

4 MW Biomass Combined Heat & Power Plant Project, Loluwagoda, Mirigama

ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
Report

8/28/2015

This EIA Report is prepared for KMRI SMG Asset Company Ltd., which is an incorporated private company engaged in power generation. The purpose is to assess the environmental and social impacts of the proposed project in keeping with environmental and social safeguard policies, laws and regulations of both Sri Lanka as well as international best practices, in particular the operational guidelines of the European Investment Bank. The proposed power generation project complements Sri Lanka's energy policies. The project will have an installed capacity to generate 4.0 MW of electricity (combined power & heat) to be partly used by the existing industry owned by Silver Mills Group and the balance to be connected to the national grid. The project is being constructed on a land where the Silver Mills Group has its coconut processing plant being operated for the last few decades. The fuel wood supply chain lies within a radius of 50 km from the location of the power plant which includes villages in the Kegalle, Kurunegala and Gampaha Districts of Sri Lanka

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Abbreviations

BDFT	Blow Down Flash Tank
BEASL	Bio-Energy Association of Sri Lanka
BET	Biomass Energy Technology
BEF	Baseline Emission Factor
BMP	Biomass Power Plant
BOI	Board of Investment
CDM	Clean Development Mechanism
CEA	Central Environmental Authority
CEB	Ceylon Electricity Board
DoF	Department of Forest
DS	District Secretary
DSD	District Secretaries Division
ECF	Energy Conservation Fund
EIB	European Investment Bank
EPL	Environmental Protection License
GoSL	Government of Sri Lanka
GND	Grama Niladhari Division
GPS	Global Positioning System
GSS	Grid Sub Station
GWh	gigawatt-hour
IEE	Initial Environmental Examination
ktCO ₂	1000 tons of carbon dioxide equivalent
kV	kilovolt
LA	Local Authority
LAA	Land Acquisition Act
LTGP	Long Term Generation Plan
MoPE	Ministry of Power and Energy
MSL	Mean Sea Level
NEA	National Environmental Act
NCRE	Non-Conventional Renewable Energy
SEA	Sri Lanka Sustainable Energy Authority
tpd	Tons per day

Non-technical summary of findings and recommendations

Background

KMRI-SMG Asset Company Ltd., plans to build own and operate a Dendro Power Plant with a capacity of producing 4 MW of electricity for which site clearance has already been obtained from the Board of Investment (BOI) of Sri Lanka. The project is located in Loluwagoda, Mirigama, on a land where Silver Mills Group (SMG) has its Coconut Processing Mill. Of the land extent of 22 acres, this project will occupy around 04 acres within which associated structures will be constructed. The project does not require approval from the CEA under the Prescribed List of activities for which IEE or an EIA is mandated in terms of the National Environmental Act. However since the project was approved by the BOI following a joint inspection by BOI and CEA technical officials, a list of compliance conditions to be adhered to by the Developer for the mitigation of possible environmental and social impacts arising from the construction and operation of the proposed project were given. Besides, the Pradeshiya Sabha of Mirigama has granted the necessary building approval for the project. This Environmental Impact Assessment Report is now prepared for perusal by the European Investment Bank, which requires clients to adhere to E&S compliance based on its Environmental and Social Management System. The procedure for such requirements is laid down in the Environmental& Social Handbook of the EIB. A team of experts (whose names are given below) studied the likely E&S impacts arising from the project and their findings have been incorporated into this document.

Justification of the project

The long term vision, goals and objectives of the power and energy sector of Sri Lanka is stated in the Sri Lanka Energy Sector Development Plan (2015-2025) of the Ministry of Power & Energy. According to the Vision embodied in the Plan, the Energy Sector will be more dependent on non-conventional renewable energy sources in terms of energy mix and as far as targets are concerned the Ministry of Power & Energy envisages to achieve 20% share of the overall energy mix with Non-Conventional Renewable Energy by 2020. With a view to promoting NCRE, the Ministry of Power & Energy Ministry as well as the Sustainable Energy Authority has given prominence to producing energy using bio mass, solar, wind and hydro (which has already reached its saturation point). The target as given in the said plan is to ensure that by 2020 the energy mix will have 153 MW from bio mass projects.

In terms of bio mass, the portfolio of its inclusion into the existing energy mix is very insignificant yet, to boost the investments, the Ministry has introduced a Feed in Tariff which is very favorable to prospective investors who could produce energy using sustainably grown fuel wood. The project in this regard will contribute to the long term sustainable energy objectives of the country. Furthermore it has been found to be a viable and profitable enterprise.

The project which is on Build Operate and Own basis will be operational for a period of 20 years. There will be 69 staff attached to the project during its operational phase. During the construction phase, a work force of about 100 will be involved under several sub contracts. Initial building approvals have been received and the construction phase is expected to be completed by June 2016.

Existing Environment (Plant location and area covering supply chain)

The project will have the following main components:

1. Main infrastructure of the Plant, which is constructed in the 04 acre land close to the SMG Coconut Processing Factory at Loluwagoda, in Mirigama the area which falls within the District of Gampaha in the Western Province. In addition to the main infrastructure, the Disc Chipper and the fuel wood yard will be established within a distance of 2.5 km to the power plant and will be located in a separate property extending about 03 acres, which will be purchased by the developer.
2. The other major component is the supply chain of fuel wood. The project requires a minimum of 125 tons per day of sustainably grown fuel wood, which in this case is *Gliricidia Sepium* in the long term and other sustainably grown fuel wood in the short term and in the interim period. The project does not envisage having a dedicated *Gliricidia* plantation for this project but will rely on harvesting *Gliricidia* from areas where this is naturally grown by households and medium to large scale coconut and tea plantations. The Developer has linked up with *Gemi Sarana Kendraya*, which is an umbrella organization with a network of small groups of community members operating within the geographical area covering nearly 50 km radius from the central power plant of the project, with a view to establishing a firm supply chain of fuel wood. The areas falling under this radius consists of four Divisional Secretariat Divisions and nearly 65 GNDs with over 10,000 community members.

As far as existing environment is concerned, the land in Loluwagoda where the Power Plant will be established is the property of SMG, a partner of the proposed project. The property is leased by SMG to KMRI SMG Asset Company. The prevailing environment in the immediate surroundings therefore is industrial with at least three coconut processing factories operating in close proximity.

The adjacent land (owned by another land owner) has also been cleared on to the right side of the proposed plant, and when making inquiries, it was mentioned that the owner is planning to establish a coconut mill. Therefore the area in which the power plant is expected to be installed will be in an industrial area. The BOI industrial zone which has about 07 operating industries is also located about 1.7 km from the proposed power plant. The immediate surroundings consist of major roads which are connected to major cities such as Kandy, Colombo and Kurunegala. The area in which the power plant is being built is not a highly congested urban area with a significant density of human habitation but there is a presence of medium to large privately owned coconut plantations. The proposed Disc Chipper will be located in one of the coconut estates which is also about 2.5 km away from the project area.

The area which is identified for the collection of fuel wood covers a large extent, extending to four divisional secretariat areas namely, Gampaha, Kurunegala, Kegalle and Warakapola. The areas where the fuel-wood will be collected are predominantly rural with diverse socio economic backgrounds. Those areas are characterized by small homesteads with lands extending from ½ acre to about 3 acres, their home gardens consisting of different types of vegetation including timber, fruit and commercial crops such as coconut, tea and in some cases rubber. The *Gemi Sarana* village organization is present in many of the villages with women being members, actively involved with the parent organization.

There is a programme already initiated by *Gemi Sarana* in these areas through participation of the members to grow *Gliricidia Sepium* in their home gardens. Most of the members of *Gemi Sarana* are women, who are devoting time to improve their home gardens. Other than those who have larger land plots (2-3 acre or over), the owners of the small parcels of land (1/4 to 1 acre) do not consider their homesteads as a source of main income. They have permanent income sources from their own employment/business activities.

Women consider that their home gardens will bring in a subsistence income. SMG which is one of the oldest coconut processing industries is very well connected to the coconut producers at the village level. Therefore a trust has already being built between the Developer and the coconut producers where SMG receives coconuts produced by the village level farmers in exchange for various support mechanisms to sustain their supply of coconut.

A part of the project area belongs to the coconut triangle. In parts where tea is being cultivated, a natural vegetation of *Gliricidia* is observed (Small holdings). The reason is that most coconut and tea plantations are intercropped with Pepper which is a favorable commercial crop. Where Pepper has been intercropped, *Gliricidia* is largely available as a supporting tree. According to published data nearly 363,000 ha of land is under coconut cultivation. Small holders are those who own less than 20 acres of coconut land. 75% of coconut lands are held by small holders. Coconut is grown widely in Kurunegala and Gampaha districts and therefore there is a possibility that the project could have its share of *Gliricidia* stocks from close proximity.

Environmental Impacts

Environmental impacts have been assessed in terms of anticipated ecological and social impacts. In addition, health and safety impacts too have been appraised. Ecological impacts have been investigated through a fauna and flora survey undertaken by experts. The observations made by these experts have been incorporated into the main report. Environmental impacts that are likely to arise from waste, noise, smoke, ash etc., have been assessed by physical observations and by reviewing the process flow diagrams and other technical design documents. Social assessments were carried out by the team leader in close consultation with key stakeholders.

Energy generation will be dependent on the use of non-conventional renewable energy sources (fuel wood) and therefore the net CO₂ emissions will be minimized. Vehicular emissions will be the major source of carbon, which may be offset by the plantation crops, when a programme is up and running for *Gliricidia*. It is expected that the project shall accrue more environmental and social benefits than environmental and social costs.

Anticipated Ecological and Social Impacts

The plant is being established in abandoned coconut cultivation. Several other timber species such as Jak are also present on the land and those trees are commercially not productive. The land which is used for the construction of the fuel storage yard and the Disc Chipper too are within an area of coconut cultivation and the extent is about 3 acres. Clearing of the existing coconut trees will not require the approval from the CEA, but the owner of the land may seek approval from the Coconut Cultivation Board in order to obtain approval.

The areas where *Gliricidia* fuel wood will be harvested consists of land used for planting different types of trees and plants and therefore they belong to a modified ecosystem. They are not natural ecosystems such as forests or wetlands. Being small scale land areas, with *Gliricidia Sepium* is naturally occurring along live fences of those lands or as supporting trees for pepper or shade trees in the tea estates. Harvesting *Gliricidia* as a source of fuel wood will not pose any ecological imbalances. Through *Gemi Sarana Kendraya*, its membership has already initiated a homestead programme to plant *Gliricidia* and sometimes, for lack of space they plant under shade conditions. Necessary instructions have been given to the community members as to the factors that must be considered when planting *Gliricidia*. One of the areas of concern is the loss of some important plants in homesteads due to the decision of the house holders to plant *Gliricidia* after clearing existing homestead vegetation. During the ecological survey, it was observed that some of the floral species in home gardens are an important form of conservation. The list is provided. More awareness needs to be given to the community members to protect such species during harvesting periods.

Another ecological concern is that forest trees can be impacted due to harvesting of a large stock of fuel wood for the use of the power plant on a daily basis. In the quest to supply fuel wood the suppliers may cut forest trees unless there is a strict system in place to ascertain if the *Gliricidia* as well as any other sustainably grown fuel wood are sourced from certified plantation areas and not from the wild. The project plans to have a mix of sustainably grown fuel wood such as *Gliricidia*, *Acacia*, cashew etc. on an interim basis, until the full cycle of harvesting *Gliricidia* is established, at least within the second year of the project's operation.

As far as other environmental impacts are concerned, the most important elements are the waste water and ash during the project's operational phase. Social impacts are rather high in

connection with the harvesting and supply of *Gliricidia* fuel wood. The impacts have been studied in detail in the relevant chapter. Injuries that may be caused to community members, when harvesting is carried out using manual tools, snake bites, accidental falls that could arise when harvesting and collecting of fuel wood have been identified and can be mitigated if adequate safeguards are taken. The possibility that community conflicts could arise over common property when competing for fuel wood collection are also possible.

Proposed Mitigation Measures

During the construction period, there should more care should be taken on complying with occupational, health and safety guidelines. The present system of maintaining a good working environment must be further improved.

During the operation and maintenance:

- The BOI has already issued a list of E&S compliances which the developer needs to adhere to.
- The Mirigama Pradeshiya Sabha has stipulated several compliance requirements with the approval of the Building Plans which must be adhered to.
- Although the adverse environmental impacts from the project can be minimised, the challenge of the sustainability of the project lies in steady supply chain of fuel wood. It is important that very clear instructions are given by the developer to suppliers of fuel wood that no felling of forest species is undertaken in the direct or indirect supply. A certification system is necessary to ensure that the supply chain is sustainable. This can be introduced at the household level. Close monitoring of the supply chain will be necessary.
- Liquid effluents need to be treated as per the national environmental quality standards to be released on land, for irrigation purposes. This will be discharged into adjacent coconut plantations. A mechanism s to be developed to ensure that the treated effluent is tested to the required national standards before they are released.
- Ash will be transported to the Coconut Research Institute, to be used as fertilizer. The CRI has already communicated to the developer, of the willingness to accept the ash from the power plant.
- The plant operators should have and use the required personal protective equipment.

- *Gami Sarana Kendraya* and its membership need to be provided with more awareness, about the possibility of injuries during collection and harvesting of fuel wood. Safety measures should be introduced at each of the collection centers. (These have been explained in the Health and Safety Management Plan).

Conclusion

The EIB Environment and Social Handbook stipulate standards/procedures for the following:

1. Assessment and management of Environmental and Social Impacts and Risks
2. Pollution Prevention and Abatement
3. Bio diversity and Ecosystems
4. Climate Change Considerations
5. Cultural Heritage
6. Involuntary Resettlement
7. Rights and Interests of Vulnerable Groups
8. Labour standards
9. Occupational, Public Health and Safety

Having analyzed the above impacts for both the construction phase and the operational phase, it is established that the likely environmental and social impacts of the project could be reversed through appropriate mitigation measures. The mitigation measures which have been prescribed in the permits and approvals issued by the approving authorities (BOI, LCs) were carefully reviewed and incorporated into the ESMP. The CEA will issue an Environmental Protection License, on completion of the construction phase of the project, which will deal with the discharge of waste into the environment.

The project does not call for involuntary resettlement, nor does it have any impact on vulnerable groups. There is no impact on the cultural heritage. Climate change considerations have been discussed, but the project will contribute significantly to Carbon sequestration. There is no severe threat to Biodiversity but a system of certification of fuel wood supplied through sustainable means needs to be adopted. Pollution in terms of waste, water and noise and dust needs to be arrested and measures have been proposed.

Occupational, Public Health and Safety will be a concern for the workers as well as for the community linked to the fuel wood supply chain. Possible injuries, community conflicts are possible outcomes when community members participate on a long term basis in growing, harvesting and collecting fuel wood and transport of same over a period of time. They may need overall guidelines which are provided in the Health and Safety plan of the ESMP. Therefore it is concluded that the project is acceptable for implementation subject to the proposed mitigation measures and continuous monitoring and evaluation.

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1 INTRODUCTION

In the background of increasing demands for electrical power in Sri Lanka and the need to find environmentally friendly solutions not leading to any further increase in the Green House Gas (GHG) emissions, the use of sustainably grown biomass for generation of electricity has been identified as a viable alternative. KMRI-SMG Asset Co. (Pvt) Ltd., proposes to apply their experience and knowledge for this purpose by developing a 4 MW Biomass Combined Heat and Power (CHP) Project at the Loluwagoda village of Mirigama Divisional Secretariat Division (DSD) of the Gampaha District. The project site can be accessed by the Pasyala – Mirigama-Giriulla Road, 2 km from Mirigama town. The initial feasibility study for the Dendro Power Project was commissioned way back in 2012. The electricity that will be generated will be fed into the national grid after consuming at least 0.5 MW for the existing coconut processing facility owned by Silver Mills Group.

The purpose of the project is to sell electricity to the national grid under the small power purchase scheme. The Developer sought initial site clearance from the Board of Investment (BOI) which has been received subject to compliance requirements. The compliances issued by BOI is given in Annex (1). The available prefeasibility report has very briefly appraised the environmental and social issues related to the location of the power plant, water availability and access and the tentative economic and financial viability of the project. Having decided that the project could go ahead, the Developer had sought financial investment capital from Banking sources (DFCC/EIB) which has recommended that a comprehensive environmental and social assessment report as well as a comprehensive study of the supply chain of the fuel wood be conducted in keeping with both the country E&S compliance requirements and the guidelines given in the environmental and social hand book of EIB. A team of experts, whose names are given above, studied the likely E&S impacts from the project and their findings have been incorporated into this document. It is to be noted that the initial construction activities of the project have commenced based on the building approval received from the Local Authorities, by the time this report was commissioned.

1.1 The Developer

The Developer, KMRI-SMG Asset Co. (Pvt.) Ltd., proposes to develop a power plant on land on which the Silver Mills Group Mills (SMG) and its administrative complex have been located. The project proponents KMRI-SMG Asset Co. (Pvt.) Ltd holds longstanding background and experience in the development of renewable energy projects. In addition to this project, KMRI is currently engaged in developing two small hydro power projects in Uganda. SMG which is the longest coconut processing industry in Sri Lanka has the experience of operating boilers as Silver Mills Coconut Processing Factory currently generates steam using their own low pressure biomass boiler plant. The Plant consumes about 40 tons of biomass per day to meet its steam requirements at roughly 2 LKR / kg of steam. The full costs of plant (labor, consumables) are not precisely known, but the biomass used is a mix of Dendro and saw dust (about 50% each).

1.2 Objectives and justification of the project

While the main objective of the project is to invest in a viable power generation project thereby increasing the business interest of the developer, the implementation of Bio-mass Power projects is far more environmentally friendly over conventional plants.

Advantages of using bio-mass for non-conventional renewable energy generation are well established and there is a large body of literature that exists in Sri Lanka, justifying the economic benefits to rural communities accrued from such projects. This is in addition to the fact that the conversion of biomass to energy is seen as a viable option for reducing CO₂ build up in the long term mitigation of climate change impacts.

A report entitled 'Private Sector Small Scale Grid Connected Power Generation in Sri Lanka' commissioned by the Development Finance Corporation Ceylon, (DFCC) has elaborated on the experience and progress of the energy sector for the decade ending 2006. This report highlights the fact that indigenous, non-conventional renewable energy generation has a significant positive impact on the economy, society and environment of Sri Lanka.

Renewable biomass energy systems also offer a number of social benefits from employment to entrepreneurship. The proposed project will be supported by the large extents of *Gliricidia*

already available in abundance in the project area under manmade agricultural ecosystems. There is potential for expansion of *Gliricidia* in small scale home gardens and small landholdings, which is an advantage for the farming community.

Local benefits will include poverty alleviation in the rural sector, development of livestock industry, reduced soil erosion, restoration of degraded lands and amelioration of large scale impacts from fossil fired power generation. *Gliricidia* has been widely accepted as the most suitable type of wood fuel. In addition, its foliage is used as a nitrogen rich fertilizer and a valuable fodder for livestock. These properties together with the ability of the plant to grow anywhere in the country has made GOSL declare it as the most important economic crop after tea, rubber and coconut.

Recently, renewable biomass has attracted fresh interest as a resource for electricity generation due to its potential as a low cost, indigenous supply of power, not subject to vagaries of weather and for its environmental and developmental co- benefits. The main objective therefore is to complement the national initiatives of GOSL to harness sources of NCRE and to make power generation more environmentally friendly.

The proposed project would make an important contribution to the future sustainable energy generation for the national grid with the added advantage of a distributed source of generation which reduces the losses in long distance transmission of electricity from large central power plants such as coal power plants. The project aims at large scale “Import Substitution” of Fossil Fuel with existing locally available resources, thereby saving valuable foreign exchange outflows from Sri Lanka.

Gliricidia as a source of fuel wood will be planted to supply the biomass requirements of the power plant, which could be used as a source of carbon credits, bringing in further foreign exchange. Steam will be utilized in the Silver Mill Group factory in Loluwagoda, the present market leader in the export of coconut based products.

1.3 Power Sector Overview of Sri Lanka

Power sector overview in Sri Lanka		
Population:	20.65 million	
Electrification Rate:	89%	
Population Connected to Grid:	87%	
Energy Stakeholders:	Ceylon Electricity Board and Private Power Producers	
Installed Capacity:	2807 MW	
	Hydro	1,205 MW
	Thermal	1,379 MW
	NCRE	233 MW
Generation	Hydro	40%
	Thermal	60%
Electrification Level	89%	
Grid Connected	87%	
Off-Grid	02	

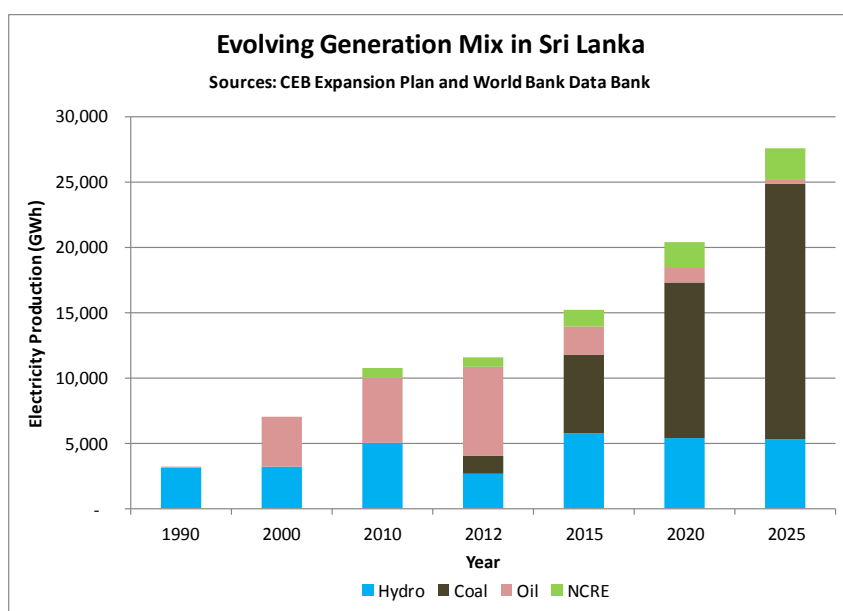
(Source- This Table was drawn from data extracted from a Power Point presentation made by Kithsisri Dissanayake, Chairman, SEA on 6th December 2011, for International Circular Economy, Conference, Rhineland, Palatinate)

The major forms of primary energy used in Sri Lanka during the year 2013 were biomass (43.3%), hydroelectricity (13%), coal (4.3 %), new renewable energy 2.6% and petroleum oil (36.9 %). ¹The long term generation plans of the Ceylon Electricity Board continue to predict all future generation to be essentially based on use of fossil fuels, particularly coal. There are plans to install more coal fired power plants, in addition to the Norochcholai plant, even though adverse environmental and other experiences at Norochcholai have been many. With the realization that coal is no longer the promised source of cheap power, as illustrated in the chart below, the need for alternative renewable energy resources has become even clearer.

The data given in Figure (1) illustrates the gradual increase in the share of thermal based electricity over the years. Out of a total estimated potential of 2000 MW of hydropower,

¹ (Sri Lanka Energy Balance 2013).

more than 75% has already been harnessed. Development of the remaining potential is becoming increasingly difficult owing to social and perceived environmental impacts. The periodical shortfall in energy from hydropower due to variation in water inflow to the hydro reservoirs is also a matter of concern. While the viability of wind and solar power generation has improved and significant amounts of wind power (90 MW) is already connected to the grid, vagaries of season is an issue which prevents large scale integration of these sources as generation options. These factors tend to justify the need to increase the share of thermal based electricity generation in the future.



1.1 Government policy regarding the related sectoral development

GOSL in its economic policy has embedded in the Power and Rural Economy sectors and the development of renewable energy as one of its key activities towards poverty alleviation and economic growth. The Minister in charge of Environment and Renewable Energy has expressly underlined the importance of this sector and in particular, the importance of biomass as a renewable and substantial resource capable of replacing fossil fuels in the future energy scenario of Sri Lanka. The Government envisions increasing the share of NCRE by 10% in grid electricity by 2016 and further increasing the target to 20% by 2020.

Cost of producing bio mass energy over conventional sources:

There has been a shift towards NCRE based energy generation projects since 1998 and in order to promote bio mass based power projects, efforts have been made by several organizations including the Sustainable Energy Authority (SEA), Bio Energy Association (BEA) and Development Finance Corporation of Ceylon (DFCC), to study the pitfalls in this sector as well as to lobby with GOSL on the promotion of a higher tariff and enabling environment for developers to invest in viable projects. Principally the power sector in Sri Lanka has a significant emphasis on NCRE of which Dendro appears to be one area of interest with a fewer number of operational power plants in this sector.

Recently conducted studies have proved that bio-mass energy is the lowest cost option, for power generation. The chart below indicates the historical and future growth of electricity demand in Sri Lanka. Biomass power using sustainably grown fuel wood would meet this requirement eminently if the supply of adequate fuel wood is assured. This has the added advantage over other renewable energy sources such as wind and solar due to the fact that it is a source of firm power not subject to the vagaries of weather and time of day. In this regard the use of Short Rotation Coppicing (SRC) tree species such as *Gliricidia Sepium* is of importance, both due to its abundance and a plethora of other benefits.

It is therefore important to install suitably sized biomass based power plants to lay the foundation for this essential change from the use of fossil fuels towards a sustainably grown biomass based power generation regime for future energy security of the country.

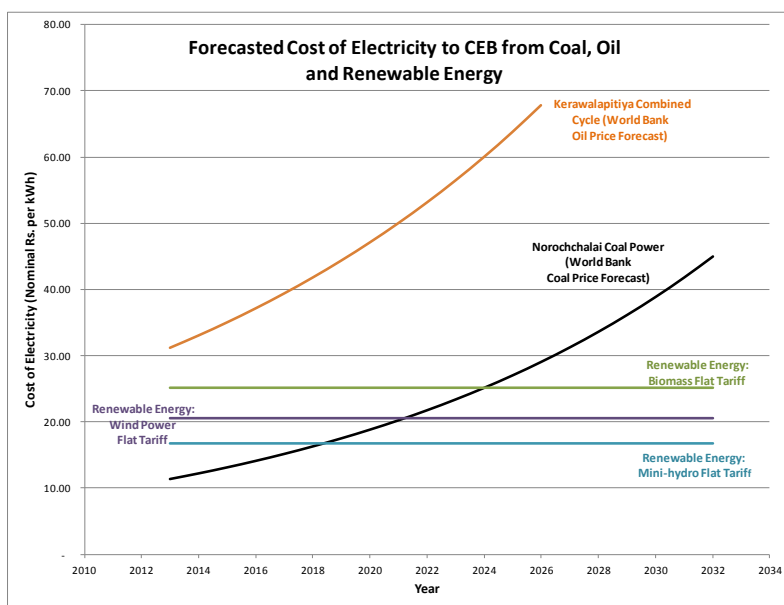


Fig 2 – Relative Costs of Power Generation

1.2 Extent and scope of the study

The project was considered as an investment under the BOI Act of Sri Lanka. The operations of all enterprises or projects approved by the BOI need to conform to the provisions of the National Environmental Act (NEA) and its regulations. The enforcement of provisions under the NEA is carried out by the BOI in respect of all projects established within its Export Processing Zones (EPZ). In respect of projects established outside EPZ, the BOI grants environmental clearance and issues Environmental Protection Licenses after obtaining concurrence from CEA where necessary.

In keeping with the above, the developer submitted a site clearance application to the BOI in 2012 for approval. The letter of approval with condition therein is given in the Annex (2) to this report. However, there has not been a comprehensive Environmental Impact Assessment carried out as project of this nature is not prescribed as requiring EIA. Thus only the key environmental and social issues contained in the application have been considered by the authorities together with information gathered through a technical site visit. Nevertheless the European Investment Bank (EIB) which serves as a refinancer to the main financier of the developer, requires to ensure that the project is meeting environmental and social compliances as per the operational policies of the Bank.

The Environmental and Social Hand Book of the EIB describes that where a comprehensive environmental and social impact assessment is required, the promoter shall prepare such a report which will include at a minimum:

- Current knowledge and methods of assessment, as well as the applicable laws and regulations of the jurisdictions within which the project operates and that relate to environmental and social matters. Gap analysis between the relevant national legislation and standards and the applicable international framework;
- Description of the methodologies applied in the assessment;
- The characteristics, technical capacity and location of the project, alternatives to the proposed project and the extent to which certain matters (including the evaluation of alternatives) are more appropriately assessed at different levels (including planning level - using the outcomes of the SEA, if applicable), or on the basis of other

assessment requirements (e.g. biodiversity assessment, human rights impact assessment, etc.);

- The description of the baseline scenario – adequate and appropriate quantitative and qualitative, primary and secondary data on the relevant aspects of the existing state of the environment and social context and the likely evolution thereof without implementation of the project, paying attention to any area of particular environmental and social importance and the use of natural resources;
- The description of the environmental and social aspects likely to be affected by the proposed project¹¹ and the assessment of the significance of the identified impacts based on clear and predetermined criteria articulated in the assessment methodology;
- Assessment of the likely significant effects of the proposed project on environmental and social aspects, including human rights, resulting from *inter alia* the existence of the project, the use of natural resources¹², the risks to human well-being, cultural heritage or the environment, and the cumulating of effects with other projects and/or activities. The description should cover the direct effects and any direct, secondary, cumulative, trans-boundary, short-, medium and long-term, permanent and temporary, positive and negative effects of the project;
- Description and justification of the measures foreseen to prevent, reduce and where possible, compensate/remedy any significant adverse effects on the environment and human well-being and where appropriate any proposed monitoring arrangement or post-project analysis as part of the overall promoter's environmental and social management plan;

The broad scope of this EIA Report is therefore:

- To conduct field visits to collect data relevant to the study area, collect secondary data so as to establish the baseline environmental status of the study area which includes the area in which the plant will be located together with its associated structures such as the Chipping Yard and the area from which the project will receive bio mass.
- To assess the environmental impacts of project components due to their location, design, construction and operation;
- To prepare a mitigation plan outlining the measures for protecting the environment including institutional arrangements and environmental monitoring;

- To identify critical environmental aspects required to be monitored subsequent to the implementation of the proposed project;
- To carry out consultation with local people so as to identify the public perception of the project; and
- To establish an Environment Monitoring Plan (EMP) and Health & Safety Plan for compliance by the developer.

This report was prepared on the basis of surveys, field studies and with the help of available secondary data.

Brief outline of the methodologies adopted:

A Biomass power plant needs certain basic facilities which are:

- Fuel wood
- A suitable land area
- Water
- Other infrastructural facilities;

Therefore this EIA is extended all the above aspects. The approach and methodology used for data collection and assessment include;

- Desk based work involving literature reviews as well as field surveys of specific sites of the project area namely;
 - Area where the project's main power plant will be established (Loluwegoda in Mirigama)
 - Location where the Disc Chipper will be installed which is close to the main power plant location (about 2.5 km)
 - Area of about 50 m radius of the main power plant which lies within at least 04 Divisional Secretariat areas from which fuel wood will be sourced.

The quantity of fuel wood to be supplied from potential sources has been examined in detail and documented as part of the work undertaken and the socio economic impacts with regard to the supply chain has been addressed.

- Field Assessments and gathering primary data:

The assessments in the field level include primarily the ecological assessment, sociological assessment, assessment of health and safety standards at the construction site, assessment of potential pollution sources and assessment of the supply chain of fuel wood. The assessment based on the literature review is mainly of the legal, institutional and regulatory environment that is applicable to power generation especially pertaining to non-conventional renewable energy generation.

Ecological Assessment:

Survey of habitats/ distribution of flora was carried out to assess project impacts and to propose mitigation actions and an environmental monitoring programme. It was intended to identify major habitats / vegetation formations, populations and communities of flora (terrestrial and aquatic) in and around the project sites (including areas from where fuel wood will be sourced) and to assess possible impacts on habitats and flora.

The survey area was confined to the specific locations and immediate surroundings directly affected by the proposed project activities. As there are no records of habitats and flora in the project areas, the EIA study team examined the areas using scientific field sampling methods. Flora in different habitats varied according to their climatic zone, geology of the area, soil types, and the microclimate of the specific site.

Plant species found in all habitats of the project areas have been recorded by walking along transects to assess the plant diversity. In addition, several transects were marked in representative habitats and 5x100 m plots/ quadrants demarcated to enumerate flora/ populations and plant communities. Land use maps (1:50,000 or 1:10,000) will be used as base maps for the EIA study.

Vascular plant species have been recorded on a plot-by-plot basis (10 m x 5 m) within every quadrant (100 m x 5 m) of a transect. The number, estimated height (with the exception of climbers) and DBH (diameter at breast height) of individuals exceeding 30 cm DBH were also recorded.

If the felling of trees was required for project activities (Example: Jak Trees), a list of species and their diameter (>30 cm DBH) has been prepared. Each herbaceous species within a quadrat was recorded and individuals are not counted. The conservation status of the species has been determined according to the Red List (2012) of Sri Lanka.

The name of the plant family, species name, local name of plant, life form, taxonomic status (Endemic, Indigenous, Introduced), and conservation status (threatened, endangered etc.) of species found in all habitats of the proposed project area has been compiled.

The observed flora species has been identified using published descriptions and taxonomic keys provided by Dassanayake and Fosberg- Handbook to the Flora of Ceylon (1980 - 1991), Dassanayake et al. (1994 - 1995), Dassanayake and Clayton (1996 - 1999) and Senaratna (2001). Anticipated impacts of the subproject on habitats, populations and communities of plants especially on ecologically sensitive habitats, endemic and threatened plant species (Critically endangered (CR), Endangered (EN) and Vulnerable (VU)) were studied, and mitigation actions proposed.

Methodology for Faunal Survey

Information on fauna found in the project area was collected from publications and field investigations. An inventory of the fauna present in the project site has been compiled using the following methodology.

The project area was stratified to sampling units based on habitat types defined by the botanist and the sites identified for various project activities. Sampling within each selected sampling unit was carried out using standard techniques.

The line transect method is the main method used. It was used to sample mobile species such as birds, butterflies and large mammals. Each line transect was designed within each sampling unit in a manner to capture the maximum possible environmental gradient present.

The animal classification, nomenclature, endemism and local names have been used as per D'abrera (1998), Fonseka (1998), Pethiyagoda (1991), Dutta and Manamendra Arachchi, (1996), De Silva (1996); Pethiyagoda & Manamendra-Arachchi, (1998), Inskipp et al (1996), and Corbet and Hill (1992).

The amphibians usually occupy the surface layer of the water and also inhabit the area closer to streams or water bodies. Birds were sampled using the line transect method. Both direct observations and indirect observations were recorded.

Determination of conservation and taxonomic status:

The conservation status of the species was determined according to the Red List (2012) of Sri Lanka. The endemism and commercial importance has been determined based on the published information on these species.

Socio Economic Assessment

The socio economic survey was intended to collect data and information of the socio economic issues mainly of the influence area of the project. This includes the location of the main power plant, associated structures (such as the shredder) and the supply chain of fuel wood. Information pertaining to the demographic characteristics of the people living in the area i.e small scale fuel wood suppliers as well as large scale estate owners was collected through field assessments and through recently published data.

The land use and the livelihoods of the people were documented based on the field visits and discussions with community members. Information pertaining to dwellings and housing data, roads and rail networks, infrastructure and industries, cultural sites of importance is of particular importance for analyzing socio economic impacts. These have been collected from the field visits and secondary sources.

The health and safety aspects of the construction site has been assessed using methods such as physical observations, discussions with technical staff in the construction site and staff of associated companies of SMG in the same premises. Information pertaining to supply of water, sewage facilities and other services to be offered by local authorities have been collected through discussions with respective stakeholders.

Assessment of the supply chain

The supply of *Gliricidia* has been evaluated in three different systems;

1. Naturally grown (planted but not utilizing properly) in homesteads and roadsides
2. Purposely planted and maintained properly to serve specific purposes (Support tree for vines, shade tree for tea, intercrop for fuel wood or green manure production, planted in closer space over contours to control soil erosion and planted and maintained properly in fences)

3. Expansion possibility has been considered (intercropping under coconut plantations using only one scenario and if required it could be calculated in different scenarios since base information is available).

Study area: The biomass study covers the area under 50 km radius from Loluwagoda (Coordinates 7°18'21.47" N 80°07'43.98" E) at the center in Mirigama DS in Gampaha District (See figure 01). Three administrative districts of Gampaha, Kurunegala and Kegalle come under this survey covering the Divisional Secretariats (DS) listed below.

Sample is drawn from where *Gemi-sarana Kendraya* is present and where large scale plantations are existing. For this project, SMG will assist the small holders of coconut and tea cultivations to secure the rights to intercrop *Gliricidia* and other woody biomass on approximately 8,000 acres of SMG-managed land and land owned by government agencies within a 50 km radius of the proposed plant.

No	Kegalle district	Gampaha district	Kurunegala district
1	Thalgaspitiya	Gampaha	Alawwa
2	Mawanella	Minuwangoda	Bingiriya
3	Aranayaka	Diwulapitiya	Ganewatta
4	Rambukkana		Katupotha
5	Galigamuwa	Dompe	Kobeigane
6	Warakapola	Attanagalla	Kuliyapitiya East
7	Ruwanwella	Mirigama	Kuliyapitiya West
8	Ambepussa		Kurunegala
9	Bulathkohupitiya		Mallawapitiya
10	Yatyanthota		Maspotha
11	Kitulgala		Mawathagama
12	Dehiovita		Narammala

Table 1: DS cover by the study

Population size of the survey

The approximate area covered, the population and the population density per square km is given in the table 02 below. Only 10% of the land area is covered in the survey, in view of

the larger extent of the geographical area where the fuel wood supply chain is extended. A comprehensive assessment with full accuracy can be done only through the use of technologically improved data gathering tools such as interpretation of aerial photos and to identify areas with land suitable for *Gliricidia* and thereby to make conclusions based on mathematical models. These will require more time and resources. Taking into account such limitations sampling techniques have been used to extrapolate data obtained from the field survey, employing enumerators with questionnaires.

A preliminary mock survey was conducted in the field by the consultant with one enumerator testing the developed questionnaire for further alterations. Land availability, land use, livelihood of people living in the area and agro climatological factors have been considered to locate sustainable fuel wood species among other available species. *Gliricidia Sepium* and *Gliricidia Maculatha* has been selected and surveyed in this study as it has obtained lot of merit over other possible species available.

This survey has located and quantified biomass resources that have been sustainably grown, which could be continued sustainably without compromising on food security or other requirements of communities. At the same time future potential has been forecasted for expansion in possible locations either through existing or different systems practiced in the area (possibly the developer's expansion of *Gliricidia* intercropping under coconut plantations as an out grower expansion model).

Two types of information bases have been considered to build up the methodology criteria;

- Availability of pepper plantations (number of households, extent of pepper and number of pepper holdings) in each DS
- Availability of coconut plantations (Number of households, coconut extents less than .25 ha, greater than 0.25 ha and estate sector plantations) in each DS

After application of the methodology, more detailed information of selected DSs obtained by visiting (Grama Niladhari level extent of coconut and pepper availability etc). The available information collected through *Gemi Sarana*, the information published and unpublished on the subject and information to be collected from the key stakeholders were evaluated and analyzed.

Other methods used:

- Assessment of the vehicular traffic resulting from the supply of fuel wood to the shredder
- Assessment of health and safety impacts of the project (during its construction phase and operational phase. This included appraising the health and safety practices introduced by the SMG as well as the construction partners.

Determining Impact Significance:

Criteria for determining the impact significance is given in the table below:

Impact scale	Description
Severe	<ul style="list-style-type: none"> ▪ Irreversible, wide spread, covering local, regional and global indirect influence area. ▪ Will lead to high mortality of important endangered species on site and off site. ▪ Exceeds limits set by environmental standards both national and international. ▪ Major contribution to known global environmental problem with tangible effects. ▪ Causing widespread nuisance both onsite and offsite. ▪ Leading to the release of hazardous wastes which lethal effects in the environment. ▪ Permanent loss of livelihoods for entire community. ▪ Leaves permanent and irreparable scars on the landscape.
Moderate	<ul style="list-style-type: none"> ▪ Noticeable effects on the environment which are reversible over the long term ▪ Localized degradation of resources restricting potential for further usage ▪ Limited effects on locally or globally endangered species with no long term effects on their reproduction and migratory behaviours. ▪ Increased pollution of water bodies in the short term but drops with time ▪ Noise and air pollution above maximum levels accepted in the environment. ▪ Disruption of livelihoods in the short term but no long term effects. ▪ . Leads to a repairable scar on the landscape but reparable over time
Minor	<ul style="list-style-type: none"> ▪ Noticeable effect on the environment, but returning naturally to original state in the medium term. Minimum degradation of resources but does not does not constrain future use ▪ Disruption of the behaviour of threatened/endangered species but returns to normal in the short term.

