



NICOL-MIRO FORESTRY COMPANY LTD

Final Environmental Impact Statement for Proposed Reforestation of 5000 hectares of Degraded Forest Lands in Boumfum Forest Reserve, Near Agogo, Ashanti

EIA Report

July 2014

PURPOSE OF THIS DOCUMENT

Nicol-Miro Forestry Company Ltd (NMFC) proposes to develop 5000 hectares of degraded forest lands in the Boumfum Forest Reserve (BFR), near Agogo in the Asante Akyem North district. The proposed development will require a systematic development of the 5000 hectares in stages. In this regard the company proposes to plant about 1000 hectares of tree plantations per year; commencing 2013/2014.

An Environmental Impact Assessment (EIA) has been conducted by Winniwood Consulting, an independent consulting firm, to evaluate and assess the potential social and environmental impacts that may occur as a result of the proposed development. The EIA has been conducted in accordance with statutory requirements of the Environmental Assessment Regulations 1999 (LI 1652). The proposal from NMFC falls into the category of undertakings (Regulation 3) for which an EIA is required.

The Environmental Regulations make provision for the Environmental Protection Agency (the national environmental authority) to consider the various issues identified during the main assessment. Therefore, this Report and its contents serve the following purposes:

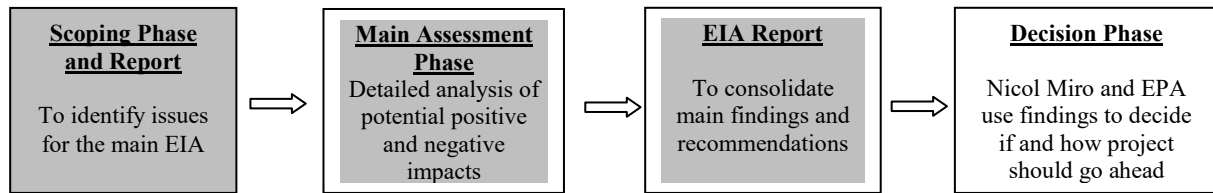
1. An introduction to the EIA that is to be undertaken for the proposed reforestation development of 5000 hectares of degraded forest lands within the Boumfum Forest Reserve near Agogo in the Asante-Akyem North District.
2. Description of the Regulatory framework for the Environmental Impact Assessment.
3. Desk studies
4. Description of the NMFC proposed project and its objectives.
5. Description of the stakeholder consultation process and identification of all issues raised by stakeholders.
6. The impact assessment methodology and impact assessment of the proposed project
7. Analysis of Alternatives to the project and its design
8. Mitigations
9. Conclusions and Recommendations

Stakeholders can comment on this main assessment Report in the following ways:

1. Written submissions to the Company, its Consultants and the Environmental Protection Agency.
2. Comment by Email and Telephone to all of the above.
3. Attend stakeholder meetings arranged by Nicol Miro Forestry Company Ltd

Having completed the Scoping assessment, the next stage of an EIA is the main impact Assessment Phase (Fig 1). This stage also examines the key environmental sensitivities in detail and the likely impacts of the proposed development on the environment and stakeholder interests. It is also during this stage that the Consultants are able to recommend

mitigations to limit negative impacts; as well as make appropriate recommendations for adoption by the project proponents.



An Environmental Impact Assessment consists of 4 main phases. This report is the final phase of the EIA.

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Executive Summary

The Boumfum Forest Reserve has been in a seriously degraded state for almost 15 years, with only 10% tree canopy cover remaining, prone to wild forest fires and experiencing illegal migrant settler activity. The financial contribution of the reserve to the socio-economic development of Agogo has virtually ceased due to the cessation of commercial forestry activities 15 years ago. This situation therefore requires management and technical interventions to restore the reserve. The Forestry Commission of Ghana, in its bid to attract much needed foreign direct investment for restoration of forest reserves under its control, recognises that fast growing commercial plantations are a necessary undertaking for reforestation of degraded forest reserves. It is also a necessary beginning to restore the supply of timber for export and national development. This undertaking requires significant investments in modern forest plantation technology, equipment, forest management expertise and the application of international best forestry practices.

Nicol Miro Forestry Company Ltd (NMFC) is a joint venture between a UK forest investment company, Miro Forestry UK Ltd and a local Ghanaian company, NICOL seeking to develop projects that impact positively on the communities in which they operate. The company proposes to develop 5000 hectares of Teak and Eucalyptus plantations on degraded forest lands in the Boumfum Forest Reserve, near Agogo, Ashanti; that it has acquired from the Forestry Commission on a 50 year unencumbered land lease.

NMFC plans to invest over \$10m over the next 10yrs to achieve its planting objectives. Subject to planting objectives being met, the estimated financial benefits; accruable to local stakeholders, is in excess of \$10m. This will have positive impacts in Agogo and surrounding areas in the form of restoration of parts of the reserve, renewed supply of timber products, forest fire management support, local employment, skills development and capacity building, improved incomes for workers, increased spending in the local economy, substantial financial benefits for local and institutional stakeholders, support for development of good social causes, close stakeholder collaboration, integration with local and regional development and supporting health and sanitation initiatives.

However, in any project of this nature, there are likely to be some negative environmental and social consequences which require detailed study. Therefore, in undertaking the impact assessment, the Consultants undertook desk and field studies pertaining to legal frameworks and relevant national policies, soils, topography, geology, hydrology and aquatic life, climate, rainfall, noise, air quality, vegetation, fauna and flora of the 5000ha allocated to the company. Field visits to the allocated compartments and testing of soil and water samples were undertaken to assess the suitability and impact on soils and water from the project. This provided the consultants with certain baseline information and parameters by which an impact assessment could be undertaken. The company's operational plans were also reviewed and stakeholder consultations were undertaken to identify areas of interest and concern and how they would be impacted by the project and its objectives. Key mitigations were then prescribed for soils, hydrology, land clearing, soil preparation, use of agro-chemicals, control

of illegal settler farmers and management of stakeholder interests and are subsequently described.

Following our assessment of the soils and its structure, we have identified major risks associated with soil erosion in some parts of the reserve which could lead to soil erosion rills and gullies being created in some of the allocated compartments. It has been identified that although some parts of the reserve contain deep well drained soils, most of the compartments allocated to NMFC comprise two (2) soil types - *Haplic Leptosols* and *Haplic Lixisols*. These soils are shallow with loose top soil structures; occurring in some of the hilly terrain of the reserve. This does not preclude them from being suitable for planting of trees but it makes them susceptible to high levels of erosion during the rainy seasons. Following the impact assessment from proposed land and soil preparation activities, mitigations in the form of planting between contour bunds, ploughing without harrowing and planting on ridges across slopes and contours have been prescribed and adopted in the company's Environmental Management Plan. These mitigations, when combined with proper planning and effective supervision and monitoring will greatly minimise soil erosion in the NMFC allocated compartments.

From a nutrient perspective, some of the top soils (*which act as nutrient reservoirs*) in some of the allocated compartments require soil enrichment interventions due to the loss of soil nutrients from previous soil erosion activities caused by illegal farming activities, forest fires and the hilly terrain of the reserve. NMFC's proposed mixing of cleared vegetation (mulch) into the soils will improve nitrogen in the soils and significantly reduce soil erosion. Controlled application and proper supervision of use of fertilisers by NMFC will also improve the key nutrients of the soils – *nitrogen, calcium, magnesium and potassium*. It is also recognised that once trees are established, the shedding and decomposition of leaves on the forest floor and the resultant development of a micro climate will contribute significantly to soil nutrient enrichment.

Agro-chemicals are commonly used in agro-forestry projects as herbicides and for soil enrichment purposes. Generally care should be exercised in the use of agro-chemicals to ensure that water catchments, water bodies and aquatic life are not adversely affected. NMFC proposes to use Glyphosate. Poor application and spillages can result in high concentrations in soils. To minimise the risks associated with disposal of individual containers, it has been recommended that NMFC adopt a bulk buying strategy and then decant needed quantities into larger sized containers for use in the field. This will greatly reduce the number of containers to be disposed off; and is easier to manage and control.

The hydrological characteristics of the reserve are such that the low lying valley parts of the reserve are prone to flooding due to poor drainage and erosion of some of the soils. This natural occurring phenomenon can lead to siltation and sedimentation in the water bodies in and around the reserve. The flooding is mainly due to the Boumfum and Ongwam rivers which tend to overflow their banks in the low lying valleys of the reserve. To limit siltation and sedimentation of water bodies; and in line with the Riparian Buffer Zone Policy for Managing Fresh Water Bodies of the Water Resources Commission, it has been proposed that

NMFC establish 10m natural vegetation buffers near sensitive water bodies and to avoid soil preparation activities near such water bodies if encountered in any of its compartments. Currently, most sections of the river channels are vegetated by riparian strips acting as buffers. These should be maintained and NMFC should refrain from soil and land preparation activities in and around these sensitive areas. Mitigation interventions should therefore ensure that the buffers are sound and adequate for preventing soil erosion and sedimentation into the rivers.

Testing water samples from both rivers has revealed that the water quality of the Ongwam river is much lower than that of the Boumfum river. This may be due to the large catchment area of the former; thus serving as a source of high level of organic waste deposited upstream into the river water. This has implications for use of water for the raising of seedlings in the nursery and also availability of oxygen for aquatic life. With the Ongwam river passing nearby the nursery, this water would be an ideal source of water for the nursery. However, the low water quality of the river poses serious risks to the survival of seedlings in the nursery. Since good quality water is a critical component for proper development of seedlings, the Company has therefore opted for the use of a bore hole inside the nursery and is in the process of obtaining the necessary registration and operating permits from the Water Resources Commission. Our analysis of groundwater consumption estimates 50,000 litres /day (0.5litres/sec) for 5 months per year. This accounts for approximately 3% of groundwater recharge and therefore the impact is minor. Nevertheless, it is recommended that NMFC conduct regular testing to monitor the river water quality. This will support future use of river water during the rainy season when flows are more rapid and pollution less likely and rather make use of groundwater only during the dry seasons.

The choice of Teak and Eucalyptus seedlings for the proposed development is satisfactory and suitable for the reserve. Teak has been used in many plantation projects in Ghana; with the Boumfum reserve being no exception. Eucalyptus has also been previously planted in many parts of the country; the only difference being that the species type being proposed by NMFC are mainly hybrids designed to suit varied environmental conditions of climate, soils, rainfall and temperature. Following discussions with the Forestry Commission, it has approved a Teak and Eucalyptus mix of 60:40 respectively for use in the allocated compartments. This is adequate for the reserve and will ensure a rich mix of plantation tree species and natural occurring indigenous tree species. Once established, the fast growing plantation trees will rapidly contribute to the development of a much needed micro climate capable of supporting wildlife, flora and biodiversity in the reserve.

The reserve has been the subject of encroachment by illegal migrant settlers. These settlers engaged in illicit financial transactions with private plantation developers to gain access to reserve lands. This is in contravention of land lease agreements the developers had signed with the Forestry Commission for the establishment of Teak plantations during the Modified Taungya System in the early to late nineties. Farming is the economic mainstay of the people of Agogo and since the cessation of logging activities and weak monitoring of the reserve; this activity has illegally spread into the reserve lands. This illegal practice has been long

standing until the recent arrival of NMFC who encountered illegal settlers on some reserve lands allocated to it by the Forestry Commission which were thought to be unencumbered at the time of allocation. As a result of this, the Forestry Commission; who is the management custodian of the reserve lands, evicted the illegal settlers from the reserve in June/July of this year to serve as a deterrent to other migrant farmers and to prevent the reserve being overrun by these settlers. This was met with little opposition from the illegal settlers; who have since moved out of the reserve.

In attempting to plan its operations, NMFC has had litigation brought against it in 2012 by a group of 123 local farmers, led by a local Pastor, claiming compensation of GHC1.68m for destruction of farms. It is worth noting that the reserve lands are under the management and control of the Forestry Commission; who have not allocated any reserve lands to any of the said local farmers. In reality, any claims for compensation should be directed to the Forestry Commission; who have since joined the court action in support of NMFC. The case is currently in court; awaiting submission of purported land ownership documents from the Pastor and his plaintiffs. NMFC has no interest in social conflicts and has therefore petitioned the Forestry Commission for replacement unencumbered lands in the reserve; pending the outcome of the court case. This is receiving favourable attention from the Commission. As a form of future mitigation, NMFC should seek to offer alternative employment – *planting trees* – to local farmers. Under strict controlled conditions, inter-cropping alongside plantation trees could also be considered; but this should be done with permission and support from the Forestry Commission and stool landowners.

Stakeholder discussions have revealed general support for the NMFC proposed development; Key areas of concern and interest centre on the need for effective management and monitoring of the reserve, controlling the spread of illegal migrant settlers in the reserve, limiting forest fires, limiting poaching of game, preventing damming of water courses for irrigation, controlling the use of agro-chemicals, establishment of buffer and riparian strips near water bodies, controlling use of water resources, creation of employment, support for the establishment of a vocational training centre, skills development and capacity building, providing scholarships and educational grants, allocating portions of the eastern part of the reserve for future expansion of Ananekrom and requests for permission to farm and herd cattle in the reserve. Some of these interests and concerns can only be addressed by the Forestry Commission and Stool Landowners, whilst others are already addressed in the NMFC Environmental Management Plan. It is worth noting that NMFC has already supported the establishment of a vocational training centre in Hwidiem, near Agogo which is now operational. With the company committing 1% of its annual operating budget to supporting local good causes, this is a welcome and positive contribution towards the people of Agogo.

Following our overall assessment of the proposed project, it is our submission that NMFC has the capability and the required technical and financial resources to undertake this project in a professional manner; taking into account the socio-economic needs of the local populace and implementing the necessary mitigations for limiting any negative effects on the

environment. Nevertheless, this cannot be achieved by the company single handed; and therefore requires the active participation and contribution of both local and institutional stakeholders to support the realisation of project objectives that will bring significant benefits to Agogo and its surrounding communities.

1. INTRODUCTION AND BACKGROUND

1.1 Background to the Project

Ghana's timber resources have been dwindling at an alarming rate with the resultant effect that there is a general shortage of good quality timber species. The responsibility of the Forestry Commission of Ghana is to manage the 241 forest reserves of Ghana. The Boumfum Forest Reserve, near Agogo, in which the project is being proposed, is a 26,000 hectare reserve which has been logged over a number of times. In 1983, large areas of the reserve were destroyed by wild fires, resulting in damage to trees, vegetation, habitats and ecosystem. The reserve is now seriously degraded and therefore requires management and technical interventions to restore it. It is recognised within the forest industry that fast growing commercial plantations are a necessary undertaking for reforestation of degraded forest reserves. It is also a necessary beginning to restore the supply of timber for export and national development.

Currently, the reserve is experiencing signs of illegal migrant farmers and cattle encroaching on the reserve and establishing settler camps. Many of these settler farmers have been the cause of many forest fires encountered in the reserve. This is of major concern to the Forestry Commission and the stool landowners, who are very keen to see the reserve restored and protected from such encroachment. In the early to mid nineties the Forestry Commission, as part of its strategy to restore the reserve, allocated various compartments to Ghanaian timber industry companies for the development of tree plantations under the Modified Taungya System. Unfortunately, the majority of these concessionaires failed to develop allocated areas after signing lease agreements and have not paid lease fees to the Commission.

This has been detrimental to the Forestry Commission's vision of reforestation of the degraded reserve on behalf of traditional landowners. The Forestry Commission, through various Acts of Parliament and Legislative Instruments, established Forest Reserves as a way to secure and ensure a sustainable forest resource in Ghana. However, severe deforestation of these reserves and a lack of reinvestment into the Ghanaian timber industry have put the continued availability of domestic timber and forest product resources in serious jeopardy. Of the 1.8 million hectares designated by these reserves at the start of the millennium, just 800,000 hectares of good forest with canopy cover greater than 50% currently remain.

Continued harvesting at high and unsustainable levels, coupled with the conversion of much Forest Reserve lands to agricultural lands, threatens the survival of the Ghanaian timber industry in its current form. Few large companies in the current timber industry are engaging in serious efforts to reforest the reserves, and have not developed a clear strategy for the continued provision of timber for their industries. Local communities who traditionally rely on forest products, particularly on non-timber forest products, are finding access to such resources increasingly difficult.

With worldwide focus on reforestation and climate change mitigation, the Forestry Commission, who has been entrusted to manage the lands in the reserve, is keen to see the reforestation of the reserve and for it to once again contribute positively to the socio-economic development of the local populace. Reforestation programmes require significant investments in capital, use of modern technology and expertise, implementation of best forestry practices and close collaboration and interactions with key stakeholders. Faced with budgetary constraints and coupled with the need for immediate interventions to reverse the degraded state of the reserve, the Forestry Commission has allocated and leased 5000ha of lands within the reserve to a plantation forest development company, Nicol-Miro Forestry Company Ltd (NMFC) to develop fast growing tree plantations in the reserve.

1.2 Profile of Nicol Miro Forestry Ltd

Nicol Miro Forestry Company Ltd (NMFC) was founded in Ghana as a joint venture company between Miro Forestry Company UK Limited (“MFC”) and the National Interests Company Limited (NICOL) in April 2009. Nicol-Miro Forestry Company (NMFC) is managed and financed by its parent company, Miro Forestry Ltd; with NICOL providing local support.

MIRO Forestry Company (MFC) is a UK based forest investment company seeking to expand its forest operations in the West African Sub region. The company already has a 21,000 hectare plantation in Sierra Leone. The Company aims to continue delivering both attractive returns to investors as well as significant social and environmental benefits within local communities.

The National Interest Company Ltd (NICOL) on the other hand is a company founded by a group of conscientious individuals, who hold a strong background in conflict prevention and transformation, preventive diplomacy and sustainable development of local communities. NICOL’s mission is the development of business and investment models for environmental-friendly social development projects to alleviate poverty and environmental degradation. Since founding in 2005, NICOL has been investigating the development of new businesses to improve living conditions, sanitation and health, as well as care for the environment in Ghana.

NMFC strongly believes that the prospects for commercial success are intimately linked with the creation of social, economic and environmental benefits for all stakeholders in the business. It is the company’s aim to ensure the implementation of the very highest standards of best practice in all its operations. Most importantly, the company believes that good relationships with its employees and the local community are critical for long term success. It is therefore the company’s aim to develop a community development strategy to include forestry education programs, healthcare, clean water and education.

The company will plant predominantly Eucalyptus and Teak. In addition, sensitive ecological areas will receive conservation and protection interventions to encourage the survival and

regeneration of indigenous species. The company also plans to investigate the potential of other species to be included in its commercial planting mix.

1.3 Project Objectives

The Project objectives of Nicol Miro Forestry Ltd are:

- ✓ To support the Forestry Commission's goal of promoting tree plantation development as a means of re-forestation degraded forest reserves.
- ✓ To establish plantation timber crops for the production of wood biomass, poles, sawn timber and other wood products;
- ✓ To bring substantial economic, social and environmental benefits to the communities associated with the business;
- ✓ Build the company's infrastructure and personnel to meet a planting capability in excess of 1,000 hectares per annum from 2014 onwards;
- ✓ To introduce agro-forestry to provide alternative means of livelihood provision to communities currently farming the Forest Reserve, as well as to subsidise establishment and weed control costs.
- ✓ To develop associated wood processing industries;
- ✓ To provide local employment at various stages of the project over the next 20 years,
- ✓ To enhance the living conditions of its potential workforce
- ✓ To support the building of an educational training institute and
- ✓ Collaborate with local traditional authorities to achieve social responsibility obligations.

Aims of the Environmental Impact Assessment

The Company's aims in carrying out the EIA are as follows:

- ✓ To predict the environmental, social and economic consequences of the project's proposed actions.
- ✓ To encourage active participation by local community groups, governmental organisations and other stakeholders in the assessment.
- ✓ To support the Company's goals of environmental management, sustainable development and responsible best practice.

The Company wants to achieve these aims by ensuring that:

- ✓ Appropriate environmental management and monitoring activities are brought to bear on the proposed development by the company's management.
- ✓ Action is taken to mitigate, where possible, any adverse effects on the environment
- ✓ Benefits of the project are maximised for all stakeholders.
- ✓ Environmental, social and economic issues are taken fully into account at all stages of the proposed development

The Company wants to use the assessment to:

- ✓ Be the basis for its forestry management activities.
- ✓ Aid the development of its local labour recruitment strategy.
- ✓ Demonstrate the potential benefits that would accrue to stakeholders should the Company be able to increase the size of the land upon which it operates in the Boumfum Forest Reserve.
- ✓ Show that the company is committed to operating to the highest international environmental, social and economic standards.
- ✓ Be the basis for its pursuit of the internationally recognised Forest Stewardship Council certification.

1.4 Legislative and Regulatory Framework

The following key legislative and regulatory documents are relevant to the proposed project and the EIA process and are important for future compliance monitoring. These are:

1. The 1992 Constitution of the Republic of Ghana, Article 267
2. The Environmental Protection Act (Act 490), 1994
3. The Environmental Assessment Regulations (LI 1652), 1999.
4. Forest and Plantation Development Act (Act 583), 2000
5. The Concession's Act (Act 124), 1962
6. The Forest Ordinance (Cap 157), 1927 sections 17&18
7. The Forest Protection (Amendment) Act (Act 624), 2002
8. Timber Resource Management (Amendment) Act (Act 617), 2002
9. Wildlife Conservation Regulations (L.I. 685), 1971
10. Ghana Forest and Wildlife Policy, 1994
11. Water Use Regulations, (L.I. 1692) 2001
12. Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana, Water Resources Commission, 2012.
13. National Integrated Water Resources Management Plan, Water Resources Commission, 2012
14. International Labour Organisation Code of Practice - Safety and Health in forestry work, 1998. International Labour Office, Geneva

1.5 Function of the Regulatory and Legal Framework and its Obligations on NMFC

✓ Article 267 of the 1992 Constitution of the Republic of Ghana

Article 267 of the 1992 Constitution stipulates that “*All stool lands in Ghana shall vest in appropriate stool on behalf of and in trust for the subjects of the stool in accordance with customary law and usage*”. In practice, all stool lands belong to paramount chiefs who are the traditional heads of paramount stools. Ownership is often hierarchical with paramount divisional, town or village stools all having an interest in the land according to the mode of

acquisition. Under this Act and Article, NMFC cannot claim title to stool lands but may lease lands in agreement with the stool landowners and the Forestry Commission; the management and monitoring agency of forest reserves in Ghana.

✓ **The Concession's Act (Act 124) 1962**

The Concession's Act (Act 124), 1962 indicates that *“the timber and land in forest reserves or subject to timber concessions (both within and outside the reserved forests) are vested in the State in trust for the landowning communities”*. The exploitation of the production forest reserves is administered by central government through the Ministry of Lands and Natural Resources (MLNR) and the Forestry Commission. Under this arrangement the landowners have a right to a share of revenue from both natural timber harvesting and forest plantation development within the forest reserves. NMFC has therefore entered into benefit sharing agreements with stool landowners and other stakeholders. Copies of the agreement have already been submitted to the EPA as part of the Scoping Assessment.

✓ **The Forest Ordinance (Cap 157) 1927**

The Forest Ordinance (Cap 157), 1927 section 18(1) provides *“that the ownership of land is not altered by its declaration as a forest reserve”*. The stool landowners therefore have the right to a share of the benefits from the development of plantations in forest reserves. The Benefit Sharing Agreement signed by NMFC and the Forestry Commission in May 2009 for Commercial Forest Plantation Development states that the *“Landowner is entitled to 6% of the standing tree value (STV) of thinning and final harvest, the Forestry Commission is entitled to 2% of standing tree value of thinning and final harvest, the Local community shall also receive 2% of standing tree value of thinning and final harvest. The balance of 90% shall accrue to the plantations investor.*

✓ **The Environmental Assessment Regulations (LI 1652), 1999**

This legislative instrument empowers the Environmental Protection Agency to ensure that project undertakings in Ghana are subjected to Environmental Impact Assessments in accordance with the environmental regulations of Ghana. The agency is also responsible for issuing of Environmental Permits as well as issuing enforcement notices, where the agency deems that an undertaking poses a serious threat to the environment or public health. The Agency is also mandated under the regulations to conduct monitoring activities on projects. By submitting this EIA for assessment by the EPA, NMFC is complying with the requirements of environmental legislation and intends to submit itself to the Agency for periodic monitoring of its undertakings and renewal of environmental permits as and when required.

✓ **Timber Resource Management (Amendment) Act (Act 617), 2002**

The function of this provides for incentives and benefits applicable to investors in forestry and wildlife and to provide for matters related to these. NMFC is a joint venture between the National Interest Company Ltd (NICOL) and Miro Forestry UK Ltd (MIRO), registered with the Ghana Investments Promotion Council and therefore entitled to investment incentives as outlined by the GIPC.

✓ **The Forest and Plantation Development Act (Act 583), 2000**

The Act establishes a fund for plantation development in Ghana. The aims of the Fund are to provide:

- financial assistance for the development of forest plantation on lands suitable for timber production, and
- for research and technical advice to persons involved in plantation forestry.

As the project evolves, NMFC will embark on research in soils, water and tree species and may wish to apply to the Forestry Commission for technical assistance in these areas.

✓ **The Forest Protection (Amendment) Act (Act 624), 2002**

The function of this Act pertains to forest reserves and defines the offences and corresponding penalties that may be imposed by the Forestry Commission in the event of unauthorized setting of fires which run out of control, obstruction of rivers and waterways, erection of buildings, moving or destroying a forest reserve boundary marker. This Act therefore imposes strict guidelines on how NMFC should operate in the Boumfum reserve with particular regard to management of fires, erection of permanent structures and use of water bodies.

✓ **Wildlife Conservation Regulations (L.I. 685), 1971**

The Boumfum Reserve where the NMFC project is being proposed contains some game and wild animals, mainly on the far western part of the reserve. This legislative instrument places restrictions on the hunting of game, the need to apply for game licences and permits for export of game. NMFC does not intend to hunt any game. However, by its presence in the reserve, NMFC has a responsibility to inform the Forestry Commission of any persons that may be in contravention of this regulation.

✓ **Ghana Forest and Wildlife Policy, 1994**

The Forest and Wildlife Policy 1994 promotes conservation and sustainable development of the nation's forest and wildlife resources. The policy aims to provide for the maintenance of environmental quality and perpetual flow of optimum benefits to all segments of society. The Policy outlines the enabling conditions under which the Forestry Commission aims to achieve

its objectives. It encourages local stakeholder participation in forestry and highlights the need for reforestation of the country's degraded forest reserves. NMFC proposes to reforest 5000 hectares of Boumfum Reserve and therefore this policy provides the company with guidelines on how it can contribute to the policy and realisation of the Forestry Commission's vision. NMFC has also engaged local stakeholders to gain proper understanding of their interests and concerns.

✓ **Water Use Regulations (LI 1691) 2001**

This regulation lays down the procedures and conditions for use of water resources. The Water Resources Commission administers and enforces this regulation. NMFC does not intend to use water from the nearby Onwang river for its nursery because of the low water quality; which poses a risk to the survival of seedlings. The company has rather opted for a borehole; and in compliance with the provisions of this regulation, NMFC has submitted an application to the Water Resources Commission for a water use permit to drill a bore hole. This application is currently being reviewed by the Water Resources Commission.

✓ **Riparian Buffer Zone Policy for Managing Freshwater Bodies, 2012**

This policy lays down prescriptions for the effective management and protection of water systems. In particular the policy provides guidelines and recommendations for the establishment of buffers nearby water systems. Within forest areas, the policy makes recommendations of establishing a minimum of 10m buffers near water systems. NMFC has exceeded this minimum requirement by specifying 20-30m buffers in its provisional environmental management plan in the Appendix of this report.

✓ **National Integrated Water Resources Management Plan, Water Resources Commission, 2012**

This national plan provides a framework and strategy for managing water resources and impact of growing demand on water resources. It provides NMFC with background information on national policy and an overview of the level of water resources currently available. NMFC evaluated key data during its hydrology assessment of water resources in the company's allocated compartments to gain proper understanding of the water resources available in the reserve.

1.6 DESCRIPTION OF THE PROPOSED NMFC DEVELOPMENT

Nicol Miro Forestry Ltd (NMFC) proposes to develop a 5000 hectare plantation comprising mainly Teak (*Tectona grandis*), Eucalyptus (*Eucalyptus spp*) and indigenous species such as Ceiba (*Ceiba pentandra*) and Wawa (*Triplochiton scleroxylon*). The proposed development will involve nursing of seedlings, land preparation, creation of conservation management areas, planting of fast growing Teak and Eucalyptus tree species, upgrading and maintenance of old logging roads, sustainable selective harvesting, creation of employment opportunities for locals in Agogo, development of modern agro-forestry initiatives, collaboration with key stakeholders to support local good causes and distribution of financial benefits from plantation outputs for stakeholders.

Project Justification

Timber demand in West Africa is growing with booming economic growth and construction. This is against a backdrop of decreasing timber supply, as stocks of standing timber continue to be depleted with unsustainable harvesting. These macro factors provide an economic opportunity on which to build a profitable and hence sustainable and economically secure plantation forestry business. Construction timbers (for poles, sawn timber and wood based panels) represent the largest and fastest growing segment of the timber market in West Africa. Ghana is currently experiencing serious shortages in good quality timber and therefore, it is recognised within the Forestry Commission and industry that fast rotation growing plantations is the future for rehabilitation of forest reserves and improving the supply of timber to the domestic market.

It is also Government policy to promote private sector participation in commercial forest plantation development in order to sustain the supply of timber and timber products to the timber and wood-based industries. For these and other reasons extensive areas of sustainably managed forest plantations are needed in the country to meet the growing demand for industrial timber.

NMFC therefore proposes to invest over \$10m over the next 5 years in developing and establishing 5000ha of plantations. Some of these cash outflows will impact positively and directly in the local Agogo area in the form of employment, income for workers, increased purchases and spending within the community, education and training, provision of funds for development of a vocational training institute for the area and strong stakeholder collaboration. This will no doubt result in economic spin-offs for the community and its stakeholders. Therefore the value of the proposed development has far reaching consequences for the people of Agogo and surrounding communities; but principally it has the potential to:

- a) Generate significant accruable financial benefits (in excess of \$10m) for its key stakeholders
- b) Provide increased local employment at various stages over the next 10-15 years,
- c) Enhance the living conditions and well being of its potential workforce and their families

- d) Build strong stakeholder collaboration with local traditional authorities to achieve social responsibility obligations and support of good causes.
- e) Support the establishment of a vocational training institute in Hwidiem, near Agogo.
- f) Support the Government of Ghana, through the Forestry Commission to secure direct foreign investments for fast growing tree plantation development and rehabilitation of degraded forest reserves.
- g) Support government efforts in achieving climate change mitigation through the sequestration of carbon from trees via the Reduced Emissions from Deforestation and Degradation (REDD+) initiative.

The project will ultimately contribute to increased supply of timber and timber products as well as revenue to the Forestry Commission derived from local and export levies that would accrue from harvesting, processing and export of timber products. Small and medium-scale support businesses are also likely to spring up to boost economic activities; particularly at Agogo and other surrounding villages close to the project area.

The environmental benefits expected from the project will include the improvement of the protective function of the forest cover within the project area. The project will adopt best practices to ensure sustainable forest management and contribute to the establishment of a vegetative cover to minimize the intensity of desiccating winds, improvement in soil and water conservation; as well as the reduction in the loss of soil nutrients through erosion. The project's plan to develop conservation areas and protect areas of environmental sensitivity will contribute greatly to environmental conservation in the reserve.

The fringe communities in the project area will benefit from diverse employment opportunities that will be offered by the project. The project will encourage agro-forestry and inter-cropping practices which will contribute to income generation in and around the project area and ultimately lead to improved welfare and generally a reduction in poverty.

Even though not part of the terms and agreement for the current project, the company has a longer term vision of establishing a modern sawmill and timber treatment plant to process the outputs from the plantations; subject to finding suitable land in the area. In support of these initiatives, the Forestry Commission, with approval from local Stool landowners; have allocated 41 of the 225 compartments in the Boumfum Forest Reserve, near Agogo in the Asante-Akyem North District to NMFC.

1.7 Key Project Activities

The key project stages and timelines for the NMFC proposed development are as follows:

- a) 2010 – 2012 – Pre-planning phase, Signing of leases, Land allocation, Land surveys,
- b) 2011 – 2013 – Land Mapping, Selection and Compartment surveys/ planting trials
- c) 2013 – 2014 - Scoping and EIA Approvals Stage
- d) 2013 - 2018 – Nursery Establishment and Seedlings Development
- e) 2014 – 2016 – Land Preparation
- f) 2014 – 2018 – Planting of Teak and Eucalyptus trees
- g) 2014 – 2018 - Road maintenance and construction
- h) 2014 – 2019 - Replanting of Indigenous species
- i) 2014 - 2019 – Creation of conservation areas and Buffer Zones/Riparian strips
- j) 2019 – 2022 - Thinning and Maintenance of tree plantations
- k) 2019 – 2023 - Selective Harvesting
- l) 2013 – 2015 - Labour and Staff recruitment
- m) 2013 – 2018 - Forest Fire Mitigation Management
- n) 2013 - 2023 - Annual Social Responsibility Commitments/Agreements
- o) 2019 – 2023 – Establishment of Sawmill and Timber Treatment Plant

Land Mapping and Planning

As part of the initial project activities, NMFC and the Forestry Commission have mapped out the boundaries of the proposed development using Geographical Information Systems (GIS) and field verification of boundary pillars as shown in the image below. Each of the points on the map below represents a boundary pillar point for the allocated Blocks A-G.



Fig 1: Land mapping of NMFC Blocks

The individual blocks are then subjected to detailed zoning to identify areas for planting, conservation, riparian strips, buffer zones, community farms etc. An example of this is shown in the zoning of Block F below.

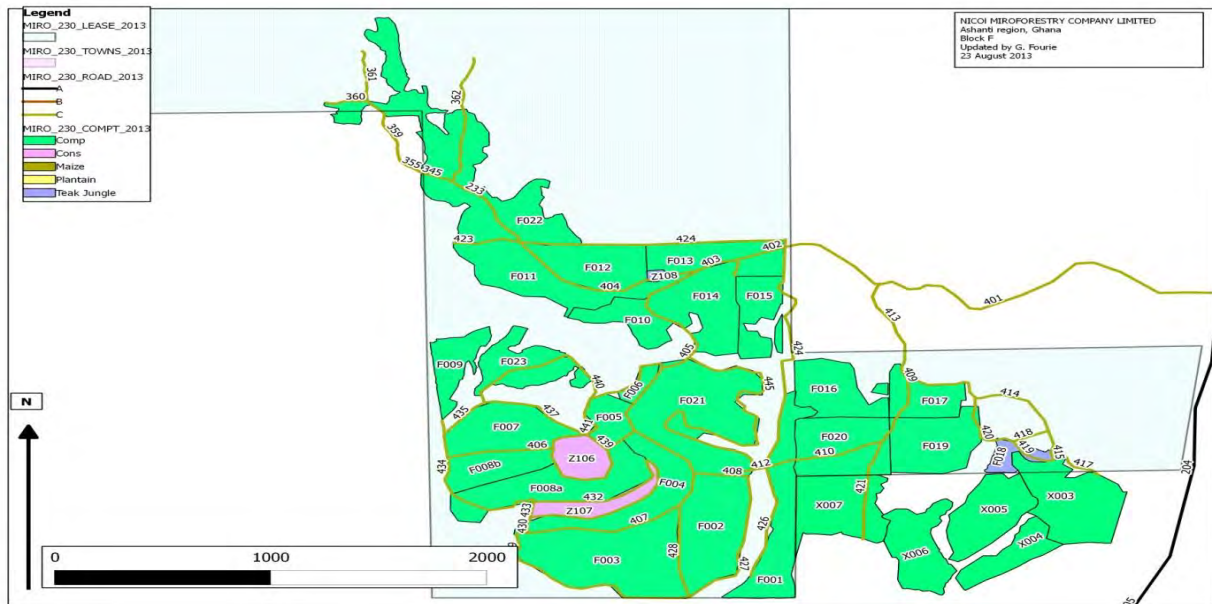


Fig 2: Sub zoning of Block F for land planning

NMFC assesses the terrain and examines the basic structure of soils and grass vegetation. Special consideration is given to important land planning issues such as land slope, water bodies, identification of any cultural sites, identification of riparian strips and sites for conservation protection, existence of agricultural farms, condition of old logging roads and wildlife habitats. NMFC is currently in the process of finalizing arrangements for a satellite land and vegetation mapping exercise to be carried out in its compartments; based on 1m contour intervals and 0.5m pixel quality. This will provide a very detailed high resolution mapping of the reserve. This information will enable NMFC to identify areas for conservation, boundary verification, silvicultural planning; assist in site and species matching, and to plan the best possible options for achieving a balance between land use, sustainable forest practices and care for the environment.

Nursery

The establishment of a nursery is an important component of the proposed project. NMFC proposes to establish a nursery located on 65ha of privately leased land located some 3km outside the Boumfum reserve. The nursery will be used to raise seedlings for transplanting into the field and to ensure that the Teak and Eucalyptus seedlings are properly prepared and selected for planting. The seeds are first planted in trays with Coco-peat medium, and then germinated under 35% shade netting. After 3-4 weeks the seedlings are transferred to steel tray tables to harden off for a further 3-4 weeks with the roots being air-pruned. Water sources for the seedlings were initially to be derived from the nearby Ongwam River but due to the low water quality after water testing, the Company has opted for use of a bore hole and has applied to the Water Resources Commission for appropriate permits. The source and

seedlings type for the project have been approved by the Forestry Commission and are listed below:

| Scientific Name | Common Name | Source |
|--|---------------------|---------------------|
| <i>Eucalyptus grandis</i> | Eucalyptus | Brazil |
| <i>Eucalyptus urophylla</i> | Eucalyptus | Brazil |
| <i>Eucalyptus urophylla</i> cross <i>grandis</i> | Eucalyptus (hybrid) | Brazil/South Africa |
| <i>Eucalyptus grandis</i> cross <i>camaldulensis</i> | Eucalyptus (hybrid) | Brazil/South Africa |
| <i>Tectona grandis</i> | Teak | Ghana |

Species Selection

Eucalyptus and Teak have been approved by the Forestry Commission for the project and according to suitability of species for the rehabilitation of the country's degraded forest reserves. Teak has been planted in Ghana since the 1920's when the colonial government used it to provide fuel wood in boiler plants for the supply of electricity. Teak and Eucalyptus have also been planted in Ghana's forest reserves for over 70 years without any adverse effects. Between 2005 and 2011, Ghana exported over 250,000m³ of Teak logs and billets to India, Vietnam and China.

Eucalyptus is a versatile timber, of high density and close grain formation. It is currently the major source of pulp-wood for the international paper industry and is the major timber used for transmission poles across the tropics because of its high bending strength and natural durability characteristics. Ghana already imports about 70,000 Eucalyptus poles for use as transmission poles in electrification schemes. The species can also be used in the construction of wood based panels including Plywood, Orientated Strand Board (OSB), Particle Board, and Medium Density Fibreboard (MDF). With improved wood stains it is becoming an increasingly popular sawn-timber and for the ever expanding bio-mass market, Eucalyptus is ideal.

As a result of the widespread adoption of eucalyptus by international commercial industry, there is a considerable base of international experience available in its management. A huge amount of research and development work has been done on eucalyptus, particularly with regard to the development of hybrid species which seek to combine the favourable tree characteristics (*e.g. high growth rates, fire and drought resistance, good stem form, resistance to pests/diseases and favourable density characteristics*) of more than one eucalyptus species. The company aims to import eucalyptus species and work alongside the Forestry Commission to develop the best species technology for various sites and climatic conditions in Ghana.

Ghana has a tropical climate and it is principally for this reason that Teak has been the most widely planted exotic tree species in Ghana. Unfortunately there are no large well-managed commercial Teak plantations and most mature Teak plantations have long been harvested and the products exported in various forms (poles, air-dried lumber and billets). However in recent times it is fast becoming a familiar and suitable species as a replacement for many of

Ghana's natural forest species which have seriously dwindled in supply. Besides its economic importance, Teak has been selected primarily because of its suitability to soil and ecological conditions and the fact that there is much local knowledge in silviculture about the species.

The Forestry Commission also mandates a minimum of 5% of planting areas should be planted with indigenous species. The Company has identified *Ceiba pentandra*, *Terminalia superba*, *Triplochiton scleroxylon* and *Nauclea diderichii* to be planted in conservation areas and along streams and rivers in order to enrich the forest cover along the water bodies and provide maximum protection to the various water courses in the reserve. In further support of conservation objectives, NMFC has also identified small mosaics and clusters of old indigenous tree species such as *Sterculia* which will be turned into conservation areas, protected and maintained.

Land Preparation

Appropriate land preparation is a silvicultural requirement that aims to avoid unnecessary environmental damage and successfully establish a plantation. Land preparation operations must be related to prevailing site conditions and must be cost-effective since these initial costs are compounded over an extended period. Incorrectly applied or careless operations particularly on sensitive soils may result in long-term damage to the site. Table 1 below provides soil preparation methods for different slope classes. The required operations for establishment will vary with soil and site characteristics.

Table 1: Land preparation options under various conditions

| Slope (%) High | Soil Erodibility Low | Type of cultivation | Tillage direction | Remarks |
|---------------------------|---------------------------------|--|--------------------------|---|
| 0 – 8% | 0 – 12% | Full conventional | Across slope | Leave surface as rough as possible. |
| 9 – 15% | | 1. Full primary cultivation with tined implement only. 2. Strip cultivation with any implement leaving minimum 1m between strip which may be ripped or sprayed. | Across slope | |
| 13 – 20% | | Full unrestricted primary cultivation followed by secondary cultivation along the plant line only | Across slope | |
| 16 – 25% | 21 -30% | Full primary cultivation with tined implement only. | Across slope | Plant within 1 month. Weed control via herbicide strip (1.5m wide or more) or hand hoe around the tree, no mechanical control. |
| 21 – 30% | 31 – 40% | Single rip/sub-soiler tiner along plant line. | Across slope | Tracked tractor recommended. Weed control as above, spray prior to planting. |
| >30% | >40% | Pit | | Maximum diameter 1m. Weed control as above, restrict hand hoeing to pitted areas. |

Land preparation involves appropriate soil preparation and soil testing and analysis. This will ensure optimisation of the site as soil preparation, to a large extent, determines the success of the planting. The company intends to undertake soil preparation when the moisture content of the soil is optimal. As part of the land preparation activities, weeds will be controlled by the application of Glyphosate; as well as the use of a soil enrichment fertilizer in the form of Urea (46%) Nitrogen. The inter-cropping of trees with leguminous crops such as cowpeas, soya and onions by farmers contributes to improving the nitrogen content in soils.

Ripping of soils will be undertaken on soils with a clay content of over 35%. Ripping will be done along the contour. If ripping is not done along the contour, then the ripline should be a maximum of 50 metres long with a 5 metre buffer zone between riplines. The depth of rip should be sufficient to overcome the limiting factor in the soil.

NMFC will also undertake ploughing of lands in order to loosen the soils for planting. In this regard NMFC will plough along (i.e. parallel to) the contour to avoid erosion, and will not be undertake this activity on gradients steeper than 10%.

Planting

Planting is targeted for between May – June annually depending on the weather during that period. All potted planting materials will be transported from the nursery using flat-bed trucks and brought to the planting site on the day of planting. The project will adopt a general spacing of 2m x 3m for Eucalyptus spp (1333 stems per hectare) and 3m x 3m for Teak (1111 stems per hectare) in each planting unit except for areas requiring the planting of indigenous species where a spacing of 4m x 4m will be used. This activity will be completed by the end of April of each planting year depending on the weather.

Eucalyptus will be grown on an 8 to 10 year rotation for transmission poles and ply. An average MAI of 28m³/ha/annum is assumed across the plantation, though as soil surveys are completed this year (2014) and permanent sample plot data become available management will further define site classes and revise MAI forecasts. The company fully expects to be able to improve on the MAI achieved following improvement in species-site matching. At age 3 individual eucalyptus compartments will be reviewed against the target product end market and a suitable thinning regime initiated, probably including thinnings at years 3 and 6.

Teak will be grown on a 20 to 25 year rotation for saw logs and an average mean annual increment (MAI) of 12m³/ha/annum will be assumed across the plantation – as soil surveys are completed this year (2014) and permanent sample plot data become available management will define specific site classes based on field data. NMFC will collaborate with the Forestry Commission to obtain clones from certified sources of early-maturing and higher-yielding nurseries of Teak to propagate for planting. Expected teak yields will be based on projected planting plans and anticipated silvicultural regimes; 3 thinnings at years 6, 10 and 13 are expected, though this will vary from site to site.

Maintenance

It should be noted that most common weeds grow faster than newly-planted trees and unless the weeds are controlled effectively, the plantation investment will suffer seriously (and may even fail completely). Weeds cause many problems within a plantation: they take up nutrients that would have been used by trees to enhance growth; once taller than trees, weeds can shade them from sunlight; lower plantation hygiene as a result of weed growth can render the plantation susceptible to pest and disease attack; most importantly, weeds provide fuel for forest fires, creating a fire hazard. Careful planning can greatly reduce the impact of weeds on tree growth as well as minimizing costs.

Weeding, whether performed manually or by hand, can only remove weeds that have germinated – seeds will continue to germinate and follow-up inspections and weeding will always be required. Weeding must therefore be performed before the weeds are able to seed in order to be effective.

Three weeding events will take place in March/April, June/July and September/October for the first and second years after planting and two weeding events in the 3rd year in each coupe. Two rounds of line cleaning may take place in each coupe in the fourth years by which time canopy closure is expected. Weed control will be on a flexible as-needed basis, using the following methods where appropriate:

Following planting, a manual ring weed will be undertaken to minimize competition to ensure good growth of the seedlings. The ring weeding will be done within one month of the seedlings having been planted. The aim of the operation is to create a weed-free zone of 50cm radius around each newly-planted seedling. This operation is best carried out using a hoe and care will be taken not to hoe right up to the stem, as this causes soil to be removed from the base of the stem which can lead to the seedling falling over.

Tractors will be used where appropriate, towing a disc, plough, rotavator or flail mower to slash down weeds. This can be very cost-effective if carried out under the correct conditions; whereby great care is taken to ensure that the conditions are suitable and that there is sufficient inter-row space.

