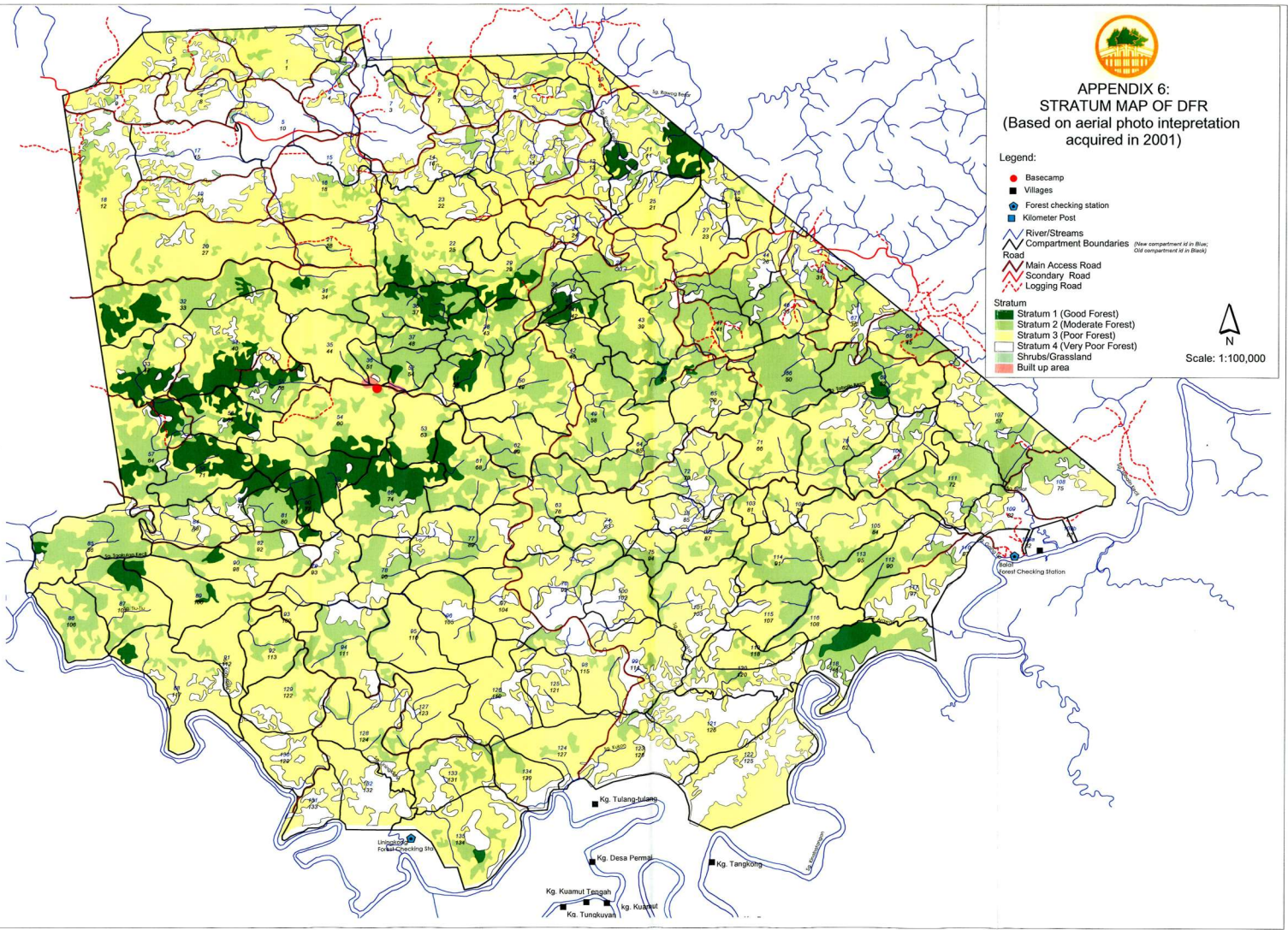
- Basecamp
- Villages
- Forest checking station
- Kilometer Post
- ~ River/Streams
- ~ Compartment Boundaries (New compartment of in Blue; Old compartment of in Black)
- Road
 - Main Access Road
 - Secondary Road
 - Logging Road

Stratum

- Stratum 1 (Good Forest)
- Stratum 2 (Moderate Forest)
- Stratum 3 (Poor Forest)
- Stratum 4 (Very Poor Forest)
- Shrubs/Grassland
- Built up area