	<ul style="list-style-type: none"> ▪ Release of periodic particulate matter that is circulated in the short term ▪ Intermittent noise nuisance ▪ Changes in water and air quality levels not above maximum acceptable limits.
Negligible	<ul style="list-style-type: none"> ▪ No noticeable or limited local effect on the biophysical environment that rapidly returns to its original state. ▪ Unlikely to lead to any changes in ambient air and water quality. ▪ Unlikely to affect resources in any noticeable way. ▪ No anticipated effect on livelihoods ▪ Will not change the landscape in any way

2 APPLICABLE LAWS, REGULATIONS AND STANDARDS

2.1 Country policies laws and regulations

2.1.1 Sustainable and Renewable Energy Policy (Existing situation and future Policy) Biomass:

Sri Lanka recently revised her National Energy Policy and Strategies consisting of (a) Energy policy Elements (b) Implementing Strategies (c) Specific Targets, Milestones and Institutional Responsibilities. The major guiding policy elements are the following:

1. Providing Basic Energy needs
2. Ensuring energy security
3. Promoting energy efficiency and conservation
4. Promoting indigenous resources
5. Adopting an appropriate pricing policy
6. Enhancing energy sector management capacity
7. Consumer protection and ensuring a legal playing field
8. Enhancing the quality of energy services
9. Protection from adverse environmental impacts of energy facilities

Vision of the Energy Sector²

The National Energy Policy and Strategies of Sri Lanka, published by the Ministry of Power and Energy by Gazette Extraordinary of the Democratic Socialist Republic of Sri Lanka dated 10.06.2008, details Sri Lanka's Energy Sector Policy. According to the policy,

²<http://www.powersrilanka.com/Sri%20Lanka%20-%20Power%20sector.pdf>

sustainable development of energy resources, conversion facilities and delivery systems to enable access to and use of energy services by the entire population and the safe, reliable delivery of such energy services at a regionally competitive price through commercially viable institutions subjected to independent regulation has been considered the broad policy objective. The policy states that the Government has announced a new initiative to grow biomass as a commercial fuel and an incentive scheme is already operational to grow biomass as under-crop in coconut plantations.

Renewable Energy Policy of Sri Lanka:

Promoting Indigenous Resources is one of the energy policy elements. The policy states that *“Indigenous energy resources will be developed to the optimum levels to minimize dependence on non-indigenous resources, subject to resolving economic, environmental and social constraints. Minimum dependence on non-indigenous resources and optimum development of local energy resources will minimize the vulnerability of energy supplies to external factors such as the international socio-political environment.....”*

Promoting Indigenous Resources has identified the following strategies:

- The use of economically viable, environmentally friendly, non-conventional renewable energy sources will be promoted by providing a level playing field to both conventional and non-conventional energy sources...”
- Necessary incentives will be provided to develop other renewable non-conventional energy resources when necessary to ensure their contribution to the energy supply in special situations even if they are marginally viable economically
- A separate facilitation center dedicated to the systematic planning and promotion of non-conventional renewable energy sources will be established.
- Biomass-based energy projects will be developed in areas where land resources are available, enabling a new industrial activity in such areas emphasizing on creating rural income generation avenues
- Research and development on adopting new technologies and practices, particularly in the use of non-conventional renewable energy, to suit local conditions will be promoted
- Initiatives of other institutions to convert biomass and other waste to energy will be encouraged and supported where appropriate.

.Other Ministries and Departments³ having a mandate on Energy Generation and Sustainability principles:

Sector	Name of the Act	Policy thrust/Instruments	Relevant Institution/s	Relevant Regulations
Environment	<p>National Environmental Act No 47 of 1980</p> <p>National Environmental Act (Act No. 56 of 1988) Part IV 'C'</p> <p>National Environmental (Amendment) Act, No. 53 of 2000.</p> <p>Greater Colombo Economic Commission Law, No. 4 of 1978 as amended <i>inter alia</i> by Act, No 49 of 1992</p>	<p>Gazette Extra Ordinary No. 859/14 of 23rd February 1991 approving Project</p> <p>Approving Agencies (PAA) which includes Board of Investment (BOI) as the project approving Agency</p> <p>“Prescribed Projects” (PP) requiring Initial Environmental Examination (IEE) / and or Environmental Impact Assessment (EIA),</p> <p>Gazette Notification No: 1533/16 of 25.01.2008 which prescribes industries under three categories such as Part A, B and C & requiring obtaining the EPL from the CEA Provincial or District Offices.</p>	<p>Ministry of Environment and Natural Resources</p> <p>Central Environmental Authority</p> <p>Board of Investment (BOI)</p>	<p>EIA Regulations</p> <p>Environmental Protection License (EPL)</p> <p>Water Quality Standards.</p> <p>Tolerance limits for the Discharge of Industrial Waste in to Island’s Surface Waters.</p> <p>Ambient Air Quality Standards, which is the quality of air in our surrounding environment& Stationary Source Emission standards for stack emissions which are emitted from a particular activity.</p> <p>National Environmental (Noise Control) Regulations No.1 1996 dealing with noise Levels</p>
	<p>Fauna and Flora (Protection) Ordinance in 1993</p>	<p>To provide for the conservation of the fauna and flora of Sri Lanka and their habitats; for the prevention of commercial and other misuse such</p>		<p>Wildlife Conservation Department</p>

³Based on the previous regime of parliament before the presidential elections 2015 January

		fauna and flora and their habitats; for the conservation of the biodiversity of Sri Lanka		
	13th amendment to the Constitution of Sri Lanka in November 1987	Gazette Notification No: 1533/16 of 25.01.2008 which prescribes industries under three categories such as Part A, B and C & requiring obtaining the EPL from the CEA Provincial or District Offices.	North Western Provincial Environmental Authority (NWPEA)	Delegated powers to implement laws pertaining under Environmental Act (to carry out and approve EIAs) for all projects to be implemented in North Western Province.
	Soil Conservation Act No 25 of 1951 subsequent amendments: 25 of 1951; 29 of 1953; 57 of 1981; 24 of 1996	Enhancement and substance of productive capacity of the Soil; to restore degraded land for the prevention and mitigation of soil erosion; for the Conservation of soil resources and protection of land against damage by floods, salinity, alkalinity water logging. Regulation No 1 of 2009 published in gazette extra ordinary No 1633/4 dated December 21, 2009; gazette extra ordinary No 1550/9 dated May 22, 2008	Department of Agriculture	Soil conservation guidelines in planting plantation crops in conservation areas declared by the Act; Declaration of land as conservation areas
	Factories Ordinance	Factories regulations (No1) 1960 published in gazette No 12494 dated 23 rd June 1961	Department of Labour	Specifies items/areas to be examined in the steam boilers and related equipment
Energy including NCRE	Sri Lanka Electricity Act No 20 of 2009 & Amendments. Ceylon Electricity Board	National Energy Policy; Sri Lanka Energy Sector Development Plan for a knowledge based Economy	Ministry of Power and Energy Ceylon Electricity Board	

	Act	<p>Generation, transmission, distribution and use of electricity in Sri Lanka by repealing previous Acts</p> <p>The electricity (Application for Licenses and exemptions) regulations, 2009 published in gazette No 1617/34 dated 3rd September 2009 requiring License for power generation</p> <p>The methodology for determining feed in tariffs for NCRE based electricity generation, approved by PUCSL</p>	Public Utilities commission of Sri Lanka (PUCSL)	
	<p>Sri Lanka Sustainable Energy Authority Act No 35 of 2007</p> <p>(Sri Lanka Renewable Energy Authority)</p>	<p>Develop renewable energy resources; to declare energy development area; to implement energy efficiency measures and conservation programmes; to promote energy security;</p>	Sri Lanka Sustainable Energy Authority	<p><i>Current total installed power generation capacity of the country is approximately 4,050 MW, consisting of 900 MW of coal power, 1,335 MW of oil burning thermal power, 1,375 MW of hydro power and 442 MW of non-conventional renewable energy sources such as wind, mini hydro, biomass and solar power plants.</i></p> <p>(Sri Lanka Energy Sector Development Plan for a knowledge based Economy)</p>
Fuel wood supply chain	Coconut Development Act No 46 of 1971 and subsequent amendments	Cultivation of Gliricidia in coconut plantation	Ministry of Coconut Development and Janatha Estate Development	
	Ministry of Plantation Industries	Declaration of Gliricidia as a fourth national plantation crop of Sri Lanka		In year 2005 the Cabinet of Ministers of Sri Lanka took the decision to introduce Gliricidia as the country's Fourth Plantation Crop, based on a cabinet

				memorandum of the Ministry of Plantation Industries.
Transport of fuel wood	Forest Conservation Act <i>“Timber and forest produce” includes trees when they have fallen or have been felled, and all wood, “Timber depot” includes any firewood shed</i>	The Forest regulation No 1 of 2008 published in gazette extra ordinary No 1548/29 dated May 9,2008 and amended by gazette extra ordinary No 1762/1 dated June 11,2012 restricting Transport of Timber	Department of Forest Conservation Divisional Secretaries The Police Department	For the following species no permit is required to transport throughout the country: Coconut; Rubber, Arecanut, Cashew, Cultivated Cinnamon, Kottamba, Gadumba; Gansuriya, Pulun, Cultivated Mango, Kitul; Albizia; Moluccana Amberella; Katu imbul; Gliricidia; Hawarinuga; Lunumidella; Sabukku; Rambutan; Ipilipil; Kenda; Wanasapu; Wal kaduru; Erabadu; Rukattana; Avacado
Supply of biomass	Felling of Trees (Control) Act No 9 of 1951 and its Amendments	The main purpose of this ordinance is to provide for the prohibition, regulation or Control of the Felling of Trees. This has been amended in two times (by 30 of 1953 of 2000) and last updated is by act no 1 of 2000.	The Divisional Secretary has authority to issue a permit for falling up to 03 of the above mentioned trees. The District Secretary could issue a permit to fall 3 to 15 of those trees.	Permits should be obtained for falling of Jack, Bread Fruit and female Palmyra trees because yield (nuts) of those trees are used as daily food of human beings If the numbers of those trees are above 15 the Secretary of the Ministry of Agriculture could issue a permit on the recommendation of the Divisional Agriculture Committee and the District Secretary.
Labour engagement	Factories’ Ordinance	Main purpose is to ensure safety of the worker’s engaged in factories,, The Regulations issued under Factories Ordinance stipulated under Section (3) the manner in which the interior and	Department of Labour	Reports to be submitted to the Labour Department on stipulated Forms on accidents; injuries and maintenance of Boilers etc.

		the exterior of a steam boiler should be prepared for the purposes of an examination under section 34 of the Ordinance		
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2.1.2 Other legal instruments having a bearing on the project

Pradeshiya Sabha Act No. 15 of 1987

Pradeshiya Sabhas are empowered to formulate by-laws for governance of the areas under their jurisdiction on the subjects devolved to them under the Pradeshiya Sabha Act No. 15 of 1987. Some activities falling under this Project such as building activities, waste disposal etc. come under the purview of the Pradeshiya Sabha and as such they need approval. The building plans for this project have been approved by Mirigama Pradeshiya Sabha.

Environmental Protection License:

The Environmental Protection License is a regulatory/legal tool under the provisions of the National Environmental Act, No. 47 of 1980 (NEA). It was first introduced by the National Environmental (Amendment) Act, No. 56 of 1988 and was further amended by the National Environmental (Amendment) Act, No. 53 of 2000. The main objective of the EPL is to prevent or minimize the release of discharges and emissions into the environment from development activities in compliance with national discharge and emission standards.

Section 23A of NEA states that no person shall carry out any prescribed activity except under the authority of an Environmental Protection License. Therefore in effect legal authorization under certain conditions is granted for industries/activities to discharge effluents, deposit wastes, emit smoke/gases/fumes/vapor or excessive noise/vibration into environment. Industries/activities that are prescribed in accordance with the regulations of the National Environmental Act (NEA) have to obtain EPL in order to comply with the standards published under the NEA. According to the Gazette Notification No: 1533/16 of 25.01.2008, industries are prescribed under three categories such as Part A, B and C.

In part 'A' comparatively 80 high polluting industries, in part 'B' 33 medium polluting industries and in part 'C' 25 low polluting industries are prescribed. Prescribed industries are published in the Gazette Notification No: 1533/16 of 25.01.2008. The EPL holder has legal authority for the discharge of effluents, deposit wastes, emit smoke/gases/fumes/vapor, noise/vibration into the environment in accordance with the standards and criteria stipulated by the CEA.

This will help the EPL holder to prevent or minimize the discharges and emissions into the environment from the industrial activity. Public confidence in the industry may be gained and the products will be able to attract foreign investors or buyers towards the industry. The EPL holder will be able proceed towards the ISO certification to provide the means to fulfill international obligations relating to environmental protection.

- Industries/activities which are prescribed under parts “A” and “B” according to the Gazette Notification No: 1533/16 of 25.01.2008 has to obtain the EPL from the CEA Provincial or District Offices.
- Industries/activities which are prescribed under part “C” has to obtain the EPL from the respective Local Authority (LA) - Municipal Council/Urban Council/ Pradeshiya Sabha to the location of industry. (The powers of the CEA with regard to issue of EPLs have been delegated to the Local Authorities under Section 26 of the NEA).
- Industries/activities which are registered under Section 17 of the Act of the Board of Investment of Sri Lanka (BOI), has to obtain EPLs from the BOI.

Water Quality Standards:

There are (2) types of discharge standards stipulated in the gazette in NEA. The two types are:

1. Standards based on the receiving source where standards are included for four different types of receiving bodies. These standards are given below.
 - a. Tolerance limits for the discharge of industrial waste in to inland surface waters.
 - b. Tolerance limits for industrial waste discharged into land for irrigation purposes.
 - c. Tolerance limits for industrial and domestic waste discharged into marine coastal areas.
 - d. Tolerance limits for discharge of effluents into public sewers with central treatment plants.
2. Industry Specific Standards for three types of industrial activities. These standards are:
 - e. Tolerance limits for waste from rubber factories being discharged into inland surface waters.
 - f. Tolerance limits for waste from textile industries being discharged into inland surface waters.
 - g. Tolerance limits for the waste from tanning industries being discharged.

The Water quality standards are given in **Annex 3**.

Atmospheric emissions

There are two types of air pollution standards stipulated by gazette under the NEA. The standards are:

1. Ambient Air Quality Standards, which is the quality of air in our surrounding environment
2. Stationary Source Emission standards for stack emissions which is emitted from a particular activity.

Noise Control

The permissible noise levels are defined in the National Environmental (Noise Control) Regulations No.1 1996.

For more details please refer to Annexure (4)

The above standards are applicable for pollution abatement purposes from the proposed project.

2.2 EIB Environmental & Social Standards

The EIB Environment & social Handbook stipulates standards/procedures for following:

1. Assessment and management of Environmental and Social Impacts and Risks
2. Pollution Prevention and Abatement
3. Bio diversity and Ecosystems
4. Climate Change Considerations
5. Culture and Heritage
6. Involuntary Resettlement
7. Rights and Interests of Vulnerable Groups
8. Labor standards
9. Occupational, Public Health and Safety

The procedures and guidelines are very comprehensive and it will be necessary to ensure that impact assessment considers the components and their standards as stipulated in the Handbook.

3 KEY STAKEHOLDERS:

Key stakeholders of the power sector development in Sri Lanka are:

- Ministry of Power and Energy (MOPE) – the policy maker
- Public Utilities Commission of Sri Lanka (PUCSL) – the regulator
- Sri Lanka Sustainable Energy Authority (SLSEA) – the facilitator
- Ceylon Electricity Board (CEB) – the main utility provider
- Lanka Electricity Company (Pvt.) Limited – (LECO) – a utility provider
- Independent Power Producers (IPPs) – private electricity companies that generate and sell electricity to CEB

Other key stakeholders as provided in the table below for their specific role

Name	Role of the stakeholders	Future engagement
Ministry of Finance	Responsible for determining the relevance and viability of subsidies and their application through the national budgetary process, regularly evaluates the costs of such subsidy schemes and makes recommendations for their future direction.	Negotiations on Tariff; Duty free concessions to be received as a BOI approved Company; (The Power Purchase Agreement signed between the CEB & the Developer is based on the Tariff given by the MF)
Board of Investment (BOI)	BOI has granted site clearances and will be responsible for monitoring of the E&S compliance by the Developer. In this task BOI will work with the CEA Officials.	Compliance to the requirements as per the site clearance letter, Joint inspection during the operational phase regarding the compliance on the EPL (Through the office in Mirigama)
Central Environmental Authority (CEA)	CEA took part in the technical evaluation of the project after a site visit. CEA will continue to monitor the E&S compliance together with the BOI	Issuance of the EPL during the operational phase, joint monitoring meetings and review of environmental reports (through Regional Office in Gampaha)
Pradeshiya Sabawa Mirigama	Building approval has been granted by Pradeshiya Sabawa.	Compliance monitoring as per the building approvals during and after construction.
Gemi Sarana network of CBOs	Has the network of CBOs having more than 10,000 families attached	Work within the MOU for the facilitation of Fuel wood supply

	to assist in the supply of Fuel wood.	through the CBO network. Management of the filed coordinators and serve as a conduit between the Developer and the fuel wood supply chain
Silver Mills Group	Silver Mill in Mirigama is a large coconut processing industry that also provides energy services to other industries. The company partners with KMRI to implement the power plant project and will support coconut intercropping model to increase fuel wood availability in association with CCB, <i>Gemi-sarana</i> .	Effluent waters from the plant once treated will be partly released to the landscaping purpose of the SMG occupied land area. The labour engagement policies, health & safety policies will be replicated.
Coconut Cultivation Board	The CCB has an existing subsidy scheme through which growers are incentivized to cultivate <i>Gliricidia</i> to replace nitrogenous fertilizer input. Coconut-fuel wood intercropping model will be promoted through the CCB by strengthening and adding value to the existing scheme.	Work with Gemi-Sarana and SMG in strengthening links for developing the supply chain of Fuel-wood through intercropping, technical advice and other facilitations.
Coconut Research Institute	CRI has research developed in areas of intercropping, use of fuel wood ash for fertilising coconut and is a stakeholder in the project for providing as a source of ash collection. CRI promotes both cultivation of <i>Gliricidia</i> as sources of fodder/fertilizer for coconut plants as well as a supportive for pepper and other crops.	The CRI has indicated that the ash of <i>Gliricidia</i> can be accepted by them for use as fertilizer for coconut plantation. In that situation, there is a possibility that ash can be safely disposed and can be made good use of the same. The correspondence indicates that the Developer is in the process of making this arrangement.
Bio Energy Association	Inaugurated in 2004 BIO continued to campaign, both to promote the growing of <i>Gliricidia</i> , and for the wider acceptance of the feasibility of using <i>Gliricidia</i> for power generation and for thermal energy in industry.	

	Continuously lobbied for a reasonable tariff for the energy generated.	
DFCC Bank	Key player in renewable energy financing and extends the financing support for the project through EIB	Provide technical oversight and review progress reports as per the requirements of the EIA report, its ESMP.

4 DESCRIPTION OF THE PROPOSED PROJECT & REASONABLE ALTERNATIVES

4.1 SMG and KMRI

Silver Mills Group is Sri Lanka’s oldest coconut processing industry having started its industrial operations the late 1920s. The company is now restructured to have a more diversified portfolio of production lines to include food, beverage and renewable energy. SMG is present both in Giriulla (in the Kurunegala District) and in the Mirigama (in the Gampaha District) with a total of 1350 employees engaged in different spheres of production lines. The sister companies within Mirigama complex consisting of:

- Mr. Silva and Sons Lanka Pvt. Ltd;
- Silver Mills Natural Beverages Pvt. Ltd., and
- Ceylon Shell Flour Pvt. Ltd.

The above three alone engage 850 workers. Nearly 50% of them are females and the company on principle does not engage child labor. Where renewable energy is concerned, the SMG has joined with KMRI. KMRI is a US based Company which develops high reliability renewable energy infrastructure to displace diesel usage in telecom towers, resorts and islands and utility mini-grids in Southeast Asia and Africa. Both join in this project to generate combined a Heat and Power (CHP) plant which is the first of its kind in Sri Lanka thus far. With the establishment of the project, it is planned that the SMG will receive its steam requirements from the power plant where as an excess to the tune of 3.5 MW of electricity will be stepped into the national grid. (Certification of Incorporation is in annex 5).

SMG having been in the coconut industry for a long time has already established a network of coconut producers holding very small scale to large scale plantations where the intercropping of *Gliricidia* is practiced in general. Therefore the main inputs required for the

project in the long term being fuel-wood (*Gliricidia*) the company has an advantage over any other to have access to the required quantities. This network of coconut producers is extended around 50 km radius of the plant location.

4.2 Site Location and Technical Description with maps and diagrams:

The project will be located at Mirigama; about 65 km from Colombo in the village named Loluwagoda where the SMG has its industrial complex. The land area required for the power plant is around 4.0 acres which SMG has leased to KMRI SMG Asset Co. Ltd., from its 22 acre extent of land where their main coconut and beverage processing plants are located. The land is situated on the Giriulla / Mirigama road frontage and can be accessible by road from Colombo within 1½ hours. BOI Mirigama is in close proximity to the project area (in the vicinity of 1.5 km.) The construction of the power plant and its associated structures is in progress and there is a labor force of about 100 workers representing four sub-contractors.

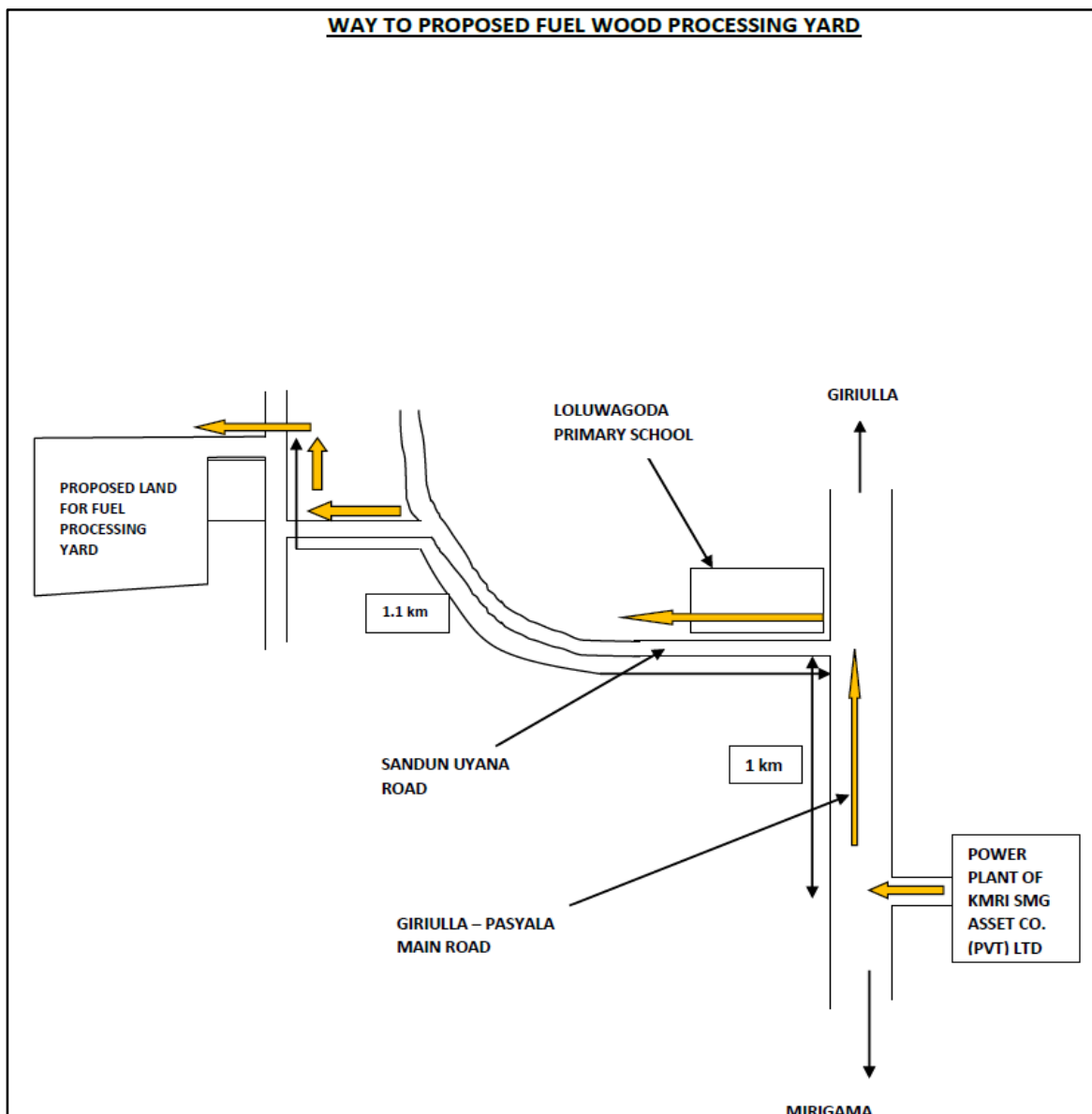
Land is required for:

- Main power plant building
- Steam generator (boiler) and auxiliaries
- Boundary wall and drainage system
- Water reservoir and collection facility
- Start-up power supply and power evacuation facility
- Stores and workshop
- Laboratory facilities for analysis of fuel and water, etc.
- Utilities such as demineralized water plant, cooling tower
- Ash handling system
- Biomass storage, handling and preparation system
- Electrical switchgear, transformers and control systems.

The Conceptual Lay-out of the Power plant is provided in Fig (5) below.

4.3 Disc Chipper & Associated Facilities

The Chipping Yard which too is a major component of the project will be located on a 03 acre land, 2.1 km away from the main power plant. Access to the location where the Disc Chipper will be installed is given in the fig below. The Developer is in the process of purchasing this land from a private land owner. The Chipping machine as well as the storage of unprocessed fuel wood material (*Gliricidia* pellets) and chipped *Gliricidia* (ready for the end use) will be located on this land. The land can be accessed through a separate gravel road.



The 03 acre land will serve as part of the project land. A few of the existing coconut trees will be removed.

The following facilities will be located in this land:

- The Chipping machine (Disc Chipper):
- Open storage of fuel wood
- Area for handling large trucks/lorries
- Accommodation for staff engaged for chipping activities
- Security Hut

The conceptual lay out of the Chipping yard and the Disc Chipper are given in Fig (3& 4) below:

Legend to be read as:

T = Tool & Spare Parts store

S = Security Office

C = Canteen

W = Weighbridge

ME = Main Entrance

ER = Entrance Road

O = Accounts Office

A = Weighing Office

CS = Cycle Shed

LR = Staff Rest Room, Lunch Room, Toilets

IR = Internal Roads

Wood Chipping and Splitting Area = 40 m x 25 m = 1000 sqm

REQUIRED AREA – 120 m x 100 m = 12000 sqm = 1.2 Hectares = 3 Acres

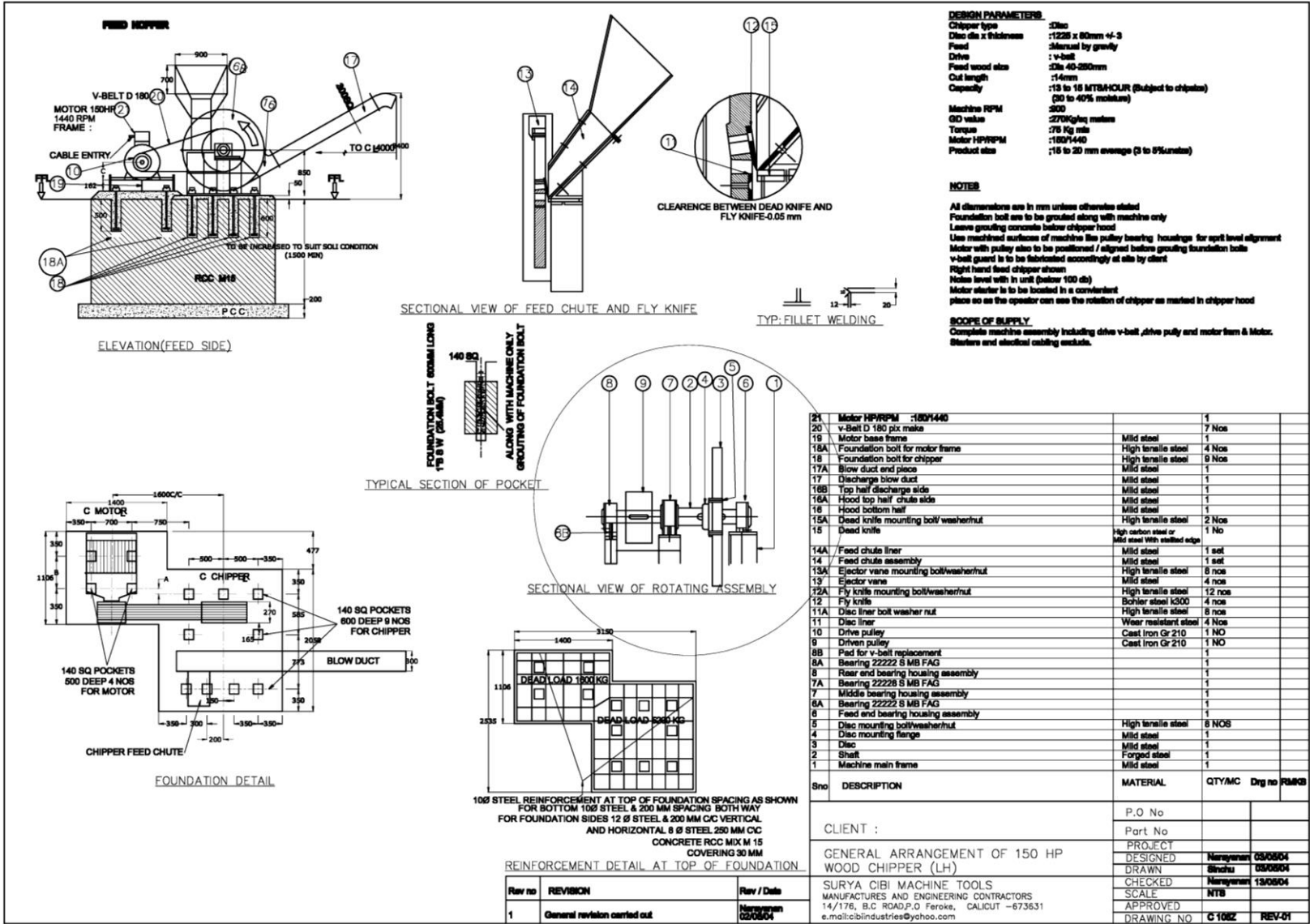


Figure 3 Illustration of the Disc Chipper

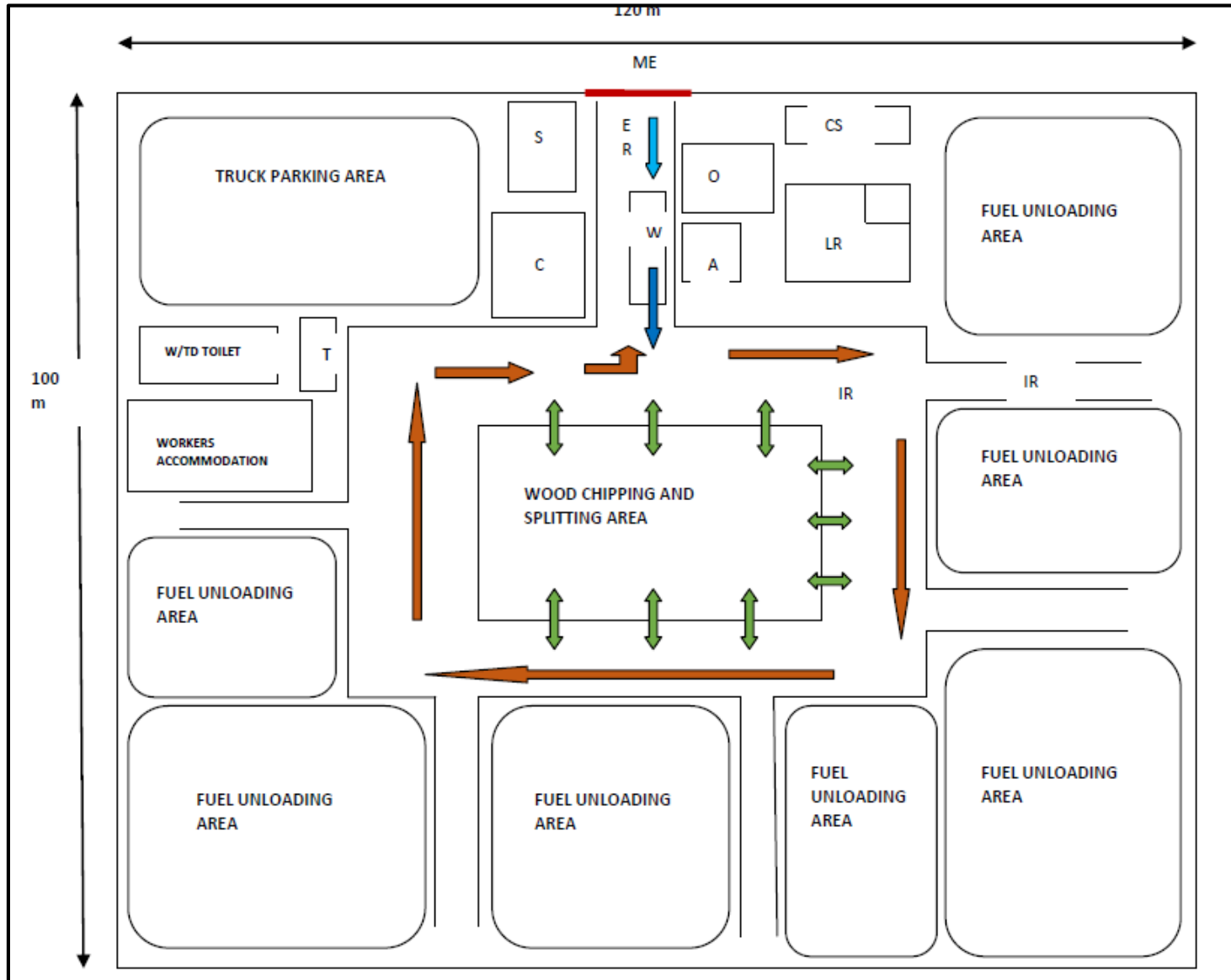


Figure 1 Chipping Yard-conceptual drawing

4.4 Topography of the land and the landscape of the project area:

The land (extent of 22 acres) of the existing SMG facilities consists of two flat terrains with about 1.5 m difference in elevation (The land area on the lower elevation is considered for the proposed project). With the allocation of 04 acres for the project, SMG continues to have around 18 acres of the rest of the land for ongoing industrial operations. In its close vicinity there are no houses; only unoccupied coconut land. The land is bounded to the east by the main road of Mirigama / Giriulla and to the North is a private property. The other two sides are mainly bounded by the SMG property where other factories are located.

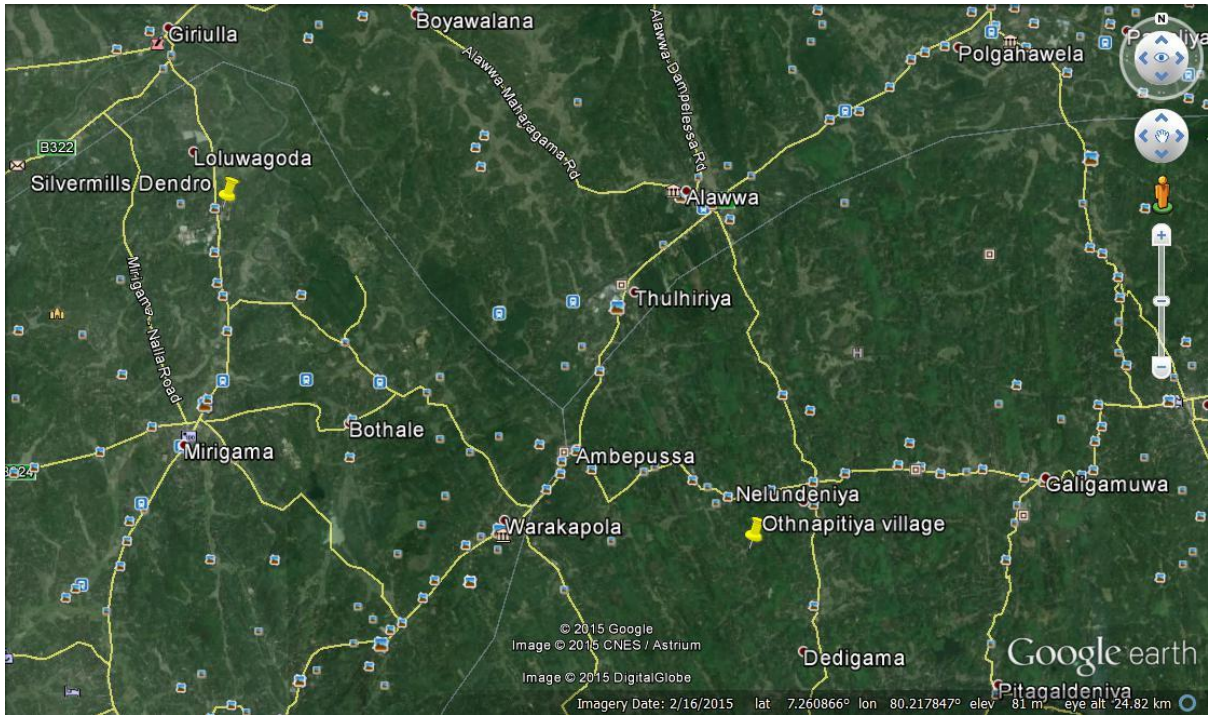
The land in the extent of 03 acres which is going to be purchased for the Disc Chipper is also located about 2.1 km away from the proposed power plant and can be accessed through motorable roads. The land is under coconut and banana cultivation. The site is interior to the existing villages and it is assumed that there will not be any noise that may disturb the communities around this area.

4.4.1 Land Ownership

The land in an extent of 22 acres on which the SMG existing coconut processing plant is located and the proposed Power Plant is owned by Silver Mills Groups (SMG). Four acres of the land is dedicated to the power plant and its associated infrastructure (as detailed in the Land Survey Plan). The land on which the main Shredder (Chipping facility) is to be located is being purchased by the developer,

4.5 Project Area of Influence

Provincial Council	District	DS Division	
Central Province	Kegalle	Several of the DS Divisions	Supply Chain Extends into this area
North Western Province	Kurunegala	Several of the DS Division	Supply Chain Extends into this area
Western Province	Gampaha	Mirigama (and neighbouring DS Divisions)	Power Plant Location; Shredder; Maha-Oya Water Source; BOI Power Evacuation and supply chain



Mirigama

Gampaha

Western

1 590.5

The 03 acre land where the Disc Chipper will be located is also purchased outright by KMRI-SMG Asset Company Ltd.