When necessary chemical weeding will be undertaken using Glyphosate (herbicide) to kill undesired weeds. Being mindful that the chemical can also kill the seedlings if applied without care, the application will be safer in the pre-planting clearing. When used in post-planting weed control, measures will be taken to prevent it coming into contact with the planted trees. Therefore cones 1m in diameter will be placed over the planted trees to prevent any contact.

Before undertaking chemical weed control the spraying team will be well-trained in the use of the chemical and equipments and provided with personal protection equipment (PPE).

Pruning

This operation will be carried out to provide a knot-free timber from the growing tree. Branches that develop up to, at least, a third of the tree height will be removed during the third, fourth and fifth years of establishment. Intensive pruning of buds and branches will also be undertaken regularly after the first pruning operation.

Thinning and Final Harvesting

The main species to be cultivated in the Bomfoum Forest Reserve will be industrial timber species including eucalyptus as well as an element of high value species including teak. Both will be managed according to the predominant best practice methods understood worldwide. The targeted products are poles for power transmission and rural electrification, sawn timber for the local and regional markets and ply for the construction industry. Thinning will be carried out in each annual coupe to ensure that the final crop develops under conditions that will maximize volume increment.

Road Construction and Maintenance

Many of the old logging roads in the reserve were poorly constructed and as such require maintenance to bring them up to modern forestry standards. NMFC will therefore rehabilitate old logging roads; where they occur within its allocated compartments.

The planning, construction and maintenance of the forest road network, depots, landings and extraction routes are referred to as access development. This is necessary to enable equipment and personnel to gain access to the standing tree to remove products from the forests. Tactical planning is a necessary step in road planning and construction and should be a function of the time frame of the tactical harvesting plan. NMFC therefore aims to achieve an optimal balance between forest roads, extraction routes, depots and landings to maximise the profitability of the forest estate. As part of its road planning activities, NMFC will consider the following during the planning and construction of roads:

- **Size of corridor to be cleared;**
- **Soil properties, topography and terrain;**
- **Prevailing climate;**
- **Availability and type of harvesting methods to be used; and**
- **Volume of timber to be transported.**

The location of roads and proposed harvesting systems are linked in the way that the potential road location will be influenced by the choice of harvesting system, but if a road is already in place the choice of harvesting system is restricted by the road location. This is a situation that is very common in forestry and if not carefully managed can lead to unnecessary roads being constructed. A trade-off between the harvesting system in place and an alternative system will be investigated before any road is constructed. Road density is theoretically determined

by dividing the total road length by the total land area. A guideline to aim for is anything between 20ha to 30ha (planted) per kilometre of constructed road. It must be noted that the optimum road spacing is only be used as a guide to assist in road planning, because most logging areas are not perfectly flat. As a general rule, if NMFC must deviate from the optimum road spacing, it will increase the distance between roads rather than to decrease it. Table 2 below outlines road spacing guidelines that will be adopted by NMFC.

| Ground Slope (%) | Road spacing slope (metres) | Road density (km/ha) |
|------------------|-------------------------------|----------------------|
| 0 to 15% | 800 | 27 |
| 15 to 30% | 600 to 800 | 37 to 27 |
| 30 to 60% | 300 to 400 | 73 to 55 |
| >60% | 400 with uphill cable yarding | 55 |

Table 2: Road spacing guidelines for varying terrain conditions

Fire Management

NMFC considers fire protection a key issue since it poses the greatest physical risk to the company's biological assets as well as to the already heavily-degraded reserve. Fire protection will therefore focus on fire prevention, fire risk reduction and fire preparedness and suppression. This is extremely important for the effective protection of the reserve and to avoid a repeat of the devastating fires of 1983 and its attendant smoke related consequences.

Fire prevention measures require projects of active engagement with the local community. Most fires are man-made, started to clear land or for the purposes of hunting. Agricultural methods using fire to clear land are less efficient in terms of retaining nutrients and organic matter in the soil, and efforts will be made through education programmes to re-educate local farmers who clear land in this way.

Fire risk reduction methods will focus on physical methods of preventing fires from occurring or reducing the potential severity of fires. Weed control methods will aim not only at preventing competition with young trees but also at reducing the volume of combustible material that builds up beneath the trees. Intensive weed control methods as outlined above will be used for both purposes. Fire breaks are a further tool that will be used to reduce the impact of fires and aid in the ability to fight them. Fire breaks 10 metres wide will be created around planting units within the plantation and also serve as access routes within the plantation. Some green belts have been established and will be extended further into other high-danger areas at strategic locations along the perimeter of the reserve. Local farmers will be encouraged to plant groundcover crops within the green belts to further enhance their capacity to retard the spread of fire.

Fire preparedness is of high importance during the fire season (December – April). NMFC is in the process of acquiring fire equipment to manage fire outbreaks. Three (3) Hilux 4WD pickups are to be permanently fitted with high-pressure, water deployment devices for rapid

fire fighting interventions. Every day during the fire season a member of the senior management team will be designated as being on call with regard to fire management. Roaming security guards will be employed and deployed on 24-hour patrol of the plantation during the dry season. The guards will be provided with transport and communication gadgets to facilitate communication between the groups for rapid response to manage fire outbreaks. The company has introduced a fire index system that takes temperature, wind speed and humidity into account and all staff will be alerted every morning as to the current index and the fire risk for the day. In support of its fire fighting efforts, NMFC also proposes to partner with locals for effective fire management support.

Inter-cropping schemes

In line with the company's objective of introducing alternative livelihood schemes to the local farmers the project will allow selected registered farmers to intercrop the tree seedlings with selected seasonal food crops (preferably vegetables, legumes and non-woody fruit plants). The inter-cropping schemes will be developed in close collaboration with Traditional Councils and local stakeholders after land preparation activities have been completed and trees planted.

Labour and Staff Recruitment

NMFC will recruit workers for its field operations from within the Agogo community and surrounding areas. These workers will complement and support plantation development managers who will oversee the implementation of the project. It is estimated that about 140-150 workers will be recruited to support plantation development objectives; together with 20-30 management and administrative support staff. It is also worth noting that subject to the company meeting its plantation goals and securing appropriate land, another 70-100 workers could be employed in the development and operation of a timber treatment plant and sawmill.

Annual Social Responsibility Commitments

The Company has instituted a policy that a minimum of 1% of its annual operating budget will be ring-fenced for the funding of socially and environmentally beneficial projects aimed at addressing the needs and requirements of the local communities in which it operates, with a particular emphasis on projects which will enhance education and healthcare.

The Company has already initiated the development of a Vocational Training Centre project, in partnership with a semi-governmental vocational development organization and the local community. The Company has provided limited funds for materials to refurbish a dilapidated and uncompleted school block to create the Vocational Training Centre for educating youths in employable skills. Enrolment is now commencing for courses including masonry, plumbing, wiring, dress making, and agriculture, with the common teaching of Mathematics, English, Information Communication Technology (ICT) and business skills to therefore equip pupils to manage their own business on graduation.

The project has been managed by the Integrated Community Centre for Employable Skills (ICCES), which is responsible for developing and managing the operation of vocational training centres in Ghana. With ICCES management, prior graduates from other vocational training centres helped to build and refurbish the centre, with the full support and help of the local community, who also supplied local materials. Youths enrolling from the community will be formally trained in the centre in employable vocational skills, under specific national curriculums. Currently the centre has over 20 youths enrolled on a permanent basis.

NMFC will sustain its collaborative efforts to support local initiatives to provide other social amenities that qualify for funding under the package.

1.8 Materials and Labour Requirements

During the first five establishment years of the project, NMFC estimates the use of the following key inputs:

- ✓ Teak seedlings – 240,000 per/yr for 5 yrs
- ✓ Eucalyptus seedlings – 1,440,000 per/yr for 5 yrs
- ✓ Glyphosate for weed control – 18,000 litres/yr for 5 yrs
- ✓ Urea (46%) Nitrogen as a soil enrichment fertilizer
- ✓ Reusable seedling trays
- ✓ 3 Fire fighting water pumps, drums and hoses
- ✓ 2 tractor ploughs, 1 ridger and 1 ripper
- ✓ Ancilliary Tools – cutlasses, hoes, forks etc
- ✓ 3 pickup vehicles
- ✓ 2 buses for transporting workers
- ✓ 1 Road Grader and compact roller (hired locally)
- ✓ 140 field workers and 20 office support staff

2. ENVIRONMENTAL BASELINE

2.1 Land and Land Use

The land of the Boumfum Forest Reserve is owned by the peoples of Agogo, Kwamang and Kumawu traditional areas; each represented by their stool leader or Chief. The implication is that these three stools have the title to the land and all benefits accruing from the land are due to them. It is of interest to note that the people of the three towns are from common ancestral backgrounds and indeed see themselves as cousins. As a result of this blood-relation, there are no physical stool land boundaries in the Reserve for the three identifiable owners. Under the reservation agreement, the people have hunting rights in the Reserve and are allowed to collect firewood and non timber forest products (NTFPs). Admitted farming rights were granted to some families and the village of Ananekrom was designated as an admitted settlement just inside the far eastern boundaries of the Reserve.

The Forestry Commission is the mandated custodian of the reserve lands and has been entrusted by the stool landowners to manage and maintain the reserve as a forest on behalf of the stool landowners. The current land use of the reserve can be described as varied. Some parts of the reserve are being used by some locals for agricultural farming such as onions, cassava, maize and plantain whilst other parts have been previously used for the establishment of Teak plantations. Field surveys have also identified illegal migrant settler farmers who have encroached upon the reserve and established plantain and maize farms; and are also undertaking cattle grazing in many parts of the reserve.

Desk studies have revealed a number of legislative instruments pertaining to land tenure and use. Article 267 of the 1992 Constitution stipulates that “*All stool lands in Ghana shall vest in appropriate stool on behalf of and in trust for the subjects of the stool in accordance with customary law and usage*”. In practice, all stool lands belong to paramount chiefs who are the traditional heads of paramount stools. Ownership is often hierarchical with paramount divisional, town or village stools all having an interest in the land according to the mode of acquisition.

The Concession’s Act (Act 124), 1962 indicates that “*the timber and land in forest reserves or subject to timber concessions (both within and outside the reserved forests) are vested in the State in trust for the landowning communities*”. The exploitation of the production forest reserves is administered by central government through the Ministry of Lands and Natural Resources (MLNR) and the Forestry Commission. Under this arrangement the landowners have a right to a share of revenue from both natural timber harvesting and forest plantation development within the forest reserves.

The Forest Ordinance (Cap 157), 1927 section 18(1) provides “*that the ownership of land is not altered by its declaration as a forest reserve*”. The landowners therefore have the right to a share of the benefits from the development of plantations in forest reserves. The Benefit Sharing Agreement signed by NMFC and the Forestry Commission for Commercial Forest

Plantation Development states that the “Landowner is entitled to 6% of the standing tree value (STV) of thinning and final harvest, the Forestry Commission is entitled to 2% of standing tree value of thinning and final harvest, the Local community shall also receive 2% of standing tree value of thinning and final harvest. The balance of 90% shall accrue to the plantations investor. Benefit sharing arrangements, which include landowners, are therefore defined in lease agreements between NMFC and the Forestry Commission; copies of which have already been submitted to the EPA as part of the initial Scoping Exercise.

The land area allocated to NMFC by the Forestry Commission is earmarked for the development of tree plantations to support the reforestation efforts of the Forestry Commission for the reserve. Specifically 5000ha of the 26,000ha reserve have been demarcated for the NMFC development. This can be seen as Blocks A-G on the map below. ***It is worth noting that Block C will not be subjected to any plantation development by NMFC because of its prohibitive distance and location from Agogo; as well as its close proximity to the Bomfobiri Wildlife Sanctuary.***

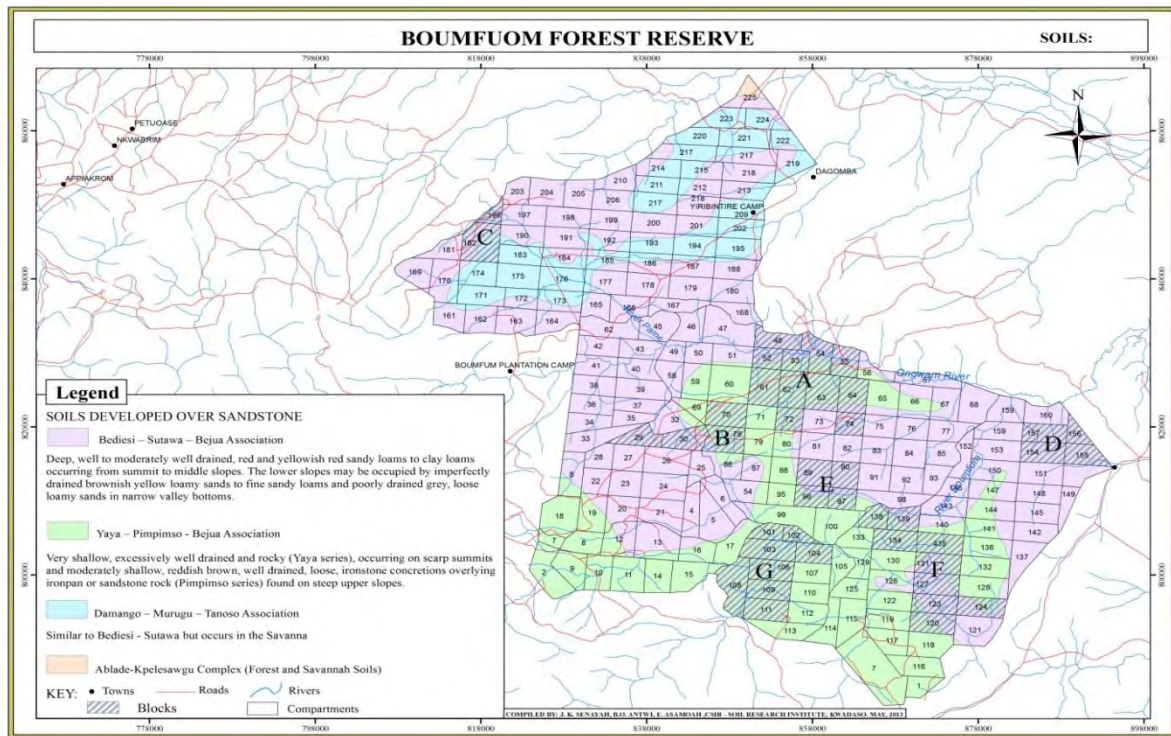


Fig 3: NMFC allocated compartment blocks (A-G) within the Boumfum Forest Reserve

2.2 Climate

The Boumfum Forest Reserve occurs in the forest-savanna transition agro-ecological zone. In the late 1970's, the reserve was generally characterized by relatively high rainfall of about 1400 mm per annum with a bimodal pattern (Adu and Mensah-Ansah, 1995). However, desk studies and research undertaken indicate that average annual rainfall has reduced to about 1370 mm. This shows that annual rainfall amounts have not changed much. The rainfall trend is typified by major season rains occurring between April and mid-July with a peak in May/June. There is a short dry spell from mid-July to mid-August. The minor rainy season starts from mid-August to about the end of October with a peak in September. A long dry period is normally experienced from November to March with possibilities of occasional rains.

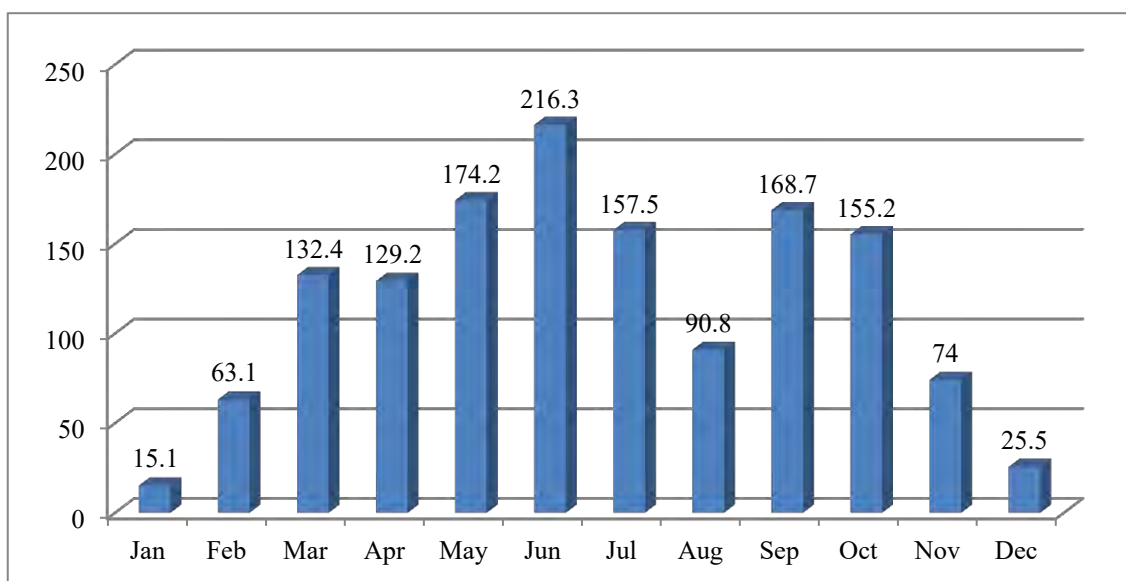


Fig 4: Mean Monthly rainfall (mm) distribution for Agogo

The rainfall and temperature values are within limits that are generally suitable for a wide range of tropical trees, particularly Teak. These are considered against the background that Teak and Eucalyptus trees grow well within a temperature range of 13 - 40°C and optimal rainfall ranging from 1,250 to 3,750 mm per year (Kaosa-ard, 1981; Agyeman *et al*, 2010). However, for the production of good quality timber, the trees require a dry season of three to five months with relatively low precipitation which occurs from November to February. Temperatures are normally high throughout the year with very little variations. The mean monthly temperatures usually range from 25°C in July/August to 28°C in March/April. The temperature data pattern is shown in the Figure 5 below.

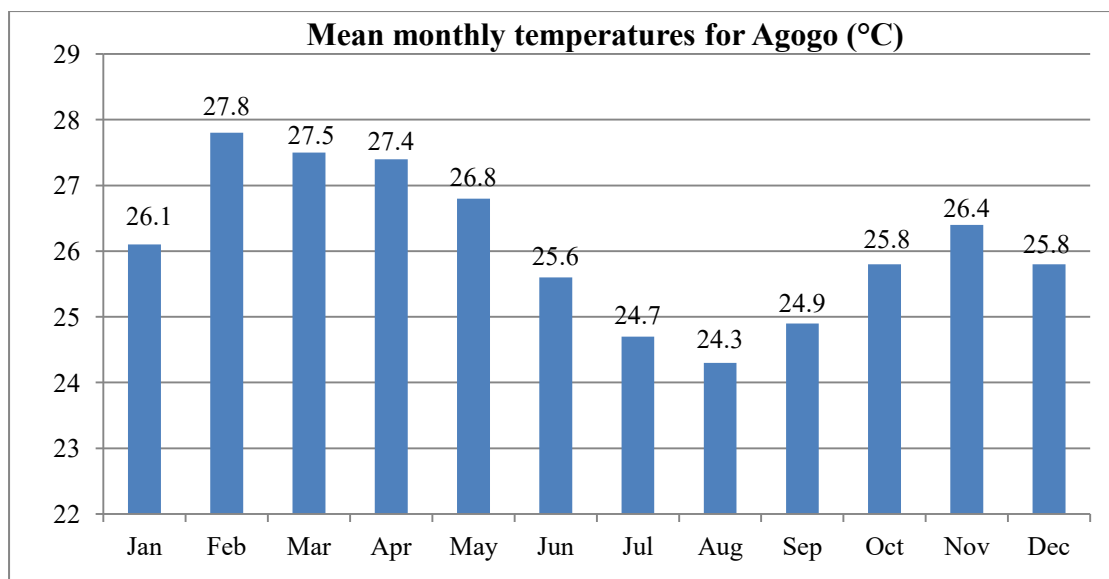


Figure 5: Mean monthly temperatures for Agogo

2.3 Geology and Topography

The Reserve occurs within the Voltaian Basin. The underlying geology of the Voltaian Basin consists almost entirely of sedimentary rocks, mainly coarse-grained sandstones, clay shales and mudstones of Devonian or early Carboniferous age (Junner and Hirst, 1946; Adu and Mensah-Ansah, 1995). The reserve itself is entirely underlain by sandstone with the exception of the northern tip of compartment 225 where shale is encountered. Soils weathered from the sandstone are characteristically sandy at the top and sandy clay loams in the subsoil or loamy sand throughout the profile. On the highlands of the reserve the topography is undulating to slightly rolling with slopes of 5-10% for the undulating lands and 10 – 15% to the peak of rising isolated hills. Cliffs showing thick layers of sandstone rocks can be seen in many parts of the reserve. The altitude of the highlands ranges from 150m to 400m. The reserve consists of dissected hills which constitute the headwaters of numerous streams which flow into the main Ongwam and Boumfum rivers.

2.4 Soils

The soils of the reserve are generally weathered from the Voltaian sandstone ((Adu & Mensah-Ansah, 1995), which was confirmed during the Scoping exercise. Soil erosion is a major issue particularly arising from sandy top-soils and the steep slopes of the hilly topography. It may be induced and accelerated by land clearing, bushfires, road construction on some of the steep slope characteristic of the Boumfum reserve topography. Erosion may be common on large stretches of newly prepared lands for tree planting. Consequently, soil nutrients may be washed away.

Within the NMFC allocated compartments, two soil association units are encountered. Each soil association consists of a group of individual soils which are often found together in the landscape. They are the:

- a) Yaya-Pimpimso Soil Association which are dominantly *Lithic or Haplic Leptosols* (WRB /FAO, 2006) and
- b) Bediesi – Sutawa which are dominantly *Haplic Lixisols*.

Yaya – Pimpimso soil unit (*Leptosols*) were found to be mainly associated with the hilly terrain. It is dominated by the occurrence of rock outcrops and generally shallow soils. Soil depth and sandy texture constitute the critical soil limitations in this soil unit. They are characteristically shallow (depth<50cm) and rocky with numerous outcrops in the compartments in which they occur (Fig 6).



Fig 6: Yaya – Pimpimso soil type characterized by rock outcrops

The rocks are particularly prominent on the numerous cliff faces in most of the compartments. It was also observed that the soils have loamy sand textures where clay amount within 50 cm depth is less than 5% and sand content in the particle size fraction is more than 60%. However, within this dominantly *Leptosol* unit (Yaya –Pimpimso), there are pockets of deep, well drained *Lixisols* (Bediesi – Sutawa).

Compartments that are entirely occupied by the Yaya – Pimpimso soil unit or the *Leptosols* are as follows:

- a) Block A- 61,62, 63, 64, 72;
- b) Block B- 70, 78;
- c) Block E- 96, 97;
- d) Block F- 134, 135, 138;
- e) Block G- 101, 102, 103, 104, 106, 108, 109, 111.

Bediesi – Sutawa Association are *Lixisols* associated with deep (120 cm), well drained, gravel-free, sandy loam / loamy sand topsoil overlying sandy clay loam / clay loam subsoil on uplands. They have very good physical properties for plant development. Establishing tree plantations on this soil unit would be highly suitable. Compartments occupied entirely by Bediesi – Sutawa soil unit are

- a) A 48;
- b) B 29, 30,
- c) D 154, 155,156, 157;

- d) E 89, 90;
- e) F 123.

It was also observed that some of the compartments have both the Leptosol and the Lixisol units in varying proportions and these are

- a) A 52,53, 54, 55;
- b) F 120,124, 127, 131, 139.

During field surveys, some valleys were observed to be poorly drained. In a valley observed in compartment 127, the water table was encountered at 80 cm. However, drainage grooves occurring on the hills have good drainage but are narrow. The soils are deep with loamy sand and sandy loam textures.

2.5 Fertility status of the soils

In order to establish the fertility status of the soils in the reserve and their suitability for plantation development, soil samples were taken from the compartment blocks and analysed by the Soil Research Institute, Kumasi in August 2013. Generally, the results show that the fertility status of the soils is low in some areas and needs to be improved for a vigorous tree growth, particularly, the exchangeable cations (Ca, Mg). Soil reaction (pH) is very good and for this reason application of rock phosphate as means of improving the exchangeable cations will not show good response.

A copy of the test report can be found in the Appendix. The results of the laboratory analyses of the soil samples are summarized as follows:

Soil Reaction and Exchangeable Cations

Soil pH for all the soil samples ranged from 6.0 to 7.1 which is within the optimal pH requirement for tree growth (Table 1). However, exchangeable Ca, Mg, K and effective cation exchange capacity are low for samples A and very low for B and C. The exchangeable cations therefore need serious improvement.

Organic Matter and Total Nitrogen

Only the top soil of sample A showed high organic matter status; while the rest of the samples (*subsoil for Sample A and top and subsoils of samples B and C*) showed lower values. Total nitrogen followed a similar trend; being very low for all the sites and depth; except the top soil of sample A which was moderate. In general terms the organic matter and Nitrogen status of the soils are low (Table 1).

Available Phosphorus

Available phosphorus was moderate for site A and high for the other sites (Table 3 below).

Table3. Chemical Properties of Soil Samples (Fertility Tests)

| Soil Samples | Depth Cm | pH | O.C | TN | OM | Bray's Available | | Ca | Mg | K | Na | T.E.B | Exch. Acidity | E.C.E.C | Base Sat. |
|------------------|----------|------|------|------|------|------------------|---------|---|------|------|------|-------|---------------|---------|-----------|
| | | | % | | | P mg/kg | K mg/kg | Exchangeable cations [cmol(+)kg ⁻¹] | | | | | | | % |
| A (Comp G111) | 0 -20 | 6.57 | 2.05 | 0.19 | 3.53 | 16.10 | 72.37 | 8.01 | 4.01 | 0.15 | 0.04 | 12.21 | 0.10 | 12.31 | 99 |
| | 20 – 40 | 6.06 | 0.9 | 0.09 | 1.55 | 5.10 | 30.43 | 4.81 | 1.34 | 0.06 | 0.02 | 6.23 | 0.13 | 6.36 | 97 |
| B (Comp D157) | 0 -20 | 7.14 | 0.73 | 0.07 | 1.26 | 41.70 | 42.61 | 3.47 | 1.34 | 0.07 | 0.02 | 4.90 | 0.05 | 4.95 | 98 |
| | 20 – 40 | 6.35 | 0.49 | 0.05 | 0.84 | 9.41 | 29.76 | 4.27 | 0.80 | 0.06 | 0.03 | 5.16 | 0.11 | 5.27 | 97 |
| C (Comp F127) | 0 -20 | 6.51 | 0.79 | 0.08 | 1.36 | 35.56 | 41.59 | 2.94 | 1.07 | 0.07 | 0.02 | 4.10 | 0.10 | 4.20 | 97 |
| | 20 – 40 | 6.46 | 0.34 | 0.03 | 0.59 | 6.54 | 28.74 | 2.14 | 1.34 | 0.05 | 0.02 | 3.55 | 0.10 | 3.65 | 97 |

Notes: O.C.-Organic Carbon; TN – Total Nitrogen; OM – Organic Matter; Ca –Calcium; Mg- Magnesium; K –Potassium; Na –Sodium; P-Phosphorus; TEB – Total Exchangeable Bases (sum of Ca, Mg, K and Na); ECEC –Effective Cation Exchange Capacity; Base Sat – Base saturation

2.6 General assessment of soil units for Teak and Eucalyptus (species / site matching)

Under this section, the growth requirements of trees are matched against the soil properties of the various mapping units. The mapping units derived for this purpose are based on soil units occupying individual compartments. They are compartments occupied by:

- i. Bediesi – Sutawa – Bejua Association, dominantly *Nitic and Haplic Lixisols*,
- ii. Yaya – Pimpimso Association, dominantly *Lithic and Haplic Leptosols*
- iii. Bediesi – Sutawa and Yaya – Pimpimso combination

Soil physical characteristics common to favourable growth of trees include,

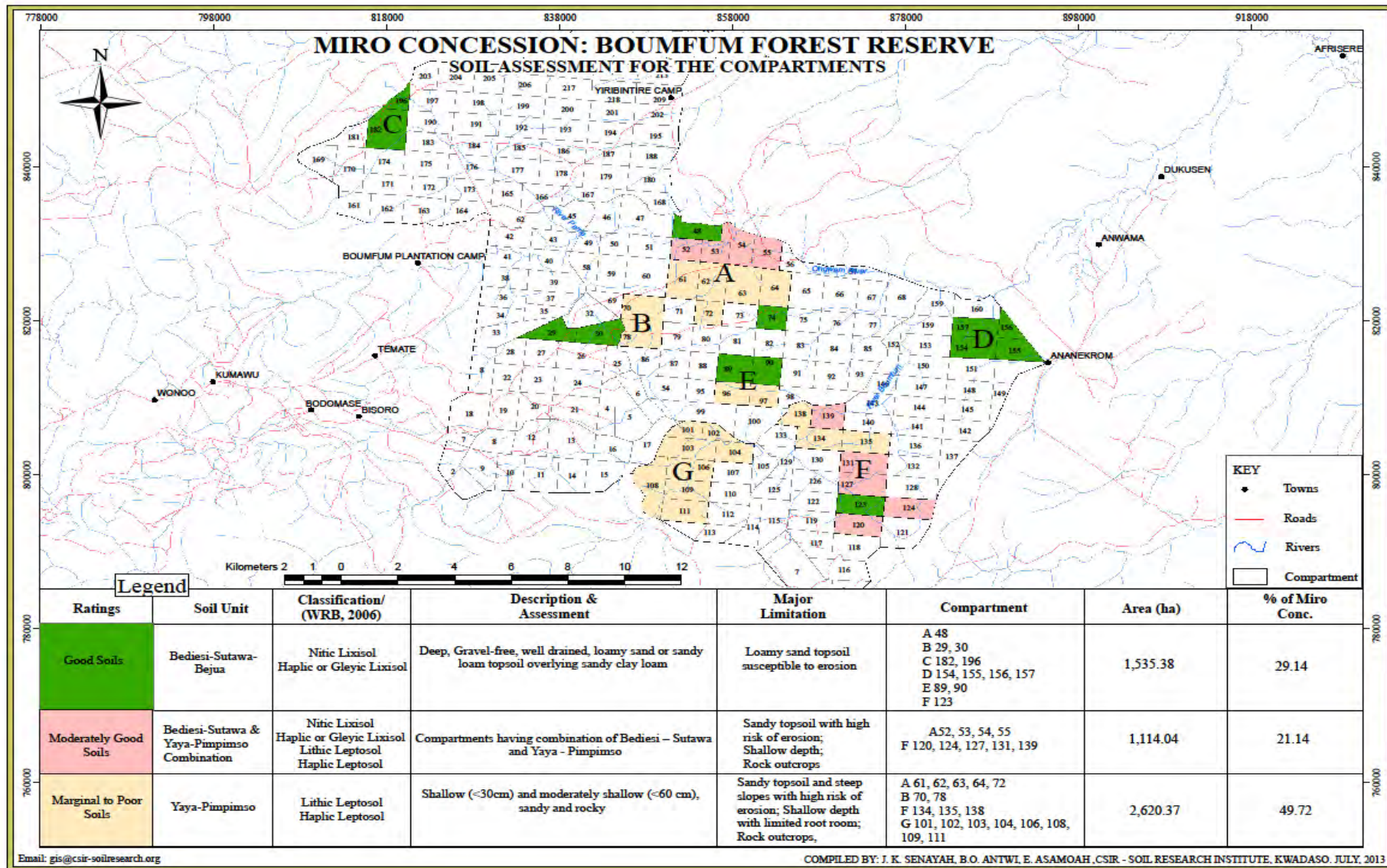
- a. Deep soil depth from 60 to over 100 cm
- b. Good drainage (well drained –*very good*, moderately well drained –*good* and imperfectly drained –*moderate*)
- c. Medium – textured soils – sandy loam, loam, sandy clay loam, clay loam, silt loam and silty clay loam. The other extremes like light textures (sand and loamy sand) and heavy textures like clay, silty clay may pose constraints like structure which affect aeration, porosity and moisture holding capacity.

In a summary, Teak and Eucalyptus species can grow on a variety of soils. The quality of its growth, however, depends on the depth, structure, porosity, drainage and moisture holding capacity of the soil. They normally develop best on deep, well drained and fertile soils. The optimal soil pH is between 6.5 and 7.5. The calcium content of the soil is also an important factor for Teak; calcium deficiency in the soil results in stunted growth of Teak (Kaosa-ard, 1981).

Teak and Eucalyptus grow well within a temperature range of 13 - 40°C. Optimal rainfall ranges between 1,250 and 3,750 mm per year. However, for the production of good quality timber, Teak in particular requires a dry season of three to five months with less than 60 mm precipitation (Kaosa-ard, 1981; Agyeman *et al*, 2010).

In terms of climatic conditions, Boumfum Forest Reserve is located in the forest – savanna transition zone. Total annual rainfall as represented by Agogo and Kumawu is about 1400 mm but could reduce to about 1200 mm in some years. Mean monthly temperatures range from 24 to 28°C. These are optimal climatic conditions for Teak and Eucalyptus species.

For the purpose of site / species matching reference is made to mapping units derived for this purpose in the map below. This shows that Bediesi-Sutawa unit (*Lixisols*) have the best soils which covers about 1,535 hectares (29% of the NMFC concession). The compartments occupied by this soil unit are however, not contiguous. The moderately good compartments containing the combination of Bediesi – Sutawa and Yaya – Pimpimso (*i.e. the Lixisols and Leptosols*) cover about 1,114 hectares (21% of NMFC concession). The marginal to poor compartments cover about 2,620 hectares (50% of the NMFC concession). This is depicted in the map below.



2.7 Soil erosion hazard

Soil erosion hazard represents the susceptibility of the surface soil to be transported away by water. It causes both on-site impacts (soil loss, nutrient loss) and off-site impacts (reduced water quality and increased sedimentation).

In all the compartments the soils have high sand fractions compared to silt and clays as shown in Table 4 below.

| Samples | Depth (cm) | % Sand | % Silt | % Clay | Texture |
|----------------|-------------------|---------------|---------------|---------------|----------------|
| Compt G111 | 0-20 | 66.92 | 19.08 | 14.00 | Sandy Loam |
| | 20-40 | 68.20 | 11.80 | 20.00 | Sandy Loam |
| Compt D157 | 0-20 | 83.32 | 9.68 | 7.00 | Loamy Sand |
| | 20-40 | 80.56 | 9.84 | 9.60 | Loamy Sand |
| Compt F127 | 0-20 | 82.34 | 11.66 | 6.00 | Loamy Sand |
| | 20-40 | 82.98 | 10.62 | 6.40 | Loamy Sand |

The risk of erosion by water occurs wherever the soils have high sand or silt content and exposed to prolonged rainfall. Signs of erosion were observed in the compartments as increased depths of sandy and silty loams in the valleys (sedimentation). In undertaking the soil erosion risk assessment, soil texture and steepness of slope were considered. The soil erosion hazard keys for evaluating site sensitivity to operational planning were used to assess the degree of site contributing factors to soil erosion. These include

- Climate,
- Topography,
- Depth to water restricting layers,
- Surface soil detachability,
- Subsoil permeability.

The inputs for this assessment were extracted from climate, topographic and soil data from NMFC compartment blocks. Table 3 below presents the results and shows that erosion hazard for the soils within the compartments are moderate to high. Since this is a forest plantation, it is expected that erosion of the soils will remain low when surface litter are not burnt. However, during initial planting, the soils could be exposed to severe erosion. This implies that erosion rates could be initially high and then decline after the first two years.

Table 5: Soil erosion hazard for NMFC compartments

| | Precipitation | Topography | Slope length/ Uniformity | Depth of water-restricted layer (cm) | Surface detachability (0-15 cm) | Coarse fragments (10-15 cm) | Subsoil permeability (16-60 cm) | Total Rating | Erosion hazard rating |
|---|---------------|------------|-----------------------------|--------------------------------------|---------------------------------|-----------------------------|---------------------------------|--------------|-----------------------|
| Block A | High | 5%-12% | Moderate | 57cm depth | loamy sand to silty loam | 16-30 | Silty loam | 23 | High |
| Rating | 6 | 1 | 2 | 3 | 6 | 3 | 2 | | |
| Block B | High | 10%-15% | Moderate | 75 cm depth | loamy sand to silty loam | 16-30 | Silty loam | 21 | Moderate |
| Rating | 6 | 2 | 2 | 2 | 6 | 3 | | | |
| Block D | High | 2%-5% | Moderate | 48cm depth | loamy sand to silty loam | <16 | Silty clay | 26 | High |
| Rating | 6 | 1 | 2 | 3 | 6 | 4 | 4 | | |
| Block E | High | 10%-15% | Moderate | 66 cm depth | loamy sand to silty loam | 16-30 | Silty loam | 23 | High |
| Rating | 6 | 2 | 2 | 2 | 6 | 3 | 2 | | |
| Block F | Moderate | 3%-12% | Moderate | 75 cm depth | loamy sand to silty loam | 16-30 | Silty loam | 22 | Moderate |
| Rating | 6 | 1 | 2 | 2 | 6 | 3 | 2 | | |
| Block G | Moderate | 30%-40% | Moderate | 48 cm depth | loamy sand to silty loam | 31-60 | Silty clay | 26 | High |
| Rating | 6 | 3 | 2 | 3 | 6 | 2 | 4 | | |
| NB: Soil erosion hazard point rating: Low (<16); Moderate (16-22); High (23-31); Very high (>31) | | | | | | | | | |

2.8 Hydrology

As part of the desk study, the EIA has taken into consideration a number of key national documents and policies pertaining to management and use of water bodies. These are the:

1. Ghana Environmental Protection Energy Sector Guidelines – Water Quality Impact Assessment Section; Volume 2 (EPA, 1999),
2. Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana (Water Resources Commission, 2012a),
3. National Integrated Water Resources Management (IWRM) Plan for Ghana (WRC, 2012b).
4. Water Use Regulations (LI 1827), Water Resources Commission, 2006

From a water quality perspective, the main water resources at risk from the proposed NMFC development are:

- Ongwam River
- Boumfum River and
- Groundwater

The water resources in the reserve provide the main sources of domestic water supply for humans and animals around Kokode, Ananekrom and beyond. They are in the form of rivers, springs, dugouts and impoundments or ponds depending on the season.

The highlands from which the main water resources obtain their source of water range from 150m to 400m above sea level. They are known to have the best water supplies in the whole Volta Basin (Adu and Mensah-Ansah, 1995). This is due to the good and well distributed rainfall conserved by extensive forests and favourable underlying Voltain sandstone rocks. Presently, Ongwam River dries into discontinuous pools in the dry season. The Boumfum River dries up in the dry season but is prone to overflowing some of its banks and flooding parts of the reserve during the rainy season.

The tributaries that feed these rivers last for short periods and are intermittent in nature. They also provide much of the hydrological and ecological linkages to the Boumfum landscape. Although lacking perennial flow, they constitute a large percentage of the stream network in the reserve, connecting them to Ongwam and Boumfum rivers.

2.9 Hydrological climate

Agogo is the nearest rain recording station close to NMFC compartments. The average monthly rainfall depths distribution determined from the data recorded at Agogo is considered to be representative of the average monthly rainfall distribution for the reserve. Table 6 below presents the general climatic parameters for the area.

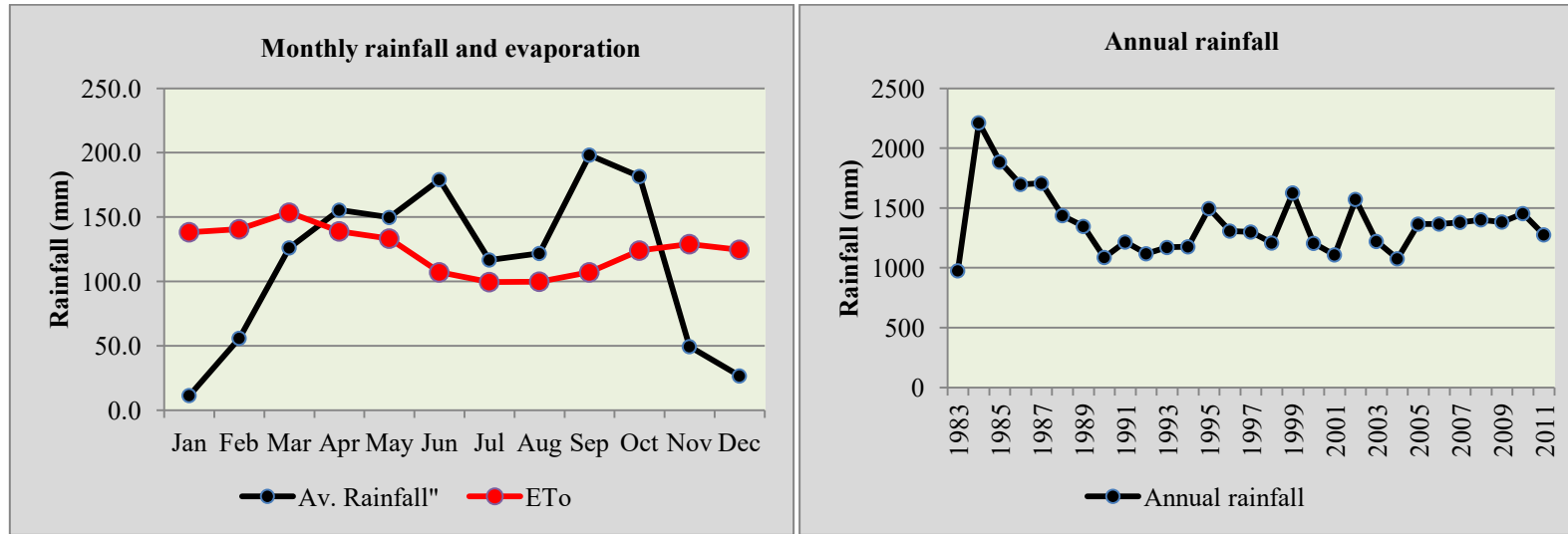
Table 6: Monthly Rainfall and weather parameters for Agogo

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sept | Oct | Nov | Dec |
|--|------|------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|
| Mean Rainfall (mm) | 11.8 | 57.9 | 130.6 | 161.0 | 155.1 | 185.5 | 120.9 | 126.1 | 205.3 | 188.1 | 51.1 | 27.5 |
| Monthly rainfall distribution (%) | 0.8 | 4.1 | 9.2 | 11.3 | 10.9 | 13.1 | 8.5 | 8.9 | 14.4 | 13.2 | 3.6 | 1.9 |
| Rainydays/month | 0.8 | 2.5 | 5.6 | 6.7 | 7.2 | 8.2 | 5.3 | 5.4 | 9.0 | 8.9 | 3.0 | 1.4 |
| Eto mm/day | 4.46 | 5.02 | 4.95 | 4.63 | 4.3 | 3.57 | 3.21 | 3.22 | 3.57 | 4 | 4.3 | 4.02 |
| Wind Vel. m/s | 1.8 | 2.1 | 2.2 | 2.1 | 1.9 | 1.9 | 2.2 | 2.2 | 2 | 1.8 | 1.5 | 1.3 |
| %Sunshine hrs | 58 | 60 | 56 | 55 | 56 | 43 | 32 | 30 | 38 | 55 | 68 | 61 |
| Min Temp °C | 20.9 | 21.9 | 21.9 | 21.9 | 21.7 | 21.0 | 20.4 | 20.2 | 20.6 | 20.9 | 21.7 | 21.4 |
| Max Temp °C | 31.6 | 33.1 | 32.6 | 31.7 | 30.9 | 29.2 | 27.7 | 27.3 | 28.1 | 29.6 | 30.6 | 30.3 |
| *Source: Ghana Meteorological Service and International Water Management Institute | | | | | | | | | | | | |

The data shows that monthly maximum and minimum temperature differences are high (10.7 – 7.3°C). The wind speeds of 1.5 – 2 ms⁻¹ occur at the same time in the dry months between November and May. This is the period when the forest is prone to fire. The other climate parameters show that the high monthly rainfall occurs in June (185.5 mm), September (205.3 mm) and October (188.1 mm). The low or dry months are in December (27.5 mm), January (11.8 mm) and February (57.9 mm). These wet and dry days, together with other environmental factors, affect the hydrology of the site.

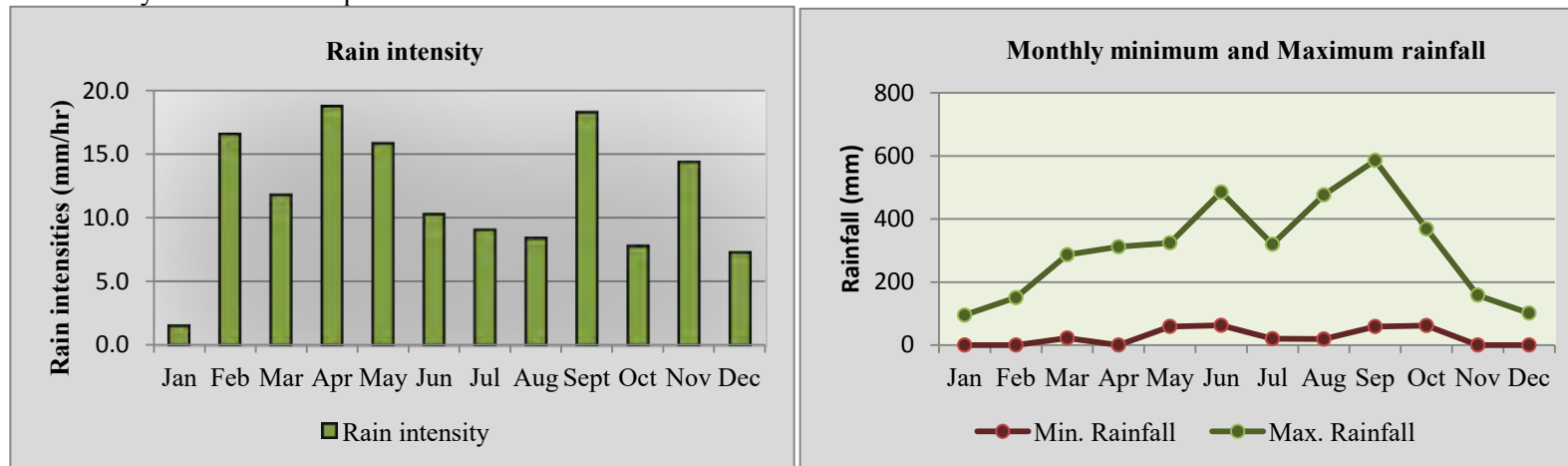
Fig 7 below shows hydrological climate of the reserve. Fig 7a shows that between April to October, evapo-transpiration is less than average rainfall. However, in November to March, there is moisture deficit.