Scale: 1:100,000





APPENDIX 7: Distribution of HCVF in DFR

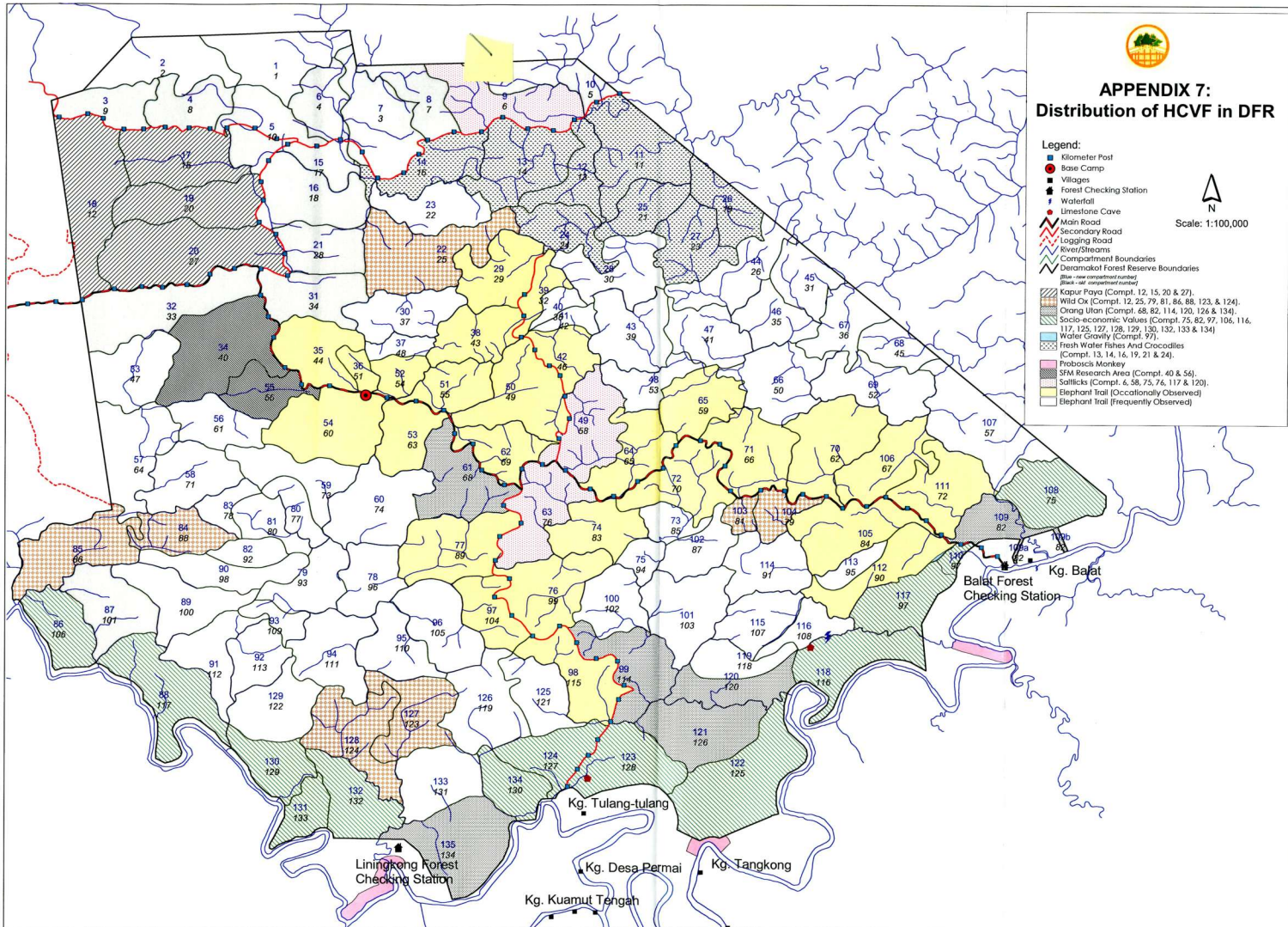
Legend:

- Kilometer Post
- Base Camp
- Villages
- Forest Checking Station
- f Waterfall
- Limestone Cave
- Main Road
- Secondary Road
- Logging Road
- River/Streams
- Compartment Boundaries
- Diaramakol Forest Reserve Boundaries













Scale: 1:100,000

- Kapur Paya (Compt. 12, 15, 20 & 27)
- Wild cv (Compt. 12, 53, 79, 81, 86, 88, 123 & 124)
- Orang Utan (Compt. 68, 82, 114, 120, 126 & 134)
- Socio-economic Values (Compt. 75, 82, 97, 106, 116, 117, 125, 127, 128, 129, 130, 132, 133 & 134)
- Water Growly (Compt. 97)
- Fresh Water Fishes And Crocodiles (Compt. 13, 14, 16, 19, 21 & 24)
- Proboscis Monkey
- SPM Research Area (Compt. 40 & 54)
- Sallicks (Compt. 6, 58, 75, 76, 117 & 120)
- Elephant Trail (Occasionally Observed)
- Elephant Trail (Frequently Observed)