4.6 Project summary:

Project Type	Combined Heat and Power Generation
Plant Capacity	4 MW (Net) electrical output (4 MW)
Boiler Size	20 (tpd)
Total energy & Steam generation	19.98 GWh & 66,000 steam
Plant Factor	85%
Operation Mode	CHP & Power Only
Plant operation	250 days (CHP Mode) 75 days Power Only Mode:
Net Electric Generation	2.28 MW CHP 3.50 MW Power Only
Project Years	20
Fuel wood requirement	125 Tons per day (40,625 Tons per year @ 35 % MC)

Water Requirement	364 m ³ (per day) CHP 531 m ³ (Per Day) Power Only Mode
Equipment	01 No. Boiler generating steam at 47 kg/cm ² / 01 No. Controlled Extraction cum condensing turbine with water cooled condenser system
Effluent	Fly ash and bottom ash
Solid Waste Quantities	From Chipping & Shredding operations: 600-800 kg per day From sweepings from the storage areas: 400-500 kg per day
Waste Water	Boiler Blow Down: 5 m ³ /day Water treatment plant waste water – 2.4 m ³ /day Waste from Cooling Tower Blow Down - 122.4 m ³ /Day
Fuel wood type	Gliricidia (with 35-50% moisture)

4.7 Project time schedule:

- ❖ Construction Starts; Nov 21 2014 NTP
- ❖ End of construction: Feb 2015
- ❖ Expected commissioning: June 2015 (as per 18 months with bank loan)

ID	Task Name	Baseline Start	Baseline Finish	Start	Finish	% Complete	Start Variance	Finish Variance	Gantt Chart					
									2nd Half Qtr 3	Qtr 4	1st Half Qtr 1	Qtr 2	2nd Half Qtr 3	Qtr 4
1	KMRI 3MG Asset Company Pvt Ltd	Wed 19-11-14	Fri 18-03-16	Wed 19-11-14	Fri 18-03-16	20%	0 days	0 days	[Gantt bar from 19-11-14 to 18-03-16]					
2	Major Mile Stone Activities	Wed 19-11-14	Fri 18-03-16	Wed 19-11-14	Fri 18-03-16	7%	0 days	0 days	[Gantt bar from 19-11-14 to 18-03-16]					
3	Notice to Proceed	Wed 19-11-14	Wed 19-11-14	Wed 19-11-14	Wed 19-11-14	100%	0 days	0 days	[Milestone diamond at 19-11-14]					
4	Kick of Meeting	Thu 27-11-14	Thu 27-11-14	Thu 27-11-14	Thu 27-11-14	100%	0 days	0 days	[Milestone diamond at 27-11-14]					
5	Zero Date of the Project	Wed 19-11-14	Wed 19-11-14	Wed 19-11-14	Wed 19-11-14	100%	0 days	0 days	[Milestone diamond at 19-11-14]					
6	Plant commercial Operation	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	0%	0 days	0 days	[Milestone diamond at 18-02-16]					
7	Readiness of Boiler Foundation	Tue 21-04-15	Tue 21-04-15	Tue 21-04-15	Tue 21-04-15	100%	0 days	0 days	[Milestone diamond at 21-04-15]					
8	Readiness of ESP Foundation	Fri 25-06-15	Fri 25-06-15	Fri 25-06-15	Fri 25-06-15	0%	0 days	0 days	[Milestone diamond at 25-06-15]					
9	Readiness of Auxiliaries Foundation	Fri 25-06-15	Fri 25-06-15	Fri 25-06-15	Fri 25-06-15	0%	0 days	0 days	[Milestone diamond at 25-06-15]					
10	Readiness of TG Deck	Mon 10-08-15	Mon 10-08-15	Mon 10-08-15	Mon 10-08-15	0%	0 days	0 days	[Milestone diamond at 10-08-15]					
11	Readiness of TG Auxiliaries Foundation	Tue 25-08-15	Tue 25-08-15	Tue 25-08-15	Tue 25-08-15	0%	0 days	0 days	[Milestone diamond at 25-08-15]					
12	Readiness of TG Hall structure, Roof	Sat 05-09-15	Sat 05-09-15	Sat 05-09-15	Sat 05-09-15	0%	0 days	0 days	[Milestone diamond at 05-09-15]					
13	ERECTION / COMMISSIONING ACTIVITY	Wed 22-04-15	Fri 18-03-16	Wed 18-06-15	Fri 18-03-16	9%	40.25 days	0 days	[Gantt bar from 22-04-15 to 18-03-16]					
14	Start of Boiler Column Erection	Wed 22-04-15	Wed 22-04-15	Wed 10-06-15	Wed 10-06-15	0%	40.25 days	40.25 days	[Milestone diamond at 10-06-15]					
15	Start of ESP Erection	Sat 27-06-15	Sat 27-06-15	Sat 27-06-15	Sat 27-06-15	0%	0 days	0 days	[Milestone diamond at 27-06-15]					
16	Boiler Drum lifting	Tue 30-06-15	Fri 03-07-15	Tue 30-06-15	Fri 03-07-15	0%	0 days	0 days	[Milestone diamond at 03-07-15]					
17	Boiler Hydraulic Test	Mon 09-11-15	Tue 10-11-15	Mon 09-11-15	Tue 10-11-15	0%	0 days	0 days	[Milestone diamond at 10-11-15]					
18	Boiler Light up & Alkal Soil Out	Thu 07-01-16	Tue 12-01-16	Thu 07-01-16	Tue 12-01-16	0%	0 days	0 days	[Milestone diamond at 12-01-16]					
19	Steam Blowing	Thu 28-01-16	Sat 30-01-16	Thu 28-01-16	Sat 30-01-16	0%	0 days	0 days	[Milestone diamond at 30-01-16]					
20	Safety Valve Setting	Tue 02-02-16	Tue 02-02-16	Tue 02-02-16	Tue 02-02-16	0%	0 days	0 days	[Milestone diamond at 02-02-16]					
21	Start of Erection of TG	Sun 20-09-15	Sun 20-09-15	Sun 20-09-15	Sun 20-09-15	0%	0 days	0 days	[Milestone diamond at 20-09-15]					
22	Turbine Boring Gear	Wed 10-02-16	Wed 10-02-16	Wed 10-02-16	Wed 10-02-16	0%	0 days	0 days	[Milestone diamond at 10-02-16]					
23	Turbine Rolling & Synchronization	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	0%	0 days	0 days	[Milestone diamond at 18-02-16]					
24	Reliability Run	Sun 28-02-16	Sun 28-02-16	Sun 28-02-16	Sun 28-02-16	0%	0 days	0 days	[Milestone diamond at 28-02-16]					
25	Performance Guarantee Test	Fri 18-03-16	Fri 18-03-16	Fri 18-03-16	Fri 18-03-16	0%	0 days	0 days	[Milestone diamond at 18-03-16]					
26	Plant Commercial Operation	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	Thu 18-02-16	0%	0 days	0 days	[Milestone diamond at 18-02-16]					
27	ENGINEERING	Wed 19-11-14	Tue 27-10-15	Wed 19-11-14	Mon 31-08-15	79%	0 days	-47 days	[Gantt bar from 19-11-14 to 31-08-15]					
28	Final Plot Plan submissions	Tue 02-12-14	Tue 02-12-14	Tue 02-12-14	Tue 02-12-14	100%	0 days	0 days	[Milestone diamond at 02-12-14]					
29	Finalization of Plant Layout	Fri 13-03-15	Fri 13-03-15	Fri 13-03-15	Fri 13-03-15	100%	0 days	0 days	[Milestone diamond at 13-03-15]					
30	Soil Investigation Report	Thu 15-01-15	Thu 15-01-15	Thu 15-01-15	Thu 15-01-15	100%	0 days	0 days	[Milestone diamond at 15-01-15]					
31	GA Drawing Approval (Boiler)	Tue 09-12-14	Tue 09-12-14	Tue 09-12-14	Tue 09-12-14	100%	0 days	0 days	[Milestone diamond at 09-12-14]					
32	P & ID Diagrams approval - Boiler	Tue 09-12-14	Tue 09-12-14	Tue 09-12-14	Tue 09-12-14	100%	0 days	0 days	[Milestone diamond at 09-12-14]					
33	P & ID Diagrams approval - TG	Wed 18-03-15	Wed 18-03-15	Wed 18-03-15	Wed 18-03-15	100%	0 days	0 days	[Milestone diamond at 18-03-15]					
34	Release of Boiler Foundation Drg.	Fri 23-01-15	Fri 23-01-15	Fri 23-01-15	Fri 23-01-15	100%	0 days	0 days	[Milestone diamond at 23-01-15]					
35	Release of Chimney Foundation Drg.	Thu 19-02-15	Thu 19-02-15	Thu 19-02-15	Thu 19-02-15	100%	0 days	0 days	[Milestone diamond at 19-02-15]					
36	Release of ESP Foundation Drg.	Tue 12-05-15	Tue 12-05-15	Tue 12-05-15	Tue 12-05-15	100%	0 days	0 days	[Milestone diamond at 12-05-15]					
37	Release of Fan Foundation Drg.	Wed 06-05-15	Wed 06-05-15	Wed 06-05-15	Wed 06-05-15	0%	0 days	0 days	[Milestone diamond at 06-05-15]					
38	Release of TG Foundation Drg.	Thu 30-04-15	Thu 30-04-15	Sat 27-06-15	Sat 27-06-15	0%	47 days	47 days	[Milestone diamond at 27-06-15]					
39	Release of TG Hall Foundation Drg.	Sun 12-04-15	Sun 12-04-15	Mon 01-06-15	Mon 01-06-15	0%	39.38 days	39.38 days	[Milestone diamond at 01-06-15]					
40	Release of BFP Foundation Drg.	Mon 18-05-15	Mon 18-05-15	Mon 18-05-15	Mon 18-05-15	0%	0 days	0 days	[Milestone diamond at 18-05-15]					
41	Release of Duct Support Foundation	Tue 12-05-15	Tue 12-05-15	Tue 12-05-15	Tue 12-05-15	0%	0 days	0 days	[Milestone diamond at 12-05-15]					
42	Release of Slow down tank foundation	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	0%	0 days	0 days	[Milestone diamond at 15-05-15]					
43	Release of Dosing system foundation	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	0%	0 days	0 days	[Milestone diamond at 15-05-15]					
44	TG Hall pipe support details	Thu 30-04-15	Thu 30-04-15	Sat 01-06-15	Sat 01-06-15	0%	75.13 days	75.75 days	[Milestone diamond at 01-06-15]					
45	Raw water pump house foundation details	Wed 10-06-15	Wed 10-06-15	Wed 10-06-15	Wed 10-06-15	0%	0 days	0 days	[Milestone diamond at 10-06-15]					
46	DM water storage tank foundation details	Sat 20-06-15	Sat 20-06-15	Sat 21-03-15	Sat 21-03-15	100%	-73.13 days	-73.13 days	[Milestone diamond at 21-03-15]					
47	Fuel Storage shed Foundation	Mon 06-04-15	Mon 06-04-15	Mon 31-08-15	Mon 31-08-15	0%	118.13 days	118.13 days	[Milestone diamond at 31-08-15]					
48	Ash silo foundation & bucket elevator foundati	Fri 03-07-15	Fri 03-07-15	Fri 03-07-15	Fri 03-07-15	0%	0 days	0 days	[Milestone diamond at 03-07-15]					
49	Water Treatment Plant Foundation	Thu 14-05-15	Thu 14-05-15	Thu 14-05-15	Thu 14-05-15	0%	0 days	0 days	[Milestone diamond at 14-05-15]					
50	Cooling Tower Foundation	Wed 24-06-15	Wed 24-06-15	Wed 24-06-15	Wed 24-06-15	0%	0 days	0 days	[Milestone diamond at 24-06-15]					
51	CT Pump Foundation	Sat 27-06-15	Sat 27-06-15	Sat 27-06-15	Sat 27-06-15	0%	0 days	0 days	[Milestone diamond at 27-06-15]					
52	Aux Transformer Foundation	Sat 13-06-15	Sat 13-06-15	Sat 13-06-15	Sat 13-06-15	0%	0 days	0 days	[Milestone diamond at 13-06-15]					
53	Power Transformer Foundation	Sat 13-06-15	Sat 13-06-15	Sat 13-06-15	Sat 13-06-15	0%	0 days	0 days	[Milestone diamond at 13-06-15]					
54	Fire Fighting system Foundation	Tue 30-06-15	Tue 30-06-15	Tue 30-06-15	Tue 30-06-15	0%	0 days	0 days	[Milestone diamond at 30-06-15]					
55	Completion of Boiler Structural Engineering	Sat 28-02-15	Mon 02-03-15	Sat 28-02-15	Mon 02-03-15	100%	0 days	0 days	[Milestone diamond at 02-03-15]					
56	Completion of Boiler Pressure Parts Engineer	Wed 25-03-15	Wed 25-03-15	Wed 25-03-15	Wed 25-03-15	100%	0 days	0 days	[Milestone diamond at 25-03-15]					
57	Completion of Boiler Non Pressure Parts Engi	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	Fri 15-05-15	0%	0 days	0 days	[Milestone diamond at 15-05-15]					
58	Completion of Plant Piping Engineering	Wed 15-07-15	Wed 15-07-15	Wed 15-07-15	Wed 15-07-15	0%	0 days	0 days	[Milestone diamond at 15-07-15]					

Project: KMRI L3 Schedule 1
Date: Sat 02-05-15

Task: [Progress bar] Progress
Split: [Milestone diamond] Milestone
Summary: [Gantt bar] External Tasks
Project Summary: [External Milestone diamond] External Milestone
Deadline: [Green arrow] Deadline

4.8 A Brief Description of the Different Components of the Project:

4.8.1 Raw Materials

The use of Steam Turbine Generators with wood fired boilers is the preferred technology based on capital cost, reliability and low operating and maintenance costs. The raw material (Bio mass⁴) is *Gliricidia Sepium* ('wetamara' in Sinhala) for the specially designed reciprocating Grate type boiler where the raw material requirement is nearly 125 Tons per day estimated at 35% moisture content at full load operation. The supply chain management study covering three district of Gampaha, Kurunegala and Kegalle is in progress. The project proponent does not expect to own land for fuel wood plantation but promote village people to grow and sell the fuel wood to the power plant. It is expected that by year 2 of project full operations, there will be a complete cycle of harvesting *Gliricidia Sepium* and that the plant will be depending fully on same. In the interim, the Developer may use other sustainably grown fuel wood at least to bridge any supply gaps created as a result of the short supply of *Gliricidia*. However this situation will be only for not more than 01 year from its operation commences.

4.8.2 Process technology

The technology of direct combustion and steam turbine generation technology is adapted for the conditions in Sri Lanka to suit Sri Lanka scenario and available fuel wood chemical composition. The project will use a Steam Turbine and an Alternator with superheated steam supplied at specified pressure and temperature for power generation. The Boiler uses fire wood as fuel. The wood, which is prepared to the specified size and moisture content, is fed mechanically into the combustion chamber of the Boiler, where combustion of the wood fuel takes place. The Boiler generates the steam, which is delivered to the turbine at specified temperature and pressure. The exhaust steam from the turbine is condensed in a water-cooled shell and tube condenser, and the water is pumped into the Boiler feed tank. The condenser cooling water is pumped into the forced draft cooling tower where the cooling of the water takes place. The cooled water is then collected in the cooling water tank, from which it is re-circulated through the condenser.

⁴Biomass is organic matter of plants and animals (Twidell & Weir). It is the organic carbon based material that is useful to produce energy. Biomass may be present in various forms such as, fuel wood, straw, crop fiber, animal waste and sewage sludge.

4.8.3 Water supply

The project will require around 531 m³ per day for the project when operating under the Power Only mode. This requirement is only 364 m³ when operated under the CHP mode. Water will be supplied through the BOI water collection point. There is also the possibility of constructing a shallow well within the same premises to extract water.

4.8.4 Equipment description:

Boiler & Auxiliaries

One (1) Number Bi drum, natural circulation, balanced draft bottom supported, water tube type, continuous ash discharge travelling grate boiler suitable for 100% *Gliricidia* Stalks and other bio mass designed to generate 20 RPH (gross) steam at 47 Kg/cm² (a) pressure & 445+/-5⁰C main stream temperature

Steam Turbine & Auxiliaries

- One No. of 4.0 MW (Gross) Bleed cum condensing Steam Turbine Generator (with mid pressure extraction for supply of the process in Silver Mills) set with emergency stop valves, gland sealing system, bleed steam systems for De-aerator, all control & protection devices, Turbine Lubricating & Control Oil system equipment complete with auxiliary oil pumps, emergency oil pump, oil purification unit and oil coolers, water cooled condenser with steam jet air evacuation system
- 2X100 % horizontal centrifugal condensate extraction pumps
- The cooling water temperature shall be 32-42 C, Wet Bulb Temperature as 28 C

Power Cycling Piping

Complete Power Cycle Piping including steam, condensate, cooling water piping, DM Water Piping and Compressor air piping with fittings & valves as required for the boiler and steam turbine islands and connected systems upto Balance of Plant

Water Treatment Plant

- Is designed considering the source as river water and the analysis of raw water.
- For boiler make –up 1X100% Clarifier 1X100% UF Plant and 1X100% DM plant are considered
- Fully automatic for UF Plant and manual operation for DMF & DM Plant
- One No. induced Draft (FRP) counter flow cooling tower with RCC basin with PVC film type fill arrangements;

- 1X80m3 DM< water Storage tanks of carbon steel construction and required doping tanks
- Miscellaneous Pumps with Drives

Fuel Handling System

Fuel handling system to feed Gliricidia Stalks and other bio-mass fuels and one number Pit.

Ash handling System

Submerged Ash Conveyor, Dense Phase fly ash handling system and (1) No. MS fly ash Silo
2X 100% 1W+1S Lubricated screw type air compressor for Ash Conveying Requirements;

Others

- Two Nos. 1 W 1 S) instruments cum service air compressor of lubricated screw type with 2X 100% heatless type air drier
- Spilt type air conditioning system
- Fire hydrant system, fir defectors and Alarm System and Portable fire extinguishers in key locations
- Roof Exhausters in TG Hall and Simple Exhaust Fans

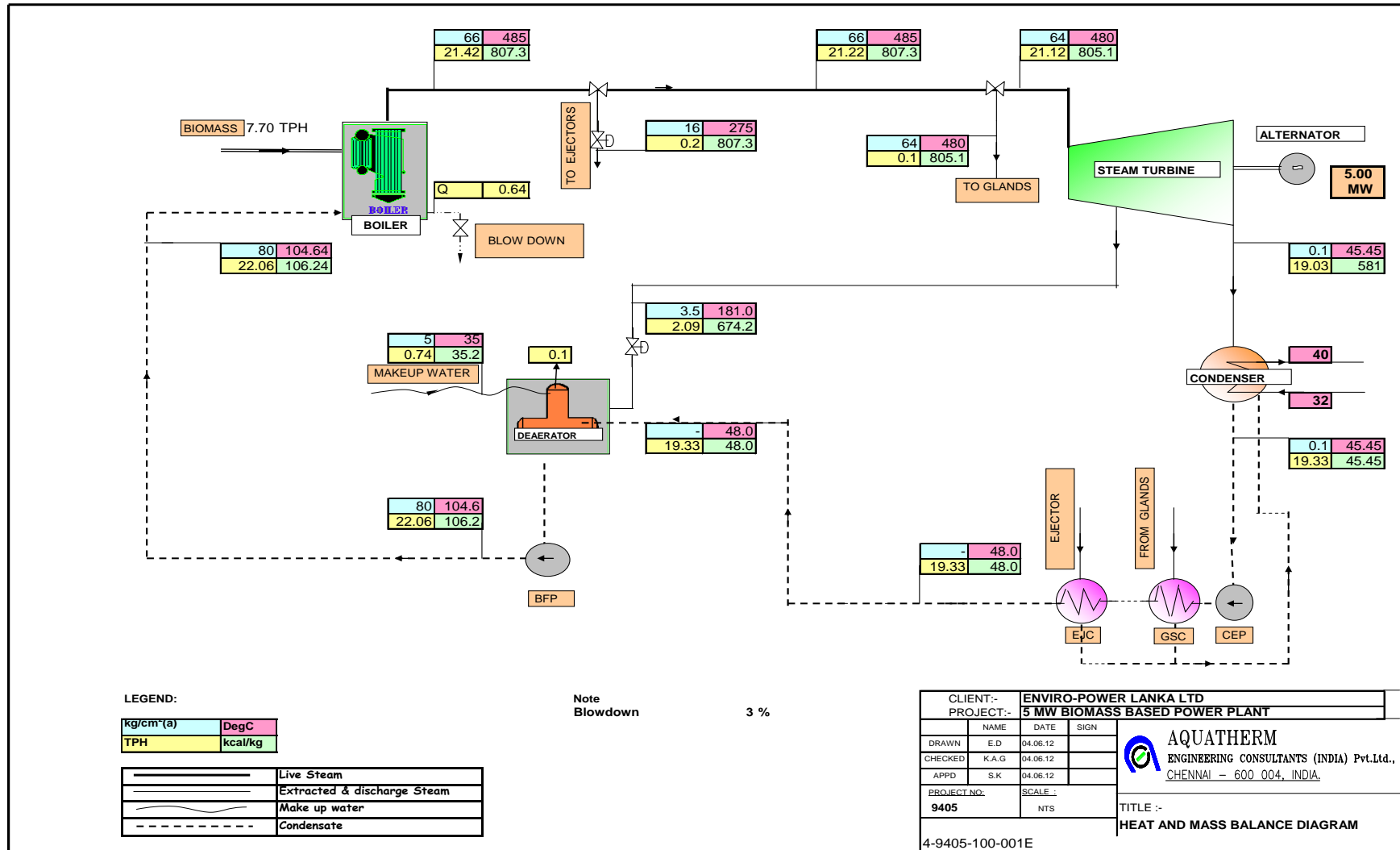
Electrical

- 4.0 MW Synchronous Generator
- 01 Number 1250 (indicative) 11/0 433 kV, LV auxiliary distribution
- LV switch Gear /Motor Control Center (MCC) / Main and sub Distribution Board (DB)
- 01 No. 100 AH 110V DC system
- 01 No. of 50 KVA , 415V Lighting
- 01 No. of 125 KVA , 415V 0.8 pf Emergency DG Set

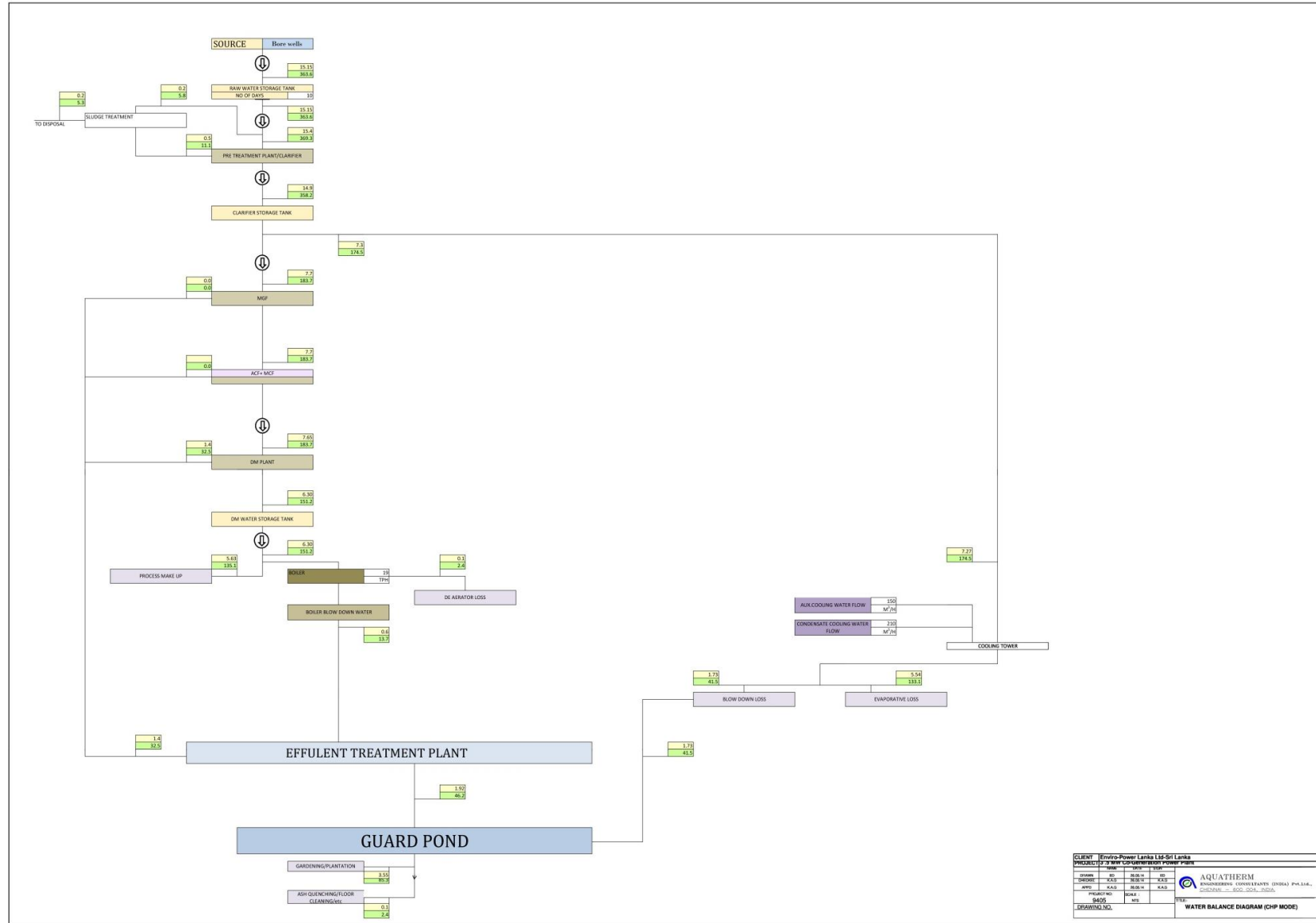
Control & Instrumentation (C&I)

- C&I Including DCS comprising data acquisition, sub system, closed loop and open loop controls, Data highways; Gateways, Operator Stations, & control Device, Printers, Engineering Work Station, and Engineering Software.

MASS BALANCE CALCULATION:



EIA Report for the 4 MW Biomass Combined Heat and Power Plant Project-Mirigama



CLIENT		Enviro-Power Lanka Ltd-Sri Lanka	
PROJECT		4 MW CHP Generation Power Plant	
DESIGNED BY	DATE	REVISED BY	DATE
APPROVED BY	DATE	REVISED BY	DATE
DRAWN BY		M.S.	
CHECKED BY		K.A.S.	
DATE		2014	
SCALE		AS SHOWN	
SHEET NO.		1/1	
SHEET TOTAL		1/1	
 AQUATHERM ENGINEERING CONSULTANTS (PVT) LTD. 108/1, S.S.C. ROAD, S.S.S.			
WATER BALANCE DIAGRAM (CHP MODE)			

4.9 Repairs and Maintenance Activities

The power plant is designed for the operation throughout the year as follows

- 250 days CHP Mode and
- 75 days Power only mode.

This will be shut down for maintenance during the rest of the days. Backup systems are provided on essential items other than the main equipment such as Boiler and STG, such that necessary running repairs can be done without the total shut down of the power plant. However annual maintenance shutdowns are planned to ensure the long term reliability of the operation of the plant.

4.10 Power Evacuation:

The electrical system of the power plant will comprise the internal electrical system up to the metering point and the external power transmission system. The boundary of these two constituents of the electrical system also demarcates the boundary between ownership of these assets (typically, the power plant meter is considered the boundary). The internal electrical system is to be build and maintained by the developer while the power transmission component, even if built by the developer, would ultimately be transferred to CEB for them to operate and maintain.

The project has been designed to export power to the national grid. For this purpose the generator output at 11 KV is to be stepped up to 33 kV at the on-site transformers and switch yard. The electrical network of this area consists of a 33 kV overhead distribution network centered on a distribution gantry located in Mahayaya in Mirigama. The Mahayaya gantry is fed by a grid substation where two step-down transformers tap into the 132 kV transmission network and deliver power at 33 kV. Two feeder lines bring in power from the grid substation to Mahayaya out of which one is dedicated to supply the gantry.

The 33 kV distribution line serving the Loluwagoda Mills originates from the Mahayaya gantry. It is proposed to construct a dedicated 33 kV power line from the power plant up to the Ceylon Electricity Board gantry at Mahayaya at the entrance of the Mirigama Export Processing zone which is only 1.6 km away. The Gantry is already well connected to the main national grid HT system thus ensuring a secure evacuation path for the power generated with minimal interruptions. This is expected to be constructed on the side of the main road such that there would be no need for additional way leaves to be obtained for the construction

of the HT line. It may be feasible to use the existing poles/towers along the road to provide supports for this line thus minimizing any additional impacts by the construction of this line.

4.11 Evaluation of alternatives

4.11.1 No Action Alternative

The No-action alternative will not be beneficial. There is an absolute need for improving the portfolio of NCRE in the energy mix in Sri Lanka to make it more dependent on indigenous resources. The potential for Dendro as base materials for NCRE is better exploited through this project. Having considered the environmental and social benefits as well as the cost per kW, it is essential that more Dendro power plants will be added to the NCRE portfolio. The sustainability of the supply chain is analyzed and it appears that *Gliricidia sepium* will be supplied in adequate quantities during the life of the project.

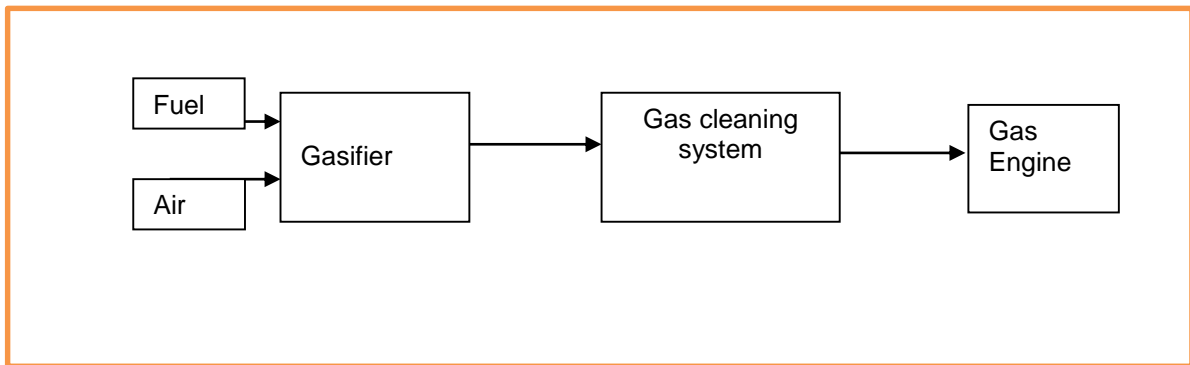
4.11.2 Alternative design, technology selection, construction techniques and maintenance procedures etc.

Currently, there are many technologies and options available for generation of power from biomass. The options include:

1. Gasification of biomass and power generation in a gas turbine or internal combustion engine
2. Combustion in a boiler and power generation by expanding the steam in a steam turbine.

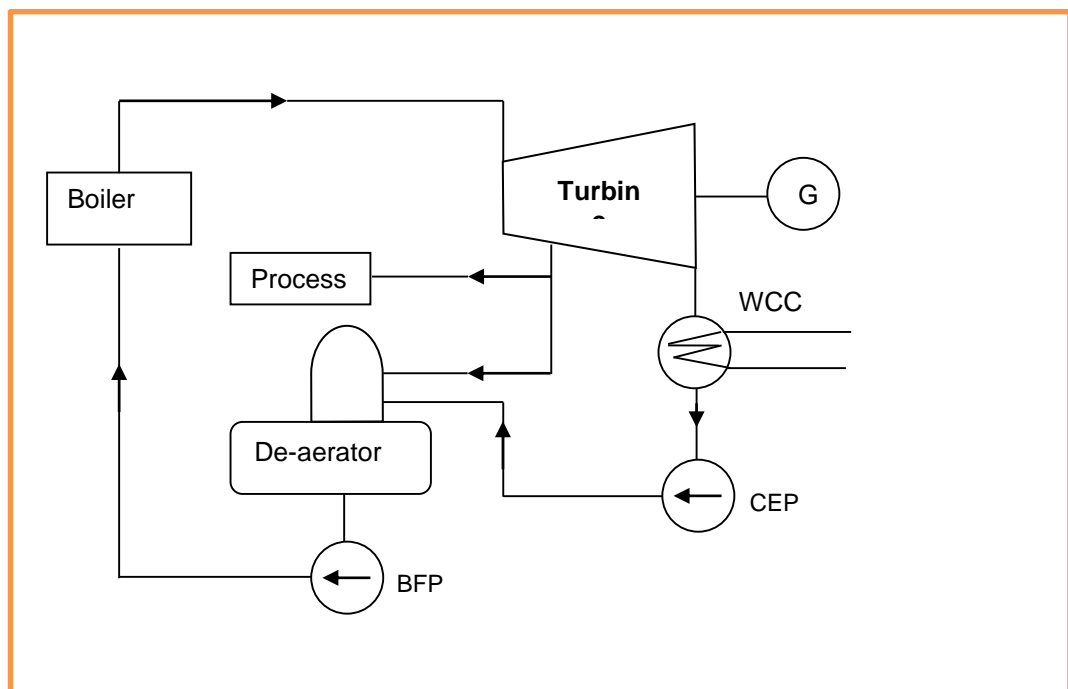
4.11.2.1 Gasification Route

In the gasification route for power generation, the biomass is first gasified into low calorific value gas by thermal gasification process. The gas generated is scrubbed to clean of all contaminants, oils and tars. The clean gas is used as fuel in a gas engine (for low capacities in the 250 kW to 500 kW range) to generate power. There are however, many operational problems associated with these systems. The major problem being the operation of gas cleaning systems. If the gas obtained is not clean, it leads to various problems in the gas engine /turbine.



4.11.3 Rankin Cycle Route

Generating power from biomass is through the Rankine Cycle route. In this system, the biomass is used as fuel in the Boiler to produce high pressure steam. The steam is then expanded in Turbo-generator to generate power. These systems are much more reliable and are in operation for quite long period in conventional power plants. Same cycle can be used for biomass power plants also. The variables to work with the Rankine cycle are temperature, pressure, dryness fraction, heat quantity, quantity of work, rate of heat quantity transferred as related to the temperature at which the heat transfer takes place.



4.12 Approvals to be received by the Developer:

Upon submitting an application to the BOI for approval of the project, in keeping with the requirements of the BOI Act, a developer needs to obtain following approvals:

- Investment Approval
- Site (Engineering) Approval;
- Environmental Clearance

Above document lead the BOI to issue an Agreement with the Developer upon which the Developer will receive preliminary planning clearance for the building. On completion of the construction work, BOI provides a Certification of Conformity.

In keeping with the above, the BOI after considering an application submitted by the Developer on 2nd October 2012 for the setting up of a 3.5 MW⁵ Dendro Power Plant at Loluwegoda, Mirigama had granted site clearance by letter dated 11th December 2012, in which it had stated that the Developer could locate the project at Loluwegoda, Mirigama subject to conditions therein. The conditions are given in the Annex (1) to this report.

In terms of section 1.4 of BOI approval letter, the Developer is required to obtain approval for the building plans from Mirigama Pradeshiya Sabawa. (Local Authority)

4.12.1 Clearance/permits to be obtained from state agencies and/ or local authorities

According to the regulation of the local authority the Developer requires to obtain the approved:

- Building plans;
- Plan for the Fuel storage shed,
- Plan for the Boundary wall,
- Plan for the administrative facility building and plan for the pump house.

It appears that the Mirigama Pradeshiya Sabawa (PS) has approved all the required plans during June 2015. These approvals have been issued with conditions which the developer

⁵ However in the subsequent feasibility report the capacity of the plant is considered 3.53 and not 5 MW.

needs to comply with. In keeping with condition, there is a need to locate the septic tank 50 m away from any surface water facility including drinking well, there should be 4 m wide internal roads, 06m wide access roads, there should be a closed pit to drain the effluent water, all premises should have a setback of 25 feet from the main road etc. The approval has been made valid for a period of 4 years upon completion of which the Developer needs to apply for renewal.

The Developer is required to apply for Environmental Protection License (EPL) from the Central Environmental Authority for which joint inspections will be made by BOI and CEA officials to monitor the EPL conditions

4.12.2 Permits required for transport of fuel wood

Transport of firewood will be a major activity to sustain the routine operations of the project. Transport will involve, transporting *Gliricidia* stems from the collection centers in the identified locations from distant areas such as Warakapola, Nelumdeniya in Kegalle District. As per the definition of “timber” in the Forest Ordinance, firewood is also considered as timber.

Therefore when transporting branches, waste products or off cuts etc., which are used for firewood, a permit is required. However, *Gliricidia* wood is excluded from this requirement for felling and transport.

Engagement of labor:

The project may need 100 staff during the construction period. A staff consisting of 69 employees of different skill categories will be required during the operation and maintenance period of the power plant, whereas around 30 casual workers will be engaged in the fuel wood chipping process at the Disc Chipper. The Department of Labor needs to be kept informed of the project in keeping with the Factories Ordinance, where Labor Officials make regular visits to check the appliances as per the regulations.

4.12.3 Total human resources including that of the supply chain:

In addition, the fuel wood supply will have a network of community members supervised by 20 Assistant Managers at the field level. These Assistant Managers will be paid by *Gemi*

Sarana Kendraya, which is linked with KMRI-SMG through a Memorandum of Understanding. Although they are considered external to the direct operations of the Power Plant, their role is critical for the uninterrupted continuation of the plant operations.

Project civil works, labor engagement summary:

	Project component	Major project Attributes
	Duration of Pre construction; Construction & Operation	Pre-Construction – 2012 since approval by the BOI Construction 18 months – from 2015 May Operation- 20 years from June 2016
	Major construction components and sub-contractors	Construction of the general lay out - Boiler: Fuel Yard- Water Piping system
	Land requirement	04 Acres for4 the Power Plant and associated facilities 03 Acres for the Disc Chipper and associated fuel wood storage facilities
	Estimated number of workers during construction and during operation	During the construction around 100 (including workers attached to at least three sub-contractors and the EPC Contractor. During the Operation phase: (As per table below:

4.12.4 Staff engagement Plan

Site	Category of Staff	No
Plant	Power Plant Engineer- in-charge	01
	Shift Supervisors (Control room)	04
	Skilled (Technicians and operators)	16
	Unskilled	16
	Plant Security	08
	Fuel Handling – Plant Labour)	08
	Driver for front end loaders	04
Fuel preparation yard-offsite	Cutter, Chipper Dozer Operations with helpers	08
	Drivers to transport to site	02
	Supervisor	01
	Security	01
		69

5 DESCRIPTION OF THE EXISTING ENVIRONMENT

5.1 Climate and Meteorology

The proposed project is located within the western and south western regions of the island which are typically known as the wet zone (Figure 5.1). Agro-ecologically, the proposed project and its area of immediate influence falls within the Districts of Gampaha, Kurunegala and Kegalle. The Gampaha District is located within WL3 zone, Kegalle is located in WL2b and Kurunegala is located in IL1a. The 75% expectancy values of annual rainfall in the wet zone Gampaha and Kegalle is 1,700-3,300 mm. In Kurunegala which is located in the intermediate zone, annual rainfall is 1,100-2,400 mm. The annual average mean sea level pressure in the country is from 1,010 to 1,012 hPa. It is generally lower during the months of May, June, July and August and significantly high during the months of December, January, February and March.

According to the Department of Meteorology, the climate of Sri Lanka is heavily influenced by the mountainous topography of the south-central region and the wind driven by the southwest and northeastern monsoons. The country is basically characterized into four climatic seasons as follows,

- Inter monsoon (March-April)
- Southwest monsoon (May-September)
- Inter monsoon (October-November)
- Northeast monsoon (December-February)

Temperature variations of the country are mainly controlled by contrast of the altitude. However, the mean monthly temperatures of the country significantly vary by the seasonal movement of the sun with some influence caused by wind and rainfall. Colombo and Kurunegala districts are the two most important meteorological sites close to the project and its supply chain. Average monthly and annual temperature, precipitation and humidity for both Colombo and Kurunegala stations are given in the Table 4.2 and 4.3.

Thirty years average precipitation data for four rain gage stations in Gampaha district is given Table 4.1. Based on Colombo data, climate of the south western region where the proposed project is located is fairly moderate throughout the year. Especially, a maximum temperature of 31⁰C is reported from March to April. The only major change in the Colombo weather

occurs during the monsoon seasons from May to August and from October to January. This is the time of the year where heavy rains can be expected with minimum average temperature (22⁰C). Average annual rainfall in the south western region is around 2,400 mm.

Table 5.1 Thirty years average rainfall data for four rain gage stations in Gampaha district

Rain gauge station	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ambepussa	82	70	127	269	213	188	123	111	189	383	316	79
Pasyala	91	87	132	308	271	225	160	144	229	430	372	127
Katunayake	63	66	98	216	270	162	89	105	207	353	323	111
Henarathgoda	81	63	102	234	320	212	138	135	250	369	303	126

Source: Department of Meteorology

Table 5.2 Climate data of Colombo

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Average high ⁰ C	31	31	32	32	31	30	30	30	30	30	30	30	31
Average low ⁰ C	22	23	24	25	26	26	25	25	25	24	23	23	24
Daily mean ⁰ C	27	27	28	28	28	28	28	28	28	27	27	27	27
Precipitation mm	58	73	128	246	392	185	122	120	245	365	414	175	2524
% humidity	69	69	71	75	78	79	78	77	78	78	76	73	75

Source: World weather information center – Colombo, World Meteorological Organization

The Northern boundary of the supply chain of the proposed project falls within the administrative units of the Kurunegala district. According to data, the climate of Kurunegala is tropical and warm throughout the year. The surrounding rocks of the district play a major role to determine the temperature since these rocks increase and retain the heat. During April, the temperature can rise up to about 35 ⁰C. The only major change in the Kurunegala weather occurs during the monsoons from May to August and October to January. This is the time of year where heavy rains can be expected. In general, temperatures from late November to mid-February are lower than the rest of the year. The average annual rainfall is about 2,000 mm.

