LIBERIA ELECTRICITY CORPORATION

LIBERIA ACCELERATED ELECTRICITY EXPANSION PROJECT (LACEEP)

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT FOR PAYNESVILLE – KAKATA 66kV TRANSMISSION LINE

FINAL REPORT

August, 2014
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<tr>
<td>AIS</td>
<td>Alien Invasive Species</td>
</tr>
<tr>
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</tr>
<tr>
<td>HC</td>
<td>Hydrocarbon</td>
</tr>
<tr>
<td>Ha</td>
<td>Hectares</td>
</tr>
<tr>
<td>km</td>
<td>Kilometer</td>
</tr>
<tr>
<td>kV</td>
<td>Kilovolt</td>
</tr>
<tr>
<td>KVA</td>
<td>Kilovolt Ampere</td>
</tr>
<tr>
<td>LEC</td>
<td>Liberia Electricity Corporation</td>
</tr>
<tr>
<td>m</td>
<td>Meter</td>
</tr>
<tr>
<td>mm</td>
<td>Millimeter</td>
</tr>
<tr>
<td>Ma</td>
<td>Million Years</td>
</tr>
<tr>
<td>MW</td>
<td>Megawatt</td>
</tr>
<tr>
<td>NAAQS</td>
<td>National Ambient Air Quality Standards</td>
</tr>
<tr>
<td>NH₄-N</td>
<td>Ammonia Nitrogen</td>
</tr>
<tr>
<td>NOₓ</td>
<td>Nitrogen Oxides</td>
</tr>
<tr>
<td>OSHA</td>
<td>Occupation Safety and Health Administration</td>
</tr>
<tr>
<td>PCBs</td>
<td>Polychlorinated biphenyls</td>
</tr>
<tr>
<td>PM</td>
<td>Particulate Matter</td>
</tr>
<tr>
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<td>Personal Protective Equipment</td>
</tr>
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<td>Persistent Organic Pollutants</td>
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<tr>
<td>RAP</td>
<td>Resettlement Action Plan</td>
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<tr>
<td>ROW</td>
<td>Right of Way</td>
</tr>
<tr>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
</tr>
<tr>
<td>SS</td>
<td>Suspended Solids</td>
</tr>
<tr>
<td>TDS</td>
<td>Total Dissolve Solids</td>
</tr>
<tr>
<td>TSP</td>
<td>Total Suspended Particles</td>
</tr>
<tr>
<td>TN</td>
<td>Total Nitrogen</td>
</tr>
<tr>
<td>TSS</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td>USEPA</td>
<td>United States Environmental Protection Agency</td>
</tr>
<tr>
<td>VOC</td>
<td>Volatile Organic Compound</td>
</tr>
<tr>
<td>WAPP</td>
<td>West African Power Pool</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
</tbody>
</table>
EXECUTIVE SUMMARY

Liberia Electricity Corporation (LEC), a 100% public enterprise owned by the Government of Liberia established in 1973 with the sole provision of producing electrical energy and distributing it throughout Liberia, is the proponent of a proposed 56 km 66 kV single circuit electrical transmission line, and intends to construct, own and operate said line that will extend between the LEC’s Substation at Paynesville and Kakata, on the outskirts of Monrovia (Figure 1). The Transmission Line will be re-installed on the Government of Liberia (GOL)-LEC existing right-of-way (RoW ~ along the Kakata-Monrovia Highway).

It should be noted that, the above existing RoW is a GOL/LEC RoW that was established for use by many Utilities, is clearly in the Public’s best interest and was in use for electricity transmission and distribution lines and substations before the nearly two decades of civil conflict in Liberia. Like many GOL/LEC RoW’s, this RoW along the public Highway, between Kakata and the existing LEC substation at Paynesville is still being used by Utilities such as a 2.5 km section of the Monrovia grid 66 kV transmission line, recently reconstructed and energized by LEC and the European Commission in Liberia.

In support of the approvals required by the Environment Protection and Management Law of Liberia and the World Bank Safeguard Policies, LEC prepared this Environmental and Social Impact Assessment (ESIA).

This ESIA Study seeks to meet the following objectives:

- Ensure compliance with the local laws and regulations;
- Determine the compatibility of the proposed Project with the surrounding environment;
- Generate baseline data that will be used to monitor and evaluate the mitigation measures implemented during the Project cycle;
- Identify and assess environmental and social impacts, both adverse and beneficial in the Projects’ area of influence;
- Evaluate and select the best Project alternative from the various options;
- Manage by avoiding or at least minimizing potential environmental impacts and
risks on the surrounding population and environment within acceptable limits;

- Assist decision makers in protecting, conserving and managing the surrounding environment as well as affected communities according to the principles of sustainable development;

- Incorporate environmental management plans and monitoring mechanisms during construction and operation phases of Project development;

- Assure open and balanced process through public information by promoting improved social and environmental performance of BR Power

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**Figure 1 Transmission lines route**

**LEGISLATIVE FRAMEWORK**

This ESIA/ESMP has been prepared to fulfill the requirements of Sections 11 and 13 of the Act creating the Environment Protection and Management Law of Liberia, the Terms of Reference previously approved by the Environmental Protection Agency (EPA), the World Bank Safeguard Policies, and the International Finance Corporation (IFC) Environmental, Health, and Environmental, Health, and Safety Guidelines for Electric Power Transmission
and Distribution. The purpose of this document is to inform the EPA, the World Bank and Interested and Affected Parties of beneficial environmental and socioeconomic impacts together with the potential adverse impacts of the proposed Project, its alternatives, and the mitigation measures that will avoid or reduce any significant adverse impacts.

THE PURPOSE AND NEED FOR THE PROJECT

The proposed Transmission Line is an important component in the revitalization of Liberia, a country desperately attempting to rebuild its infrastructure, rehabilitate its economy, attract investment, and improve the livelihood of its citizens following years of civil unrest and civil conflict. The Liberian government is taking great strides to develop strategies and policies to promote sustainable development and sound environmental management. Infrastructure constraints or non-availability of power, water, and communications services are major impediments to economic recovery and growth.

Achieving a reliable and environmentally sound supply of electrical energy is central to sustainable development that the GOL is endeavoring to promote and develop. Improvements made in the energy sector will be instrumental in:

- Establishing a major infrastructure component for the supply of vitally needed electricity;
- Improving health and sanitation;
- Reducing poverty and hunger;
- Establishing employment, training, human resource development, and technology transfer opportunities;
- Increasing earning potential;
- Enabling industrial and commercial growth;
- Encouraging community and rural developments; and
- Contributing to the national treasury through tax payments.

Increasing population and demand for fuel wood (firewood) and charcoal places great pressure on environmental resources. Given the unsustainable manner in which these traditional fuels are produced in Liberia, biodiversity and forests are threatened.
Improvements in the energy sector will play a crucial role in stabilizing and developing the social and economic welfare of the country and its people. Energy is central to reducing poverty and hunger, improving health, and increasing literacy and education. Insufficient and unreliable electricity sources will further inhibit economic growth and foreign investment. The proposed Project will create substantial improvements in the country’s energy transmission in addition to the power produced at the Power Plant, and will provide positive socioeconomic benefits through the creation of jobs, education and training programs, decrease dependence on increasingly expensive fossil fuel imports and more desirable conditions for public-private partnerships and foreign investment.

PROJECT PROFILE AND DESCRIPTION

<table>
<thead>
<tr>
<th>Project Owner</th>
<th>Liberia Electricity Corporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Project</td>
<td>Construction and operation of a 56 km long 66 kV electrical Transmission Line</td>
</tr>
<tr>
<td>Location</td>
<td>Adjacent to the Kakata-Monrovia Highway, commencing at LEC’s Paynesville Substation and terminating in Kakata</td>
</tr>
</tbody>
</table>
| Electrical Design Capacity  | • Three-phase system with a nominal voltage of 66 kV  
|                             | • Rated power frequency of 50 Hz  
|                             | • Nominal Power rating of 36 MW  
|                             | • Highest rated three-phase withstand voltage of 140 kV |
| Electrical Supply           | Paynesville Substation |
| Engineering, Procurement & Construction | NA |
| Operator                    | Liberia Electricity Corporation |
| Project Construction Duration| 16-18 months (approximately) |

PROJECT ACTIVITIES

The project activities will consist of a range of operations aimed at ensuring that the 66 kV electrical Transmission Line from Paynesville to Kakata will be completed in time and will be operational as required to meet the proposed Power Plant’s testing/commissioning schedule. The main project activities will be:

- Mobilization
- Construction
- Operations & Maintenance
PROJECT DESCRIPTION

The Transmission Line will be re-installed entirely within the existing 150-foot-wide (46-meter-wide) GOL/LEC Right of Way (RoW) that includes the Kakata-Monrovia Highway between Paynesville and Kakata. The standard distance between the outer boundary of the LEC RoW and the centerline of the existing highway is 75 feet (23 meters). The Transmission Line route (tower centerline) will be at least 10 feet (3 meters) from the edge of the roadway, and at least 25 feet (8 meters) from the outer boundary of the LEC RoW. The maximum width of the intended transmission line corridor for construction will be 40 feet wide (12 meters) abutting the Kakata-Monrovia Highway.