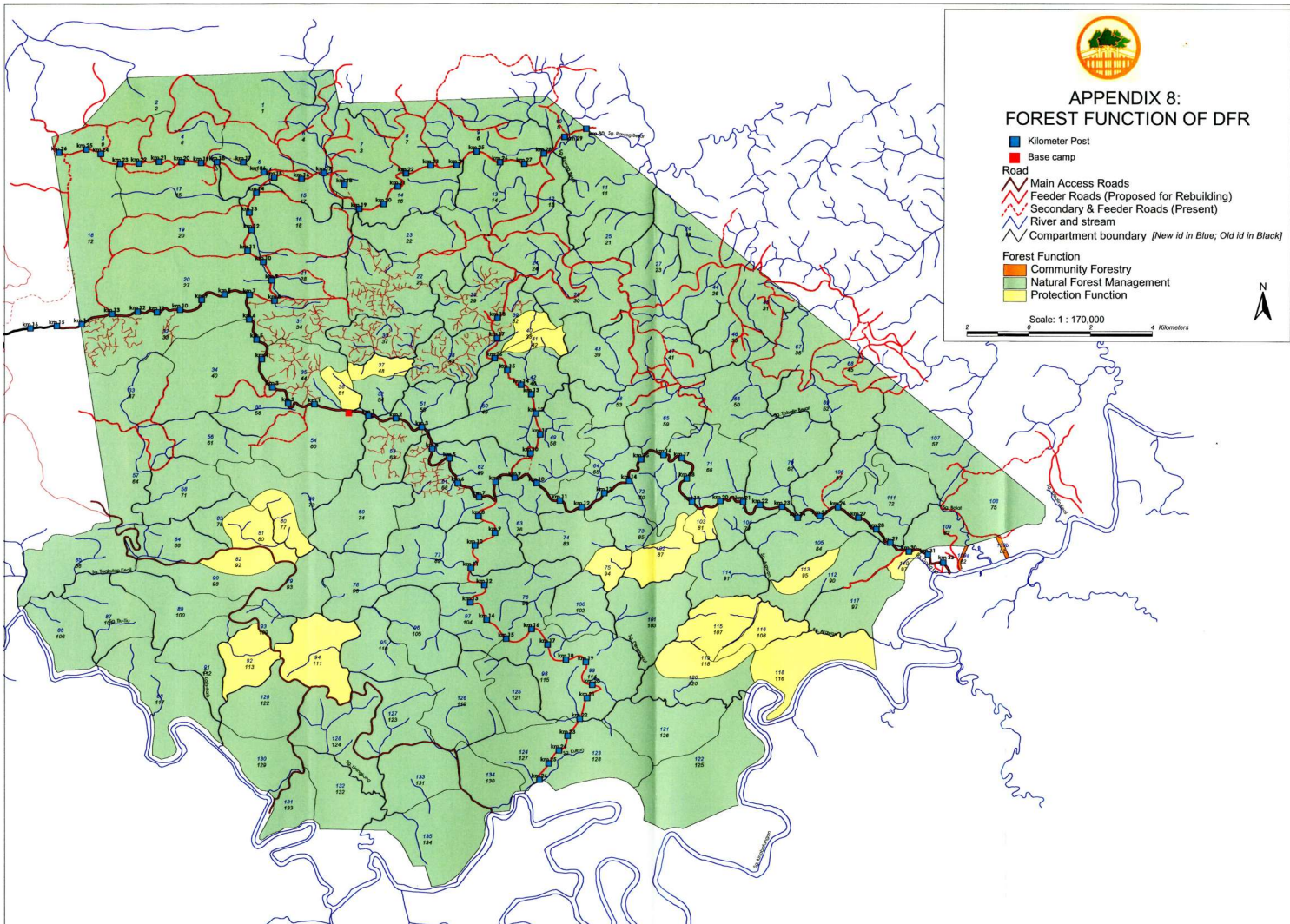
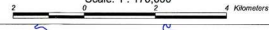




APPENDIX 8: FOREST FUNCTION OF DFR

-  Kilometer Post
-  Base camp
- Road**
 -  Main Access Roads
 -  Feeder Roads (Proposed for Rebuilding)
 -  Secondary & Feeder Roads (Present)
 -  River and stream
 -  Compartment boundary (New id in Blue; Old id in Black)
- Forest Function**
 -  Community Forestry
 -  Natural Forest Management
 -  Protection Function