Table 5.3 Climate data of Kurunegala

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Average high °C	31	33	35	34	32	31	31	31	32	31	31	30	32
Average low °C	21	21	22	24	24	24	24	24	24	23	22	22	23
Daily mean °C	26	27	28	29	28	28	27	27	28	27	27	26	27
Precipitation mm	62	92	138	262	194	156	114	93	159	359	327	139	2095
% humidity	65	59	60	69	73	74	73	71	71	74	74	72	70

Source: World weather information center – Colombo, World Meteorological Organization

5.2 Wind

Wind direction and wind speeds in the western and north western regions of the country are dependent on the pressure gradient. According to maps given by the Department of Meteorology, wind rises are developed for the months of January, April, July and October. General wind directions and speeds within the western and northwestern regions can be given as follows:

- **January** - Northerly - average speed of 7.2 – 9.4 kmph
- **April** - Calm wind with average speed of 5.4 – 7.6 kmph
- **July** - South west - average speed of 7.6 – 15.5 kmph
- **October** - South west - average speed of 5.8 – 9.0 kmph

5.3 Surface water

Maha-Oya is the major surface water body in the area which meanders about 7 to 8 km away from the project site. Maha-Oya is a perennial water body and a source for the National Water Supply and Drainage Board to provide potable water.

As the project is approved by the BOI, the developer has requested BOI (Mirigama) to supply the required quantities of water to the project. This request has not been refused by the BOI. The BOI draws water for the projects both inside its zone in Mirigama and outside from the intake of Maha-oya which is about 7 km away. BOI has a capacity to store 3,200 m³ of water in its facility but it appears that only 600 m³ is currently used for all industrial purposes. Water extracted by the BOI from its intake at Madurupitiya is sent to an aerator through pipes and then to settlement ponds before the water is chlorinated. Below is the Maha-Oya Basin and how it is extended to the project area in Mirigama.

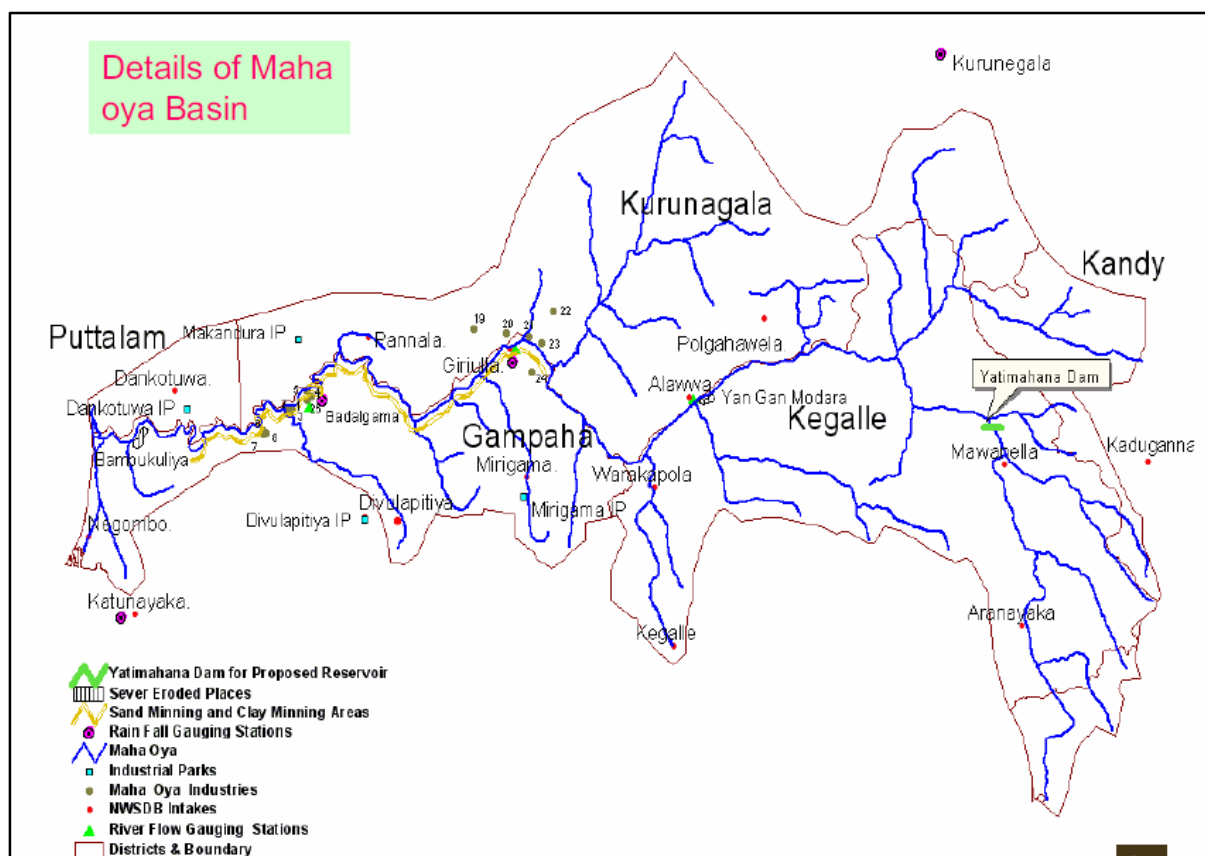


Figure 2 Maha Oya Basin

Surface water quality of the rivers and tributaries can significantly change with time and its chemistry is usually similar to rain water. Based on unpublished data, the average water quality is given in Table 5.5.

According to these results the surface water is slightly acidic. Diminishing of electrical conductivity may indicate the rain water composition and limited dissolution of minerals in the soil. In general, lower levels of turbidity reflect the lack of runoff and sedimentation during the dry season. However during the rainy season this situation can change significantly. Coliform levels and BOD levels indicate possible contamination by human activities. However, higher Dissolved Oxygen levels are maintained due to shallow depth and surface water flow.

Table 5.5 Average surface water quality around the proposed project area

	EC ($\mu\text{S/cm}$)	pH	Turbidity (NTU)	Coliform MPN/100mg	DO	BOD
Avg	179	5.7	9	985	6.4	7.9
Min	29	3.5	1	250	5.3	1.0
Max	567	6.6	24	1800	7.8	16.0
SD	184	0.9	8	578	0.7	5.0

Source: Based on unpublished data

5.4 Geology & Soil

The developer has already commissioned a comprehensive geological study at the location where the power plants is being built. Six numbers of bore holes have been drilled in locations where major components of the plant are to be installed. Standard penetration tests have been conducted at regular intervals of 1.5 m. The depth of the water table was measured from the surface of the borehole, 24 hours after removal of casings and when the water level was stabilized. All the soil/ rock samples in the core boxes except washed samples were tested in the laboratory to determine the following parameters and in accordance with ASTM/BS Standard Test Methods:

- Particle Size Distribution (Sieve Analysis)
- Consistency Limits (LL & PL)
- Unconfined Compressive Strength of Intact Core Specimen

The observations and the study main recommendations is provided in Annex (6)

The geotechnical investigations have revealed the subsurface conditions of firm strata suitable for construction without piling or other special foundations. Also the geology is stable so as not to have any adverse effects on the adjacent lands during the constructions or operation of the power plant.

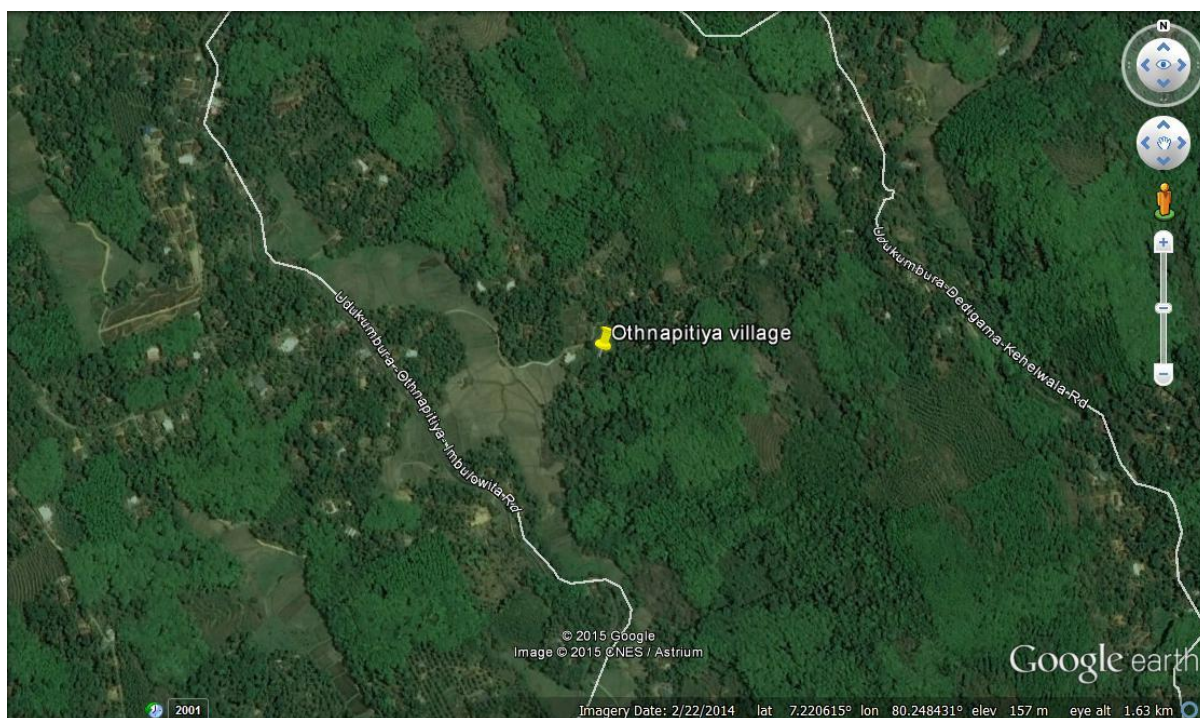


Figure 3: Overview of the area from which Fuel wood (*Gliricidia*) will be harvested

5.5 Socio-economic and environmental baseline information

Administrative districts and spatial distribution of the supply chain:

The administrative district of the Mirigama where the power plant is located will be the Gampaha District Secretariat. Mirigama is one of the Divisions under Gampaha District and its socio economic baseline data has been mainly derived from the resource profile of the Mirigama Divisional Secretariat. The supply chain of fuel wood is distributed along the area within 50 km to the center of the Plant at Mirigama. There will be 04 Divisional Secretariats and around 60 GN Divisions. This is well discussed in the project influence area.

5.5.1 Population statistics of all locations:

Table 5.6: District population and population density km⁻²

District	Area km ²	Population	Population density km ⁻²
Gampaha	1,387	2,294,641	1,711
Kegalle	1,693	836,603	497
Kurunegala	4,816	1,610,299	348

Source – Wikipedia

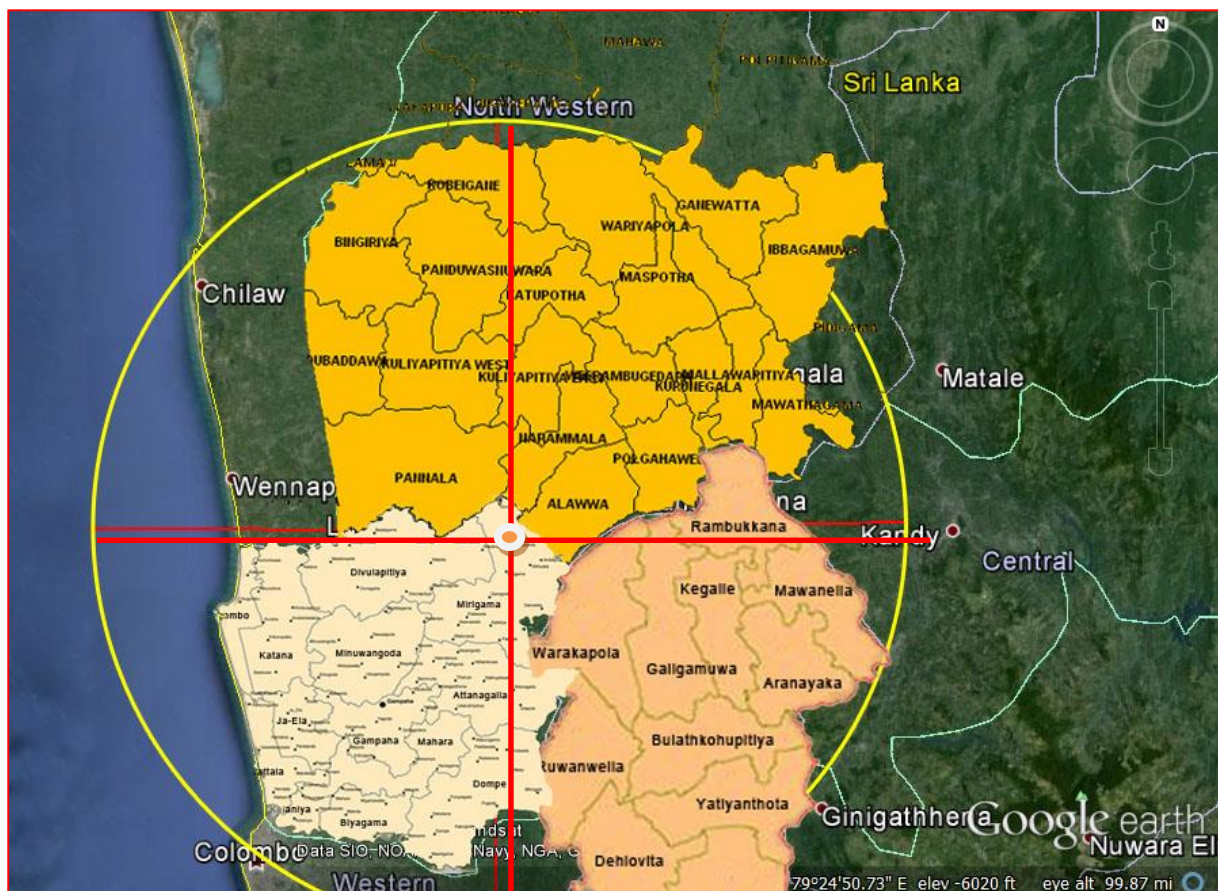


Figure 4 Spatial distribution of project's supply chain for fuel wood

Image courtesy –Google earth

5.5.2 Gampaha District:

The Gampaha District is located in the west of Sri Lanka and has an area of 1,387 km². It is bounded by Kurunegala and Puttalam Districts from north, Kegalle district from east, Colombo district from south and by the Indian Ocean from west. The borders of the district are the Maha Oya River in the north, Kelani River in the south and 1,000 ft. contour line on the east. The Gampaha district is divided into 13 Divisional Secretariat Divisions (DS Divisions), each headed by a Divisional Secretary. The DS Divisions are further sub-divided into 1,177 Grama Niladhari Divisions (GN Divisions).

Demographic characteristics

The population of the district was 2,294,641 in 2012. The majority of the population is Sinhalese, with a minority of Sri Lankan Moor and Sri Lankan Tamils. The population density of Gampaha district is 1700/km². The male population representing 48.60% amounts to 1,115,349 persons. The female population accounts for 1,179,292. On a community basis, the Sinhalese accounts for 2,079,115 persons. This is 90.61% of the total population of the district. Muslims accounts for 95,501 persons and Tamils accounts for 80,071 persons. In categorizing the population on the basis of religions, 1,640,166 persons are Buddhists, 114,851 belong to Islam and Hindu religions and Christians account for 52,221 and 486,173 respectively.

House hold size/Income

The number of individuals for a household in the Gampaha District is recorded as 4.19 members whereas 8% of the population in the Gampaha District is engaged in agriculture, 40.6 in industry and 51.4 % in the service sector. 94.3% of the households own the land in which they live and 91.5% have their own houses. Mean household income is Rs.22,416.00.⁶

Land use characteristics

Major crops cultivated in Gampaha are paddy, coconut, rubber, vegetables, fruits and flowers. Large areas still exist under agricultural production, paddy cultivation, taking a prominent place. Gampaha District holds nearly 11,977 ha of agricultural land in paddy, whereas in Colombo this is around 5600 ha. However research has found that abandoned agricultural land is on the increase in the Gampaha District. Considering its 200 m buffer zone, the land use of the proposed project area consists of 3,928,877m² of land covered by paddy lands, plantations and home gardens (in the areas falling within Colombo District). Similar land use is seen in areas of 4,525,725 m² of land in the Gampaha District, but the extent of land under paddy cultivation is relatively higher in this District compared to the Colombo District.

Mirigama DS Division:

The Mirigama DS Division is one of the 13 DS Divisions of the Gampaha District and therefore this is important for the project. Loluwagoda is located in the administrative area

⁶ (According to the Population & Census data issued by the Department of Census & Statistics for the year 2003/2004.)

falls within Mirigama DS Division. The current population in the Division is in excess of 160,000, which indicates that the Division is having a population density of 899.3 inhabitants per sq km. The total land area in the Division is about 183 km². According to the population census of 2001, the population stood at 143,633 and therefore there is indication that the population of the Division is fast growing. Mirigama is strategically important for the project as the BOI industrial zone is located about 1.7 km from the plant site.

5.5.3 Kegalle District

The Kegalle district is situated between the central highlands and the south western planes. The altitude of the western region is less than 175 m from the sea level whilst the eastern region exceeds 300 m. The extent of the district is 1,692.8 km². Kegalle is the capital city of the district which is one of the two districts belonging to the Sabaragamuwa province, the other being Ratnapura district. Boundaries of the Kegalle district are; Kurunegala district by North, Kandy and Nuwara Eliya districts by East, Ratnapura district by South, and Colombo and Gampaha districts by West.

Demographic Characteristics

There are 11 DS divisions, 1,677 villages and 12 police stations located within the Kegalle district of the Sabaragamuwa province. A total population of 818,000 is distributed within the 11 DS divisions of the district representing all ethnic and religious groups in the country. Warakapola Divisional Secretariat Division (DSD) records the highest population (110,422) and lowest population can be seen in Bulathkohupitiya DS. Considering the population density, Mawanella DS has a higher population density than the 10 DS divisions in the Kegalle district. 18,372 people live in the urban area whilst 741,310 and 53,318 people live in rural areas and estates respectively (Source - Department of Census and Statistics 2010).

75,356 families are receiving *Samurdhi*, assistance given by district authorities in 2010. 9,364 families in the Warakapola DS is the highest number that received *Samurdhi* assistance in 2010. Altogether 1,690 manufacturing industries are located in the Kegalle district. Textile, weaving, apparel and leather (428), wood, wood production and furniture (352), food, beverages and tobacco (270) and mining and quarrying (154) are the major manufacturing industries. In addition to these four, Basic metal industries, metal products, machinery and equipment, chemicals, petroleum rubber and plastic and paper products and printing industries contribute to the national production process (Source - Local Government

Institutes 2010). 11,188 commercial entities can be seen in the district. Among them retail shops, restaurants and canteens, meat, fish and vegetable shops.

Land Use and Agriculture

According to the land use pattern in the district, in 2010, home gardens (59,271 ha) is the major land use pattern in the Kegalle district. As commercial crops, rubber (51,976.0 ha), tea (11551.0 ha) and Coconut (12,507.0 ha) can be seen. In addition to rubber, tea and coconut, cinnamon is cultivated at plantation scale (61.0 ha). Out of a total area in the district (2952.0 ha) 2.0% and (6188.0) 4.0% are categorized as irrigated paddy land and paddy land by using rainwater respectively. The available forests in Kegalle were classified in to three groups namely dense forests (4226.0 ha), open forests (3432.0 ha) and planted forests (3201.0 ha). Other major land use patterns in the district are grass lands/chena (4814.0 ha), marshes and mangroves (5.0 ha), reservoirs (1017.0 ha), sand and mountains (1369.0 ha), abandoned land (1280.0 ha) and sacred places, roads, cemetery etc. (3486.0 ha). (Source - District Land use Planning Office 2011)

Health and Educational Facilities

To uplift the educational levels of people in the Kegalle district, 522 schools are established in three educational zones namely Kegalle, Dehiovita and Mawanella. According to the 2010 statistics, 159,317 students attend school in these three educational zones. Within the 2010 period, 24,367 students had studied at GCE Ordinary Level classes (Grade 11). Altogether 18,705 GCE Advanced Level students follow sciences, commerce and arts subjects. According to statistics of the Provincial Deputy Director's Office of Health Services, a total of 20 hospitals are distributed in the DSs of the Kegalle district. These include a single provincial general hospital at Kegalle and three base hospitals at Mawanella, Karawenella and Warakapola. There are 4 district hospitals, 8 rural hospitals and 3 rural estate hospitals also located within the district to facilitate the 122,926 outdoor patients and 113,705 indoor patients.

5.5.4 Kurunegala District:

The Kurunegala District, which is situated in the North Western Province, is comprised of 30 Divisional Secretariats (DS) and 47 Grama Niladhari Divisions (GNDs), of which 12 are within the Municipal area. The District spans a part of the dry zone and the intermediate zone of Sri Lanka. The agricultural areas covered in this study are within the area defined as

intermediate zone (low country).The Kurunegala District falls within the upper part of the Deduru Oya River Basin which flows 140 km from Central Sri Lanka to the west coast, reaching the sea at Chilaw (7.34 N, 79.48E) through a basin area of 2623 km² and 9 tributaries (Survey Department 1988; Somaratne et al.2003).

Demographic Characteristics

The population of the District is just over 1.5 million and the city of Kurunegala has a population of 28,571. The labor force participation rate in Kurunegala District was found to be around 51% with almost twice as many men as women (DCS 2004; DCS 2003). Figures for the DS Division were not available. The literacy rate of the population over 10 years of age in Kurunegala District is 92.7%

Land Use and the Agriculture

In the Kurunegala District 272,072 ha of land are cultivated, of which 133,635 ha are under coconut cultivation and 62,516 ha are under paddy cultivation. These lands are sometimes cultivated with paddy in Maha season and other field crops such as chilies, mung bean and ginger in the Yala season, especially if they are raid-fed



Figure 5 Traditional Dara Maduwa (Firewood storage)

Household energy in the project

Influence Area

Among almost all the communities living in the villages which are within or in close proximity to the areas from where fuel wood will be collected, there are common socio economic issues. In most cases the community members have their own homesteads extending at least ½ acre to in some case two to three acres of land in which they cultivate perennial crops such as either tea, timber trees, fruit trees or coconut inter-cropped with other spices such as pepper, betel, vegetable etc. All households have been connected to electricity

and most of the internal roads are motor-able and in fairly good condition. Nonetheless, a majority use bio mass for cooking and most keep some in their backyard enclosures which is traditionally called ‘*Maduwa*’.

Firewood is still a major source of energy for cooking as indicated in the 2012 population census:

Table (5.7) Household Energy in the three districts

District	Total HHs	% using firewood	Lighting (Electricity)
Gampaha	604,183	61.7%	96.1 (From Grid)
Kurunegala	404,944	94.4	84.6 (Same)
Kegalle	220,154	93.6	86.2 (same)

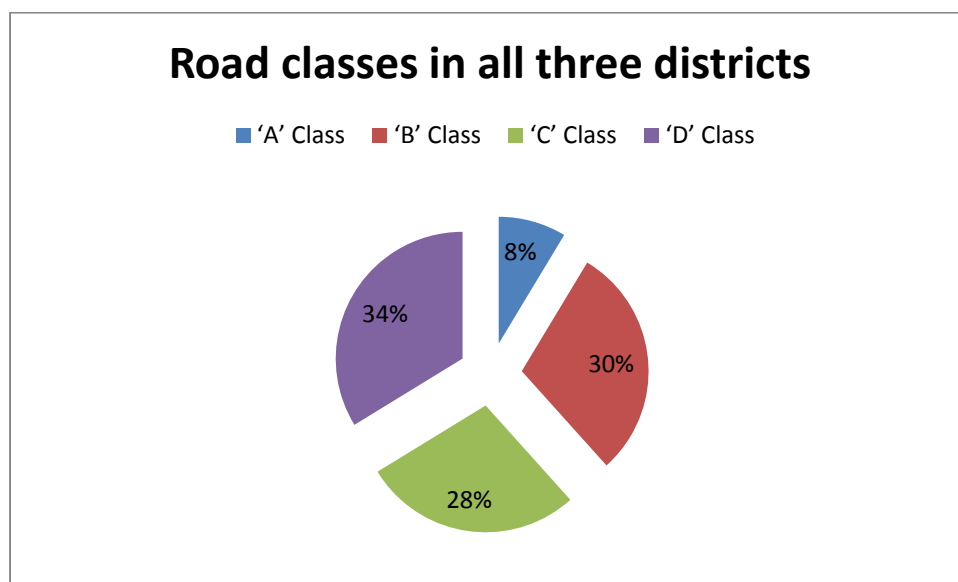
Source (Census of Population and Housing Sri Lanka -2012)

Roads

The three districts have a decent road network extending around 5,427 kilometers of all types of roads. Of that C and D class roads are considered meandering within remote villages. These roads are meant for small lorries. During rainy weather some are not conducive for transport of heavy loads of fuelwood. A proper identification of road conditions, appropriate engagement of vehicles for collection and transporting of fuel wood will be necessary. When the fuelwood collection and transportation is considered, different kinds of trucks such as Lorries and land vehicles will be used when transporting *Gliricidia* into the collecting centers and from collecting centers to the chipping yard and from there to the plant. The suitability of the roads for transport of laden trucks depends on the rainy season, the culverts and the road conditions. Most of the roads will not be suited when transporting heavily laden Lorries in those roads especially during the rainy season. All collection from within the interior villages therefore requires using light vehicles such as hand tractors or hand carts until they are stacked at places where collection is possible by large trucks/lorries which can carry 7-10 tons of loads.

Table (5.8) Types of roads available in the three districts:

	'A' Class	'B' Class	'C' Class	'D' Class	Total
Gampaha	128	610	370	507	1614
Kegalle	144	365	477	483	1468
Kurunegala	197	638	668	842	2345
Total	469	1613	1515	1832	5427



“A” Class – All roads within the network of Trunk Roads connecting the national capital with the provincial capitals and also connecting these capitals with one another. Also included are other major roads (all roads paved and bitumen surfaced with carriage way between 24ft. to 36ft. and platform width 36ft. to 56ft.).

“B” Class – Main roads connecting other important towns and also providing important links within the trunk route system (Metaled and bitumen with a small percentage graveled.).

“C” Class – Other roads such as agricultural roads and local roads (Single carriage way of 12ft. width and a platform width of 22ft. mostly metaled but with a small percentage graveled.).

“D” Class – Graveled road with 8ft. – 10ft. width surface generally motorable during dry weather only.

At the village level, the transport of fuel wood will require small hand tractor, hand cart which are more suitable to the ‘E’ Class roads or roads which are not classified but are under

the administration of local authorities, other management entities such as Plantation Companies, Forest Department etc. E Class roads and unclassified roads consist of all local roads, village foot paths, and gravel roads of not more than 10 feet wide.

Road types in Sri Lanka					
Type	Class		Description	Administration	Max Speed
National Roads	A	AA	Connecting major cities	Ministry of Highways and Road Development - RDA	20-25-30-35 mph 32-40-48-65 kmph * <i>please see note below</i>
		AB			
		AC			
	B	Roads connecting major urban areas			
Provincial Roads	C	Major feeder roads	Ministry of Provincial Councils & Local Government - PRDA		
	D	Minor feeder roads			
Local Authority Roads	E	Local roads			
Other Roads	Not Classified		Plantation, forest, irrigation, roads	Ministry of Rural Development (MORD) Private Company, Agriculture Cooperative	Set by administration/Motor traffic

Ecology of the project influence Area

The fuel wood supply chain area and the proposed power plant lies in the lowland wet zone of the country and floristically it belongs to the 'Northern Wet Lowlands' floristic region and the typical climax vegetation found in the area described as Tropical wet evergreen forest. The natural vegetation is not found in the project area due to the existing home gardens, cultivation of agricultural and plantation crops, mainly coconut. Agro-ecologically this area belongs to the wet lowlands WL2, having undulating and rolling terrain with Red-Yellow Podzolic and Low Humic Gley soils. The average annual rainfall is 2000 to 3500 mm and the

South-west monsoon (May-August) brings more rain to this area. The mean annual temperature varies between 25 to 27.5 °C and the average altitude of the project area varies from 70 to 153 m (local coordinates 07.220757, 80.248359). The power plant is located adjacent to the Loluwagoda Silver Mill premises. The fuel wood yard (including chipper) is located in a coconut land that 2 km away from the power plant site. The home gardens and coconut plantation for growing the *Gliricidia* is found within a 30 km circle from Loluwagoda power plant. Home gardens are the major habitat type present in this area. Many introduced plant species (ornamentals, timber species, naturalized exotics) are abundant in home gardens. Generally the size of the home gardens is vary from 0.5 - 1.5 acre. Most of the home gardens in this area are in less productive stage. It is expecting to grow large amount of *Gliricidia* along the fence of these home gardens instead of using the core area.

Flora & Fauna

Flowering plant species were recorded in proposed power house location (Loluwagoda), proposed fuel wood yard (including chipper) and two sites in Othnapitiya village (Kegalle District) were 196 (see Annex, Table 1). Around 50% of recorded plant species were exotics (91 species). Only seven endemic species were recorded and all of them are common species. Five nationally threatened species (all are in VU – vulnerable category) were recorded in the area.

The terrestrial habitats of the proposed project sites comprise predominantly of man modified ecosystems such as home gardens, coconut lands. The fauna recorded in this area comprised mainly of common species that are found associated with such man modified habitats. A lists of fauna recorded during the study is given in annexes, and summary of the fauna recorded is given below.

A total of 77 faunal species were recorded from the project area. Only four species recorded from the project area is (2 mammals and 2 birds) endemic to Sri Lanka. One mammal species (Giant Squirrel) categorized as a threatened species.

Table 5.9 Summary of the recorded fauna

Faunal Group	Total	Endemic Species	Threatened Species
Mammals	18	2	1
Birds	32	2	-
Reptiles	11	-	-
Amphibians	2	-	-
Butterflies	14	-	-
Total	77	4	1

5.6 Meeting Fuel Wood needs of the power plant:

The project envisages procuring fuel wood (*Gliricidia*) from several sources in the long term. There will not be a dedicated fuel wood plantation, but the project will rely on the natural stocks which are perennial to the area close to the project. The potential sources are:

1. Small scale Home-gardeners (connected to *Gemi-Sarana* programme)
2. Small scale Home-gardeners outside *Gemi-Sarana* Programme (Connected to Dept. of Export Agriculture/CCB)
3. Large scale coconut producers connected to SMG (Private companies/CCB)
4. Other man-made habitats within the 50 m radius and outside the radius.



Figure 6: Pepper-Tea Intercropped with *Gliricidia*



Figure 7: *Gemi-Sarana* Officials having discussion with KMRI staff

5.6.1 Potential sources of Fuel wood:

Sri Lanka has a tree cover of about 65% in forests, home gardens, plantations etc., which has an enormous potential to produce fuel wood sustainably. To be able to meet the growing demand by commercial and industrial establishments for fuel wood and to facilitate fossil fuel-using industrial SMEs to change part of their current and future energy needs to Dendro (i.e. wood-based) energy, it is necessary to develop sustainably grown fuel wood and biomass supply chains. To help achieve this goal, the then Ministry of Plantation Industries has declared *Gliricidia* as the ‘fourth’ plantation species (alongside tea, rubber and coconut). Under this programme, fuel wood cultivation is expected to be mixed with food crop production either as under-planting (such as in coconut or pepper/vanilla cultivations) or as co-planting to provide structural support to food crops. Live fences, using *Gliricidia*, have been established to safeguard the boundaries of small plots. Although *Gliricidia* has been declared the fourth plantation crop, this declaration has not been translated yet into a meaningful cultivation practice.

Currently, incentives available for energy plantations is LKR 7,500.00 per ha, as given by the Coconut Cultivation Board for intercropping *Gliricidia* in coconut plantations. However, it has been reported that this grant scheme is not making considerable impact on the establishment of energy plantations as yet as this inadequately addresses the upfront cost of planting and other barriers have not been removed. As a result, by 2009 only around 500 acres of *Gliricidia* intercropping in coconut plantations has come under this grant scheme⁷;

Fuel wood	Amount	% of total fuel	Landed Price
<i>Gliricidia</i> from <i>Gemi Sarana</i>	67tpd; up to 115+ tpd available	50%	Rs. 6.90*
<i>Gliricidia</i> from Out-growers	5 tpd	4%	Rs. 6.90*
Total	115-135 tpd	100%	Weighted avg: Rs. 6.10**

⁷ APCTT, 2009, Renewable Energy Report, Sri Lanka, Asian and Pacific Centre for Transfer of Technology of the United Nations — Economic and Social Commission for Asia and the Pacific (ESCAP)

Gliricidia is a well-known multipurpose leguminous tree species with the ability of fixing the soil with nitrogen in the air. *Gliricidia* supply tree products such as fuel wood, construction poles, crop supports, green manure and fodder. In addition, it is used in living fences, to stabilize soils and prevent) and to shade plantation crops. Recognizing the importance of this tree species, the government of Sri Lanka has named *Gliricidia* as the fourth plantation crop, next to tea, rubber and coconut. This species grows well under various soil and climatic conditions, and it is draught resistant once established. The easy coppicing nature of *G. sepium* contributes to its acceptability as a source of fuel wood; e.g. it can be coppiced at heights of 20, 40 or 609 cm without much difference in biomass production. Fuel wood is obtained through the occasional lopping of branches or by completely coppicing trees to low levels above ground. Accumulation of woody biomass is very much dependent on climate and soils, management, planting density and length of rotation. – Source

Project Title: Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies-UNDP, GEF

Calorific value of fuel wood species used for bio mass energy ⁸

The following table shows calorific value of different fuel wood species. *Gliricidia sepium* has the highest calorific value and can be sourced from low and mid elevation areas.

Species	Avg. wood Production (cum/ha)	Calorific Value (kcal / kg)	Uses / region (in Sri Lanka)
<i>Gliricidia sepium</i>	25-40	4,900	Tea, pepper, vanilla, coffee, cocoa plantations, live fences and other hedge rows: Low and mid elevations
<i>Calliandra calothyrsus</i>	15-50	4,500-4,750	Tea lands: Mid and high elevations
<i>Acacia decurrens</i>	15-25	3,530-3,940	Tea lands: high altitudes
<i>Acacia auriculiformis</i>	05-60	4,800-4,900	Wide spread: Low and mid altitudes
<i>Pariserianthus falcata</i>	30-50	2,865-3,357	Mainly on tea lands: Low and mid altitudes
<i>Casurina equisetifolia</i>	30-50	4,950	Coastal areas
<i>Leucaena leucocephala</i>	24-60	4,200-4,600	Wide spread in low altitudes
<i>Clusia rosea</i>	125-150	4,154	Tea lands in: Mid and high elevations
<i>Eucalyptus grandis</i>	40-200	4,700-4,800	Mid and high elevations

⁸Promoting Sustainable Biomass Energy Production and Modern Bio-Energy Technologies-UNDP, GEF

5.6.2 Small Scale Home Gardeners of Gemi-Sarana CBO network

'Gemi-Sarana' which means (rural strength) is a network of village based CBOs, founded in the year 1997 and registered as a non-governmental organization at the provincial administration (Sabaragamuwa), having its registered offices in Sanhidiyawa, Kahagalla, Thuntota, Warakapola in the Kegalle District of Sri Lanka. The organization is administered by a staff of 15, of which 13 are women. The Organisation's network of CBOs is extended to 06 Divisional Secretariat Divisions covering more than 182 GN⁹ Divisions in the Districts of Gampaha, Kegalle, Kurunegala and Matale Districts. (Map below)

The network consists of over 19,000 member families in 1,796 small groups that have been mobilized towards achieving a wider goal of building a '*happy family*'. In that the community members recognize that their resources (especially human capital, organizational capacities, agricultural resources, training and skills), can be invested into socio economic wellbeing as well as ethical and cultural development within the family. Their small group network is extending into more hierarchical but a strong institution to represent them at Regional, Divisional and District levels. The network has been considered a forum to improve the homesteads thereby the supply of fuel wood required for the project will be sought from those homesteads. An initial survey carried out has revealed that the member households living within the 50m radius of the project consist of about 10,000 who are holding their own homesteads with an extent of ½ to ¾ acre and another category of HHs having over 3 to 4 acres of land.

⁹ GN Division is called Grama Niladhari Division, which is the lowest administrative unit at the village level.

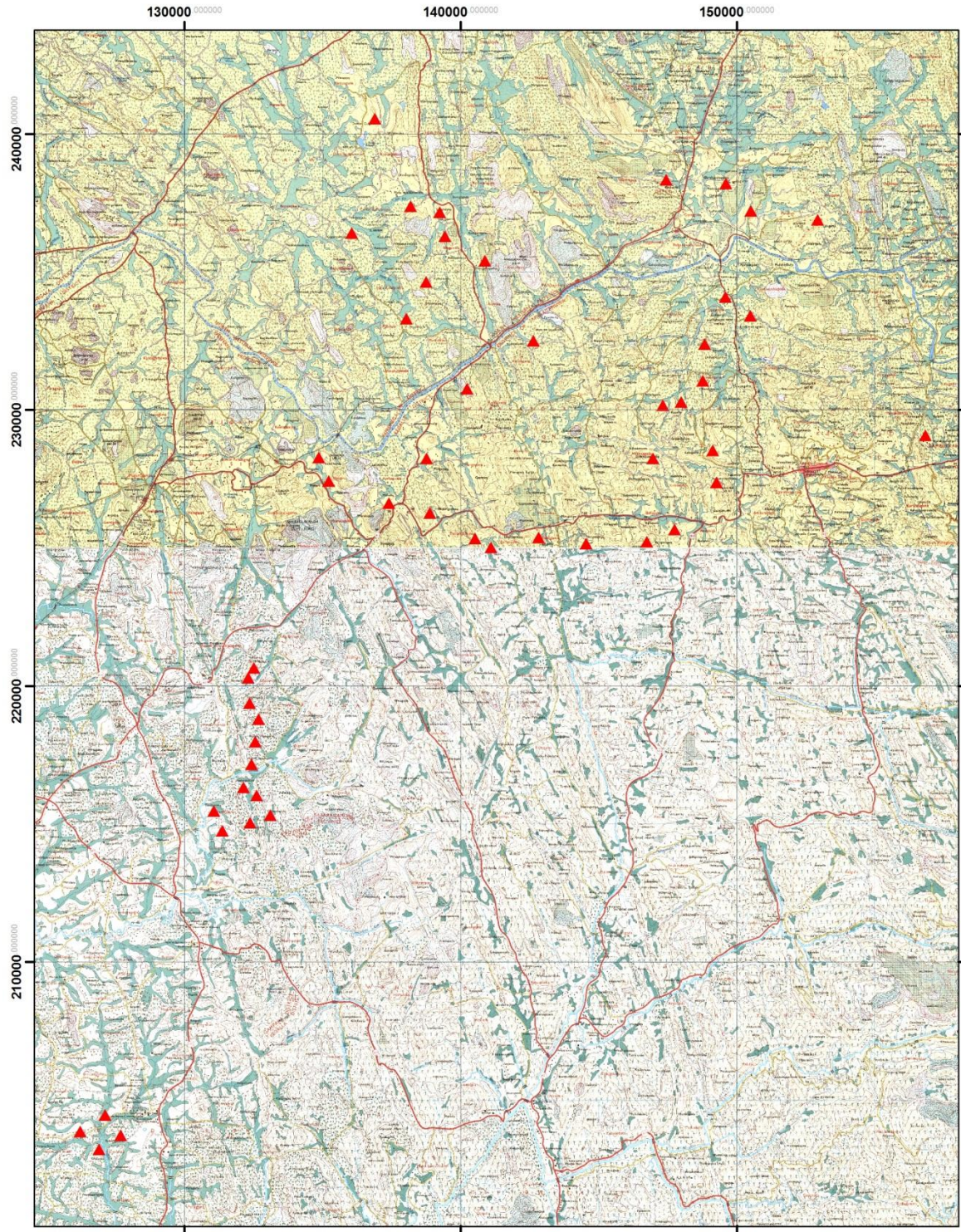


Figure 8 Potential areas from where *Gliricidia* will be collected through *Gemi Sarana* CBOs

Discussions with the farmers as well as the members of the *Gemi-sarana* network of farming communities has indicated that they are in favor of the project in view of the integration of value addition to the crops that they have already planted in their homesteads. The intercropping as at present is that *Gliricidia* is intercropped in coconut, tea and pepper as a co

plant to support structurally to main crops. They are dedicated to achieve household food security and responsible citizen's objectives through their contribution to sustainable development initiatives, human rights and gender equality.