Since there are no rainfall intensity records for Agogo; the rain intensity in the adjacent catchment at Ejura was used (Fig 7c). The rain intensities are high at the commencement of each planting season March-April, and September-October. Fig 7b shows that the annual rainfall pattern has stabilized at a low level since 1990; though during each year, there are some three to four months that account for over 50% of total annual rains. The rains in the month of September tend to cause unforeseen floods in the reserve.



a. Monthly rainfall and evaporation

b. Trend of annual rainfall



c. Rainfall intensity adapted from Ejura

d. Monthly minimum and maximum rainfall

Fig 7: Hydrological climate of Boumfum Forest Reserve

2.10 Runoff coefficient of compartment blocks

The Runoff co-efficient is the amount of rainwater that travels on soil surfaces into water systems. The methods used to determine the runoff coefficient involved assessment of terrain relief, soil infiltration, vegetal cover and surface water storage. A Geographical Information System (GIS) was used to determine the land contours. The contours were then used to determine the gradients. Field studies were carried out to verify the selected sites and also to determine depths of soils to rocks. It was also identified that some of the lands in the reserve have been cultivated on deep soils and there were also sites of rocky terrain with bare or shallow soils.

There is no discharge gauging station on any of the rivers in the reserve. Therefore, for such an area, a qualitative method of assessing runoff coefficient was used to assess run-off in the NMFC compartments. Tables 7a-7f below show the results of annual runoff coefficient for the compartments. The results show that:

- a. In compartments A, B and F, runoff coefficient is high. This is due to the lack of properly defined channels for water storage.
- b. In compartment E, runoff coefficient is high because the vegetation cover is low and
- c. In compartment G, runoff coefficient is extreme because of low soil infiltration and rocky surface of the terrain.

Annual Runoff Coefficients for NMFC Blocks

| Table 7a. BLOCK A Compartments | | | | |
|---------------------------------------|--------------------|--|--------------------|---------|
| | | | Runoff coefficient | |
| | Parameter | Description | Value | Rating |
| | Relief | Nearly uniform slope (5-12%) | 0.15 | Normal |
| | Water infiltration | 65% Deep fine sandy loam to silty loam soils 40 -100 cm to bedrock, 40% rocky surface, gravelly topsoils | 0.07 | Normal |
| | Vegetation cover | Good vegetal cover (maize, groundnut, cassava) 30% | 0.08 | Normal |
| | Water storage | No well defined drainage channel. Main channel outside block | 0.11 | Extreme |
| | | Total | 0.41 | Normal |
| | | 100 yr return period | 0.5125 | High |

| Table 7b. BLOCK B. Compartments | | | | |
|--|--------------------|--|--------------------|--------|
| | | | Runoff Coefficient | |
| Area (ha) | Parameter | Description | Value | Rating |
| 520 | Relief | Undulating terrain with slopes 10-15% | 0.2 | Normal |
| | Water infiltration | 60% Deep fine sandy clay loams 40 -100 cm to bedrock, gravelly topsoils, 35% rocky surface | 0.08 | Normal |
| | Vegetation cover | Good vegetal cover, trees, cultivated crops >50% | 0.07 | Normal |
| | Water storage | One main drainage system in block | 0.09 | High |
| | | Total | 0.44 | Normal |
| | | 100yr return period | 0.55 | High |

| 7c. BLOCK D. Compartments | | | |
|---|---|--------------------|--------|
| Parameter | Description | Runoff Coefficient | |
| | | Value | Rating |
| Relief Water infiltration Vegetation cover Water storage | Relief undulating 2-5% slope | 0.14 | Normal |
| | 90% Deep fine sandy clay loams 40 -100 cm to bedrock, 10% rocky surface, bare areas of dotted settlements | 0.07 | Normal |
| | Good vegetation cover (70%) of plantain , maize farms, Ceiba and Bombax trees. grass and shrubs | 0.06 | Normal |
| | Well defined drainage system, with small depressions | 0.08 | Normal |
| | Total | 0.35 | Normal |
| 100yr return period | | 0.44 | Normal |

| Table 7d. BLOCK E Compartments | | | |
|---|---|--------------------|--------|
| Parameter | Description | Runoff Coefficient | |
| | | Value | Rating |
| Relief Water infiltration Vegetation cover Water storage | Undulating terrain <15% with Channel slope 8% | 0.18 | Normal |
| | 50% fine sandy clay loams 40 -100 cm to bedrock, gravelly topsoils | 0.07 | Normal |
| | 50% rocky surface | | |
| | Low plant cover <20% | 0.11 | High |
| | No well defined drainage channel. One main channel dissects the block | 0.08 | Normal |
| Total | | 0.44 | Normal |
| 100yr return period | | 0.55 | High |

| Table 7e. Group F Compartments | | | | |
|--------------------------------|--------------------|---|--------------------|---------|
| | Parameter | Description | Runoff Coefficient | |
| | | | Value | Rating |
| | Relief | Relief summits 3-12% slope, undulating terrain Slopes<20%. | 0.25 | High |
| | Water infiltration | 60% fine sandy loams 40 -100 cm to bedrock; topsoil gravelly, 40% rocky surface | 0.06 | Normal |
| | Vegetation cover | Plantain, cassava maize crops, onion farms with few trees scattered within valleys (<20% cover) and 10% grassland | 0.08 | Normal |
| | Water storage | Drainage system defined but dry, marshland area of negligible size | 0.09 | Extreme |
| Total | | | 0.48 | High |
| 100yr return period | | | 0.6 | High |

| Table 7f. Group G Compartments | | | | |
|--------------------------------|---|---|--------------------|---------|
| | Parameter | Description | Runoff Coefficient | |
| | | | Value | Rating |
| | Relief Water infiltration Vegetation cover Water storage | Steep sided valleys and cliffs >40% ,Summits 3-12% slope | 0.22 | Normal |
| | | Rocky surface with 10% area covered by sandy loam soils to silty loam<60 cm depth to sandstone rock. | 0.14 | Extreme |
| | | Tall guinea grass (<i>Panicum maximum</i>) and Acheampong weed (<i>Chromolaena odorata</i>), Plantain, cassava , maize crops, with few trees scattered within valleys. About 15% cover. | 0.12 | High |
| | | Few drainage ways with no ponds and marshlands | 0.1 | Extreme |
| Total | | | 0.58 | High |
| 100yr return period | | | 0.725 | Extreme |

Table 8: Monthly runoff coefficients for Blocks A, B and D**BLOCK A**

| | <i>Jan</i> | <i>Feb</i> | <i>Mar</i> | <i>Apr</i> | <i>May</i> | <i>Jun</i> | <i>Jul</i> | <i>Aug</i> | <i>Sep</i> | <i>Oct</i> | <i>Nov</i> | <i>Dec</i> | <i>Total</i> |
|-----------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|
| <i>Excess rain</i> | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| <i>% Runoff Coefficient C</i> | 0.0 | 0.0 | 0.0 | 2.7 | 2.7 | 9.7 | 2.6 | 3.2 | 12.1 | 7.9 | 0.0 | 0.0 | 41.0 |
| <i>Return period % C (100 yr)</i> | 0 | 0 | 0 | 3.23 | 3.19 | 11.50 | 3.13 | 3.85 | 14.39 | 9.39 | 0 | 0 | 48.7 |

BLOCK B

| | <i>Jan</i> | <i>Feb</i> | <i>Mar</i> | <i>Apr</i> | <i>May</i> | <i>Jun</i> | <i>Jul</i> | <i>Aug</i> | <i>Sep</i> | <i>Oct</i> | <i>Nov</i> | <i>Dec</i> | <i>Total</i> |
|-----------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|
| <i>Excess rain</i> | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| <i>% Runoff Coefficient C</i> | 0.0 | 0.0 | 0.0 | 2.9 | 2.9 | 10.4 | 2.8 | 3.5 | 13.0 | 8.5 | 0.0 | 0.0 | 44.0 |
| <i>Return period % C (100 yr)</i> | 0 | 0 | 0 | 3.23 | 3.19 | 11.50 | 3.13 | 3.85 | 14.39 | 9.39 | 0 | 0 | 48.7 |

BLOCK D

| | <i>Jan</i> | <i>Feb</i> | <i>Mar</i> | <i>Apr</i> | <i>May</i> | <i>Jun</i> | <i>Jul</i> | <i>Aug</i> | <i>Sep</i> | <i>Oct</i> | <i>Nov</i> | <i>Dec</i> | <i>Total</i> |
|-----------------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|--------------|
| <i>Excess rain</i> | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| <i>% Runoff Coefficient C</i> | 0.0 | 0.0 | 0.0 | 2.3 | 2.3 | 8.3 | 2.3 | 2.8 | 10.3 | 6.8 | 0.0 | 0.0 | 35.0 |
| <i>Return period % C (100 yr)</i> | 0 | 0 | 0 | 2.90 | 2.86 | 10.32 | 2.81 | 3.46 | 12.92 | 8.43 | 0 | 0 | 43.7 |

Table 8 Contd: Monthly runoff coefficients for Blocks E, F and G**BLOCK E**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|----------------------------|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-----|-----|--------|
| Excess rain | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| % Runoff Coefficient C | 0.0 | 0.0 | 0.0 | 2.9 | 2.9 | 10.4 | 2.8 | 3.5 | 13.0 | 8.5 | 0.0 | 0.0 | 44.0 |
| Return period % C (100 yr) | 0 | 0 | 0 | 3.65 | 3.60 | 12.99 | 3.54 | 4.35 | 16.26 | 10.61 | 0 | 0 | 55 |

BLOCK F

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|----------------------------|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-----|-----|--------|
| Excess rain | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| % Runoff Coefficient C | 0.0 | 0.0 | 0.0 | 3.2 | 3.1 | 11.3 | 3.1 | 3.8 | 14.2 | 9.3 | 0.0 | 0.0 | 48.0 |
| Return period % C (100 yr) | 0 | 0 | 0 | 4.15 | 4.10 | 14.76 | 4.02 | 4.95 | 18.47 | 12.06 | 0 | 0 | 62.5 |

BLOCK G

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
|----------------------------|-----|-----|-----|-------|-------|-------|-------|-------|-------|-------|-----|-----|--------|
| Excess rain | 0 | 0 | 0 | 22.05 | 21.76 | 78.43 | 21.35 | 26.28 | 98.15 | 64.05 | 0 | 0 | 332.07 |
| % Runoff Coefficient C | 0.0 | 0.0 | 0.0 | 3.9 | 3.8 | 13.7 | 3.7 | 4.6 | 17.1 | 11.2 | 0.0 | 0.0 | 58.0 |
| Return period % C (100 yr) | 0 | 0 | 0 | 4.81 | 4.75 | 17.12 | 4.66 | 5.74 | 21.43 | 13.98 | 0 | 0 | 72.5 |

2.11 Monthly contribution of water from compartments

A simple moisture accounting system was used to estimate monthly contribution of water from the compartments. The monthly water contribution (ha-m) to the system (W_{mi}) is the sum of rainwater stored in deep percolation below the root zone and that is lost as surface runoff after taking into account monthly evapo-transpiration (Et_{mi}). A_{mi} is the compartment area. For a monthly rainfall (P_{mi}) the equation was expressed as:

$$W_{mi} = A_{mi}(P_{mi} - Et_{mi}) \dots\dots\dots (1)$$

When monthly evapo-transpiration is greater than monthly rainfall, values of W_{mi} were taken as zero. A zero value indicates that during the month, there was no excess water contribution to Boumfum Forest Reserve by the compartment. Monthly runoff coefficient C_m was assessed as:

$$C_m = \frac{W_{mi}}{\sum_{1}^{12} W_{mi}} C_c \dots\dots\dots (2)$$

C_c is the runoff coefficient for each compartment.

Table 9 below shows that there is a total of 1453502 ha-m of water not absorbed by the compartments; but runs off into water catchment areas. It also shows that there is water deficit from December to March due to limited amounts of rain which are insufficient to cause run-off during this period. However, water is adequate in April, May, July and August. In June, September and October, there is usually too much water in the compartments.

| Table 9: Monthly contribution of water from compartments | | | | | | | | | | | | | |
|--|-----|-----|-----|-------|-------|-------|-------|-------|--------|-------|-----|-----|--------|
| Monthly volume of run-off by compartment blocks (ha-m) | | | | | | | | | | | | | |
| Blocks | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Total |
| A | 0 | 0 | 0 | 23748 | 23436 | 84469 | 22994 | 28304 | 105708 | 68982 | 0 | 0 | 357639 |
| B | 0 | 0 | 0 | 11444 | 11293 | 40705 | 11081 | 13639 | 50940 | 33242 | 0 | 0 | 172344 |
| D | 0 | 0 | 0 | 9658 | 9531 | 34352 | 9351 | 11511 | 42990 | 28054 | 0 | 0 | 145447 |
| E | 0 | 0 | 0 | 23748 | 23436 | 84469 | 22994 | 28304 | 105708 | 68982 | 0 | 0 | 357639 |
| F | 0 | 0 | 0 | 21102 | 20824 | 75058 | 20432 | 25150 | 93930 | 61296 | 0 | 0 | 317791 |
| G | 0 | 0 | 0 | 21146 | 20868 | 75214 | 20475 | 25203 | 94126 | 61424 | 0 | 0 | 318455 |

2.12 Water quality

Water samples were collected from both the Ongwam and Boumfum rivers to assess the quality of the water in relation to water quality guidelines as outlined in the Water quality guidelines of the Environmental Assessment Regulations 1999 (LI 1652). At the time of sample collection, it was noted that the Boumfum River was at low flow while Ongwam River was at normal flow. The samples were analysed in July 2013 by the Council for Scientific and Industrial Research (CSIR) to determine the levels of key water quality parameters and establish a baseline of river water quality in the reserve. A copy of the test report can be found in the Appendix. Table 10 below summarises the results of water quality of Ongwam and Boumfum rivers. The low flow of Boumfum River might account for its higher concentration of water quality parameters than that of Ongwam River.

Table 11 below also presents similar analyses of surface water, groundwater and pipe-borne water of the Volta River. The acidity and electrical conductivities of the water samples from Ongwam and Boumfum is within the range for groundwater from the Volta Basin. This indicates that groundwater contribution to the quality of Ongwam and Boumfum rivers is substantial. Thus any activity that affects groundwater within the Boumfum Forest Reserve might impact on water quality outside the reserve.

| Parameter | Ongwam River | Boumfum River |
|--------------------------------|--------------|-------------------------|
| pH | 6.61 | 6.98 |
| EC ($\mu\text{S}/\text{cm}$) | 301.3 | 522 |
| Na (mg/L) | 0.003 | 2 |
| K (mg/L) | 0.015 | 0.03 |
| Ca (Mg/L) | 0.024 | 0.871 |
| Mg (Mg/L) | 0.033 | 3.024 |
| NO ₃ -N (Mg/L) | 0.058 | 0.091 |
| NH ₄ -N (Mg/L) | 0.792 | 0.682 |
| Turbidity (NTU) | 8 | 5.5 |
| BOD (ppm) | 6.5 (poor) | 2.37 (moderately clean) |

| Properties | Sources of Water | | |
|--|------------------|-------------|------------------|
| | Surface water | Groundwater | Pipe-borne water |
| pH | 6.9-7.9 | 6.5-6.9 | 7.1-7.8 |
| Conductivity ($\mu\text{S}/\text{cm}$) | 99– 287 | 236-405 | 56 –188 |
| Turbidity (NTU) | 5-15.0 | 5 – 15 | 0- 5.0 |
| Nitrate (mg/l) | 0.10 – 0.5 | 0.5-0.7 | 0.0 - 0.20 |
| Chloride (mg/l) | 13 – 276 | 75 – 280 | 6 – 63 |

Source: Amoah C. and Koranteng S.S., Volta Basin Research project, Legon (unpublished)

2.13 Dissolved Organic and Inorganic Matter and Oxygen Deficiency

Eutrophication (*i.e enriching of freshwater bodies with nutrients*) from fertilizer materials such as nitrates and organic material will have a direct effect on fish and other aquatic organisms. Water samples were therefore taken from Ongwam and Boumfum rivers for analysis for Biological Oxygen Demand (BOD) using an electrochemical analyzer for Dissolved Oxygen (DO). Table 7 above shows that BOD in Ongwam river is poor (6.5ppm) while that of the Boumfum River is moderately clean (2.37ppm).

This shows that already the Ongwam stream is somewhat polluted with organic matter and bacteria are decomposing the organic waste. Generally, when BOD levels are high, there is a decline in dissolved oxygen levels. This is because the demand for oxygen by the bacteria is high and they utilise oxygen from the oxygen dissolved in the water. Where there is not much organic waste present in the water (Boumfum River), there won't be as much bacteria present to decompose it. At BOD (<5.0 ppm) the dissolved oxygen level tends to be higher. The Boumfum river at time of sampling, had more dissolved oxygen than the Ongwam river. Since the Ongwam has a large catchment area, it is likely that most of the dissolved organic matter at present must be from areas outside the Boumfum reserve.

2.14 Seasonal flooding

The ephemeral and intermittent streams are the headwaters of the two main rivers, Ongwam and Boumfum. Given their large extent, these streams are important sources of sediment, water and nutrients downstream. They also provide habitat for many species within the riparian zone of the rivers. The two rivers flood during the rainy season. The variability of flood magnitude is much greater for ephemeral stream channel flows as compared to that of perennial stream systems of the Ongwam River. The steep nature of channel slopes enhances the generation of flash floods. Floods are known to last for days to weeks. This depends on the location of the rainfall event, duration, intensity, rainfall frequency and its distribution within the compartments. When that occurs, the main rivers can discharge for many weeks with substantial sediment load causing high turbidity levels. The turbidity levels are caused by the fine soil materials carried in suspension by the flood waters mostly from outside the reserve.

Unfortunately, there is no information on the volumes of runoff for the major rivers that traverse Boumfum Forest Reserve. Nevertheless, it is necessary to estimate flood peaks to manage floods within the plantation. One of the widely used formulas is the Rational method; even though it was derived from small catchments less than 480 ha. The method states that the discharge, *Q*, at the catchment outlet point can be calculated as:

$$Q = K_c C I_c A \dots\dots\dots (3)$$

Where *I_c* is the critical rainfall intensity, *A* is the drainage basin area, *K_c* is a conversion factor from ha-mm/hr to m³/s; *C* is the runoff coefficient. The runoff coefficient is quantitatively related to various interrelated factors such as precipitation intensity and its

seasonal distribution, precipitation, vegetation types and cover, geological outcrops, infiltration rates, the topography of the sites. During peak flows the runoff coefficient normally exceeds 70%. This is because all the catchment is taken into consideration. In this estimation, coefficient of runoff was taken as 80%. The catchment areas of the blocks were estimated using geographical information system (GIS). The critical rain intensity (I_c) during critical flow was estimated by using the relation:

$$I_c = I_o \left[\frac{2}{1+T_c} \right] \dots\dots\dots (4)$$

Where, T_c is the time of concentration. Kirpurch empirical formula was used used to estimate T_c :

$$T_c = 0.01947L^{0.77}S^{-0.385} \dots\dots\dots (5)$$

L is the maximum length of travel by water (m); S is the slope of the catchment. L and S were estimated using GIS. The results are presented in Table 12 below. The valley within compartment A can have flood levels up to 3.0 m in some places, while the flood levels in Blocks F and G are less than a metre high. The excess flood levels from Block A are due to the large catchment area of Ongwam river.

| Table 12: Peak flows in compartment blocks | | | | | | | |
|--|-------------------------------|--------------------|-----|------------------------|-----------------------|----------------|-----------------|
| Blocks | Area contributing runoff (ha) | Precipitation (mm) | Tc | Design Intensity mm/hr | Coefficient of Runoff | Discharge m3/s | Flood level (m) |
| A | 42,619 | 44 | 9 | 8.80 | 0.8 | 853.06 | 3.0 |
| F | 16,461 | 44 | 3 | 22.00 | 0.8 | 109.83 | 0.70 |
| G | 10,536 | 44 | 2.8 | 23.16 | 0.8 | 65.61 | 0.50 |

2.15 Groundwater resources

The Boumfum Forest Reserve is located within the Afram plains where extensive studies in hydro-geology have been carried out (Ophori and Yidana, 2010; Acheampong, 1996; Junner and Hirst, 1946). Many tributaries of the Boumfum and Ongwam rivers traverse the reserve and compartments allocated to NMFC. The field activities show that the hydro-geology of the sites favours the storage of groundwater. All the compartments have sandstone rocks. The exposed sandstones are stacked in layers with fractures ranging from 2.0 cm to over 30 cm wide and at different degrees of inclinations. These fractures are partially filled with weathered sandstone rocks of highly permeable sandy and fine sandy particles. The surface of the sandstones compared to weathered materials has very low permeability. This makes the fractures contribute mostly to groundwater recharge. Roadside cuttings taken along Agogo-Kumawu road show that shale is found beneath the sandstones at variable depths from as low as 20 m to over 100 m depth. Because the sandstones extend over large areas, these aquifers could have the potential to provide large amounts of water.

Hydraulic conductivity and groundwater recharge

The compartments in the reserve have been dissected into many blocks of catchments which may be small or large. These catchments allow water that fall on the mountains to recharge aquifers and streams that the mountain topography influences. The blocks of mountains, their characteristics and position determine where groundwater recharge is more effective. The upland areas are characterized in most places by sites of fractured sandstone outcrops. The water-entry potential of the fractured sandstone network must be exceeded before significant water percolation into the underlying bedrock can occur. In these areas, soil thickness is the dominant factor affecting soil moisture-storage capacity.

In most areas of the reserve, thin soils overlie the bedrocks (Fig 8 below). The hydraulic properties of the soils were derived from the particle size fractions using USDA textural triangle analysis model. From laboratory analysis of particle size fractions, the model predicts field capacity, wilting point, water saturation and available soil moisture in the soil. Table 10 below presents the hydraulic properties of the soils. Under such conditions of thin shallow soils, the soil-water content approaches saturation rapidly. If rainfall intensity exceeds the terminal percolation rate and basal infiltration rate (hydraulic conductivity of the soil), a lot of runoff is quickly generated as fast flows instead of recharging the aquifers. Since there was no observed perched water tables upland, most of the excess water in the soil is assumed to recharge the water table.



Figure 8: Depth of soil in Block F

Table 13: Hydraulic properties of some compartment blocks

| BLOCK | Mechanical analysis | | | | Hydraulic Properties | | | | |
|-------|---------------------|--------|--------|------------|---|--|-----------------------------------|---|---|
| | | | | | Field capacity <i>(cm³ water/cm³ soil)</i> | Wilting point <i>(cm³ water/cm³ soil)</i> | Hydraulic conductivity K cm/hr | Saturation <i>(cm³ water/cm³ soil)</i> | Available water capacity <i>(cm³ water/cm³ soil)</i> |
| | % Sand | % Clay | % Silt | Texture | | | | | |
| G | 67.56 | 17.00 | 15.44 | Sandy loam | 0.21 | 0.12 | 1.10 | 0.44 | 0.09 |
| D | 81.94 | 8.30 | 9.76 | Loamy sand | 0.16 | 0.08 | 4.00 | 0.39 | 0.54 |
| F | 82.66 | 6.20 | 11.14 | Loamy sand | 0.15 | 0.07 | 5.60 | 0.37 | 0.54 |

For compartments with bare or thin soils, potential evapo-transpiration can remove a substantial amount of water from storage between precipitations. However, this normally does not exceed the abstraction coefficient of available water. This creates droughty conditions. The EIA has revealed this peculiar droughty situation in some of the NMFC compartments namely;

- a. Compartments 104,108 and 111 in Block G;
- b. Compartments 134, 135 and 138 in Block F;
- c. Compartments 70 and 78 in Block B and
- d. Compartments 61 – 64 in Block A.

However, in some upland areas with thick soils such as in compartments 127 in Block F; 89 and 90 in Block E and 154 and 155 in Block D, a greater volume of water is required in the soil before the sandstones start to be recharged with water. This has implications for runoff generation potential of the various sites in the compartments that can affect water quality outside the reserve. The effects of potential evapo-transpiration in reducing soil water are also similar in alluvial sites within the valleys. The water-balance equation was used to quantify the potential recharge at the sites.

$$G_r = P - (R + ET + S) \dots\dots\dots (6)$$

where P is precipitation, R is surface runoff, G_r is deep drainage and recharge, ET is evapotranspiration, and S is water stored in the soil. At any time, the available water capacity (AWC) of soil profiles determines the maximum limit of actual evapotranspiration (ET) that can be extracted and the maximum soil moisture depletion. The AWC also determines the amount of water that can infiltrate into the soil before *deep drainage* occurs. Furthermore, not all AWC is extracted in any rain event. Under this assumption the equation (6) was modified:

$$G_r = P - (R + k * n * AWC) \dots\dots\dots (7)$$

Where k is coefficient of moisture extraction, n is number of rainy days. It was assumed that not more than 50% of moisture was extracted before the drainage water penetrates into the sandstone fractures. The annual groundwater recharge rates by NMFC compartments are graphically shown in Fig 9 below. The figure shows that in the 1980s, groundwater recharge was high. It was low in 1990s and slightly increasing in 2000s. These may be partly due to changes in annual rainfall and reduced groundwater recharge rates of surface soils resulting from the planting of annual crops. Tree roots are robust in their ability to open up rock fractures for increased infiltration than annual crops.

It was further observed that there were many areas where the rocks were in a process of weathering. Some of the rock masses were weaker than fresh ones and with changes in rock coloration. Also some of the surfaces have been indented or smoothed by runoff. This indicates that at these surfaces, runoff coefficient is high and weathered materials are quickly transported to rock crevices. In some areas, the rocks had some planar boundaries (arranged as flat layers) and oriented at some angle. The soils that had been trapped were non-sticky

and mostly very fine sands. These trapped sandy areas can reach the depth of 40 cm and serve as recharge points for groundwater.

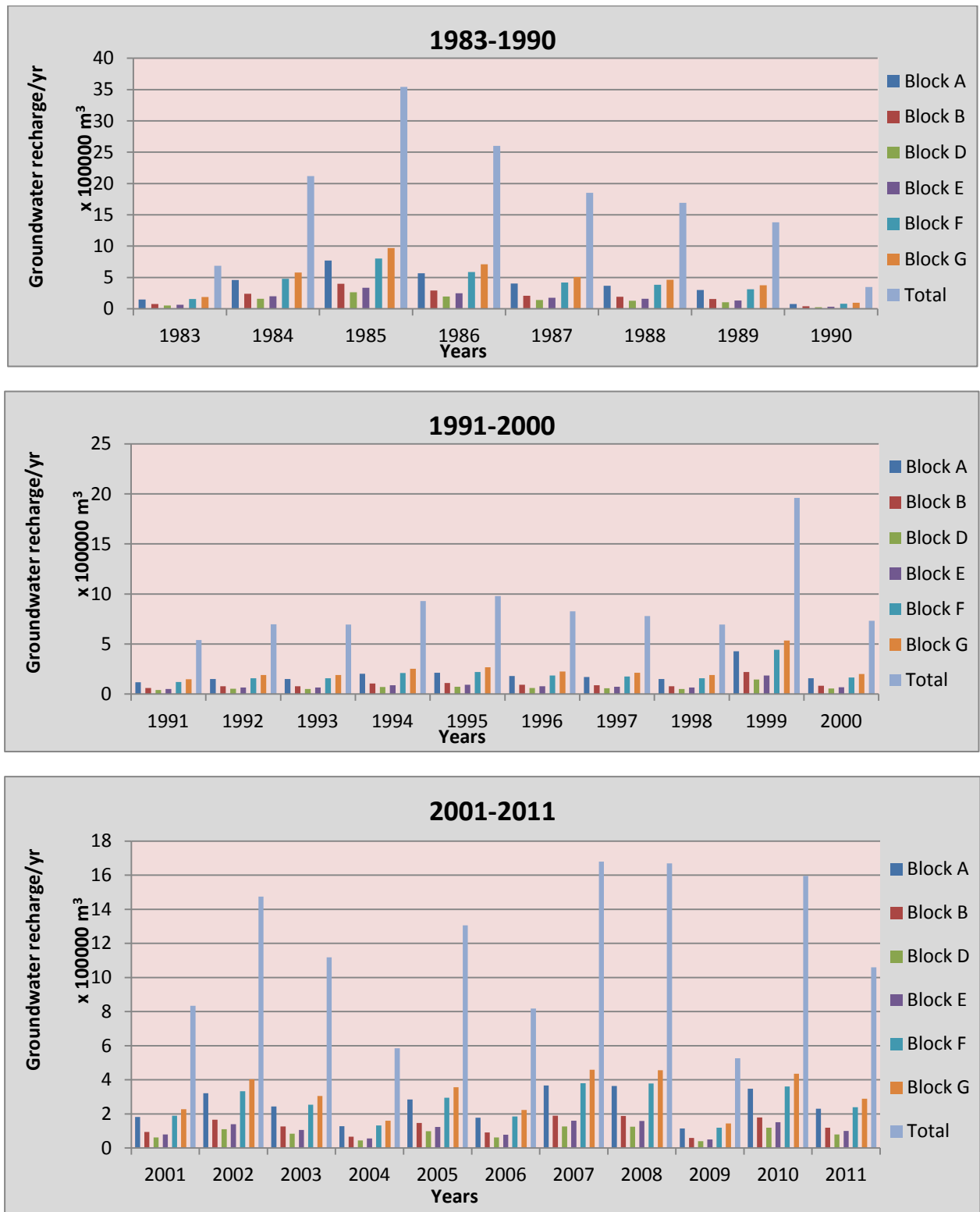


Fig 9: Annual groundwater recharge rates in NMFC compartment blocks

2.16 Characteristics of riparian strips

The riparian ecosystems (stream buffer zones) form a very small portion of the landscape in the NMFC compartments, yet they exert substantial influence on plants and animals within the inter-connecting season streams. In all the strips, illegal migrant farmers have farmed close to the streams leaving some stream channels without buffer strips (Fig 10). The riparian strips in compartment F are made up of savanna re-growth. In compartment G, the strips are of shrubby vegetation protecting the stream channel. In compartment A, the strips are thickets of about 20m on each side of the river.



Fig 10: Dried up stream channel without buffer strip in compartment G

2.17 Noise

Noise is regarded as a form of environmental pollution, and is sometimes considered an international health concern. High levels of noise can be a major concern in local, urban and rural environments. Noise can cause anxiety, tension, or even illness, and prolonged exposure to high levels of noise can cause damage to hearing; as well as threaten the habitats of wildlife in the reserve and surrounding areas.

The Boumfum Forest Reserve is located about 8 km from Agogo, 20km from Kumawu and 3km from the Ananekrom populace. The current noise situation within Boumfum, despite some occasional noise heard from felling of small trees by locals; is with little or no impact on noise generation. It has been demonstrated that planting "noise buffers" composed of trees and shrubs can reduce noise by 5dB to 10dB decibels for every 30m width of woodland, and this reduces noise to the human ear by approximately 50%. It is therefore important to ensure that careful consideration is given to the selection of tree species to be planted and the actual design of the plantation in relation to the topography of the area.

2.18 Air Quality

Air quality within the reserve and surrounding areas may be influenced by human induced activities such as industrial activity, burning of grasslands for cattle grazing and agriculture (smoke generation), commercial logging and mining activities. Industrial and mining activities are virtually non-existent within the reserve and do not have any influence on air quality. Activities that have probably reduced air quality are past commercial logging of trees and accidental fires. In these instances smoke from forest fires have been the main causes of reduced air quality. Commercial logging is now non-existent; and with the degraded state of the reserve and the proliferation of elephant grass and low-lying vegetation, air quality could now be mainly affected by man-made fires started by illegal settler farmers. This is what caused the serious 1983 fires which burnt for weeks and destroyed very large areas of the reserve and affected the air quality of some of the nearby towns and villages. About 70% to 90% of the above ground biomass in the uncultivated parts of Boumfum Forest Reserve is consumed by annual wild fires releasing carbon dioxide and ash into the atmosphere.

However air quality is known to be enhanced by the presence of trees which absorb carbon dioxide and release oxygen. Closed dense tree canopies are also less prone to fires. Tree plantations are also very efficient carbon dioxide storage systems. The NMFC development seeks to improve and maintain the quality of air through establishment of long-term tree plantations. This has the potential to improve air quality in the area and reduce risk to fires.

2.19 Fauna and Flora

The status of fauna and flora at Boumfum is determined by several factors. On a larger scale it is determined by the vegetation which is also a product of the topography, soil, temperature and rainfall. The original vegetation at the time of reservation was described as moist semi-deciduous tropical forest with three storey canopy (emergent, middle and lower canopy trees) architecture. It was also described as a forest typified by the preponderance of *Antiaris toxicaria* and *Chlorophora excelsa* species. However later ecological studies showed that Boumfum lies more in the dry semi-deciduous forest zone where both high forest and savannah species are shared. The vegetation appears to be heavily influenced by the topography. It can be observed that the south western facing slopes and valleys have tree species found in the moist semi-deciduous forest type and the North Eastern slopes and plateau tend to have dry forest and savannah species. Some of the forest tree species that were listed to be present in Boumfum include:

| Common Trade Name | Scientific Name |
|----------------------------|------------------------------------|
| Sapele | <i>Entandrophragma cylindricum</i> |
| Utile | <i>Entandrophragma utile,</i> |
| Omu / Candollei | <i>Entandrophragma candollei</i> |
| Afromosia | <i>Pericopsis elata,</i> |
| Opepe | <i>Nauclea diderrichii</i> |
| African Mahogany | <i>Khaya grandifoliola,</i> |
| Emire | <i>Terminalia superba</i> |
| Kane | <i>Anogeissus leiocarpus</i> |
| Brown Sterculia / Wawabima | <i>Sterculia rhinopetala</i> |
| Iroko | <i>Milicia excelsa</i> |
| Wawa | <i>Triplochiton scleroxylon</i> |
| Opepe/Kusia | <i>Nauclea diderrichii</i> |
| Danta | <i>Nesogordonia papaverifera</i> |
| Dahoma | <i>Piptadeniastrum africanum</i> |
| Bombax | <i>Bombax buonopozense</i> |
| Mansonia | <i>Mansonia altissima</i> |

Field surveys of the NMFC compartments show that the above mentioned species are no longer available in commercial quantities in the reserve, but only occur as scattered remnants and small isolated clusters of the old forest structure.

Historically, Boumfum was noted for its rich fauna, especially the big game that inhabited the variety of habitats (closed forest, open forest, savannah and swamps) provided by the topography. The rich fauna led to the delineation of the northern portion of the reserve for conservation as a wildlife sanctuary. Some unique fauna such as the pigmy hippos and savannah elephants are no longer found. Mammals that are now occasionally sighted include bush buck, duikers, bongo, and monkeys (Mona and spotted nose). Bird species included plantain eaters, falcon, owl, partridge and pigeons. Reptiles include snakes and lizards that live in the creeks of the rocks and crocodiles in the rivers. As noted above, the production

area of Boumfum no longer has the big mammals. Most of the surviving animals have moved into the Bomfobiri Wildlife Sanctuary, located in the north-western part of the Reserve which is prohibited from forest plantation and other related activities.

A field survey of compartments 120, 123, 127 and 131 in Block F revealed that most of the vegetation was mainly fallow grass with scattered remnant of trees from the old forest. The main shrubs and grass types encountered are listed below.

Shrubs

Alchornea cordifolia

Combretum spp

Solanum spp

Baphia nitida

Grifonia simplisifolia

Paulinia piñata

Herbs and grasses

Abutilon spp

Afframomum spp

Amorphophallus johnsonii

Cida accuta

Centrosema pubescens

Chromolaena odoratum

Euphorbia heteropylla

Euphorbia hirta

Gloriosa superba

Mucuna spp

Panicum maximum

Pennisetum purpureum

Tridax procumbens

2.20 Biodiversity

In this report biodiversity is described in terms of Vegetation, Flora and Fauna. The descriptions are based on both secondary and primary data. Secondary data was obtained from technical reports on natural resource surveys especially vegetation analysis, botanical surveys and faunal surveys from the Forestry Commission. It was found necessary to have information spanning over the past 30-50 years or even longer where information was available. Primary data was obtained mainly from field reconnaissance surveys and interviews.

Vegetation analysis

The current vegetation status has been described first by studying records on the types and condition of vegetation in the project area for the past 30 - 50 years. This information was

sourced from the different vegetation surveys conducted in the pre and post reservation period that formed the basis for describing and categorizing the vegetation of the Buomfum Forest.

To describe the threats to degradation of natural vegetation, information such as: rate of conversion of natural vegetation to other land use; existence and extent of protected natural vegetation; effectiveness of protected area (Forest Reserves, Wildlife Reserve, sacred groves, riparian vegetation) management and incidence of wildfire was collected through interviews and literature surveys. Field visits were made to identifiable sites of priority natural vegetation (e.g., unique habitats).

To prepare the list of plant species that are known or are highly probable to occur within the reserve, various botanical surveys reports (Geo-botanical survey 1978, Forest tree Inventories 1989, Forest biodiversity survey 1992, multi-resource inventory 2010 and Ethno-botanical survey 2007) were studied. The plant list is categorized into four main groups (Trees, shrubs, herbs and grasses). Expert knowledge has been used to identify species that are threatened using a three level scale of (readily available; available at few locations; not available).

Information on fauna was collected on four main taxa namely: large mammals; small to medium sized mammals; birds and reptiles. The information on these major groupings covers species richness, abundance, and distribution and conservation status. Only secondary data was used in describing the faunal status.

Vegetation Cover

The original vegetation at the time of reservation was described as moist semi-deciduous tropical forest with three storey canopy (emergent, middle and lower canopy trees) architecture. It was also described as a forest typified by the preponderance of *Antiaris toxicaria* and *Milicia excelsa* species hence the *Antiaris-Milicia* Association (Taylor, 1962). However, later ecological studies showed that Buomfum lies partly in the moist semi-deciduous forest but more in the dry semi-deciduous forest zone where both high forest and savannah species are shared (Hall and Swaine, 1981). The vegetation as described in the forest management plan appears to be heavily influenced by the topography.

It can be observed that the south western facing slopes and valleys have tree species found in the moist semi-deciduous forest type and the North Eastern slopes and plateau tend to have dry forest and savannah species.

A field reconnaissance survey in Blocks D, (Compartments 154 and 157), F (compartments 120, 123, 127 and 131) and G (compartments 111, 103 and 106), revealed that the original vegetation as described in 1964 and in 1987 has changed completely. The close canopy forest that was reported to characterise the area when the reserve was established is completely lost. Using a hand held hemispherical densitometer to take readings of canopy openness; an average reading of 95 to 100% from 100 points was recorded in 5 different compartments. This means that canopy cover now is less than 10%. During interviews with forest officers at

the Forestry Commission Regional Office in Kumasi and Forest Services District Office in Kumawu, it was learnt that the degradation happened between 1980 and 2000. It all began during the extensive logging that took place between 1970 and 1980 that opened up the forest canopy allowing for invasion of annual weed species such as *Chromolaena odoratum* and the guinea grass. These weeds provided fuel for bush fires during the dry season. The degradation of the reserve was mainly caused by unsustainable levels of commercial logging and severe forest fires usually started by illegal farmers seeking to gain land for agriculture. The recurrent bush fires since 1983 has made it impossible for any significant natural regeneration of trees to occur as well as survival of older trees. Secondary forest re-growth occurs mainly in the valleys and along streams.

Currently the natural vegetation cover is predominantly shrubs and herbaceous plants. In most locations the vegetation is mainly tall elephant and guinea grass with scattered remnant of trees from the old forest and patches of secondary forest developing in the valleys or along streams (as shown in the pictures below).



Fig 11: Level of vegetation change found in Buomfum during field reconnaissance survey in June 2013. The picture on the left shows grass and other herb invasion. The picture on the right shows remnant *Ceiba pentandra* trees in secondary forest background.

Flora

Forest inventory records in 1964 (FD, 1964) and that of 1989 (FIP 1989) have reported of hundred different tree species that have been found to occur in Buomfum Forest Reserve. These comprised 40 commercial timber species that could grow up to 70 cm diameter and higher and 60 other species that grow up to 50 cm diameter.

Table 14: List of Timber tree species in terms of abundance

| Genus | Species | 1965 | 1989 | 2012 |
|----------------------------|----------------------|------|------|------|
| <i>Triplochiton</i> | <i>Scleroxylon</i> | 3 | 3 | 1 |
| <i>Antiaris</i> | <i>Toxicaria</i> | 3 | 3 | 1 |
| <i>Ceiba</i> | <i>Pentandra</i> | 3 | 3 | 1 |
| <i>Celtis</i> | <i>Mildbraedii</i> | 3 | 2 | 1 |
| <i>Chlorophora/Milicia</i> | <i>Excelsa</i> | 3 | 2 | 0 |
| <i>Terminalia</i> | <i>Superba</i> | 3 | 2 | 1 |
| <i>Nesogordonia</i> | <i>Papaverifera</i> | 3 | 2 | 0 |
| <i>Piptadeniastrum</i> | <i>Africanum</i> | 3 | 2 | 0 |
| <i>Entandrophragma</i> | <i>Angolense</i> | 3 | 2 | 0 |
| <i>Bombax</i> | <i>Buonopozense</i> | 2 | 2 | 1 |
| <i>Rhodognaphalon</i> | <i>Brevicuspe</i> | 2 | 2 | 0 |
| <i>Mansonia</i> | <i>Altissima</i> | 3 | 1 | 0 |
| <i>Khaya</i> | <i>Grandifoliara</i> | 2 | 1 | 0 |
| <i>Entandrophragma</i> | <i>Cylindricum</i> | 2 | 1 | 0 |
| <i>Pericopsis</i> | <i>Elata</i> | 1 | 0 | 0 |
| <i>Entandrophragma</i> | <i>Candollei</i> | 1 | 0 | 0 |

Key: Readily Available - 3, Available at Few Locations - 2; Scarce - 1; Absent - 0

A reconnaissance survey conducted in Blocks D, F, and G revealed that in the current degraded condition of the forest most of the economic timber species are absent as shown in the table above. The only economic timber species found in all of the blocks were *Ceiba pentandra*, *Antiaris toxicaria*, and *Pterygota macrocarpa* that occurred as remnant trees. Most of the species encountered during the field reconnaissance were secondary forest trees that are now regenerating after the extensive removal of the forest canopy and the emergent trees. Few young saplings of some timber species such as *Milicia spp*, *Khaya spp* and *Triplochiton scleroxylon* were also encountered. It is presumed that these saplings might have come from the soil seed bank or seeds from some mother trees nearby. If this is deemed to be true, then it suggests that some level of natural regeneration can be obtained over a very long period; especially if human activity such as farming is prohibited and fire is prevented from occurring in the reserve. The most common secondary forest trees and other herbaceous species found are listed in the table below:

| SECONDARY TREE SPECIES | | |
|-------------------------------|--------------------------------|---------------------|
| Genus | Species | Habitat |
| <i>Blighia</i> | <i>Unijugata</i> | Dry Forest |
| <i>Cola</i> | <i>Gigantean</i> | Dry Forest |
| <i>Erythrophleum</i> | <i>Ivorense</i> | Dry Forest |
| <i>Spathodea</i> | <i>campanulata</i> | Dry Forest |
| <i>Anogeissus</i> | <i>leiocarpus</i> | Dry Forest/Savannah |
| <i>Millettia</i> | <i>rhodantha</i> | Dry Forest/Savannah |
| <i>Parkia</i> | <i>biglobossa,</i> | Dry Forest/Savannah |
| <i>Terminalia</i> | <i>glaucescens</i> | Dry Forest/Savannah |
| <i>Anthocleista</i> | <i>nobilis</i> | Moist Forest |
| <i>Rhodonophalgon</i> | <i>brevicuspe</i> | Moist Forest |
| <i>Sterculia</i> | <i>rhinopetala</i> | Moist Forest |
| <i>Trema</i> | <i>guineensis / orientalis</i> | Moist Forest |
| <i>Recinodendron</i> | <i>heudelotii</i> | Moist Forest |
| <i>Sterculia</i> | <i>trgacantha</i> | Moist/ Dry Forest |
| <i>Alstonia</i> | <i>boonei</i> | Moist/Dry Forest |
| <i>Elaeis</i> | <i>guineensis</i> | Moist/Dry Forest |
| <i>Ficus</i> | <i>sur</i> | Moist/Dry Forest |
| <i>Albizia</i> | <i>zygia</i> | Moist/Dry Forest |
| <i>Albizia</i> | <i>adianthifolia</i> | Moist/Dry Forest |
| <i>Ficus</i> | <i>exasperata</i> | Moist/Dry Forest |
| <i>Holarherna</i> | <i>floribunda</i> | Moist/Dry Forest |
| <i>Morinda</i> | <i>lucida</i> | Moist/Dry Forest |
| <i>Newboldia</i> | <i>laevis</i> | Moist/Dry Forest |
| <i>Acacia spp</i> | | Savannah |

3. SOCIO-ECONOMIC BASELINE

3.1 Sites of Cultural Importance

Field surveys have not identified any sites of special cultural importance within NMFC's allocated compartments. The most noticeable site of importance is the Bomfobiri Wildlife Sanctuary which is actually located in the north-western part of the reserve and excluded from any forestry activities. However, discussions with some farmers and locals walking through the reserve have revealed that there are some shrines outside the eastern part of the reserve that are visited by some of the local communities. Some of the access roads leading to these reported shrines run through some of the NMFC allocated compartments; especially in compartments 152 and 155, close to the town of Ananekrom.

3.2 Community Farming

The Boumfum Forest Reserve is seriously degraded. Consequently, the reserve has become a major source of land for farming and related activities. Desk studies show that farming is not the principal desired function of the reserve by the traditional landowners and the Forestry Commission. However, it is recognised that farming can co-exist with forestry under very controlled conditions. This is the underlying principle of the Modified Taungya System (MTS) for plantation development since the 1980's.

Most of the allocated compartments for plantation development under the MTS were never developed. Rather concessionaires leased their allocated compartments to illegal migrant farmers for a fee; in contravention of lease agreements with the Forestry Commission. This has led to a proliferation of plantain and maize farms in the reserve and raised concerns for traditional landowners and the Forestry Commission about maintaining the reserve as a forest.