Scale: 1 : 170,000





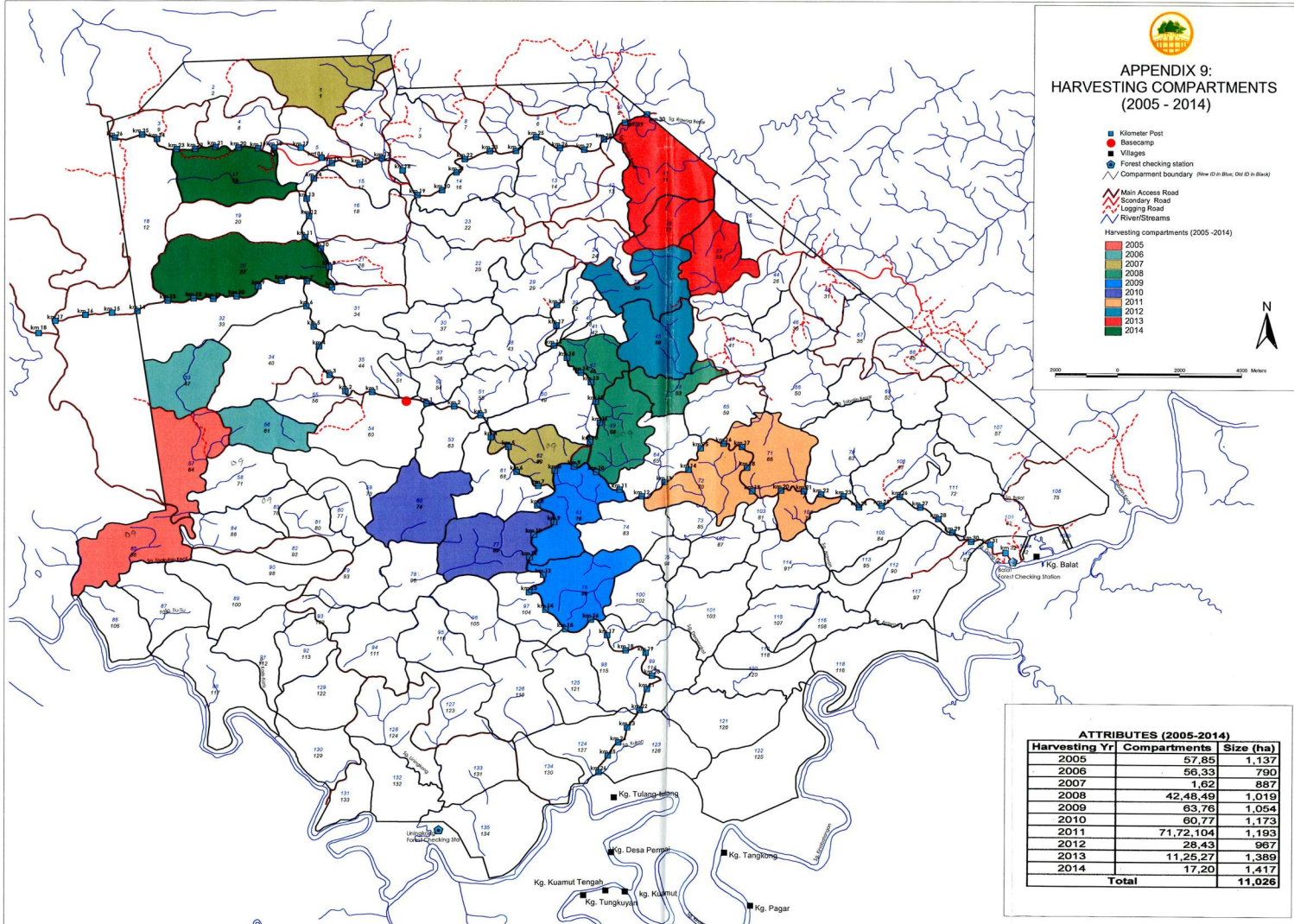
APPENDIX 9: HARVESTING COMPARTMENTS (2005 - 2014)

- Kilometer Post
- Basecamp
- Villages
- Forest checking station
- Compartment boundary (New (D) in Blue, Old (O) in Black)
- Main Access Road
- Secondary Road
- Logging Road
- Rivers/Streams

Harvesting compartments (2005 -2014)