A wide range of activities are being regularly conducted with the participation of the public and private sector institutions enabling the members to enrich skills, participation, savings and networks. Among the key programme for which the members are exposed to on a regular basis are the programmes focusing on gender participation and drug addiction among the family members, nutritional programmes targeting the children and women, youth development, community cohesion, livelihood development and environmental conservation.

The households have their homesteads mostly intercropped with spices whereas in most cases they have tea or coconut as primary plantations. *Gliricidia* is being planted along the fences as well as within the intercropped plants. The network is therefore able to produce a substantial quantity of firewood provided they are induced thorough other support mechanisms to plant more and more *Gliricidia* in the vacant



spaces. (A complete survey of the households with a view to quantifying the potential supply is being separately carried out which will constitute a part of this study)

The supply chain of fuel wood for the project would principally come from the network of the *Gemi-Sarana* community members. The network organization has already been made aware of the potential benefits to the income of households from the *Gliricidia* plantations in their homesteads.

In order to sustain their interest in continuing the production of fuel wood, SMG in association with the Coconut Development Board have conducted several programmes that

allow the households to have coconut seedlings. SMG in consultation with minor export crops have carried out awareness programmes to enhance income from spices grown in the homesteads. A certification scheme is being introduced enabling the households to receive a higher income. Such strategies have been introduced in order to create a symbiotic relationship between the developer and members of the network, which is of importance in terms of developing the fuel wood supply chain as well as increasing the income of householders.

Buyback arrangement:

The buyback arrangement of *Gliricidia* will be possible through *Gemi-Sarana*, through a layer of collectors introduced in between. These collectors serve as agents who are engaged in cutting, harvesting, transporting the materials to the main shipping yard. This buy-back arrangement will be arranged through a Memorandum of Understanding (MOU), between the developer and the Executive President of *Gemi-Sarana*. (A copy of which is attached in Annex (7))

It is proposed that each ten kilos of *Gliricidia* fuel wood will be paid a farm gate price of Rs. 220/=. The following maps indicate the special distribution of the *Gemi-Sarana* programme and the areas where homesteads are located.

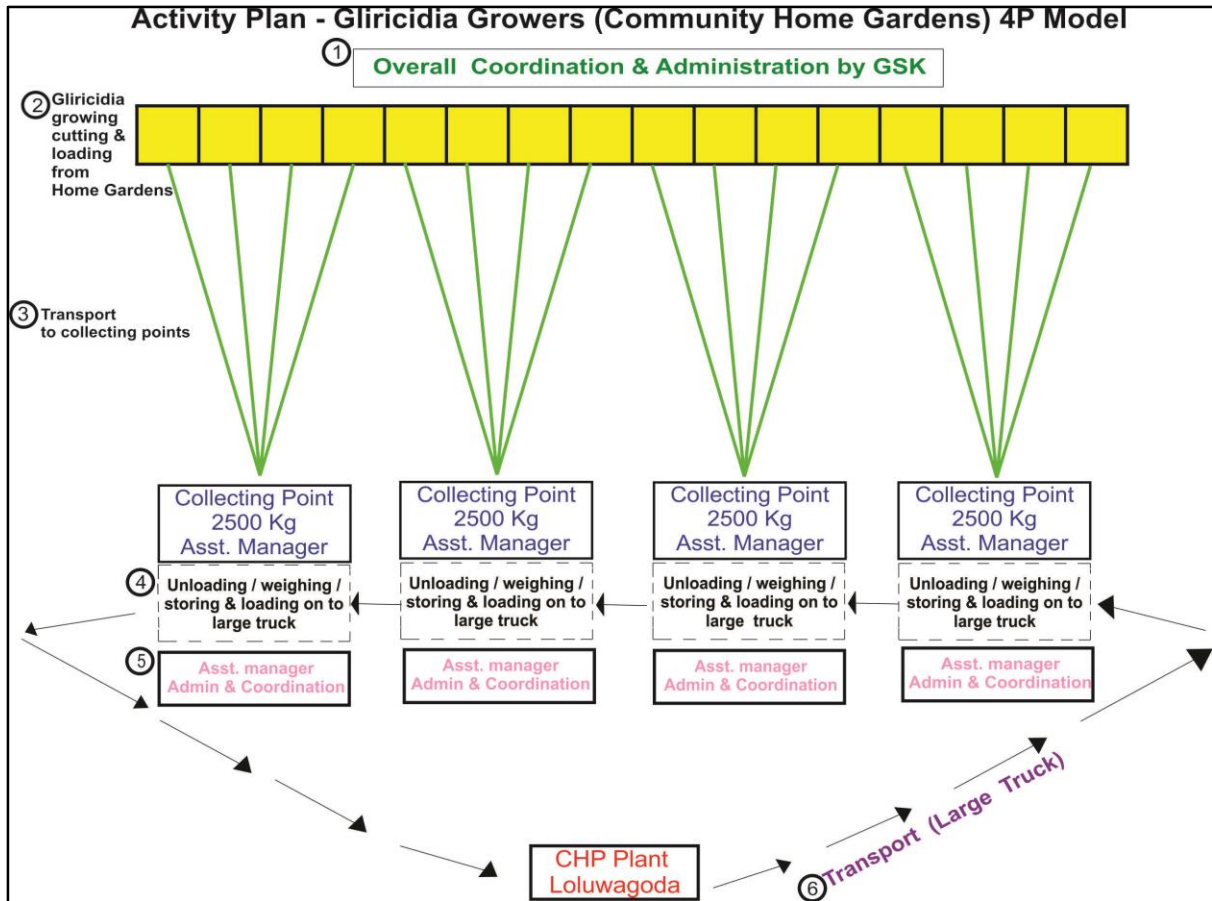


Figure 9: Process Flow chart - Gliricidia supply chain

5.7 Water

The project will require approximately 500 m³ of water which can be either received from its own shallow well, the National Water Supply and Drainage Board (NWS&DB) or from the BOI (Mirigama). A discussion with the Senior Manager BOI Mirigama has indicated that providing water from its facility will be possible, but cannot be extracted through pipe connections or from any point in between the intake and the settlement tank. According to him, the water required by the project can be bowser supplied. However, this option is practically and financially not feasible. If a pipe connection is possible, it will only be possible from the point of the settlement pond and after careful consideration of the feasibility. Chlorinated water is supplied at Rs. 70/-per unit and that it will also be a waste of good quality water, if it is used to meet raw water requirements. However it is proposed that the project will receive water from the facility before it is treated and hence the project will bear less cost for its operational activities. The other option is to have a shallow well in the project premises and draw water from the shallow well, which is feasible according to the geological study. The third but more expensive option is to have water from the distribution network of the National Water Supply and Drainage Board. This is the potable water that is provided to the consumption of the general public. The NWS&DB too has given a letter to the Developer indicating the possibility of supplying the required quantity of water to the project on a regular basis.



Figure 10 water intake & weir at the Maha Oya



Figure 11 Weir crossing the Maha Oya



Figure 12 settlement [pond at the BOI Facility



Figure 13 Aerator at the BOI facility



Figure 14 Pumping station



Figure 15 Main distribution valve

6 ENVIRONMENTAL, HEALTH & SOCIAL IMPACTS

There will not be any involuntary resettlement as result of the project requiring land for the construction of the power plant or any of the associated structures such as the chipping machine. Biomass energy projects to be permitted in Sri Lanka will not involve logging of trees. Fast growing wood species will be planted in degraded, abandoned agricultural lands where only branches of the tree species will be harvested and used as fuel wood. Since fuel wood will be harvested mainly from home gardens and coconut plantations, no deforestation will occur and no destruction of natural habitats will take place. The fuel wood planted areas belong to community members and therefore there is no involuntary displacement that may occur due to land being used for fuel wood planting.

Environmental, health and social impacts could arise in areas of plant effluent emissions (Mainly arising from discharge of waste water and emitting noise), biomass harvesting, and transporting. The process to convert *Gliricidia* into the end product of chips involve a long process including harvesting, collecting, sizing, transporting, chipping and finally to the facility for consumption. A number of likely public safety, health and social impacts are discussed below.

The supply chain needs to be cost effective, reliable and adequately resourced with year around supply. Therefore *Gemi-Sarana* network of community based organizations is to play a vital role in this regard in summary the project will accrue the following benefits:

Social well being

The Project activities generate additional employment to rural poor, directly and indirectly through the following:

- Biomass cultivation, processing and supply chain management
- Collection and transportation to Project sites
- Biomass fuel handling at Project sites

The power plant and the catchment area for fuel wood supply will be constructed in rural areas where biomass availability is high. Therefore the project will specially contribute to alleviation of poverty and leading to improvement in the quality of life of the rural people. Further, the project offers employment opportunities to both genders thereby contributing towards removal of social disparities.

Economic well being

- Replacing fossil fuel based power generation equal to the electricity generation by the project will reduce import of fossil fuels and thereby will save foreign exchange to the country.
- The generation of electricity by the project activity will improve availability of electricity to the national grid and also provide more opportunities for setting up of industries in the region.
- Income from sale of surplus biomass would improve economic conditions of the people.

Environmental well being

The project activity will result in:

- Reduction of harmful GHG emissions,
- Reduction of other harmful gases such as Sulphur from fossil fuel combustion,
- Effective utilization of biomass resource and reducing open dumping and firing

6.1 Social Benefits:

It is estimated that every megawatt of Dendro power installed creates employment for 300 people in rural communities. Unused land and agricultural small holds are ideal locations for the establishment of biomass plantations and people can enhance their earnings by selling fuel wood to Dendro plants. Employment opportunities are also generated out of the need to establish and manage fuel wood plantations and for plant construction and maintenance work. Fuel wood cultivation will be mixed with food crop production either as under-planting (such as in coconut or pepper/vanilla cultivations) or as co-planting to provide structural support to food crops. Live fences, again using *Gliricidia*, will be established to safeguard the boundaries of small plots. The leaves of the *Gliricidia Sepium* tree can also be used as cattle feed or as a substitute for urea as a soil nutrient.

6.2 Environmental Benefits

Environmental benefits of bio mass based energy has been extensively discussed in recently published policy and research papers. Biomass is a renewable energy source which is almost carbon neutral as the carbon emissions released during combustion are recaptured during re-growth. However in practice not all biomass generation will be carbon neutral as

transportation to the generation plant will generate carbon emissions. Nevertheless, with the rising importance of reducing carbon emissions and addressing climate change, biomass is becoming recognized as a feasible fuel substitute for conventional energy sources.

6.2.1 CDM Potential of the Project

The project is eminently eligible for registration with the UNFCCC as a Clean Development Mechanism (CDM) project under the Kyoto Protocol, as it falls under the renewable energy generation category, eliminating the emissions due to an equivalent amount of power generation using fossil fuels. In Sri Lanka there is no mandatory requirement for private sector or government agencies to invest in small biomass power projects. The contribution of the project to sustainable development in the country is substantiated based on the following indicators stipulated by GOSL for sustainable development in the approval guidelines for CDM Projects.

Based on the current status of the power generation structure in Sri Lanka the Carbon Credit potential of the project expressed as tons of Carbon Dioxide Equivalent saved or Certified Emission Reductions (CERs) can be calculated based on the following parameters

1. Capacity of the power plant	4.0 MW
2. No of days of operation per year	325 days
3. Internal consumption of the power plant	12 %
4. Current Sri Lanka Baseline Emission factor	0.714 kg/kWh
5. Estimated Net Energy exports to the grid	20 GWh

The CER potential per year works out to 14,280 tons of CO₂ equivalent.

The project is therefore a means of reducing the GHG emissions in the country by replacing the equivalent amount of CO₂, which would otherwise have been emitted for the generation of the equivalent amount of electrical energy. Since Sri Lanka has a mix of different sources of power generation with both fossil fuel based generation and a number of renewable energy sources, this equivalent amount of CO₂ abatement is determined taking in to consideration, the above mix and the contribution by each source. The method of calculation of this equivalent amount termed National Emission Factor is defined by the UNFCCC. In Sri

Lanka, the responsibility of making this calculation is vested with the Sri Lanka Sustainable Energy Authority which publishes same periodically in the Sri Lanka Energy Balance published in their web site www.energy.gov.lk. The present (2013) emission factor as per the SLSEA web site is 0.7142 kg of CO₂ per kWh. However in the case of the current project, the total amount of emissions reductions cannot be claimed based only on the number of units generated, for two reasons:

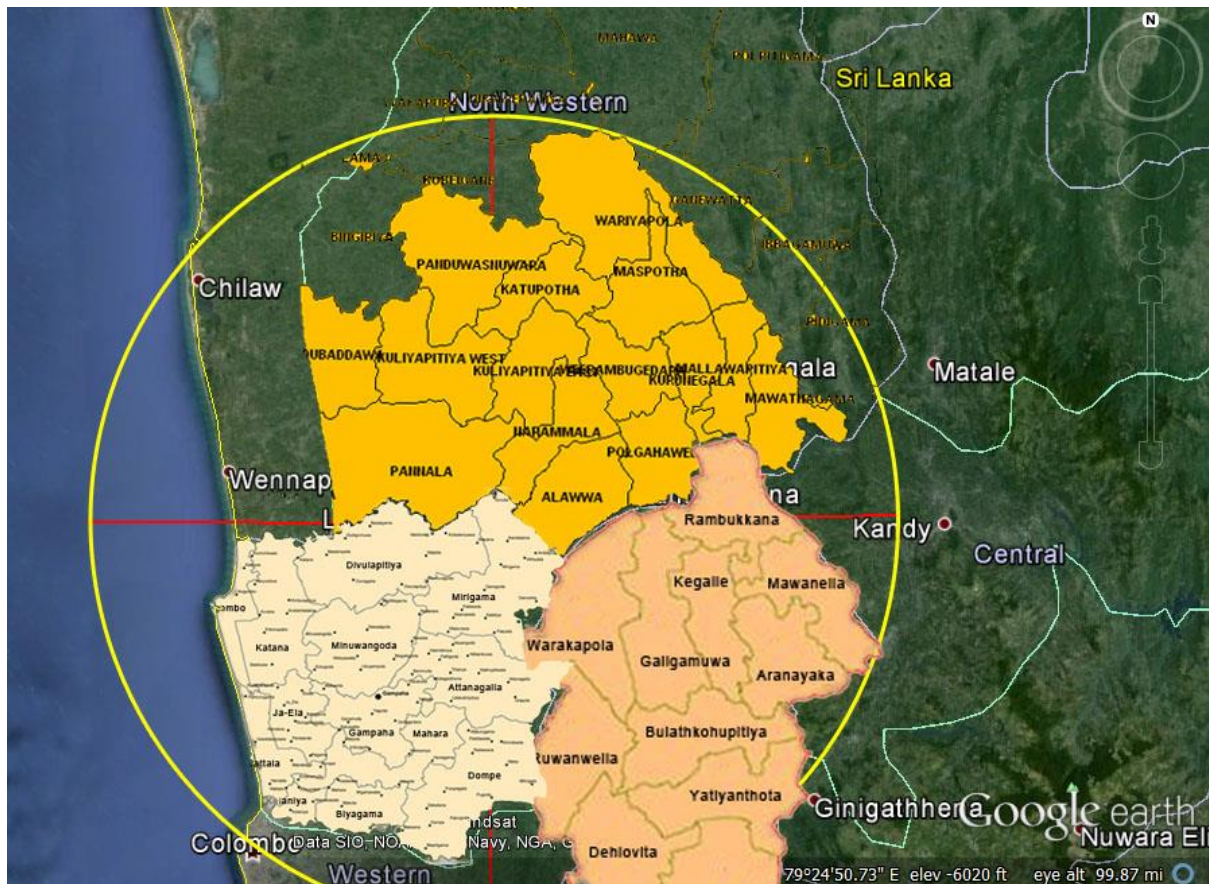
1. There is an internal consumption of power,
2. The transport of fuel wood to the power plant is done using vehicles using fossil fuels and is thus emitting CO₂ in the activity

The issue of the internal consumption is handled by only claiming the emission reduced based on the net energy delivered to the national grid. The plant operates under the CHP mode with some stem extracted for process use. Therefore the energy sales have been computed net of the internal consumption and the period on which the plant is on the CHP mode 250 days and 75 days on Power Mode.

The net energy exports of the power plant is = 20,000 MWh per annum

In case of the leakage during the transport is estimated based on consideration of the sources of fuel wood and the transport distances involved. For the purpose of this calculation a significantly large sample of the fuel wood supply logistics, which can be considered representative to arrive at an estimate of the leakage per ton of fuel wood delivered, is considered as described below.

The fuel wood supply for the project is expected to be collected from the three districts of Gampaha, Kegalle and Kurunegala. The map below illustrates the catchment area.



An estimate has been made of the present available supplies from these three districts divided into 4 Divisional Secretariat divisions. The expected quantities and the average transport distances from each DS division is depicted in the Table 6.1 below.

The estimated annual quantity of fuel wood estimated for collection from the three districts is 34,777 tons per annum. The Ton Kilometers for this collection is estimated as 1,579,714 Ton-Km. “Building on the fuel supply strategy presented to DFCC Bank in the business plan, KMRI-SMG Asset Company has finalized its fuel supply strategy in two parts: a short-term and long-term plan. Per the financial model, the total fuel requirement for the plant is 40,625 tons per year at 35% moisture. The strategies below account for the following: (i) 250 days of operation in combined heat and power (CHP) mode where fuel requirement is 125 tons per day; and (ii) 75 days in power only mode where fuel requirement is 125 tons per day.”

Thus the weighted average travel distance for the fuel wood supply is 45.42 km

Table (6.1) Distance travelled per transport vehicles for Fuel wood supply

Divisional secretariats	Estimated fuel wood in /year	Distance in Km to Loluagoda		Weighted Average
Kegalle district			Total Kg Kms	Km/kg
Aranayaka	6,856	51	349656	
Mawanella	2,345	48	112560	
Rambukkana	516	46	23736	
Kegalle	2,310	35	80850	
Galigamuwa	694	30	20820	
Warakapola	715	16	11440	
Ruwanwella	1,051	52	54652	
Bulathkohupitiya	15,820	50	791000	
Gampaha district	-			
Minuwangoda	374	27	10098	
Diwulapitiya	387	21	8127	
Mahara	161	41	6601	
Dompe	730	45	32850	
Attanagalla	433	24	10392	
Mirigama	563	8	4504	
Kurunegala district	-			
Alawwa	144	14	2016	
Kuliyapitiya East	74	30	2220	
Kuliyapitiya West	106	35	3710	
Kurunegala	94	38	3572	
Mallawapitiya	276	42	11592	
Maspotha	55	45	2475	
Mawathagama	422	50	21100	
Narammala	151	20	3020	
Panduwasnuwara	10	50	500	
Pannala	238	16	3808	
Polgahawela	127	30	3810	
Udubaddawa	17	40	680	
Wariyapola	53	45	2385	
Weerambagedara	55	28	1540	
Total Estd Collection Tons	34777	Total Distacne Travelled	1579714	45.42

The total fuel wood requirement for the power plant is 54,000 tons per annum at 40% moisture content, estimated as the MC at the point of loading. . This is expected to be delivered in diesel engine driven trucks of average capacity 8 tons each.

Thus the diesel consumption for the transport activity is estimated as

Total number of Truck Trips $54,000/8 = 6,750$ trips

Total travel distance (both ways) $6,750 \times 45.42 \times 2 = 613,170$ km

Average Fuel Consumption for an 8 ton truck 6 km/l

Therefore Total Diesel Consumption = $102,195$ l Say $110,000$ l

Carbon emission per kg of diesel 3.0 kg CO²/kg

The total leakage emission due to transport = 3 x 110,000 x 0.85 = 280,500 kg.

Thus the leakage to be allowed is 287 Tons of CO²/year, leaving a net emission reduction or Certified Emission reduction potential of 14,280 -280= 14,000 Tons per annum

World Bank Indicators - Sri Lanka - Emissions¹⁰

	1990	2000	2010	
CO2 intensity (kg per kg of oil equivalent energy use) in Sri Lanka	0.7	1.2		[+]
CO2 emissions (kg per 2000 US dollar of GDP) in Sri Lanka	0.4	0.6		[+]
CO2 emissions (kt) in Sri Lanka	3770.3	10161.3		[+]
CO2 emissions (metric tons per capita) in Sri Lanka	0.2	0.5		[+]
CO2 emissions (kg per PPP dollar of GDP) in Sri Lanka	0.2	0.2		[+]
CO2 emissions (kg per 2005 PPP dollar of GDP) in Sri Lanka	0.1	0.2		[+]
Other greenhouse gas emissions; HFC; PFC and SF6 (thousand metric tons of CO2 equivalent) in Sri Lanka	0.0	0.0		[+]
Agricultural methane emissions (% of total) in Sri Lanka	64.1	64.8		[+]
Energy related methane emissions (% of total) in Sri Lanka	11.5	12.4		[+]

6.3 Economic Benefits

A 20 percent (20%) contribution by non-conventional renewable energy (NCRE) for the power generation by year 2020 will require at least 300 mw of power to be generated from Dendro power plants using *Gliricidia* and other suitable Short Rotation Coppicing tree species. These will contribute very favorably to the other sectors of the national economy such as livestock development, reduced inorganic fertilizer inputs for food production and enhancement of income of rural farmers, as well.¹¹ On the other hand increasing tree cover in small homesteads can increase soil fertility by improving moisture retention, soil structure, and nutrient content (by decreasing leaching, providing green manure, and adding nitrogen if nitrogen fixing plants are used). Tree planting can also stabilize soils by reducing water and

¹⁰<http://www.tradingeconomics.com/sri-lanka/energy-related-methane-emissions-percent-of-total-wb-data.htm>

¹¹ Daily News 13th an 2012

wind erosion on slopes and in adjacent agricultural fields. However, large commercial plantations have the potential for causing negative environmental impacts of considerable scope and magnitude.

6.4 Environmental, Social, Health Impacts during Construction Period

Major construction elements of the proposed project include foundation treatment, construction of the boiler, internal roads and office building, as well as other facilities for water storage, sanitary facilities, fencing of the boundary (Boundary walls) and security huts. The buildings are of prefabricated structures, roads are made of mass asphalt or concrete and general yard surface will be laid with interlocking concrete blocks. Pollution sources during the construction period consist mainly of mechanical noise, engineering dust, engineering wastewater and construction waste. An analysis of environmental impacts during construction period for the proposed project and proposals on pollution prevention and control measures and managerial requirements may reduce negative impacts by project construction to a minimum.

6.1 Construction Impacts on the existing environment

There is a need to perform earthworks to obtain adequate level areas required for the construction of the facilities. These would create a certain amount of silt formation due to surface run off carrying the disturbed soil. These works have already been done to a great extent and the siltation and other impacts have already stabilized. There is no evidence of any blockages of water ways or other permanent impacts noted. The existing natural water runoff patterns have been disturbed to some extent.

There are no changes in the surface or ground water quality due to the project except during the short period of construction. There being no liquid effluents of significance (only boiler blow down water and domestic sewage effluent being discharged) this is not considered a potential source of surface or ground water contamination during the operation of the plant. These quantities and the means of their handling and disposal are described in the relevant section. There will be some insignificant amount of wastewater released from the construction activities of the project. This includes cleaning water for engineering equipment and water from concrete work for masonry component of the construction.

There will be nearly 100 on-site construction personnel who contribute to domestic wastewater, due to washing and for cleaning. This amount of waste water will be around at 40 liters per head per day, the amount of domestic wastewater is at 3.5 m³ /d, and that will be discharged into the existing wastewater drainage system. .

The Disc Chipper is located about 2.1 km away from the project main power plant. Although this is situated on a land in an extent of 3 acres, and is well secured around thick vegetation, that includes, coconut, areca-nut, Jak, Cashew, Banana. Several trees (coconut) need to be felled to find adequate space for the construction of the Disc Chipper. About 150 m on either side of the proposed Disc Chipper, there are houses which are on the adjacent



Figure 16 Vegetation in the land identified for the Disc Chipper

lands. There may be a possibility that accident to happen as the either side of the access road in neighboring area is populace. As a result during construction safety issues need to be addressed.

The main source of noise expected during the construction stage is from the earth moving machinery. During the construction phase, there is no considerable noise generation envisaged as there is no piling work or deep excavations. Since the major component of the earth work is already completed, this temporary source of noise is not expected to last for more than a few more months. Since the nearest residential community is over 100 m from the project site, the level of noise will be considerably attenuated before reaching this distance.

The transport of construction materials will require use of the access road and thus will create some noise induced by vehicles. However this will be of intermittent nature.

In the early stages of construction there would be some dust created depending on the weather conditions. With the majority of the earthworks already completed the main source

of dust emission is already completed. Since the construction areas are well away from the site boundaries, the impact of the dust emissions during construction is not expected to be of impact to the neighbors.

Pollutions on ambient air by the proposed project include mainly dust from surface leveling at the construction site, movements of transportation vehicles and their loading/unloading of construction materials, earthwork by construction machinery and temporary piling of spoils. There will be safety impacts due to haphazard electrical wiring, non-adherence by the workers using personal protective equipment.



Figure 17 general site after removal of soil



Figure 18 Construction in progress



Figure 19 Some of the construction sites not protected properly



Figure 20 Upkeep of the site needs further improvement

6.2 Environmental, Health & Social Impacts of the project during operational phase

Effluents: One is the blow down water from the boiler. This is estimated at 1% of the boiler capacity amounting to 5 m³ per day. This stream is of relatively high total dissolved solids. It is proposed that this shall be allowed to cool down to room temperature and be diluted to the level of concentration permitted for use on land as irrigation water.

Cooling water supply make up: to ensure that use of water for cooling and for boiler feed water make-up may result in waste streams from the water treatment plants estimate as 2.4 m³ per day. As the project is expected to obtain its full requirement of water from the BOI, which is either fully or partly treated, the main raw water treatment plant is assumed to be located outside the project boundaries.

The other stream of effluents is from the sewage and waste water from domestic consumption. While the sewage will be disposed via suitably sized septic tanks, the waste water will be collected and directed to adequately sized soakage pits. The total volume of the sewage flow is estimated at 2 m³ per day and the waste water stream at 5 m³ per day. None of these streams are large enough or have any deleterious effects after the proposed methods of treatment to have any significant adverse effects on the environment or the surface or ground water.

Particulate emissions: the emission of unburned particles and ash from the exhaust stack, which requires to be managed within allowable limits. (a recommended emission standard has been issued by CEA, and a new standard is presently under discussion)

Other effluents: The power plant will have other effluents such used lubricating oil, and these have to be carefully managed and disposed of. The mode of disposal of the liquid effluents conforming to the approved standards has been already described.

Solid Waste: There would be some solid waste generated by way of wood particles and bark, during the fuel wood chipping and storage at the site. These would need to be collected periodically. The estimated quantities from these operations are:

From chipping/shredding operation - 600-800 kg/day

From sweepings in the storage areas – 400-500 kg/day

Noise: The power plant as well as the shredder can cause noise pollution owing to the high pressures at which they work. The air blowers and any wood processing machines are likely to be the source of highest intensity noise generators. The EPC contractors are required to ensure that noise level be restricted to 85 dB (A) @ 1 m distance for all rotating equipment like fans, compressors etc., except STG and Boiler Feed up Pump. Noise level for STG is considered to be 90 dB (A) at 1 m distance and noise level for boiler feed up pump to be at 92 dB (A) @ 1 m distance. It also specifies that 01 no. common silencer shall be provided at the outlet of super heater safety valve and super heater start up vent to limit the noise level to 110 dB (A) at 3 m distance.

The Disc Chipper is also located on a land about 2.1 km from the main power plant. Access to the land is through existing motorable roads, along which are number of houses. There will be a frequent playing of vehicles and that safety of the people in the close vicinity of the Disc Chipper need to be ensured. During the Disc Chipper operation, there will be noise, but it will not be significant issues as it is, since the closest house is located about 150 m away from the Disc Chipper. But in years ahead there may be possibility that more houses will emerge in the area and that noise will become an issue later. Driver awareness, road humps, speed limits are necessary to control unexpected accidents.

Ash

Ash will be discharged from the boiler furnace and also from the exhaust cleaning system, to be carefully disposed, without any pollution of air or ground water at the power plant or at disposal sites. Ash generated in the combustion process, collected as a wet stream at the boiler and dry stream from the flue gas cleaning system.

There will be fly ash collected from air heater hoppers economizer hoppers and ESP. The ash will be transported through pipes to the fly ash silo which will be provided with discharging system for disposal by trucks. The dewatered ash will be taken by a belt conveyor to bed ash chute and disposed through trucks.

Table (6.2) Ash Quantities calculated under different scenarios

Column 1	Column 2	Column 3	Column 4	Column 5
DESCRIPTION	UNITS	70 % Gliricidia stalk + 30 % Coconut fronds	75 % Gliricidia stalk + 25 % Rice husk	100 % Gliricidia stalk
Total ash generated	Kg/hr	204	386	176
Total fly ash generated	Kg/hr	143	270	123

(Please note that column (3) & (4) have been provided only for comparison purposes to indicate the quantity of ash produced under each scenario)

These two streams are proposed to be handled in the following manner so that they do not constitute a disposal problem. From past records it is evident that the fire wood based fuel produces approx. 1% of ash when combusted. The ash is removed periodically (as per boiler manufacturer's specification, should be removed once every 6-8hrs) from the Boiler combustion chamber. The chemical composition of the ash is given below.

Table 4: Composition of Wood Ash¹²

<i>Calcium as Ca</i>	3.1 %
<i>Magnesium as Mg</i>	0.88 %
<i>Potassium as K</i>	1.7 %
<i>Sodium as Na</i>	0.16 %
<i>Phosphate as P</i>	0.32 %

Safety during Fuel wood handling

Fuel wood harvesting, sizing, collection and transporting and thereafter chipping processes may result in likely safety, health and social impacts. Harvesting of *Gliricidia* involves, identification of mature branches, cutting them and branch trimming. Principally there are no mechanical methods developed for this process. This is traditionally a manual operation carried out by rural farmers using knives or other sharp tools. Once the branch is severed from the tree they do trimming of the leaves and small tender branches manually which will be tough on the hand muscles, may prone to injuries (Knife cuts) unless they are better

¹²Tests as per SLS 646 Parts 4,5,6,7,pf 190 by SGS Laboratories

equipped to handle the process. It should be considered that the process although is known by traditional farmers, there is likelihood that more women will get involved in this process and that they will do it on a commercial scale.

The mechanical tool widely used for timber feeling is the electric chain saw, which may be used by the farmers for sizing the large trees. But for the rest they use simple tools such as above. However using the right kind of tool may avoid any likely injuries that the farmers may sustain during harvesting and sizing

Some pictures of the traditional tools used by the rural farmers in processing timber trees are given below:



Figure 21 Conventional tools used by village community

Possible falls

Gliricidia is planted very often as part of Sloping Agriculture Land Technology (SAT) and can therefore be assumed that the accessibility may vary from flat terrain to steep areas where working on higher platforms or any other similar devices will be required in order to harvest mature braches of trees grown on hedges and to remove them for safe places before they are sized and made ready for collection.. Safety of the people working on such places will be in danger. Unless people are well informed of imminent accidents resulting from such work, injuries may occur.

Health hazards during harvesting and staking of *Gliricidia* material:

Another possible injury that farmers may be exposed will be as a result of snake bites when harvesting *Gliricidia* in home gardens and plantation areas. *Gliricidia* stumps, once harvested and sized will be temporarily stored in open areas such as ‘*Kamatha*’¹³ or vacant lands close to the collection points. The collection will be either weekly or in close intervals between weeks. The stuffing of the materials into then Lorries will be manual and that still the farmers can sustain injuries in that process. Snake bites can take place; other physical injuries can occur unless some amount of awareness is given to them.

Other undesirable social outcomes arising from the tree harvesting

There will be a number of other adverse social impacts to arise during the process of harvesting and sizing of *Gliricidia*. One possible impact would occur within the household when there is a tendency among the households to engage child labour into this activity. Very often, this will be a subsistence income for the family and that income will be maximised by engaging more HH labour. This practice will be against social norms and the global best practices as well.

Other types of social impacts are to arise from conflicts over land boundaries; access to common property and crop damages due to tree felling. Land boundaries are very often demarcated by the live fences and both parties living within a land separated by a live fence can claim rights over the trees planted. This will be more intensive when the *Gliricidia* plants have a market value. There will be competition for the *Gliricidia* on common property such as parks, cemeteries etc. in the rural areas where one might get access to *Gliricidia* hedges. When people compete with each other to claim rights over them there can be conflicts, which may disturb their harmonious existence.

Health impacts due to fuel shredding at the Chipping Yard

In the chipping centre transported stumps will be graded and chipped using rollers and cutters. This is a mechanical process and that possible injuries to the workers engaged in the chipping yard will be resulting from the excessive sound, dust particles and may be from the serpents found in the stocks. The chipping processes conducted within the chipping facility will produce some solid particles such as bark and sawdust and wood chips. These will have

¹³ Kamatha is the vacant land commonly used by paddy farmers to grind paddy with the use of cattle after paddy harvest.

to be managed properly to be used as fuel in the power boiler after necessary processing to a form acceptable form the boiler as the preferred mode or disposed of otherwise, Accumulation of wood and bark pieces and dust in the fuel wood storage and feeding systems

6.3 Impact Mitigation Measures:

6.3.1 Environmental quality Impacts

Managing waste water from operations

The total water input requirement is estimated as 531 m³/day in the power generation mode according to the Water Balance attached. A further 7 m³/Day is estimated as the requirement for the wash rooms, canteen and worker amenities. It is proposed to obtain 500 M³/day of this quantity from BOI. The Silver Mills presently obtains up to 45 m³. day for its boiler and other process requirements. Since the project will be providing the full requirement of steam for the Silver Mills, their requirement of water for the boiler will now be diverted to meet the balance requirement for the power plant operation

The source of this water is the BOI Free Trade Zone at Mirigama. There are no plans for use of surface or ground water. (The notation in the water balance as boreholes as the source of water is an assumption of the consultants who prepared the water balance)

Liquid Effluents.

The proposed project will generate waste water for disposal. The amount of waste water thus created is estimated as:

- a. Boiler Blow Down - 5 m³/day
- b. Water treatment waste stream -2.4 m³/day
- c. Waste from Cooling Tower Blow Down 122.4 m³/Day

The project has provided for pretreatment of the total quantity of water in a pretreatment plant and further treatment is done according to the points of consumption. Filtration and Demineralization facilities are provided for the Boiler feed water and sterilization is provided for the potable water requirements

The proposals for the disposal of the liquid effluents emanating from the different uses is done after adequate treatment to enable the disposal by irrigation on green spaces of the power plant project site and on the coconut lands belonging to the Silver Mills adjacent to the project site. The quality standards for disposal on lands stipulated by the Central Environmental Authority is given in the Annex 4

Sewage water from toilets estimated as 2 m³/day– These will be disposed via suitably designed septic tanks to be constructed close to the points of generation. Mitigation actions are in keeping with the requirements as laid down in the Building approval.

Domestic water from canteen and wash rooms – These streams does not require any treatment and will be disposed in soakage pits. The estimated quantity is 5 m³/day.



Figure 22 Existing Water Treatment Plant at SMG Coconut Processing Plant

Managing Ash

The combustion of the fuel wood will result in a quantity of ash to be disposed of. Two streams are identified.

1. Ash collected from the bottom grate of the boiler furnace taken out as wet slurry
2. Ash from the dust collection system from the boiler exhausts which is in dry form.

As the ash contains useful minerals for plant growth, it can be disposed as a fertilizer for augmenting plantations where the fuel wood supply network exists. As such this need not be considered as a waste product from the plant in need of special disposal methods and requiring mitigation measures. Having considered the value of ash as soil enrichment in coconut plantation, the Coconut Research Institute (CRI) of Sri Lanka has already shown interest in buying the stocks of fuel wood (*Gliricidia*) ash.

The correspondence in this regard is provided in Annex (7 & 8). The collected ash shall be conveyed using a fully enclosed Screw conveyor and accumulated in a silo for easy disposal. The ash collected should be transported for proper disposal. In this regard, disposal may be by means of trucking than away to areas where it could be reused as fertilizer.

Air Quality:

The impact on air quality will only arise through the operation of the boiler where fuel wood is combusted. The Central Environmental Authority / BOI has published standards to be met by the final exhaust of the flue gases from the Chimney (Vide Annex 4). The project has provided for the installation of an Electro Static Precipitator prior to the chimney to bring down the particulate concentration within standards. The EPC contractor has been provided with ash standards to be met and the 99% efficiency of collection guaranteed by the contractor should ensure meeting such standards. The only fuel used being fuel wood all other constituents are either not stipulated or within the limits stipulated in the standards.

The total Ash content from the combustion of 125 Tons per day of firewood is estimated as 176 kg/hr (4.2 Tons /day) of which 123 kg/hr (2.9 Tons/Day) is fly ash collected in the ESP. Provision has been made for sampling of the exhaust stream to periodically monitor the performance of the dust control systems as required to be reported annually to obtain the Environmental Protection License to operate the power plant

Noise & vibration on public / Mitigations Actions:

The CEA /BOI environmental Standards specify the allowable noise levels at the boundary of the project site to ensure the impact on the public. The project has provided adequate mitigation measures to meet such standards. These are detailed under sections 6.3

All noise generating equipment would need to be provided with inlet and out let airline silencers and as required enclosures to ensure that noise generated is adequately attenuated to meet the specified standards. The criteria to be met as per environmental authorities are the noise at the boundary. These are specified in the CEA Gazette as well as the BOI environmental norms. Where the noise levels are higher than the levels specified by the occupational health authorities at locations within the premises, such as near the blowers, even after the silencers, ear protection equipment would need to be provided for the operating staff.

In order to meet the standards on noise at the boundary, after the practicable measures have been taken at the sources of noise, further mitigation measures may need to be implemented such as providing vegetation buffer zones to act as noise abatement barriers. Thus adequate bands of free lands will need to be identified and kept free for establishment of such green belts.

This can take place along with plans for landscaping of the site, after completion of the construction activities. Introduction of plants and trees that should offset any negative impacts associated with the removal and loss of existing trees at the project site as well as trees that may absorb noise (such as cashew) need to be planted along the boundary of the project site.

Enhancing the aesthetic appeal of the project site through replanting and landscaping will be essential and will provide the means for partially restoring the site's natural elements and ecological habitats. It is therefore a significant mitigation activity with a positive impact. The landscaping plan should seek to avoid the use of non-native and potentially invasive species.

6.3.2 Managing Social and Economic Impacts

There are no adverse social impacts; nevertheless there may be a possibility that during the cutting and collection stage of the fuel wood, health, public safety impacts can arise due to manual operations that are not guided by any acceptable safety measures/guidelines.

In general, there exists lack of awareness on the additional benefits of *Gliricidia*. Awareness is basically limited to the process of mixed cropping/intercropping with fuel wood, but this is largely focusing on nitrogen fixing species for fertilizing effect rather than for the wood.

However there is greater potential to incentivize and encourage mixed cropping models, especially in pepper growing areas, under coconut, and as erosion barriers in sloping areas, as fertilizer replacement among farmers and coconut/spice small holders or as shade tree for coffee and tea cultivation. In general, there is limited experience with various biomass growing models;

Anticipated traffic congestions during rainy seasons when collecting Fuel wood from interior roads can be prevented by providing awareness in advance, stocking adequate fuel wood in anticipation of rains that disrupt in some parts where firewood will be collected and with back up plans when Lorries are stuck.

All social impacts to arise from harvesting and collecting of fuel wood have been addressed and mitigation actions recommended in the preceding chapter.

A few are:

- Sign/renew agreements / MOUs to establish formal supply chain relationship with *Gemi Sarana Kendraya*.
- Stipulate payment on a mutually agreeable basis and renew them on a yearly basis;
- Create more awareness on the ethical practice of not using child labour/forced labour in the supply chain
- For those involved in the supply chain, it is necessary to provide regular awareness and training, good practice guidelines in harvesting techniques under safe conditions; introduce tools appropriate for manual work

6.3.3 Managing Occupational Health & Safety Impacts:

There will be 69 workers engaged on a shift duty basis when commissioning the plant. All workers engaged by the Developer need compliance to relevant Sri Lankan labor laws and the stipulation in the Shop and Office Act in regard to payment of wages, working hours and worker safety.

Accordingly the Developer needs to have a labor engagement policy, procedures for hire and fire, procedures for establishing working hours and remuneration for the workers on shifts, overtime, maternal and paternal leave procedure for health insurance, personal protective equipment, health services and accident services including appointment letters and maternity leave.

Identifying hazards in jobs (Operators) and providing job specifications based on the specialized job requirements will be necessary. It must be ensured that qualified persons are engaged for specialized jobs. Orientation and training must be provided. Insurance protection: EPF: ETF as per the labor laws and carrying out Labor Audits by appointing Independent Audit teams on a regular basis will be essential.