Field visits and land use surveys have revealed that some of the lands allocated to NMFC; which were thought to be unencumbered upon; have actually been occupied by these illegal settlers and their plantation and maize farms. To avoid the reserve being overrun by illegal settlers, the Forestry Commission has recently undertaken eviction of illegal settlers in the reserve. Stakeholder meetings and discussions have revealed that there is support from traditional councils, chiefs and the local populace to evict the illegal migrant farmers from the reserve. Minutes of stakeholder meetings can be found in the Appendix. NMFC intends to develop a farmer inter-cropping scheme to support livelihoods; once lands have been properly prepared.

3.3 Traditional Rights

Local communities have traditionally used the Boumfum Forest Reserve as a means of providing key inputs to support their livelihoods and subsistence. These include hunting for game, collection of dead wood for fuel and collection of medicinal plants. However, the

degraded state of the reserve has resulted in some negative effects for communities. For example, the degraded areas in the reserve have resulted in less tree stands being available for fuelwood and animal game have migrated to more protective forested areas such as the Bomfobiri Wildlife Sanctuary. Agogo is predominantly an agro-forestry and fishing community and it is therefore important that these traditional rights are protected and continuously contribute to the lives of local communities.

3.4 Population and Demographics

Agogo, currently has a population of approximately 54,000. According to the Ghana Statistical Service Census data of 2010, over 50% of the population (78,000) in the Asante Akyem North District (which includes Agogo) fall within the 15-64 years age grouping. This working group comprises about 36,000 males and 42,000 females. This group is also the main working age group and have traditionally been employed in agricultural, forestry and fisheries related activities. This demonstrates the importance of these sector activities to the local populace. With the cessation of logging and timber production in the reserve, farming to produce plantain and maize has become the principal activity in the area. Despite this, unemployment is a major issue in the town of Agogo. This has an impact on incomes, health and sanitation in the area. Good running water is not easy to come by due to a lack of investment in the water infrastructure and the growing needs of the population. Housing and accommodation is also a major problem in the area; as land for housing developments is not easy to come by and rental rates not being affordable for most locals.

3.5 Jobs, Education and Training

The proposed development by NMFC makes provision for employing local people and providing them with the necessary skills to participate in the development and reforestation of allocated areas within the forest reserve. NMFC currently employs some 140 workers and intends to increase this figure as the project develops. Initial discussions with NMFC has revealed that the company has already supported the construction of a vocational training institute to train and develop local people in agricultural, forestry, masonry, dress making etc.

3.6 Health Issues

It is recognised by all stakeholders and the proponent that health is a key factor in determining the quality of life of the local populace. In 2012, Malaria was the main disease treated by the Agogo Hospital but Pneumonia was the highest cause of death; accounting for 15% of all deaths. Maternal deaths are on the increase due to late referrals, low awareness and poverty amongst the community for early visits to health centres. This problem is compounded by the lack of sufficient mid-wives. Teenage pregnancies are on the increase due to low awareness of birth control. Further disease patterns for 2012 can be seen in Tables 15 and 16 below.

| TABLE 15: TOP TEN (10) OUT PATIENT DEPARTMENT CASES IN AGOGO HOSPITAL (2012) | | |
|---|--------------------|-----------------------|
| Disease | No of Cases | % Of all Cases |
| Malaria | 13165 | 9.15 |
| Acute Eye Infection | 12129 | 8.43 |
| Cough and Colds | 10415 | 7.24 |
| Gynaecological conditions | 4291 | 2.98 |
| Urinary Tract Infections | 4130 | 2.87 |
| P.U.D | 3670 | 2.55 |
| Skin diseases and Ulcers | 2752 | 1.91 |
| Pregnancy Related | 2486 | 1.73 |
| Lower Abdominal | 2052 | 1.43 |
| Road Traffic Accidents | 1489 | 1.03 |

Source: Asante Akyem Presbyterian Hospital Performance Report 2012

| TABLE 16: TOP TEN (10) CAUSES OF DEATHS IN AGOGO HOSPITAL (2012) | | |
|---|--------------------|-----------------------|
| Disease | No of Cases | % Of all Cases |
| Pneumonia | 54 | 15.00 |
| Anaemia | 23 | 6.39 |
| Liver Cirrhosis | 23 | 6.39 |
| Tuberculosis | 20 | 5.56 |
| CVA | 19 | 5.28 |
| Cardiac Diseases | 17 | 4.72 |
| Pre mature Births | 15 | 4.17 |
| HIV/AIDS | 14 | 3.89 |
| Malaria | 12 | 3.33 |
| Hypertension | 9 | 2.50 |

Source: Agogo Presbyterian Hospital Performance Report 2012

NMFC has revealed that the company ensures that all potential employees are trained in occupational health and safety procedures. To ensure that this is an integral part of the company's operational procedures, a Safety, Health and Environmental Quality Manager has been appointed. The objective is to create awareness amongst staff about possible hazards associated with working with various types of machinery and tools on the proposed development. The company is also in the process of identifying ways in which it can collaborate with local stakeholders to support the development of an effective waste disposal strategy for the Agogo township.

4 STAKEHOLDER CONSULTATIONS

NMFC recognises the need to consult local and institutional stakeholders about its reforestation project in the reserve. In trying to get a deeper understanding of the key stakeholder issues, the company and its consultants engaged in discussions and interactions with key local and institutional stakeholders. A consultation schedule and key observations for each stakeholder are outlined in the table and consultation minutes below.

| Date | Name | Title/Organisation | Consultants/NMFC staff in Attendance |
|------------------------------|-----------------------------|---|--------------------------------------|
| 22 nd March 2013 | Mr Ralph Yeboah | Executive Director, Forestry Commission HQ | Hugo Slabber |
| 22 nd March 2013 | Nana Okyere Barfour | Kumawu Traditional Council | Hugo Slabber |
| 22 nd March 2013 | Nana Apagyahene | Agogo Traditional Council | Hugo Slabber |
| 22 nd March 2013 | Nana Gyasi Amoako Adaboh II | Hwidiemhene | Hugo Slabber |
| 22 nd March 2013 | Mr Daniel Ofosu | District Manager, Forest Services Division | Hugo Slabber |
| 22 nd March 2013 | Mr Paul Asante | Farmers Representative | Hugo Slabber |
| 22 nd March 2013 | Mr Agyemang | Herdsmen Representative | Hugo Slabber |
| 22 nd March 2013 | Mr Michael Opoku Nkansah | Leader, Kumawu Traditional Council | Hugo Slabber |
| 22 nd March 2013 | Opanyin Kwadwo | Opinion Leader, Kumawu | Hugo Slabber |
| 21 st May 2013 | Mr Ben Ampomah | Acting Executive Director, Water Resources Commission | Paul Ankrah |
| 21 st May 2013 | Mr Joseph Bilinda | Park Manager, Wildlife Division, Kumawu | Kwame Adam |
| 21 st May 2013 | Mr Daniel Fosu | District Forest Manager, Forest Services Division, Kumawu | Kwame Adam |
| 22 nd May 2013 | Mr Joseph Boakye | Regional Forest Manager, Forest Services Division, Kumasi | Kwame Adam |
| 23 rd May 2013 | Mr James Ware | Deputy Regional Forest Manager, Ashanti Region | Kwame Adam |
| 29 th May 2013 | Nana Adomako Kyei Barfo | Akombeahene, Agogo Traditional Council | Paul Ankrah Kwame Adam |
| 6 th June 2013 | Nana Kofi Adu-Nsiah | Executive Director, FC Wildlife Division, Accra | Kwame Adam |
| 17 th July 2013 | Mr Hugh Brown | Plantations Director, Forestry Commission HQ | Kwame Adam |
| 27 th August 2013 | Mr Kofi Sarpong | Health Administration Manager, Agogo Hospital | Paul Ankrah |
| 27 th August 2013 | Mrs Faustina Dufie-Sefah | Primary Health Care Coordinator, Agogo Hospital | Paul Ankrah Boasiako Antwi |
| 29 th August 2013 | Mr Boasiako Antwi Brobbey | Coordinating Director, Asante-Akyem North District Assembly | Paul Ankrah James Senayah |
| 29 th August 2013 | Mr Eric Djokoto | District Works Engineer, Asante-Akyem North District Assembly | Paul Ankrah |

Interests and Concerns of Agogo and Kumawu Traditional Councils

- Effective monitoring and management of the Reserve is required to reduce the damaging effects of illegal settler farmers over running the reserve and torching the vegetation to establish farms and cattle grazing. This has been the source of many major forest fires in the area. It was suggested that the Forest Services Division employ more staff to monitor the reserve.
- Employment is a key issue in the area and it was suggested that NMFC should provide jobs for the well being of young people in the area.
- Revenue earning streams from forest outputs for stool landowners has virtually ceased to exist since commercial logging ceased in 2000. The general viewpoint is any reforestation project that can generate financial returns to the stools and community is highly desirable.
- Financial support has been required by the Agogo Traditional Council for the development of a vocational training centre in Hwidiem. It was noted that NMFC has already contributed some funds towards this Centre, which is now operational in developing the vocational skills and needs of young students in the Agogo area.
- Written requests have been made to the Forestry Commission to consider allocating part of the eastern portion of the reserve to support the expansion of Ananekrom, which has already encroached some of the reserve lands.
- Removal of illegal migrant settlers in the reserve is highly desirable to avoid over-running of the reserve and mitigating possible social conflicts with locals.
- Would like to have scholarships and educational grants for deserving students to achieve a tertiary level of study in Agro-forestry related disciplines.

Interests and Concerns of Squatter Farmers and Herdsmen Representatives

- The grazing of cattle in the reserve has been a major source of local discontent as this has resulted in damage to crops by cattle. It was suggested that a means for cattle to be identified in the reserve should be introduced; as cattle owners refused to accept liability for herd damage to food crops.
- It was noted that the farmers (local and migrant) made requests to allow farming to co-exist alongside the establishment of plantations as this was an important food source for the community.
- It was also noted that the farmers acknowledged their illegal entry into the reserve, stating that this was not intentional; but due to the fact that some plantation developers under the previous Modified Taungya System; had collected monies from the farmers and illegally allocated portions of the reserve lands to them. There was therefore a plea to allow farmers to continue farming in the reserve; whilst observing the rules and regulations governing the reserve.

Interests and Concerns of Forestry Services Division of Forestry Commission

- FSD supports reforestation of the reserve to meet landowner and local aspirations.
- Uncontrolled spread of illegal settlers entering the reserve must be curtailed to avoid the reserve being overrun.
- The management and control of fire is a major concern for this stakeholder due to the spate of forest fires that occur in the reserve; the most severe being the fire of 1983. It was noted that the illegal farming and settler activity is a major cause of forest fires in the reserve. Faced with budgetary constraints, the FSD is of the opinion that the reserve must be maintained as a forest reserve for future generations and therefore tree plantation development projects are necessary to restore the reserve; as this will serve to inform the community accordingly.
- FSD believes that by having an experienced plantation developer working in the reserve, better management and monitoring of the Reserve will eventually evolve due to the sharing and exchange of information on activities in the reserve.

Interests and Concerns of Wildlife Division of Forestry Commission

- This stakeholder was principally concerned about the impact of agrochemicals and spent oils discharged on fauna through possible poor control, use and disposal of such chemicals.
- Concern was also raised about the possible poaching of game by local communities and workers of NMFC; although most game having migrated to the nearby Wildlife Sanctuary.
- It was also noted that the spread of uncontrolled farm fires started by farmers had the tendency to spread. Coupled with their lack of fire fighting equipment, these farmers are unable to bring the fires under control and consequently these fires spread uncontrollably and result in serious damage to wildlife and their habitats.
- Damming of water courses for irrigation can lead to flooding and also affect the biodiversity and water accessibility of the areas in which they exist. It was noted that this form of practice is highly undesirable and hoped that NMFC will not engage in this practice.

Interests and Concerns of the Water Resources Commission

- The Commission welcomed the planting of trees in the reserve as this would be highly beneficial to the environment and local stakeholders.
- Establishment of Buffer and Riparian Strips is of major importance to this stakeholder; and should form a key part of NMFC operations. Buffers and riparian strips serve to support and maintain biodiversity in forest areas. It was noted that the Commission recommended that NMFC pay attention to the “*Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana, 2012*” because of the proximity of rivers and seasonal streams traversing the reserve.

- The WRC stated that there should be controlled use of water systems in the reserve and that water sources from rivers and boreholes should be monitored on a regular basis.
- As a regulator, the WRC wishes to ensure that all necessary permits must be obtained to ensure compliance with the LI 1692 Water Use Regulations, 2001; the exception being water for fighting forest fires
- The WRC also expressed concern about the use of uncontrolled chemicals by farmers in and outside the reserve; as this could result in damage to aquatic life and biodiversity sensitive areas.

Interests of Asante-Akyem North District Assembly

- The Assembly's principal desire is to see more locals being employed by NMFC, currently the second largest employer in Agogo; after the Agogo Presbyterian Hospital.
- The Assembly indicated a keen interest to see the Boumfum Reserve restored as quickly as possible because of its former contribution to the local economy during the commercial logging era.
- The Assembly also indicated its interest to be involved in stakeholder groups and thus contribute to sharing of information and to identify areas for future collaboration.
- Having just gained autonomy from the Konongo Municipal Council, Agogo District Assembly is finalising its own development plans for Agogo; and as such deem it necessary to include the NMFC project as part of its regional and local development plans.

Interests and Concerns of Agogo Presbyterian District Hospital

- The upgrading of Ananekrom health centre is of primary importance to the Agogo Primary Health Care; as the town has expanded rapidly. A field visit to the area confirms that the Ananekrom is in urgent need of a new health centre as the previous building is structurally unsound and unsafe.
- The hospital and its health care affiliates are interested in collaborating with locals and firms to assist it in promoting health educational programmes; as well as supporting its need for a new health centre in Ananekrom.
- The hospital has indicated that in order to be able to provide a better service to workers of the NMFC project, it would be appropriate for occupational health hazards information for tools, machinery handling, and agro-chemicals to be made available to the hospital in advance of any likely accidents or health related issues.
- It was also indicated that waste disposal and sanitation practices needs urgent attention in Agogo. It is the view of the hospital and its affiliates that the implementation of a waste disposal strategy needs the input and collaboration of all local stakeholders; including the traditional chiefs, firms and the district assembly.

Minutes Of Stakeholders' Consultative Workshop**Pentecost Auditorium, Agogo,****On Friday, 22nd March, 2013.**

1. The meeting started exactly at 9:30 am with an open prayer said by Pastor M. A. Owusu of the Saviour Church of Ghana, Agogo.
2. Introduction of Chairman and other Dignitaries was done by the MC of program, Mr. Daniel Ofori (District Manager, FSD, Kumawu).

3. Chairman's Remark

The chairman, Nana Gyasi Amoako Adaboh II, Hwidiemhene, accepted the seat and thanked the Organizers of the program for the honour. He elaborated on the purpose of the program as being a stakeholders' consultative workshop on the Boumfoum Forest Reserve towards the regeneration of the fast depleting reserve. He further gave a brief history of the Boumfoum and Bandai reserves as at 1970s where the forest used to be a virgin forest and only some brave hunters had the courage to enter the Boumfoum Reserve. He also said the Boumfoum Reserve which used to be one of the largest reserves in the Ashanti Region is depleting at a faster rate and we must therefore do away with all anthropogenic activities that deplete the forest. He cautioned that the reserves should be protected for posterity.

4. Welcome Address by the Assistant Regional Manager, Forest Services Division, Kumasi.

He started by thanking members present and observing all protocols. He said the forest is very important to the nation and therefore must be managed well and properly taken care of to avoid the dangerous effects that would follow after its depletion. He stressed that the forest should be holistically and sustainably managed for the present and future generations.

5. The status of the Boumfoum Forest Reserve presented by Mr.F.S. Amoah, Consultant

- Mr F. S. Amoah was called upon to throw light on the above topic. By way of introduction, he said NMFC is jointly-owned by National Interest Company Limited (NICOL), a registered Company in Ghana and Miro Forestry Company (MFC) from the Cayman Islands which signed for a reforestation project covering an area of 5000 ha in the Boumfoum Forest Reserve. According to him, NMFC is aiming at FSC Certification and therefore working to ensuring the required quality standards in its operations. Mr. Amoah also said in addition, the company will deal with a number of socio-economic challenges which have affected the smooth implementation of the project plans.

- On the purpose of the exercise he undertook with FSD Kumawu, Mr F. S. Amoah said the main purpose was to enable FSD Management to address the request submitted by NMFC to assess the status of reforestation activities, if any, in targeted unused compartments in the reserve and to provide candid impressions about the general and specific conditions of those compartments.
- On observation, he said, generally the pillaring along the boundary of the reserve has become problematic. According to him along the north-eastern boundary FRBP154 was not in place and a position which had been fixed with a beacon and supposed to be the location of FRBP 154 was off the boundary line and about thirty (30) metres into the reserve. Two pillars without inscriptions and positioned about three (3) metres apart were located after FRBP14 towards FRBP13. He also observed that between FRBP1 and FRBP15 only FRBP14 was found with its inscription clearly on top; FRBP4 was in place with its top broken while others along that stretch of boundary either had no inscriptions on top or were missing. FRBP12 which was supposed to be a reference point for the identification of compartments 105, 107, 110 and 112 was not in place.
- Most parts of the reserve are accessible though some through difficult terrain. During the rainy season the Bomfuom River and its major tributaries overflow their banks apparently dividing the whole reserve into sections which become temporarily inaccessible without bridges.
- He said that, the reserve is seriously degraded. What appears to be existing intact natural vegetation consists of narrow strips of the riparian forests saved along the Bomfoum River and its major tributaries. Few trees of indigenous species predominantly *Cola gigantea* and *Ceiba pentandra* can be found dispersed in the reserve. A dense coverage of grasses dominated by *Panicum maximum* and *Imperata cylindrica* occupy very extensive parts of the reserve.
- He also observed some squatters who carry out illegal farming activities in the reserve. **Ananekrom** settlement has now developed into a township and occupied by 3000+ inhabitants with well-built houses and basic amenities (schools, a clinic, sheds, mosque, shops and a big market centre).
- Mr F.S. Amoah concluded that, previous plantation developers have breached the terms for accessing the reserve land for reforestation since the interest is obviously more in cultivating the land for food crops rather than planting trees.
- With the large number of settlers, mostly migrant farmers in search of fertile lands for agriculture and the extent of farming over the years, there is a tendency to compromise any future management of the reserve.
- Wildfires still remain one of the major challenges for managing the forest reserve; for

which reason pragmatic fire management measures (early burning, effective fire patrolling and creation of firebreaks along the periphery of the reserve) will have to be pursued to protect the reserve.

- The terrain conditions of the reserve now feature a hilly landscape which has its rock formations exposed as a result of the past poorly-controlled logging operations and recurrent wildfires.
- In recent times the non-forestry activities by squatters and illegal farmers have worsened the condition of the reserve and these activities must be curtailed as a matter of urgency to allow well- designed and intensive reforestation programmes by capable investors to restore the integrity of the reserve.
- Ananekrom is developing rapidly into the reserve, a situation that has assumed a dimension beyond the capacity of the District and Regional Forestry Offices to curtail.

Mr F. S. Amoah recommended that:

- ✓ Forestry Commission management should formerly withdraw the following ten (10) compartments which have not seen any reforestation activities because the beneficiary companies failed to show up for the project after the allocation. The compartments are 87, 94, 105, 107 110, 112, 119, 130, 146, 160 totalling 1108.27 ha.
- ✓ Since there were no records to indicate that compartments 88 and 115; totalling 241ha had ever been allocated to any company and there have not been any reforestation activities in these compartments at the time of the field verification, the two compartments are therefore available for allocation to capable investors for reforestation.
- ✓ In view of the demonstrated capacity to undertake a large-scale reforestation project FSD Management should respond positively to the request by NMFC for additional compartments by allocating all the 12 compartments listed above to NMFC.
- ✓ It would be very helpful if FSD Management could set out a plan to verify the progress of work by all other private developers in the reserve to determine the level of compliance with the reforestation undertaking.
- ✓ Where developers have taken several compartments but have demonstrated their incapability, technically and financially to undertake the reforestation project, their compartments could be withdrawn for re-allocation to more determined and capable investors.
- ✓ NMFC is determined to take up such compartments in order to close up the gaps in their allocations.
- ✓ NMFC will have to promptly conclude the on-going negotiations with the companies

that have expressed the wish to do so in order to determine the relevant compartments that will come under its management and to allow for a comprehensive review of the Reforestation Plan.

- ✓ FSD Management should activate a special task team and with the required logistics to support Forest Services Division, Kumawu to destroy all unauthorized structures and flash out all illegal occupants in the reserve in keeping with directives from the Executive Director of the FSD.
- ✓ The biggest challenge in handling the Ananekrom issue will be the decision to either evict the inhabitants from the encroached portions of the compartments or at least, create a physical barrier to curtail further incursions into the untouched portions of the reserve. However, being mindful of the political and socio-economic implications of any decisions to address the issue; the timing to execute any action plan should be carefully decided. A starting point for the action plan could be a high-level and all inclusive stakeholders' meeting to build consensus on a collaborative action plan to restore the integrity of the reserve,
- ✓ Boundary pillaring (replacement and repairs) should be given the necessary attention without delay to avoid serious errors and conflicts during surveys in future.
- ✓ Meanwhile the locations of other private developers should be reviewed by GPS coordinates to determine whether they are carrying out their projects within the right compartments.
- ✓ Thereafter the necessary corrections should be done for all affected documentations to avoid future conflicts

6. Farmers' representative statement by Mr. Paul Asante

He first thank the elders who reserved the Boumfoum forest and further stated that it was not the will of the farmers to enter into the forest; but some Private Developers collected monies from some farmers for portions of the forest for farming. He also tackled the issue of over grazing by cattle in the forest which needs immediate attention and redress. He stressed on the importance of the 'Taungya' system which has resulted in food abundance in forest fringe communities and the entire country as a whole. He pleaded that the farmers be allowed to continue to farm in the reserve and promise to abide by all rules and regulations governing the reserve.

7. Statement by Herdsmen Representative (Mr Agyemang)

Mr. Agyemang suggested that there should be means of identifying cattle as it bring problems to the community because herdsmen fail to accept that their animals damage people farms. He also requested traditional and political authorities to help address the problems of herdsmen by identifying areas for the animals to be kept.

Mr. Michael Opoku Nkansah asked what the FSD and the Traditional Council did about the state of the Boumfoum forest all these years. The FSD should define Ananekrom land to avoid further extension. He however stated that if the FSD cannot protect or manage the forest on behalf of the people then it should be given back to 'Nananom'.

8. Statement by Nana Okyere Barfour, representative of the Kumawu traditional Council

Nana asked the FSD whether or not they are supervising those farmers under the Taungya system. He cautioned that if the FSD cannot manage the forest on behalf of the people, then the forest be given back to their owners to manage it. In conclusion, Nana asked the FSD to adhere to their task and work hard to ensure sustainable forest management in the area.

9. Statement by Representative of Agogo Traditional Council

Nana started with the introduction of members of the Agogo traditional council present. He said the current status of the Boumfoum Reserve is due to the inability of the FSD to work effectively and efficiently towards ensuring sustainable management of the reserve. Nana advised that more workers be employed into the FSD to enable effective delivery of their duty. He said we should think about posterity in forest management. He cautioned farmers under the Taungya system to desist from the use of weedicides within the reserve and their activities be monitored closely by the FSD. He added that there should be a policy towards cutting down of trees and saplings by the legal farmers as most of them cut down all trees during land preparation. Reforestation program should be enhanced in our quest to regenerating the reserve. Nana also touched on the activities of the timber companies within the area, stating that FSD should monitor closely their activities as they turned to fell almost all trees in their concessions which impede regeneration of the forest. Illegal settlers and squatters within the Bandai Forest Reserve should be dealt with, Nana added.

10. Statement by the Representative of the Hon Member for Parliament Asante Akyem South

When the last tree dies the last man dies, was his opening statement after observing all protocol. He said the emergence of the illegal farming the reserve was due to the delay of reforestation project by the FSD after the forest burnt off. The Hon member also said some of the farmers claimed they bought the land from plantation developers. He also said the interaction between the Chiefs and the FSD is not encouraging. If there is regular meeting between the FSD and the Chiefs, the issue of illegal farming would not be a problem. He advised that, there should be collaboration between FSD and the traditional council towards achieving sustainable forest management and there should also be interaction between the national security and the FSD to review the activities of herdsmen in the area. In conclusion, he advised the private plantation developers [il] the area to employ the local people to cut down labour costs.

11. Statement by District Coordinating Director, Kumawu

He was of the view that the forest revenue to the District Assembly has reduced drastically and attributed it to the depleting of the forest resources as result of chiefs and politicians always pleading on behalf of wrong doers. He added that in addition to FSD, the local assembly should help to protect the forest by reporting all illegal cases to the FSD.

Also the District Assembly has received money under the Ghana Social Opportunity Project and has invested it in community plantation project within the Bomfobri reserve.

Mr. Sarpong: FSD should monitor closely the activities of farmers. Also farmers should desist from planting cassava and use of weedicides. He however pleaded on behalf of the farmers not to be driven away as it can leads to social vices.

Opanin Kwadwo: FSD and Nananom should allow the farmers to dwell on the land but can drive away those who are not law abiding.

Nana Apagyahene, Agogo:

Farmers should be given incentives for their participation in nurturing the tree.

Nana Pese Dankwah, Assemblyman (Agogo): There should be supervision of the activities of herdsmen within the reserves.

12. Statement by Director, Forestry Commission Legal Department

He explained the legal backing of the Forestry Commission laws such as; forest protection decree instituted by the then head of state I.K Acheampong- *'no one should enter the forest without the permission of FSD'* and in 2000 Act 604 which adds that a fine of 10 million cedis or 2 years imprisonment or both be given as a penalty for unlawful entry. He concluded by advising the communities to embark on tree planting exercise for carbon credit.

13. Forest Services Division (FSD) Plans For Reclamation of Boumfoum Forest Reserve from encroachment by the Executive Director, Mr Ralph Yeboah

Mr Yeboah began by thanking the chairman, Nananom, etc, all protocols observed for making the program successful. He said there are about 241 forest reserves nationwide of which Boumfoum Forest Reserve is one of them. Boumfoum Forest Reserve used to have 1st class species but the forest is depleting at a faster rate due to wild fires and poor management of the reserve. Over population have also contributed to the degradation of the forest, he added. He also said, the forest land was given to the government by the chiefs for care taking and therefore edges that no other person should allocate or enter the forest without prior notice of the FSD and the chiefs. He said the president asked him to remind all present that the Boumfoum and the Bandai Forest Reserves still remain forest reserves and that there

should be a holistic approach towards the management of the reserves. There should be re-pillaring of the Boumfoum Forest Reserve and temporally freezing of all allocation of the forest to the plantation developers. He cautioned that all illegal structures within the reserves would be demolished very soon by the rapid response team and all cattle herdsmen would be sacked from the reserves.

He also said, the chiefs should be in good terms with the private plantation developers within their areas to ensure a win win situation for all parties. Companies should show commitment regarding the Social Responsibility Agreement. He added that there would be special monitoring team in collaboration with the Rapid Response Team to demolish all illegal structures within the reserves. Three (3) months ultimatum has been given to all illegal land owners within the reserves to acquire a genuine lease from the traditional council or face the risk of losing their lands. He told the chiefs not to hesitate to consult the Forestry Commission on any issue bothering their minds on sustainable forest management and the activities of the illegal farmers. The natural forest alone cannot provide the needed trees for the nation unless supported by plantation, the Forestry Commission boss concluded.

Father John Aduse Poku: After the re-zoning what happens if a land belonging to someone happened to be found in another person's land? FC boss answered; there would not be re-zoning rather re-pillaring but if that happens, then the issue on that parcel of land should be solved through negotiation and dialogue between the two parties involved.

Representative of the Hon. Member of Parliament

He pleaded that the FC should temper justice with mercy concerning sacking of the illegal farmers from the reserves but rather include them in the Modified Taungya System.

One of the members also advised the FSD to educate the community on the benefits of the forest to the community and the country at large. He also asked Mr. Yeboah about the law regarding chainsaw operation. The FC boss answered that the law does not permit the use of chainsaw for cutting and processing of wood for sale. Chainsaw can only be used for cutting and processing of wood if and only if it is used for community, church, etc projects.

Chairman's Closing Remarks

He said there is the need for people to be law abiding concerning sustainable forest management. Also companies with the capacity to develop plantation properly, be given permit. In conclusion, Nana advised that, there should be a standing committee of farmers, traditional council, companies and the FSD to resolve forestry related issues.

Vote of Thanks was done by the Juaso FSD District manager and closing prayer was said by Father John Aduse Poku of the Agogo Cathlic church.

The program came to an end exactly 1:37 PM.

Minutes of Stakeholder Meeting with
Agogo Traditional Council
29th May 2013, 1.00pm
Venue: Chief's Palace, Agogo

Present:

Paul Ankrah – Consultant, NMFC

Kwame Adam – Consultant, NMFC

Nana Adomako Kyei-Barfo – Ankombeahene of Agogo Traditional Council

1. Meeting began by Mr Paul Ankrah and Mr Kwame Adam introducing themselves to Nana Akombeahene; who also informed us that he is the spokesmen for the Agogohene on matters pertaining to the reserve as he is an ex-forester.
2. Mr Adam then introduced the Nicol Miro Forestry Project to Nana Akombeahene together with the Environmental Impact Assessment being carried out on the NMFC project proposal.
3. Nana Akombeahene informed the consultants that the Boumfoum Reserve is owned by the stools of Agogo, Kumawu and Kwamang and that the NMFC project was introduced to them by Nicol, the Ghanaian joint venture partner and is very welcome and supported by the three stools.
4. Mr Ankrah then sought to gain an understanding of the history of the reserve and its current status and challenges.
5. Nana informed all present that following the cessation of logging activities, some companies who were allocated lands by the Forestry Commission to develop plantations in the early to late 1990's, never developed plantations but rather entered into illegal allocations of the reserve lands to farmers. This had led to the proliferation of illegal migrant settlers and farms currently in the reserve.
6. Nana also informed the consultants, that the illegal settlers were causing social conflicts with locals.
7. It was also mentioned that at a March stakeholders meeting, it was agreed by all parties present at that meeting that the illegal settlers should be given three months to vacate the reserve or face eviction; as the Forestry Commission is the mandated authority responsible for management and monitoring of the reserve.
8. Nana also mentioned that there was general acceptance in the town of Agogo that Forestry Commission has the right and duty to reclaim the reserve lands to ensure that the reserve is protected as a forest.
9. Nana also mentioned that the recent support from NMFC in developing a vocational training institute in Hwidiem was very welcome from the community.
10. The Consultants then asked Nana to comment on the relationship that existed between the traditional councils and the NMFC project. Nana mentioned that there had been some very important and fruitful discussions between all parties but stressed that the project should endeavour to strengthen its relationship and communications with Nana Sarpong, the Agogohene.

11. On the question of illegal farmers, Nana mentioned that the illegal farmers do not pay any royalties to the council and are in clear contravention of the land use purpose of the reserve.
12. Nana stated that if the illegal farmers were not removed from the reserve, it would result in the reserve being overrun; which may not be easy to reclaim.
13. He also stated that there had been some tensions between NMFC and some illegal farmers operating in lands allocated to the Company under the unencumbered land lease agreement with the Forestry Commission. He stated that farming was the principal activity in the area and there was therefore a need to ensure that any farming done on the reserve must be strictly monitored and controlled by the Forestry Commission in conjunction with Stool landowners.
14. The consultants sought to gain Nana's view about the expansion of Ananekrom into the reserve land boundaries, thus affecting NMFC's proposed planting in lands allocated to it by the Forestry Commission. In response, Nana acknowledged the expansion into the reserve lands but informed us that the Council had appealed to the Forestry Commission to allocate parts of the affected reserve lands to allow for the expansion of Ananekrom and its related social needs. With regard to NMFC, he suggested that they be given alternative lands in the reserve by the Forestry Commission. He also informed us that these proposals are under consideration by the Forestry Commission.
15. Nana also commented that there was need for the Forestry Commission agencies to be more vigilant in monitoring activities in the reserve and that forest rangers rarely visited the reserve following cessation of logging activities. Nana went on to state that with the recent arrival of NMFC, it presented Agogo with a unique opportunity to reforest about 25% of the reserve and help to limit the damaging effects of forest fires on the community and surrounding areas.
16. The Consultants then asked Nana to comment on some of the social expectations from the project. Nana commented that the key issue for the community was employment and therefore he would encourage NMFC to employ as many locals as possible and also include women during recruitment of labour.
17. He also stated that NMFC should consider offering scholarships to deserving students keen to pursue agro-forestry education; as this would benefit the project and the town in the long run.
18. The meeting ended at 2.45pm

**Minutes of Stakeholder Consultative Meeting
with Asante-Akyem North District Assembly**

26th August 2013, 1.00pm

Venue: District Assembly Offices

Present:

Mr Eric Djokoto – District Works Engineer

Mr Paul Ankrah – Consultant, NMFC

1. The meeting began by Mr Ankrah introducing the consultants to Mr Djokoto.
2. Mr Ankrah then outlined the NMFC project proposal to Mr Djokoto.
3. Mr Djokoto mentioned that he was aware of the project during its initial conception stage but was not too aware of the project details.
4. Mr Ankrah and Mr Senayah then informed Mr Djokoto about the Environmental Impact Assessment being undertaken as part of the project proposal.
5. Mr Djokoto stated that as a resident of Agogo, he had experienced some of the effects of forest fires from the reserve on the community and that the re-forestation proposal by NMFC is very welcome indeed to ensure the protection of the reserve.
6. He also stated that non-traditional forest products such as medicinal plants and herbs should be protected as the Agogo Hospital was trialling forest medicinal plants.
7. Mr Ankrah then sought to gain a better understanding of the likely effects of the NMFC project. In response Mr Djokoto stated that the major issue for the assembly and local community was employment; and that the project should employ as many locals as possible. It was also stated that the success of the project could lead to economic migration; but it was Mr Djokoto's view that such a development if managed properly in conjunction with all stakeholders could prove to be positive for Agogo.
8. Mr Ankrah then asked whether such migration would not put a strain on the housing problems already associated with the Agogo area. In response, Mr Djokoto stated that companies that seek to move into Agogo should include plans to build accommodation for its employees and that early collaboration with local authorities and institutions is the key.
9. Mr Djokoto then urged that the NMFC project should hold regular consultations and discussions with the Assembly to ensure that the project can contribute to the development of regional and local development plans which are likely to impact it.
10. Mr Ankrah then asked Mr Djokoto what the key expectations were from the project. In response Mr Djokoto stated that employment of locals was key and that training and skills development should also form a key part of the project; as the council was concerned about the migration of semi-professionals from Agogo. Furthermore, inter-cropping alongside plantation development should be considered as Agogo is more of a farming community.
11. Mr Djokoto also stated that the town together with stakeholders needs to have a fire fighting strategy for fighting forest fires caused by migrant farmers. He welcomed the re-forestation plan, stating that it was a big step towards reducing forest fires in the reserve.

- 12.** Finally, Mr Djokoto stated that he would like to see more corporate social responsibility and that Agogo urgently needs the input of stakeholders to develop a water supply and waste management strategy.
- 13.** The consultants, then thanked Mr Djokoto and the meeting ended at 2pm.

**Minutes of Stakeholder Consultation Meeting with
Water Resources Commission, Head Office, Accra
29th May 2013. 11am**

Present: Mr Paul Ankrah – Consultant, NMFC
Mr Ben Ampomah – Executive Director, Water Resources Commission

Venue: Offices of the Water Resources Commission, Labone , Accra

1. Meeting began at 11am with Mr Paul Ankrah introducing himself and outlining the Nicol Miro Forestry project to Mr Ampomah. Mr Ampomah welcomed the re-forestation project; stating that the planting of trees was very important for protecting the environment and could be beneficial to local communities.
2. Mr Ankrah then asked Mr Ampomah to outline the functions of the Water Resources Commission and its guidelines and policies regarding the use of water resources.
3. Mr Ampomah stated that the Commission was first of all a regulator responsible for the controlled and efficient use of water resources in Ghana. Mr Ampomah stated that he was aware of the Boumfoum Forest reserve and the water resources located within the reserve.
4. Mr Ankrah then proceeded to ask what policies and regulations pertained to the use of river and groundwater resources. Mr Ampomah informed Mr Ankrah that the Water Use Regulations (LI 1692) 2001 and the Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana 2012 were key documents that needed to be referred to in the development of the project.
5. Mr Ampomah also mentioned that there may be the need for water permits to be obtained from the Commission; depending on water volumes to be used by the project.
6. Mr Ampomah mentioned that the Commission had concerns regarding the use of agro chemicals near water bodies and their potential impact on riparian areas. He mentioned that there was a need to ensure that buffer strips are properly planned and introduced to ensure protection of these sensitive areas.
7. He also stated that because of the large water catchment area within the reserve, preventive measures should be taken to limit soil erosion and sedimentation of river bodies; as this could affect aquatic life.
8. Mr Ampomah mentioned that he would send Mr Ankrah a copy of the Riparian Buffer Zone Policy to assist in the development of the project.
9. Mr Ankrah then thanked Mr Ampomah for his time and contribution and the meeting ended at 12.10pm.

Minutes of Stakeholder Meeting with
Agogo Presbyterian Hospital
27th August 2013; 10.00am

Present:

Mr Paul Ankrah – Consultant, NMFC

Mrs Faustina Dufie-Sefah – Primary Health Coordinator, Agogo Hospital

Mr Kofi Sarpong – Administrator, Agogo Hospital

Venue: Agogo Presbyterian Hospital, Agogo

1. The meeting began by Mr Ankrah introducing himself and the Nicol Miro Project to Mr Sarpong and Mrs Dufie-Sefah.
2. Mr Ankrah then asked Mr Sarpong to provide a summary overview of the key health issues faced by Agogo and its surrounding communities.
3. Mr Sarpong then gave Mr Ankrah the annual disease trend reports for 2011 and 2012; outlining the key health issues faced in the community.
4. Mrs Dufie Sefah then proceeded to talk about the key health and social issues in more detail; namely:
 - Maternal deaths are on the increase due to late referrals to the hospital. She attributed this to the low level of awareness by expectant mothers and the lack of sufficient mid-wives.
 - Hospital itself was experiencing financial difficulties which impact on the delivery of essential health services.
 - Hospital needs financial support for outreach community and health educational programmes.
 - The incidences of malaria are due to poor sanitation which is a major problem. She highlighted the fact that poor and unacceptable sanitation practices by the locals; is a major contributor to the sanitation challenges being experienced by the community.
 - Kids immunization is poorly patronised even though there are 6 immunisation centres. This she attributed to the low level of awareness by mothers.
 - Teenage pregnancies are on the increase together with drug abuse.
 - Anankrom community needs a new health clinic as the current building is structurally unsafe.
 - Running water is a major problem and it is common to experience 3-6 months without water supply in Agogo.
 - Accommodation is difficult to come by and rather expensive. On average a single room will cost GHC60 per month; with a chamber and hall fetching GHC300 per month.

5. Mr Ankrah then asked Mrs Sefah to outline her views and concerns regarding the Nicol Miro project. Mrs Sefah stated that the reforestation exercise being proposed by the project should help to drive out the migrant Fulani farmers who were causing social conflicts with locals. She mentioned that Agogo was mainly an agro-forestry community and therefore any forestry project that brought about employment within the community is most welcome.
6. She also stated that the spread of forest fires should hopefully be curtailed by the renewed activity in the forest reserve.
7. Mrs Sefah also commented on the need to firms in the Agogo area to come together and assist the Hospital in developing a waste management strategy for Agogo. She also felt that the locals needed educational awareness programmes to improve basic health practices.
8. She also stated that it would be good for the NMFC project to furnish the hospital with health and safety data on agro-chemicals to be used by the project; as this would provide them with all necessary information which may be needed in the event of an agro-chemical related incident.
9. When asked what were the health and social priorities for Agogo, Mr Dufie Sefah indicated that the Ananekrom health centre needs to be replaced and that education and employment issues must be addressed by all local businesses and the community.
10. The meeting was concluded at 11.15am.

SUMMARY OF MINUTES FROM FORESTRY COMMISSION AGENCIES**STAKE HOLDER CONSULTATIONS**

| DATE AND LOCATION | STAKEHOLDER ORGANISATION | PERSONS CONSULTED | CONCERNS AND VIEWS OF STAKEHOLDERS |
|--------------------------|---|---|---|
| 21 May 2013; Kumawu | Forestry Services Division District Office, Kumawu | Mr. Daniel Oforu , District Forest Manager. In charge of the management and protection of the Boumfum Forest reserve | <ul style="list-style-type: none"> ▪ As at now the boundaries of the three stools owning the Forest reserve land has not been defined on the ground and this is likely to affect the distribution of revenue that will come from the plantation proceeds. ▪ The presence of the plantation developers will require that FSD put more staff at Boumfum to assist in offence patrol, fire control and other environmental monitoring. This will be a challenge in the early years of development but could be addressed with time. ▪ Confirmed that the FC Head quarters had raised concerns about the use of a Eucalyptus hybrid as one of the species to be planted by NMFC. Contended that no information about that species had been made known to FC and that there will be the need for FC to understand the behaviour and characteristics of the species before allowing it to be planted ▪ Noted that the squatter farmers occupying parts of NMFC concession need to be ejected to allow the company to have smooth operation. The ejection must be done by FC |
| 21 MAY 2013, Kumawu | Wildlife Division, Bomfum Wildlife Sanctuary, Park Office | Mr Joseph Bilinda , Park Manager | <ul style="list-style-type: none"> ▪ Clearing of remnant trees may disorient movement of birds to and from the reserve ▪ Increased human population within close vicinity of the park due to presence of plantation workers may increase demand for bush-meat and the likelihood of increased poaching from the reserve. ▪ Removal of vegetation cover during the establishment phase will increase erosion and movement of debris into the river beds causing siltation and early drying up of water ▪ Use of Agro-chemical may pollute the source of drinking water for the |

| DATE AND LOCATION | STAKEHOLDER ORGANISATION | PERSONS CONSULTED | CONCERNS AND VIEWS OF STAKEHOLDERS |
|-----------------------|--|---|--|
| 22 MAY 2013 Kumasi | Forest Services Division Ashanti Regional Office, Kumasi | Mr Joseph Boakye , Regional Forest Manager, Ashanti | <p>wildlife</p> <ul style="list-style-type: none"> ▪ Observed that degradation of the forest started in 1983 after the nation-wide bush fire disaster and the subsequent management prescription for salvage removal of dead and dying trees ▪ Confirmed that in order to restore the forest after the fire disaster some individuals and timber companies were given permits to convert the burnt areas into plantations but almost all the beneficiaries turned the area into crop farms instead of tree plantations. The few areas planted were also left unmanaged. These unmanaged plantations are now seen as patches of teak stands in some compartments some of which are found in NMFC area. ▪ A definite decision must be taken on how to treat or deal with the abandoned teak stands ▪ Observed that some of the squatter farmers present are there on the authority of the companies and individuals who were granted the plantation permit. However, there are some who come in seasonally to cultivate maize. He agreed that these are illegal farmers and must be ejected from the forest. ▪ Observed that there is a boundary dispute between the Saviour Church of Agogo and NMFC. The church was also allocated some areas in the forest for plantation but failed to comply but they are still holding on to the permit and farming on the land. It was revealed that the church was claiming that NMFC had taken part of their land and also destroyed their crops. The Church was threatening NMFC with legal suit. |
| 23 MAY 2013 Kumasi | Forest Services Division, Regional Office , Ashanti | Mr James Ware , Deputy Ashanti Regional Forest Manager | <ul style="list-style-type: none"> ▪ Confirmed that the stool land boundary is not marked on the ground but each stool is familiar with their territory as has been applied earlier in the sharing of royalties. This notwithstanding it will be necessary for the company |

| DATE AND LOCATION | STAKEHOLDER ORGANISATION | PERSONS CONSULTED | CONCERNS AND VIEWS OF STAKEHOLDERS |
|-----------------------|---|---|---|
| | | | <p>to complete SRA with all the three stool owners.</p> <ul style="list-style-type: none"> ▪ Indicated that the obligations of FC and that of NMFC are well spelt out in the plantation agreement and that will be adhered to. ▪ Noted that due to limited field staff and late release of funds it will be difficult to provide NMFC with services required on time ▪ Confirmed that the NMFC have challenges with the compartment boundary schedule made available by FSD. The compartment map does not tally with the coordinates picked in the field by NMFC. There will be the need to harmonise the boundary information. There is the need to re-survey and pillar the compartment boundaries |
| 06 June 2013 Accra | Wildlife Division Forestry Commission, Head Office | Nana Kofi Adu-Nsiah, Executive Director Wildlife Division of Forestry Commission | <ul style="list-style-type: none"> ▪ Showed utmost concern about the controls that the company will put in place to ensure that the company's employees do not undertake poaching in the Wildlife Sanctuary ▪ Wanted to know if the company has any plan of damming any of the streams to create a reservoir for harvesting water as such a structure could deprive wildlife of water or attract wildlife to make them vulnerable to hunters ▪ Showed concern about the possibility of water pollution occurring from agro-chemical to be used by the company ▪ Wanted to know if any of the tree species to be planted by NMFC has the potential to invade and colonise the area. ▪ Warned against the use of herbicide as it can affect the fertility of wildlife that come into contact with herbs that have been sprayed with some herbicide. ▪ Warned against the use of fire for land preparation or weed control. Uncontrolled burning could spread into the wildlife Sanctuary and destroy the habitat. |

STAKEHOLDER CONSULTATION PICTURES



Pic 1: Andrew Collins, CEO of NMFC addresses local chiefs and stakeholders



Pic 2: Agogo, Kumawu & Hwidiem chiefs, farmers and assemblymen at NMFC stakeholder consultation meeting. March 2013



Pic 3: Francis Amoah, Forestry Commission consultant addresses Chiefs and local stakeholders at NMFC stakeholder meeting. March 2013



Pic 4: NMFC in consultations with senior Forestry Commission officials



Pic 5: Andrew Collins, NMFC in discussions with Raphael Yeboah, FSD Executive Director and Hugh Brown, FSD Plantations Director.