Construction of the proposed transmission towers will require an estimated 8 meter square temporary construction work area at each tower location. The permanent footprint of each tower will be approximately 6 square meters at each tower location.

Partial restoration of LEC’s Paynesville Substation is part of the Monrovia transmission & distribution grid restoration project being performed by others (LEC and its management contractor, Manitoba Hydro International, and others) that is presently underway in Liberia. The Monrovia transmission & distribution grid restoration project will add the necessary equipment to connect the proposed 66kV Transmission Line, from the Power Plant in Kakata, to the restored Paynesville Substation.

Construction of the proposed Transmission Line will utilize skilled, semi-skilled, and unskilled labor.

ALTERNATIVES

Several project alternatives were investigated. These alternatives included a no action alternative, system alternatives, route variations and design alternatives, such as using underground cable systems, overhead transmission line, and comparison between towers and poles. Alternative locations were also reviewed for the proposed tower locations.

The no-action alternative (i.e. not to construct the proposed Transmission Line) would have no impact to the local environment; however, the direct and indirect economic and social
benefits that would have been accrued by the local communities because of an increase in electricity supply, and provision of labor opportunities would not be realized. In addition without the electric transmission infrastructure, LEC would not be able to provide electrical energy to Monrovia and surrounding communities.

No alternative transmission line routes were considered, since no other alternate RoW exists between the Paynesville Substation and Kakata, and a new “green-field RoW would be very difficult for obvious reasons including social, environmental, land use, legal, economic and schedule reasons. The proposed Transmission Line will be reinstalled within an existing utility corridor owned by LEC, primarily in the same location as the previous transmission line, and will parallel an existing highway. Any alternative routes would require establishment of a new easement within undeveloped areas resulting in greater impacts to environmental resources. Therefore, LEC concluded that no other potential transmission line routes could offer an environmentally or economically preferable alternative to the existing LEC RoW.

Design alternatives were considered, with proposed design of the Transmission Line being an overhead transmission line system, which enjoys less excavation works and less negative environmental and socio economic impact.

ENVIRONMENTAL SETTING/IMPACTS/MITIGATION/MONITORING

GENERAL

As stated above, the proposed transmission line will be installed within the existing GOL/LEC RoW that was established for use by many Utilities, was in use for electricity transmission and distribution lines and substations before the nearly two decades of civil conflict in Liberia, and will minimize impacts from construction of a transmission line which is clearly in the Public’s best interest. Like many GOL/LEC RoW’s, this RoW along the public Monrovia-Kakata Highway, between the existing LEC substation at Paynesville and Kakata is still being used by Utilities. A 2.5 km section of the Monrovia grid 66 kV Transmission Line was recently reconstructed and energized by LEC and the European Commission in Liberia within this RoW.
IMPACTS ON NATURAL ENVIRONMENT

Water Quality

There are no current water quality requirements or water discharge regulations established by the EPA, and there is no governmental sponsored water quality monitoring program. Communities existing along the Transmission Line, rely primarily on local waterbodies for their water needs. Shallow water wells are also used when surface water supply is low or due to inaccessibility.

Two rivers drain the area: Du River in the upper part near Kakata and Ba River close to Careysburg. Several streams and creeks crossing the Transmission Line route contribute to the Du and Ba Rivers. The Yoimbus Creek and the Bo Creek also cross the Transmission Line route and form tributaries of the Ba River. Moving from Careysburg to the Greater Monrovia District, several other creeks including the Muu Creek cross the Transmission Line route. Water sampling and analysis addressing the water quality of these specific creeks crossed by the Transmission Line was not conducted.

Impacts on water resources are expected to be of limited duration and of low magnitude and significance consisting of possible accidental spills, runoff, erosion and sediment transport mainly during construction activities. Mitigation measures include the installation of traps, correct chemical storage, guidelines for cleanup of accidental spills, and installation of sediment and erosion controls. Additionally, a Riparian Management Zone will be maintained for protection of surface waters and streams.

Topography and Soil

The Transmission Line route will extend between the upper parts of Greater Monrovia District and the upper eastern section of the Todee District of Montserrado County. The line also crosses approximately 1.5 km of the Mamba-Kaba District in Margibi County. The topography of the project area is generally flat with some undulating rises and an average elevation of approximately 75 meters above sea level. Moving towards SW from the Power Plant, elevation tends to decrease gradually from 100 m above sea level to 10 m above sea level. The Transmission Line crosses small streams and runs adjacent to small farming plots,
secondary growth forests that are generally out of the RoW. Vegetation adjacent to the corridor is comprised mostly of weedy plant species, secondary growth trees, and agricultural crops. The Transmission Line does not cross the Ramsar Wetlands or Nationally Protected Forests.

Impacts on soil resources are projected to be temporary and of low magnitude and significance, occurring mainly during the construction phase. Accidental discharge of chemicals and wastewater will be mitigated by correct storage and lining. Increased erosion due to excavation activities, compaction by heavy machinery and vegetation removal will be mitigated by avoidance of susceptible areas, covering of excavated material and their use for refilling, and replanting degraded areas with local species of vegetation including suitable sediment binding grasses. Soil erosion due to construction activities may result in siltation of watercourses crossing the RoW. The impacts are expected to be temporary and of low magnitude and significance and will be mitigated by scheduling construction to avoid heavy rainfall periods as well as maintenance of Riparian Management Zones to decrease sediment influx into aquatic environments. In addition use of pesticides and herbicides will be limited to where is strictly necessary to decrease risk of contamination of surface waters.

**Vegetation**

No sensitive habitats, including native forests, wetlands with conservation status, or coastal environments exist in the project area. The Transmission Line crosses open lands, small streams and wetlands, small farming plots, secondary growth forest, and dwellings/huts for local squatters. Vegetation adjacent to the corridor is comprised mostly of weedy plant species, secondary growth trees, and agricultural crops. Existing vegetation on the proposed transmission tower locations will be removed for construction and operation of the Transmission Line and will result in minor direct long-term impacts.

Impacts on landscape and visual intrusion will result in both temporary and permanent impacts. During the construction phase, storage areas and construction machinery and activities will form a short-term impact which will be mitigated by screening, while the Transmission Line itself and the towers will form a permanent change in the landscape. The Transmission Line will be located within the existing LEC RoW thereby limiting visual
Vegetation clearing for tower construction will result in limited alteration of terrestrial habitat by transforming existing vegetation and topographic features. Impacts on terrestrial habitat are expected to be moderate although permanent in nature, since the construction work areas for each tower will only affect a narrow width of land along a previously established utility and transportation corridor. Mitigation measures will include avoidance of critical habitat areas and re-vegetation of disturbed areas with native plants.

**Wildlife**

No evidence of rare or endangered species were encountered along the right-of-way during field surveys. Since, the Transmission Line crosses mostly in urban and agricultural areas, no rare or endangered are expected to occur in its vicinity. The Project will not result in significant alteration to the surrounding ecosystems or impact the viability composition of most wildlife communities. The Project will have minor direct and indirect long-term impacts on the wildlife and habitat in the project area.

**Collision of Birds with the Transmission Line**

The Transmission Line will increase the risk of bird collisions especially for large terrestrial birds that will be at increased risk of collision with the earth wire. These risks will be mitigated by maintaining correct spacing between energized components, and evaluating the need for bird deterrents or diverters, insulated jumper loops, and elevated perches to protect avian fauna.

**National Parks and Protected Areas**

There are no national parks or other protected areas located in or near the project area. The construction and operation of the Project will not impact any protected area.

**Renewable or Non-renewable Resources**

Renewable resources in Liberia are primarily renewable forest and freshwater. Non-renewable resources include iron ore, gold, and diamonds. There are no non-renewable
resources known to occur in the project area.

**Waste**

Impact from waste is projected to be temporary and of low magnitude and significance occurring mainly during the construction phase of the Project. Construction wastes and debris will be used for reclamation and fill purposes wherever possible. Chemical wastes will be segregated, labeled and stored in designated areas in corrosion resistant containers. General refuse will be stored in enclosed bins and collected by a solid waste collector certified by the EPA, with recycling wastes such as aluminum cans segregated where possible.