Other measures include:

- Provide suitable accommodation; drinking water; toilet facilities; space for recreation; dining for all resident staff;
- Provide appropriate Safety Equipment (PPE) for the workers exposed to different specialized jobs;
- Provide necessary training and PPE for safeguarding them from possible injuries;(Ensure that there is first aid, firefighting equipment , and a doctor engaged to attend to urgent accidents:
- Provide necessary training and PPE to safeguard them from ailments resulting from inhaling ash. They can be checked through in-house or outdoor health centers:
- Unforeseen accidents due to handling of fuel wood at the Disc Chipper Yard can be prevented by proper illumination ; proper staking methods and by providing necessary PPE for the workers

6.3.4 Managing Ecological Impacts

Natural or ecologically sensitive habitats and species are not found in the site of the proposed Dendro power plant, in the land where the Disc Chipper will be installed or in the fuel wood supply areas in Gampaha and Kegalle districts. The habitats found in the project site at Silver Mills premises and fuel wood supply area are man modified habitats such as home gardens, paddy fields, other agricultural lands and coconut plantations. These habitats are degraded and therefore the project will not have adverse impacts on fauna, flora and the habitats. Most of the plant and animal species recorded from the habitats are commonly found in the adjacent areas of the project site. Therefore plants and animal populations would not have detrimental impacts.

Table (6.1) Name and diameter of trees to be cut/ uprooted for the construction of Dendro power plant, at Silver Mills Premises

Botanical name	Common name	Diameter at Breast Height (DBH-cm)
<i>Artocarpus heterophyllus</i>	Kos	7 trees (dbh- 56, 37, 47, 60, 55, 58, 54)
<i>Cocos nucifera</i>	Pol	01 tree with 17.5

In keeping with the existing procedures, the developer needs to seek permission from the local authority when felling the Jak trees.

Impacts on Flora and Fauna

All recorded fauna and flora species in the project area are not habitat specialists or rare species. Also the endemic or point endemic fauna and flora species were not recorded from the project site. The fauna and flora comprise mainly of common species that are found associated with man modified habitats. Therefore the impacts on animal and plant communities and populations would be negligible. Natural or undisturbed habitats are not found in the project area. Replanting of *Gliricidia* will be carried out in the growing spaces found in home gardens or in open areas nearby. The home garden habitat enrichment will take place due to the growth of legume species that fixes nitrogen and provide it to the soil. These plants provide habitats for faunal species such as birds and butterflies.

Impact on habitats/ Terrestrial Ecology

The proposed project area will not intersect or block any wildlife corridors or recorded animal movement pathways. Wetlands of international importance are not located in the project area. Habitat and/ or breeding area for rare and endangered species or wild races of crop plants are not found in the project site. Aquatic ecosystems, such as swamps and marshes are not found.

6.4 Statutory / Local Government Approvals

Environmental Site Clearance: Environmental Site Clearance was issued by the BOI, in consultation with the Central Environmental Authority and it dates back to 2012.

Standardized Power Purchase Agreement: There is already a power purchase agreement signed between the CEB and the Developer signed on 28th May 2014.

Building Plans: The approval is valid for a period of 4 years upon completion of which the Developer needs to apply for renewal.

Environmental Protection License (EPL): The Developer is required to apply for Environmental Protection License (EPL) from the Central Environmental Authority for which joint inspections will be made by BOI and CEA officials to monitor the EPL conditions.

Transport of Fuel Wood- Make sure whether Forest Department approval needs to be obtained for the supply of fuel wood and seek the approval / permit well in time.

7 PROJECT CONTINGENCY PLAN

The risks associated with the success of the project are closely linked to the project location.

Others are:

- a. Availability and Reliability of Supply
- b. Quantities needed regularly in acceptable quality
- c. Risks associated with the properties of Bio Mass
- d. Efficiency of energy conversion
- e. Adverse effects on equipment
- f. Environmental Concerns

Contingent planning in the event of Fuel wood Supply Interruptions

This is the primary risk to be evaluated. The viability of the project and the financial returns of a Dendro project are made attractive by the possibility of achieving high level of plant factor in the order of 90% or higher. This is made possible by ensuring the supply of fuel wood year round. Since the survey conducted has indicated considerable availability even at this stage the level of the risk is minimal. However it is necessary to expand the survey to cover the remaining GS divisions outside *Gemi-Sarana Kendraya* and also to commence mobilization and negotiations to enter into supply contracts with independent suppliers in case the existing supply chain is interrupted.

A large demand exists for other industries to convert their boilers from oil to fuel wood. Although the profits from such a venture may be marginal or nil, the establishment of the supply chain for the Dendro power plant and creating the positive environment for more farmers to engage in *Gliricidia* cultivation would be a great boon. These externalities need to be appraised in the contingency plan.

In order that the fuel wood supply schemes can be affected early in the project program, the possibility exists of making purchases immediately and supplying the fuel wood to SMG with a view to developing confidence and to establish the supply chain with required procedures and good practices. The establishment of a market for the foliage products is another measure which can enhance the supply and the interest in expansion of the plantations from an early stage of the project.

The expansion of the plantations close to the selected power plant site will mitigate this risk as the final cost of supplies would be dependent on the transport distances and costs

Diseases affect the fuel wood plantations and the fuel wood supply

There are no records of any diseases seriously affecting the *Gliricidia* plantations in Sri Lanka. However it will be important to assist the research in this area for the sustainability of the supply chain.

Interruptions on the Transmission Line

The financial viability of the project depends heavily on the maximization of the energy exports. This can be compromised if there are interruptions due to faults in the transmission line which will prevent the export of power even if the plant is able to run. As such this risk is best mitigated by ensuring that the transmission line is dedicated to the power plant and it is as short as possible. The possibility of a suitable insurance policy can also be investigated.

Water Shortage

The optimal project design is for the use of water from the cooling system. As such the project location is being sought with an abundant supply of water. However if there is any shortage of water due to droughts or any other factors there would be drastic effects on the ability to operate the power plant.

As such extra care is needed in ensuring the supply of water and providing for redundancy of supply quantities and sources. It will also be necessary obtain as much historical data and ground surveys to minimize this risk.

Unless there is adequate confidence on the uninterrupted supply of water, it would be necessary to consider an air cooled system which does not suffer from this disadvantage. There is the possibility of having back up water supply scheme from within the Plant location as the site is suitable for a shallow well.

Adverse weather

Any inclement weather, particularly heavy rains and floods could interrupt the supply chain and drying of the fuel wood. Provision has been made for maintaining a stock of wood adequate for 20 days and covered storage for a week's supply.

The selection of the boiler should take this possibility into account and provide for the use of wetter wood on occasion so that there is no total disruption of the power plant operation. There would however be a loss of efficiency and the generation capacity during such periods.

The tightening of the supply base with minimum transport distances should be a long term goal to reduce the risk of interruptions of supply due to floods. The plant is usually designed to operate as an outdoor plant and rainy weather should not interrupt the operation of the power plant as such

Labor Issues

The number of workers necessary to operate the plant is not excessive. As such any labour issues are not considering a particular risk. However, the availability and retention of skilled labor and operational staff in the power plant location may pose a problem. Provision of attractive terms and facilities is the only mode of alleviating this risk. In this regard, it is necessary to comply with the terms and conditions as stipulated by the Board of Investment (BOI) which is given below:

Accidents

The occupier of a factory has to give written notice of any industrial accident which results in the death of a person or disables a person from earning his flat wages for a period of 3 days or make a person unconscious as a result of heat exhaustion, electrical shock or inhalation of un-irrespirable or poisonous fumes or gases. Such accidents must be intimated to the District Factory Inspecting Engineer/Labor Department, Labor Secretariat, Colombo 5 on Form 10 (Notice of Accident under Section 61 of the Factories Ordinance) with a copy to the Industrial Relations Department of the BOI).

Employment Injury Compensation

Workmen's compensation, at present rates shall be paid to a worker in respect of an injury caused due to an accident arising out of and in the course of employment or disease is of an occupational origin.

Where the occupier of a factory opts to take an insurance policy to cover such risks he should obtain such a policy from a recognized insurance organization.

Trade union and collective bargaining rights of employees

- i. The employees of BOI enterprises shall have the right to form and in trade unions of their own choosing and to bargain collectively, subject to the provisions of the Trade Unions Ordinance and the Industrial Disputes Act.
- ii. A trade union representing the employees in any BOI enterprise shall have the right to enter into collective bargaining negotiations with the employer, on behalf of the employees whom it seeks to represent, with a view to concluding a collective agreement, provided the union has the right to bargain collectively with such employer in accordance with the provisions of the Industrial Disputes Act.
- iii. Every employer in a BOI enterprise shall respect the right of the employees to form and join trade unions of their own choosing and to bargain collectively.
- iv. No employer in any BOI enterprise shall –
 - (a) Require an employee to join, or refrain from joining any trade union, or to withdraw from, or to refrain from withdrawing from his membership of a trade union of which he is a member, as a condition of his employment.
 - (b) Dismiss an employee by reason only of his membership of a trade union or of his engaging in trade union activities.
 - (c) Give any inducement or promise to an employee for the purpose of preventing him from becoming or continuing to be a member, office-bearer or representative of a trade union;
 - (d) Prevent an employee from –
 - (i) Forming a trade union, or
 - (ii) Supporting a trade union by financial or other means;
 - (e) Interfere with the conduct of the activities of a trade union;
 - (f) Dismiss, or otherwise take disciplinary action against, any employee or office bearer of a trade union –
 - (i) For any statement made by such employee or office-bearer in good faith before any tribunal or person in authority; or
 - (ii) For any statement regarding acts or commissions of the employer relating to the terms and conditions of employment of the members of such trade union made by such employee or office-bearer, in pursuance of an industrial dispute for the purpose of securing redress or amelioration of working conditions of such members;

- (g) Refuse to bargain with a representative trade union (i.e. a union which has to the right to bargain collectively with the employer of the employees in the enterprise on whose behalf it seeks to bargain in accordance with the provisions of the Industrial Dispute Act, Chapter 131)
- (h) Where both a recognized trade union having bargaining status and an Employees' Council exist in an enterprise, the employer shall not use the Employees' Council to undermine the position of such trade union and its representatives and shall encourage co-operation on all relevant matters between the Employees' Council and trade union concerned.

8 ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM:

The Developer will have an environmental and social management system; in view of the fact that the Developer is engaged in environmental friendly sustainable business. The ESMS have following components:

1. Environmental and Social Policy of the Developer
2. Organizational Structure for the implementation of its environmental friendly energy generation (power) projects
3. Environmental and Social Management Plan for the Dendro power Plant (based on the compliances:
4. A monitoring and Reporting Plan:

8.1 Environmental & Social Policy statement KMRI-SMG Asset Company (Pvt) Ltd.

The following E&S Policy adopted by the Developer emphasises that the company is committed to contributing to sustainable development and that NCRE has been considered a way forward to accomplishing such goals.

Preamble

As a diverse business dedicated in clean energy development, KMRI – SMG Asset Company Pvt. Ltd recognizes the complex challenges of achieving sustainable development. We are well aware of the potential environmental, social and economic consequences arising from operations that need interfacing with human and natural resources with which the development initiatives interlinked.

As a provider of non-conventional renewable energy sources, we endeavour very much to contribute to global carbon foot print reduction targets and to lead in the direction of being the market leader in harmonizing efforts for sustainability among the private and public partners in pursuing NCRE national targets

Objectives

Our Environmental and Social Policy serves as the framework for facilitating all our activities and operations to be environmentally and socially responsible and compliant to the regulatory environment and social standards as applicable.

Policy Statement

Our E&S Policy is founded on the long experience of our partner organizations namely the Silver Mills Group and KMRI which also have individual E&S Policies, which are now collectively binding and strengthened with one single E&S policy statement.

Our businesses align with sustainability objectives of the countries that we operate in and in that we do recognize the objectives of the Ministry in charge of generating power, in Sri Lanka and its long term vision, goals and targets of achieving sustainability in the energy sector.

We are committed to adopting robust safeguard management practices to mitigate environmental and social impacts arising from our activities in the field of energy generation. We work closely with our stakeholders to maintain high environmental and social standards in this regards. We comply fully with national environmental standards, code of practices as stipulated by the Central Environmental Authority & Board of Investment as well as other associated regulations at both regional and local level. We also adhere to relevant international standards and international conventions which are fundamentally onus on our efforts to introduce environmentally feasible and sustainable energy sources.

We also strive to comply with social safeguard practices which are essential when our operations require working with human resources. Our human resources policies are geared towards providing equitable opportunities for individuals irrespective of their ethnicity or religion and we avoid engaging child labor. We give prominence to worker safety and continuous improvement of their knowledge and skill. Thereby we harness their support for compliance to environmental and social stipulation throughout our operations.

We monitor environmental and social impacts of our activities and operations with clearly defined indicators and structured programs, and report our sustainability performances periodically based on locally and/or internationally accepted reporting guidelines and standards.

Organizational Structure of the Developer for the management of the proposed project

The organizational chart as proposed by the Developer is provided in the fig. below. The project during its operational phase will be manned by experienced staff under the supervision of a Plant Manager and a Fuel wood Outsourcing Manager (Head of Bio Mass). Both will be directly guided by the Chief Executive Officer (CEO of the Company).

In order to implement the mitigation actions as proposed in the EIA report as well as in the BOI / CEA compliance conditions, there will be a full time Environmental Officer and a full time Health & Safety Officer.

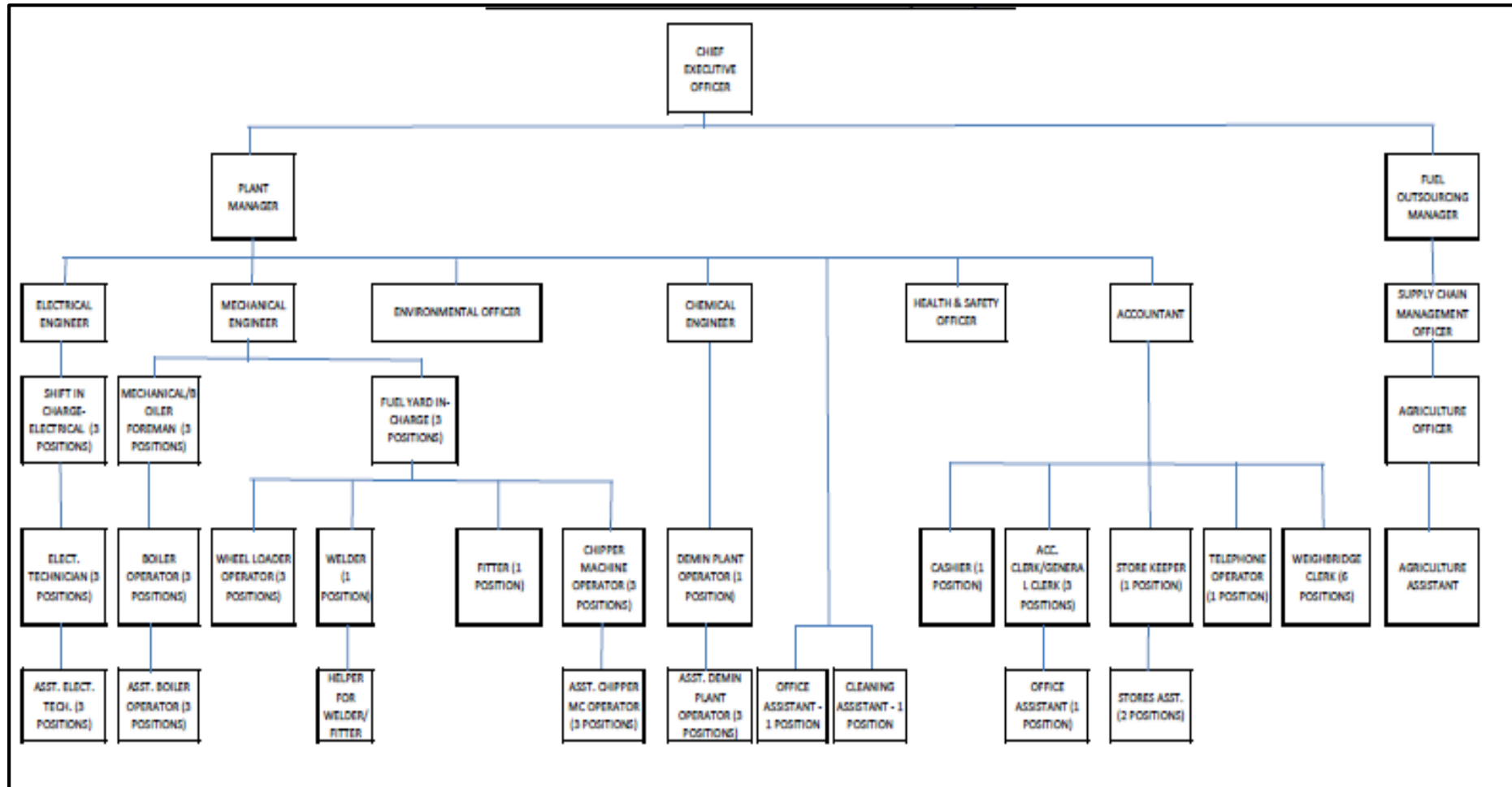
Responsibilities of the Environmental Officer

He or she will be responsible for implementing necessary measures with a view to meeting the terms and conditions which will be stipulated in the Environmental Protection License (EPL). In addition he/she will liaise with the BOI (environmental Office) and the Central Environmental Authority (CEA) for areas which need consultation and reporting on environmental compliances. Assist the CEA/BOI officers during the monitoring missions. Collect /renew necessary permits / Licenses

Responsibilities of the Health & Safety Officer

- ✓ Maintain all records required relating to the Safety Plan i.e. Risk assessment reports, safety meeting attendance/ near misses.
- ✓ Ensure that safety training is provided as required and conduct drills for fire safety emergency availability and evacuation procedure.
- ✓ Conduct of onsite risk assessment to assess potential hazards & provide hazard information to on-site workers.
- ✓ Ensure that the working area has good housekeeping practices in terms of proper collection and storage of construction waste and material such as nails (bent or unbent), other sharps, pieces of cut reinforcement material.
 - ✓ Maintain fire protection equipment at all possible fire hazard points and maintain the expiry of each equipment.
 - ✓ Maintenance of Health, Safety and Environment notices.

Organization Chart for the proposed Dendro power plant project



8.2 ENVIRONMENTAL & SOCIAL MANAGEMENT PLAN (ESMP)

Potential Environmental Impacts	Level of significance	Impact mitigation Measure	Reference Document / Permit	Responsibility	Monitoring Indicators	Frequency
Assessment & management of environmental & social Impacts and Risks						
Assessment of E&S Impacts	Significant	Carry out Environmental Impact Assessment studies and analyse potential E&S Impacts , implement mitigation measures as per the EIA report approved by EIB	EIA Report prepared for EIB/ Prefeasibility Report/ Site Clearance Application	Snr Management of the KMRI SMG Company	Availability of approved EIA & supplemental studies	
Sustainability of Fuel Wood Supply Chain	Significant	Sustainability of Fuel wood supply chain Study report			Availability of the Reports	
		Prepare ESMS and adopt E&S Policy		Officer in charge of Environment	Availability of reports at the beginning of the project	
		Implement E&S Monitoring and Reporting system	Loan covenants by the Banks requiring E&S compliance	Officer in charge of Environment	Progress reports	Every Three Months

			statement			
Approvals and Permits from statutory agencies	Significant	<ul style="list-style-type: none"> • Renew BOI approval on completion of three years • Obtain EPL from CEA before Commissioning • Renew building application after one year • Receive approval from the FD for Transport of Fuel Wood 	BOI Letter of approval/PS approval letters	Officer in charge of Environment		
Pollution Prevention & Abatement						
<i>Construction Phase</i>						
Contamination of surface drainage water when mixed with polluted water from construction site	Modest	Allow all construction waste water to run into a septic tank.	BOI letter of approval	Contractors in charge of civil work	Observed drainage pattern in the site	Monthly
Silt formation due to earth works	Not significant	Clear all spoils to proper fill areas , grade and compact as part of landscape preparation	As per standards by CEA/BOI	Contractors in charge of civil work	Observed drainage pattern in the site	Monthly
Surface erosion due to change of natural run off patterns due to earth works	Not Significant	Clear all natural drainage paths in the construction site immediately after excavation work	As per standards by CEA/BOI	Contractors in charge of civil work	Observed drainage pattern in the site	Monthly
Waste water released from construction activities. Washing & cleaning of	Modest	Drivers should not be allowed to wash equipment & vehicles where water will be directly drained to natural drains.	BOI letter of approval	Contractors in charge of civil work	Observed drainage pattern in the site	Monthly

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vehicles & Equipment						
Waste water from worker camps (around 3.5m ³ per day)	Not Significant	Can be discharged into the existing waste water drainage systems/ soakage pits as recommended by the BOI	BOI letter of approval	Contractors in charge of civil work	Observed drainage pattern in the site	Monthly
Noise			CEA /BOI Standards			
Noise generated from construction equipment	Not significant	Unloading of machinery & equipment from containers which may cause excessive noise can be managed through proper handling of loading and unloading work. Operator awareness will be useful. Maintenance of equipment on time		Contractors in charge of civil work	Operator awareness programmes	At least once in 04 months
Air						
Earth work can generate dust during dry seasons	Not significant	If there is excessive dust use sprinkler and make the areas wet.		Contractors in charge of civil work	Availability of dust sprinklers at site	Check every one month during the dry seasons.
Operational Phase						
Blow down water from the Boiler 5 m ³ per day. Contain high level of dissolved solids.	Modest	Allow blow down water to cool down to room temperature & dilute to the standards before releasing to irrigation in the coconut plantation. Can be managed by using the same to the watering of the nearby estate as well.	CEA/BOI emission standards given in the annex	Plant Manager	Water quality test to be carried out and reports to be availed	At least every six months
Sewage flow (2 m ³) & waste water (5m ³)	Modest	Ensure that septic tanks/soakage pits are fitted to all the staff toilets and	Building Plan Approval	Plant Manager	Inspections by the Site	Every month

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from operational staff		that the drainage to be directed to the septic tanks. Keep required set back limits	Letter		Environmental Officer	
		Ensure that septic tanks collect all waste water released from operational rooms.	Same	Plant Manager	Inspections by the Site Environmental Officer	Every month
Solid waste From Chipping & Shredding Operations will be (600 - 800 kg/day)	Modest	Being combustible materials can be used for combustion after aggregation and compaction Or can be disposed to vendors after aggregation.		Plant Manager	Inspections by the Site Environmental Officer	Every month
Sweepings in the storage areas will be- 400 - 500 kg/day	Modest	Being combustible materials can be used for combustion after aggregation and compaction Or can be disposed to vendors after aggregation		Plant Manager	Inspections by the Site Environmental Officer	Every month
Safe collection and disposal Ash (around two tons per day)	Modest	Dewatered ash to be taken by a belt to a bed ash chute and deliver through fully covered trucks (CRI has own interest in purchasing all stocks)	As per the technical specifications and the letter by CRI	Plant Manager	Inspections by the Site Environmental Officer	Every month
		Ash to be removed from the combustion chamber every 6-8 hours and conveyed through fully enclosed screw conveyor to ash chute		Plant Manager	Inspections by the Site Environmental Officer	Every month
		Storage of ash until taken away should be dust tight.		Plant Manager	Inspections by the Site Environmental Officer	Every month
Noise during	Modest	Disc Chipper can emit Noise during	Noise to be	Manager in charge	Inspections	Every

operation		its operations – Need to adopt technological measure to reduce noise	restricted to 85 dB(A)	of the Disc Chipper	by the Site Environmental Officer	month
		Overall operation of ash collection , feeding of pellets to the Boiler from the conveyor can cause noise but can be managed within the limits prescribed by the BOI/CEA	As per specifications given in the foot note: ¹⁴	Manager in charge of the Disc Chipper	Inspections by the Site Environmental Officer	Every month
		Control of noise at the outlet of super heater safety valve and super heater start up vent to have a common silencer.	As per technical specifications	Plant Manager	Inspections by the Site Environmental Officer	Every month
Biodiversity & Ecosystems						
<i>Construction Phase</i>						
Felling of Trees (minimum number 07 Jak Trees & 02 Coconut trees)	Not Significant	Require to have permit from the local authority to fell Jak Trees.	As per the building plan	EPC Contractor	Availability of permits issued by the Local Government	Once before felling of trees
Operational Phase						
Aesthetic beauty of the site premises	Enhancing existing environment	Planting of trees around the perimeter to make the area aesthetically beautiful and to control noises	As Per The EIA Report.	Plant Manager	Number of trees with large canopies	Every Two Years
Home garden Habitat (Will be enriched due to growth of legume species)	Positive Impact	Can be enhanced through better community awareness & Training	As per the MOU	GSK and the member of the GSK	Subsequent ecological inspection	Every one year

¹⁴ Rotating equipment (fans, Compressors) 85 dB (A), STG & Boiler Feed up Pump 90 dB (A) at 1 m distance & 92 dB (A) at 1 m distance respectively, Super Heater Start up Vent 110 dB(A) at 3 m distance

					by the subject specialists	
Home gardens with small size will have Gliricidia grown under shade conditions.	Insignificant ecological impact	Provide more awareness to the community members about the techniques of growing Gliricidia	As per the MOU	GSK and the member of the GSK	Awareness sessions and observation of the home gardens	Every one year
Climate Change Considerations						
<i>Construction Phase</i>						
Not arising Only a few machinery engaged emit obnoxious gases during operations	Not significant	Maintenance of the machinery & equipment well on time	Contractors' Documents	Civil Contractor	Updated records of vehicle maintenance	Every three months
Operational Phase						
Bio Mass based power will have no GHG impacts	Positive	Carbon Sequestration can be enhanced by growing more <i>Gliricidia</i> .				
There will be vehicular emissions from transport of Fuel wood and the atmospheric pollution that may increase GHG.(at least 15-20 lorry loads per day)	Not significant	Engage mass transport systems where possible. (Containers); Ensure that vehicles are tested for vehicular emissions. To avoid traffic congestions, plan transport of materials during non-peak hours.	Transport Contractors' Documents	Bio Mass Head	Updated records of vehicle maintenance	Every three months
Carbon Emission Reduction calculations	Positive	Carry out audits periodically	As per the EIA	External Party	Reports	Every year

Cultural Heritage						
<i>Construction Phase</i>						
No relevance	Not significant					
Operational Phase						
No relevance – There is no possibility that the cultural site will be affected as a result of the project or its supply chain activities	Not significant					
Involuntary Resettlement						
<i>Construction Phase</i>						
No relevance	Not significant					
<i>Operational Phase</i>						
No relevance – No involuntary settlement take place. Land requirement is minimal and the Owner provide a portion of the land	Not significant					
Rights & Interests of Vulnerable Groups						
<i>Construction Phase</i>						
No relevance	Not significant					
Operational Phase						
In the supply chain women may be	Significant	As <i>Gemi Sarana Kendraya</i> (GSK) is more women represented, their	MOU with GSK	Bio Mass Head & President GSK	Reports by GSK	Every month

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discriminated based on equity		involvement will be high in the supply chain of Fuel wood. They should be treated equally in terms of paying for their supplies ; providing training and awareness;				
Supply chain may deploy Child Labour	Significant	Parents should be warned against deploying children for any work in the supply chain. Necessary awareness need to be given	MOU with GSK	Head of Bio Mass and President GSK	Reports by GSK	Every month
Conflicts over common property rights that affect vulnerable people	Significant	Necessary that GSK institute a proper grievances handling mechanism at the CBO level to hear grievances of vulnerable people.	MOU with GSK	Head of Bio Mass & President GSK	Reports by GSK	Every month
Labour Standards						
<i>Construction Phase</i>						
Noncompliance by Contractors when engaging casual workers	Significant	All workers engaged by the contractors need compliance to labour laws and shop & office Ordinances in regard to payment of wages, working hours and safety.	As per Labour Regulations	Contractor	Check appointment letters issued to labour gangs	At three months periods
<i>Operational Phase</i>						
Number of workers to be engaged 69 & their worker rights may be breached	Significant	Comply with country laws pertaining to Shop & Office Ordinance & other Labour Laws which stipulate working hours; wage levels; Appointment letters; maternity leave;	As per Labour Regulations	Plant Manager	Check appointment letters issued to labour gangs	At three months periods
Necessity of Engagement of Skilled	Significant	Identify hazard in jobs (Operators) and provide job specifications based	As per Labour Regulations	Plant Manager	Check job specificatio	At three months

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personnel for specialised Jobs to prevent exposure to hazards.		on the specialised job requirement.			ns for different categories	periods
		Engage qualified personnel for specialised jobs; Provide orientation and training	As per Labour Regulations	Plant Manager	Check appointment letters issued to labour gangs	At three months periods
		Provide worker Insurance protection : pay EPF : ETF as per the labour laws	As per Labour Regulations	Plant Manager	EPF/ETF returns	Every 06 months
		Carry out a Labour Audit by appointing an Independent audit team on a regular basis	As per Labour Regulations	Plant Manager		
Supply Chain Labour	Significant	Sign/renew agreements / MOUs to establish formal supply chain relationship with Gemi Sarana Kendraya.	As per the MOU	Head of Bio Mass	Availability of signed MOU	Every one year
		Stipulate payment on a mutually agreeable basis and renew them on a yearly basis.	As per the MOU	Head of Bio Mass	Rates as defined in the MOU	Every one year
		Create more awareness on the ethical practice of not using child labour/forced labour in the supply chain	As per the MOU	Head of Bio Mass	Availability of signed MOU	Every one year
Occupational, Public Health & Safety						
<i>Construction Phase</i>						
Worker Safety due to haphazard electrical	Modest	Need to improve the general upkeep / cleanliness of the Construction Site	As per the recommendati	EPC Contractor	Site's Visual	Daily

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wiring in the construction site		:	ons of the Health & Safety Plan		environmen t	
Worker safety due to no availability of railings and protections around excavated areas	Modest (only for a few more months)	Need to have proper railing around areas already excavated.	As per the recommendati ons of the Health & Safety Plan	EPC Contractor	Site's Visual environmen t	Daily
Exposure to hazards during manual operations (Welding, digging, removing soil) etc	Modest	All worker attached to different contractors should be provided with PPE, need to supervise that they were them, (Minimum Gloves, Goggles (for welders) safety boots	As per contractor documents	EPC Contractors	Site's Visual environmen t	Daily
Operational Phase						
Worker Accommodation for resident workers	Modest	Provide suitable accommodation; drinking water; toilet facilities ; space for recreation; dining for all resident staff	As per contractor documents	Plant Manager	Site's Visual environmen t	Daily
		Provide appropriate Safety Equipment (PPE) for the workers exposed to different specialised jobs.	As per contractor documents	Plant Manager	Site's Visual environmen t	Daily
Those who work at the Disc Chipper	Significant	Provide necessary training and PPE for safeguarding them from possible injuries	As per contractor documents	Plant Manager	Training session conducted	Every six months
Ash handling work and possible health impacts	Significant	Provide necessary training and PPE to safeguard them from ailments resulting from inhaling ash.	As per contractor documents	Plant Manager	Training session conducted	Every six months
		Present them to regular medical examinations	As per contractor documents	Plant Manager	Individual worker's medical reports	Every six months

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Fuel wood handling and possible health & safety Impacts	Significant	Those involved in the supply chain, it is necessary to provide regular awareness and training , good practice guidelines in harvesting techniques under safe conditions ; introduce tools appropriate for manual work	MOU document	Head of Bio Mass and GSK	External evaluators inspection documents	Every six months
		Unforeseen accidents due to handling of fuel wood at the Disc Chipper Yard can be prevented by proper illumination ; proper staking methods and by providing necessary PPE for the workers		Officer in charge of the Disc Chipper	Site Safety Officer's incident reports	Every Month
Transport of firewood and possible accidents	Significant	Prepare a transport Plan; Provide necessary awareness to the drivers; source competent drivers and ensure that the entrance to the Disc Chipper Yard and the respective collection centres by the Drivers are managed with Traffic linesmen.	Contingency Plan	Officer in charge of the Disc Chipper	Site Safety Officer's safety plan/Traffic Management Plan	Every Month
Anticipated traffic congestions during rainy seasons when collecting Fuel wood from interior roads	Significant but occasional	Can be prevented by providing awareness in advance, stocking adequate fuel wood in anticipation of rains that disrupt in some parts where firewood will be collected and with back up plans when lorries are struck.	Contingency Plan	Site Safety Officer's safety plan/Traffic Management Plan	Awareness materials /contingency plan	Every week during the rainy season

9 CONCLUSION

The EIB Environment and Social Handbook stipulates standards/procedures for the following:

1. Assessment and management of Environmental and Social Impacts and Risks
2. Pollution Prevention & Abatement
3. Bio diversity & Ecosystems
4. Climate Change Considerations
5. Cultural & Heritage
6. Involuntary Resettlement
7. Rights and Interests of Vulnerable Groups
8. Labor standards
9. Occupational, Public Health & Safety

Having analyzed impacts considering the above, for both the construction phase and for operational phase, it is established that the project's likely environmental and social impacts are not significant. Any impact which is considered significant can be reversed through appropriate mitigation measure. Mitigation measure which have been prescribed in the permits, approvals issued by the approving authorities (BOI, LCs) were carefully reviewed and incorporated into ESMP. It is also presumed that the CEA will issue an Environmental Protection License, on completion of the project's construction phase, which may also deal with pollution abatement.

The project does not call for involuntary resettlement, nor does it have any impact on vulnerable groups. There is no impact on the cultural heritage. Climate change consideration has been discussed but the project is significantly contributing to saving carbon emissions. There is no severe threat to Bio Diversity but a system of certification of fuel wood supplied through sustainable means need to be adopted. Pollution in terms of waste, water and noise, dust needs to be arrested and measures have been proposed.

Occupation, Public Health and Safety will be a concern for the workers as well as for the community linked to fuel wood supply chain. Possible injuries, community conflicts have been possible outcomes when community members participate on a long term basis in growing, harvesting and collecting fuel wood and transport of same over a period of time. They may need overall guidelines which are provided in the Health & Safety plan of the ESMP. Therefore it is concluded that the project will be acceptable for implementation.

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- 10.3 National Energy Policy & Strategies of Sri Lanka; Government Gazette Notification; 2008, June 10th
- 10.4 Investment Guide; Board of Investment Sri Lanka; November 2014
- 10.5 Namal, D.D Ananda; Report on background paper on biomass energy related national policies, regulations and laws
- 10.6 Document entitled ‘Contract Agreement for supply and for Supervision for erection, commissioning of Civil Works’; (Copy of the EPC Agreement)
- 10.7 Good Practice Guide: Production of wood Fuel from Forest Landings; Technical Guidance Note 0.9 (Literature browsed from Internet)
- 10.8 PDF Document Entitled “Renewable Energy and the development of dendro power in India and SE Asia’ by VVN Kishore and P Raman, The Energy and Resources Institute, India Habitat Centre, Lodhi Road, New Delhi;
- 10.9 Document entitled “Fuel Supply Summery, Mirigama Combined Heat & Power Plant; Oct. 2014 (KMRI SMG Asset Company)
- 10.10 Pre-Feasibility Study for a Bio Mass Based Power Plant for KMRI-SMG Asset Co. (Pvt.) Ltd., Loluwagoda, Mirigama Sri Lanka; June 2012;
- 10.11 Document Entitled “Private Sector Small Scale Grid Connected Renewable Power Generation in Sri Lanka”; A review of experiences of the past decade (1996-2006) prepared for Project Director, RERED Project , World Bank, January 2008; DFCC Consulting Pvt. Ltd.
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11 ANNEXES

11.1 Approval conditions by of Board of Investment of Sri Lanka

Project to set up a 5 MW Dendro Power Plant at Mirigama

GENERAL CONDITIONS

- 1.1 The site approval is valid only for the specific purpose referred to above. It should be implemented adopting only the processes outlined in the project application submitted to the BOI.
- 1.2 The land earmarked for the proposed project should be purchased or leased out in the name of the enterprise.
- 1.3 All conditions stipulate in the BOI approval letter under reference should be compiled with.
- 1.4 You are advised to obtain approval for the building plans from the Mirigama Pradeshiya Sabha and to pay those taxes, rentals etc. as per regulations in force.
- 1.5 All statutory requirements/regulations stipulated under relevant legal enactments including the Factories Ordinance and National Environmental Act should be adhered to when improvements are made to the premises and during the operational period of the project.
- 1.6 All building plans pertaining to the project should be submitted to the Engineering Approvals Department of the BOI, prior to commencing and development activities at the site, (refer “General guidelines for Factory Buildings” and “Environmental Norms” issued by the BOI).

2. ENVIRONMENTAL CONDITIONS

2.1 (a) Water shall be obtained from the National Water Supply & Drainage Board (NWS & DB) as indicated in letter of KMRI – SMG A set Company (Pvt) Ltd dated 16.11.2012.

(b) No ground water shall be extracted unless it is recommended by the Water Resources Board on safe extraction limits of ground water.

© If the water is extracted or pumped from a natural water body prior approval of the Irrigation Department shall be obtained.

2.2 Air conditioning technology shall be adopted. Water cooling technology shall not be adopted.

- 2.3 (a) Cultivation of Gliricidia shall be done as intercropping in the cultivated lands as mentioned in the project proposal. Copies of agreement for cultivation of Gliricidia as intercropping shall be submitted to the CEA/BOI within one month period from the date of this letter.
- (b) Any other private or government lands shall not be used for cultivation of Gliricidia without prior approval from the relevant Authorities.
- (c) Ash generated from burning of wood shall be handed over to above 2.3 (a) cultivators and shall not be disposed of elsewhere. Until disposal of ash, it shall be stored in an enclosed area to prevent spreading all over.
- 2.4 Lay out of the plant shall be designed in such a manner that dust and noise generating activities are away from residential activities. In this regard, advice from the Environment Management Department of the BOI shall be obtained prior to finalization of the plat lay out.
- 2.5 Wood storage area shall be constructed in consultation with the Engineering Approvals & Special Projects Department of BOI for advice on the buffer zone to be maintained and storage methodologies required for preventing fires.
- 2.6 Surface run off around wood storage and handling areas shall be diverted into a central location and shall subject to adequate settling to prevent any particulates escaping along with the rain water.
- 2.7 (a) A proper air pollution control system shall be installed to control fugitive dust emissions. The proposal for controlling fugitive emissions shall be submitted to the Environment Department of the BOI/CEA.
- (b) Suitable safety gear shall be provided to workers exposed to dust generating operations.
- (d) Total Suspended Particulate Matter in the plant area shall not be greater than 450 ug/m³ as specified in the schedule IV in the CEA interim air emission limits proposed for stationary sources (refer annex I)
- (e) An analytical report on the air quality in the plant area shall be obtained from *industrial* Technology Institute (ITI) or any other recognized Laboratory and shall be submitted to the Environment Management Department of the BOI/CEA on a quarterly basis.
- 2.8 Chimney of the boiler shall be constructed to a height (minimum) in accordance to the requirement No. 11 given in the CEA interim air emission limits proposed for stationary sources. A copy of this requirement is annexed (annex II)

- The proposal for preventing emission of Suspended Particulate Matter (SPM) from the chimney shall be submitted to the Environment Department of the BOI/CEA.
- An assessment on the performance of the above 2.8 (b) shall be carried out prior to commissioning commercial operations of the boiler and the report shall be submitted to the Environmental Department of the BOI/CEA.
- Chimney shall be fitted with a sample port and emissions shall be within the limits specified below

Parameter	Standards
NOx	450mg/Nm ³
Particulate Matter	200mg/Nm ³
Smoke	20% opacity

(e) An analytical report on the quality of chimney emission shall be obtained from Industrial Technology Institute (ITI) or any other recognized Laboratory and shall be submitted to the Environment Management Department of the BOI/CEA on a quarterly basis.

- 2.9 Proper functioning and regular maintenance of the dust control units shall be ensured by;
- ✚ Proper operations and regular cleaning of the cyclone units. During cleaning, necessary precautionary measures shall be taken to prevent emission of dust.
 - ✚ Frequent cleaning of tanks used in for sedimentation of particular in the scrubber system.
 - ✚ Regular replacement of water used in for scrubbing.
 - ✚ Efficient functioning of electrostatic precipitators.
- 2.10 Domestic waste water including sewage shall be directed into properly constructed soakage pits/septic tanks. No waste water shall be discharged into storm water drains/canals.
- 2.11 All machinery which is likely to generate excessive noise/vibration shall be installed on resilient foundation in enlisted areas to reduce generation and spread of noise /vibration.

In the event the noise level exceeds 85dB (A) suitable ear muffs shall be provided to those who are exposed to such noise in order to protect their hearing.