0 2000 4000 Meters

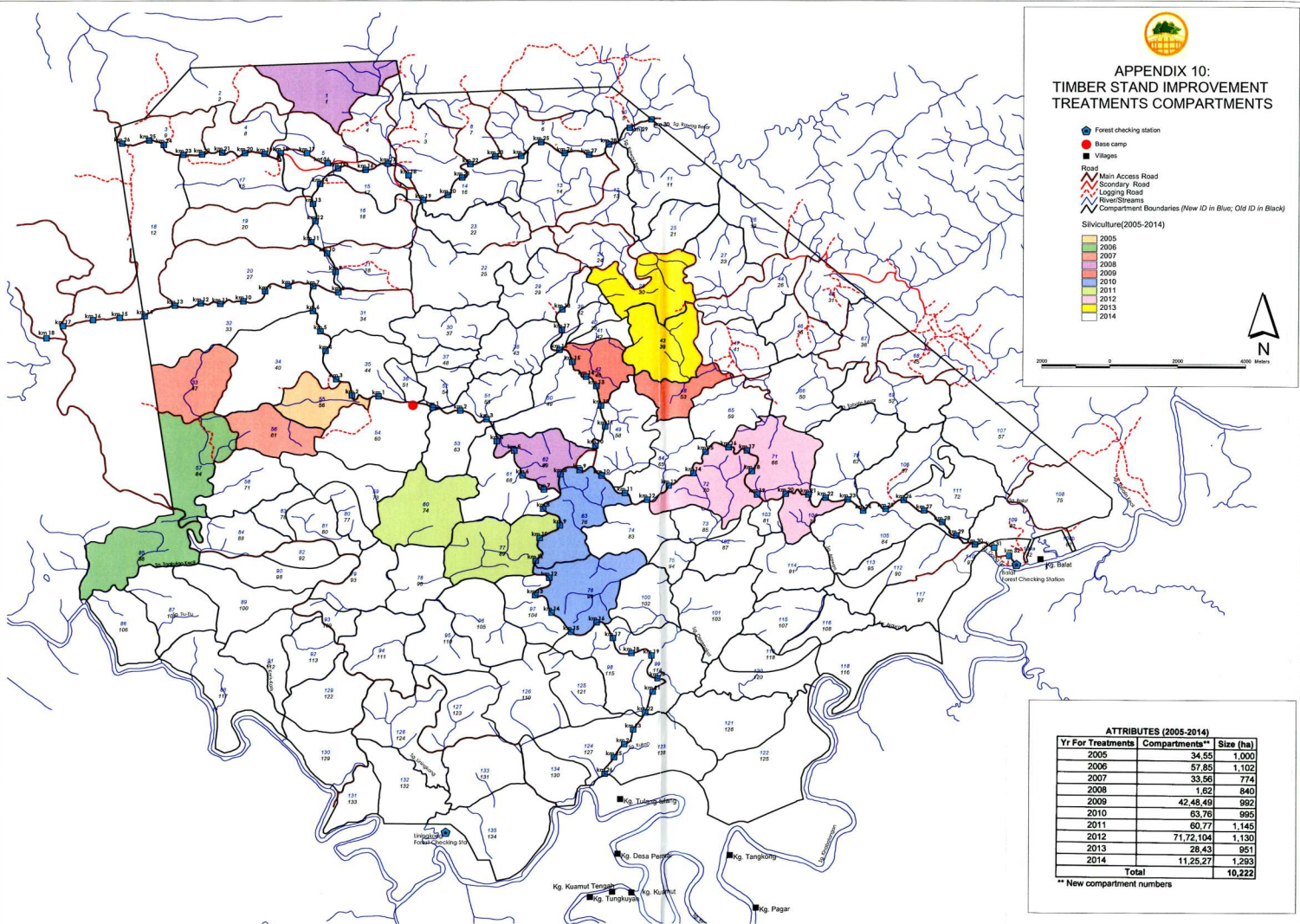


ATTRIBUTES (2005-2014)

Harvesting Yr	Compartments	Size (ha)
2005	57,85	1,137
2006	56,33	790
2007	1,62	887
2008	42,48,49	1,019
2009	63,76	1,054
2010	60,77	1,173
2011	71,72,104	1,193
2012	28,43	967
2013	11,25,27	1,389
2014	17,20	1,417
Total		11,026



APPENDIX 10: TIMBER STAND IMPROVEMENT TREATMENTS COMPARTMENTS



ATTRIBUTES (2005-2014)		
Yr For Treatments	Compartments**	Size (ha)
2005	34.55	1,000
2006	57.85	1,102
2007	33.56	774
2008	1.82	840
2009	42.48.49	992
2010	63.76	995
2011	60.77	1,145
2012	71.72,104	1,130
2013	28.43	951
2014	11.25,27	1,263
Total		10,222