**Air Quality**

There are no historic data for air quality available for the project area, and therefore, no baseline data has been developed. The current/existing principal source of air pollution throughout the entire project area is emissions from vehicular traffic (particulates and combustion emissions) along the highway, and dust from vehicles travelling on local roads, all of which are unsealed.

The local ambient air quality around the project area will be temporarily impacted during construction of the Transmission Line as a result of air emissions generated by construction activities. Air emissions of particulate matter (PM) will be limited during construction by spraying water on dirt roads and piles of cleared debris/loose soil during the dry season, as well as enclosure and proper handling procedures of dust generating materials such as cement. Grading of unpaved access roads will decrease PM release into the surrounding atmosphere.

Combustion emissions generated by on-site equipment and traffic will be reduced by maintaining equipment properly, ensuring use of high quality fuel, and minimizing idling.

The operation of the Transmission Line will have no short-term or long-term impacts to the air quality of the surrounding area.
Noise

Background noise along the Transmission Line route is dominated by existing vehicular traffic along the Monrovia-Kakata Highway. Other noise sources in the project vicinity are rubber tapping, charcoal production and subsistence farming; all of which are operations serviced mainly by foot. Thus, mainly transient noise (intermittent with short duration) exists in the project area; with the exception of the Redlight section (along the Monrovia-Kakata Highway and about 2.5 km north of LEC’s Paynesville Substation) where the noise is high and constant in day hours when the Redlight market is open. Sources of this latter noise are primarily: traffic congestion, market cycle, small industries and craft work. Noise levels during the construction phase may exceed international noise level standards at times and will be mitigated by use of physical barriers such as material stockpiles; use of quiet well maintained equipment with silencers or mufflers to reduce vibration; scheduling noise activities during morning hours and enforcing noise monitoring. For employees, ear protection will be provided in high noise level construction areas.

IMPACTS ON HEALTH AND SAFETY

Electrocution

Though projected to be of low magnitude, there will be a permanent increase in the risk of electrocution resulting from the installation of the Transmission Line. Mitigation measures will include barriers, grounding, anti-climbing devices included in the design of the towers, and signs, in addition to education of public regarding potential dangers.

Electromagnetic Fields (EMF)

The frequency of the proposed Transmission Line is determined by the rate at which EMFs change their direction each second. For the proposed Transmission Line in Liberia, the frequency of electric power is 50 Hz. Based on the results of published studies and empirical field measurement data collected for similarly sized transmission lines, LEC concluded that the exposure to the general public will remain below the established limits.

Precautionary mitigation measures against possible adverse health risks to employees associated with exposure to EMF generated by the Transmission Line include identifying
potential exposure levels, using personal monitors, training, and establishing and identifying safety zones. BR Power will also implement action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations.

**Accidents and Other Hazards**

During construction and rehabilitation activities, health and safety at the site are considered primarily in terms of accident occurrence (direct and indirect) to workers on-site, pedestrians, and machine operators or passengers, and exposure to hazardous substances or dangerous situations. A safety specialist will be responsible for the preparation, implementation and maintenance of a comprehensive safety program, which will be periodically evaluated. Public safety measures including access restriction and installation of warning signs will be instituted. Employees will receive training about occupational health and safety procedures and provided with appropriate personal protective equipment. A Protection Plan will be implemented to decrease the risk of accidental falls from elevated heights, and only trained employees will be allowed to handle hazardous chemicals such as pesticides and herbicides. Access to a nearby first aid facility will be provided and a driver and an ambulance will be made available should there be a need to transport patients to another location.

**Traffic and Road Network**

Increase in use of established road network during construction may result in deterioration of road surfaces due to increased wear and tear. Thus any damage sustained due to project activities will be repaired. In addition increased traffic on road networks may result in inconvenience to motorists and increased risk of accidents. Mitigation measures will include Traffic Control Plan to minimize these negative effects.

**SOCIO-ECONOMIC IMPACTS**

**Residences and Public Infrastructure**

**Land Use**

Clearing for the construction work areas at tower locations and access roads will result in
minimal change of land use including interference and fragmentation of agricultural, residential and forested land since the Project is being implemented in a previously established utilities RoW. The proposed Transmission Line will have less of an impact on land use than a newly established corridor. Land clearing will be limited to the tower locations, access points, and material storage areas thus decreasing any resulting negative impact on land use.

**Cultural Heritage**

Damage to such cultural resources constitutes a threat to social cohesion and would ferment anger and dissatisfaction against the Project. Avoiding cultural resources during planning stages, performing field surveys and ensuring community participation in the decision making process help mitigate the impact of the Project on cultural resources. Many graves and even family/community graveyards were found within the existing LEC RoW. Based on field surveys, no cultural or archaeological resources were identified in the proposed transmission line corridor. LEC will implement, in accordance with IFC Performance Standard 8, its Chance Find Procedures in the event that previously unreported and unanticipated cultural resources are found during construction and operations of the transmission line.

**Impacts on Economic Activity**

In the short term there will be an increase in employment opportunities during construction activities which would provide job opportunities for local unskilled labor. Ensuring a high rate of local employment will improve the economic status of local inhabitants and help foster a sense of good will towards the Project.

**Occupational Health and Safety**

The main occupational hazards during the construction and operation phases of the Project include physical, chemical, and radiological hazards. Physical hazards include falls, electrical equipment, dust, noise, and heat. Potential chemical hazards consist of fumes and fire, and radiological hazards include electric and magnetic fields.

Employee risk from electrocution will be mitigated using prevention and control methods
including training (and ensuring that only qualified employees install and repair electrical equipment), correct insulation during Transmission Line-wire work, and ensuring that all electrical safety precautions are adhered to.

The Project will be constructed and operated in a manner which will eliminate, control, or minimize occupational hazards which could impact employee health and safety. A Health and Safety Plan will be developed and implemented to ensure compliance with the Ministry of Health Guideline for Occupational Health and Safety and the IFC guidelines.

**MANAGEMENT & MONITORING**

Table 1 presents a summary of the proposed mitigation measures for the potential environmental and social impacts arising from the implementation of the 66 kV transmission line project. As for the cost of the mitigation, it will be allocated as such:

- During the design phase, mitigation cost will be included in the final design preparation;
- During the construction phase, mitigation cost will be included with construction costs;
- During operation, mitigation costs will be part of the operation costs.

The schedule of implementation of the mitigation measures will be consistent with the project execution phases.