The noise level at the boundary due to operation of machinery shall be maintained at or below 55dB (A) from 6/00 a.m. to 6.00 p.m. and 45 dB (A) from 6.00 p.m. to 6.00 a.m.

1.12 Chemicals shall be handled, stored and used in accordance with acceptable procedures. Copies of Chemical Safety Data Sheets in respect of all the chemicals used in the factory operations shall be obtained and maintained within the factory for easy reference by those handling such chemicals.

1.13 Health and safety of workers shall be ensured as stipulated in the factories Ordinance and its amendments.

2.14 In consultation with the Fire Brigade;

- ✚ Adequate precautions shall be taken to prevent the occurrence of accidental fires.

- ✚ Adequate number of fire extinguishers shall be installed at strategic points to extinguish any accidental fires.

1.14 All non-hazardous solid wastes generated shall be collected to a central place and got rid of periodically in an environmentally safe and nuisance-free manner in consultation with the Mirigama Pradeshiya Sabha.

No open air burning of Solid waste shall be carried out within or outside the premises.

No solid wastes shall be dumped into any water body or at a site where it is likely to enter a water body.

1.15 Loading, unloading, transport and handling of wood/ash shall be carried out in such a way as not to cause a nuisance to others by way of dust, noise, spillage or other means.

1.16 Vehicles shall be parked in such a way as not to obstruct pedestrians, neighbors and the smooth flow of traffic on the roads.

1.17 20 u.m. 920 microns) or less in thickness polythene products shall not be used for the activity of the industry or for domestic purposes.

- 1.18 Any expansion/extension to the industry, operation or process shall not be affected without prior approval of the CEA/BOI.
- 1.19 Any additional recommendations stipulated by the CEA/BOI as and when required for controlling any kind of pollution created by operations shall be strictly adhered to.
- 1.20 An Environmental Protection License (EPL) shall be obtained from the BOI prior to commencement of operations at this site. An application form for an EPL could be collected from the Environment Management Department of the Board or can be down loaded from the CEA website (www.cea.lk) a completed application form shall be submitted to the Director (Environment Management) of the BOI one month prior to commencement of trial operations.
- 1.21 All operations shall conform to the National Environmental Act and its Regulations.

If the necessity arises to apply further mitigatory conditions when project is in operations the BOI will stipulate such conditions as and when necessary and such conditions shall be adhered to.

The above list is not exhaustive and it is obligatory for the enterprise to ensure that all mandatory requirements under applicable legal enactments are complied with.

Annex I

Schedule IV

(Regulation 4)

Fugitive Dust Emission Standards

- a) The difference between two simultaneous 3 hr Total Suspended Particulate Matters (TSPM) measurement (gravimetric) carried out on upwind and downwind basis from emission area or process area shall not be greater than 450ug/m³.
- b) Measurement location shall be within 10m from any process equipment or emission area towards upwind and downwind directions.
- c) The wind direction shall be the most predominant wind direction during the time of measurement.

Schedule V

(Regulation 5)

Fugitive Total Volatile Organize Carbon (TVOC) Emission Standards

The Total Volatile Organic Compound (TVOC) emission from any process area shall not be greater than 1 mg/m³ (Methane and Non Methane determined using USEPA accepted methods). The measurement location shall be within 5m downwind from the process area.

Schedule VI

(Regulation 6)

Fugitive Acid Mist and Ammonia Emission Standards

Fugitive Acid mists or fugitive ammonia emissions (determined by USEPA accepted methods) from any process area shall not be greater than 30 mg CaCO₃/m³. The measurement location shall be within 5m downwind from the process areas.

Schedule VII

(Regulation 7)

Asbestos Fiber Emission Standards

Ambient Asbestos fiber concentration in process area shall not be greater than 1 fiber/m³ (Test Method: USEPA accepted methods). The measurement location shall be within 20m downwind from the process area.

Annex II

Minimum chimney height C (m) in meters of any combustion point source shall be defined by following equation.

$$C(m) = H(m) + 0.6U(m)$$

Where H shall be the height of the tallest building within 5 U radius of the chimney and U shall be the uncorrected height for heat input.

U shall be defined by following equation.

$$U(m) = 1.136Q^{0.6}$$

Where Q shall be the gross heat input in MW.

In any case, chimney height shall not be less than 20m.

11.2 Health & Safety Guidelines issued by the Board of Investment (BOI)

EMPLOYMENT INQUIRY

8.1 Accidents

8.1.1 The occupier of a factory has to give written notice of any industrial accident which results in the death of a person or disables a person from earning his flat wages for a period of 3 days or make a person unconscious as a result of heat exhaustion, electrical shock or inhalation of un-respirable or poisonous fumes or gases.

8.1.2. Such accidents must be intimated to the District Factory Inspecting Engineer/Labor Department, Labour Secretariat, and Colombo 5 on Form 10 (Notice of Accident under Section 61 of the Factories Ordinance) with a copy to the Industrial Relations Department of the BOI.

8.2 Employment Injury Compensation

8.2.1. Workmen's compensation, at present rates shall be paid to a worker in respect of an injury caused due to an accident arising out of and in the course of employment or disease is of an occupational origin.

8.2.2 Where the occupier of a factory opts to take an insurance policy to cover such risks he should obtain such a policy from a recognized insurance organization.

(8.A) Where there is any inconsistency or conflict between the provisions contained in Section (1)-(8), save and except Section (5.A), of this Manual and the relevant statutory provisions, the latter shall prevail.

TRADE UNION AND COLLECTIVE BARGAINING RIGHTS OF EMPLOYEES

- v. The employees of BOI enterprises shall have the right to form and in trade unions of their own choosing and to bargain collectively, subject to the provisions of the Trade Unions Ordinance and the Industrial Disputes Act.
- vi. A trade union representing the employees in any BOI enterprise shall have the right to enter into collective bargaining negotiations with the employer, on behalf of the employees whom it seeks to represent, with a view to concluding a collective

- agreement, provided the union has the right to bargain collectively with such employer in accordance with the provisions of the Industrial Disputes Act.
- vii. Every employer of employee in a BOI enterprise shall respect the right of the employees to form and in trade unions of their own choosing and to bargain collectively.
- viii. No employer in any BOI enterprise shall –
- (i) Require an employee to refrain from joining any trade union, or to withdraw from, or to refrain from withdrawing from his membership of a trade union of which he is a member, as a condition of his employment.
 - (j) Dismiss an employee by reason only of his membership of a trade union or of his engaging in trade union activities.
 - (k) Give any inducement or promise to an employee for the purpose of preventing him from becoming or continuing to be a member, office-bearer or representative of a trade union;
 - (l) Prevent an employee from –
 - (iii) Forming a trade union, or
 - (iv) Supporting a trade union by financial or other means;
 - (m) Interfere with the conduct of the activities of a trade union;
 - (n) Dismiss, or otherwise take disciplinary action against, any employee or office bearer of a trade union –
 - (iii) For any statement made by such employee or office-bearer in good faith before any tribunal or person in authority; or
 - (iv) For any statement regarding acts or commissions of the employer relating to the terms and conditions of employment of the members of such trade union made by such employee or office-bearer, in pursuance of an industrial dispute for the purpose of securing redress or amelioration of working conditions of such members;
 - (o) Refuse to bargain with a representative trade union (i.e. a union which has to the right to bargain collectively with the employer of the employees in the enterprise on whose behalf it seeks to bargain in accordance with the provisions of the Industrial Dispute Act, Chapter 131)
 - (p) Where both a recognized trade union having bargaining status and an Employees' Council exist in an enterprise, the employer shall not use the Employees' Council to undermine the position of such trade union and its representatives and shall encourage

co-operation on all relevant matters between the Employees' Council and trade union concerned.

11.3 Project Geological Investigation Report (Main Recommendations only)

Bore Hole Investigation Report

For The Proposed 3.5 Mw Combined Heat & Power Plant at Dendro Producers Lanka (Pvt) Ltd, Loluwagoda, Mirigama

1. Introduction

Dendro Producers Lanka (Pvt.) Ltd intends to install a 3.5 MW Combined Heat and Power Plant in the factory premises at Loluwagoda, Mirigama to cater their needs. Aquathern Engineering Consultants India (Pvt.) Ltd is the Project Consultant. The geotechnical Investigation pertaining to this project was awarded to Civil Engineering Material Testing Laboratory by the Client and the team for borehole drilling was mobilized & commenced drilling operations on 13.07.2014 and completed on 21.07.2014.

2. Scope of work

The Geotechnical Investigation involved carrying out 6 No. boreholes in locations where major components of the plant are to be installed as per the site plan provided by the Client/ Consultant, to ascertain the characteristics and engineering properties of actual sub-surface soil strata and basement rock and to submit recommendations for type of foundations.

3. Field Investigation

A rotary hydraulic drilling machine was used for the drilling work at site using HW & NW casings in the overburden formation. Wash boring was the technique adopted for the advancement of the bore holes.

Standard Penetration Tests were conducted at regular intervals of 1.50m, the test was carried out by driving a 50mm diameter Standard split tube sampler into the soil to a depth of 45 cm using 63.5 kg hammer falling freely through a height of 760 mm. The number of blows 'N' required to penetrate the standard sampler through 30 cm was taken as the Standard Penetration value. On encountering the highly weathered rock formation where the hammer rebounded and the standard sampler showed no significant penetration, NWG core bit mounted to NWG Single Tube was used to advance the borehole within the dense formation. The borehole was cased with NW casings up to the Bed Rock formation level. Thereafter drilling the bed rock with NWM Core bit mounted to NWM Double Tube Core Barrel was continued to a depth of 1.0m.

The depth of the water table was measured from the surface of the borehole, 24 hours after removal of casings and when the water level had stabilized.

The logs of Boreholes are given in Annex

4. Sampling

Samples collected from ground level to the bed rock of the boreholes during Standard Penetration Test and the washed samples collected when no yields in the split tube sampler were then labeled and arranged in the order of depth of material encountered in core box relevant to each borehole.

5. Laboratory Testing

All the Soil/Rock samples in the core boxes except the washed samples were tested in the laboratory to determine the following parameters and in accordance with ASTM/BS Standard Test Methods.

- Particle Size Distribution (Sieve Analysis)
- Consistency Limits (LL & PL)
- Unconfined Compressive Strength of Intact Core Specimen

Following the Laboratory Testing, the soil in boreholes were classified to various groups as given in Unified System of soil classification. The Visual Classification of soil made at site and entered in the Borehole Log was changed if there was an anomaly with the observation made in the laboratory, while rest of the data in the borehole log remains unchanged.

6. Recommendations

Recommendations for foundations for structures for proposed 3.5 MW Combined Heat and Power Plant at Loluwagoda, Mirigama

This report should be read in conjunction with the factual report of the Soil Investigation carried out at the site and reported in August 2014.

1. Project and Site details

It is proposed to construct a 3.5 MW Combined Heat and Power Plant at Loluwagoda, Mirigama. The Project Consultants are Aquathem of India.

The site for the proposed development is a 3-Acre lateritic hillock at Mirigama.

The Consultant has reported that the major components of the Power Project to be installed are:

- I. Steam Turbine Generator & its auxiliaries (BH-01 & BH-02)*;
- II. Boiler & its auxiliaries (BH-03)*;
- III. Chimney (BH-04)*;
- IV. Cooling Tower (BH-05)*;and
- V. Water Treatment Plant (BH-06)*.

(*) These locations are shown in Fig 1 which is the Layout Plan for Option 1. Recommendations given I this report are for this option. (it should be noted that there is another Option 2 for the Layout Plan, for which these borehole locations are irrelevant.)

2. Borehole Investigations

The position of the boreholes was shown on the ground by the Client.

All boreholes were initially advanced up to hard rock. Thereafter, they were further advanced by coring the rock using a double tube core barrel. Details of the depths of drilling are indicated in the table below. The depth to ground water level (GWL) is also shown in the table. All depths are reported with respect to a zero depth at the top of each borehole.

Location	BH-01	BH-02	BH-03	BH-04	BH-05	BH-06
Depth to GWL(m)	7.45	7.75	7.45	3.2	6.75	4.35
Depth to rock (m)	16.60	21.60	22.80	19.60	17.60	30.60
Depth of borehole(m)	17.60	22.60	23.80	20.60	18.60	31.60

Rock coring in the boreholes had given the following results for the Core Recovery (CR) and the Rock Quality Designation (RQD):

Borehole No.	Depth(m)	CR(%)	RQD(%)
BH-1	16.60-17.60	75	52
BH-2	21.60-22.60	76	54
BH-03	22.80-23.80	75	52
BH-04	19.60-20.60	70	53
BH-05	17.60-18.60	70	52
BH-06	30.60-31.60	70	52

Three Nos. of rock cores were tested for their uniaxial compressive strength (UCS). The strength results varied between 71.66 N/mm² and 80.67 N/mm²; giving an average UCS value of 76.04 N/mm².

3. Steam Turbine Generator & its auxiliaries (BH-01 & BH-02)

3.1 Sub-surface conditions

From a study of the borehole log, it is concluded that the overburden at BH-01 can be modeled by successive layers as indicated below.

Layer No	Position (m)	Layer description	SPT NO.
1a	0.0-11.9	Lateritic soils – I	14
1b	11.9-12.9	Lateritic soils – II	32
2	12.9-15.6	Highly weathered rock	>50
3	15.6-16.6	Moderately weathered rock	-
4	> 16.6	Basement rock	

Ground water level (GWL) was at a depth of 7.45m.

Similar layering is observed at the other borehole location BH-02.

3.2 Recommendations for geotechnical design parameters

Recommendations for the geotechnical design parameters for sub-surface layers are given in the table below based on the visual observation of the soil samples collected, the measured SPT values, and experience with similar sub-surface conditions.

Layer description	Average SPT	Shear Strength parameters	Ultimate bearing capacity (kN/m ²)	Elastic Modulus E (kN /m ²)
Lateritic soils – I	14	C'= 7 KPa, Q=27	> 320	12,000
Lateritic soils – II	32	C'= 7 KPa, Q =30	>530	20,000
Highly weathered rock	>50	C'= 10 KPa, Q=38	1500	25,000

3.3. Recommendations for foundations

It is noted that Turbine Generator will be mounted on a pedestal which is constructed on the ground floor slab. It is recommended that the ground floor slab be laid directly on the layer of Lateritic soils – I for which the allowable bearing capacity can be taken as 125kN/m². Details of the auxiliaries were not available. The foundations would consist of:

- a) Either raft foundations placed within the layer of Lateritic soils – I for which the allowable bearing capacity can be taken as 125 kN/m²;
- b) Or individual pad footings for which the allowable bearing capacity can be taken as 160 kN/m².

4. Boiler & its auxiliaries (BH – 03)

4.1 Sub-surface conditions

The sub-surface conditions are as given previously in Section 3.1.

4.2 Recommendations for geotechnical design parameters

Recommendations for the geotechnical design parameters for sub-surface layers are as given in Section 3.2.

4.3 Recommendations for foundations

Recommendations for foundations are as given in Section 3.3.

5. Chimney (BH -04)

5.1 Sub-surface conditions

The sub-surface conditions

The sub-surface conditions are as given previously in Section 3.1 with the following differences:

- The average SPT of Layer No. 1a was 30;
- GWL was at a depth of 3.2m.

5.2 Recommendations for geotechnical design parameters

Recommendations for the geotechnical design parameters for sub-surface payers are as given in Section 3.2.

5.3 Recommendations for foundations

It is recommended to adopt a raft foundation at a depth of around 1.5m for which the allowable bearing capacity can be taken as 140 kN/m².

5. Cooling Tower (BH-05)

6.1 Sub-surface conditions

The sub-surface conditions are as given previously in Section 3.1.

6.2 Recommendations for geotechnical design parameters.

Recommendations for the geotechnical design parameters for sub-surface layers are as given in Section 3.2.

6.3 Recommendations for foundations

It is recommended to adopt a raft foundation at a depth of around 1.5m for which the allowable bearing capacity can be taken as 140kN/m².

7. Water Treatment Plant (BH-06)

7.1 Sub-surface conditions

The sub-surface conditions

The sub-surface conditions are as given previously in Section 5.1.

7.2 Recommendations for geotechnical design parameters

Recommendations for the geotechnical design parameters for sub-surface layers are as given in Section 3.2.

7.3 Recommendations for foundations

Recommendations for the foundations are as given in Section 5.3.

Prof. B.L. Tennakoon
Emiritus Professor
University of Moratuwa

11.5 Applicable Environmental Quality Standards

Name of the Regulation/ Guidelines	Relevance to the project								
National Environmental (Protection & Quality) Regulations, No 01.of 1990	To be complied with during construction & Operation Phase – Require to obtain EPL during operational phase								
National Environmental (Ambient Air Quality) Regulation, 1994	To be complied with during the construction stage								
National Environmental (Noise Control) regulations No. 1 of 1996	To be complied with during the Construction stage								
Stream Reservations under State Land Regulations No 9912 of 15.10.1948: <table border="1" data-bbox="196 1122 818 1352"> <thead> <tr> <th data-bbox="196 1122 547 1178">Stream width</th> <th data-bbox="547 1122 818 1178">Reservation</th> </tr> </thead> <tbody> <tr> <td data-bbox="196 1178 547 1234">< 15' (4.6m)</td> <td data-bbox="547 1178 818 1234">20m</td> </tr> <tr> <td data-bbox="196 1234 547 1290">15'- 50' (4.6m-15.2m)</td> <td data-bbox="547 1234 818 1290">40m</td> </tr> <tr> <td data-bbox="196 1290 547 1352">>50' (15.2)</td> <td data-bbox="547 1290 818 1352">60m</td> </tr> </tbody> </table>	Stream width	Reservation	< 15' (4.6m)	20m	15'- 50' (4.6m-15.2m)	40m	>50' (15.2)	60m	To be complied with if construction will involve stream Reservations. In this case no compliant will be necessary
Stream width	Reservation								
< 15' (4.6m)	20m								
15'- 50' (4.6m-15.2m)	40m								
>50' (15.2)	60m								

Tolerance Limits for Industrial Waste Discharged on Land for Irrigation Purpose

No	Parameter	Unit type of limit	Tolerance Limit value
1	Total dissolved solids	mg/l.max.	2100
2	pH at ambient temperature	-	5.5 – 9.0
3	Biochemical oxygen demand		
	(BOD ₅ in five days at 20 ⁰ C or BOD ₃ in three days at 27 ⁰ c)	mg/l.max.	250 30
4	Oils and greases	mg/l.max.	10
5	Chemical Oxygen Demand (COD)	mg/l.max.	400
6	Chlorides (as Cl)	mg/l.max.	600
7	Sulphates (as SO ₄)	mg/l.max.	1000
8	Boron (as B)	mg/l.max.	2.0
9	Arsenic (as As)	mg/l.max.	0.2
10	Cadmium (as Cd)	mg/l.max.	2.0
11	Chromium. total (as Cr)	mg/l.max.	1.0
12	Lead (as Pb)	mg/l.max.	1.0
13	Mercury (as Hg)	mg/l.max.	0.01
14	Sodium adsorption ratio (SAR)	-	10 - 15
15	Residual sodium carbonate (RSC)	mol/l,max.	2.5
16	Electrical conductivity	uS/cm.max.	2250
17	Faecal coliform	MPN/100ml,max	40
18	Copper (as Cu)	mg/l.max.	1.0
19.	Cyanide (as CN)	mg/l.max.	0.2
20	Radio Active Material:		
	(a)Alpha emitters	Micro curie./ml,max.	10 ⁻⁹
	(b)Beta emitters	Micro curie./ml,max.	10 ⁻⁸

Ambient air quality standards under the NEA

The National Environmental (Ambient Air Quality) Regulations 1994, published in Gazette Extraordinary No 850/4 of December 1994 are hereby amended by the substitution for the schedule to that regulation of the following-

Gazette Extraordinary of the Democratic Socialist Republic of Sri Lanka-15.08.2008

Schedule

pollutant	Averaging time*	Maximum Permissible Level		+ Method of measurement
		Pgm ³	Ppm	
Particulate Matter- Aerodynamic diameter Is less than 10 mm in size(PM ₁₀)	Annual	50	-	Hi- volume sampling and Gravimetric or Beta Attenuation
	24 hrs	100	-	
Particulate Matter Aerodynamic diameter is less than 2.5 pm. In size (PM _{2.5})	Annual	25	-	Hi-volume sampling and Gravimetric or Beta Attenuation
	24 hrs	50	-	
Nitrogen Dioxide (NO ₂)	24 hrs	100	0.05	Colorimetric using Saltzman method or equivalent Gas phase chemiluminescence
	8hrs	150	0.08	
	1 hr	250	0.13	
Surplus Dixoxide(SO ₂)	24 hrs	80	0.03	Pararosanilene method or equivalent pulse Fluorescent
	8 hrs	120	0.05	
	1 hr	200	0.08	
Ozone(O ₃)	1 hr	200	0.10	Chemiluminescence method or Equivalent Ultraviolet photometric
Carbon monoxide (CO)	8 hrs	10.000	9.00	Non-Dispersive infrared Spectroscopy
	1 hr	30.000	26.00	
	Anytime	58.000	50.00	

* Millennium number of observations required to determine the average over the specified period.

03 hour average – 03 consecutive hourly average

08 hour average- 08 hourly average

24 hour average - 18 hourly average

Yearly average- 09 monthly average with at least 02 monthly average each quarter

+ By using Chemicals or Automatic Analysers.

Noise Levels

SCHEDULE I

(Regulation 2)

Maximum Permissible Noise Levels at Boundaries in Laeq ‘ T

Area	Laeq T	
	Day Time	Night Time
Low Noise	55	45
Medium Noise	63*	50
High Noise	70	60
Silent Zone	50	45

Provided that the noise level should not exceed 60 dB (A) inside existing houses, during day time.

“Low noise area” means an area located within any Pradeshiya Sabha area.

“Medium noise area” means an area located within any Municipal Council or Urban Council area

“High noise area” means any export processing zone established by the Board of Investment or industrial estates approved under Part IV C of the National Environmental Act:

“Silent Zone means the area covered by a distance of 100 meters from the boundary of a courthouse, hospital, public library, school, zoo, sacred areas and areas set apart for recreation or environmental purposes.

11.6 Communication on disposal of Ash with CRI

K.M.R.I S.M.G ASSET COMPANY (PVT) LTD

32, Gower Street, Colombo 05, Sri Lanka. Tel: +94 114 061890/1 Fax: +94 114 502102
E Mail: ruwanp@kminfrastructure.com

03rd July 2015

The Director General
Coconut Research Institute
Lunuwila

Dear Sir:

WOOD ASH FROM GLIRICIDIA BASED DENDRO POWER PLANT

We are pleased to inform you that the construction of our Dendro power Plant of capacity 3.53 MW has commenced recently at Lotuwagoda Mill Premises of the Silver Mills Group at Mirigama.

The source of Fuel for this Steam based power generation unit is Gliricidia Sepium which we plan to obtain from the surrounding farmers. Approximately 216 Tons per day of fuel would be used generating 176 kg/day of ash from the boiler and the dust collection systems, which will be collected and stored centrally.

We understand that the research conducted by the Coconut Research Institute has confirmed the value of this ash as a source of nutrients for coconut plantations and that your institution would be able to receive the ash generated from operations such as ours.

We kindly request your confirmation in principle that the Coconut Research Institute is interested in accepting such ash and will be pleased to enter into a formal agreement with you on the basis of transfer.

Your early response would be much appreciated.

Thank You

Yours faithfully,



Bhatiya Ranatunga
Chief Executive Officer

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Renewable Energy for a Cleaner Future

Directors: Romesh Bandaranaike / Krishnan Raghunathan / Anil Cabraal / Suresh Silva / Amitha Silva



කොconut පර්යේෂණ ආයතනය
தென்னை ஆராய்ச்சித் தாபனம்
COCONUT RESEARCH INSTITUTE

Tel : 031-2255300, 031-2262000
031-2262001
Fax : 031-2257391, 031-2255583

වණ්චිරිප්පුව පර්යේෂණ මධ්‍යස්ථානය, ලුණුවිල 61150 ශ්‍රී ලංකා.
பண்டிரிப்புவத் ஆராய்ச்சி நிலையம், லுணுவில 61150 ஸ்ரீ லங்கா.
Bandirippuwa Research Centre, Lunuwila 61150 Sri Lanka.

Chairman /CRB : 031-225549
Director /CRI : 031-225589
E-mail: directoreri@sltnet.lk

මගේ අංකය/ எனது இல./ My Ref.

D/CRI/2015

ඔබේ අංකය/ உமது இல./ Your Ref.


Mr. Bhatiya Ranathunga
K.M.R.I. S.M.G. Asset Company(Pvt) Ltd.
Chief Executive Officer
32, Gower Street
Colombo 05

WOOD ASH FROM GLIRICIDIA BASED DENDRO POWER PLANT

This is reference to your letter of 03rd July 2015 on the above.

The samples of gliricidia wood ash of Dendro power generation plants have been analyzed and revealed that contain approximately 5% of Potassium(K) which is an essential plant nutrient for coconut. So, gliricidia wood ash is a K fertilizer and the Coconut Research Institute is willing to purchase it.

Yours faithfully


Dr. H A J Gunathilaka
Director
Coconut Research Institute

13.07.2015

/s.

11.7 MOU

MOU BETWEEN KMRI- SMG & GEMI SARANA KENDRAYA FOR THE SUPPLY AND PROCUREMENT OF GLIRICIDIA SEPIUM FOR THE OPERATION OF MIRIGAMA DENDRO POWER PROJET

This Memorandum of Understanding is signed between KMRI – SMG Asset Company Pvt. Limited., (Known as Mirigama Dendro Power Company herein after referred to as MDP) of No: 148/1, Kynsey Road, Colombo 8, hereinafter referred to as MDP together with its associate, Silver Mill Group (SMG) **AND** Gemi Sarana Kendraya herein after referred to as GSK having its registered Head Office at Kahagalla, Thuntota, and shall mutually agree that:

- MDP will require Fuel wood (Gliricidia Sepium) at 150 tons per day (tpd as harvested), for the operation of the Dendro Power Plant proposed to be commenced its operations in April 2016 at its plant at Loluwagoda, Mirigama in Gampaha District,
- Having appraised the potential of supplying Gliriidia Sepium through Gemi Sarana Kendraya, the MDP recognizes GSK as one of the main suppliers for supply of Gliricidia fuel wood;
- Whereas, GSK has shown willingness and continued support through its membership to grow, collect, and supply on a continuous basis the required quantities of Gliricidia Sepium
- In order to meet those supply targets, GSK shall mobilize the grass root members of the GSK to grow, and supply same estimated to be 50,000 tons per year (i.e. 150 tpd as harvested) on the understanding of the direct economic benefits. (The direct economic benefits which will be accrued to the membership by way of supply of Gliricidia firewood will be to the tune of 156 Mn LKR in annual income distributed among the GSK network members):
- MDP will also carry out a full scale survey of availability of existing Gliricidia plantations of the 03 Districts in which membership of Gemi Sarana Programme has been extended. (Namely Kegalle, Kurunegala and Gampaha) This information which will be comminuted to the membership of the GSK, will be vital for the membership to organize their harvesting and supply schedules.
- MDP shall pay for Gliricidia Fuel wood at mutually agreed prices delivered to the Power Plant gate as follows:
 - Gliricidia (as harvested) cut to 03 ft length (maximum) and not less than 01 inch diameter without any green bark.

Whereas both the parties agree that there will be following other benefits that could be inter-alia accrued as a result of this partnership namely:

1. A programme of Coconut saplings to be introduced by SMG to the members of the GSK at 100% subsidized rate, where each family will receive 04 coconut saplings, to develop organic Coconut plants in their home gardens using Gliricidia leaves. To this end, all beneficiaries agree with GSK and SMG that they

will sell coconuts harvested from a minimum of 02 trees to SMG at market price. Further, the families should plant at least 700 Gliricidia stems in their home gardens. (Note: 3995 no's of Coconut saplings has already been issued to GSK members at 100% subsidized rate).

2. Members of GSK will have the benefit of 03 plant nurseries introduced by MDP (Rs. 125,000/= will be allocated for each nursery) in order to provide them with Planting Materials of Minor Export Crops, Fruits and Vegetable seedlings for organic home gardens as an incentive for growing Gliricidia. In addition MDP will extend support for community members for other income generating activities such as Bee Keeping as an incentive to grow Gliricidia in their homesteads.
3. Agreement to buy the following cash crops - Cinnamon, Pepper, Coconut to start with. SMG will come up with partially subsidized Cinnamon growing program for GSK families.
4. Further, SMG will also help the members to sell their cash crops (including spices) at selected locations through collection centers to be established by MDP / SMG with the assistance of GSK; (for which prices will be determined).
5. A project coordinator from MDP to work with GSK Managing Director to help with 4P (Public-Private-Peoples-Partnership) Community program activities.
6. One computer for GSK and a MDP data analyst to work with GSK to create database of their entire membership. Further details given in Para 19.
7. GSK to commence its operations initially with 04 Collecting Centres and an Incentive program for the 04 collectors if they meet targets set as periodic targets on agreed prices, commencing 05th September 2015 (Note: These targets will be amended as and when necessary in consultation with GSK). Further details given in Para 16.
 - a. Each Collector (Assistant Manager): Above 40 tons per month of Gliridicia (Rs. 5,000 per month) i.e. approx 02 tons per week in addition to the 08 tons per week as the given target.
 - b. Complete data base for target families (Assistant Manager)) within 03 months.
8. An incentive program for GSK Managing Director (Rs. 8000 per month) for overall supervision of the 03 districts, when group targets are met.
9. 05 Bikes for the 04 collectors and MDP/GSK coordinator + fuel allowance monthly (i.e. Rs. 5000/= each for the 04 collectors and Rs. 8000/= for the GSK coordinator).

10. MDP to purchase 01 Isuzu Elf 350 or equivalent truck dedicated for the collection of fuel wood from GSK families. A driver will also be provided by MDP.

Whereas GSK shall initiate the following activities, ensure sustainable supply of Gliricidia for the uninterrupted operation of the project.

11. That GSK mobilizes at least ten thousand (10,000) member families within a radius of 50 km from the power plant to grow Gliricidia fuel wood trees in their home gardens and will supply the fuel in the long term to MDP. This is envisaged to be in 03 phases namely:
 - a. In the 01st phase starting from the year 2015 October (beginning rainy season), 5000 families to commence growing Gliricidia at minimum 700 trees per family.
 - b. In the 02nd phase (February 2016), additional 2000 families will plant minimum 700 trees per family and
 - c. Additional 3000 families in the 03rd phase (May 2016).

Total number of Gliricidia grown will be around 07 million trees when the three phases will be completed.

12. For the above purpose, the Households will be encouraged to grow Gliricidia Sepium long live fences round the properties having land in extent of ½ acre to 03 acres, and where members have introduced planting pepper and Tea with other export cash crops, they be encouraged to grow at least 20% coverage for Gliricidia from the present level.
13. Develop a database for the 10,000 families with the information agreed between MDP and GSK.

Following logistic will be initially agreed upon:

14. Grouping of the supply chain: 10,000 member families who will supply Gliricidia will be in groups of 500 families in each Group. There will be 01 Assistant Manager for a group of 500 families in order to organize collection and transport: In all there will be 20 Assistant Managers serving for 10,000 families.
15. Appointment of Assistant Managers:
 - a. The main responsibility of the Assistant Managers will be (with the assistance of GSK farmer members) growing, cutting, sizing, collection of Gliricidia to Collecting Points (CP's) and supply also of produce including cash crops and remunerated by **GSK on an incentive basis** on the produce they have supplied. Such incentives will be agreed upon depending on the market price of the commodities.
 - b. GSK will have the responsibility of coordinating and managing these officers through the Managing Director of the GSK.

16. Initial Supply of Gliricidia:

- a. GSK will commence supplying Gliricidia sticks from existing harvestable sources starting with 02 (tpd) commencing 05th September, incrementally increasing to 10 (tpd) by 31st October 2015.
- b. GSK will ensure that its membership start planting 3.5 Mn trees by 31st October 2015.

17. Collection, Weighing and Transporting:

- a. MDP to provide necessary platform weighing scales for the Collecting Points of fuel wood. This will help start the logistics infrastructure between the families of GSK and MDP.
- b. Initially, MDP will make available a lorry capable of carrying 03-04 tons for the transport of Gliricidia fuel wood. The cost will be discussed as required.

18. Payments:

- a. Payments will be done by MDP by electronic transfer to GSK account on a daily basis as at 2.00 pm for the deliveries of previous 24 hours.

19. Supply Chain Management and data storage:

- a. All information will be electronically stored.
- b. MDP will allocate a person, pay suitable remuneration and update information, provide reports and help organize the data collection with the help from MDP. Information such as membership records, Gliricidia growers, number of Grilicidia trees planted, quantities of minor export crops produced etc. will also be recorded and updated;
- c. Required IT facility (computer, training and associated infrastructure) will be initially provided by MDP to GSK

Progress Review: The progress against the above terms shall be reviewed every month by all the parties at a regular meeting convened every quarter.

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First party
KMRI – SMG Asset Company (Pvt) Ltd

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Second party
Silvermill Group

.....
Third Party
Gemi Sarana Kendraya

Date:

Signed Original MOU in Sinhala Language:

මිරිගම ඩෙන්ට්‍රෝ විදුලි බල ව්‍යාපෘතිය ක්‍රියාත්මක කිරීමට ග්ලිරිසීඩියා සෙපියම් සැපයීම සහ ලබාගැනීම සඳහා KMRI-SMG සහ ගැමි සරණ කේන්ද්‍රය අතරේ ඇති කරගත් එකඟතා ලියවිල්ල.

මෙම ගිවිසුම සීමාසහිත KMRI-SMG ඇසට් (පුද්ගලික) සමාගම (මිරිගම ඩෙන්ට්‍රෝ විදුලි බල සමාගම - මින් මතු MDP ලෙස හැඳින්වන) ලිපිනය අංක 148/1, කින්සි පාර, කොළඹ 8, මින්මතු MDP ලෙස හැඳින්වෙන සහ මෙම සමාගමේ හවුල්කරු වන සිල්වර්මිල් සමූහ ව්‍යාපාරය (SMG) සහ ගැමි සරණ කේන්ද්‍රය ලියා පදිංචි ප්‍රධාන කාර්යාලය, කහගල්ල, තුන්තොට (මින් මතු GSK ලෙස හැඳින්වන) සමග අතිකරගත් ගිවිසුම් කොන්දේසි පහත සඳහන් වේ.

- මිරිගම ඩෙන්ට්‍රෝ විදුලි බල (MDP) සමාගමට (ග්ලිරිසීඩියා සෙපියම්) ඉන්ධන දර දිනකට ටොන් 150 ක් අවශ්‍ය වේ. මෙය ගම්පහ දිස්ත්‍රික්කයේ , මිරිගම, ලොලුවාගොඩ වර්ෂ 2016 අප්‍රේල් දී යෝජිත මෙහෙයුම් ක්‍රියාවලිය ආරම්භ කිරීමට බලාපොරොත්තු වන ඩෙන්ට්‍රෝ විදුලිබල නිශ්පාදනාගාරය ක්‍රියා කිරීම සඳහාය.
- ගැමි සරණ කේන්ද්‍රය හරහා ග්ලිරිසීඩියා සෙපියම් ඉන්ධන දර සැපයීමට MDP සමාගම භාරගෙන තිබෙන අතර, ග්ලිරිසීඩියා ඉන්ධන දර සැපයීමට ගැමි සරණ කේන්ද්‍රය ප්‍රධාන සැපයුම්කරු ලෙස MDP සමාගම හඳුනාගෙන ඇත.
- අවශ්‍ය ග්ලිරිසීඩියා සෙපියම් ප්‍රමාණයන් වගා කිරීමට එකතු කිරීමට සහ අඛණ්ඩව සැපයීමට ගැමි සරණ කේන්ද්‍රය තම කැමැත්ත සහ සහාය දක්වා ඇත.
- මෙම සැපයුම් ඉලක්ක සපුරාලීමට ගැමි සරණ කේන්ද්‍රය ගම් මට්ටමේ සාමාජිකයන් එක් රැස් කර, වර්ෂයකට ග්ලිරිසීඩියා ටොන් 50,000 වැටීමට සහ සැපයීමට (අස්වැන්න දිනටක ටොන් 150 ක්) තීරණය කර ඇත. ගැමි සරණ කේන්ද්‍රය මෙම ව්‍යාපෘතියේ සෘජු ආර්ථික ප්‍රතිලාභ අවබෝධ කර ඇත. මෙම ග්ලිරිසීඩියා දර සැපයීමෙන් සාමාජිකත්වයට අයත්වන සෘජු ආර්ථික ප්‍රතිලාභය, වර්ෂයකට රුපියල් මිලියන 156 වනු ඇත.)
- ගැමි සරණ වැඩ සටහනේ සාමාජිකත්වය වැඩි කරන තිබෙන දිස්ත්‍රික්ක වන කැගල්ල, කුරුණෑගල, සහ ගම්පහ ප්‍රදේශයන්හි දැනට පවතින ග්ලිරිසීඩියා වගාවන් පිළිබඳ ව සම්පූර්ණ සමීක්ෂණයක් MDP සමාගම විසින් කරනු ඇත. මෙම තොරතුරු ගැමි සරණ කේන්ද්‍රයේ සාමාජිකත්වයට දැනුම් දීමෙන් ඔවුන්ට අස්වැන්න නෙලා ගැනීම සහ සැපයීම සංවිධාන කර ගත හැක.
- විදුලි බලාගාරයට සපයන ලද ග්ලිරිසීඩියා ඉන්ධන දර සඳහා කලින් පොරොන්දු මිල ගණන් වලට MDP සමාගම විසින් පහත සඳහන් පරිදි ගෙවනු ලැබේ.
 - දිග (උපරිම) අඩි 03 ක් වන සහ විෂ්කම්භය අගල් 01, වන කොළපාට පොත්තක් නොමැති, ග්ලිරිසීඩියා මෝරපු දර,

මෙම හවුල් ව්‍යාපාරය තුළින් පහත සඳහන් පරිදි වෙනත් ප්‍රතිලාභ ලැබෙන බව දෙපාර්ශවය පහත සඳහන් පරිදි එකඟ වේ.

1. ගැමි සරණ කේන්ද්‍රයේ සාමාජිකයන්ට 100% සහනාධාර මිලකට ආයතනය විසින් පොල් පැළ ලබා දීමේ වැඩ සටහනක් තුළින් පොල් පැළ 04 ක් ලැබෙනු ඇත. ග්ලිරිසිඩියා කොල භාවිතා කර සාමාජිකයින්ගේ ගෙවතු වගාවන් හි කාබනික පොල් පැළ වර්ධනය කිරීමට මෙය උපකාරී වේ. ඉන් පසු අවම වශයෙන් ගස් 02 කින් ලැබෙන අස්වැන්න මෙම සාමාජිකයින් විසින් SMG ආයතනයට වෙළඳ පොළ මිලට විකිණීමට සියලුම ප්‍රතිලාභීන් GSK සහ SMG ආයතන සමග එකඟ වී ඇත. තවද, අවම වශයෙන් ග්ලිරිසිඩියා දඩු 700 තම ගෙවතු වල එම පවුල් පැල කළ යුතුයි.