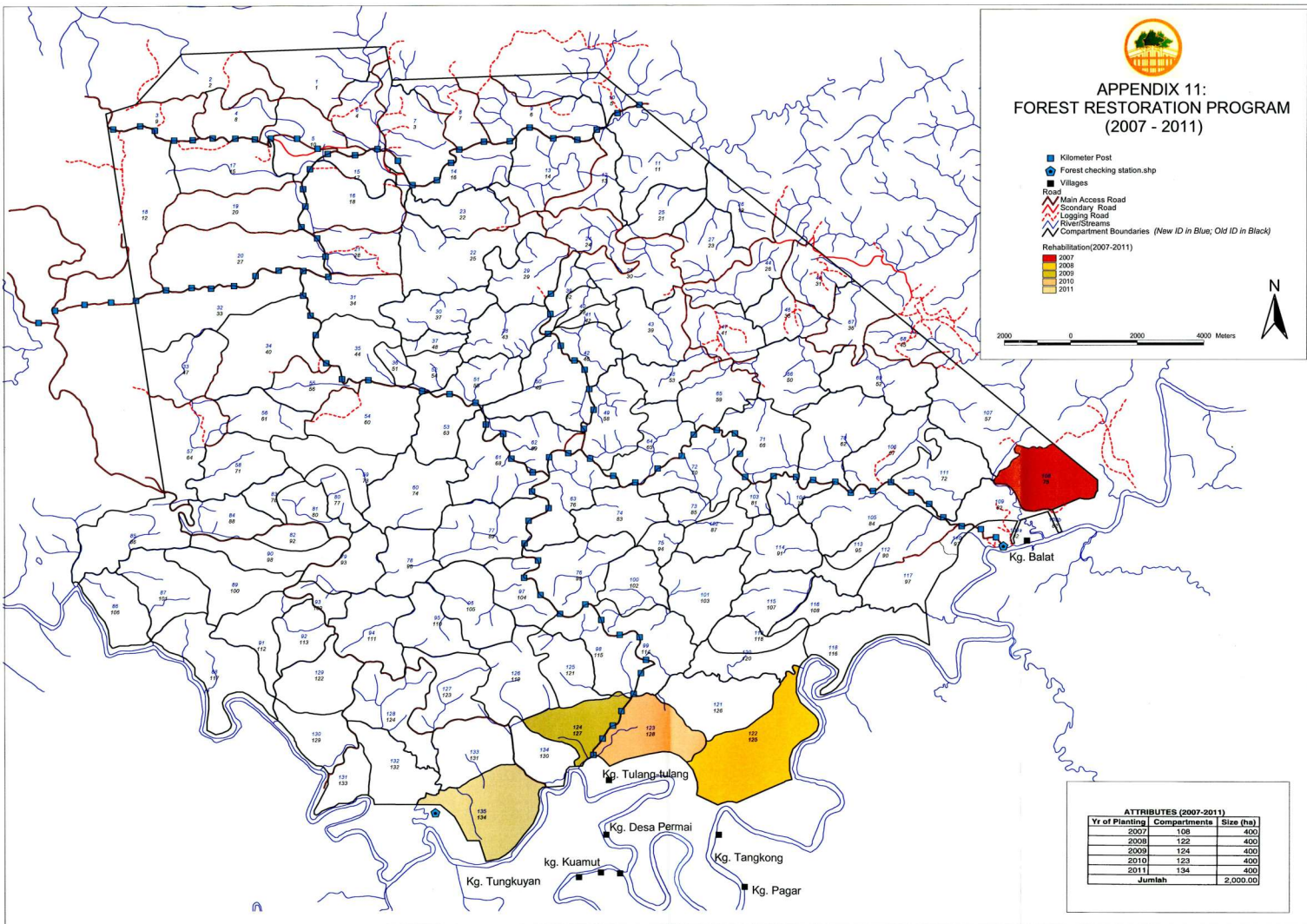
** New compartment numbers



APPENDIX 11: FOREST RESTORATION PROGRAM (2007 - 2011)

- Kilometer Post
 - Forest checking station.shp
 - Villages
 - ▬ Road
 - ▬ Main Access Road
 - ▬ Secondary Road
 - ▬ Logging Road
 - ▬ River/Streams
 - ▬ Compartment Boundaries (New ID in Blue; Old ID in Black)
- Rehabilitation(2007-2011)
- 2007
 - 2008
 - 2009
 - 2010
 - 2011

2000 0 2000 4000 Meters



ATTRIBUTES (2007-2011)		
Yr of Planting	Compartments	Size (ha)
2007	108	400
2008	122	460
2009	124	400
2010	123	400
2011	134	400
Jumlah	134	2,000.00

APPENDIX 12

LIST OF COMPARTMENTS

COMPARTMENT #		FUNCTION		
New Cpt. #	Old Cpt. #	Community Forestry (Ha)	Conservation (Ha)	Natural Forest Management (NFM)
				Cable Crane and Ground Skidding (Combined System)
1	1			554
2	2			498
3	9			303
4	8			330
5	10			467
6	4			309
7	3			601
8	7			321
9	6			564
10	5			359
11	11			667
12	13			297
13	14			608
14	16			399
15	17			192
16	18			550
17	15			578
18	12			770
19	20			546
20	27			901
21	28			370
22	25			732
23	22			382
24	24			339
25	21			299
26	19			305
27	23			426
28	30			475
29	29			440
30	37			410
31	34			432
32	33			702
33	47			452