A summary of the monitoring parameters with corresponding location, and frequency is presented in Table 2 and Table 3.
<table>
<thead>
<tr>
<th>RECEPTOR</th>
<th>MITIGATION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATURAL ENVIRONMENT</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Water | • Cover open stockpiles of construction materials on site with tarpaulin or similar fabric during rainstorm events to prevent the washing away of construction materials  
• Compact earthworks as soon as the final surfaces are formed to prevent erosion especially during the wet season  
• Follow guidelines and procedures for immediate cleanup of spillage of oil, fuel or chemicals  
• Install natural or synthetic liners beneath chemical storage tanks  
• Use Oil and Bar traps  
• Install sediment and erosion controls |
| Soil | • Grade unpaved roads  
• Schedule construction/ rehabilitation to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical  
• Install natural or synthetic liners beneath chemical storage tanks  
• Use non-toxic and readily biodegradable chemicals on-site whenever possible  
• Install sediment and erosion controls |
| Landscape and Visual Intrusion | • Prohibit the parking of construction equipment, construction materials, and transport vehicles outside the fenced boundary of the material storage area |
| Terrestrial Habitat Alteration | • Select right-of ways to avoid important natural areas such as wild lands and sensitive habitats  
• Utilize appropriate clearing techniques (hand clearing vs. mechanized clearing)  
• Maintain low native ground cover beneath lines  
• Replant disturbed sites  
• Manage RoW to maximize wildlife benefits |
| Aquatic Habitat Alteration | • Schedule construction activity to avoid heavy rainfall, where possible  
• Limit use of herbicide to what is strictly necessary and avoid use near watercourses  
• Maintain RMZ |
| Wildlife Species | • No significant impacts expected |
| Collision of Birds with Transmission Lines | • Avoid critical habitats and flight paths where possible  
• Consider use bird diverters on transmission lines, if deemed necessary |
| Hydrocarbons | • Ensure correct storage of fuels and lubricants  
• Use oil traps  
• Carefully fuel/refuel vehicles and machinery |
| Waste and Wastewater | • Use generated construction debris materials for reclamation purposes whenever possible  
• Minimize construction and demolition wastes through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials  
• Sort construction and demolition wastes into various categories and adopting reuse  
• Recycle on site whenever deemed feasible;  
• Segregate chemical wastes and properly storing and disposing of it as hazardous waste  
• Store chemical wastes in a separate area that has an impermeable floor, adequate ventilation and a roof to prevent rainfall from seeping  
• Clearly label all chemical waste in English and Liberian, storing it in corrosion resistant containers and arranging so that incompatible materials are adequately separated  
• Secure a prior agreement with the EPA for the disposal of hazardous waste generated on-site  
• Draft an agreement with the solid waste collector in the county where the
<table>
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<tr>
<th>RECEPTOR</th>
<th>MITIGATION MEASURES</th>
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</thead>
<tbody>
<tr>
<td><strong>Health &amp; Safety</strong></td>
<td></td>
</tr>
</tbody>
</table>
| Air Quality and Dust | • Water surfaces to control dust emissions  
• Cover the road surface with a new material of lower silt content  
• Grade gravel roads  
• On-site mixing and unloading operations  
• Properly handle cement material  
• Maintain minimal traffic speed on-site and on access roads to the site  
• Cover all vehicles hauling materials likely to give off excessive dust emissions  
• Ensure adequate maintenance and repair of construction machinery and vehicles  
• Avoid burning of material resulting from site clearance  
• Cover any excavated dusty materials or stockpile of dusty materials entirely by impervious sheeting  
• Maintain trucks and equipment properly  
• Adopt a traffic management plan while avoiding congested routes  
• Adopt proper maintenance procedures for on-site construction equipment and the use of diesel fuel of acceptable quality  
• Turn off equipment when not in use |
| Noise             | • Effectively utilize material stockpiles and other structures to reduce noise from on-site construction activities  
• Choose inherently quiet equipment  
• Operate only well-maintained mechanical equipment on-site  
• Keep equipment speed as low as possible  
• Shut down or throttle down to a minimum equipment that may be intermittent in use  
• Utilize and properly maintain silencers or mufflers that reduce vibration on construction equipment  
• Restrict access to the site for truck traffic outside of normal construction hours  
• Proper site logistics and planning  
• Limit site working hours if possible  
• Schedule noisy activities during the morning hours  
• Inform the locals when noisy activities are planned  
• Enforce noise monitoring |
| Electrocution      | • Use signs and barriers  
• Disseminate information  
• Ground conducting objects  
• Only allow trained employees to install, maintain or repair electrical equipment  
• Only allow fully trained employees to do live-wire work |
| Electromagnetic Fields | • Site facility to minimize exposure to public  
• Use ICNIRP reference levels to evaluate potential exposure to public  
• Use engineering techniques to decrease exposure to public  
• Train employees to identify EMF levels and hazards  
• Develop action plan to address exposure levels that exceed reference occupational limits |
| Aircraft Safety    | • Avoid siting of transmission line at known flight paths  
• Consult with air traffic authorities prior to installation |
<p>| HIV/AIDS and other | • Provide surveillance and active screening |</p>
<table>
<thead>
<tr>
<th>RECEPTOR</th>
<th>MITIGATION MEASURES</th>
</tr>
</thead>
</table>
| STD’s as well as Ebola        | • Conduct health awareness initiative  
|                               | • Provide health care to employees                                                                                                                             |
| Accidents and other Hazards   | • Provide a safety specialist responsible for the preparation, implementation and maintenance of a comprehensive safety program  
|                               | • Provide nearby first aid facility  
|                               | • Restrict access to the camp sites by proper fencing  
|                               | • Provide guards on entrances and exits to the site  
|                               | • Install warning signs at the entrance of the site to prohibit public access  
|                               | • Train employees on the fundamentals of occupational health and safety procedures  
|                               | • Provide appropriate personal protective equipment (PPE) (impermeable latex gloves, working overalls, safety boots, safety helmets, hearing protection)  
|                               | • Ensure that the protective material is being used wherever it is required  
|                               | • Ensure that especially sensitive or dangerous areas (like areas exposed to high noise levels and areas for especially hazardous work etc.) are clearly designated  
|                               | • Ensure all maintenance work necessary for keeping machines and other equipment in a good state will be regularly carried out  
|                               | • Ensure that the workers are qualified, well trained and instructed in handling their equipment, including health protection equipment  
|                               | • Provide adequate loading and off-loading space  
|                               | • Develop an emergency response plan  
|                               | • Provide appropriate lighting should night-time works take place  
|                               | • Implement speed limits for trucks entering and exiting the site  
|                               | • Ensure hazardous substances are being kept in suitable, safe, adequately marked and locked storing places  
|                               | • Ensure containers of hazardous substances are clearly marked, and that material safety data sheets are available  
|                               | • Ensure workers dealing with hazardous substances are adequately informed about the risks, trained in handling those materials, and trained in first aid measures to be taken in the case of an accident  
|                               | • Designate an area where contaminated materials and hazardous waste can be stored for proper disposal according to environmental guidelines  
|                               | • Implement a fall protection program and materials  
|                               | • Eliminate pools of stagnant water, which could serve as breeding places for mosquitoes  
|                               | • Train personnel for correct mode of application of pesticides  
|                               | • Ensure hygiene practices are followed to avoid family exposure to pesticide residue  
|                               | • Select biodegradable pesticides whenever possible  
|                               | • Provide firefighting equipment such as dry powder extinguishers  
|                               | • Conduct fire fighting and leak checks training drills for the construction staff  
|                               | • Prohibit smoking as well as litter or weed build up in the area as these may pose fire risks  |
| Socio-Economic Impacts        |                                                                                                                                                                                                                    |
| Housing                       | • Locate Project away from areas with high density housing wherever possible;  
|                               | • Utilize alternative siting, and designs to reduce land and RoW width requirements to minimize housing impacts  
|                               | • Perform field survey and public consultation  |
| Land Acquisition and resettlement | • Locate Project to avoid important areas of human activity where possible;  
|                               | • Utilize alternative designs to reduce land and RoW width requirements and minimize impacts  
|                               | • Work with GOL on any resettlement issues as required  |
| Public Infrastructure and Services | • Locate the Project to avoid areas of commercial activity where possible  
|                               | • Utilize alternative designs to reduce land and RoW width requirements and minimize impacts  |
### Table 2 Summary of Monitoring Activities during Construction Phase

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>Monitoring means</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Air quality</strong></td>
<td>Construction site and selected receptors</td>
<td>Visual inspection</td>
<td>Continuous</td>
</tr>
<tr>
<td><strong>Noise levels</strong></td>
<td>Construction site and selected receptors</td>
<td>Inspection and measurement of noise level (Leq) at selected receptors</td>
<td>As needed</td>
</tr>
<tr>
<td><strong>Solid Waste Generation and Disposal</strong></td>
<td>Construction site Disposal site</td>
<td>Visual inspection and photographic documentation</td>
<td>Continuous</td>
</tr>
<tr>
<td><strong>Surface water</strong></td>
<td>At nearby surface water body</td>
<td>Visual Inspection</td>
<td>As Needed</td>
</tr>
<tr>
<td><strong>Soil Quality</strong></td>
<td>At construction site</td>
<td>Visual inspection of soil surfaces.</td>
<td>As Needed</td>
</tr>
<tr>
<td><strong>Biological Environment</strong></td>
<td>Project site and surrounding areas</td>
<td>Occurrence of key species at start of the project and initiate annual follow-up</td>
<td>Prior to and upon completion of construction activities</td>
</tr>
<tr>
<td><strong>Traffic</strong></td>
<td>Construction site and nearby road network</td>
<td>Inspection</td>
<td>Upon complaints</td>
</tr>
<tr>
<td><strong>Health and safety</strong></td>
<td>Project site</td>
<td>Visual inspection, photographic documentation, review of records</td>
<td>Continuous Daily</td>
</tr>
</tbody>
</table>
### Executive Summary

**Socio-economic**
- Project site and surrounding areas
- Jobs created for local people
- The effectiveness of acquisition procedure and of compensation disbursement
- Continuous

**Land resources**
- Along the constructed line
- Visual inspection
- As the line is being constructed

**Physical cultural resources**
- All vulnerable sites adjacent to project
- Disturbance of known sites
- Document chance findings
- Annually