Pic 6: NMFC and Forestry Commission officials hold discussions



AGOGO TRADITIONAL COUNCIL
Omanhene's Office
P.O. BOX 1
AGOGO, ASHANTI, GHANA
TEL/FAX: 051-92191
Email: agogotradingcouncil@nanaakuokosarpong.com

BANKERS:
Ghana Commercial Bank

Our Ref: ATC-75/NMC/23

Your Ref:

28-03-14.20

Dear Sir,

RE: NICOL MICRO FORESTRY- BOUMFOUM REFORESTATON PROJECT

We have been informed by the above that following the submission of their Environmental impact Assessment report; you have reviewed the report and indicated a request for evidence of consultation between the company and ourselves as a key stakeholder.

We are pleased to confirm that consultations on the project took place between Nicol –Miro Forestry Company and the three Stools of Agogo, Kumawu and Kwamang together with senior officials of the Forestry Commission, District Council and opinion leaders on 22nd March, 2013.

During the scope of the project, I also met with the company's Environmental Consultants on 29th May, 2013 and reiterated the key expectations, issues and concerns from our stakeholder consultations with the company.

The Stools and Traditional Councils are supportive of Nicol –Miro's efforts and plans to reforest 5000 hectares of the reserve. It is our belief that the project will promote employment opportunities in the area as well as realizing social and economic benefits to Agogo and its surrounding areas. We are appreciative of the initial contribution that the company has made towards the rehabilitation of a vocational training centre in Hwidiem, near Agogo. We therefore look forward to working with the company in the future.

Yours sincerely,

(JOSEPH ANTTI)

ASST. REGIONAL REGISTRAR
AGOGO TRADITIONAL COUNCIL
AGOGO ASH/AKIM

.....
NANA ADOMAKO KYEI BAFFOUR
(ANKOBEAHENE OF AGOGO TADITIONAL AREA)

THE ENVIRONMENTAL PROTECTION AGENCY
P. O. BOX M358
MINISTRIES
ACCRA

ASANTE AKIM NORTH DISTRICT ASSEMBLY

P.O. BOX AG 155 AGOGO

TEL: 03221 -

OUR REF : AANDA/

YOUR REF:



REPUBLIC OF GHANA

28TH MARCH, 2014**RE: MESSRS NICOL MIRO FORESTRY – BOUMFOUM
REFORESTATION PROJECT**

We have been informed by Messrs. Nicol Miro Forestry Company Ltd. that you have received and reviewed as well the Company's Environmental Impact Assessment (EIA). You have further requested for evidence of consultations between the Company and the District Assembly as a key stakeholder.

We are pleased to confirm that consultations on the project took place between Messrs. Nicol-Miro Forestry Company and our Management team headed by Mr Eric Djokoto, the District Works Engineer on 29th August, 2013. Minutes of our discussions can be found in the EIA report submitted to the Agency.


As a precursor to the meeting above, I have also had discussions with the Company on two (2) occasions with the aim of identifying ways by which the company could assist and contribute to our local development plans and job creation opportunities in the Agogo area. These initiatives and proposals are currently being developed by the Assembly for discussion with other interest groups, including the Company, with the overall objective of incorporating the results into our Medium Term Development Plan (MTDP) under our Local Economic Development Initiative.

We are supportive of Messrs. Nicol-Miro's efforts and plans to reforest 5000 hectares of the depleted reserve; as we believe that this will go a long way to create employment opportunities in the area and reduce the high incidence of perennial bush fires and its related effects on the destruction of farms and properties, sometimes of whole communities/settlements.

It is my candid hope that you will accord Messrs. Nicol Miro Forestry the corporate support and courtesies for an effective implementation of the programme.

I hope I can count on your maximum co-operation

Thank you.



For: DISTRICT CHIEF EXECUTIVE
(ANTWI-BOASIAKO BROBBEY)
DISTRICT CO-ORDINATING DIRECTOR

THE CHIEF DIRECTOR,
THE ENVIRONMENTAL PROTECTION AGENCY
P.O. BOX MB326
MINISTRIES POST BOX
ACCRA.



FORESTRY COMMISSION
(FOREST SERVICES DIVISION)

P. O. BOX 527 ACCRA, GHANA
TEL: (233-0302) 401210 / 401227 / 401216 / 401231 / 401249
FAX: (233-0302) 401215
E-MAIL: info_fsd@hq.fghana.com

0190.5.280177

7th April, 2014

The Environmental Protection Agency
P.O. Box M358
Ministries
Accra

Dear Sirs,

MESSRS. NICOL-MIRO FORESTRY COMPANY LIMITED

We have been informed by Messrs. Nicol-Miro Forestry Company Limited that following the submission of their Environmental Impact Assessment report; you have requested evidence of consultations between the company and ourselves as a key stakeholder and are also seeking justification for the approval of Teak and Eucalyptus species.

We are pleased to confirm that Messrs. Nicol-Miro Forestry have been having regular consultations with the Forestry Commission since 2009, when the company first approached the Commission to discuss leasing degraded forest reserve lands for plantation development and reforestation. As a key stakeholder and being the agency responsible for the protection and management of the Boumfum Forest Reserve, we actively participated in a multi-stakeholder consultation meeting held on March 22nd 2013 with our respective district forest officers, traditional authorities, District Assemblies, farmers, cattle herdsman, assembly men and opinion leaders. Details of our deliberations are outlined in the company's EIA report. We recently held further discussions with the management of the company at the Forestry Commission on the 20th March, 2014 to identify ways in which future supply of timber to the local market can be secured from its plantations in the future; as well as discussing how inter-cropping schemes for local farmers could be developed.

On the subject of Teak and Eucalyptus, it may interest you to know that Teak has been planted in many of our forest reserves for over 70 years without any adverse environmental issues. Currently teak is one of the exotic timber species recommended by the Forestry Commission within the Dry and Moist Semi-deciduous forest zone. Eucalyptus has equally been approved for planting within the Savannah, Moist and Dry Semi-deciduous forest zones. Both of these fast growing timber species will play a vital role in ensuring that our degraded reserves are reforested as quickly as possible and also contribute to improving the short supply of timber to our local and regional markets.

Within the allocated 5,000 ha, areas have been delineated for biodiversity conservation and protection of riparian areas and other ecologically sensitive areas which will be kept in their natural state and possibly enriched with recommended indigenous tree species. Additionally, the company is obliged to plant at least 5% of the total area with indigenous timber tree species.

The Commission is therefore supportive of the company's plans to reforest 5000 hectares of the degraded Boumfum Forest Reserve and trust that you will accord the company the necessary assistance to enable it proceed with its reforestation plans.

Yours faithfully,

RAPHAEL YEBOAH
EXECUTIVE DIRECTOR

cc: The Managing Director
Messrs. Nicol-Miro Forestry Co. Ltd. ✓
P. O. Box 3
Agogo - Asante-Akyeam North

VISION: To leave future generations and their communities with richer, better, more valuable forestry and wildlife endowments than we inherited.

5. IMPACT ASSESSMENT

5.1 Methodology for Impact Assessment and Predictions

This chapter provides an overview of the type of environmental related issues examined in more detail during the Impact Assessment phase of the EIA. The consultants have evaluated all potential impacts on the environment in six stages to determine the significance of each impact:

Stage 1 – Description of the nature of the impact

This evaluates whether the project impact is beneficial or not. It also determines the project consequences on the environment and its severity as well as its effect on stakeholder interests. A beneficial impact is assigned positive (+ve) value because it does not have an adverse effect on the environment and/or stakeholders. A negative (-ve) value indicates an adverse effect.

The impact description rating table below is allocated the highest point scores range of -8 to 8 because of the different possibilities of impact - negative/positive, direct/indirect and reversible/irreversible.

- a) Positive/Negative (*beneficial or adverse*)
- b) Direct/Indirect (*directly or via intermediate factors that influences the determinants of an impact*).
- c) Reversible/Irreversible (*is the impact reversible or not*)

| IMPACT DESCRIPTION | | | |
|----------------------------------|--------------|----------------------------------|--------------|
| Negative Impact Rating | | Positive Impact Rating | |
| Negative impacts | Points (-ve) | Positive impacts | Points (+ve) |
| Negative, direct, irreversible | -8 | Positive, direct, irreversible | 8 |
| Negative, indirect, irreversible | -6 | Positive, indirect, irreversible | 6 |
| Negative, direct, reversible | -4 | Positive, direct, reversible | 4 |
| Negative, Indirect, reversible | -2 | Positive, Indirect, reversible | 2 |

Stage 2 – Description of Magnitude of impact

This is a measure of the scale of the impact of the project activities: *i.e Does the impact occur at a national, regional, local or project site level?*

| MAGNITUDE | Adverse | Beneficial |
|------------------------|----------------|-------------------|
| Scale of Impact | Points | Points |
| National | -4 | 4 |
| Regional | -3 | 3 |
| Local | -2 | 2 |
| Site only | -1 | 1 |

Stage 3 – Duration of Impact

Duration refers to the length of time over which the environmental impact may occur:

| DURATION | Adverse | Beneficial |
|----------------------------------|----------------|-------------------|
| Impact Duration | Points | Points |
| Long term/Permanent (over 10yrs) | -4 | 4 |
| Medium term (5-10 years) | -3 | 3 |
| Short term (0-5 years) | -2 | 2 |

Stage 4 – Potential Consequences

This is the actual result and scale that an impact might have. The potential consequence of an impact depends on the magnitude of the potential changes to the environment caused by an activity and the level of sensitivity of the recipient environment and or stakeholder groups. These are depicted below.

Extreme – *An effect resulting in serious and irreversible degradation/destruction of the environment and/or results in major health conditions (HIV, hepatitis, malaria, etc) or has a major negative impact on the well being of the local populace and/or stakeholders.*

Great – *An effect that is usually irreversible resulting in a positive impact or negative consequence on the environment (soils, water systems, vegetation, topography etc) and/or local populace*

Considerable – *An effect that may result in major change to the structure and composition of an environmental factor. e.g soil, land topography, diversion and damming of waterways and/or result in a some partial health effects on the local populace.*

Small – *These are small impacts or inconveniences that tend to be very temporary with very little effect on the environment or health of workers or the local populace. E.g dust from use of forest roads etc*

Hardly Any – *These are mere nuisances not effecting the environment in any significant manner and/or affecting health and welfare of the populace within the project area.*

| POTENTIAL CONSEQUENCES | Adverse | Beneficial |
|---|---------|------------|
| Consequence | Points | Points |
| Extreme (serious and irreversible) | -4 | 4 |
| Great (Irreversible consequences) | -3 | 3 |
| Considerable (Partial adverse or positive change) | -2 | 2 |
| Small (temporary impacts) | -1 | 1 |
| Hardly any (mere nuisances with little or no significant impacts) | 0 | 0 |

Stage 5 – Likelihood of occurrence/probability

This is an assessment of the probability of the impact occurring. It is used as a multiplication factor because it influences the degree of significance of the impact.

| PROBABILITY | |
|--------------------------|--------|
| Likelihood of Occurrence | Points |
| High (80-100%) | 5 |
| Medium High (60-80%) | 4 |
| Medium (40-60%) | 3 |
| Medium Low (20-40%) | 2 |
| Low (<20%) | 1 |

Stage 6 – Severity/Degree of significance

The final stage of the assessment looks to determine the significance of the impact as a result of previous five stages of assessment by rating significant adverse and significant beneficial effects. The degree of significance (Dsig) of the impact is rated by using the following formula:

$$\mathbf{Dsig = (Id + Mg + Dr + Pc) \times Pr}$$

Where, Id is the Impact Description, Mg is the Magnitude, Dr is the Duration, Pc is the Potential Consequences and Pr is the Probability of occurrence. The degree of significance ratings for both adverse and beneficial effects is listed in the table below.

Table 17: Degree of Significance Classifications

| Negative Impacts | | |
|-------------------------|------------|---|
| Significance | Points | |
| Severe | > -75 | An impact which could influence the decision about whether or not to proceed with the project |
| Major | -51 to -75 | An impact which could influence the decision if mitigation is adopted |
| Moderate | -26 to -50 | Impact could influence the decisions about the project if left unmanaged |
| Minor | -10 to -25 | Impact that has very little effect on modification of the project design |
| Negligible | < -10 | Adverse impact which may be ignored in deciding to implement project |
| Positive Impacts | | |
| Significance | Points | |
| Highly Beneficial | >75 | Beneficial impact which strengthens decision to proceed with the project and with no modification of project design |
| Major | 51 to 75 | Beneficial impact which strengthens decision to proceed with project with minor modifications to project design |
| Moderate | 26 to 50 | Beneficial impact strengthens decisions to proceed with project with few modifications of project design |
| Minor | 10 to 25 | Beneficial Impact that needs to be taken into account in overall decision making to implement project |
| Negligible | < 10 | Beneficial Impact which may be ignored in deciding to implement project |

5.2 Key Project Activities

The key activities for the NMFC proposed development are as follows:

1. Nursery Establishment
2. Landscape Planning
3. Creation of Special Management Zones (*Cliff edges and Rocky outcrops, wetland and riparian strips, archaeological/cultural sites, indigenous species and forests, conservation areas*)
4. Site and Tree Species matching
5. Road Construction and Maintenance
6. Land Clearing and Preparation
7. Soil Preparation
8. Slash Management
9. Planting of Trees
10. Weed Control
11. Thinning and Maintenance
12. Harvesting and Felling
13. Forest Fire Management
14. Establishment of Sawmill and Timber Treatment Plant
15. Labour and Staff recruitment

The environmental sensitivities likely to be affected by the proposed development activities have been identified by evaluating the impact of **each** NMFC project activity on **various** environmental and social economic conditions. This is because each key NMFC activity is likely to impact a number of environmental/social factors. The key NMFC activities and their respective likely impacts are listed below; and subsequently each is described.

5.3 Key Project Activities and Likely Impacts

Nursery

- Impact on groundwater

Landscape Planning

- Impact on Land use
- Impact on harvesting plans and landscape visual aesthetics
- Impact of poorly managed slash on landscape

Creation of Special Management Zones (*Cliff edges and Rocky outcrops, wetland and riparian strips, archaeological/cultural sites, indigenous species and forests, conservation areas*)

- Impact on Protection of biodiversity rich and unique habitats
- Impact on Protection of indigenous natural forest species

- Impact on Reduction of wetland water levels by trees with high water absorption rates
- Impact on Protection of cultural and archaeological sites

Site and Species matching

- Impact on Soil nutrients
- Impact on changes to soil physical properties
- Impact on micro-climate conditions
- Impact of colonisation by invasive species
- Impact on food sources for fauna

Road construction and maintenance

- Impact on soil erosion
- Impact on surface run off
- Impact on impoundment of streams
- Impact on quality of water bodies
- Impact on noise pollution
- Impact on air quality
- Impact on vegetation
- Impact on access to reserve

Land Clearing

- Impact on vegetation and canopy cover
- Impact on fauna habitats
- Impact on biodiversity
- Impact on soil erosion
- Impact on recharge of aquifers
- Impact on soil nutrients
- Impact of material transport into water-bodies
- Impact on illegal plantain and maize farms
- Impact on livelihoods of illegal and migrant farmers

Soil Preparation

- Impact on Soil nutrient enhancement/degradation from use of chemicals
- Impact on Soil erosion
- Impact of sedimentation on nearby water bodies

Slash Management

- Impact of Slow release of nutrients into soils
- Impact on soil moisture
- Impact of smoke inhalation by workers and surrounding settlements
- Impact on fire ignition and spread
- Impact on Soils

Planting of trees

- Impact on the development of micro climates
- Impact on alteration of reserve landscape
- Impact on employment and sub-contracting of farmers
- Impact on Inter-cropping by local farmers

Use of agro-chemicals

- Impact on soils, water bodies and aquatic life
- Impact on eutrophication
- Impact on health and safety of workers
- Impact on wildlife population

Thinning and Maintenance of Tree Stands

- Impact of fire risk from dry fuel matter
- Impact on soil compaction and erosion
- Impact on sedimentation run-off into water bodies

Harvesting and Felling

- Impact on corridors used by fauna
- Impact on flora
- Impact on soil compaction and erosion
- Impact of noise from harvesting machinery
- Impact of dispersal of dust from use of roads
- Impact on landscape aesthetics
- Impact of increased fire risk from dry fuel matter (twigs, leaves, branches, bark etc)

Forest Fire Management

- Protection of potential stakeholder revenues from forest outputs
- Protection of workers livelihoods
- Health of the local communities
- Support regeneration of the reserve
- Protection of wildlife habitats and fauna

Establishment of Sawmill and Treatment Plant

- Impact on employment
- Impact on skills development and training
- Development of support industries and services
- Impact from economic migration of people from outside project area seeking jobs, housing and social amenities

Labour and Staff recruitment

- Impact on employment
- Impact on income generation for workers
- Impact on gender balance in employment

Stool Stakeholder Interests

- Monitoring and Management of the Reserve
- Revenue earning streams from forest outputs for stool landowners
- Distribution of financial benefits amongst 3 stool land owners
- Employment and well being of young people
- Training and skills development of local populace
- Development of a vocational training centre
- Poverty alleviation
- Health and welfare

Squatter Farmers and Herdsmen Interests

- Farming and Cattle Grazing in Reserve
- Permission for Inter-cropping on reserve lands

Forestry Services Division

- Reforestation of the reserve to meet landowner and local aspirations.
- Management and Monitoring of the Reserve.
- Uncontrolled spread of illegal settlers entering the reserve.
- Management and Control of Fire

Wildlife Division of Forestry Commission

- Spread of Uncontrolled Farm Fires
- Impact of Agrochemicals and Spent Oils Discharged on Fauna
- Poaching of Game by Local Communities and workers of NMFC
- Damming of Water Courses for Irrigation.

Water Resources Commission

- Establishment of Buffer and Riparian Strips
- Controlled Use of Chemicals and Monitoring
- Controlled Use of Water Systems
- Surface and Underground Water Pollution
- Underground Water Re-charge

Asante-Akyem North District Assembly

- Creating Employment Opportunities In Agogo
- Integration with regional and local development plans.

Agogo Presbyterian District Hospital

- Support for upgrading of Ananekrom health centre
- Obtaining advance knowledge of likely forestry accidents and causes
- Obtaining occupational health hazards information pertaining to use of forest tools, machinery and use of agro-chemicals
- Development of a waste disposal management strategy for Agogo

Description of Potential Impacts from the NMFC Proposed Project Activities

5.4 Establishment of a Nursery

5.4.1 Impact on Groundwater and Rivers

The nursery requires approximately 50,000 litres a day (0.5litres/second of groundwater extraction) at peak production. According to Water Use Regulations Act of Ghana (L.I.1692), groundwater extraction less than 5litres/sec requires NMFC to only register its use of a borehole with the Water Resources Commission. During the start-up phases, NMFC estimates the use of approximately 25,000 litres from a borehole for irrigating seedlings. The average groundwater recharge per annum from the Boumfum reserve nearby is 300,000 m³ per annum. The nursery is expected to operate for a period of 5 years; and after 2022 produce seedlings for approximately 1500ha annually. Assuming that the pumping from the bore hole is continuous for 5 months per year, this will take only about 3% of annual groundwater recharge. NMFC has already approached the Water Resources Commission to register the bore hole and is in the process of receiving all relevant water permits for use of groundwater from the bore hole. NMFC does not make use of any water from the nearby Ongwam river; as the risk of water contamination from upstream sources could pose a serious threat to the survival its seedlings.

The impact of the nursery activity on groundwater is rated as negative, direct, reversible, site only and short term; the potential consequence is small; with probability of the impact occurring rated as medium low (20-40%) The degree of significance of the impact is therefore rated as Minor.

| <i>Use of Groundwater and Rivers</i> | <i>Points</i> |
|--|---------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -16 |
| <i>Overall Adverse Impact Rating</i> | <i>Minor</i> |

5.5 Landscape Planning

5.5.1 Impact on Land Use

The NMFC proposed development has the potential to affect land use patterns in the reserve. The reserve is severely degraded; with little remnants of the old forest remaining. Currently, land use patterns are primarily limited to agriculture and cattle grazing activities by illegal migrant farmers. This activity contravenes the land use conditions for which the reserve was established – *forestry and small community farming*. With the Forestry Commission actively promoting the development of commercial plantations by serious minded investor groups, it

is likely that plantation establishment successes achieved by the project will attract the attention of other investors. This will lend more support for reforestation of the reserve; a much desired objective of the Stool landowners and the Forestry Commission.

The impact of landscape planning on land use is therefore positive, direct and irreversible, local, permanent. The probability of this impact occurring is rated as medium high (60-80%) with a potential consequence rating of great. Generally, the degree of significance of the impact on land use is therefore rated as Highly Beneficial.

| <i>General Land Use</i> | <i>Points</i> |
|--|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>85</i> |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.5.2 Expansion of Ananekrom

There is a specific potential negative impact on land use in and around the town of Ananekrom, located on the far eastern corner of the reserve. At the time of the creation of the reserve in the 1920's, Ananekrom was a very small town located just inside the reserve. However, due to population growth over the last thirty years, the town has outgrown its original boundary areas and has now expanded into compartments 152 and 155 within the reserve. These compartments were allocated to NMFC by the Forestry Commission as part of the 5000ha allocated to the company in 2010 for plantation development.

However, subsequent field visits reveal that what was thought to be unencumbered Forestry Commission land for NMFC's plantation development; has already been encroached on by the town and residents of Ananekrom. This unauthorised expansion impacts adversely on the planning activities of NMFC for plantation development in the affected compartments. NMFC have therefore concluded that it will not be able to use the lands in the aforementioned compartments due to the nature of expansion and associated developments in Ananekrom.

The Company is therefore in discussions with the Forestry Commission with a view of being allocated replacement compartments in other parts of the reserve. Incidentally, the Agogo Traditional Council has also petitioned the Forestry Commission to consider allocating the affected encroachment compartments of 152 and 155 to the town of Ananekrom for future expansion and development. Both petitions are currently under review by the Forestry Commission.

Therefore, the impact of landscape planning on land use in compartments 152 and 155 near Ananekrom is negative, direct, irreversible, local, permanent, but the probability that

this impact is likely to occur is however rated as low (0-20%) with a potential consequence of hardly any; as NMFC has no intention of using the affected compartments for plantation development. The degree of significance of the impact is therefore rated as Minor.

| Land for Expansion of Ananekrom | Points |
|--|---------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | 0 |
| Probability of Occurrence (Pr) | 1 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -14 |
| <i>Overall Adverse Impact Rating</i> | <i>Minor</i> |

5.5.3 Impact on Harvesting and Slash Management

Every landscape has a distinctive character (e.g. stony desert versus closed canopy forest). Any agro-forestry activity placed in that landscape will contrast or blend with the character of the landscape, and NMFC aims to manipulate these variables for positive and harmonious landscape effect.

Poor landscape planning and harvesting can have a detrimental effect on the reserve. The reserve is already seriously degraded. The virtual absence of trees in the open degraded landscape is such that in its current form, the reserve is subject to wild fires fuelled by the lack of trees to act as wind breaks and provide moisture in tree undergrowth and below tree canopies. If the present openness of the reserve is allowed to remain, then increased winds are likely to be encountered within the reserve and surrounding areas. In the event of any fires, these winds will fuel fire spread, resulting in increased smoke generation and the attendant consequences of lowering the air quality and risks to the health of the local surrounding populace. Similarly, poorly managed slash (*debris of small leaves, twigs and branches*) from harvesting operations can contribute to negative perceptions and should therefore be avoided at all costs. Slash can also be a source of fire ignition and fire spread.

The impact is rated as positive, direct, reversible, local and long term. The potential consequences are rated as considerable and probability of the impact occurring is high (80-100%). The degree of significance of impact is rated as Major.

| Harvesting and Slash Management | Points |
|--|------------------------------|
| Impact Description (Id) | 4 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 3 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 55 |
| <i>Overall Positive Impact Rating</i> | <i>Major Benefits</i> |

5.6 Management of Special Zones (Cliff edges, Rocky outcrops, wetlands and riparian strips, archaeological/cultural sites, indigenous species, conservation areas)

5.6.1 Protection of rich biodiversity habitats

The reserve possesses some cliff and rocky outcrops which contain high biodiversity habitats which need to be protected. These include habitats for snakes, grass-cutter, lizards, ants and some birds. This is particularly present in some of the Block G compartments. In the absence of proper management of biodiversity habitats, there is a danger that such habitats are ignored and/or poorly managed or damaged. Currently, there are no known management interventions and visible physical buffers to protect these habitats. This leaves them open to damage and exploitation by locals. The proposed NMFC development intends to zone off the cliff and rocky outcrop areas by creating a buffer 30 metres from the occurrence of such outcrops and to facilitate the management and protection of these outcrop areas. These zones will not be subject to any tree planting activity.

The impact is rated as positive, direct and irreversible, with a site only scale of impact and of permanent duration. The potential consequences are great and the probability of the impact occurring is medium high (60-80%). The degree of significance is rated as having Major Benefits.

| <i>Protection of rich biodiversity habitats</i> | <i>Points</i> |
|--|-----------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 1 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>64</i> |
| <i>Overall Positive Impact Rating</i> | <i>Major Benefit</i> |

5.6.2 Protection of indigenous natural forest tree species

Most of the indigenous trees have been extracted by commercial logging or destroyed by the forest fires. This has contributed to the degraded state of the reserve. However, field surveys have revealed small pockets of indigenous trees dotted all over the reserve and within NMFC allocated compartments. These include *Sterculia*, *Moraceae*, *Triplochiton*, *Terminalia*, *Bombax* and *Ceiba*. NMFC proposes not to touch these and other indigenous tree species as they provide habitats for a variety of fauna and play a major role in maintaining and restoring the character of the reserve. Where these trees occur in large clusters, it is proposed to create conservation zones. In addition, NMFC proposes to re-introduce some of these indigenous species (via seedlings from FORIG, Ghana) to assist in restoring some of the natural characteristics of the reserve.

The impact is rated as positive, direct and irreversible; local and permanent in duration. The potential consequences of such an impact are rated as small. The probability of this impact occurring is high (80-100%). The degree of significance is rated as being Highly Beneficial.

| <i>Protection of Indigenous Tree Species</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 80 |
| <i>Overall Impact Rating</i> | <i>Highly Beneficial</i> |

5.6.3 Wetlands and Riparian strips

Wetlands and riparian strips are sensitive areas because of their proximity to water bodies, contribution to protection of biodiversity and support of wildlife habitats. NMFC's operational plans to protect riparian strips meet the guidelines of the Water Resources Commission. However, planting of trees with high evapo-transpiration rates close to wetlands could affect water tables and their contribution to maintaining such wetlands. Various forest expert viewpoints have been expressed on the effect of Eucalyptus trees on hydrology:

“Eucalyptus plantations in several countries have been the subject of criticism because of their high water use and other negative environmental impacts. Examination of the evidence for these claims has usually concluded that well-managed plantations are beneficial rather than detrimental to the environment” (Poore and Fries 1985, White et al. 1995, Casson 1997).

In reality, there is not enough evidence to support this. The roots of fast growing Eucalyptus species will create cracks in the rocky areas of the Boumfum reserve for higher groundwater recharge rates to compensate for water absorbed, while slow growing ones will have a limited water absorption rate. The results of studies on water usage by Eucalyptus are mixed and dependent on the type of Eucalyptus species used. In Tanzania, China, Brazil, Australia, Indonesia and South Africa, *Eucalyptus urophylla*, *alba*, *deglupta* and *camaldulensis* and its hybrids are the major plantation species being planted today.

Despite the worldwide success of *Eucalyptus* in many countries, it is expected that large plantations of *Eucalyptus* close to riparian strips could reduce wetland water levels depending on the species and growth rates; and are generally not recommended in close proximity to such areas.

This impact is rated as negative, direct and reversible, local with long term duration. The potential consequence is rated as considerable with the probability of the impact occurring rated as medium (40-60%). The degree of significance is rated as moderate.

| <i>Wetlands and Riparian Strips</i> | <i>Points</i> |
|--|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-36</i> |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.6.4 Protection of archaeological and cultural sites

Following the scoping assessment and field surveys conducted as part of the main assessment, no archaeological or cultural sites have yet been located in any of the NMFC allocated compartments. It is however noted that some shrines do exist outside the reserve near Block D. In the event that such sites are later found, NMFC proposes to create a 5m exclusion buffer zone around such sites. If it is determined that tree planting operations will affect such sites, provision is made in NMFC operational plans to increase the buffer distance accordingly.

This potential impact is described as positive, direct and irreversible, local and permanent. The potential consequence is described as small. The probability of the impact occurring is rated as medium high (60-80%). The degree of significance of the impact is therefore rated as being a major benefit.

| <i>Protection of archaeological and cultural sites</i> | <i>Points</i> |
|--|-----------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>64</i> |
| <i>Overall Positive Impact Rating</i> | <i>Major Benefit</i> |

5.7 Site and Species Matching

5.7.1 Soil Nutrients

Soil nutrient is indicated by the chemical properties of the soil. Following soil testing, the chemical properties indicate general low levels of soil nutrients, especially organic matter, nitrogen, calcium, magnesium and potassium. Most often top soils serve as the nutrient reservoir; holding and releasing nutrients into the soils. In the Boumfum forest reserve where the topsoil (0-20cm) indicates low nutrient status, this may be explained by a number of factors such as:

- a. Continuous cropping by illegal settler farmers mining the soil of nutrients without replenishment and
- b. The loss of nutrients of the top soils through erosion and leaching

With the soils already depleted of nutrients, implementing the project without embarking on soil nutrient improvement measures will result in aggravating the current nutrient status. However, the pH levels and general soil conditions are suitable for both Teak and Eucalyptus; albeit some compartments may need some soil enrichment activities to promote better tree growth.

The NMFC project is expected to reduce or eliminate the problem of soil mining by initially embarking on soil improvement measures by the application of fertilizers or poultry manure to enhance plant growth. After the Teak and Eucalyptus trees are well established, leaves fall and their decomposition will create environmental and soil conditions that will build up the nutrient status as well as improve the soil's capacity to hold nutrients and moisture.

The potential impact is rated as negative, direct, reversible; local, short term with considerable potential consequences. The probability of occurrence is medium high (60-80%). The degree of significance of the impact is therefore rated as moderate.

| <i>Site and Species matching on soil nutrients</i> | <i>Points</i> |
|--|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>- 40</i> |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.7.2 Changes to Soil properties

Soil depth, structure and drainage are essential soil physical properties for tree growth. With the development of the project, conditions may be created to affect the above mentioned physical properties of the soil. Soil depth can be improved by the micro-climate conditions that would be created by the established Teak and Eucalyptus trees to promote weathering and decomposition of regolith material. Biomass falling to the ground would decompose to improve on soil structure. By planting Eucalyptus in poorly drained sites, the species will improve on the drainage conditions of such sites. This is contrary to the misconception that Eucalyptus reduces groundwater level. Studies have shown that Eucalyptus is rather more efficient in the use of water, making use of more water where the water table is high and adjusting its demand when conditions are dry (Munishi, 2007).

The impact of Site and Species matching on the soil properties is rated as positive, direct, reversible, local and permanent. Potential consequences are great with the probability of occurrence rated as high (80-100%). The degree of significance is therefore rated as major.

| <i>Site and Species matching on soil properties</i> | <i>Points</i> |
|--|----------------------|
| Impact Description (Id) | 4 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>65</i> |
| <i>Overall Positive Impact Rating</i> | <i>Major</i> |

5.7.3 Colonisation by invasive species site species

Some plant species introduced as exotics for forest plantation activities have the tendency to produce prolific natural regeneration when they start producing seeds. These seeds can be dispersed by air and birds into other areas in the reserve. This may result in a negative and undesired spread and colonisation by such species. It is therefore always difficult and expensive to eliminate invasive species. However, the *Eucalyptus* and *Tectona grandis* species to be planted by NMFC are not known to have such prolific natural regeneration. Both of these species have been used previously by the Forestry Commission on various planting sites around the country and are therefore not deemed likely to invade the areas within and outside NMFC allotted areas in the Boumfum reserve.

The impact by invasive species is rated as negative, indirect and irreversible. Its magnitude is local. The duration is deemed to be long term and the potential consequences are great. The probability of occurrence is however low (0 – 20%) and the degree of significance of the impact is therefore rated as Minor.

| <i>Colonisation by invasive species</i> | <i>Points</i> |
|--|----------------------|
| Impact Description (Id) | -6 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 1 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-15</i> |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.8 Road Construction and Maintenance

5.8.1 Soil erosion

Access into the compartments will have to be created; making road construction and its maintenance a very important component of the proposed project activities. During road construction or maintenance, the topsoil is excavated with the intention of getting to the firm and compacted subsoil to support vehicular movement. The compacted road surface will result in high run-off and eventually induce erosion with potential serious impact on the water quality on any nearby water bodies. During the erosion process, soil particles (topsoil) are removed by run-off and the soil material is transported down slopes and deposited in the lowlands. Rills and gullies may be created as a result of this. The deposited material ending up in streams and rivers result in siltation and consequently facilitate the drying up of water in the channels. Some vegetation and biodiversity would be lost in the process of the road construction. Also surface run-off potential and material transport in water bodies will be high.

The impact is rated as negative, direct and irreversible. Its magnitude is local and confined to the roads and its immediate environment. The impact is long term and the potential consequences are great. The probability of occurrence is medium high (60 – 80%) and the degree of significance of the impact is therefore rated as Major.

| <i>Soil Erosion from Road Construction and Maintenance</i> | <i>Points</i> |
|---|---------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-68</i> |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.8.2 Surface Run Off

Road construction is a major cause of surface water run-off which could result in severe erosion if not well managed. The run-off is as a result of surface compaction created by the heavy construction machines. The run-off could cause soil erosion.

The impact is rated as negative, direct and irreversible. Its magnitude is local and confined to the roads and its immediate environment. The impact is long term and the potential consequences are great. The probability of occurrence is medium high (60–80%); the degree of significance of the impact is major.

| <i>Surface Run Off From Road Construction</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -68 |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.8.3 Impoundments of seasonal streams

Channels of many seasonal streams may be blocked during forest road construction if care is not taken by NMFC to install culverts or suitable outlets for water flow during rainy season. This can affect the flow into the main rivers and also create local waterlogged situations around the impounded area that may also impact on tree growth and survival. It may also result in the creation of breeding sites for mosquitoes.

This potential impact is rated as negative, direct, reversible, local and permanent. The potential consequences are considerable with the probability of occurrence rated as medium (40-60%) The degree of significance is therefore rated as moderate.

| <i>Impoundment of seasonal streams from road construction</i> | <i>Points</i> |
|--|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -36 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.8.4 Contamination of water bodies

The NMFC project will involve some road construction and maintenance. These activities are likely to result in some forest machinery crossing some temporary and permanent water channels. The turbid water with its suspended soil particles will affect the water quality of streams inside and outside the reserve as the water flows.

The impact is negative, direct and reversible and local. It is short term and potential consequences are considerable. The probability of occurrence of this impact is high (80-100%). This is rated as of moderate degree of significance.

| <i>Contamination of water bodies from road construction</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -45 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.8.5 Noise pollution

The NMFC road and construction activity will inevitably involve the use of forest machinery and power tools. These will generate some minor noise and may result in some minor inconvenience for workers who operate such machinery. As part of its field operations, NMFC ensures that noise abatement devices such as earphones and earplugs are worn by all operatives who operate machinery. In any event, operations involving forest machinery will be intermittent and very short term and therefore any health related effects from machinery noise are very minimal. From a community perspective, the nearest settlements are typically about 4-5km away from NMFC allocated compartments. These distances are such that sound and/or noise emanating from forest operations are barely audible.

The impact of the proposed activity on noise is negative, direct and reversible, the scale of the impact is site specific and duration is short term. Potential consequence is rated as small and temporary. The probability of the impact occurring is rated as medium low (20-40%). The degree of significance of the impact is therefore rated as minor

| <i>Noise Pollution from Road Construction</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | 0 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -14 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.8.6 Dust Dispersion

Dust generation will vary according to the source used to generate the dust and the velocity and frequency at which the source is used. Large scale earth moving equipment such as road graders, caterpillars and tipper trucks used in the construction of roads and are likely to generate more dust than a small tractor plough used to prepare land. The amount of dust generated is directly related to the intensity of use, speed of the equipment and the general compactness of soils; as well as prevailing weather conditions at the time. Dry environments will generate significantly more dust than moist/damp environments. NMFC activities will generate some temporary levels of dust, albeit in small quantities, when construction is done

in the dry season. This will be caused by the use of road construction machinery. The dust generated will be temporary and the quantities are insufficient to pose any major health risks. NMFC provides its field workers with dust masks and protective gear as part of its field operations. Road construction will not be an all year round activity and will be carried out in the early stages (1-3yrs) of the project; after which a less intensive road programme is adopted to maintain the roads.

The impact is rated as negative, direct and reversible, the scale of impact is site specific, and the duration is short term. The potential consequences of the impact are small and probability of the impact occurring is medium (40-60%). The degree of significance is therefore rated as minor.

| <i>Dust Dispersion from Road Construction</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -24 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.8.7 Clearing of vegetation

NMFC proposes to construct some new roads as part of its operations and there will be an inevitable clearing of land vegetation that falls within designated road corridors and their alignment with the topography of the reserve. This will result in displacement of some fauna and flora from their natural habitats; even though most of the fauna in the reserve have migrated to the Wildlife Sanctuary as a result of the degraded state of the reserve. Furthermore, the cleared vegetation, if not disposed off properly, can also be a source for fire ignition and fire spread.

This impact is negative, direct and irreversible. The scale of impact is site specific and duration is permanent. The potential consequences are small and the probability of the impact occurring is rated as medium (40-60%). The degree of significance of the impact is therefore rated as Moderate

| <i>Road Construction on vegetation clearing</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -48 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.8.8 Unauthorised access to reserve

The construction of new roads has the potential to open up the reserve to illegal and unauthorised access. This can lead to undesirable activities such as illegal establishment of plantain and maize farms, cattle grazing, poaching of game and illegal logging of remnant trees from the old forest being conducted within the reserve.

The impact of road construction on access to the reserve is rated as negative, indirect and irreversible. The scale of impact is local, medium term and has a potential consequence rated as considerable. The probability of this impact occurring is rated as medium (40-60%). The degree of significance is therefore rated as moderate

| <i>Road Construction on unauthorised access to the reserve</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -6 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -3 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -39 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.9 Land Clearing

5.9.1 Clearing of vegetation and flora

The plantation establishment process by NMFC will require the complete removal of **some** existing vegetation cover. This leaves clear land surface for land zoning and land planning activities. It also implies that all plant material in the form of trees, shrubs and herbs including grasses will be removed in some areas through slashing, lopping and stumping. This represents a potential loss of representatives of plant species occurring on the cleared site.

The impact of land clearing on vegetation and flora is rated as negative, direct and irreversible. The impact is site specific, short term and has a potential consequence rated as considerable. The probability of this impact occurring is rated as high (80-100%). The degree of significance is therefore rated as Major.

| <i>Land Clearing on loss of vegetation and flora</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -3 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -70 |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.9.2 Disturbance of wildlife habitats, food and biodiversity

Even in its degraded form, the trees, shrubs, herbs and grasses in the Boumfum reserve form important source of food for the wildlife found in and around the NMFC site. Even though most of the wildlife has migrated to the more forested conditions in the nearby Bomfobiri Wildlife Sanctuary, clearing of the vegetation is likely to limit the diet variability available to the small quantities of wildlife that remain or occasionally visit the reserve for food. This disturbance can result in changes to fauna behaviour patterns (dwelling, feeding, breeding, daily and seasonal movements etc). The aggregated effects could result in decline in fauna population or permanent absence of species very sensitive to habitat disturbance.

Biodiversity is described in terms of floral and fauna diversity. The reserve is already degraded as a result of over exploitation of trees, widespread fires, illegal farming activities and loss of flora and fauna biodiversity. The land clearing will create unfavourable conditions for the habitats of some micro and macro organisms. The progressive clearing of vegetation across the landscape gradually affects the frequency and distribution of species between cleared and areas not cleared and consequently the biodiversity over time.

This potential impact is rated as negative, direct and reversible. The magnitude of the impact is deemed to be site specific and of permanent. The potential consequences are small. The probability of the impact occurring is rated as medium (40-60%). The degree of significance of the impact is rated as Moderate.

| <i>Land Clearing on wildlife habitats, food and biodiversity</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -42 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.9.3 Soil erosion and depletion of soil nutrients

Soil erosion is inevitable due to the steep slopes and sandy nature of the topsoil. Land clearing will expose the soil to the first few rains which could trigger off erosion. The process of the erosion involves the removal, transportation and deposition of soil material. The topsoil is usually the store-house of soil nutrients and therefore, nutrients are washed away during the erosion process. The soil therefore becomes impoverished under continuous erosion. However, under the NMFC proposed project, clearing will be by slashing and the cleared material (thrash) is left on the surface to decompose and then mixed into the soil to act as soil nutrient. The land therefore is not left completely bare. Erosion under this condition is slight to moderate until weeds grow to give a cover. The process would be

repeated for the initial few years (about 2 – 3 years) when the tree canopy would begin to form to give some cover.

The impact of the erosion and soil nutrient loss is negative, direct, reversible and local. It is short term. The potential consequence is considerable with a medium (40-60%) probability of occurrence. The degree of significance of the impact is rated as moderate.

| <i>Land Clearing on soil erosion and soil nutrients</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -30 |
| <i>Overall Impact Rating</i> | <i>Moderate</i> |

5.9.4 Recharge of Aquifers

Land clearing is normally carried out during the dry months. This NMFC activity will expose the soil to increased evaporation if the vegetative cover acting as mulch is removed for seedling planting. Initial rains cause surface sealing and thus reducing soil permeability. The reduced surface water infiltration, increased surface runoff and dryness of the soil increase the soil and artesian moisture deficit between monthly precipitations. Subsequently, groundwater recharge is reduced, increasing surface runoff to valleys and streams. NMFC proposes to give the plant lines a 2m secondary tillage to reduce surface sealing of soils and thus allow for improved soil permeability.

The impact is negative, direct and reversible. The effect is restricted to sites alone, and of short term duration. However, the potential consequences are small and temporal. The probability of occurrence is medium low (20-40%). The degree of environmental significance is therefore rated as moderate.

| <i>Land Clearing on Recharge of Aquifers</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -26 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.9.5 Material transport into water-bodies

Land clearing is normally carried out in the dry months where wind speeds range from 1.3 - 2.2 m/s. This involves the removal of soil material, which may be transported and deposited

in rivers and streams occurring at the bottom of slopes. The transported material normally consists of soil particles, organic debris and chemical elements contained in the soil. The organic debris is then likely to float on the surface of the water and get deposited elsewhere. The debris then dries out and some may be blown into stream and dry valleys. As the rainy season begins, the debris will decompose to reduce oxygen content for aquatic organisms. The chemical elements are then diluted with the water and flows away, while the soil particles, particularly sand, do not travel far and get deposited on the river bed. These deposits could either raise the bed of the affected rivers. This results in flooding during rains or silting and drying up of small streams. However, in the case of NMFC, vegetative material is not removed from the site but rather mixed with the top soil layers to improve organic matter and essential nitrogen. Also the planned establishment of a vegetative buffer zone of 10 metres from the water bodies by NMFC will significantly minimize the transportation of material into them.

The potential impact is rated as negative, direct, and irreversible. It is also local and permanent. The potential consequence is considerable with a low (0-20%) probability of occurrence. The degree of significance is rated as minor.

| <i>Land Clearing on Material Transport into water bodies</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 1 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -16 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.9.6 Eutrophication

Land clearing can result in a lot of plant debris. These may be blown into streams river valleys and later carried out into main surface drinking water. Most of the transported plant debris will decompose to add dissolved organic matter into the water bodies. This tends to reduce oxygen content for aquatic organisms.

The impact is negative, direct, reversible, restricted to the locality and short term. The consequence is considerable with medium (40-60%) probability of occurrence. The degree of environmental significance is moderate.

| <i>Land Clearing on Eutrophication</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -30 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.9.7 Seasonal Flooding

The two rivers Ongwam and Boumfum flood during the rainy season. The variability of flood magnitude is much greater for ephemeral stream channel flows compared to perennial stream systems of the Ongwam and Boumfum rivers. The steep nature of channel slopes enhances the generation of flash floods. Clearing large tracts of land without adequate control measures to slow down surface runoff will cause temporary floods within the flat valleys.

The impact is rated negative, direct, irreversible, local, short term with considerable potential consequences. The probability of occurrence is high (80-100%). The degree of significance of the impact is rated as Major.

| <i>Land Clearing on seasonal floods</i> | <i>Points</i> |
|--|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-70</i> |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.9.8 Aquatic Life

Vegetation clearing, when it happens in close vicinity to water channels, increases runoff and movement of soil and vegetable matter into streams. This debris may be deposited downstream at the spawning sites of fishes or increase the organic matter content of the water to levels detrimental to other aquatic life. During the establishment phase (*first 5 years*) of the NMFC project this is likely to be an annual occurrence. However, NMFC has indicated in its operational plans that it will not conduct land clearing close to water bodies but rather proposes to install 10m buffer zones to protect such water systems and their aquatic life.

The impact of land clearing on aquatic life is negative, direct and reversible. The scale of impact is local and the duration is short term. The potential consequences of the impact are small and the probability of this impact occurring is rated as low (0-20%). The degree of significance is therefore rated as Minor

| <i>Land Clearing on Aquatic Life</i> | <i>Points</i> |
|--|----------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-18</i> |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.9.9 Clearing of illegal plantain and maize farms

Approximately 15% of the allocated NMFC compartments contain plantain and maize farms illegally established by migrant settlers. This has been the source of some tensions between the farmers, Forestry Commission and NMFC. Land clearing in these compartments for plantation development will inevitably result in the destruction of these illegal farms and loss of incomes for the farmers, most of whom are illegal migrant settlers. It is worth noting that the Forestry Commission has recently (June/July 2013) evicted these illegal settlers from the reserve with support from the local stool landowners.

The impact of this activity is negative, direct and irreversible. The scale of the impact is site specific and duration is permanent. The potential consequence is rated as considerable and the probability of this occurring is rated as medium high (60-80%). The degree of significance is therefore rated as Major

| <i>Clearing of illegal plantain and maize farms</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -60 |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.9.10 Livelihoods of illegal migrant farmers

The clearing of lands for plantation development by NMFC will affect the livelihoods of farmers who have established farms in some of NMFC compartments, albeit illegally. This is because most farmers sell the outputs from farms to Agogo and surrounding areas. This land clearing activity could therefore affect the incomes of the illegal farmers and may also impact the supply and availability of plantain and maize in local markets.