34	40			771
35	44			429
36	51		102	
37	48		118	
38	43			384
39	32			168
40	38		95	
41	42		97	
42	46			256
43	39			493
44	26			451
45	31			316
46	35			312
47	41			376
48	53			264
49	58			502
50	49			592
51	55			315
52	54			174
53	63			330
54	60			662
55	56			292
56	61			340
57	64			557
58	71			443
59	73			400
60	74			582
61	68			506
62	69			333
63	76			501
64	65			414
65	59			393
66	50			498
67	36			329
68	45			234
69	52			490
70	62			627
71	66			513
72	70			503
73	85			172
74	83			383
75	94		132	
76	99			554
77	89			591

78	96			342
79	93			346
80	77		192	
81	80			230
82	92		164	
83	78			151
84	88			315
85	86			581
86	106			363
87	101			460
88	117		635	
89	100			467
90	98			356
91	112			370
92	113		294	
93	109			131
94	111		480	
95	110			359
96	105			480
97	104			320
98	115			453
99	114			509
100	102			341
101	103			550
102	87		276	
103	81			94
104	79			179
105	84			550
106	67			454
107	57			705
108	75			469
109A	82	7		
109B	82	11		
109C	82			247
110	97		50	
111	72			497
112	90			416
113	95		125	
114	91			413
115	107		346	
116	108			205
117	97			396
118	116		499	
119	118		244	

120	120			336
121	126		574	
122	125			870
123	128			499
124	127			376
125	121			358
126	119			536
127	123			474
128	124			566
129	122			444
130	129			334
131	133			217
132	132			439
133	131			452
134	130			289
135	134			670
Total		18	3,473	51,592

Summary

Function	No Of Compartment	Total Area (Ha)
Community Forestry	(sub-cpts under NFM)	18
Conservation	17	3,473
NFM	118	51,592
Total	135	55,083

APPENDIX 13

FINANCIAL ANALYSIS OF SUSTAINABLE FOREST MANAGEMENT IMPLEMENTATION IN DERAMAKOT FOREST RESERVE (2005 - 2014)

1. Projected Revenue

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Log Volume (m3)	13,196.49	12,942.47	20,408.17	16,694.10	18,938.27	17,622.99	19,796.86	19,259.39	15,375.74	21,240.93
Round logs sales (RM)	5,902,013	5,656,296	9,346,872	6,992,683	8,376,952	7,847,614	8,324,389	8,570,439	9,387,728	10,111,185
Eco-Tourism	-	-	-	100,000	200,000	300,000	400,000	400,000	400,000	400,000
Mobile Sawmill	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000
Total	5,962,013	5,716,296	9,406,872	7,152,683	8,636,952	8,207,614	8,784,389	9,030,439	9,847,728	10,571,185

2. Projected Costs

	2005	2006	2007	2008	2009
Harvest Planning	94,800	106,440	122,280	126,480	140,760
Harvesting Operation	1,781,526	1,747,234	2,755,103	2,253,704	2,556,666
Silviculture Treatment	72,750	284,250	197,500	221,750	254,750
Forest Restoration	-	-	472,000	904,000	1,336,000
Road	785,567	420,576	559,889	536,226	876,011
Eco-Tourism	50,000	50,000	50,000	50,000	50,000
Certification				300,000	
CFI	6,005	4,800	5,794	4,356	5,794
Machineries	400,000	1,200,000	1,450,000	400,000	400,000
Admin	1,037,535	1,070,356	1,104,817	1,141,002	1,178,996
Buildings	-	100,000	-	500,000	350,000
Maintenance	115,000	115,000	115,000	115,000	115,000
Gen-Set	190,000				
Multi Purpose Hall	-	250,000	-	-	-
Water Treatment Plant	150,000	-	-	-	-
Forest Protection	-	-	-	-	-
TOTAL COST	4,683,183	5,348,655	6,832,383	6,552,518	7,263,977

2. Projected Costs (Continue)

	2010	2011	2012	2013	2014
Harvest Planning	143,160	116,040	166,680	177,240	180,000
Harvesting Operation	2,379,104	2,672,576	2,600,018	2,075,725	2,867,525
Silviculture Treatment	263,500	293,250	298,250	241,750	-
Forest Restoration	1,768,000	2,056,000	1,584,000	1,152,000	720,000
Road	489,134	441,421	729,372	501,561	-
Eco-Tourism Certification	50,000	50,000	50,000	50,000	50,000
CFI	4,356	6,002	5,885	5,129	4,709
Machineries	400,000	400,000	400,000	400,000	400,000
Admin	1,218,890	1,260,779	1,304,762	1,350,944	1,399,435
Buildings	-	-	-	-	-
Maintenance	115,000	115,000	115,000	115,000	115,000
Gen-Set	-	-	-	-	-
Multi Purpose Hall	-	-	-	-	-
Water Treatment Plant	-	-	-	-	-
Forest Protection	-	-	-	-	-
TOTAL COST	6,831,145	7,411,068	7,253,967	6,419,348	5,736,669