(සැ.යු. 100% ක සහනාධාර ක්‍රමයට GSK සාමාජිකයන්ට දැනටමත් පොල් පැළ 3995 ලබා දී ඇත)
2. MDP ආයතනය මගින් අනුග්‍රහය දෙනු ලබන පැළ තවාන් 03 ක් GSK සාමාජිකයන්ට ලබා දෙනු ඇත. (එක් පැළ තවානයකට රු 125,000/- වෙන්කර තිබේ.) මෙය සාමාජිකයන්ගේ ගෙවතු වගාවන්හි සුළු අපනයන හෝග , පළතුරු සහ එළවළු පැළ වගා කිරීම සහ ග්ලිරිසිඩියා වැවීම සඳහා දිරි ගැන්වීමක් වනු ඇත. මීට අමතරව තම ගෙඋයනේ වෙනත් ආදායම් උපදවන ක්‍රියාවලියන් වන මීමැසි පාලනය සඳහා ප්‍රජාවේ සාමාජිකයන්ට MDP ආයතනය තක්සේරු සහ වෙනත් ආධාර කරනු ඇත. මෙයද ග්ලිරිසිඩියා වගා කිරීම සඳහා දිරිගැන්වීමක් වේ.
3. පහත සඳහන් සුලු අපනයන මිලදී ගැනීම සහා ගිවිසුම වන කුරුදු , ගම්බිරිස්, පොල්, වලින් පටන්ගෙනු ලැබේ. GSK සාමාජිකයන් වෙනුවෙන් කුරුදු වගා කිරීමේ වැඩ සටහනක් (කොටසක් සහනාධාර වශයෙන්) ආරම්භ කිරීමට ද SMG ආයතනය බැඳී සිටී.
4. තවද, ගැමි සරණ කේන්ද්‍රයේ සහාය සමග MDP/SMG ආයතනය විසින් පිහිටුවීමට නියමිත ඇති, තෝරාගත් ස්ථානවල තිබෙන එකතු කිරීමේ මධ්‍යස්ථානවල සාමාජිකයන්ගේ සුළු අපනයන හෝග (කුළුබඩු) විකිණීමට ආයතනය උපකාර වනු ඇත. (මෙම හෝග වල මිල ගණන් තීරණය කරනු ඇත)
5. 4 පී (රාජ්‍ය, පුද්ගලික සහ ජනතා සම්බන්ධතාව) ප්‍රජා වැඩ සටහන් සඳහා GSK කළමණාකරන අධ්‍යක්ෂ සමග ආයතනයේ ව්‍යාපෘති සම්බන්ධීකරණ නිලධාරී කෙනෙකු වැඩ කිරීම.
6. ගැමි සරණ කේන්ද්‍රයේ සම්පූර්ණ සාමාජිකයන්ගේ තොරතුරු ඇතුළත් දත්ත සමුදායක් ඇති කිරීමට සහ GSK සහ MDP දත්ත විශ්ලේෂණයක සමග වැඩ කිරීමට එක් පරිගණක යන්ත්‍රයක් ලබා දීම. ((වැඩි විස්තර 19 වන ඡේදයේ සඳහන්ය)
7. ආරම්භයේදී එකතු කිරීම මධ්‍යස්ථාන 04 ක් මෙහෙයුම් කටයුතු ගැමි සරණ කේන්ද්‍රය යනු ඇත. එකතු කිරීමේ නිරත වන නිලධාරීන් 04 දෙනාට දිරිගැන්වීමේ වැඩ සටහන් සකසා ඇත. මෙම දිරිගැන්වීම කලින් ගිවිසගත් මිල ගණන් වලට දෙන ලද ඉල්ලක

සපුරාලීම සිදු කල විට පමණි. ආරම්භය 2015 සැප්තැම්බර් මස 05 වන දින. (සැ.යු සමග සාකච්චා කර මෙම ඉලක්ක අවශ්‍ය වූ විට වෙනස් කරනු ඇත) වැඩි විස්තර 16 වන ඡේදයේ සඳහන්ය.

අ) එකතුකරන්නෙකු (සහකාර කළමණාකරු) :- එනම් දෙන ලද ඉලක්ක වන ග්ලිරිසිඩියා ටොන් 40 කට වැඩි වන අවස්ථාවේ ඉලක්කය වන (මසකට රු. 5000/- ගෙවීම), සාමාන්‍යයෙන් එකතු කරන සතියට ටොන් 08 කට අමතරව සතියකට ටොන් 02 කට ආසන්න ප්‍රමාණයක්.

ආ) මාස 03 ක් ඇතුළුව පවුල් පිලිබඳව දත්ත සමුදාය සම්පූර්ණ කරන්න (සහකාර කළමණාකාර)

8. ඉලක්ක සපුරාලීම සඳහා , දිස්ත්‍රික්ක 03 ක් අධීක්ෂණය කිරීම සඳහා GSK කළමනාකාර අධ්‍යක්ෂකට මසකට රු 8000/- ක දිරි දීමනාවක් ලබා දීම.
9. එකතු කරන්නන් 04 දෙනෙකුට සහ MDP/GSK සම්බන්ධීකරණ නිලධාරීට යතුරු පැදි 05 ක් සහ ඉන්ධන දීමනාවක් එක් කෙනෙකුට මසකට රු 5000/- බැගින් එකතු කරන්නන් 04 දෙනාට සහ GSK සම්බන්ධීකරණ නිලධාරී ට රු 8000/- ක ඉන්ධන දීමනාවක් ගෙවීම.
10. GSK සාමාජිකයින්ගේ ඉන්ධන දර එකතු කිරීම සඳහා ඉසුසු එල්ෆ් 350 ට්‍රක් රථයක් හෝ එවැනි සමාන රථයක් MDP ආයතනය විසින් මිලදී ගැනීම. එම රථය ධාවනය කිරීමට රියදුරෙකු MDP විසින් ලබාදෙනු ඇත.

මෙම ව්‍යාපෘතිය බාධා රහිතව ක්‍රියා කිරීම සඳහා සහ ග්ලිරිසිඩියා අඛණ්ඩව සැපයීමට GSK විසින් පහත සඳහන් ක්‍රියාවන් ආරම්භ කරනු ඇත.

11. විදුලි බලාගාරයෙන් කිලෝමීටර 50 ක අර්ධවිෂ්කම්භයක පදිංචි අවම වශයෙන් සාමාජික පවුල් 10,000 ක් තම ගෙවතු වල ගිලිසිඩියා ඉන්ධන ගස් වැවීමට GSK විසින් 'සාමාජිකයන් උනන්දු කරවනු ඇත. මෙම ඉන්ධන දර MDP සමාගමට සපයනු ඇත. මෙය අදියර 03 කින් ක්‍රියාත්මක කරනු ලැබේ.

අ) වර්ෂ 2015 ඔක්තෝම්බර් මස සිට පටන් ගන්නා 01 වන අදියරයේ (වැසි සෘතුවේ ආරම්භය) පවුල් 5000ක් ගිනිසිරියා අවම වශයෙන් එක් පවුලක් ගස් 700 වැවීම ආරම්භ කරනු ඇත.

ආ) 02 වන අදියරයේදී (2016 පෙබරවාරි) මස සිට අතිරේක පවුල් 2000ක් අවම වශයෙන් එක් පවුලක් 700 ක් වැවීම ආරම්භ කරනු ඇත.

- ඇ) 03 වන අදියරයේදී අමතර පවුල් 3000ක් (මැයි 2016) අදියර තුන සම්පූර්ණ වන අවස්ථාවේදී ග්ලිරිසිඩියා ගස් මිලියන 07 ක් වගාකර තිබෙනු ඇත.
- 12. ඉහත සඳහන් අරමුණ සඳහා අක්කර 1/2 ක් සිට අක්කර 03 දක්වා ඉඩම් ප්‍රමාණ ඇති ගෙවතු හිමියන්ට ග්ලිරිසිඩියා සෙපියම් ගස් වැටවල් තම ඉඩම වටේ වැවීමට උනන්දු කරවනු ඇත. මෙම ඉඩම්හි සාමාජිකයන් සාමාජිකයන්, දැනට ගම්මිරිස්, තේ සහ වෙනත් අපනයන භෝග වවා ඇත අතර ඉඩම් ප්‍රමාණයෙන් අවම වශයෙන් 20% ක් ග්ලිරිසිඩියා වැවීමට උනන්දු කරවනු ඇත.
- 13. MDP සහ GSK හිවිසගත් පරිදි පවුල් 10,000 ක තොරතුරු ඇතුළත් දත්ත සමුදායක් සකස් කිරීම.

පහත සඳහන් සැලසුම් සංවිධානයට එකඟ වනු ඇත.

- 14. සැපයුම් දමය කණ්ඩායම් ගත කිරීම
එක් කණ්ඩායමක පවුල් 500 බැගින් ගිනිසිරියා සපයන පවුල් 10,000 ක් කණ්ඩායම් ගත කෙරේ. එකතු කිරීම සහ ප්‍රවාහනය සංවිධානය කිරීම සඳහා පවුල් 500 ක කණ්ඩායමකට එක් උප කළමනාකරුවෙකු ඇත. පවුල් 10,000 ක් සඳහා උප කළමනාකරුවන් 20 දෙනෙක් සිටී.

15. උප කළමනාකරුවන් පත් කිරීම

- අ) උප කළමනාකරුවන්ගේ ප්‍රධාන වගකීම (GSK ගොවි සාමාජිකයන්ගේ සහාය ඇතිව) ගිනිසිරියා වගා කිරීම, කැපීම, ප්‍රමාණ වලට කපා සකස් කිරීම , එකතු කිරීම සහ එකතු කිරීමේ මධ්‍යස්ථානවලට යැවීම සහ සුළු අපනයන භෝග සැපයීම. ගැමි සරණ කේන්ද්‍රය විසින් ඔවුන් සපයා ඇති නිෂ්පාදනයන් සඳහා දිරි දීමනා ලබා දෙනු ඇත. මෙම දිරි දීමනා බෝග වල වෙළඳ පොල මිල අනුව වේ.
- ආ) ගැමි සරණ කේන්ද්‍රයේ කළමනාකරණ අධ්‍යක්ෂක මාර්ගයෙන් මෙම නිලධාරීන්ගේ සම්බන්ධීකරණය සහ පාලනය , ගැමි සරණ කේන්ද්‍රයේ වගකීම වේ.

16. ගිනිසිරියා ප්‍රථම වරට සැපයීම :-

- ඇ) දැනට පවතින අස්වැන්න නෙලා ගත හැකි ගිනිසිරියා සැපයීම, GSK මගින් ආරම්භ කරනු ඇත. මෙය සැප්තැම්බර් මස 05 වන දින සිට දිනකට ටොන් 02 ක් බැගින් සැපයීම ආරම්භ කර , 2015 ඔක්තෝම්බර් 31 වන දිනට දිනට ටොන් 10 බැගින් සැපයීම.
- ආ) වර්ෂ 2015 ඔක්තෝබර් මස 31 වන දිනට ගස් මිලියන 3.5 ක් සාමාජිකයන් විසින් පැළ කර තිබීමට GSK වග බලා ගනු ඇත.

17. එකතු කිරීම බර කිරීම සහ ප්‍රවාහණය කිරීම

- අ) ඉන්ධන දර එකතු කරණ ස්ථානයන්හි අවශ්‍ය බර කිරීමේ තරාදි, MDP සපයනු ඇත. මෙතුලින් ගැමිසරණ කේන්ද්‍රයේ පවුල් සහ ආයතනය අතර සැලසුම් සංවිධානය ඇති කිරීමට හැකිවනු ඇත.
- ආ) ආරම්භයේදී MDP ආයතනය විසින් ටොන් 03 -04 ක් පමණ ගිනිසිරියා ඉන්ධන දර ගෙන යෑමට හැකි ලොර රථයක් ලබාදෙනු ඇත. මේ සඳහා වැය වන මුදල් සාකච්ඡා කරගනු ඇත.

18. මුදල් ගෙවීම

- ආ) පෙර පැය 24 තුළදී බාරදී තිබෙන නිෂ්පාදන සඳහා දෛනික වශයෙන් ප.ව 2.00 ට ආයතනය MDP විසින් විද්‍යුත් මාර්ගයෙන් මුදල් ගැමි සරණ කේන්ද්‍රයේ ගිනුමට බැර කරනු ඇත.

19 සැපයුම් දමයේ කළමනාකරණය සහ දත්ත රැස්කිරීම

- අ) සියලුම තොරතුරු පරිගනකයට ඇතුලත් කරනු ඇත.
- ආ) MDP වආයතනය විසින් තොරතුරු යාවත්කාලීනව කිරීමට, වාර්තා සැපයීම GSK ආයතනයේ සහ MDP සහාය ඇතිව දත්ත එක් රැස් කිරීමට කෙනෙකුට පත් කර ඔහුට සුදුසු ගෙවීමක් කරනු ඇත. සාමාජිකත්වයේ තොරතුරුවන ගිනිසිරියා වගාකරන්නන්, ගිනිසිරියා ගස් වගා කරන ලද ප්‍රමාණය සුළු අපනයන බෝග නිෂ්පාදන ප්‍රමාණය යනාදිය වාර්තා ගත කර යාවත්කාලීන කරනු ඇත.
- ඇ) අවශ්‍ය තොරතුරු තාක්ෂණ පහසුකම් (පරිගණක පුහුණු කිරීම සහ සම්බන්ධිත සැලසුම්කරණය) MDP විසින් GSK ආයතනයට ලබාදෙනු ඇත.

ප්‍රගති සමාලෝචනය ඉහත සඳහන් කාර්යයන්හි සැම මසකම ප්‍රගතිය සියලුම පාර්ශවයන් සැම කාර්තුවකදීම එක්වූ රැස්වීමකදී සාමාලෝචනය කරනු ඇත.

K.M.R.I.S.M.G. ASSET COMPANY (PVT) LTD.

Shaly Karalaya

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AUTHORIZED SIGNATORY (S)
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 ගැමිසරණ කේන්ද්‍රය

A. D. Athukorala
 Chairman/Execu: Director
 Gami Sarana Kendriya
 Kegalle - Tuwatota.

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23-08-2015

11.8 List of Fauna and Flora species identified during the ecological survey and their conservation status

Table 1 - Common names, taxonomic status, habit, uses and conservation status of recorded flowering plant species in proposed project site (power plant area) and fuel wood supply area

(PH – Power House Site, S1 – Study Site 1, S2 – Study Site 2, Uses – mp – medicinal plant, f – food, t – timber, o – ornament, TS= Taxonomic Status – N – Native, Ex – Exotic, Ex -N– Naturalized Exotics, E – Endemic, Ex -N– IAS – Invasive Alien Species, NCS = National Conservation Status according to 2012 National Red List.LC- Least Concerned (Not Threatened),VU – Vulnerable, NT- Near Threaten, Habit – S – Shrub, H – Herb, T – Tree, C – Climber, GC – Ground Cover)

Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Acanthaceae	<i>Asystasia gangetica</i>		*		Puruk	Chinese violet	mp	N	LC	H
Amaranthaceae	<i>Achyranthes aspera</i>	*			Karal haba	Pickly chaff flower	mp	N	LC	H
Amaranthaceae	<i>Aerva lanata</i>	*			Polpala	Aerva	mp	N	LC	H
Amaranthaceae	<i>Amaranthus lividus</i>	*			Thampala			Ex-N		H
Amaranthaceae	<i>Celosia argentea</i>	*			Kiri-henda	Cockscomb	mp	N	LC	H
Anacardiaceae	<i>Spondias pinnata</i>		*		Wal ambarella	Hog plum tree	mp	N	VU	T
Anacardiaceae	<i>Lannea coromandelica</i>	*			Hik	Wodier Jhingam	mp	N	LC	T
Anacardiaceae	<i>Semicarpus nigro-viridis</i>		*	*	Geta badulla		mp	N-E	LC	T
Anacardiaceae	<i>Mangifera indica</i>	*	*	*	Amba	Mango	mp,f	Ex		T
Annonaceae	<i>Annona muricata</i>			*	Katu-Anoda	Soursop	mp,f	Ex		T
Apiaceae	<i>Centella asiatica</i>			*	Gotukola	Indian pennywort	mp,f	N	LC	H
Apiaceae	<i>Eryngium foetidum</i>			*	Andu	Long coriander	mp	Ex-N		H
Apocynaceae	<i>Allamanda cathartica</i>			*	Wal-Ruk-Attana	Yellow allamanda	mp,o	Ex-N		C
Apocynaceae	<i>Alstonia scholaris</i>	*			Ruk-Attana	Devil tree	mp	N	LC	T
Apocynaceae	<i>Plumeria obusta</i>	*			Sudu araliya	Temple tree	mp,o	Ex		T
Apocynaceae	<i>Tabernaemontana divaricata</i>		*	*	Wathusudda	Grape jasmine	mp	Ex		S
Apocynaceae	<i>Pagiantha dichotoma</i>	*	*		Divi-Kaduru	Eve's apple	mp	N	LC	T
Araceae	<i>Anthurium andraeanum</i>		*		Anthurium		o	Ex		H
Araceae	<i>Alocasia macrorrhizos</i>			*	Habarala	Giant taro	mp	Ex-N-IAS		H
Araceae	<i>Lasia spinosa</i>			*	Kohila		mp,f	N	LC	H

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Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Araceae	<i>Syngonium angustatum</i>			*	Wel-kohila	Fivefingers	mp	Ex-N		H
Araceae	<i>Colocasia esculenta</i>			*	Gahala	Coco yam	mp	N	LC	H
Araceae	<i>Pothos scandens</i>	*	*	*	Pota-Wel		mp	N	LC	C
Arecaceae	<i>Corypha umbraculifera</i>		*		Thala	Talipot palm	mp	Ex		T
Arecaceae	<i>Phonix pusilla</i>		*		Wal indi	Small wild date palm	mp	N	LC	T
Arecaceae	<i>Areca catechu</i>	*	*	*	Puwak	Areca-nut	mp,f	Ex		T
Arecaceae	<i>Caryota urens</i>	*	*	*	Kithul	Fish-tail palm	mp,f	N	LC	T
Arecaceae	<i>Cocos nucifera</i>	*	*	*	Pol	Coconut	mp,f	Ex		T
Asparagaceae	<i>Asparagus falcatus</i>			*	Maha hathavariya		mp	N	LC	C
Asteraceae	<i>Tithonia diversifolia</i>		*		Naththasuriya	Wild sunflower	mp	Ex-N		S
Asteraceae	<i>Ageratum conyzoides</i>		*		Hulantala	Goat weed	mp	Ex-N		H
Asteraceae	<i>Eclipta prostrata</i>		*		Kikirindi	Marsh Daisy	mp	N	LC	H
Asteraceae	<i>Chromolaena odorata</i>	*			Podi-singno-maran	Siam Weed	mp	Ex-N- IAS		S
Asteraceae	<i>Mikania cordata</i>	*	*	*	Gam-palu	Mile-a-minute	mp	Ex-N- IAS		C
Asteraceae	<i>Vernonia cinerea</i>	*	*	*	Monorakudumbiya	Little iron weed	mp	N	LC	H
Asteraceae	<i>Synedrella nodiflora</i>	*	*			Nodeweed		Ex-N		H
Basellaceae	<i>Basella alba</i>		*		Niviti	Malabar spinach	mp,f	N		H
Bignoniaceae	<i>Tecoma stans</i>		*		Kelani tissa	Yellow elder	o	Ex		T
Bignoniaceae	<i>Oroxylum indicum</i>			*	Totila	Indian trumpet tree	mp	N	LC	T
Bromeliaceae	<i>Ananas comosus</i>		*	*	Annasi	Pine apple	mp,f	Ex		S
Cannabaceae	<i>Celtis philippensis</i>		*		Meditella		mp	N	LC	T
Cannabaceae	<i>Trema orientalis</i>	*			Gadumba	Charcoal tree	mp	N	LC	T
Cannaceae	<i>Canna indica</i>	*			Buthsarana	Indian shot	mp	Ex-N		H
Caricaceae	<i>Carica papaya</i>	*			Gas-Labu	Papaw	mp,f	Ex		T
Cleomaceae	<i>Cleome rutidosperma</i>	*				Common spider flower		Ex-N		H
Clusiaceae	<i>Garcinia quaesita</i>		*		Rat Gorka		mp,f	N-E	LC	T
Combretaceae	<i>Terminalia arjuna</i>			*	Kumbuk	Arjun	mp,t	N	LC	T
Combretaceae	<i>Terminalia catappa</i>	*			Kottamba	Country almond	mp	Ex-N		T
Convolvulaceae	<i>Ipomoea batatas</i>		*		Batala	Sweet potato	mp,f	Ex		H

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Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Convolvulaceae	<i>Evolvulus alsinoides</i>		*		Visnu-kranthi	Little glory	mp	N	LC	H
Convolvulaceae	<i>Argyreia populifolia</i>	*			Girithilla		mp	N-E	LC	C
Convolvulaceae	<i>Merremia umbellata</i>	*			Mahamadu		mp	N	LC	C
Costaceae	<i>Costus speciosus</i>		*		Tebu	Spiral ginger	mp,f	N	LC	S
Crassulaceae	<i>Kalanchoe pinnata</i>		*		Akkapana	Airplant	mp	Ex-N		H
Cucurbitaceae	<i>Momordica charantia</i>		*		Karavila	Bitter gourd	mp,f	N	LC	C
Dioscoreaceae	<i>Trichopodium zeylanicum</i>			*	Bim-pol		mp	N	VU	H
Elaeocarpaceae	<i>Elaeocarpus serratus</i>		*	*	Weralu	Ceylon olive	mp	N	LC	T
Euphorbiaceae	<i>Hevea brasiliensis</i>		*		Rubber		t	Ex		T
Euphorbiaceae	<i>Acalypha wilkensiana</i>		*			Copper leaf		Ex		H
Euphorbiaceae	<i>Euphorbia heterophylla</i>		*		Wal Rabber	Mexican fireweed		Ex-N		H
Euphorbiaceae	<i>Mallotus philippensis</i>		*		Molabe	Monkey face	mp	N	LC	T
Euphorbiaceae	<i>Codiaeum variegatum</i>			*		Croton	o	Ex		S
Euphorbiaceae	<i>Acalypha indica</i>	*			Kuppamenia	Indian Acalypha	mp	N	LC	H
Euphorbiaceae	<i>Ricinus communis</i>	*			Endaru	Castor oil plant	mp	Ex-N		S
Euphorbiaceae	<i>Manihot esculenta</i>		*	*	Maiokka	Cassva	mp,f	Ex		T
Euphorbiaceae	<i>Macaranga peltata</i>	*	*	*	Kenda	Roxburgh's lotus croton	mp	N	LC	T
Fabaceae	<i>Centrosema pubescens</i>		*			Butterfly pea		Ex-N		C
Fabaceae	<i>Pueraria phaseoloides</i>		*			Tropical kudzu		Ex-N		C
Fabaceae	<i>Acacia caesia</i>		*		Hinguru	Soap bark	mp	N	LC	C
Fabaceae	<i>Leucaena leucocephala</i>		*		Ipil-Ipil	Ipil ipil	mp	Ex-N- IAS		T
Fabaceae	<i>Acacia mangium</i>	*				Northern balck wattle		Ex		T
Fabaceae	<i>Pongamia pinnata</i>	*			Karanda	Indian beech	mp	N	LC	T
Fabaceae	<i>Sesbania grandiflora</i>	*			Katuru-murunga	Swamp pea	mp,f	Ex		T
Fabaceae	<i>Tamarindus indica</i>	*			Siyambala	Tamarind	mp	Ex		T
Fabaceae	<i>Gliricidia sepium</i>	*	*	*	Ginisooriya	Mexican lilac	mp	Ex		T
Fabaceae	<i>Mimosa pudica</i>	*	*	*	Nidi-kumba	Sensitive plant	mp	Ex-N		H
Hypoxidaceae	<i>Curculigo orchioides</i>		*		Heen-bin-tal	Black musli	mp	N	LC	S
Lamiaceae	<i>Clerodendrum infortunatum</i>		*		Pinna,		mp	N	LC	S
Lamiaceae	<i>Clerodendrum paniculatum</i>	*				Danger flower		Ex-N		S

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Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Lamiaceae	<i>Gmelina arborea</i>	*			At-demata	Candahar tree	mp	N	NT	T
Lamiaceae	<i>Hyptis capitata</i>		*	*		Knobweed		Ex-N		S
Lauraceae	<i>Cinnamomum cassia</i>	*			Dawul-Kurundu	Wild cinnamon	mp,t	N	LC	T
Lauraceae	<i>Litsea glutinosa</i>		*	*	Bombi, Bomi	Common Tallow Laurel	mp	N	LC	T
Lauraceae	<i>Persea americana</i>	*	*	*	Aligeta-pera	Avacado	mp,f	Ex		T
Lecythidaceae	<i>Careya arborea</i>		*		Kahata	Pathana-oak	mp	N	LC	T
Magnoliaceae	<i>Michelia champaca</i>			*	Gini sapu	Champak	mp,t	Ex		T
Malvaceae	<i>Hibiscus furcatus</i>		*		Napiriththa		mp	N	LC	S
Malvaceae	<i>Sida acuta</i>		*		Gas-Bevila	Common wireweed	mp	N	LC	S
Malvaceae	<i>Urena sinuata</i>		*		Heen-epala	Bur mallow	mp	N	LC	S
Malvaceae	<i>Hibiscus rosa-sinensis</i>			*	Wada	Shoeflower	mp,o	Ex		S
Malvaceae	<i>Abutilon indicum</i>	*			Beth anoda	Indian mallow,	mp	N	LC	S
Malvaceae	<i>Berrya coridifolia</i>		*		Halmilla	Trincomalee wood	mp,t	N	LC	T
Malvaceae	<i>Ceiba pentandra</i>	*			Pulun	Kapok tree	mp	N	LC	T
Malvaceae	<i>Melochia corchorifolia</i>	*			Gas-kura		mp	N	LC	H
Malvaceae	<i>Corchorus aestuans</i>	*			Jaladara		mp	Ex-N		H
Malvaceae	<i>Sterculia balanghas</i>		*	*	Nava		mp	N	LC	T
Malvaceae	<i>Grewia damine</i>	*	*		Daminiya	Dhaman	mp	N	LC	S
Melastomataceae	<i>Clidemia hirta</i>		*	*	Katakalu-Bovotiya	Soap bush		Ex-N-IAS		S
Meliaceae	<i>Melia dubia</i>		*		Lunu-Midella	Ceylon mahogany	t	N		T
Meliaceae	<i>Azadirachta indica</i>			*	Kohomba	Neem	mp,t	Ex		T
Meliaceae	<i>Swietenia macrophylla</i>		*	*	Mahogani	Honduras mahogany	t	Ex-N-IAS		T
Menispermaceae	<i>Anamirta cocculus</i>	*	*	*	Titta-wel	Fish berry	mp	N	LC	L
Moraceae	<i>Artocarpus nobilis</i>		*		Bedi-Del	Wild bread fruit	mp,t,f	N-E	LC	T
Moraceae	<i>Ficus callosa</i>		*		Gonna		mp	N	LC	T
Moraceae	<i>Ficus hispida</i>		*		Kota-Dimbula	Wild fig	mp	N	LC	T
Moraceae	<i>Streblus taxoides</i>		*		Gongotu	Fig-lime	mp	N	LC	T
Moraceae	<i>Ficus exasperata</i>	*			Bu-Thediya	Furniture lear	mp	N	LC	T
Moraceae	<i>Artocarpus heterophyllus</i>	*	*	*	Kos	Jak	mp,t,f	Ex		T
Moraceae	<i>Artocarpus incisus</i>	*	*	*	Rata-Del	Bread fruit tree	mp,f	Ex		T

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Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Muscaceae	<i>Musa x paradisaca</i>	*	*	*	Kehel	Banana	mp,f	Ex		H
Myrtaceae	<i>Syzygium malaccensis</i>			*	Jambu	Malayrose apple	mp,f	Ex		T
Myrtaceae	<i>Psidium guajava</i>	*			Pera	Guava	mp,f	Ex		T
Myrtaceae	<i>Syzygium aromaticum</i>		*	*	Karambu	Clove	mp,f	Ex		T
Nyctaginaceae	<i>Bougainvillea spectabilis</i>			*	Bouganvilla		mp,o	Ex		S
Ochnaceae	<i>Gomphia serrata</i>			*	Go-kera		mp	N	LC	S
Olacaceae	<i>Olax zeylanica</i>		*		Mella		mp,f	N	LC	T
Oleaceae	<i>Nyctanthes arbor-tristis</i>			*	Sepalica	Coral jasmine	mp	Ex		S
Passifloraceae	<i>Passiflora edulis</i>			*	Wel dodam	Passion fruit	mp,f	Ex		C
Phyllanthaceae	<i>Sauropus androgynus</i>		*		Japan batu	Star gooseberry	mp,f	N	LC	S
Phyllanthaceae	<i>Phyllanthus debilis</i>		*		Ela pitawakka		mp	N	LC	H
Piperaceae	<i>Peperomia pellucida</i>			*	Diya thippili	Shiny bush	mp	Ex-N		H
Piperaceae	<i>Piper nigrum</i>		*	*	Gam-Miris	Black pepper	mp	Ex-N		C
Poaceae	<i>Bambusa vulgaris</i>	*	*		Kaha una	Bambos	mp	Ex		G
Poaceae	<i>Eleusine indica</i>	*			Bela-tana		mp	N	LC	G
Poaceae	<i>Panicum maximum</i>	*			Gini tana	Guinea grass	mp	Ex-N- IAS		G
Rubiaceae	<i>Mussaenda frondosa</i>		*		Wel-Butsarana	White mussaenda	mp	N	LC	S
Rubiaceae	<i>Oldenlandia auricularia</i>		*		Geta-kola			N-E		H
Rubiaceae	<i>Spermacoce latifolia</i>		*			Oval leaf false buttonweed		Ex-N		H
Rubiaceae	<i>Oldenlandia diffusa</i>	*			Embul pala		mp	N	LC	H
Rubiaceae	<i>Coffea arabica</i>		*	*	Kopi	Coffee	mp,f	Ex		S
Rubiaceae	<i>Paederia foetida</i>			*	Apasu madu			Ex-N		C
Rutaceae	<i>Acronychia pedunculata</i>			*	Ankenda		mp	N	LC	T
Rutaceae	<i>Aegle marmelos</i>			*	Beli	Bael fruit tree	mp,f	Ex		T
Rutaceae	<i>Murraya paniculata</i>	*			Etteriya	Orange jessamine	mp	N	LC	T
Salicaceae	<i>Flacourtia inermis</i>			*	Lovi		mp,f	Ex		T
Sapindaceae	<i>Cardiospermum halicacabum</i>	*			Wel penela	Ballon vine	mp,f	N	LC	C
Sapindaceae	<i>Allophylus cobbe</i>		*	*	Kobbe		mp	N	LC	S
Sapindaceae	<i>Nephelium lappaceum</i>	*	*	*	Rambutan	Rambutan	mp,f	Ex		T
Sapotaceae	<i>Chrysophyllum oliviforme</i>	*				Date plum	f	Ex		T

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Family	Species	PH	S1	S2	Sinhala Name	English name	Uses	TS	NCS	H
Solanaceae	<i>Capsicum annuum</i>		*		Miris	Red pepper	mp,f	Ex		S
Solanaceae	<i>Brunfelsia americana</i>			*	Cheeththa mal	Tester day-today and tomorrow		Ex		S
Solanaceae	<i>Physalis angulata</i>	*				Cutleaf groundcherry		Ex		H
Solanaceae	<i>Solanum americanum</i>	*			Kalukammeriya	American black nightshade	mp	Ex-N		H
Thymelaeaceae	<i>Gyrinops walla</i>		*	*	Walla patta	Sri Lankan Agarwood	mp	N	VU	T
Verbanaceae	<i>Duranta repens</i>		*			White heliotrope		Ex		S
Verbenaceae	<i>Stachytarpheta jamaicensis</i>		*		Balu-nakuta	Berbena		Ex-N		H
Verbenaceae	<i>Lantana camera</i>			*	Rata-hinguru	Common lantana	mp	Ex-N-IAS		S
Verbenaceae	<i>Tectona grandis</i>			*	Thekka	Teak	mp,t	Ex		T
Verbenaceae	<i>Lantana camera</i>	*			Sudu gandpana	White lantana	mp	Ex		S
Vitaceae	<i>Cissus trilobata</i>			*				N	LC	C
Xanthorrhoeaceae	<i>Aloe vera</i>		*		Komarica	Indian Aloe	mp	Ex-N		H

Table 2. Recorded mammal species in the proposed project site and fuel wood supply area

(* and **bold** denotes the endemic species, Conservation status - VU=Vulnerable, LC=Least Concerned according to the 2012 National Red List)

No.	Family	Scientific Name	English Name	Sinhala Name	Conservation status
1	Canidae	<i>Canis aureus</i>	Jackal	Nariya/Hiwala	LC
2	Cercopithecidae	<i>Macaca sinica</i>*	Sri Lanka Toque Monkey	Sri Lanka Rilava	LC
3	Cercopithecidae	<i>Semnopithecus priam</i>	Grey Langur	Eli Wandura	LC
4	Leporidae	<i>Lepus nigricollis</i>	Black-Naped Hare	Wal Hawa	LC
5	Muridae	<i>Bandicota indica</i>	Malabar Bandicoot	Uru Miya	LC
6	Muridae	<i>Mus musculus</i>	Indian House Mouse,	Ge-heen miya/ Koseta miya	LC
7	Pteropodidae	<i>Cynopterus sphinx</i>	Short-nosed fruit bat	Thala vavula	LC
8	Scuridae	<i>Funambulus palmarum</i>	Palm squirrel	Leena	LC

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No.	Family	Scientific Name	English Name	Sinhala Name	Conservation status
9	Herpestidae	<i>Herpestus brachyurus</i>	Brown Mongoose	Bora Mugatiya	LC
10	Herpestidae	<i>Herpestes edwardsi</i>	Grey Mongoose	Alu mugatiya	LC
11	Hystricidae	<i>Hystrix indica</i>	Porcupine	Ittawa	LC
12	Muridae	<i>Rattus rattus</i>	Common House-Rat or Black Rat	Podu ge miya	LC
13	Pteropodidae	<i>Pteropus giganteus</i>	Flying fox	Ma wavula	LC
14	Scuridae	<i>Ratufa macroura</i>	Giant Squirrel	Dandu Leena	VU
15	Soricidae	<i>Suncus murinus</i>	Common musk shrew	Podhu hik miya	LC
16	Suidae	<i>Sus scrofa</i>	Wild boar	Wal Ura	LC
17	Tragulidae	<i>Moschiola meninna</i> *	Sri Lanka mouse deer	Sri Lanka Meeminna	LC
18	Viverridae	<i>Paradoxurus hermaphroditus</i>	Palm-Cat	Uguduwa	LC

Table 3. Recorded Bird species in the proposed project site and fuel wood supply area

* and bold denotes the endemic species, # - denotes migrant species, Conservation status - LC=Least Concerned according to the 2012 National Red List)

	Family	Scientific Name	English Name	Sinhala Name	Conservation status
1	Accipitridae	<i>Accipiter badius</i>	Shikra	Ukussa	LC
2	Accipitridae	<i>Spilornis cheela</i>	Crested Serpent Eagle	Sarpa Ukussa	LC
3	Alcedinidae	<i>Alcedo atthis</i>	Common Kingfisher	Pilihuduwa	LC
4	Ardeidae	<i>Ardeola greyii</i>	Pond Heron	Kana Koka	LC
5	Ardeidae	<i>Egretta garzetta</i>	Little Egret	Koka	LC
6	Ardeidae	<i>Bubulcus ibis</i>	Cattle Egret	Gava Koka	LC
7	Bucerotidae	<i>Ocyrceros gingalensis</i> *	Sri Lanka Gray Hornbill	Alu Kendetta	LC
8	Charadriidae	<i>Vanellus indicus</i>	Red wattled Lapwing	Kirala	LC
9	Columbidae	<i>Chalcophaps indica</i>	Emerald Dove	Neela kobeiyya	LC
10	Columbidae	<i>Streptopelia chinensis</i>	Spotted Dove	Alu kobeiyya	LC
11	Corvidae	<i>Corvus leuallantii</i>	Jungle crow	Kaputa	LC
12	Dicruridae	<i>Dicrurus caerulescens</i>	White bellied Drongo	Kauda	LC
13	Centropodidae	<i>Centropus sinensis</i>	Greater Coucal	Ati Kukula	LC
14	Cuculidae	<i>Eudynamys scolopaceus</i>	Asian Koel	Koha	LC

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15	Estrildidae	<i>Lonchura malacca</i>	Black headed munia	Hisa Kalu Weekurulla	LC
16	Halcyonidae	<i>Halcyon smyrnensis</i>	White throated kingfisher	Laya sudu Pilihuduwa	LC
17	Hirundinidae	<i>Hirundo rustica</i> #	Barn Swallow	Wehilihiniya	-
18	Muscicapidae	<i>Copsychus saularis</i>	Oriental Magpie-Robin	Polkichcha	LC
19	Muscicapidae	<i>Terpsiphone paradisi</i> #	Asian Paradise Flycatcher	Suduredihora	-
20	Nectariniidae	<i>Nectarinia lotenia</i>	Lotan's Sun-Bird	Sautikka	LC
21	Oriolidae	<i>Oriolus xanthornus</i>	Black-naped Oriole	Kahakurulla	LC
22	Phasianidae	<i>Gallus lafayettii</i>*	Sri Lanka Jungle fowl	Walikukula	LC
23	Picidae	<i>Dinopium benghalense</i>	Red-backed Woodpecker	Kerala	LC
24	Psittacidae	<i>Psittacula krameri</i>	Rose-ringed Parakeet	Mala Girawa	LC
25	Pycnonotidae	<i>Pycnonotus cafer</i>	Red-vented Bulbul	Konda Kurulla	LC
26	Pycnonotidae	<i>Pycnonotus luteolus</i>	White browed bulbul	Bamasudu kondaya	LC
27	Rallidae	<i>Amaurornis pheonicurus</i>	White breasted waterhen	Laya Sudu Korawakka	LC
28	Ramphastidae	<i>Megalaima zeylanica</i>	Brown-headed Barbet	Poloskottoruwa	LC
29	Sturnidae	<i>Acridotheres tristis</i>	Common Mynha	Myna	LC
30	Sturnidae	<i>Gracula religiosa</i>	Common Hill Mynha	Selalihiniya	LC
31	Sylviidae	<i>Orthotomus sutorius</i>	Common Tailorbird	Batthichcha	LC
32	Timaliidae	<i>Turdoides affinis</i>	Southern Common Babbler	Demalichca	LC

Table 4. Recorded Reptile species in the proposed project site and fuel wood supply area

(Conservation status - LC=Least Concerned according to the 2012 National Red List)

No.	Family	Scientific name	English Name	Sinhala Name	Conservation status
1	Agamidae	<i>Calotes calotes</i>	Green Garden Lizard	Pala Katussa	LC
2	Agamidae	<i>Calotes versicolor</i>	Garden Lizard,	Gara Katussa	LC
3	Colubridae	<i>Ahaetulla nasuta</i>	Green Whip Snake	Ahetulla	LC
4	Colubridae	<i>Ptyas mucocus maximus</i>	Common Rat snake	Gerandiya	LC
5	Elapidae	<i>Naja naja</i>	Cobra, Common Cobra	Naya	LC
6	Gekkonidae	<i>Hemidactylus frenatus</i>	House Gecko	Gewal Hoona	LC
7	Natricidae	<i>Amphiesma stolatum</i>	Buff-striped Keelback	Aharakukka	LC
8	Scincidae	<i>Eutropis macularia</i>	Bronz Green Little Snake	Sulaba Hikanala	LC
9	Varanidae	<i>Varanus bengalensis</i>	Land Monitor	Thalagoya	LC
10	Viperidae	<i>Daboia russelii</i>	Russell's Viper	Tith polanga	LC
11	Viperidae	<i>Hypnale hypnale</i>	Hump-nosed Viper	Kunakatuwa	LC

Recorded Amphibian species in the proposed project site and fuel wood supply area

(Conservation status - LC=Least Concerned according to the 2012 National Red List)

No.	Family	Scientific Name	English Name	Sinhala Name	Conservation status
1	Bufoidea	<i>Duttaphrynus melanostictus</i>	Common Toad	Gei Gamba	LC
2	Dicroglossidae	<i>Euphlyctis cyanophlyctis</i>	Indian Skipper Frog	Uthpathana Mediya	LC

Recorded Butterfly species in the proposed project site and fuel wood supply area

(Conservation status - LC=Least Concerned according to the 2012 National Red List)

No	Family	Scientific Name	English Name	Sinhala Name	Conservation status
1	Lycaenidae	<i>Jamides celeno</i>	Common Cerulean	Seruliya	LC
2	Lycaenidae	<i>Castalius rosimon</i>	Common Pierrot	Konangiya	LC
3	Nymphalidae	<i>Danaus chrysippus</i>	Plain Tiger	Pahan Gomara	LC
4	Nymphalidae	<i>Elymnias hypermnestra</i>	Common Palmfly	Ramba Thaliya	LC
5	Nymphalidae	<i>Junonia iphita</i>	Chocolate Soldier	Miyuru Hewa	LC
6	Nymphalidae	<i>Neptis hylas</i>	Common Sailor	Selaruwa	LC
7	Nymphalidae	<i>Orsotriaena medus</i>	Nigger	Iri Siw Mudda	LC
8	Nymphalidae	<i>Parantica aglea</i>	Glassy Tiger	Palingu Gomara	LC
9	Nymphalidae	<i>Ypthima ceylonica</i>	White Four Ring	Sithiri Siwwa	LC
10	Papilionidae	<i>Pachliota aristolochiae</i>	Common Rose	Sewwandiya	LC
11	Papilionidae	<i>Papilio polymnestor</i>	Blue mormen	Neela Parindaya	LC
12	Papilionidae	<i>Papilio polytes</i>	Common Mormon	Wesgaththi	LC
13	Pieridae	<i>Catopsilia pomona</i>	Lemon Emigrant	Dehi Seriya	LC
14	Pieridae	<i>Eurema blanda</i>	Three spot grass yellow	Thun Pulli Thruna Pithaya	LC