The impact of this activity is negative, direct and irreversible. The scale of the impact is site specific and duration is permanent. The potential consequence is rated as considerable and the probability of this occurring is rated as medium high (60-80%). The degree of significance is therefore rated as Major

| <i>Land clearing on Livelihoods of illegal farmers</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -60 |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

5.9.11 Control of illegal migrant farmer activities

During the scoping assessment, the consultants were made aware by the Forest Services Division of the Forestry Commission; of their intention to evict illegal settlers from the reserve; after providing them with three months notice to leave. Following recent field visits as part of the main assessment, it was noted that the evictions have been carried out with little resistance from illegal settlers. It is not known exactly where these illegal settlers have moved to. However, all indications from locals suggest they have moved out of the boundaries of the reserve. It must be noted that the stool landowners have supported the eviction of the illegal settlers because of the manner in which they were establishing illegal farms and settlements in the reserve; in contradiction of the land use purpose of keeping the reserve as a forest. The land clearing activity displaces the illegal migrant farmers in the immediate short term. However, it actually helps to limit and control the undesired illegal activities of the migrant farmers in the reserve.

The impact of the activity, taking into account Forestry Commission and Stool landowner rights and wishes; is rated as positive, direct, and irreversible. The scale of the impact is local and permanent. The potential consequences are considerable and the probability of the impact occurring is rated as high (80-100%).

| <i>Land Clearing on Control of illegal migrant activity</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Impact Rating</i> | <i>Highly Beneficial</i> |

5.10 Soil Tillage/Preparation

5.10.1 Soil nutrient enhancement

The project's ultimate benefit to the soil when the trees are established would be the enhancement of soil nutrients as a result of the creation of favourable environments for the soil's macro and micro-organisms. The shade and micro climate provided by the tree canopy will lower temperature, increase humidity; and coupled with the leaf litter on which the organisms will feed, this will provide conditions for nutrient cycling. Furthermore, the soil enrichment fertilizers to be used on the project are Urea and Nitrogen based and will therefore contribute much needed nitrogen and phosphorus to the soils. In addition, michoriza (*a root volume supplement*) will be added to increase root surface volume and the uptake of phosphate. Cover crops such as cow peas for nitrogen fixing will also be introduced to reduce the application of non-organic fertilizer.

Generally, this is rated positive, direct, reversible and local. It is permanent and the potential consequence is great. The probability of occurrence is high (80-100%) with degree of significance rated as major.

| Soil Tillage on enhancement of soil nutrients | Points |
|---|---------------|
| Impact Description (Id) | 4 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 65 |
| Overall Positive Impact Rating | Major |

5.10.2 Soil erosion

The physical properties of the soils indicate that they are highly susceptible to severe erosion as a result of the sandy topsoil and the steep slopes. During the erosion process, soil particles (topsoil) are removed by run-off emanating from rains. The material transported down the slopes is deposited in the lowlands. Rills and gullies may be created while soil nutrients may also be carried away. The deposited material ending up in streams and rivers could result in siltation and consequently facilitate the drying up of water in the channels and even affect domestic consumption. NMFC has recognised this natural phenomenon and by adopting measures such as ridging along contours, controlled ploughing in parallel to contours, mechanical pitting etc, soil erosion will be greatly minimised.

The impact is negative, direct, irreversible, regional in character and permanent. The potential consequences are rated as great. The probability of occurrence is rated as medium (40-60%). The degree of significance is rated as Major.

| Soil tillage on soil erosion | Points |
|---|---------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -3 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -54 |
| Overall Negative Impact Rating | Major |

5.10.3 Contamination of nearby water bodies from sedimentation

During the erosion process, soil particles (topsoil) are removed by run-off emanating from rains and the material transported down-slope and deposited in the lowlands. The deposited material ending up in streams and rivers could result in siltation and consequently facilitate the drying up of water in the channels. The volume of transported materials may be significant particularly with road construction. However with the creation of a vegetative

buffer along rivers and streams as indicated in the Environmental Management Plan of NMFC, most of the sediments and contaminants would be trapped. It is worth noting that currently, most sections of the Ongwam and Boumfum rivers are densely vegetated along the river channels by riparian strips of vegetation; acting as buffers.

This impact is negative, direct, irreversible and local. It is permanent and of considerable potential consequences. The probability of occurrence is medium (40 – 60%) and the degree of significance is moderate.

| <i>Soil tillage on sedimentation of water bodies</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -48 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.11 Slash Management

5.11.1 Smoke inhalation by workers and surrounding settlements

Slash is defined as twigs, branches and small remnants of non-marketable timber. During thinning of plantations and harvesting of trees, slash is a normal consequence of such operations. However, poor management of slash can be a dry fuel source for fire ignition and fire spread. In the event of fire, smoke inhalation can be a trigger source of respiratory diseases such as asthma, breathing problems and other cardiovascular diseases. NMFC, as part of its operational and environmental management plans for its allocated areas, has developed a detailed set of procedures for fire management and prevention; as well as training programmes for its entire field staff.

This impact is rated as negative, direct and reversible. The scale of the impact is local and of short term duration. The potential consequences are considerable and the probability of this impact occurring is medium low (20-40%). The degree of significance is therefore rated as minor.

| <i>Poor Slash management on workers health</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -20 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.11.2 Slow release of nutrients into soils

Under slash management, the slashed material left on the forest floor will provide organic material that will decompose to improve the organic matter status of the soil. This will result in nutrients being held and slowly released into the soil. Release of nutrients into the soil would be rapid due to the sandy nature of the topsoil in the reserve. The topsoil is usually the storage reservoir for the nutrients from where they are released for use by plant species. It is the organic matter that holds the nutrients. The slash will also serve as a protective cover to minimize run-off and erosion.

The impact is rated as positive, direct, irreversible, local, short term. The potential consequences are considerable. The probability of occurrence is medium high (60-80%). The degree of significance is rated as moderate.

| <i>Slash Effect on improving soil nutrients</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 2 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 42 |
| <i>Overall Positive Impact Rating</i> | <i>Moderate</i> |

5.11.3 Soil damage

During slash management, a lot of wood debris and biomass accumulated on the surface serve as material that could potentially cause fire. In the event of such fires, tree canopies may be temporarily lost; resulting in soil exposure and destruction of the soil structure. Soil improvement organisms e.g. earthworms and ants may also be affected. All these affect the general fertility status of the soil.

The impact is rated as negative, direct, reversible, local and medium term. The potential consequences in the event of fire is great. The probability of occurrence is medium low (20-40%). The degree of significance is rated as Minor.

| <i>Parameter</i> | <i>Points</i> |
|---|---------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -3 |
| Potential Consequences (Pc) | -3 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -24 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.11.4 Protection of soil moisture

Soil moisture in the soil is normally held by clay and organic matter content which are low in the soils of the reserve. Alternate means of preserving moisture in the soil is by mulching. This involves providing cover in the form of vegetative thrash or any suitable material that will prevent evaporation of moisture from the soil. Slash management therefore would be a beneficial activity that will provide mulching material to the soil. This will compensate to some extent for unfavourable sandy nature and the low organic matter status.

This impact is rated as positive, direct, irreversible, local, and short term. The potential consequence is great. The probability of occurrence is high (80-100%) and the degree of significance is Major.

| <i>Protection of soil moisture</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 2 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 75 |
| <i>Overall Positive Impact Rating</i> | <i>Major</i> |

5.12 Planting of trees

5.12.1 Development of micro climate

Few years after tree establishment and canopy closure, micro-climatic condition developing as a result, would impact positively on the immediate environment. The various elements of the micro-climate (air/soil moisture, light intensity, air movement, air/soil temperature etc.) at the planting site are expected to change progressively and stabilise when the planted trees have gained their maximum height growth. A unique micro-climate will be created in the plantation that will have beneficial effects on the surrounding environment. The shade effect would lower temperature and the trees would also serve as wind breaks. At a local level, a favourable micro-climate would also be created for wildlife habitat and soil organisms within the established plantations. These benefits will include reduction in wind speed; stabilization of relative humidity and; soil nutrient re-cycling.

This impact is rated as positive, direct, local, reversible and short term. The potential consequence is considerable with high (80-100%) probability of occurrence. The degree of significance of such an impact is therefore rated as Major.

| <i>Development of a micro climate</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | 4 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 2 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 50 |
| <i>Overall Positive Impact Rating</i> | <i>Major</i> |

5.12.2 Transformation of reserve landscape

When the tree seedlings get established and the trees gain significant height growth (15-30m), the forest canopy cover will be transformed from the open patchy forest to continuous canopy. In the wet season the canopy will be closed to give luxuriant horizons of green canopy that will enhance the aesthetic view of the landscape. In the areas to be planted to Teak which is a deciduous tree, the canopy will change from green to grey in the dry season to break the monotony of the green canopy. The resultant effect of this on the overall degraded state of the reserve will be a much desired positive transformation of the landscape.

This impact is rated as positive, direct and irreversible. The scale of impact is local and the duration is short term. The potential consequences could be considerable and the probability of this impact occurring is high (80-100%). The degree of significance of the impact is therefore rated as Highly Beneficial.

| <i>Transformation of Reserve Landscape</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.12.3 Carbon sequestration

Carbon sequestration is closely related to climate change mitigation. Trees and forests are well known to be very efficient carbon storage systems. According to the UN Convention on Climate Change, fast growing tree plantation forests can store approximately 19-20 tons of carbon per hectare per year. With 5000 hectares of plantations to be established, the NMFC plantations can potentially sequester 100,000 tons of carbon per annum.

This impact is positive, indirect and irreversible. The scale of the impact is local and the duration is medium term. The potential consequence of such an impact will be considerable. The probability of this impact occurring is rated as medium (40-60%). The degree of significance is therefore rated as Major Beneficial.

| <i>Carbon Sequestration</i> | <i>Points</i> |
|--|--------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 3 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>65</i> |
| <i>Overall Positive Impact Rating</i> | <i>Major Beneficial</i> |

5.12.4 Inter-cropping by local farmers

NMFC has proposed to allow short-term inter-cropping of certain crops alongside the planting of tree seedlings by local legitimate farmers. These include onions, water melons, and peas. However, there are strict conditions for inter-cropping activities to ensure control of use of herbicides by farmers, choice of crops, preparation of soil beds to minimise soil erosion and run-off into water bodies. This arrangement also encourages the exchange and sharing of inter-cropping information, provides income generation opportunities for bona fide local farmers and strengthens the working relationships between NMFC and farming stakeholders.

The impact is rated as positive, direct and reversible. The scale of the impact is local and the duration is short term. The potential consequences are small and the probability of the impact occurring is medium high (60-80%) The degree of significance of the impact is therefore rated as moderate.

| <i>Inter-cropping by local farmers</i> | <i>Points</i> |
|--|------------------------|
| Impact Description (Id) | <i>4</i> |
| Magnitude (Mg) | <i>2</i> |
| Duration (Dr) | <i>2</i> |
| Potential Consequences (Pc) | <i>1</i> |
| Probability of Occurrence (Pr) | <i>4</i> |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>36</i> |
| <i>Overall Positive Impact Rating</i> | <i>Moderate</i> |

5.13 Use of Agrochemicals for Weed control

5.13.1 Contamination of soil, water bodies and aquatic life

Glyphosate is used for weed control and is administered by spray. This form of application results in the chemical being applied mainly to foliage. It contains phosphorus which is beneficial to the soil. However, poor application and control of use may result in applying high concentrations of the chemical and in some cases spillage. Furthermore, inappropriate disposal of containers can be a source of contamination that can impact negatively on soil organisms and water bodies.

The impact is rated as negative, indirect and irreversible with local impact. The duration of impact is short term, with small or temporary potential consequences. The probability of occurrence is medium (40-60%). The degree of significance is rated moderate.

| <i>Use of Agro chemicals for weed control</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -6 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -33 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.13.2 Aquatic Life

The main agrochemical to be used by the project is a glyphosate weedicide for the control of weeds and Urea-Nitrogen for soil enrichment. It is most likely that some nutrients such as nitrates and phosphorus may be dissolved during rains and through runoff be transported into rivers and streams. The dissolved nutrients encourage excessive growth of aquatic plants and cause eutrophication. This results in depletion of oxygen content in water bodies. Excessive amounts are detrimental to the health of aquatic life including fish. The main rivers in the reserve are used for fishing by the small local communities and therefore any uncontrolled use of chemicals in close proximity to water bodies is likely to affect local communities who use the rivers for fishing.

This impact is rated as negative, direct, reversible, local and short duration. The potential consequence is considerable with medium (40-60%) probability of occurrence. The degree of significance is rated as moderate.

| <i>Aquatic life</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -30 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.13.3 Health and safety of workers

Inappropriate control and use of agrochemicals can affect the health and safety of the workers via inhalation and/or direct contact with the body. This is recognised in the Environmental management plan of NMFC. To ensure proper control and use of such chemicals, NMFC provides protective clothing such as nose masks, boots, helmet and overalls for all staff likely to come into contact with agro-chemicals.

The impact is rated as negative, direct, irreversible and local. It is short term and the potential consequence is considerable. The probability of occurrence is medium (40-60%) and the degree of significance is moderate.

| <i>Use of chemicals on health and safety of workers</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -42 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.14 Thinning and Maintenance of Tree Stands

5.14.1 Soil compaction and erosion

Activities involved in thinning and maintenance of tree stands will include the use of heavy vehicular haulage trucks expected to cause some disturbance to the soil. The potential impact is soil compaction that will be caused by heavy trucks. The compaction will result in run-off and soil erosion.

The impact is rated negative, direct, reversible, local and short term. The potential consequence is considerable with medium high (60-80%) probability of occurrence. The degree of significance is moderate.

| <i>Soil compaction and erosion from thinning and maintenance</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -40 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.14.2 Sedimentation run-off into water bodies

During thinning and maintenance of tree stands, the tree canopy tends to open up. The rain drops from leaves of trees cause detachment of soil particles. Any runoff picks up the detached soil particles and moves them permanently elsewhere as sediments. In the process some fine particles such as clay are carried in suspension into streams. The movement of soil particles by runoff increases with the slope of the land. Permanent land shapes such as rills and gullies may thus be created. This may negatively affect the aesthetics of the reserve landscape. However, the residues from the thinning process will limit sedimentation run-off.

The impact is negative, direct, irreversible, local and permanent. The potential consequences are rated as considerable. The probability of occurrence is medium (40-60%). The activity is therefore rated as Moderate.

| <i>Sedimentation run off into water bodies</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -48 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.15 Harvesting and Felling

5.15.1 Landscape aesthetics

The Boumfum reserve topography is undulating with lowlands and mountain peaks ranging from approximately 130-480m. The reserve is also traversed by many tributaries and intermittent streams of the main Boumfum, Ongwang and Pame rivers. NMFC proposes to limit widespread harvesting of trees by adopting landscape planning, selective harvesting techniques and ensuring that the forest landscape is maintained as far as is practically possible. However, harvesting and felling practices will have an effect in defining the characteristics of the reserve topography by opening up certain compartments for harvesting; albeit this not being expected until the beginning of 2020.

The impact is negative, direct and irreversible. The scale of the impact is local and the duration is permanent. The potential consequences are rated as small and the probability of this impact occurring is rated as medium (40-60%). The degree of significance of the impact is therefore rated as Moderate.

| <i>Harvesting and Felling on Landscape aesthetics</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 45 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.15.2 Damage to corridors used by fauna and Loss of flora

The NMFC reforestation project will result in the creation of desired habitats and corridors for fauna. However, there will be some harvesting of some of the trees to realise the economic value of the project. Harvesting and felling activities will result in the use of

harvesting equipment like harvesters and chain saws. This activity will interrupt the corridors used by fauna in the short term and also result in some loss of flora from the forest floor.

This is a negative impact, direct and reversible. The impact scale is site specific and the duration is short term. The probability of this impact occurring is High (80-100%) and the potential consequences are considerable. The degree of significance of the impact is rated as Moderate.

| <i>Damage of fauna corridors and loss of flora</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -40 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.15.3 Soil compaction and erosion

Harvesting activities require the use of machines like tractors, harvesters, haulage trucks etc. The use of such machinery would disturb the soils in the harvesting area and the routes for transportation of harvested materials. The heavy machines would definitely compact the soil which, as a result, will affect soil porosity and reduce infiltration. In the event of rain, high run-off would therefore be created and this will cause erosion. NMFC has planned to adopt low impact harvesting methods, which will reduce soil compaction and erosion.

The impact is rated negative, direct, reversible, local and short term. The potential consequence is considerable with medium high (60-80%) probability of occurrence. The degree of significance is moderate.

| <i>Soil compaction and erosion from harvesting</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -40 |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.15.4 Dispersal of dust on workers and community health

Harvesting and felling activities are likely to generate dust from use of harvesting machinery within compartments and log transport machinery using logging roads. This is inevitable and the extent to which roads are properly constructed and compacted will influence the amount of dust generated. The dust, albeit on a very small scale, may affect the health of workers and

operators of forest machinery. NMFC actively enforces the use of dust masks and protective gear during field operations and it is therefore expected that any effects from dust will be very small indeed. From a community point of view, the distances (3-5km) from the project area to the nearest towns are such that there is no anticipated effect on any community.

The impact is rated negative, direct and reversible. The scale of the impact is site only specific and duration is short term. The potential consequence is small with a medium low (20-40%) probability of occurrence. The degree of significance is therefore rated as Minor.

| <i>Dust Dispersal on health of workers and community</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -4 |
| Magnitude (Mg) | -1 |
| Duration (Dr) | -2 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 2 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -16 |
| <i>Overall Negative Impact Rating</i> | <i>Minor</i> |

5.16 Forest Fire Management

The Boumfum reserve has been the subject of many forest fires; with the 1983 fire being one of the worst fires that occurred in the reserve. This was mainly due to the degraded nature of the reserve, absence of trees and torching of land by farmers for agricultural activities. During thinning of plantations, road construction and harvesting of trees, there will be sufficient amounts of slash (*twigs, branches, bark and vegetation*) generated and this can contribute to fire ignition and spread if proper fire management procedures are not observed. A fire management strategy serves to:

- ✓ Support regeneration efforts of the reserve
- ✓ Prevent destruction of wildlife habitats and biodiversity
- ✓ Protect communities from smoke related diseases from forest fires
- ✓ Protects community livelihoods gained from farming and tree planting
- ✓ Protects the long term benefits accruable to stool landowners and the local community from the sale of forest outputs.

NMFC has outlined a fire management strategy as part of its Environmental Management Plan and already has fire fighting equipment and vehicles with water available to quickly tackle incidences of fire if and when they do occur. Whilst the focus is always on fire preventive measures, staff and workers have been trained in fire fighting techniques; in the event that a fire does occur in parts of the reserve.

The impact of a fire management strategy is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%). The degree of significance is therefore rated as Highly Beneficial.

| <i>Fire Management and Prevention</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.17 Establishment of Sawmill and Timber Treatment Plant

5.17.1 Jobs Creation

Subject to plantation objectives being achieved and finding a suitable location, NMFC proposes to establish a timber treatment plant in 2019/2020 to treat small plantation logs for use as electric poles for domestic electrification. This is to support the growing electrification needs of the country. A sawmill is also planned from 2023 to process sawn timber and board material. The proposed treatment plant and sawmill could provide approximately 100 direct jobs for the local populace during the construction of the plants and another 100 once they become operational. The estimated NMFC investment for these two plants is approximately \$5m. It is also anticipated that support industries such as machine tooling, transport and logistics are likely to evolve. This development also has the potential to foster appropriate skills development and training, integration with local and regional development and overall increased economic activity in Agogo and surrounding areas.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Job Creation from Treatment Plant and Sawmill</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.17.2 Migration of people from outside project area for jobs, housing and social amenities

The proposed establishment of a timber treatment plant and sawmill is likely to stimulate increased economic activity in Agogo and surrounding areas. This could spark off migration of skilled and unskilled people into Agogo seeking gainful employment with NMFC or any of the support industries likely to evolve as a result of the NMFC proposed development.

Agogo is a small agro-forestry and fishing town with a total population of approximately 140,500; and already facing housing challenges. Therefore such migration is likely to increase pressure on housing and social amenities.

The impact is rated as negative, indirect and irreversible. The scale of impact will be regional and the duration will be permanent. The potential consequences are great and the probability of this impact occurring is rated as medium (40-60%). The degree of significance is rated as moderate.

| <i>Migration of labour to Agogo from surrounding areas</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | -6 |
| Magnitude (Mg) | -3 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | <i>-45</i> |
| <i>Overall Negative Impact Rating</i> | <i>Moderate</i> |

5.18 Labour and Staff Recruitment

5.18.1 Employment and Income

The NMFC proposed development seeks to employ various workers and staff at different stages of the proposed development. NMFC has estimated that it would seek to directly employ approximately 260 staff at various stages, namely:

| | |
|---|------------|
| ✓ Nursery and Seedlings Development | 40 |
| ✓ Land preparation, planting and management | 100 |
| ✓ Roads and Maintenance | 20 |
| ✓ Office, Admin and Security Staff | 30 |
| ✓ Timber treatment plant | 40 |
| ✓ Sawmill | <u>30</u> |
| | <u>260</u> |

NMFC currently pays its field workers a minimum wage of GHC8.00 per day and confirms that this will be the minimum wage paid to future workers hired by the company. This is significantly higher (53%) than the new (1st May 2013) national minimum wage of GHC5.24 announced by the government and signed by the Minister of Employment and Labour Relations. In addition to the GHC8.00 per day paid to workers, NMFC also provides food and transport for its workers daily.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Employment from Labour Recruitment</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.18.2 Gender Equality

Field surveys and discussions with NMFC have revealed that of the 140 workers currently employed to assist in small land preparation and trials, approximately 48% are women. NMFC is committed to ensuring that women play an active role in its plantation project as far as is practically possible. It is well known that women are best suited for undertaking certain plantation forestry tasks such as preparing seedlings and transplanting in the field. This is a positive move in promoting gender balance and equality; as well as improving the incomes and livelihoods of women.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Gender Balance</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19 Key Stakeholder Interests

5.19.1 Revenue streams from forest outputs for key stakeholders

Traditionally, the stool landowners of Agogo, Kwamang and Kumawu have always shared in the proceeds from forest outputs. This arrangement of benefit sharing is enshrined in the Forest Ordinance (Cap 157), 1927 section 18(1) which provides that the ownership of land is not altered by its declaration as a forest reserve. The landowners therefore have the right to a share of the benefits from both the exploitation and the development of forest reserves. Under the benefit sharing agreement reached with the Forestry Commission, the Landowner is entitled to 6% of the standing tree value (STV) of thinnings and final harvest, the Forestry Commission is entitled to 2% of standing tree value of thinning and final harvest, the Local

community shall also receive 2% of standing tree value of thinning and final harvest. The balance of 90% shall accrue to the plantations investor.

NMFC's plantation development model requires significant investments in capital and equipment in the early years to establish plantations. NMFC is committed to investing over \$10m in the establishment of 5000ha of tree plantations over a five year period. During this period, significant investments are made in plant, equipment, seedlings, forest machinery, labour, subsistence, transport, forest infrastructure and agro-chemicals. After the 6th year, it is expected that some revenues will begin to accrue from thinnings and sale of small diameter logs for electric poles. It is forecast that approximately \$120,000 per annum will initially accrue to benefit sharing partners from 2020 as a result of this. Subject to the proposed development meeting its operational targets and planting objectives up until 2030, this benefit sharing revenue is expected to grow annually and exceed \$10m by 2030. Under the benefit sharing arrangement described above, the project could potentially deliver the following *minimum* annual revenues for the following benefit sharing partners:

| | <u>From 2020 (>\$120,000)</u> | <u>By 2030 (>\$10m)</u> |
|---------------------------|----------------------------------|----------------------------|
| Stool Landowners (60%) | \$72,000 | \$6m |
| Forestry Commission (20%) | \$24,000 | \$2m |
| Local Community (20%) | \$24,000 | \$2m |

It is worth noting that between 2020 and 2030 revenues accruable to benefit sharing stakeholders will steadily grow as a result of increasing revenues from the sale of forest plantation outputs – *logs, lumber, wood chips and wood biomass*.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Stakeholder Revenues from Forest outputs</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.2 Sharing of forest revenues amongst the 3 stool landowners

The NMFC proposed development will pay financial benefits accruable to stool landowners and is defined in benefit sharing agreements between the company and the Forestry Commission. The 3 stool landowners of Agogo, Kwamang and Kumawu are ancestral cousins and as a result of this blood relationship, no stool boundaries exist within the reserve. Financial proceeds are split 3 ways between the stool landowners. Therefore all financial benefits accruable to the 3 stool landowners should be paid to the Forestry Commission, who will arrange disbursement of benefits to the three stools via the Stool Lands Administrator.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Benefit Sharing amongst 3 stool landowners</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.3 Development of a vocational training centre

During deliberations and discussions with stool landowner stakeholders, they expressed their desire to establish a vocational training centre to support the development of vocational skills for the youth in the area. This is an initiative that NMFC supports and as a demonstration of its commitment to social causes and skills development in the area, the company has already provided funds to support the realisation of the said vocational training centre in Hwidiem, near Agogo. The centre is ready for operations in dress making, masonry, plumbing, electrical wiring; in addition to core subjects such as Maths, English and IT.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Development of Vocational Training Centre</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.4 Support for Educational Grants

Stool landowners and community leaders have expressed their desire to have scholarships and educational grants to support deserving youth; with a particular emphasis on forestry, fishing and agriculture. NMFC has committed 1% of its annual budget to support good causes in the Agogo area. These causes will be reviewed on a case by case basis by the company and appropriate support offered where necessary. Whilst NMFC has not specifically committed itself to any scholarships and grants, such a commitment will serve to strengthen community relationships; as well as assist in supporting some of the educational goals and aspirations of deserving students in the Agogo area.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are considerable and the probability of the impact occurring is rated as medium (40-60%) The degree of significance is therefore rated as Moderate.

| <i>Support for local good causes</i> | <i>Points</i> |
|---|------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 3 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 48 |
| <i>Overall Positive Impact Rating</i> | <i>Moderate</i> |

5.19.5 Monitoring and Management of the Reserve

Traditionally, the monitoring and management of the reserve is the responsibility of the Forest Services Division (FSD), Kumawu. However, due to the cessation of commercial logging and recent forest fires, the reserve has been degraded. Coupled with a lack of major activity within the reserve, monitoring and management of the reserve has not been effective, with the resultant effect of illegal migrant settlers and farmers encroaching on the reserve lands. This has been of major concern to the stool landowners who are keen to see more management and monitoring of the reserve by the Forest Commission and its agencies. The NMFC proposed development therefore brings much needed focus, activity and regeneration potential to the reserve. Collaborative efforts between NMFC and the FSD will strengthen the

management and monitoring objectives for the reserve. NMFC operational activities will also serve to inform FSD and stool landowners about various activities and developments in the reserve – poaching of game, illegal settler activities, illegal logging activity, land use for farms, community access to the reserve, use of non-timber forest products etc. All these provide valuable forest use information; essential for management and monitoring of the forest.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Monitoring and Management of the Reserve</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.6 Poverty alleviation and health

According to the UN declaration at the World Summit on Social Development in Copenhagen (1995) extreme poverty is defined as “*a condition characterized by severe deprivation of basic human needs, including food, safe drinking water, sanitation facilities, health, shelter, education and information*”

The NMFC proposed development plays an important role in addressing the basic human needs of its workers. To this end the NMFC provides transport, food and safe drinking water for its workers. By providing gainful employment for its workers, income earned by workers will enable them to improve some of their basic human needs. This is particularly so when the company is paying GHC 2.76 above the national minimum wage of GHC.5.24. Education and awareness programmes for its workers also contribute to alleviating poverty. NMFC has already sensitised its current workers participating in its land trials, on the need to adopt proper basic health and safety practices pertaining to the use of plant and machinery, agro-chemicals, farming tools and handling of materials. In support of its commitment to promoting better welfare of its employees, the company has appointed a Safety, Health and Environmental Quality Manager.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Poverty alleviation and health</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 2 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 80 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.7 Job creation and Demographics

The NMFC project is already having a positive impact on the population and community. NMFC is currently the second largest employer (160 staff) in Agogo, after the Agogo Presbyterian Hospital. Subject to meeting its planting objectives, the NMFC project is hoping to employ an extra 80-100 staff within the next 6-10 years. This is likely to be when it is able to find land and gain the necessary approvals for establishing a timber treatment plant and sawmill. This will have a positive impact on job creation, the major socio-economic objective of the Asante-Akyem North District Assembly. It is also anticipated that this development will lead to the establishment of support industries and the resultant employment that could arise and benefit the local populace.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Job Creation and Demographics</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.8 Limiting Illegal allocation of forest lands to migrant farmers

Field visits and discussions with locals and stool landowners have revealed that some timber companies and individuals who acquired portions of the degraded forest with the objective of establishing private commercial plantations, rather engaged in the illegal practice of allocating portions of the reserve lands to migrant settlers and farmers for financial reward. This explains the presence of abandoned and poorly managed mosaics of old Teak plantations; as well as the presence of illegal plantain and maize farms within the reserve. Therefore the allocation of some of these lands to NMFC for plantation development will

facilitate the ejection of the illegal migrant farmers from the reserve, end these corrupt practices and bring back the degraded area into forest production. This will achieve the desired objective of the stool landowners and the Forestry Commission. Incidentally, recent field visits have confirmed that the Forestry Commission ejected the illegal migrants from the reserve in July and August of this year.

The impact is positive, direct and irreversible. The scale of impact is local and the duration is permanent. The potential consequences of the impact are great and the probability of the impact occurring is rated as high (80-100%) The degree of significance is therefore rated as Highly Beneficial.

| <i>Limiting Illegal allocation of forest lands</i> | <i>Points</i> |
|---|---------------------------------|
| Impact Description (Id) | 8 |
| Magnitude (Mg) | 2 |
| Duration (Dr) | 4 |
| Potential Consequences (Pc) | 3 |
| Probability of Occurrence (Pr) | 5 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | 85 |
| <i>Overall Positive Impact Rating</i> | <i>Highly Beneficial</i> |

5.19.9 Squatter Farming and Cattle Grazing

The degradation of the original forest vegetation into open wood land with growth of grasses has attracted many illegal cattle herdsman and farmers within the Boumfum Reserve boundary and areas allocated to NMFC by the Forestry Commission. These settlers have established illegal plantain and maize farms in the reserve and in areas allocated to NMFC by the Forestry Commission. NMFC had legal proceedings brought against it and two named employees on 25th April 2012, filed by a local Pastor on behalf of 105 plantain farmers claiming GH¢1,400,000 of compensation from the Company for clearing an area of degraded plantain farms. Subsequently, on 3rd July 2012, this claim against the Company was resubmitted by 123 plantain farmers then claiming GH¢1,680,000 of compensation from the Company. It should be noted that NMFC holds an unencumbered land-lease provided by the Ghana Forestry Commission for the establishment of forest plantations; whilst the plaintiffs have no land-lease agreements with the Forestry Commission; the management custodian of the reserve lands. The area claimed to have been cleared by the Company was grossly overstated in excess of 10 times and for which there can be provided no clear evidence of land clearing.

Furthermore, the majority of the plantain farmer names listed on the legal document are unaware of such proceedings and the Company has never encountered more than a handful of plantain farmers during field operation. NMFC has tried to support such farmers in harmony with the Company's forestry operations by offering them alternative employment with the project; but to no avail. The Company's lawyers, Bentshi-Enchill Letsa & Ankomah, have been representing the Company in court. The Forestry Commission have also been

supporting the Company's defence. The case has been in court (for over 10 months) but with little progress. The reason is that the plaintiffs have not filed requisite statement on which the court process is now waiting. The Pastor filing the proceedings is known to have filed a number of similar unsuccessful proceedings against other groups seeking monetary compensation.

The impact is negative, indirect and irreversible. The scale of impact is site specific and the duration is permanent. The potential consequences of the impact are small and the probability of the impact occurring is rated as medium high (60-80%) The degree of significance is therefore rated as Major

| <i>Squatter Farming and Cattle Grazing</i> | <i>Points</i> |
|---|----------------------|
| Impact Description (Id) | -8 |
| Magnitude (Mg) | -2 |
| Duration (Dr) | -4 |
| Potential Consequences (Pc) | -1 |
| Probability of Occurrence (Pr) | 4 |
| <i>Degree of Significance of Impact (Dsig) = (Id+Mg+Dr+Pc) x Pr</i> | -60 |
| <i>Overall Negative Impact Rating</i> | <i>Major</i> |

TABLE 18: SUMMARY OF NEGATIVE IMPACTS

| Project Activity | Impact Parameter | Assessment Scores | Overall Negative Rating |
|---------------------------|--|-------------------|-------------------------|
| Establishment of Nursery | Use of Groundwater | -16 | Minor |
| Landscape Planning | Land use by town of Ananekrom | -14 | Minor |
| Landscape Planning | Wetlands and Riparian strips | -36 | Moderate |
| Site and Species Matching | Soil nutrients | -40 | Moderate |
| Road Construction | Soil erosion | -68 | Major |
| Road Construction | Surface Run Off | -68 | Major |
| Road Construction | Impoundments of seasonal streams | -36 | Moderate |
| Road Construction | Contamination of water bodies | -45 | Moderate |
| Road Construction | Noise Pollution on workers | -14 | Minor |
| Road Construction | Dispersal of dust | -24 | Minor |
| Road Construction | Clearing of vegetation | -48 | Moderate |
| Road Construction | Increased access to the reserve | -39 | Moderate |
| Land Clearing | Loss of vegetation and flora | -70 | Major |
| Land Clearing | Disturbance of wildlife habitats | -42 | Moderate |
| Land Clearing | Soil erosion and loss of soil nutrients | -30 | Moderate |
| Land Clearing | Recharge of Aquifers | -26 | Moderate |
| Land Clearing | Material transport into water bodies | -16 | Minor |
| Land Clearing | Eutrophication | -30 | Moderate |
| Land Clearing | Seasonal flooding | -70 | Major |
| Land Clearing | Aquatic Life | -18 | Minor |
| Land Clearing | Clearing of illegal plantain and maize farms | -60 | Major |
| Land Clearing | Loss of livelihoods of migrant farmers | -60 | Major |
| Soil Tillage/Preparation | Soil Erosion | -54 | Major |
| Soil Tillage/Preparation | Sedimentation of nearby water bodies | -32 | Moderate |
| Slash Management | Fire risk from poorly managed slash | -20 | Minor |
| Slash Management | Soil damage from fire | -24 | Minor |
| Planting of trees | Use of weedicides for weed control | -33 | Moderate |

TABLE 19: SUMMARY OF NEGATIVE IMPACTS - CONTD

| Project Activity | Impact Parameter | Assessment Scores | Overall Negative Rating |
|---|-------------------------------------|-------------------|-------------------------|
| Use of Agro-chemicals | Soil Contamination | -33 | Moderate |
| Use of Agro-chemicals | Effect on aquatic life | -30 | Moderate |
| Use of Agro-chemicals | Health and Safety of workers | -42 | Moderate |
| Thinning and Maintenance of tree stands | Soil compaction and erosion | -40 | Moderate |
| Thinning and Maintenance of tree stands | Sedimentation run-off | -48 | Moderate |
| Harvesting and Felling | Damage to fauna corridors and flora | -40 | Moderate |
| Harvesting and Felling | Soil compaction and erosion | -40 | Moderate |
| Harvesting and Felling | Dust inhalation by locals | -16 | Minor |
| Establishment of Treatment plant/ Sawmill | Economic migration into Agogo | -45 | Moderate |
| Clearing of squatter farms | Loss of farms and livelihoods | -60 | Major |

TABLE 20: SUMMARY OF POSITIVE IMPACTS

| Project Activity | Impact Parameter | Assessment Scores | Overall Positive Rating |
|--|--|-------------------|-------------------------|
| Landscape Planning | Land Use | 85 | Highly Beneficial |
| Landscape Planning | Harvesting and Slash management | 55 | Major Benefit |
| Landscape Planning | Protection of rich biodiversity habitats | 64 | Major Benefit |
| Landscape Planning | Protection of indigenous tree species | 80 | Highly Beneficial |
| Landscape Planning | Protection of Archaeological/Cultural sites | 64 | Major Benefit |
| Site and Species Matching | Improvements to soil properties | 65 | Major Benefit |
| Soil Tillage/Preparation | Enhancement of soil nutrients | 65 | Major Benefit |
| Slash management | Release of nutrients into soils | 42 | Moderate |
| Slash management | Protection of soil moisture | 75 | Major |
| Planting of trees | Development of micro climates | 50 | Major |
| Planting of trees | Transformation of reserve landscape | 85 | Highly Beneficial |
| Planting of trees | Carbon credits from sequestration | 65 | Major Benefit |
| Planting of trees | Inter-cropping by local farmers | 36 | Moderate |
| Harvesting and Felling | Landscape aesthetics | 45 | Moderate |
| Fire Management and Prevention | Protection of reserve and community | 85 | Highly Beneficial |
| Establishment of Treatment plant/Sawmill | Job Creation | 85 | Highly Beneficial |
| Establishment of Treatment plant/Sawmill | Development of support industries | 85 | Highly Beneficial |
| Labour and Staff Recruitment | Employment and Income | 85 | Highly Beneficial |
| Labour and Staff Recruitment | Promoting Gender Equality | 85 | Highly Beneficial |
| Payment of Stakeholder Benefits to Stool | Revenue from sale of Forest products | 85 | Highly Beneficial |
| Payment of Stakeholder Benefits to Stool | Equal sharing of benefits amongst 3 stools | 85 | Highly Beneficial |
| Funding support for Vocational Centre | Support for vocational training | 85 | Highly Beneficial |
| Supporting educational grants and scholarships | Supporting educational causes | 48 | Moderate |
| Monitoring and management of reserve | Improved reserve Management | 85 | Highly Beneficial |
| Improved earnings of workers | Poverty Alleviation and health improvement | 80 | Highly Beneficial |
| Project Presence on Reserve Lands | Limiting illegal farm allocations/activities | 85 | Highly Beneficial |
| | | | |
| | | | |
| | | | |

6 ANALYSIS OF ALTERNATIVES

In this chapter we examine the alternatives to the project in respect of the project objectives, its design, key operational activities, site location, climate, scale of planting, land zoning etc. In undertaking this analysis, the consultants have also taken into account various baseline information such as soils, hydrology, water catchment areas, groundwater, topography, tree species, stakeholder involvement and interests etc. By adopting this approach, the basis for necessary mitigations and future compliance monitoring is established.

6.1 Comparison of Project Objectives

The table below compares the main objectives of NMFC's project in Buomfum alongside that of the FC's for managing the Boumfum Forest Reserve and our key observations.

| NMFC | Forestry Commission | Key Observation |
|---|---|--|
| To support the Forestry Commission's goal of promoting tree plantation development as a means of re-afforesting degraded forest reserves. | Reforestation of the reserve, protection of the catchment of rivers; serve as barrier to the dry harmattan winds, conservation of flora and fauna and reduction of forest fires | In its current form, the forest protection objective will not be achievable in the foreseeable future without any interventions |
| To establish plantation timber crops for the production of wood biomass, poles, sawn timber and other wood products; | To support the creation of a timber products supply chain to support community and national development | The current condition of the forest makes it impossible to provide variety of products in substantial quantities |
| To bring substantial economic, social and environmental benefits to the communities associated with the business; | To generate revenue for stool landowners and forest agencies | In its current form, the degraded Boumfum forest cannot provide any significant revenue; if any at all |
| To develop associated wood processing industries and to provide local employment at various stages of the project over the next 20 years, | To support the creation of value added processing plants for local and regional development; thereby increasing returns to stakeholders | The best way to maximise the returns from the investment, is to produce and sell value added products to local, regional and international markets |

6.2 Initial Project Adoption Considerations

In examining the initial alternatives to the project, we have identified from the Forestry Services Division, Kumawu what likely alternatives were considered for the Boumfum Forest Reserve. These were as follows:

- a) **Leave the Reserve as it is:** This option would result in further degradation of the reserve due to increased encroachment of the reserve by illegal migrant settlers seeking lands for maize, plantain development and cattle grazing. Following discussions with local farmers and the chiefs, it was identified that continued encroachment by illegal migrant farmers could lead to undesirable social conflicts. It also exposes the reserve to increased risks from fire and fire spread; usually caused by migrant farmers attempting to clear grassland for farming. This alternative was found to be contrary to the wishes and interests of the Stool landowners, who have a very keen desire to maintain the area as a forest reserve. It is also counter-intuitive to the Forestry Commission's mandate of overseeing the management and development of the reserve as a forest on behalf of the traditional stool landowners.
- b) **Convert the degraded Reserve into agricultural lands:** This option would inevitably require a change in the legal status of the reserve (de-reservation) by an Act of Parliament. Again, this alternative lacks the support of the stool landowners who prefer to keep the area forested. Such an alternative will inevitably require breaking up the land into very small affordable land parcels to be allocated to local farmers. Whilst this may be of interest to some farmers, it is rather difficult to manage and control and very prone to causing disputes amongst farmers. Again, this option would defeat the main purpose for which the reserve was created.
- c) **Reforestation of the Reserve:** This is the most desirable option for the landowners, local populace and Forestry Commission. Reforestation projects require significant investments of capital and modern technology to ensure that the reserve can generate positive impacts on the local community. The plantation development model proposed by NMFC to the Forestry Commission is one that allows for controlled community inter-crop farming alongside plantation tree species within the lands allocated to the company. The NMFC proposed development also has the potential to provide jobs for some of the locals, contribute to the socio-economic development of Agogo and ensure stakeholder participation in the sharing of the long-term financial benefits accruable from the project.

6.3 Analysis of Project location

The location of a suitable site for plantation development is a major undertaking for any forest reforestation project. In such situations, the emphasis is on ensuring that soil types and climatic conditions (rain, temperature and relative humidity) are favourable for supporting tree growth. The Boumfum Reserve is suitably located in a region that has high levels of annual rainfall (1200mm); albeit the trend is now moving towards slightly more dry

conditions. This level of rainfall is perfectly suited for the development and growth of tree species. Agogo, with a population of approximately 35,000, is the largest conurbation in the Asante Akyem North area. By locating the project in the Agogo area, access to labour resources is more assured, travelling distances to the company's allocated compartments is optimum and access to support services such as fuel, labour, water, hospitals, housing and social amenities is made more available than would have been the case if the project had been located elsewhere in the area. By locating the project in the reserve, interventions such as fire management, tree planting, controlled community farming, monitoring of the reserve and stakeholder collaborations serve to create a more collaborative approach between all stakeholders to support the much need national policy of ensuring the regeneration of degraded forest reserves.

6.4 Analysis of Topography, Soils and Land Use

The reserve is located in an area with undulating hills ranging from 100-400m which is part of the Voltain Basin. Consequently, some parts of the reserve are subject to flooding in low lying valleys and soil erosion on steep slopes. Three (3) soil units with varying nutrient levels are encountered in the reserve. These soils will promote varied growth rates for trees and it is therefore not surprising that the NMFC project proposes to apply some soil enrichment measures in support of its tree planting programme. The undulating terrain is such that care must be exercised in selection and preparation of sites and to ensure that soil erosion from rain is kept to its barest minimum; avoiding run off into any nearby water bodies.

The general fertility of the soils; as depicted in the baseline section of this report; is one that will generally support tree and plant growth. Similarly, the soils also support the growth and development of agricultural produce such as maize, cassava and plantain; as evidenced by the existence of many plantain and maize farms in the reserve. This raises the issue of what is the best land use option for the 5000ha allocated to NMFC by the Forestry Commission. With the climate gradually shifting towards drier conditions; as depicted by the rainfall statistics, the land use has to be of the type that will not be detrimental to the site. Whilst agricultural production might require some level of irrigation and intensive application of fertilizer and other soil amelioration treatments, tree planting has the capability of nutrient recycling that will not require much artificial fertilization. Traditionally, farming land in the reserve is created by torching the vegetation. This has been the cause of many forest fires that have engulfed the reserve in the last 30-40 years. The resultant effect have been fires that have run out of control, burnt for weeks, severely degraded the reserve and caused heavy smoke pollution in Agogo and surrounding areas. In any case; the land use plan as envisaged under forest reservation policy; and the designation of the area by the Forestry Commission for rehabilitation through plantation development, makes the site appropriate for the project; especially as it does not diminish the availability of agricultural lands for the community.

The company has indicated that a minimum of 15-20% of the gross land area (1000ha) will be set aside for the creation of conservation areas. This is to meet its environmental and sustainable forestry objectives. The land area will therefore be zoned principally into the conservation areas (wetlands, river buffers, cliffs and historical or cultural) and planting

areas. As a result of this zoning exercise and shallow soils due to the rock outcrops and steep cliffs, it is clear that the NMFC will not have 5000ha of land available for tree planting. Faced with such a situation the company has two options available to it; namely:

- a. Use some of the conservation areas for planting or
- b. Seek readily available replacement lands from the Forestry Commission.

As a result of the company encountering encumbered land in some of its allocated areas, the Forestry Commission is already in the process of granting the company more land in the reserve as a way of compensating it for some of the difficulties it has encountered with illegal settler farmers and rocky soils in some areas. This is the most appropriate intervention, taking into account the long term desired objectives of the stool landowners and Forestry Commission for restoring the reserve.

6.5 Analysis of choice of Teak and Eucalyptus species

The choice of species for plantation development is a very important factor in plantation development projects. Factors such as soils, site and species matching are all important considerations in deciding which species is suitable for a particular project.

In the case of Teak, this species has been used on a very wide scale in many parts of the country by private plantation developers and the Forestry Commission; the reserve being no exception. It is common to see old mosaics of Teak stands, albeit poorly managed, in many parts of the reserve. Plantation Teak is a fast growing tree species that provides lumber in 12-15 years from planting. In view of the seriously degraded nature of the reserve and the need to have it restored as quickly as possible, plantation species are the only way to rapidly restore the reserve. This is the trend in many parts of the world – Brazil, South Africa, Tanzania, Uganda, Kenya and Australia to mention a few. The choice of Teak by NMFC as a plantation species for use in the reserve is adequate and will provide a rich green texture to the reserve landscape.