### Table 3 Summary of Monitoring Activities during Operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>Monitoring means</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land resources</td>
<td>Along the constructed line</td>
<td>Visual inspection</td>
<td>Annually</td>
</tr>
<tr>
<td>Noise levels</td>
<td>Constructed line</td>
<td>Inspection and measurement of noise level upon complaints</td>
<td>As Needed</td>
</tr>
<tr>
<td>Biological Environment</td>
<td>Project site and surrounding areas</td>
<td>Presence of key species</td>
<td>Annually</td>
</tr>
<tr>
<td>Community health and safety</td>
<td>Project site and surrounding areas</td>
<td>Visual inspection, photographic documentation and review of records</td>
<td>Biannually</td>
</tr>
<tr>
<td>Occupational health and safety</td>
<td>Project Operation and maintenance sites</td>
<td>Visual inspection, photographic documentation and review of records</td>
<td>Continuous</td>
</tr>
<tr>
<td>Avian traffic</td>
<td>Constructed lines</td>
<td>Inspection</td>
<td>Continuous</td>
</tr>
</tbody>
</table>
| Socio-economic                 | Project site and surrounding areas    | Jobs created for local people
|                                | Increased production in sectors and added industries from project implementation | Continuous   |
1 INTRODUCTION

1.1 BACKGROUND

This document presents the Environmental and Social Impact Assessment (ESIA) for the rehabilitation and expansion of 56 kilometer (km) 66 kilovolt (kV) single circuit electrical transmission line between Paynesville and Kakata, also referred to as Paynesville-Kakata Electricity Transmission Line. The Project proponent is Liberia Electricity Corporation (LEC), a 100% public enterprise owned by the Government of Liberia established in 1973 with the sole provision of producing electrical energy and distributing it throughout Liberia. The transmission line will be re-installed within the Government of Liberia (GOL)-LEC existing right-of-way (RoW) - along the Kakata-Monrovia Highway- to LEC’s Paynesville substation.

The Paynesville-Kakata Electricity Transmission Line is a component of the World Bank-financed Liberia Accelerated Electricity Expansion Project (LACEEP). The project scope under LACEEP includes activities related to a) rehabilitation and expansion of transmission and distribution networks, and b) rehabilitation of facilities for off-loading, transport and storage of heavy fuel oil (HFO). The LACEEP will also finance the construction of facilities to offload and pump HFO from sea tankers with capacity in the range of 30,000 – 40,000 tons, in order to minimize unit price of freight.

LEC selected Earthtime Inc. to develop the ESIA to international standards (specifically those of the World Bank Safeguard Policies and World Bank Group Environmental, Health and Safety Guidelines of April 2007) to ensure that potential environmental and social impacts associated with the development of the Project are identified, assessed and managed appropriately.

1.2 THE ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

In accordance with the Environmental Protection and Management Law of The Republic of Liberia (November 26, 2002) and the World Bank’s Safeguard Policies - the international lending organization – the Liberia Electricity Corporation (LEC) is undertaking the Environmental and Social Impact Assessment (ESIA) for the Project. The main objective of
this ESIA is to ensure that the potential impacts from the construction, operation and decommissioning of the 56 km 66 kV electrical transmission are identified, their significance is assessed, and appropriate mitigation measures are proposed to minimize or eliminate such impacts during a reasonable timeframe, taking into consideration the investment which has to be made.

This ESIA/ESMP seeks to meet the following objectives:

- Ensure compliance with the local laws and regulations;
- Ensure compliance with the requirements of the funding agency;
- Determine the compatibility of the proposed Project with the surrounding environment;
- Generate baseline data that will be used to monitor and evaluate the mitigation measures implemented during the Project cycle;
- Identify and assess environmental and social impacts, both adverse and beneficial in the Projects’ area of influence;
- Evaluate and select the best Project alternative from the various options;
- Manage by avoiding or at least minimizing potential environmental impacts and risks on the surrounding population and environment within acceptable limits;
- Assist decision makers in protecting, conserving and managing the surrounding environment as well as affected communities according to the principles of sustainable development;
- Incorporate environmental management plans and monitoring mechanisms during construction and operation phases of Project development;
- Assure open and balanced process through public information and consultation, by promoting improved social and environmental performance of LEC.

All projects and activities identified in Annex I of the Environmental Protection and Management Law of Liberia (the Law) are required to conduct an environmental impact assessment. This ESIA has been developed in accordance with Section 8 of the Law, dated November 26, 2002 and the Republic of Liberia Environmental Protection Agency Environmental Impact Assessment Procedural Guidelines, dated 2006.
The ESIA was also prepared in accordance with the International Finance Corporation (IFC) Environmental, Health, and Safety General Guidelines (April 2007), the Electric Power Transmission and Distribution Industry Specific Guidelines (April 2007), and Performance Standards 1 through 8 (April 2006).

1.3 THE PURPOSE AND NEED FOR THE PROJECT

The proposed transmission line is an important component in the revitalization of Liberia, a country desperately attempting to rebuild its infrastructure, rehabilitate its economy, attract investment, and improve the livelihood of its citizens following years of civil unrest and civil conflict. The Liberian government is taking great strides to develop strategies and policies to promote sustainable development and sound environmental management. Infrastructure constraints or non-availability of power, water, and communications services are major impediments to economic recovery and growth.

Achieving a reliable and environmentally sound supply of electrical energy is central to sustainable development that the GOL is endeavoring to promote and develop. Improvements made in the energy sector will be instrumental in:

- Establishing a major infrastructure component for the supply of vitally needed electricity;
- Improving health and sanitation;
- Reducing poverty and hunger;
- Establishing employment, training, human resource development, and technology transfer opportunities;
- Increasing earning potential;
- Enabling industrial and commercial growth;
- Encouraging community and rural developments; and
- Contributing to the national treasury through tax payments.

Liberia’s pre-war installed electrical generating capacity was greater than 300 MW (LEC and privately-owned generation), of which about 70 MW was from two main hydropower stations. Current capacity from LEC and the Firestone power plants is about 30 MW, in addition to capacity from private diesel units. This is drastically short of the pre-conflict
power demand in Monrovia alone.

Increasing population and demand for fuel wood (firewood) and charcoal place great pressure on environmental resources. Threatened are biodiversity and forests given the unsustainable manner in which these traditional fuels are produced.

Improvements in the energy sector will play a crucial role in stabilizing and developing the social and economic welfare of the country and its people. Energy is central to reducing poverty and hunger, improving health, and increasing literacy and education. Insufficient and unreliable electricity sources will further inhibit economic growth and foreign investment. The proposed Project will create substantial improvements in the country’s energy transmission in addition to the power produced at the power plant, and will provide positive socioeconomic benefits through the creation of jobs, and education and training programs.

1.4 REPORT FORMAT

The current draft ESIA report is divided into nine sections which are summarized below:

Section 1 – Introduction

This section provides a brief description of Project background, the objectives of the ESIA, and the scope and organization of the study and format of this report.

Section 2 – Legal and Administrative Framework, and World Bank Safeguard Policies

This section provides information on policy, legal and administrative framework applicable to the Project. The section defines major legal provisions required for the Project.

Section 3 – Project Description & Alternatives

This section presents a detailed description of the Project components, the various phases of the Project including the mobilization, construction, operation, and decommissioning, and the workforce required. This section also presents the alternatives evaluated to determine if there was a preferable alternative to the proposed action. The alternatives considered included the fuel supply alternatives, decontamination alternatives, and no-action alternative.
Section 4 – Baseline Environmental Status

This section presents the methodology and findings of field studies undertaken with respect to geology; hydrology; meteorology; quality of ambient air, surface and groundwater, soils, sediments, noise levels; ecology; land use; and socioeconomics that define the existing environmental conditions of the Project area.

Section 5– Impact Assessment and Identification

This section identifies and discusses the potential environmental and socioeconomic impacts of the proposed transmission line Project, including temporary construction areas located outside of the transmission line corridor. This discussion will form the basis for the environmental management plan.

Section 6 – Mitigation Measures

This section identifies the mitigation measures to minimize, or eliminate the negative environmental impacts due to the construction and operation of the transmission line.

Section 7 – Environmental Management and Monitoring Plan

This section outlines the Environmental Management and Monitoring Plan (EMMP), taking into consideration identified impacts and mitigation measures, monitoring program, and the proposed organizational structure for the operational phase.

Section 8 – Public Consultation

This section presents the results of concerns, suggestions and other findings during consultation with people that could be affected by the Project’s activities, together with appropriate regulations and requirements.
2 LEGISLATIVE AND INSTITUTIONAL FRAMEWORK

This Chapter describes the applicable international standards and relevant Liberia regulatory framework that set the context within which the Project will operate. The Environmental Protection Agency (EPA) is the environmental regulatory authority in charge of issuing environmental guidelines and reviewing the Environmental Impact Assessment process.