3. Result of Financial Analysis

i. Return in investment

Items	
Total Revenue (RM)	83,316,171.55
Total Expenditure (RM)	64,332,912.5
Return on Investment	
Net Revenue (RM)	18,983,259.05
NPV at 7% (RM)	12,183,397.96
NPV at 4% (RM)	14,604,035.48
B/C Ratio at 7%	1.27
B/C Ratio at 4%	1.28

ii. Sensitivity Analysis

a. Discount rate: 4%

Timber Prices Fluctuation	Change in Cost				
	0%	5%	10%	15%	20%
-20%	1,321,162	(1,269,354)	(3,859,871)	(6,450,387)	(9,040,904)
-15%	4,641,881	2,051,364	(539,152)	(3,129,669)	(5,720,186)
-10%	7,962,599	5,372,082	2,781,566	191,049	(2,399,467)
-5%	11,283,317	8,692,801	6,102,284	3,511,768	921,251
0%	14,604,035	12,013,519	9,423,002	6,832,486	4,241,969
5%	17,924,754	15,334,237	12,743,721	10,153,204	7,562,688
10%	21,245,472	18,654,956	16,064,439	13,473,923	10,883,406
15%	24,566,190	21,975,674	19,385,157	16,794,641	14,204,124
20%	27,886,909	25,296,392	22,705,876	20,115,359	17,524,843

Timber Prices Fluctuation	Change in Volume				
	-20% (10.2 m ³ /ha)	-10% (12.9 m ³ /ha)	0% (15.9 m ³ /ha)	+10% (19.3 m ³ /ha)	+20% (22.9 m ³ /ha)
-20%	(2,121,392)	(209,994)	1,321,162	2,472,076	3,242,746
-15%	556,394	2,789,259	4,641,881	6,114,260	7,206,397
-10%	3,234,180	5,788,511	7,962,599	9,756,445	11,170,048
-5%	5,911,966	8,787,763	11,283,317	13,398,629	15,133,699
0%	8,589,751	11,787,015	14,604,035	17,040,814	19,097,349
5%	11,267,537.24	14,786,266.78	17,924,754	20,682,998	23,061,000
10%	13,945,323	17,785,519	21,245,472	24,325,182.8	27,024,651
15%	16,623,109	20,784,771	24,566,190	27,967,367.34	30,988,302
20%	13,945,323	23,784,023	27,886,909	31,609,552	34,951,953

b. Discount rate: 7%

Timber Prices Fluctuation	Change in Cost				
	0%	5%	10%	15%	20%
-20%	826,575	(1,403,461)	(3,633,496)	(5,863,532)	(8,093,568)
-15%	3,665,781	1,435,745	(794,291)	(3,024,326)	(5,254,362)
-10%	6,504,987	4,274,951	2,044,915	(185,121)	(2,415,157)
-5%	9,344,192	7,114,157	4,884,121	2,654,085	424,049
0%	12,183,398	9,953,362	7,723,326	5,493,291	3,263,255
5%	15,022,604	12,792,568	10,562,532	8,332,496	6,102,461
10%	17,861,809	15,631,774	13,401,738	11,171,702	8,941,666
15%	20,701,015	18,470,979	16,240,943	14,010,908	11,780,872
20%	23,540,221	21,310,185	19,080,149	16,850,113	14,620,078

Timber Prices Fluctuation	Change in Volume				
	-20% (10.2 m ³ /ha)	-10% (12.9 m ³ /ha)	0% (15.9 m ³ /ha)	+10% (19.3 m ³ /ha)	+20% (22.9 m ³ /ha)
-20%	(2,100,512)	(473,649)	826,575	1,800,162	2,447,110
-15%	188,283	2,090,351	3,665,781	4,914,573	5,836,726
-10%	2,477,078	4,654,351	6,504,987	8,028,984	9,226,343
-5%	4,765,872	7,218,351	9,344,192	11,143,395	12,615,959
0%	7054667.042	9,782,352	12,183,398	14,257,806	16,005,576
5%	9,343,462	12,346,352	15,022,604	17,372,217	19,395,193
10%	11,632,257	14,910,352	17,861,809	20,486,628	22,784,809
15%	13,921,051	17,474,352	20,701,015	23,601,040	26,174,426
20%	16,209,846	20,038,352	23,540,221	26,715,451	29,564,042