Eucalyptus species now include hybrids designed for specific site and climatic conditions. The Eucalyptus species are fast growing species that produce poles for electrification and are commonly used worldwide. Various viewpoints have been expressed by forestry experts about the effect of Eucalyptus on groundwater levels. It has been argued that Eucalyptus tends to consume high levels of water to support its rapid growth. In reality Eucalyptus is a highly adaptive species and will adjust its growth to suit the levels of water available. Many parts of the reserve are liable to flooding due to poor drainage of the soils and the rock terrain in some parts of the reserve. Poorly drained sites in the reserve, if planted with Eucalyptus will improve on the drainage conditions of such sites. This is contrary to the misconception that Eucalyptus reduces groundwater level. Studies have shown that Eucalyptus is rather more efficient in the use of water, making use of more water where the water table is high and adjusting its demand when conditions are dry (Munishi, 2007).

The use of these species in the reserve will result in transforming the NMFC allocated parts of the reserve into a monoculture (single type) of Teak and Eucalyptus species. In its halcyon

days, the reserve boasted over 100 different natural occurring species. With the exception of a few seed trees, these no longer exist due to the degraded nature of the reserve. NMFC has proposed to incorporate the planting of indigenous species in conservation areas as part of its operational plans. This will provide a rich mix of plantation and indigenous species in its allocated areas. This is highly desirable and has support from the Forestry Commission. The most important decision to make is the proportion of areas to be planted by the two species. To this end, the Forestry Commission has approved a 40:60 mix of Eucalyptus to Teak respectively. This decision is influenced not only by environmental considerations; but also by the economic and technical considerations as enumerated below.

| Environmental Factors | Technical factors | Economic Factors |
|--|--|---|
| <ul style="list-style-type: none"> • Soil water availability in relation to the water absorption and retention capacity of species • Water use efficiency of species <ul style="list-style-type: none"> • Invasiveness of species • Ability of species mix to meet environmental protective functions (e.g., slows wind speed; traps airborne sand and particles; moderates the force of rain; slows run-off of water after heavy rain) | <ul style="list-style-type: none"> • Growth rate and productivity specific to site • End use of species and product mix <ul style="list-style-type: none"> • Pest and diseases control • Tolerance of species to environmental stress (drought and fires) | <ul style="list-style-type: none"> • Trends in market demand for products • Market prices • Financial Returns <ul style="list-style-type: none"> • Maximising Stakeholder benefits |
| <p style="text-align: center;"><u>Conclusion:</u></p> <p>For environmental considerations both Teak and Eucalyptus seem to have similar behaviours especially for rain water interception. Their water consumption differs primarily because of the level of deciduousness between the two species. In this respect the mixture could be a 50% Eucalyptus and 50% Teak.</p> | <p style="text-align: center;"><u>Conclusion:</u></p> <p>Growth is remarkable in both species but they differ in the age of maximum growth. While yield in Teak is 4-18m³/ha per year and can grow continuously for more than 40 years, Eucalyptus grows very fast; up to 60 m³/ha/yr but growth may peak after 20 years. Both species are fire tolerant and coppice well after harvesting making them suitable for coppice management after first planting. Because of the early peak in growth of Eucalyptus, NMFC can increase production by stocking a larger area of Eucalyptus.</p> | <p style="text-align: center;"><u>Conclusion:</u></p> <p>While Teak lumber is in high demand and fetches higher price, it may be reasonable to grow the Teak mainly for saw logs and lumber production. The fast growth rate of Eucalyptus makes it a better candidate for pole, pulp and chip production. Judging from the product mix from the two species, a larger portion of the project site should be planted with Eucalyptus</p> |

6.6 Analysis of nursery location

The company has established a permanent central nursery located outside the Buomfum Forest to produce seedlings of *Tectona grandis* and *Eucalyptus*. Alternatively the company could have sourced the seedlings from commercial nursery operators in Ghana. The problems associated with the second option are:

- ✓ the inability to trace the sources of the seeds and
- ✓ difficulties in obtaining information on the characteristics of the tree.

Without such information, there is a risk that NMFC would be unable to meet its planting objectives which could impact negatively on its investment and financial forecasting. As an alternative the company could have employed the use of small *temporary or flying* nurseries located close to the planting areas. Despite the obvious advantage of reducing cost of transportation to planting sites; it is only suitable for Teak which does not require special nursery handling and care. The handling of the minute, delicate seeds and seedlings of Eucalyptus requires a central nursery that is installed with appropriate equipment for potting and germination; as well as sprinklers for timely watering of germinating seeds and seedlings.

In terms of cost per seedling, the use of a central nursery tends to have lower costs; especially due to high survival rate and maximization of equipment use. There is also better controlled supervision of the development of the seedlings. Another advantage of the central nursery is that it is easier to deal with management of waste and application of agro-chemicals. NMFC's decision to have a central nursery will improve the company's ability to deal effectively with environmental and technical issues associated with nursery establishment.

Water extraction for nursery:

Sustainable supply of water is one of the pre-requisites of a successful tree nursery. NMFC intends to extract water from a bore hole. However, groundwater recharge is mainly in the rainy seasons. During the rainy period, large volumes of runoff flow into streams. Therefore, it would be more prudent to extract more water from the stream in the rainy season compared to groundwater. This calls for regular monitoring of the surface water quality. Thus when surface water quality is good, it would be appropriate to extract water from the streams in the rainy season and from groundwater in the dry season. To manage the water supply situation it will be important to monitor some environmental variables.

- ✓ NMFC should consider installing about three automatic weather stations. This is to be used to monitor rainfall, wind speed, solar radiation and evaporation in the different parts of the compartments.
- ✓ The Ongwam and Boumfum rivers and groundwater water quality need to be monitored monthly; preferably before the stream enters the nursery area and about 200m downstream from the nursery.

6.7 Analysis of land preparation options

Land preparation as part of plantation establishment is done to facilitate easy access to the soil for planting and to ensure high survival rate and early growth. Generally land preparation involves removal of vegetation, removal of tree stumps and breaking of the ground either by pitting or ploughing. The methods and equipments used for any of these activities are determined by factors such as condition of vegetation, tree sizes and population, topography and other terrain conditions and the special tillage needs of the species to be planted. In most cases there will be the need for combination of manual and mechanized methods. The guiding principle is always to aim doing the minimum necessary and in the cheapest way. With the terrain at Buomfum it will not be possible to use mechanized clearing or plough all areas selected for planting. All options may have to be tried at scales that will make economic sense and also meet environmental criteria. Vegetation clearing for example, may be done by manual clearance using machetes and axes, mechanical clearance by crawler tractors and chemical clearance by applying herbicides and weedicides.

The NMFC plan for mechanised clearing involves the use of disc ploughs over stretches of land proposed for planting. Unfortunately, the soil is highly susceptible to erosion. Therefore any tillage method that will accelerate erosion needs to be carefully examined. The extensive continuous / contiguous lands that would be ploughed on long slope length have the propensity to induce severe erosion. The following alternative suggestions are therefore presented:

1. Land clearing / preparation must be done by initial slashing when the grass is tall and wait for re-growth and then spray with glyphosate weedicide.
2. Planting holes measuring about 20 cm diameter and 20 cm deep are dug at the planting points for the planting of the seedlings.
3. Mechanical pitting method can be used to accelerate the rate of planting on shallow and deep soils.
4. NMFC may apply herbicides, pesticides and fertilizers. Application of herbicides and pesticides should be limited to 20m or more from water bodies to reduce their harmful effects on aquatic organisms and fauna surrounding the banks of streams. NMFC's use of Forest Stewardship Council (FSC) approved chemicals is a positive step in the right direction.
5. Burning of vegetation as a means of land clearing may not be encouraged for the obvious reason of the likelihood of the fire getting out of control to burn unintended areas and also polluting the air with smoke.

6.8 Analysis of planting options

To maximise the number of plants per unit area; as well as give adequate growing space for individual trees, planting is usually laid out by rows and spacing between trees. The rule of thumb is that planting method should be simple, easy to apply, and practicable on the type of terrain. Other factors to be considered are whether planting and harvesting will be manual or mechanised or a combination of the two. In Ghana, manual planting is the general practice

due to lack of the right equipment and skills for mechanised planting. If NMFC should apply only manual methods, many sites with shallow soils will be left unplanted; thus reducing the net area planted.

To optimize site utilization and achieve maximum productivity in terms of yield, the spacing between rows and between trees in the row should fit the root, stem and crown development characteristic and end use of the species to be planted. For instance; when growing Teak for saw logs or lumber the spacing normally is 3m by 3m to give a stem density of 1111 per hectare. Eucalyptus grown for poles, pulp wood and saw logs starts with 2m by 3m to give an initial population 1667 stems per hectare. Eucalyptus, if grown for only saw logs, may be planted at 4x4m or 4.5 x 4.5m to give a stocking of 625 and 494 respectively. Wider spacings may be chosen by considering the effects on cost of operations, rotation age and quality of trees.

In conclusion it is noted that because close spacings are extremely expensive and very wide spacings grossly under-utilize a site; the spacing must be chosen based on product mix, anticipated stem size and length of rotation of the tree species.

6.9 Analysis of Tending options

Tending refers to the various silvicultural operations that are performed after planting to aid the planted seedlings to grow up to maturity and attain the required stem form. These operations include weed control, singling, and pruning.

Weed control will be needed in the first few years after planting till the stand achieves canopy closure. The methods of weed control to be considered are: manual, mechanised and chemical. Selection of these methods and intensity of application should be based on environmental, social and cost considerations. For instance while the manual method will be socially advantageous because it will offer more employment it tends out to be expensive because it is labour intensive as compared to chemical and mechanical control.

Singling is an operation done in the first few years after establishment to reduce the number of shoots that might sprout from planted stumps or when a stem forks very close to the ground. Both Teak and Eucalyptus have the propensity to produce more shoots. The singling operation will be needed to maintain high quality stems if the end product is saw log. Singling is essentially a manual operation done with hand saws, machete, or axe.

The operation of pruning involves the removal of branches up to a height of about 2 meters or just before canopy closure (Evans, 1986). NMFC will perform this operation mainly to achieve the following:

- Provide access into the stand for inspection and marking for thinning;
- Reduce the fire hazard by lessening the chance of ground fires burning up into the crown;
- Facilitate felling and extraction of thinning so as to make these operations safer and;
- Produce knot-free timber at the base of the tree.

Pruning may be done on all trees in a stand, or only on some and sometimes not at all. The amount of pruning needed depends on the natural pruning characteristics of a species. It is also influenced by the purpose or reason for the pruning; which then determines the pattern of pruning. These patterns are described in all standard plantation silviculture handbooks.

It is noted that the two exotic species (Teak and Eucalyptus) used by NMFC if planted at close spacing may not require pruning as the species are to a greater extent self pruning.

6.10 Analysis of Thinning Options

Thinning is one of the major operations detailed to be undertaken in the maintenance and management of NMFC plantation. It will be undertaken for the following purposes:

- ✓ To reduce the number of trees in a stand so that the remaining ones have more space for crown and root development and to encourage stem diameter increment and so reach a usable size sooner;
- ✓ To remove dead, dying, diseased, and any other trees which may be a source of infection or cause damage to the remaining healthy ones;
- ✓ To remove trees of poor form (crooked, forked, roughly branched etc) so that all future increment is concentrated only on the best trees;
- ✓ To favour the most vigorous trees with good form which are likely to make up the final crop
- ✓ To provide an intermediate financial returns from sales of thinning material.

It is obvious that NMFC may undertake thinning for a combination of the above purposes but it is clear that most of the thinning will be for intermediate returns. For instance it is planned that there will be three thinning periods for both Teak and Eucalyptus before the final felling at the estimated rotation age of 20 and 12 years for Teak and Eucalyptus respectively. Teak will be thinned at year 7, 11 and 14 after planting. Eucalyptus will be thinned at year 5, 8 and 10 after planting. The important decisions to make will be the thinning weight (Total removal per cycle), intensity of thinning (volume removed m³/ha/yr) and the method of thinning so as to achieve the objective of the operation. The time for first thinning should be guided by the time canopy closure is achieved in a stand. The thinning weight should also be guided by the rate of stem increment or volume increment per hectare per year. It is also important to ensure that thinning is not delayed such that the retained trees will not take a longer time to respond positively to the changes in canopy opening.

6.11 Pests and disease control

In protecting planted trees from pests and diseases, the company will have to adopt strategies that will ensure prevention, early detection, and application of the appropriate measures for controlling pest and diseases. The recommended approaches should be as follows:

- ✓ Selecting species that are known to be resistant to potential damaging insects and diseases prevalent in the site;
- ✓ Fixing a rotation age that will not allow the trees to become over mature and highly prone to insects and diseases;
- ✓ Thinning early and applying other practices of good forest hygiene to remove materials which would create centres for infection;
- ✓ Monitor tree appearance to detect changes in leaf colour, presence of insects etc and reporting to specialists for investigation and;
- ✓ Exploring the use of chemical and cultural controls

6.12 Road Construction

Road construction is needed to create access for movement of workers, supply of logistics, transportation of seedlings, transportation of harvested products and even combating fires. The installation of roads requires proper planning with respect to the road layout, time for construction, and design of the road (road density and specifications) to suit the right purpose. Road constructions within the confines of a Forest Reserve are guided by the Logging Manual issued by the Forestry Commission. The manual prescribes guidelines that will help to minimize soil erosion, and prevent contamination of rivers and streams. NMFC will do well to observe the prescribed guidelines of the manual.

6.13 Harvesting

The process of timber harvesting is carried out in a number of steps, starting with the felling of the trees and finishing with trucking the logs to the mill. Typically, *a number of different forest harvesting machines are combined to form a harvesting system. With careful harvest planning, it is possible to select the best harvest system that will be cost effective and safe for any given site.*

Each harvesting operation has a set of management objectives that normally include aspects of safety, profitability, forest health and environmental concerns. If the harvesting system and its equipment are mismatched to the site and its conditions, it may be impossible to achieve any or all of the abovementioned objectives. The ramifications of improper equipment selection may range from unsafe working conditions, to unacceptable cost charges and excessive environmental damage with possible legal implications.

Felling machines have rapidly become standard equipment in many harvesting operations that produce substantial volumes of timber. Incorporating a felling machine into any harvesting operation will necessitate looking beyond the felling operation into other phases of the harvesting system. Since felling machine volume production rates can be up to 5 times manual production rates, the subsequent activities in the whole harvesting system, such as extraction, debranching, loading and transportation must be taken into account and a systems approach must be followed.

Whilst cable skidders could be used to sling mechanically felled bunches of full trees, grapple skidders are better suited to work in combination with feller-bunchers. A grapple skidder should also be able to handle the bigger bunches created by the feller-buncher. It is therefore very important to select the type of grapple fitted to a skidder. There are two types of grapples available namely sorting and bunching grapples. A bunching grapple is used in large timber where a full load involves one to a few stems. On the other hand a bunching grapple is used for big loads of small stems, which is also preferred on rough ground for picking up uneven piles of scattered timber; because it allows for easier pick-ups.

Harvesting systems are changing to ensure that costs are reduced in this critical part of the business. Some of the changes in the harvesting systems are, by their nature, placing large daily volumes of timber on landings and roads in the plantations. This requires rapid removal of round wood from landings, what is generally termed as a "hot" operation. This is achieved by using large knuckle boom loaders that have the capacity to both sort and load round wood instead of the current 3-wheel loaders which are used in sorting and stacking operations. Where harvesting systems are changing, the role of transport becomes more critical in the supply chain. Trucks are to be scheduled to remove round wood at a constant flow from the harvesting site to meet the quantity and time demands of sawmill processors.

Harvesting should therefore be looked at in respect of NMFC's three main operations; namely, felling and bucking, extraction/forwarding and transportation. The decision on how to conduct harvesting or the harvesting system to use will be influenced by factors such as the objective of harvesting, the sizes of product to harvest and terrain conditions. In this project, harvesting will be for two main purposes. The first harvesting is for the removal of intermediate crop in the form of thinning and the second harvesting is the felling at the end of rotation. The product types will essentially be poles and saw logs. The method of harvesting or the harvesting operations will also be determined by factors such log dimension (diameter, length), volumes to be harvested per unit area and the likely damage to be caused to the environment.

Felling, if done for thinning or removal of poles, may be done manually using bow saws or motorised chain saws. In the case of saw logs mainly chainsaws may be used as the stem sizes will be larger than the poles. However, the use of any of the felling equipment and other felling accessories will require that the workers are given adequate training on their use. Felling should also be done adopting the required procedures and especially applying directional felling to ensure safety to workers and less damage to the environment.

Timber extraction will involve moving the log from the stump site to a landing area and then to a central log yard within the plantation site. The movement may be done by skidding the logs first to a landing site and then forwarding them to the log-yard. With the type of tree sizes and volume to be handled in a Teak and Eucalyptus plantation, the skidding machinery may have to be a tractor fitter with winch and the forwarding machinery a timber jack; all with pneumatic tyres. Crawler tractors will not be appropriate for extraction under plantation conditions. As the landings and log-yards or log depots will be sited in the plantation area it

will be important to take into accounts their location in terms of numbers and nearness to sensitive sites (buffers, riparian zone, steep slopes etc.). The Ghana Forest Logging Manual should be consulted for guidelines on selecting sites and construction of landings and depots.

Mass transportation of the logs from the log-depot to a processing location should be done by road using tractors fitted with trailers or articulated haulage rigs. The type of vehicle should be determined by the nature of the road (maximum gradient, horizontal curves, road width and road formation), time of season and volumes to be carried.

All the various options for executing harvesting operations will therefore have to be considered at the planning stage of the harvesting process so as to avoid potential environmental damage associated with timber harvesting.

6.14 Managing illegal migrant farmers

This EIA report has already alluded to the problem of illegal migrant farmers' encroachment in many parts of the reserve. As management custodians of the reserve, the Forestry Commission has exercised its authority and mandate by evicting the illegal migrant settlers from the reserve. This raises questions about the possible impacts on the livelihoods of these groups such as loss of livelihoods and incomes from destruction of these illegal farms. This brings their illegal status into conflict with the authority and mandate of the Forestry Commission. The question faced is this: *Do we allow illegal settler farmers to remain because they are already established in the reserve or do we evict them to serve as a deterrent to others and reclaim reserve lands?*

The Forestry Commission, in its wisdom, has opted for the latter; with full support from the stool landowners. The risks associated with non-eviction are too high to contend with. These include over-running of the reserve with plantain and maize farms, increased wild forest fires which are extremely difficult to control, increasing conflicts with locals and overall further degradation of the reserve. It is the Consultants' view that the action taken by the Forestry Commission is the most appropriate form of action; as failure to evict the settlers would also jeopardize forest investors' confidence in land lease agreements and also compromise the overall desired long term objective of reforestation of the seriously degraded Boumfum reserve. This is not to suggest that the question of illegal farms should be ignored. What is required is the following:

1. Educate and sensitise farmers to understand that their presence and farming activities in the reserve, unless authorised by the Forestry Commission, is against the forest reserve laws and that it will be in their utmost interest to avoid such activities in the future.
2. Subject, to Forestry Commission approval, NMFC could enter into collaborative arrangement with some farmers to plant selected crops alongside the plantation trees in a carefully controlled manner. Failure to comply with this would result in ejection of the farmer completely from the reserve.

3. NMFC could develop Outgrower Schemes, where farmers, are provided with the technical assistance and inputs to plant trees under the careful supervision of NMFC. This will require participative support from the Forestry Commission and its Agencies. By adopting this approach, farmers could enter into benefit sharing arrangements with the company.

6.15 Management of Stakeholder Relationships

The NMFC project has a number of key stakeholders namely:

- ✓ Agogo, Kumawu and Kwamang Traditional Councils
- ✓ Forestry Commission HQ
- ✓ Forest Services Division – Kumawu
- ✓ Forest Wildlife Division – Kumawu
- ✓ Forest Research Institute of Ghana
- ✓ Asante-Akyem North District Assembly
- ✓ Water Resources Commission and
- ✓ Environmental Protection Agency

These stakeholders are central to the successful delivery of the project objectives and therefore need to be managed effectively. NMFC is already engaged in stakeholder consultations and has previously organised stakeholder meetings to solicit views from its stakeholders. To derive the maximum value from its stakeholder relations, it would be prudent for the company to have a dedicated Manager to manage and oversee stakeholder relations. The management process should include quarterly updates to stakeholders and regular stakeholder meetings to ensure that progress and challenges of the project are communicated and addressed. NMFC should:

- ✓ Form stakeholder committees in the main traditional communities (Agogo and Kumawu) to collaborate issues of mutual concern
- ✓ Hold regular meetings with relevant Institutional stakeholders
- ✓ Provide progress updates to all stakeholders
- ✓ Solicit feedback from all stakeholders and
- ✓ Encourage active stakeholder participation in the development of the project

In summary, the objective of plantation establishment by NMFC at Buomfum is the most appropriate way of restoring tree cover and ensuring that all the realisable benefits such as local employment, forest, fauna and flora regeneration, financial inflows, and stakeholder participation can be derived from a forest reserve that has lost over 90% of its canopy cover.

6.16 Environmental Monitoring

- NMFC should pay close attention to soil erosion and avoid establishing plantations close to wetlands and riparian strips.
- NMFC should install three automatic weather stations to monitor rainfall, wind speed, solar radiation and evaporation in the different parts of its allocated compartments.

- The water quality from groundwater and the Ongwam and Boumfum rivers should be monitored regularly to ensure that the water quality is of a standard suitable for the development of seedlings. The risk of water contamination is high from chemicals and pathogens that may have entered the water system from upstream sources outside the reserve. To this end, water quality parameters as stated in the hydrology section of this report should serve as a basis for future monitoring, reporting and compliance.
- NMFC should provide regular updates to the Forest Services Division, Kumawu and Regional Forestry Office, Kumasi on general activities in the reserve; in particular incidences of fire.

7. MITIGATIONS

Having identified the potential impacts and possible alternatives of the NMFC proposed development on various aspects of the environment and stakeholder groups, various suggestions were proffered as mitigations for some of the impacts. Where impacts are identified as negative, suggestions have been made to minimise the impact on the environment and stakeholders.

The mitigation measures suggested for the potential impacts of the NMFC proposed development takes into account the following:

- a) The Environmental Assessment Regulations 1999(LI 1652).
- b) The Water Use Regulations, 2001 (LI 1692)
- c) Riparian Buffer Zone Policy for Managing Freshwater Bodies in Ghana, 2012
- d) The Key Project Activities proposed by NMFC
- e) The NMFC Environmental Management Plan 2013/2014
- f) Best available practices and technology for plantation forestry
- g) Health and social well being of local and surrounding communities and
- h) Key Stakeholder interests and concerns

The potential impacts of the proposed development are rated in the following tables and prior to mitigations being suggested. The impacts are then rated again after the mitigations. This gives an overview of the effect of the mitigation in minimising negative environmental, social and health impacts. The impact type whether Environmental (E), Social (S) or Health (H) is also indicated in the tables below.

Where impacts are generally positive, we have also prescribed enhancements which we deem will be value adding for the project, the environment and its stakeholders.

Table 21: Mitigation Measures for Nursery

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|-------------------------------------|-------------------------|--------------------|---|---------------------------------|---|--------------------------------|
| <i>Impact on Use of Groundwater</i> | Groundwater Recharge | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short term • Reversible | Minor | Even though water usage levels are only 3% of groundwater recharge, NMFC should consider use of river water sources during the rainy seasons and make use of groundwater during the dry season. This is will mean conducting water quality tests of river water on a regular basis. | Minor |

Table 22: Mitigation Measures for Landscape Planning

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|---------------------------|--------------------------------|-------------|--|--------------------------|--|-------------------------|
| <i>Landscape Planning</i> | Expansion of Ananekrom | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Minor | In view of the scale of Ananekrom development, NMFC should avoid planting in compartments 152 and 155 and seek to obtain replacement lands from the Forestry Commission. | Hardly Any |
| | Management of Slash Material | E, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Reversible | Major | Even though positive, NMFC should monitor and control slash; as well as provide training to all workers on effective slash management | Major |
| | Availability of Land for farms | E, S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | NMFC should develop strong stakeholder relationships with stool landowners and keep them informed of plantation developments. Conduct workshops to inform legitimate farmers about community farming practices and need to avoid farming in unauthorised areas of the reserve | Major |

Table 23: Mitigation Measures for Site and Species Matching

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|----------------------------------|---|--------------------|--|---------------------------------|--|--------------------------------|
| <i>Site and Species Matching</i> | Depletion of Soil Nutrients | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Temporary • Reversible | Moderate | NMFC should apply both organic and inorganic fertilizers. This will help in improving the nutrient status of the soils. | Minor |
| | Colonisation by Invasive Species | E | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Minor | NMFC should closely monitor the quality and source of its approved seedlings to ensure that only approved non-invasive Teak and Eucalyptus seedlings are used on the project; as invasive species are expensive to control and eliminate | Hardly Any |
| | Reduction of water table in wetlands and riparian areas | E | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Moderate | Avoid planting Teak and Eucalyptus species near wetland and riparian areas. | Minor |

Table 24: Mitigation Measures for Road Construction and Maintenance

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|--|--|-------------|--|--------------------------|---|-------------------------|
| <i>Road Construction and Maintenance</i> | Soil Erosion and Surface Run Off | E | <ul style="list-style-type: none"> Negative Direct Local Permanent Irreversible | Major | New road construction should be kept to a minimum; roads must be well compacted to minimise erosion. Where constructed, road alignment should observe gradient limits and land contours | Minor |
| | Contamination of water bodies and Impoundments of seasonal streams | E, S, H | <ul style="list-style-type: none"> Negative Direct Local Permanent Reversible | Moderate | Culverts and drain bars should be installed to control and direct any run off at short intervals. Seasonal streams should be identified during road planning stage. Avoid road construction near water bodies. | Minor |
| | Noise Pollution | E, H | <ul style="list-style-type: none"> Negative Direct Site Only Permanent Reversible | Minor | Enforce and monitor use of noise abatement devices by all relevant workers. Ensure adequate breaks from operating forest machinery | Negligible |
| | Increased levels of dust on Air Quality | E, H | <ul style="list-style-type: none"> Negative Direct Site Only Temporary Reversible | Minor | Ensure reasonable speeds and frequency of use of forest machinery to minimise dust, ensure use of protective gear and avoid operating machinery in heavy winds | Negligible |
| | Clearing of vegetation | E, S | <ul style="list-style-type: none"> Negative Direct Site Only Permanent Irreversible | Moderate | The slash produced during vegetation clearing should be used either as mulch or ploughed into the soil to improve the soil structure, water retention capacity and nutrient recycling. Ensure proper disposal of cleared vegetation where necessary | Minor |

Table 25: Mitigation Measures for Land Clearing

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|----------------------|------------------------------------|-------------|--|--------------------------|--|-------------------------|
| <i>Land Clearing</i> | Clearing of vegetation | E | <ul style="list-style-type: none"> • Negative • Direct • Site Only • Permanent • Irreversible | Major | The slash produced during vegetation clearing should be used either as mulch or ploughed into the soil to improve the soil structure, water retention capacity and nutrient recycling. Fire should not be used as a tool in the land clearing as it destroys the soil humus. | Minor |
| | Disturbance of fauna habitats | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Minor | Fire should not be used as a tool in the land clearing as it destroys the beneficial soil micro-fauna. Where ever possible snags (Senescent standing trees) and coarse wood debris should be retained to serve as dwelling sites for arboreal animals and arthropods respectively. | Minor |
| | Disruption of reserve biodiversity | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Minor | Specimens of all plant species that are known to have special uses by the community should be introduced in the conservation areas through enrichment planting or aided natural regeneration. The conservation areas when created should be managed well to always retain representative composition of the original biodiversity of the site | Negligible |
| | Soil Erosion and nutrient loss | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short term • Reversible | Moderate | By adopting slashing methods, soil erosion is reduced by ensuring that cleared thrash is left on the soil surface. This slows down erosion. | Minor |

Table 26: Mitigation Measures for Land Clearing- Contd

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|----------------------|---|-------------|--|--------------------------|---|-------------------------|
| <i>Land Clearing</i> | Recharge of Aquifers | E | <ul style="list-style-type: none"> • Negative • Direct • Site Only • Short Term • Reversible | Moderate | Protect Soil surface with debris and mulch to avoid reduction of soil permeability, reduced infiltration and increased run off | Minor |
| | Eutrophication | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Moderate | Avoid land clearing activities close to water bodies to reduce the risk of plant debris being blown into water systems. | Minor |
| | Seasonal Flooding and Aquatic Life | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Irreversible | Major | Construct contour bunds to slow down the speed of run-off. As far as possible, avoid clearing large tracts of land during rainy season to limit run off and deposits of debris in water systems; thus affecting aquatic life | Moderate |
| | Clearing of Illegal settler farms and damage to livelihoods | E, S | <ul style="list-style-type: none"> • Negative • Direct • Site Only • Permanent • Irreversible | Major | <p>Since Forestry Commission has already evicted settlers from the reserve, NMFC should in future consider offering farmers employment with the project wherever possible.</p> <p>Collaborate with landowners and stakeholders in educating illegal settlers to desist from future encroachment of the reserve. Local farmers should also be included in this process</p> | Minor |

Table 27: Mitigation Measures for Soil Preparation

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|-------------------------|---|--------------------|--|---------------------------------|---|--------------------------------|
| <i>Soil Preparation</i> | Soil Erosion | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Severe | Plant between contour bunds. Plough without harrowing. Plant on ridges across slope. Divide land preparation for seedling planting into contour strips. Strips should be separated by a year of soil preparation. | Moderate |
| | Contamination of nearby water bodies from sedimentation | E, S, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Moderate | NMFC should avoid soil preparation on steep slopes close to water bodies. NMFC should create vegetative buffers alongside water bodies to protect them from soil sedimentation. Conduct regular visual inspection of water bodies to ascertain any sedimentation of water bodies. | Minor |

Table 28: Mitigation Measures for Slash Management

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|-------------------------|--|-------------|--|--------------------------|---|-------------------------|
| <i>Slash Management</i> | Smoke inhalation from slash burning by workers and surrounding settlements | E, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Short term • Reversible | Minor | Ensure workers are properly trained in slash burning protocols and observe favourable weather conditions for burning of slash and ensure use of protective gear | Minor |
| | Soil damage | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short term • Reversible | Minor | Avoid having slash material in large floor areas. Consolidate slash in small groups and use as mulch for soils wherever possible. Burning should be a last option and carried out under strictly controlled conditions to avoid fires. | Negligible |
| | Source of fire ignition and fire spread | E, S, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Major | Ensure workers are properly trained in slash burning protocols and observe favourable weather conditions for burning of slash | Minor |

Table 29: Mitigation Measures for Use of Agro-chemicals

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|---------------------|--|-------------|---|--------------------------|--|-------------------------|
| <i>Weed Control</i> | Contamination of soils from agro-chemicals | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Irreversible | Moderate | <p>NMFC should control the application of weedicides to avoid over spills and over concentrations.</p> <p>Ensure workers are properly trained in the use and disposal methods for chemicals.</p> <p>Consider buying bulk quantities and premixing in larger quantities to avoid inappropriate disposal of smaller containers which could result in contamination of soils.</p> | Minor |
| | Contamination of water bodies and aquatic life | E, S, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Reversible | Moderate | <p>NMFC should control the application of weedicides to avoid over spills and over concentrations.</p> <p>Ensure workers are properly trained in the use and disposal methods for chemicals.</p> <p>Avoid using weedicides in areas close to water bodies and avoiding using on steep slope areas near water bodies</p> | Minor |
| | Health risk to workers | E, S, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Reversible | Moderate | <p>Ensure workers are properly trained in the use and disposal methods for chemicals.</p> <p>Provide protective equipment and clothing for all staff who handle chemicals.</p> <p>Conduct quarterly health checks on staff to ascertain any health effects</p> | Minor |

Table 30: Mitigation Measures for Thinnings and Maintenance

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|---------------------------------|---|-------------|---|--------------------------|--|-------------------------|
| <i>Thinning and Maintenance</i> | Soil compaction and erosion | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Reversible | Moderate | Apply the Forest Logging Manual guidelines. Thinning operations should be scheduled when the ground is hard | Minor |
| | Sedimentation run off into water bodies | E, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Reversible | Severe | NMFC should avoid soil preparation on steep slopes close to water bodies. NMFC should create vegetative buffers alongside water bodies to protect them from soil sedimentation. Conduct regular visual inspections of water bodies to ascertain any sedimentation of water bodies. | Moderate |
| | Fire risk from dry fuel matter (branches, twigs and slash) | | <ul style="list-style-type: none"> • Negative • Direct • Local • Short Term • Reversible | Minor | Avoid large amounts of branches and twigs lying on forest floor. Train workers in proper disposal of slash. Avoid thinning large areas at any one time. | Negligible |

Table 31: Mitigation Measures for Harvesting and Felling

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|-------------------------------|---|-------------|---|--------------------------|--|-------------------------|
| <i>Harvesting and Felling</i> | Damage to corridors used by fauna and loss of flora | E | <ul style="list-style-type: none"> • Negative • Direct • Site Only • Short term • Irreversible | Moderate | <p>Create conservations areas that may act as corridor.</p> <p>Avoid harvesting in the corridor areas.</p> <p>Retain dead and senescent trees to serve as snags.</p> <p>Ensure that areas identified with rare floral species are not clear felled</p> <p>Specimens of indigenous occurring naturally should be retained</p> | Minor |
| | Soil compaction and erosion | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Short term • Reversible | Moderate | <p>Schedule harvesting when the ground is hard</p> <p>Use extraction machinery with pneumatic or rubber tire</p> <p>Adopt harvesting plan that minimizes road and skid trail network</p> | Minor |
| | Noise Pollution from forest machinery | S, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Temporary • Irreversible | Minor | <p>Ensure all workers use noise protective gear such as earplugs and headphones to minimise noise from harvesting machinery.</p> <p>Avoid prolonged operation of machinery.</p> | Negligible |
| | Alteration of landscape aesthetics | E | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Moderate | <p>Avoid contiguous harvesting of large areas to minimise disruptions to landscape and ensure proper disposal and management of slash material.</p> | Minor |
| | Fire risk from dry fuel matter | E, H | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Major | <p>Essential dry fuel matter (twigs, branches, offcuts, etc) are properly organised for controlled burning or disposal. Some leafs may be left on undergrowth to provide nutrients to soil once decomposed.</p> | Minor |

Table 32: Enhancement Measures for Fire Management

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Enhancement | Prescribed Enhancements | Rating after Enhancements |
|--|---|-------------|--|---------------------------|--|---------------------------|
| <i>Forest Fire Protection and Management</i> | Protection of stakeholder future revenues from forest outputs | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Conduct regular stakeholder consultations on fire prevention measures in project area and outline support required from local communities and chiefs | Highly Beneficial |
| | Protection of worker livelihoods | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Ensure active participation and awareness of impact of fires by workers to protect their livelihoods | Major |
| | Protection of health of local communities | S, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Conduct awareness campaigns with stool landowners, health authorities and opinion leaders on fire ignition, health risks and control. | Major |
| | Support regeneration of reserve | E | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with Forest Services Division and Wildlife Division on effective fire management strategies and procedures | Highly Beneficial |
| | Protection of wildlife habitats and fauna | E, S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Implement appropriate and adequate fire breaks near and around wildlife habitats to avoid fire spread and damage to habitats | Major |

Table 33: Enhancement Measures for Treatment Plant and Sawmill

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|---|---|-------------|---|--------------------------|---|-------------------------|
| <i>Establishment of Treatment Plant and Sawmill</i> | Employment | S, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Train and employ more local people to work in proposed sawmill and treatment plant | Highly Beneficial |
| | Skills development and training | S, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Adopt early skills development training to support operation of treatment plant and sawmill. Ensure gender balance as part of skills development plans | Major |
| | Integration with local and regional development | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with Asante-Akyem North District Assembly and traditional leaders on regional development initiatives and ascertain contribution of NMFC to local and regional developments. | Major |
| | Development of support industries and services for increased economic activity | S | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Minor | Collaborate with District Assembly and opinion leaders to promote and attract support services industries to Agogo. e.g. transport, machine servicing, tooling, etc | Major |
| | Migration from surrounding communities and effect on jobs, housing and social amenities | E, S, H | <ul style="list-style-type: none"> • Negative • Indirect • Regional • Temporary • Irreversible | Moderate | Offer job opportunities/training to locals first. Migrant employment should be a last resort to minimise effects on housing and social amenities. Collaborate with District Assembly on migration as and when it occurs | Minor |

Table 34: Enhancement Measures for Labour and Staff Recruitment

| Project Activity | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|-------------------------------------|------------------------------|--------------------|--|---------------------------------|---|--------------------------------|
| <i>Labour and Staff Recruitment</i> | Employment of locals | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Seek to offer preferential employment to locals before considering non-local job seeking migrants wherever possible | Major |
| | Income generation for locals | S, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Seek regular opportunities to enhance income earning potential of workers; as this will help alleviate poverty and improve health | Major |
| | Gender balance and equality | S, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Reversible | Major | Create opportunities for women to obtain gainful employment with NMFC wherever possible and support their overall welfare | Major |

Table 35: Enhancement Measures for Stool Landowner Expectations

| Stakeholder | Potential Impact | Impact Type | Description of Impact | Rating before Enhancement | Prescribed Enhancements | Rating after Enhancements |
|---|--|-------------|--|---------------------------|--|---------------------------|
| <i>Meeting Agogo, Kumawu, Kwamang Stool Landowners Stakeholder Expectations</i> | Revenue streams from plantation outputs | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Ensure regular consultations with landowners on progress of the project | Major |
| | Curtailing of illegal migrant farmers encroaching on the reserve | E, S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with Forest Services Division to share information and ideas for effective monitoring and management of the reserve | Major |
| | Employment, capacity building and training for local populace | S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Build capacity of employed workers through on the job training and skills development. Seek to employ more locals as and when the need arises. | Major |
| | Monitoring and Management of the reserve | E,S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Major | Collaborate with Forest Services Division to share information and ideas for effective monitoring and management of the reserve | Major |
| | Allocation of reserve lands for admitted Ananekrom settlement | S | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Moderate | FC should review reserve boundaries within the context of Ananekrom already expanding into NMFC allocated Block D compartment | Major |

Table 36: Enhancement Measures for Forest Services Division Expectations

| Stakeholder | Potential Impact | Impact Type | Description of Impact | Rating before Enhancement | Prescribed Enhancement | Rating after Enhancement |
|--|---|-------------|--|---------------------------|--|--------------------------|
| <i>Meeting Forest Services Division Stakeholder Concerns</i> | Reforestation and management/ monitoring of the reserve | E, S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with Forest Services Division to share information and ideas for effective monitoring and management of the reserve | Major |
| | Curtailing of Illegal encroachment of the reserve by illegal settlers | E,S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with Forest Services Division to share information and ideas for effective monitoring and management of the reserve | Major |
| | Management and Control of Fire in the reserve | E, H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Strengthen collaboration with FSD on fire monitoring and management. Implement rapid response fire alert procedures, skilled fire fighters and adequate fire equipment. Conduct fire hazard awareness programmes for farmers and local communities | Major |
| | Benefit sharing formula for sharing of future forest revenues | E,S | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Major | Collaborate with FSD and the 3 stool landowners to agree procedures and channels for payment/sharing of future forest benefits amongst landowners | Major |
| | Re-allocation of previously abandoned plantations to serious minded investors | E | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Major | Keep FSD/FC informed on successes and benefits of the project to strengthen plantation development policies and mechanisms. | Major |

Table 37: Mitigation Measures for Wildlife Division Expectations

| Stakeholder | Potential Impact | Impact Type | Description of Impact | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|--|---|-------------|--|--------------------------|---|-------------------------|
| <i>Meeting FC Wildlife Division Stakeholder Concerns</i> | Impact of agro-chemicals and spend oils on Fauna | E | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Major | Ensure proper handling of agro-chemicals. Ensure strict adherence to proper disposal of empty containers. DO NOT DISPOSE OFF IN THE RESERVE. Educate farmers whenever possible. | Minor |
| | Poaching of game by workers and local communities | E | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Minor | Conduct anti-poaching awareness programmes for all field workers and local communities | Minor |
| | Management and reduction of farm fires | E | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Major | Strengthen collaboration with Wildlife Division on fire monitoring and management. Conduct fire hazard awareness programmes for farmers and local communities | Minor |
| | Damming of water courses for irrigation | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Negligible | Do not dam any water courses for plantation irrigation. | Negligible |

Table 38: Mitigation Measures for Squatter Farmers and Herdsmen Expectations

| Stakeholder | Potential Impact | Impact Type | Description | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|---|--|-------------|--|--------------------------|--|-------------------------|
| <i>Meeting Squatter Farmers and Herdsmen Concerns</i> | Clearing of illegal plantain and maize farms | S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Major | Avoid any clearing of farms found in allocated compartments and inform Forestry Commission who are the legal custodians of the land for action. Collaborate with FC for alternative replacement lands to be allocated to NMFC. | Minor |
| | Loss of access to lands for farming and cattle grazing | S | <ul style="list-style-type: none"> • Negative • Indirect • Local • Permanent • Irreversible | Minor | Seek opportunities to offer alternative employment; such as outgrower schemes within the project wherever possible; but recognising that the Forestry Commission is the final arbiter on use of reserve lands | Minor |

Table 39: Enhancement Measures for Asante –Akyem North District Assembly Expectations

| Stakeholder | Potential Impact | Impact Type | Description | Rating before Enhancement | Prescribed Enhancement | Rating after Enhancement |
|--|---|-------------|--|---------------------------|---|--------------------------|
| <i>Asante-Akyem North District Assembly Expectations</i> | Creation of Employment Opportunities | S | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Major | Provide regular updates on employment statistics. Collaborate to identify matching employment opportunities linked to planned developments. | Major |
| | Integration with local and regional development | E, S, H | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Major | Collaborate with Assembly to discuss and contribute inputs into local and regional development plans. For e.g. Long term vision for a bypass for the town | Major |

Table 40: Enhancement Measures for Agogo Presbyterian Hospital Expectations

| Stakeholder | Potential Impact | Impact Type | Description | Rating before Enhancement | Prescribed Enhancement | Rating after Enhancement |
|---|---|-------------|--|---------------------------|---|--------------------------|
| <i>Meeting Agogo Presbyterian Hospital Stakeholder Expectations</i> | Increased awareness of proper sanitation for control of malaria and water borne diseases. | S, H | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Major | Conduct waste disposal/management study in collaboration with local hospital and share information and educate local community | Major |
| | Improving workers knowledge on basic health practices | S,H | <ul style="list-style-type: none"> • Positive • Direct • Local • Permanent • Irreversible | Moderate | Conduct regular basic health training for workers and maintain training records. | Major |
| | Occupational health hazards information | S,H | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Minor | Prepare list of potential health hazards and sources from forest activities, machinery, tools and communicate to local hospital to facilitate prompt treatment when needed. | Moderate |
| | Support for the development of a new health centre for Ananekrom | S, H | <ul style="list-style-type: none"> • Positive • Indirect • Local • Permanent • Irreversible | Moderate | Consider engagement with Primary Health Care to assess how NMFC can assist. | Major |

Table 41: Mitigation Measures for Water Resources Commission Expectations

| Stakeholder | Potential Impact | Impact Type | Description | Rating before Mitigation | Prescribed Mitigation | Rating after Mitigation |
|--|---|-------------|--|--------------------------|---|-------------------------|
| <i>Meeting Water Resources Commission Stakeholder Expectations</i> | Contamination of Buffer and Riparian Strips near water bodies | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Moderate | NMFC should ensure that existing tree and vegetation buffers are sound. Where necessary adopt 10-15m buffers from water bodies. Avoid soil preparation and planting close to riparian areas. | Minor |
| | Inappropriate use of agro-chemicals | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Moderate | Adopt proper supervision of use of agro-chemicals. Avoid over-concentrations and spillages. Ensure proper collection of spent containers and ensure proper disposal. | Minor |
| | Uncontrolled use of water systems | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Minor | Avoid damming of water courses and nearby streams. | Minor |
| | Interruption of underground water recharge | E, S | <ul style="list-style-type: none"> • Negative • Direct • Local • Permanent • Irreversible | Minor | Care should be exercised during road construction to minimise soil compaction | Negligible |

7. RECOMMENDATIONS AND CONCLUSIONS

Following our investigation and analysis of the various aspects of the proposed development, we present our recommendations and conclusions for mitigating any negative environmental and social impacts from the proposed development by NMFC;

Key Recommendations

1. Collaboration with institutional and local stakeholders is critical to the successful execution of the project. NMFC should therefore seek to develop strong collaborative and participative stakeholder relationships capable of assisting the project in achieving its commercial and socio-economic objectives.
2. The Boumfum reserve was previously a natural occurring forest; which is very difficult to replicate without allowing for about 50-60 years of natural regeneration with minimalist human activity in the reserve. Therefore the proposed use of fast growing Teak and Eucalyptus plantation species accelerates the re-generation process. However, care should be exercised to ensure that a harmonious landscape is achieved from a combination of the proposed species and the re-introduction of indigenous species as part of the plans to restore the reserve.
3. Since, the Eucalyptus species are mainly hybrid varieties, NMFC should provide regular growth and general performance data to the Forestry Commission. This will serve to inform the Commission and its agencies on the best plantation practices; as well as performance and growth characteristics of these species.
4. Soil improvement measures such as the application of fertilizers should be undertaken in a carefully controlled manner; ensuring that excessive application of fertilizers is avoided at all costs. In addition, consideration should be given to encourage natural soil enrichment from decomposed leaves, twigs, and vegetation wherever possible.
5. NMFC should ensure that soil erosion is kept at a minimum by adopting the prescribed mitigations and adopting preventive measures to limit the effects of run-off from slopes during the rainy seasons. Ridging parallel to the terrain contours should be used to avoid soil erosion. Where mechanical ploughs are used, it should be done along the contours not on gradients exceeding 10%. By mixing cleared vegetation into the soils to act as mulch, soil erosion will be greatly minimised and soil nutrients enhanced from decomposed vegetation. NMFC should also ensure that appropriate expertise and supervision is deployed in the field during soil preparation activities.
6. The reserve is traversed by many seasonal streams which are likely to flood low lying valley areas in the reserve during the rainy seasons. Care must therefore be exercised in soil and land preparation activities to limit soil erosion and sedimentation of water bodies.