2.1 LIBERIAN ENVIRONMENTAL ADMINISTRATIVE FRAMEWORK

2.1.1 Government Organization

2.1.1.1 National Government

Liberia’s government comprises popularly-elected executive and legislative branches, the latter being a bicameral National Assembly consisting of the Senate (30 seats with members elected by popular vote to serve nine-year terms) and the House of Representatives (64 seats; members elected by popular vote to serve six-year terms). The country operates a dual system of statutory law based on Anglo-American common law for the modern sector and customary law based on unwritten tribal practices for the indigenous sector.

2.1.1.2 Local Government

Liberia comprises 15 administrative political subdivisions called counties, each headed by a Superintendent and further divided into Districts, each under a District Commissioner. Each District is sub-divided into Chiefdoms headed by a Paramount Chief, and each Chiefdom is divided into Clans headed by Clan Chiefs and towns headed by Town Chiefs. The clan areas were originally related to tribal sub-groupings and whilst this still largely applies, increasing urbanization and civil war has disrupted this pattern and Clans are now defined as administrative units.

2.1.2 Environmental Institutional Framework

2.1.2.1 National Level

2.1.2.1.1 Environmental Protection Agency

The Environmental Protection Agency (EPA) is an autonomous statutory body, established
under the Act creating the Environmental Protection Agency of the Republic of Liberia 2003 (GOL, 2003a), and hereafter referred to as the EPA Act, to address the country’s environmental problems. The EPA became a fully functioning entity in 2006, with the appointment of a board of directors and establishment of a Policy Council.

The EPA was established to “coordinate, monitor, supervise and consult with relevant stakeholders on all activities in the protection of the environment and sustainable use of natural resources” and as the lead national environmental agency is charged with executive authority for all environmental activities and programs relating to environmental management in Liberia. The EPA also has a key responsibility for matters relating to the issuing of an environmental impact assessment license and for compliance monitoring relating to environmental regulations and standards.

2.1.2.1.2 Ministry of Lands Mines and Energy

The Ministry of Lands, Mines and Energy has the statutory responsibility for the development of mineral, water and energy resources in Liberia; it is in charge of land surveys in all parts of the country and coordinates, administers and regulates the use of public and private lands in Liberia, including mineral resources through granting of operation licenses, and regulates beach sand mining. It works along with the Ministry of Agriculture and the University of Liberia to conduct training and research on land rehabilitation. Energy provision is administered through the same Ministry by the National Energy Committee, while water resources are the responsibility of the National Hydrological Service.

2.1.2.1.3 Ministry of Agriculture

The Ministry of Agriculture regulates the forestry as relate to plant quarantine, agro-forestry and food crop related plantations; fishery and agriculture sectors and has specific responsibilities for soil conservation. Some water resource matters used to be managed by the National Water Resources and Sanitation Board prior to the civil war, and proposals have recently been made for its re-establishment. It plans, executes, administers, manages and supervises agriculture programs and provides extension services, trains local farmers in improved cultural practices, and supplies farm inputs to enhance food security.
2.1.2.1.4 Forestry Development Authority

The Forestry Development Authority (FDA), established in 1976, was historically the government agency with primary responsibility for environmental management in Liberia. Now an autonomous body, and mandated by the National Forestry Reform Law of 2006, the FDA has responsibility for the protection, management and conservation of government-owned forests and wildlife on a sustainable basis. It manages commercial, conservation and community uses of Liberia’s forests. It provides long- and middle-range planning in the forestry sector as well as preparing forestry policy, law and administration. It exercises control of the commercial use of state-owned forests through the granting of concessions, supervises adherence to forest legislation and concession agreements, calculates and determines forestry fees, evaluates investment proposals, executes reforestation and forest research and training and monitors activities of timber companies. The 2006 law revised the institutional framework of the FDA and created a Department of Conservation which is made up of the Division of National Parks and the Division of Wildlife with the responsibility for development and management of protected areas and wildlife respectively.

2.1.2.1.5 Ministry of Planning and Economic Affairs

The Ministry of Planning and Economic Affairs (MPEA) is responsible for intersectoral coordination for the development of policies, plans and programs for the economic, financial, social, cultural and physical development of Liberia. In fulfilling its various duties, it serves as the direct link between implementing Ministries/Agencies, NGOs, private voluntary organizations, and the international community. Coordination occurs at the national, sectoral and regional planning levels and also involves the implementation of crosscutting initiatives.

2.1.2.1.6 Liberia Electricity Corporation (LEC)

The Liberia Electricity Corporation was created in 1973 to generate, transmit, distribute, and sell electricity throughout the country at economically reasonable rates. In July 2006, electricity was restored to parts of Monrovia for the first time in fifteen years.

Other governmental institutions with environment-related responsibilities include the

2.1.2.2 Local Level

2.1.2.2.1 County and District Environmental Committees

To decentralize environmental management, the Environmental Protection Agency Act authorizes the establishment of County and District Environmental Committees and directs the National Environmental Policy Council to provide guidelines for their establishment. Each County Committee is composed of county and district officials, traditional leaders, private citizens, and two local representatives to the national legislature. The Committee is staffed by a County Environment Officer, hired by the EPA, but responsible to the County Committee.

The District Environment Committees are to be established by and report to the relevant County Environment Committee. They are charged with promoting environmental awareness and mobilizing the public to manage and monitor activities within the district to ensure that they do not have any significant impact on the environment. The District Committees are composed of district officials, mayors, chiefs, and private citizens and are staffed by a District Environment Officer hired by the EPA.

In addition to assisting the County and District Committees in the fulfillment of their responsibilities, the County and District Environment Officers are responsible for compiling reports to the EPA, promoting environmental awareness, and conducting public hearings on environmental impact assessment in the County and the District.

At present, two County Environmental Committees have been established; One in Sinoe County and another in Nimba County. However, EPA has established outstation offices in eight counties. The offices are staffed by Environmental Inspectors. As the County Environment Committees are established, some of the Inspectors may be reassigned as County Environment Officers.

2.1.3 Environmental Inspectors and Courts

To provide for enforcement of environmental requirements and standards, the
Environmental Protection Agency Act provides for the appointment of Environmental Inspectors and the establishment of an Environmental Court system.

2.1.3.1 Environmental Inspectors

The Act authorizes the EPA to “designate its officers and duly qualified public officers/civil servants ... to be environmental inspectors within such Counties and District limits.” Thus, Environmental Inspectors do not have to be EPA employees, but can also be designated officers or civil servants in other branches of the government. Environmental Inspectors are authorized to enter premises, inspect activities, take samples, and review records to ensure compliance with environmental rules and regulations. The exact nature of the inspector’s enforcement authority is not defined in the Act, but the Act does state that the EPA is to “…establish the conditions, rules and regulations governing the qualifications, performance, powers and duties of the Environmental Inspectors.” The EPML confirms that Environmental Inspectors can write Restoration Orders to correct an activity deemed to be noncompliant with environmental rules and regulations.

2.1.3.2 Environmental Courts

The Environmental Protection Agency Act defines a two-tiered court system to hear and rule on compliance with environmental rules and regulations.

The first tier is the Environmental Administrative Court. This court is to hear and rule on complaints relating to the environment. The complaints may concern the actions or decisions of the EPA or an Environmental Inspector, or may be brought by a member of the public to stop activities they believe are damaging the environment.

The second tier is an Environmental Appeals Court, established at the Judicial Circuit level.

At present, the Environmental Court system has not been formally established. EPA’s five-year strategic plan (starting July 2011) provides for an administrative court to handle environmental issues for an intermediate period before the full establishment of an environmental court under the judicial system.

2.2 LEGISLATIVE FRAMEWORK
Table 2-1 describes the main categories of legislation in Liberia and Table 2-2 and Table 2-3 provide a summary of relevant Liberian environmental legislation and international environmental conventions signed/ratified by the Government of Liberia.

**Table 2-1 Categories of Legislations in Liberia**

<table>
<thead>
<tr>
<th>Law</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laws are passed by the National Legislature of Liberia comprising of the Senate and the House of Representatives. Any citizen or group of citizens, Cabinet Ministers, Managing Directors of public corporations or agencies can propose a bill to the National Legislature for enactment. The draft bill is first passed over to the appropriate Steering Committee of the Legislature. In case of environmental bill, this committee is generally the Committee on Natural Resources and the Environment. The Committee reviews, assesses and presents the bill to the Legislative Plenary with appropriate amendments for debate, public hearing and subsequent enactment by the Legislature.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Executive Order</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Executive Branch of government headed by the President can issue Executive Order without the approval of the National Legislature. The Executive orders have the power of a law provided that they do not contravene the existing law. The power of such orders has a limited time of existence.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Regulations</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The national Legislature has empowered Cabinet Ministers and Managing Directors of public corporations and agencies to issue regulations for their respective functionaries without legislative approval or supervision, provided that such regulations are consistent with the statutory laws and the constitution of Liberia.</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2-2 Relevant Environmental Laws**

<table>
<thead>
<tr>
<th>Title</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conservation of the Forests of the Republic of Liberia</td>
<td>1953</td>
<td>This Law provided the framework for the use of forest and wildlife resources and allowed for the creation of government reserves, native authority reserves, commercial forests, national parks and wildlife refuges.</td>
</tr>
<tr>
<td>Supplementary Act for the Conservation of Forests</td>
<td>1957</td>
<td>This Supplementary Law also provided the framework for the use of forest and wildlife resources and allowed for the creation of government reserves, native authority reserves, commercial forests, national parks and wildlife refuges.</td>
</tr>
<tr>
<td>The Act that created the Forestry Development Authority (FDA)</td>
<td>1976</td>
<td>The Act established and defined the responsibilities of the FDA, outlined forest offences and penalties; made provision for an Advisory Conservation Committee and specified powers of forest officers with regard to trees in reserve areas.</td>
</tr>
<tr>
<td>Public Health Act</td>
<td>1976</td>
<td>It contains provision for the protection of drinking water resources and the inspection of potential sources of pollution.</td>
</tr>
<tr>
<td>The Natural Resources Law of Liberia</td>
<td>1979</td>
<td>This Law includes chapters on forests, fish, and wildlife, soil, water, and minerals.</td>
</tr>
<tr>
<td>Wildlife and National Parks Act</td>
<td>1988</td>
<td>The Act identifies a number of protected areas; specifies policies and objectives regarding wildlife and conservation in the country.</td>
</tr>
<tr>
<td>The Environment Protection Agency (EPA) Act</td>
<td>2002</td>
<td>The Act provides the Agency with the authority of government for the protection and management of the environment in Liberia. It provides for an Environmental Administrative Court to hear from aggrieved parties. It requires that an Environmental Impact Assessment (EIA) be carried out for all activities and projects likely to have an adverse impact on the environment.</td>
</tr>
<tr>
<td>Title</td>
<td>Year</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>The Environment Protection and Management Law</td>
<td>2002</td>
<td>The Act enables the Environment Protection Agency to protect the environment through the implementation of the Law. It arranges the rules, regulations, and procedures for the conduct of EIA. It establishes regulations for environmental quality standards, pollution control and licensing, among others.</td>
</tr>
<tr>
<td>The National Environmental Policy Act</td>
<td>2002</td>
<td>It defines policies, goals, objectives, and principles of sustainable development and improvement of the physical environment, quality of life of the people and ensures coordination between economic development and growth with sustainable management of natural resources.</td>
</tr>
<tr>
<td>National New Forestry Reform Law</td>
<td>2006</td>
<td>The administration of this Act provides for the Forestry Development Authority to exercise the power under the Law to assure sustainable management of the Republic’s forestland, conservation of the forest resources, protection of the environment, sustainable economic development with the participation of and for the benefit of all Liberians and to contribute to poverty alleviation in the country.</td>
</tr>
</tbody>
</table>

Table 2-3 International Environmental Conventions Signed/Ratified by the Government of Liberia

<table>
<thead>
<tr>
<th>Convention</th>
<th>Status</th>
<th>Year</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>African Convention on Conservation of Nature and Natural Resources</td>
<td>Ratified</td>
<td>NA</td>
<td>To encourage individual and joint action for the conservation</td>
</tr>
<tr>
<td>Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES)</td>
<td>Ratified</td>
<td>1981</td>
<td>To prevent trade of endangered or threatened species</td>
</tr>
<tr>
<td>Convention Concerning the Protection of the World Cultural and Natural Heritage</td>
<td>Signed</td>
<td>2002</td>
<td>To recognize and protect cultural and natural heritage for future generations</td>
</tr>
</tbody>
</table>
| Framework Convention on Climate Change and the Kyoto Protocol             | Signed   | 2002 | ● To achieve stabilization of green house gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climatic system  
  ● To strengthen the commitment of developed country parties with a view to reduce their overall emissions |
| Stockholm Convention on Persistent Organic Pollutants (POP)             | Signed   | 2002 | ● To strengthen National Capacity and to enhance knowledge and understanding Amongst decision makers, managers, industry and the public at large on POPs  
  ● To develop a National implementation Plan (NIP) to manage the elimination of POPs. |
| Ramsar Convention on Wetlands of International Importance                 | Signed   | 2003 | ● To manage wetland systems so that the human uses of these areas are undertaken in such a way as to retain their natural capital for future generations.  
  ● To encourage and support countries to develop and implement national policy and legislative frameworks, education and awareness raising programs, as well as inventory, research and training projects. |
  ● Sustainable use of its components.  
  ● Fair and equitable sharing arising out of the utilization of genetic resources. |
<table>
<thead>
<tr>
<th>Convention</th>
<th>Status</th>
<th>Year</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convention on the Conservation of Migratory Species of Wild Animals</td>
<td>Ratified</td>
<td>2004</td>
<td>Aims to conserve terrestrial, marine and avian migratory species throughout their range</td>
</tr>
<tr>
<td>The Cartagena Protocol on Biosafety</td>
<td>Ratified</td>
<td>2003</td>
<td>To contribute to ensuring an adequate protection in the field of living modified organisms resulting from modern biotechnology</td>
</tr>
<tr>
<td>Convention on Desertification</td>
<td>Signed</td>
<td>1998</td>
<td>To combat desertification and mitigates the effect of drought in countries experiencing serious droughts and/or desertification</td>
</tr>
<tr>
<td>International Tropical Timber Agreement</td>
<td>Ratified</td>
<td>2008</td>
<td>Requires sustainable management of timber resource base, simultaneously encouraging the timber trade and the improved management of the forests</td>
</tr>
<tr>
<td>Vienna Convention for the Protection of the Ozone Layer</td>
<td>Signed</td>
<td>1996</td>
<td>States agreed to cooperate in scientific research on the ozone problem, to exchange information, and to adopt “appropriate measures” to prevent activities that harm the ozone layer. The obligations are general and contain no specific limits on chemicals that deplete the ozone layer.</td>
</tr>
<tr>
<td>Montréal Protocol on Substances that Deplete the Ozone Layer</td>
<td>Signed</td>
<td>1996</td>
<td>A protocol to the Vienna Convention for the Protection of the Ozone Layer, it is designed to protect the ozone layer by phasing out the production of numerous substances believed to be responsible for ozone depletion</td>
</tr>
<tr>
<td>International Covenant on Economic, Social and Cultural Rights</td>
<td>Ratified</td>
<td>2004</td>
<td>ICESCR commits to work toward the granting of economic, social, and cultural rights to individuals, including labor rights and rights to health, education, and an adequate standard of living. ICESCR is part of the International Bill of Human Rights, along with the Universal Declaration of Human Rights (UDHR) and the International Covenant on Civil and Political Rights (ICCPR)</td>
</tr>
</tbody>
</table>

### 2.2.1 Constitution of the Republic of Liberia

Article 7 of the 1986 Constitution of the Republic of Liberia sets the fundamental basis for the constitutional, legislative, and institutional frameworks for the protection and management of the environment. It also encourages public participation in the protection and management of the environment and the natural resources in Liberia.

### 2.2.2 The Environmental Protection Agency Act

“An Act to establish a monitoring, coordinating and supervisory authority for the sustainable management of the environment in partnership with regulated Ministries and organizations and in a close and responsive relationship with the people of Liberia; and to
provide high quality information and advice on the state of the environment and for matters connected therewith”.¹

Thus, the Environment Protection Agency of Liberia (EPA) was created by the Act creating the Environment Protection Agency of the Republic of Liberia, known as the Environment Protection Agency Act. The Act was approved on November 26, 2002 and published on April 30, 2003. The establishment of the EPA marked a significant step forward in the protection and management of the environment of Liberia.

Section 5 of the Act designates the EPA as the principal Liberian authority for environmental management which shall co-ordinate, monitor, supervise, and consult with relevant stakeholders on all the activities for environmental protection and the sustainable use of natural resources. Section 6 (b) of the Act stipulates that the EPA should propose environmental policies and strategies to the Policy Council and ensure the integration of environmental concerns in the overall national planning. Moreover, the EPA is empowered to carry out, among other things, the following aspects of environmental protection and management in Liberia:

- Establish environmental criteria, guidelines, specifications, and standards for production processes and the sustainable use of natural resources for the health and welfare of the present generation, and in order to prevent environmental degradation for the welfare of the future generations;
- Identify projects, activities, and programs for which environmental impact assessment must be conducted under this Law
- Review and approve environmental impact statements and environmental impact assessment submitted in accordance with this Act;
- Monitor and assess projects, programs, and policies including activities being carried out by relevant ministries and bodies to ensure that the environment is not degraded by such activities and that environmental management objectives are adhered to and adequate early warning and monitoring on impending environmental emergencies is given;

• Review sectoral environmental laws and regulations and recommend for amendments and to initiate proposals for the enactment of environmental legislations in accordance with this Act or any other Act;
• Encourage the use of appropriate environmentally sound technologies and renewable sources of energy and natural resources;
• Function as the national clearinghouse for all activities relating to regional and international environment-related conventions, treaties and agreements, and as national liaison with the secretariat for all such regional and international instruments.