7. Road construction and maintenance activities can lead to increased surface run-off from slopes; leading to soil erosion. Care must therefore be exercised in the construction, maintenance and alignment of roads to ensure that gradients and contours are taken into consideration during the planning process. The use of drainage bars and culverts is recommended wherever possible.
8. It is well known that most of the wildlife animals have migrated to the nearby Bomfobiri Wildlife Sanctuary. Nevertheless, there are occasional sightings of some fauna operating in and around NMFC's allocated compartments near riparian strips and water bodies. NMFC should therefore sensitise its workers to desist from poaching of game and fauna. Wherever possible, NMFC should also protect fauna habitats; especially when creating new conservation areas within the reserve.
9. Since farming is the mainstay of Agogo, NMFC should develop agro-forestry schemes such as controlled inter-cropping within its allocated areas. This may be done in small patches of land which may not be suited for tree planting but adequate for the establishment of small subsistence farming. Nevertheless, strict monitoring is required together with obtaining permission from the Forestry Commission and Stool landowners, to ensure that reserve lands are not over-run by farmers.
10. NMFC should consider adopting out-grower schemes whereby farmers are supported with all necessary technical and financial inputs for planting of trees under the supervision of NMFC. The farmers can then share in the financial returns gained from the trees after deduction of plantation investment costs. This arrangement must seek the approval and participation of the Forestry Commission; the management custodians of the reserve who have already indicated a keen interest in establishing out-grower schemes.
11. Management of fire is an essential part of protecting the reserve. NMFC should therefore hold local stakeholder consultations to identify a pool of locals who will be able to support NMFC's fire fighting efforts in the unfortunate event of a large fire outbreak in the reserve. This is a necessary stakeholder collaborative initiative aimed at protecting Agogo and its surrounding communities from the damaging effects of fire and smoke inhalation.
12. NMFC should undertake quarterly environmental monitoring activities on soil erosion, sedimentation and monitoring of river water quality. It is recommended that findings from such monitoring activities should be communicated to institutional stakeholders such as the Forestry Commission, Soil Research Institute and Water Resources Commission.
13. By way of sharing of best practices, communicating project progress, successes and challenges, periodic and annual stakeholder meetings and consultations should be undertaken with all local and institutional stakeholders.

Main Conclusions

- ✓ The Boumfum reserve is a severely degraded reserve that no longer contributes positively to the socio-economic development of nearby communities; especially Agogo. This is mainly due to the cessation of forest and commercial logging activities. In its current form, the reserve is at major risk to further degradation caused by illegal migrant settler farmers and associated forest fires. The consequences of such a development are dire and could have serious environmental and socio-economic consequences for Agogo.
- ✓ The NMFC proposed project presents a rare opportunity for much needed interventions to be made in restoration of the reserve. This is not without its challenges and requires strong stakeholder collaboration and participation in what could be a major success story for Agogo and its surrounding communities. The potential economic spin offs from successful implementation of the project are very substantial. Financial projections estimate that the cash outflows into the Agogo area over the next 10-15 years is in excess of \$10m.
- ✓ The accruable benefits attributable to the stool landowners, local community, district assembly and forest agencies; subject to achieving plantation goals is in excess of \$10m by 2023 and worthy of participative stakeholder support.
- ✓ The proposed development poses some environmental risks which require mitigations to minimise the effect on the environment and stakeholders. Of particular concern is the effect of soil erosion from some areas of the reserve on water bodies around some of NMFC's allocated compartments. These parameters require NMFC to closely monitor their proposed activities in relation to soils and water bodies; and ensuring that international best forestry practices are adopted wherever possible for effective mitigation.
- ✓ The impact of NMFC's proposed plantation development on farming in the reserve poses some serious challenges. These challenges can be addressed when the various legislative instruments pertaining to the setup, management and operation of the reserve remain the over-riding factor in what is a complex socio-economic issue. Therefore skilful and timely management interventions and close stakeholder collaborations are required to ensure that there is a balance achieved between compliance with the legal frameworks pertaining to the establishment of the reserve and ensuring the farming livelihoods of the local community.
- ✓ Although proposed as a latter value addition element of the project; and to ensure and maximise commercial and socio-economic benefits, NMFC should begin to collaborate with all necessary stakeholders to gain land for the proposed establishment of a timber treatment plant; so as to ensure that the value adding element of the project can be established in time to process the tree outputs from the Eucalyptus plantations by 2020.

- ✓ NMFC is currently the second largest employer in Agogo after the Agogo Hospital. This makes the company an important stakeholder in the development of local and regional development plans currently being drawn up by the Asante-Akyem North District Assembly. NMFC should therefore actively collaborate with the Assembly in the development of local initiatives such as water supply, housing and waste management.
- ✓ From a management point of view, the project has recruited a high calibre team of international and local forestry experts and consultants to assist it deliver the project objectives whilst taking into account key stakeholder interests and concerns. This provides confidence and assurances that the project intends to deliver value adding benefits for its stakeholders whilst ensuring a balance between commercial aspirations, socio-economic impacts and protection for the environment.

In conclusion, the NMFC proposed project is worthy of support from all local and institutional stakeholders. The long term benefits from the proposed project far outweigh any mitigated adverse effects. The potential benefits include:

- ✓ Restoration of parts of the Boumfum reserve and regeneration of wildlife and fauna habitats
- ✓ Provision of jobs for the local populace; with a focus on achieving gender balance and equality
- ✓ Daily wage earnings significantly above (53%) government approved minimum daily levels; thus contributing to improved welfare of its employees.
- ✓ Substantial long term financial returns for key stakeholders in excess of \$10m.
- ✓ Supply of much needed timber products for local and regional development.
- ✓ Development of vocational skills and capacity building for locals
- ✓ Development of agro-forestry initiatives in collaboration with the local community
- ✓ Support for local good causes by the NMFC project and
- ✓ Increased direct foreign investment into much needed plantation development schemes for restoration of the country's degraded forest reserves.

APPENDIX 1

Terms of Reference for Environmental Impact Assessment for NMFC

The Scope of Work for the conduct of the Environmental Impact Assessment will involve the preparation of an Environmental Impact Statement (EIS) that has the following components:

Non-Technical Executive Summary

This will include:

- A brief description of the proposed project and affected environments.
- Outline of the main conclusions and how they were reached.
- Main mitigation measures and interventions to be undertaken in support of the project and plans for monitoring environmental performance and any residual impacts.

Introduction and Background to the Project

The Consultant will be expected to provide detailed information on the contextual background of the project and its relative importance to the project area. This information is likely to be derived from a number of data sources; as well as institutional and local stakeholders including:

- ✓ Forestry Commission HQ
- ✓ Wildlife Division of the FC - Kumawu
- ✓ Forest Services Division - Kumawu
- ✓ Water Resources Commission
- ✓ Environmental Protection Agency
- ✓ Asante-Akyem North District Assembly
- ✓ Agogo Traditional Council
- ✓ Kumawu Traditional Council
- ✓ Agogo Presbyterian Hospital
- ✓ Local Farmers Representatives
- ✓ Local Herdsmen Representatives and
- ✓ Local Opinion Leaders

The Consultant should also identify the necessary national legislative frameworks, policies and regulations applicable to the project aims and objectives; with a view to ensuring that the necessary legal requirements form a basis for future monitoring and compliance.

Environmental Baseline Studies

The Consultant will assemble and evaluate baseline data on the relevant environmental characteristics of the study area. The objective will be to describe the environment as it is currently and as it could be expected to develop if the project were not to proceed. Some baseline data would be obtained by collecting, collating and reviewing studies and information on the project areas from such sources as the Forestry Commission and its Agencies, Soil Research Institute (SRI), Environmental Protection Agency (EPA), Asante Akyem North District Office, Ghana Meteorological Agency, Water Resources Commission, Forest Research Institute of Ghana (FORIG), Agogo and Kwamang Traditional Councils etc. These would be supplemented by information gathered from field trips to the project area and associated environment. It is envisaged that the baseline studies will generally cover the following areas:

Topography, Geology, Soils

The major topographical features of the general project area will be described. This will include characteristics indicating the elevations of natural valleys (lowlands), their trends and gradients; and any modifications of these that have resulted from man-made activities. Information will be presented on the geologic characteristics of the area including major rock and soil types in terms of permeability and erosion (wind and water). Run-off potential will be assessed with respect to the types of slopes and infiltration capacity. The physical and chemical properties of soils in the allocated compartments and the reserve will also be determined. The EIA should include some soil sampling leading to a soil map being produced for the NMFC allocated lands in the reserve.

Climate and Air Quality

Existing data on rainfall, temperature, evaporation etc., as they affect the hydrology of the study area will be collected and reviewed. The state of air quality with respect to dust and noise will be assessed.

Surface and Ground Waters

This part of the baseline study will involve collection of the following information:

Surface Hydrology

This will cover identification of surface waters including drains and ponds, field assessment of flows including flood estimation and risk where significant surface water resources are available, sediment transport, potential for erosion and assessment of dependency of inhabitants on surface waters.

Groundwater Occurrence

Groundwater occurrence and its utilization, measurement of groundwater levels and flow directions, and the lithology, thickness and structure of soil and overburden materials and structural features of bedrock or any outcrops will be examined.

Assessment of Water Quality

Samples of ground and surface water close to or within the project area, including sediments, will be collected and analysed to assess their quality.

Flora and Fauna

This requires recording and description of faunal and floral species and assessment of their importance. It will also include identification of endangered biota, if any, that need to be protected. Data collection will involve field observations and interviews of local inhabitants in the study area to be supplemented by literature reviews.

Aquatic Life

The study will involve assessment of biodiversity of nearby watercourses and other key surface waters as well as sediments. The fisheries of water bodies close to the project area will be assessed through reviews of catches by local fishermen.

Population and Demographics

This requires the collection and collation of information on population structure and available utilities and infrastructure as well as their implications for development planning. The major socio-economic activities in the project area and future trends will be described.

Land use

Collection and collation of information on land use will involve identification of areas of influence of project and main forms of zoning, assessment of land use practices including the existing agriculture and environmental implications. Others considerations include determination of land tenure and ownership and areas that need to be protected.

Public Health

Information on the health of residents in the project will be obtained from hospitals and health centres to investigate occurrence of conditions for water-associated diseases such as malaria, cholera, guinea worm and bilharzia.

Cultural Heritage

Data would be sought on any sites that may be of significance for archaeological, historical, cultural or religious reasons. Interactive and participatory methods would be used to obtain the required information.

Social Responsibility Agreements

Information will be gleaned from stakeholder interactions about the type of social and economic projects that are of interest to the people in the project area. The Consultant should endeavour to identify specific priority projects of interest and comment on the likely potential benefits to be gained by the local populace as well as the project implementers.

IDENTIFICATION AND ASSESSMENT OF POTENTIAL IMPACTS

The EIA will explain the magnitude of the impacts of the project on the area where it is located, together with the significance of the impacts dependant on the degree to which natural and social resources are affected.

An Environmental Impact Statement will be prepared by systematically assessing the effects of the construction and operation of the project on the basis of the issues identified during Scoping; as well as of details of information obtained from the baseline studies. The size of each anticipated social and environmental impact, whether positive or negative, would be determined as the predicted deviation from the baseline conditions during normal operating conditions.

In addition to whether they are beneficial or not, all impacts would be evaluated as to determine whether they are direct, indirect; reversible, irreversible; local, regional or site specific; short term, medium term or long term. The assessment shall include, but not be limited to, the following:

- ✓ Prevention of soil erosion and sedimentation;
- ✓ Prevention of contamination of surface water systems and groundwater aquifers from the operational phases of the project;
- ✓ Atmospheric pollution including noise and dust nuisance from the project;
- ✓ Preservation of populations of flora and fauna especially endangered species;
- ✓ Disturbance of vegetation and plans for re-vegetation;
- ✓ Preservation of areas and land use of unique value;
- ✓ Possible increase in population due to migration of workers and the likely social implications
- ✓ Possible impacts on stakeholder interests

ANALYSIS OF ALTERNATIVES

The EIA will include analyses of realistic alternatives with respect to the project design, its objectives, location, planned activities, and management. It is expected that, where relevant, the analyses will lead to proposals that would be considered more appropriate from an environmental, social and economic point of view, compared to what was originally proposed.

The Consultants will be expected to put forward alternatives to the original project design wherever possible; explaining the rationale behind such alternatives and taking into consideration the impact of such alternatives on stakeholder interests and concerns.

MITIGATIONS

All identified significant adverse impacts from the project activities should be considered for mitigation and specific practicable measures proposed. The main objective of mitigation would be the formulation of protection and enhancement measures to provide a framework for minimizing detrimental effects; while enhancing beneficial aspects and promoting effective management of social and environmental resources. The Consultant is expected to draw up mitigations for some of the following anticipated impacts. The list is indicative and a more exhaustive list will depend on the Consultant's findings from field visits, stakeholder consultations, expertise and review of the company's operational plans.

1. Impact on land use
2. Impact on soil nutrients
3. Impact on soil erosion
4. Impact on groundwater
5. Impact on recharge of aquifers
6. Impact on surface run off
7. Impact on eutrophication
8. Impact on impoundment of streams
9. Impact on water quality of rivers and streams
10. Impact on noise pollution
11. Impact on air quality
12. Impact on vegetation
13. Impact on food sources for fauna
14. Impact on illegal plantain and maize farms
15. Impact on livelihoods of illegal migrant farmers
16. Impact on the development of micro climates
17. Impact on alteration of reserve landscape
18. Impact on Inter-cropping by local farmers
19. Impact of dispersal of dust from use of roads

20. Impact from economic migration of people from outside project area seeking jobs, housing and social amenities
21. Impact on employment and job creation
22. Impact on income generation for workers

CONCLUSIONS AND RECOMMENDATIONS

The Consultant will be expected to draw major conclusions from the main assessment; identifying key observations and their relative importance to the project objectives and aims. In addition, the Consultant will be required to make all necessary recommendations relevant to the project; highlighting positive impacts and key areas for mitigation interventions.

ENVIRONMENTAL MANAGEMENT PLAN (EMP)

An Environmental Management Plan (EMP) has been developed by the Company and the Consultant will be expected to review the plan within the context of mitigations proposed by the consultants; thus creating the opportunity to minimise any adverse effects on the environment and ensuring that important environmental considerations form a key part of the plan.

Report Format

- The Consultant will be expected to submit a EIA Report to the Client for review and onward submission to the Environmental Protection Agency (EPA) for assessment.
- The Consultant will liaise with the EPA to determine the number of copies of the report required for review and assessment.

APPENDIX 2**Location and Description of Observed points**

| Location | | BLK | Soil series | Soil properties | Land use |
|---------------|---------------|-----|--------------------------------|---|-----------------------|
| Latitude | Longitude | | | | |
| 6° 52' 20.7" | 1° 03' 25.88" | F | Yaya-Pimpimso | Rock outcrops | Teak |
| 6° 52' 18.3" | 1° 03' 26.11" | F | Yaya | Rock outcrops | Teak |
| 6° 52' 12.97" | 1° 03' 26.19" | F | Bediesi | Deep, loamy sand | Teak |
| 6° 52' 01.9" | 1° 03' 26.04" | F | Bejua | Deep, poorly drained, loamy sand; Water table at 100cm (valley) | Fallow - grass |
| 6° 52' 14.3" | 1° 03' 40.15" | F | Pimpimso | Shallow (45cm depth); Loamy sand containing many ferruginized sandstone brash | Teak |
| 6° 52' 37.4" | 1° 04' 04.51" | F | Bediesi | Deep, well drained, sandy loam top underlain by clay loam | Onion, Plantain |
| 6° 52' 59.48" | 1° 04' 34.3" | F | Yaya | Rock outcrops abundant on the surface | Plantain |
| 6° 55' 02.21" | 1° 01' 18.04" | D | Sutawa | Deep, moderately well drained, sandy loam topsoil underlain by clay loam | Fallow |
| 6° 55' 29.8" | 1° 02' 18.9" | D | Sutawa | " | Plantain, cassava |
| 6° 56' 30.95" | 1° 02' 17.49" | | | | Nursery - Off Reserve |
| 6° 51' 28.00" | 1° 07' 21.01" | G | Bediesi – shallow (50cm depth) | Shallow (50 cm), well drained non-gravelly clay loam | Plantain, Maize |
| 6° 51' 32.3" | 1° 07' 03.00" | G | Pimpimso | Shallow (40cm); sandy loam | Maize |
| 6° 51' 32.9" | 1° 07' 01.72" | G | Bediesi – shallow (50cm depth) | Shallow (50 cm), well drained non-gravelly clay loam | Maize |
| 6° 51' 32.02" | 1° 07' 00.43" | G | Sutawa | Deep, moderately well drained, sandy loam top underlain by clay loam | Maize |



COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH
SOIL RESEARCH INSTITUTE

PRIVATE MAIL BAG
 ACADEMY POST OFFICE
 KWADASSO-KUMASI
 GHANA
 WEST-AFRICA

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 E-MAIL: soilresearch@sri.csir.org.gh
 WEBSITE: www.csir.org.gh/sri.html

Our Ref: CSIR/SP/LAB/2013/8

Date: 24/07/2013

CLIENT:
 MIRO-NICOL Forestry Company
 P.O. Box 3, Agogo, Ashanti Region

Date received: 17th July, 2013
 Date analyzed: 18th July, 2013

ATTN: Hugo, Miro-Nicol Company

RESULTS OF SURFACE WATER SAMPLE ANALYSES

| Parameter | Lab No. 1 | Lab No. 2 | Ghana standards |
|---------------------------------|------------------------|-------------------------|-----------------|
| | Sample ID Ongwam River | Sample ID Boumfum River | |
| pH | 6.61 | 6.98 | 6.5 – 8.5 |
| Electrical conductivity (µs/cm) | 301.3 | 522 | 750 |
| Sodium (mg/L) | 0.003 | 2 | 200 |
| Potassium (mg/L) | 0.015 | 0.03 | 30 |
| Calcium (mg/L) | 24 | 871 | 200 |
| Magnesium (mg/L) | 0.033 | 302.4 | 150 |
| Nitrate (mg/L) | 0.058 | 0.091 | 0.05 |
| Ammonia (mg/L) | 0.792 | 0.682 | 1.5 |
| Turbidity (NTU) | 8 | 5.5 | 5.0 |
| BOD (ppm) | 6.5 | 2.37 | |

REMARKS: Calcium and Magnesium exceed drinking water standards for Boumfum but can be used for irrigation. BOD from Ongwam indicates possible organic pollutants upstream.

Dr. F.M. Tetteh
 Senior Research Scientist
 Head of Soil, Plant and Water Analytical Laboratory

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Date: 30/08/2013

CLIENT:
 MIRO-NICOL Forestry Company
 P.O. Box 3, Agogo, Ashanti Region

Date received: 22nd August, 2013
 Date analyzed: 27th August, 2013

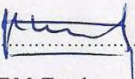
ATTN: Hugo, Miro-Nicol Company

RESULTS OF SOIL SAMPLES SUBMITTED FOR ANALYSES

Please find attached the results of soil samples submitted for analysis.

REMARKS

1. Soil pH is generally very good for plant growth and development
2. Exchangeable cations (Ca, Mg, K) are generally low and need improvement by fertilization with materials like NPK fertilizer, organic manure and dolomite. Liming is not required since the pH is close to neutral.
3. Organic matter and total nitrogen are generally low. They can be improved by application of compost / manure and mineral fertilizer (NPK)
4. Available P (phosphorus) is generally moderate and adequate. The application of mineral fertilizer will continue to maintain the levels.
5. Sand content is observed to be high in the particle size analysis while clay is low. The resulting textures are loamy sands and sandy loam which make the soil loose. The risk of erosion is therefore high and measures to prevent erosion must be seriously adopted in the farming practices.



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CSIR-SOIL RESEARCH INSTITUTE, KUMASI, GHANA
 ANALYTICAL SERVICE DIVISION
 CLIENT: NICOL – MIRO FORESTRY COMPANY LTD
 DATE RECEIVED: AUGUST 22, 2013.
 DATE ANALYZED: AUGUST 27, 2013

TABLE 1 SOIL CHEMICAL DATA, BOUMFUM FOREST RESERVE, AGOGO, ASHANTI

| lab num | labels | pH 1:1 | H ₂ O | % | C | N | % | TOT AL | % | EXCHANGEABLE CATIONS (cmol(+)kg-1) | | | | T.E.B (cmol(+) kg-1) | EXCH .A (Al+H) | E.C.E.C Cmol(+) kg-1 | % | AVAILABLE-BRAY'S | |
|---------|----------------------|--------|------------------|---|------|------|------|--------|------|------------------------------------|------|------|------|----------------------|----------------|----------------------|-------|------------------|-----------|
| | | | | | | | | | | Ca | Mg | K | Na | | | | | BASE SAT | P (mg/kg) |
| 1 | BLK G/111// 0-20 | 6.57 | | | 2.05 | 0.19 | 3.53 | 0.19 | 3.53 | 8.01 | 4.01 | 0.15 | 0.04 | 12.21 | 0.10 | 12.31 | 99.19 | 16.10 | 72.37 |
| 2 | BLK G/111// 20-40 | 6.06 | | | 0.9 | 0.09 | 1.55 | 0.09 | 1.55 | 4.81 | 1.34 | 0.06 | 0.02 | 6.23 | 0.13 | 6.36 | 97.96 | 5.10 | 30.43 |
| 3 | BLK D/157// 0-20 | 7.14 | | | 0.73 | 0.07 | 1.26 | 0.07 | 1.26 | 3.47 | 1.34 | 0.07 | 0.02 | 4.90 | 0.05 | 4.95 | 98.99 | 41.70 | 42.61 |
| 4 | BLK D/157// 20-40 | 6.35 | | | 0.49 | 0.05 | 0.84 | 0.05 | 0.84 | 4.27 | 0.80 | 0.06 | 0.03 | 5.16 | 0.11 | 5.27 | 97.91 | 9.41 | 29.76 |
| 5 | BLK F/127// 0-20 | 6.51 | | | 0.79 | 0.08 | 1.36 | 0.08 | 1.36 | 2.94 | 1.07 | 0.07 | 0.02 | 4.10 | 0.10 | 4.20 | 97.62 | 35.56 | 41.59 |
| 6 | BLK F/127// 20-40 | 6.46 | | | 0.34 | 0.03 | 0.59 | 0.03 | 0.59 | 2.14 | 1.34 | 0.05 | 0.02 | 3.55 | 0.10 | 3.65 | 97.26 | 6.54 | 28.74 |

TABLE 2 PARTICLE SIZE ANALYSIS

| SAMPLE ID | % SAND | % CLAY | % SILT | TEXTURE |
|-------------------|--------|--------|--------|------------|
| BLK G/111// 0-20 | 66.92 | 14.00 | 19.08 | sandy loam |
| BLK G/111// 20-40 | 68.20 | 20.00 | 11.80 | sandy loam |
| BLK D/157// 0-20 | 83.32 | 7.00 | 9.68 | loamy sand |
| BLK D/157// 20-40 | 80.56 | 9.60 | 9.84 | loamy sand |
| BLK F/127// 0-20 | 82.34 | 6.00 | 11.66 | loamy sand |
| BLK F/127// 20-40 | 82.98 | 6.40 | 10.62 | loamy sand |

TABLE 3. STANDARD FOR SOIL ANALYSES ASSESSMENT

| Parameters | High | Medium | Low |
|----------------------------------|--------|-------------|---------------------------------|
| Organic carbon (%) | >3.0 | 1.5 - 3.0 | < 1.5 |
| Total Nitrogen (%) | >0.2 | 0.1 - 0.2 | <0.1 |
| Bray No 1 P (mg/k soil) | >20.0 | 11 - 20 | 3 - 10:-low < 3.0 :-very low |
| Exch. Calcium {cmol (+)/kg soil} | >10.0 | 5 - 10 | <5.0 |
| Exch. Mg {cmol (+)/kg soil} | >4.0 | 1 - 4.0 | <1.0 |
| Exch. K {cmol (+)/kg soil} | >0.25 | 0.15 - 0.25 | <0.15 |
| Base Saturation (%) | 70-100 | 50-70 | <50 |

Table 2. Categories of soil pH levels

| | |
|-----------|---------------------|
| <5 | Very acidic |
| 5.1 - 5.4 | Acidic |
| 5.5 - 6.0 | Moderately acidic |
| 6.1 - 6.4 | Slightly acidic |
| 6.5 - 7.0 | Neutral |
| 7.1 - 7.4 | Slightly alkaline |
| 7.5 - 8.0 | Moderately alkaline |
| >8.0 | Alkaline |

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CURRICULUM VITAE (CV) FOR CONSULTANTS

Paul Ankrah

| | |
|----------------------------------|---|
| Position: | Managing Consultant and Team Leader |
| Profession: | Forest Products Technologist and Business Analyst |
| Date of Birth: | 31 st December, 1960 |
| Years with Winniwood: | 2 |
| Nationality: | Ghanaian |
| Membership of Professional Body: | Associate of the Institute of Wood Science, UK Ghana Institute of Professional Foresters |

Key Qualifications

Mr. Paul Ankrah is the Managing Consultant of Winniwood Consulting. He is a multi-lingual timber professional with over twenty-five (24) years experience in Forests and Wood Processing Technology, Timber Product Development, Timber Market Development, Business Analysis, Project Management, Global Best Practices, **Environmental Management, Environmental Certification**, Change Management and Financial Reporting gained in a cross-cultural timber environment across Europe, Asia, Africa and Latin America.

He was team leader for a consulting project to conduct a business and structural review of Subri Industrial Plantations Ltd for the Ministry of Trade and Industry in 2012. He was also the lead consultant to develop a timber industry blueprint for valued added processing for the Timber Industry Development Division; a division of the Forestry Commission in 2011.

Until 2011, Mr Ankrah was the Director of the Ghana Institute of Consulting where he was responsible for the training and development of public sector and private sector professionals in understanding and appreciating the rudiments of consulting practice, consulting science and consulting applications. In this role, he undertook consulting training for the Social Investment Fund to facilitate the setting up of the consulting arm of the organisation; as well as conducting business presentations to businesses in the private and public sector. He was responsible for conducting a findings presentation at an inception report workshop on an institutional reform project for senior officials of the Ministry of Environment, Science and Technology.

Mr. Ankrah was the **Head of Business Processes** of Timbmet Door Solutions Ltd, UK, for approximately two (2) years (March 2007 – December 2009). His vast experience in **Project Management** and **Organisational Development** facilitated in the development and implementation of a new business process manual for the company that resulted in a more focused and centralised approach to business planning and operational delivery. He was also responsible for **project managing** business activities in relation to the planning, production and delivery of customer timber orders that involved scheduling, purchasing, budgeted costs, materials consumption, production and delivery. He also reviewed job functions and descriptions of 4 teams (28 staff) and realigned job functions to business goals and strategy;

resulting in improved operational performance and reduction in departmental overhead costs by 4-6%.

From August 2005 to January 2007, Mr. Ankrah was contracted by Brill Sawmills UK Ltd to undertake a **Business Development and Organisational Review assignment**. He reviewed the business processes and strategic direction of the company. He also conducted a product profitability mix to assess profit contribution to the business and to identify areas for redefining the product mix to align with new business strategies. He then developed a restructuring plan for aligning internal processes with the new business strategy. His methodology resulted in a fine-tuned business and financial plan that led to improved sales and margin opportunities. He also developed a marketing communications strategy for increased adoption of new products and services from 80 newly targeted customers.

Mr. Ankrah has also worked as the **Timber Development Director** for the largest building distribution company in the world, Saint Gobain Building Distribution (October 2002 – May 2005) and had full Profit & Loss responsibility for a timber product portfolio of £153m (\$250m) turnover. He conducted a **financial appraisal** of the business and negotiated timber supplier contracts and payment terms. In addition he was responsible for streamlining supply schedules, stock management, new product development, supplier turnover and managing rebate agreements. He also conducted **strategic reviews** with regional operations directors and developed strategy and business scorecards (KPI's), in line with **international best practices**, for improved growth and profitability; resulting in an overall 10% sales growth (£153m to £168.5m) and 3% overall gross margin enhancement. Mr Ankrah also oversaw the **integration and harmonisation** of newly acquired timber businesses into Saint Gobain; ensuring that buying efficiencies were achieved by migrating new **acquisitions** to a centralised buying platform. He was responsible for developing the business strategy to setup a network of **environmental FSC chain of custody** stores across the UK branches of the company to meet the needs of environmentally discerning customers. In addition to his role, Mr Ankrah spearheaded the development and roll out of a comprehensive **timber training and development programme** for timber branches of the company.

He previously was the Timber Technology Manager of the Timbmet Group Ltd. (April 2002 to September 2002). In this role he developed and implemented a business plan, strategy and new **technology process** to reduce and stem cash outflows resulting from customer complaints and credit procedures, resulting in the dramatic reduction of credit payments by over £450,000. In this role, Mr Ankrah travelled widely across the UK evaluating products supplied to customers and assessing quality and customer service issues. He also conducted **change management** training and developed appropriate processes for 45 staff members culminating in the adoption of a new business process for sales and business development. Further, he developed an **environmental business model and business plan**, resulting in the launch of the company's CERTIM environmental products offer to its environmentally discerning customers.

In 1998, Mr Ankrah was contracted by the Forest Trust of Gainesville, Florida to lead a two man consulting team to undertake a strategic review of **environmentally certified timber**

operations in Bolivia to assess their operational capabilities and efficiencies in accessing the growing international markets for certified timber products. This culminated in the development of a strategy and business plan to set up CADEFOR; a business support organisation funded by the US Forest Service and USAID; to assist key timber operations improve their business operations to attract investments; as well as break into the growing international markets for certified timber products. Mr Ankrah later became CADEFOR's first Executive Director between 1999 and 2001; and was invited by the World Resources Institute (New Ventures), USA to address its 1st and 2nd Latin America Environmental Business Investment Forums in Brazil in 2000 and 2001.

Mr Ankrah was also the Timber Projects and Environmental Manager for Malaysian timber giant, Golden Pharos Berhad and Golden Pharos Europe Ltd (1995-1998). In this role he facilitated many timber product development and manufacturing process protocols; as well as modifying production processes to meet **international environmental standards** and requirements. He was also responsible for project managing the **Scoping and Environmental Impact Assessment** of the company's two forest concessions by the Soil Association in 1998. He also designed and implemented a complex FSC chain of custody process in two door and timber product factories in Malaysia to meet international **environmental market demands**.

Mr. Ankrah holds an MBA from Aston Business School, Birmingham, UK and a BSc in Timber Technology from the Brunel Chiltern University, High Wycombe, UK; and is also an Associate of the Institute of Wood Science, UK (A.I.W.Sc). In 2004, Mr Ankrah underwent project and industrial feasibility analysis training with the United Nations Industrial Development Organisation (UNIDO), Vienna; as well as undergoing training in business negotiation with UK renowned negotiation training provider -Hartley Brewer Associates.

Education

- Aston Business School, Birmingham, UK, 2002 – Masters in Business Administration
- Brunel Chiltern University, High Wycombe, UK, 1987 – Bachelor of Science in Timber Technology
- Associate of the Institute of Wood Science, UK, 1987

Employment History

| Period | Organization | Position Held |
|---------------|---|-----------------------------|
| 2011– date | Winniwood Consulting | Managing Consultant |
| 2010 - 2011 | Ghana Institute of Consulting | Director |
| 2007 – 2009 | Timbmet Door Solutions Ltd UK | Head of Business Processes |
| 2005 – 2007 | Brill Sawmills UK Ltd | Consultant |
| 2002 – 2005 | Saint Gobain Building Distribution UK Ltd | Timber Development Director |
| 2002 – 2002 | Timbmet Group Ltd, UK | Timber Technology Manager |
| 1999 – 2001 | Cadefor, Bolivia | Executive Director |
| 1995 – 1998 | Golden Pharos Berhad (Malaysia) | Environmental Manager |

| | | |
|-------------|--------------------------|------------------------------|
| 1990 – 1994 | Focus Do It All (UK) Ltd | Timber Technical Manager |
| 1987 – 1990 | Cuprinol Ltd – UK | Wood Finishing Trade Manager |

Languages

| Language | Speaking | Reading | Writing |
|----------|-----------|-----------|-----------|
| English | Excellent | Excellent | Excellent |
| Spanish | Good | Excellent | Good |
| Fanti | Excellent | Excellent | Fair |
| Twi | Good | Good | Fair |

Specific Employment Experience

- Timber Technical Manager, Focus Do It All (UK) Ltd; Undertook marketing research into new timber product/market opportunities and advised the £60m timber business team on the viability of identified opportunities. Conducted quality assurance audits to ensure product conformance with trading standards and British and European Standards as well as coordinating corporate activities with regard to **sustainable sourcing** of timber products and **environmental certification**. Member of the Forest Stewardship Council Technical Committee for **developing environmental standards policies** for international adoption.
- Executive Director, Cadefor, Bolivia; Conducted business evaluations of timber companies and collaborated with investors in conducting **due diligence for environmentally sound investment appraisals**. Developed business plan with financials for the setup of Cadefor, a USAID business support organisation to assist the Bolivian certified timber industry break into international markets for certified timber. In this role, he was invited by the World Resources Institute to address its 1st and 2nd Latin American Environmental Business Investment forums in Brazil in 2000 and 2001.
- Projects Manager and Environmental Manager, Golden Pharos Europe Ltd (UK) / Golden Pharos Berhad (Malaysia); Developed and implemented a chain of custody into the manufacturing processes for doors and garden furniture products; as well as project managing the **scoping assessment** of two forest concessions for **environmental certification** by the Soil Association UK Ltd.
- Consultant, TIDD, Takoradi. Lead Consultant for the development of a timber industry blueprint for transformation of the industry to adopt modern technological processes, training and capacity building for higher value-added tertiary processing.
- Lead Consultant, Ministry of Trade and Industry, Accra: Lead Consultant and Project Manager to review the operations of Subri Industrial Plantations Ltd and assess its future business options.
- Director, Ghana Institute of Consulting; Responsible for providing public sector and private sector officials with the rudiments of consulting skills practice and training. Undertook in-depth consulting skills training for the Social Investment Fund (SIF) to facilitate the setting up of a SIF consultancy organisation.

- Consultant, Brill Sawmills UK Ltd; Reviewed the business processes and strategic direction of the business within the context of its chosen timber market segments.
- Timber Development Director, Gobain Building Distribution UK Ltd; Full category P&L responsibility, budgeting and forecasting for a £153m timber product portfolio and development of **environmental certified products** through the 300 timber branch network.
- Head of Business Processes, Timbmet Door Solutions Ltd UK; Developed business process manuals for adoption by the business, reviewed production costs and profit margins; liaised and trained sales and technical teams in the adoption of new business processes and provided operational support in delivering customer timber door orders.
- Timber Technology Manager, Timbmet Group Ltd UK; Developed and implemented a business plan, strategy and new technology process to reduce and stem cash outflows resulting from customer complaints and credit procedures, resulting in the dramatic reduction of credit payments.

Dr Kwame Adam

| | |
|---|--|
| Position: | Forest Regeneration and Environmental Planning |
| Profession: | Forester |
| Date of Birth: | 11 th March 1951 |
| Years with Winniwood | 2 |
| Nationality: | Ghanaian |
| Membership of Professional Body: | Ghana Institute of Professional Foresters |

Key Qualifications

Dr Kwame Adam is a forestry consultant and research scientist with 35 years experience in **forest harvesting, natural resource management, environmental management planning and evaluation and forest regeneration.**

As Technical Director for the Ghana Timber Millers Organisation; Dr Adam has advised timber companies on Timber Resource Management, Forest Policy and Administration, and Timber Utilization Contract Area Management. He has also developed and implemented training programmes for member companies to improve forest and mill operations relating to timber harvesting, log handling/storage and processing. He also has conducted information searches on new developments in the sector and prepared information briefs for members.

Between 1999 and 2011, Dr Adam undertook many consultancy assignments for timber companies and agencies within the private and public sector. These include the Forestry Commission, Ministry of Lands, Forestry and Mines, Portal Timber Ltd, Logs and Lumber Ltd, World Bank Country Office, and Samartex Veneer and Plywood to mention a few. These assignments have been in the field of **forest resource management**, forest inventories, natural resource forest valuations, **environmental assessments** as well as forest industry planning.

As Senior Research Scientist at the Forestry Research Institute of Ghana (FORIG) Dr Adam undertook research in the areas of **forest regeneration and growth**; technologies for sustainable management of natural forests; and biodiversity conservation. Other official assignments included research programmes in **sustainable harvesting practices; watershed management**, chainsaw lumber production and rural livelihoods, organisational restructuring and strategic planning.

Education

- University of Aberdeen UK; 2003 - PhD (Forest Harvesting)
- University of Aberdeen UK; 1989 - MSc (Forest Enterprises Planning),
- University of Science and Technology, Kumasi 1987 - BSc (Natural Resource Management - Forestry Option)

Dr Adam has a Doctorate degree in Forest Harvesting and a MSc in Forest Enterprises Planning from University of Aberdeen, Scotland; as well as having gained a BSc in Natural Forest Management from University of Science and Technology, Kumasi.

Employment History

| Period | Organization | Position Held |
|---------------|--|----------------------------------|
| 2011 - date | Winniwood Consulting | Senior Consultant |
| 2010 – date | Ghana Timber Millers Organisation | Technical Director |
| 1994 – 2010 | Trescon Services, Kumasi | Consultant |
| 2008 – 2010 | WWF West Africa Forest Programme Office | Programmes Coordinator |
| 1991 – 2011 | Forest Research Institute of Ghana (FORIG) | Research Scientist |
| 1987 – 1991 | Forest Department Planning Office, Kumasi | Assistant Conservator of Forests |
| 1980 – 1984 | Sunyani School of Forestry | Forestry Tutor |
| 1974 – 1978 | Forestry Department | Forest Ranger |

Languages

| Language | Speaking | Reading | Writing |
|-----------------|-----------------|----------------|----------------|
| English | Excellent | Excellent | Excellent |
| Akan | Excellent | Excellent | Good |

Specific Employment Experience

- Dr Adam was part of the Winniwood Consulting team that reviewed Subri Industrial Plantations Ltd for the Ministry of Trade and Industry. In this role Dr Adams undertook a forest inventory and structural analysis of the Subri plantations and the company’s natural forests.
- As a Senior Research Scientist at FORIG, Dr Adam has conducted research in the areas of forest regeneration and growth; technologies for sustainable management of natural forests; and biodiversity conservation. Other official assignments included research programmes in sustainable harvesting practices; **watershed management**, chainsaw lumber production and rural livelihoods, organisational restructuring and strategic planning. He has also authored 25 technical reports and 6 journal articles.
- As a Lead Consultant to the Ministry of Lands, Forestry and Mines, Mr Adam was responsible for preparation of management Plans for Globally Significant Biodiversity Areas (GSBAs) for 13 Sites in Ghana. A twelve month contract under the Ghana High Forest Biodiversity Conservation Project of Ministry of Lands Forestry and Mines and the Forestry Commission implemented by the Forestry Services Division of the Forestry commission. The consultancy involved coordination of the process of development plans at the district and reserve levels; gathering, collating and analyzing all relevant information concerning the GSBAs.
- Was the Lead Consultant in a consultancy assignment for Portal Ltd to develop proposals for improving the Timber, Wildlife, Conservation and Ecotourism potential of Ankasa Land Management Area as part of a Forest Land Assessment for multi-purpose forest management project at Ankasaho near Prestea.

- Lead Consultant for the Forestry Commission in undertaking a review of interim forestry regulatory measures: The assignment included determining the relevance and feasibility of maintaining current high minimum exploitable diameters of trees from Forest Reserves, and Off-reserve TUCs; evaluation of the current yield formula and yield selection; Evaluation of the impact of the 40 year felling cycle on harvesting operations and health of the forest; assessment of the extent of errors associated with tree identification and measurement during stock surveys and log measurements as they impact on the determination of stumpage and the preparation of manuals to guide the Forest Services Division in the implementation of revised regulations.
- As a member of a 3 man consulting team, Dr Adam participated in the preparation of an Integrated Forest Management Plan for Yaya Forest Reserve under the Community Forest Management Project (CFMP) funded by the African Development Bank and the Ministry of Lands Forestry and Mines (MLFM) and implemented by the Community Forest Management Unit of the Forest Services Division of Ghana Forestry Commission.
- Assistant Conservator of Forests at the Forestry Department, Planning office, Kumasi. Dr Adams was responsible for the planning and execution of forest inventories; writing of forest reserve management plans; development of natural forest management techniques; and monitoring of the implementation of forest reserve management plans. He was one of the three principal architects of the forest regulation measures introduced in 1990 by the Ghana Forestry Department which included the determination of allowable cut, development of yield calculation formula and yield selection procedures.

Dr Boasiako Antwi

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| Position: | Project Consultant – Hydrology |
| Profession: | Hydrologist |
| Date of Birth: | 21 st July 1957 |
| Years with Winniwood: | 1 |
| Nationality: | Ghanaian |
| Membership of Professional Body: | Soil Science Society of America Soil Science Society of Ghana |

Key Qualifications

Dr. Boasiako Antwi is a Senior Research Scientist with 28 years working experience in Engineering Hydrology and has been involved in the planning, design and implementation of several drainage and soil and water management-related infrastructure projects in Ghana. He has many years experience in river-flow forecasting, Hydrology and design flood estimations, Floodplain management, Rainfall-Runoff modeling, Reservoir storage analysis, Management of farm irrigation systems and soil erosion modeling. He has served in various capacities including the following:

- Head, Soil and Water Management Division, CSIR-Soil Research Institute, Kumasi (1997 – Date);
- Project Leader for the survey, design and implementation of flood control dykes in the Lower reaches of Biem River at Biemso (2000);
- Member of Accra Flood Control Advisory Committee of the Council for Scientific and Industrial Research CSIR, Accra, Ghana (1995);
- Consultant to Danish International Development Agency (DANIDA) (2000) on rural drainage and settlement erosion control (2000);
- Member of Geotechnical data collection team for Auditorium and classroom structures for Garden City University, College, Kenyasi, Kumasi.

Education

- PhD Soil Science, 2006 Kwame Nkrumah University of Science and Technology (KNUST), Ghana;
- M.SC Water Resources and Environmental Engineering, University of Dar Es Salaam (1991), Tanzania;
- BSc (Hons) Agric, Kwame Nkrumah University of Science and Technology (KNUST) (1981).

Employment History

| Period | Organization | Position Held |
|-------------|--------------------------------|---|
| 2012 – date | Winniwood Consulting | Consultant |
| 1997 – date | Soil Research Institute (CSIR) | Head of Soils and Water Management Division |
| 1984 - 1997 | Soil Research Institute | Research Scientist |

Languages

| Language | Speaking | Reading | Writing |
|----------|-----------|-----------|-----------|
| English | Excellent | Excellent | Excellent |
| Fanti | Excellent | Excellent | Good |
| Twi | Good | Good | Good |

Specific Employment Experience

- Consultant to Impregillo, Rechii, Italy for the study of drainage properties of the heavy black clays during the construction of Kpong Irrigation Project Ghana (1996-1997);
- Consultant to Ricerca e Cooperation on drainage, flood and settlement erosion control (2002-2004),
- Consultant to Adventist relief Agency on settlement erosion control (ADRA) (2004-2005);
- Consultant to Northern Sugar Resources Ltd on design flood estimations for Daka Dam design, construction and irrigation system design and implementation for Sugar plantation for bio-fuel production in Ghana. 1997 – 2000.
- Consultant (Hydrologist) to Inland Valley Consortium, WARDA, Cote D’Ivoire on “Soil and Hydrological Characterisation of the Subi Inland Valley at Akyem-Abodom.

James K. Senayah

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| Position: | Project Consultant – Soils Survey and Geology |
| Profession: | Soils and Geological Scientist |
| Date of Birth: | 1 st May 1953 |
| Years with Winniwood: | 1 |
| Nationality: | Ghanaian |
| Membership of Professional Body: | Soil Science Society of Ghana Research Staff Association of Ghana |

Key Qualifications

James Senayah is a Senior Research Scientist with 26 years working experience soil sciences, soil analysis, land evaluation and surveys for agricultural purposes. In this role he has undertaken soil identification in the field, identifying their characteristics, classification, soil mapping and evaluation for various uses. He has collaborated with hydrologists, agricultural professionals, district assemblies and government ministries in determining best approaches to gain the best out of soil types. He has also undertaken studies of soils in some degraded forest areas and assessed their potential for plantation development.

He has served as a consultant on many forest based plantation projects including the following:

- Conducted geological and soil surveys for FORM International in the Asubima Forest Reserve.
- Conducted soils analysis for selected compartments for Mere Plantations in the Afram Headwaters Forest Reserve.
- Conducted detailed soil analysis for African Plantations for Sustainable Development on a site at Atebubu in the Brong Ahafo Region for forestry development.

Education

- M. Phil, Geography and Resource Development – University of Ghana, Legon, June 1995
- B.A. (Hons) in Geography with Archaeology – University of Ghana, Legon, November 1977.

Employment History

| Period | Organization | Position Held |
|---------------|--------------------------------|------------------------------|
| 2012 – date | Winniwood Consulting | Consultant |
| 2008 – date | Soil Research Institute (CSIR) | Senior Research Scientist |
| 1995-2008 | Soil Research Institute (CSIR) | Research Scientist |
| 1985-1995 | Soil Research Institute (CSIR) | Assistant Research Scientist |

Languages

| Language | Speaking | Reading | Writing |
|----------|-----------|-----------|-----------|
| English | Excellent | Excellent | Excellent |
| Twi | Excellent | Excellent | Good |
| Akan | Good | Good | Good |

Specific Employment Experience

As a Senior Research Scientist, James Senayah has mostly been involved in consultancies either as the team leader or a team player. Key amongst them include:

- 2012 - Soil study in selected compartments in the Afram Headwaters Forest Reserve which was carried out for Mere Plantations Ltd.
- 2010 – 2011: Soil consultant to Millenium Development Authority; carried out soil surveys at irrigation sites in Bontanga, Libga, Golinga and Nasia in the Northern Region of Ghana.
- 2010 - 2012: Played leading role as the Head of Division in setting up a GIS section to replace the hitherto manual map production with sponsorship from the WAAPP project.
- 1997: As a Research Scientist, he was responsible for soil surveys of The Subi valley at Akyem Abodom, Eastern Region, (Narp Rice Programme)
- 1990: He has also under taken soil surveys of the Eastern and Ashanti regions in 1990 and compiled soil maps for the area.