2.2.3 Act Adopting the Environment Protection and Management Law of the Republic of Liberia

“An Act to establish a legal framework for the sustainable development, management and protection of the environment by the Environment Protection Agency in partnership with regulated Ministries and organizations and in a close and responsive relationship with the people of Liberia; and to provide high quality information and advice on the state of the environment and for matters connected therewith”.2

Section 15 of the EMPL states that business investors should present an environmental mitigation plan to the EPA, which should include the following sections:

• Objectives
• Description of activities to be carried out by the project to mitigate any adverse effects on the environment
• Period within which the mitigation measures shall be implemented
• Proven efficacy of the mitigation measures of indicating their experimental nature

Section 12 of the EPML requires environmental review for projects or activities that may have significant impact on the environment. The project proponent shall submit to the EPA their plans for improving environmental performance including:

• Identification of the major environmental effects; and
• A comprehensive mitigation plan in accordance with section 15 of this Law.

Section 6 of EPML requires an Environmental Impact Assessment license or permit for the commencement of such projects, and Section 13 requires the preparation of an environmental impact study for such a project.

Section 24 of the EPML requires that the EPA should ensure that projects comply with their environmental mitigation plan through monitoring of its operations. Where evidence of non-compliance occurs, the EPA shall impose remedial measures and may bring action before the Environmental Court or through the Ministry of Justice to enforce compliance.

Section 25 of the EPML gives responsibility to the EPA carrying out periodic environmental audit of activities or projects that are likely to have adverse effects on the environment.

Section 58 of the EPML requires that a license must be obtained from the EPA for any type of effluent discharge into the sewage system, also in case of operation of a sewage system. This license is provided by the EPA for a period that does not exceed 1 year.

Section 61 of the EPML prohibits pollution of all Liberian Waters. In case of water pollution, a sentence and/or a fine is/are imposed on the polluting party. The latter is also responsible for the cost of the removal of the pollutant and the restoration, restitution or compensation as determined by a law court.

Section 62 of the EPML bans pollution by solid waste of any land, coastal zone or water surface, street, road or site in or on any place to which the public has access, except in a container or at a place which has been specially indicated, provided or set apart for such purpose. In case of such pollution, a fine or a prison term is imposed on the polluting party. The latter is also responsible for the clean-up of the solid waste pollution it caused.

Section 64 of the EPML requires the acquirement of a “Solid and Hazardous Waste Disposal License” in case of generation, storage, handling, transport or disposal of hazardous waste, or else ownership or operation of a waste disposal site. The EPA provides this license for a period of not more than one year. This license entails the party who is generating the waste to take up waste management measures such as treatment, determination or recycling and
re-remediation.

Section 71 of the EPML requires the acquirement of a “Pollution Emission License” for any project or activity which is likely to pollute the environment in excess of any standards or guidelines issued under the EPML. This license is provided by the EPA for a period of not more than one year.

Section 75 of the EPML prohibits the below activities in relation with a river, lake or wetland that are declared as protected areas by the EPA. These activities include:

- Use, erect, construct, place, alter, extend, remove or demolish any structure in, on, under, or over the bed;
- Excavate, drill, tunnel or disturb the bed otherwise;
- Introduce or plant any part of a plant, plant specimen or organism whether alien or indigenous, dead or alive in a river, lake or wetland;
- Introduce any animal or micro-organism whether alien or indigenous, dead or alive in a river, lake or wetland;
- Deposit any substance in a river, lake, or wetland or in or under its bed, which is likely to have adverse environmental effects on the river, lake or wetland;
- Direct or block a river, lake or wetland from its natural and normal course; and
- Drain any river, lake or wetland.

Section 91 of the EPML, states that the EPA may impose on the party that has caused or is likely to cause harm to the environment an “Environmental Restoration Order” requiring it to remedy/prevent the harm within 21 days of the service of the order. Section 92 allows the party to request the Agency to reconsider that order by giving reasons in writing within the same period. Section 107 states that non compliance with the restoration order convicts the responsible party to imprisonment and/or a fine.

2.2.4 National Energy Policy

In February 2007, the GOL, through the Ministry of Lands, Mines and Energy (MLME), with the support of the United States Agency for International Development (USAID) published the National Energy Policy (NEP). The principal objective of the NEP is to ensure universal access to modern energy services in an affordable, sustainable and environmentally-friendly
manner in order to foster the economic, political, and social development of Liberia.

The NEP recognizes the fact that energy is essential towards GOL Poverty Reduction Strategy (PRS) and the achievement of the Millennium Development Goals (MDGs).

The NEP assumes the implementation of proposed energy sector reforms founded on three essential features: (1) demonstrating the Government’s resolve for good governance and ensuring financial transparency in all sector transactions; (2) overcoming the significant obstacles to private sector investment in energy supply; and (3) creating the requisite institutional and legal framework and an independent regulatory regime. In undertaking energy sector reform, the Government will also be addressing a key component of Liberia’s commitment to the World Bank and other donors for debt relief under the program for Highly Indebted Poor Countries.

2.2.4.1 Key Policy Issues

The NEP addresses the following strategic issues that are implied in the principal policy objective – access, quality, cost, and institutional framework. These issues refer to the need for the various technologies and delivery options for energy products and services to be available, acceptable, affordable, and adequate.

2.2.5 National Environmental and Occupational Health Policy

The Ministry of Health and Social Welfare has a Division of Environmental and Occupation Health; however, the Division lacks standards and policies specific to industries and/or occupational hazards. The National Environmental and Occupational Health Policy (NEOHP) was developed in 2007 to provide a framework for identifying policy needs and actions to improve occupational health and safety. It supplements the National Health Policy (Table 2-4), which focuses on public health and health systems. The NEOHP identified the following key Environmental and occupational health needs:

1. Environmental sanitation
2. Food Safety Services
3. Water Quality and Safety
4. Vector Control & Chemical Safety
5. Waste Management
6. Disaster Management
7. Health Promotion
8. Occupational Health Services
9. Port Health
10. Pollution Control
11. Sanitary Engineering

Table 2-4 Additional Safety, Health and Welfare Laws

<table>
<thead>
<tr>
<th>Title</th>
<th>Year</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Health Law</td>
<td>1976</td>
<td>This Law provides a framework for the management of public health and health systems in Liberia. The 1976 Law is currently being updated in order to effectively govern the decentralized health sector and accommodate the changes that have taken place since its promulgation. For example, in 2010 a new chapter was added to the Law to manage HIV / AIDS.3</td>
</tr>
<tr>
<td>National Health Policy and National Health Plan4</td>
<td>2007</td>
<td>The document is a framework for health sector reforms in Liberia. The goal of the policy is to make health care delivery services throughout the country effective and efficient, thereby enhancing the quality of life of the population.</td>
</tr>
</tbody>
</table>

2.2.6 Additional Safety, Health and Welfare Laws

Other important safety, health and welfare legislation that may apply generally (not specifically to workers) to E&P activities in Liberia include the Public Health Law and the National Health Policy and National Health Plan. These are summarized in Table 2-4.

2.2.7 Liberia Land Commission Act of 2009

The objective of this act is to propose, advocate and coordinate reforms of land policy, laws and programs in Liberia. It does not have adjudatory or implementation role. The goal of the commission is “to develop comprehensive national land tenure and land use system that will provide equitable access to land and security of tenure so as to facilitate inclusive sustained growth and development, ensure peace and security and provide sustainable management of the environment”5.

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2.3 LIBERIAN ENVIRONMENTAL QUALITY STANDARDS

Several environmental quality standards are partly prepared by EPA. Some of these environmental quality standards are: 1) Air Quality Standards; 2) Water Quality Standards; 3) Noise Level Standards; and 4) Waste Management Standards.

Air quality standards are not complete for ambient air. Existing ambient air quality Standards are given in Table 2-5.

Water quality standards are only completed only for the marine waters. Drinking, domestic, industrial, agricultural and other types of water standards are still incomplete. However the Ministry of Health Water Testing Laboratory uses the drinking water standards presented in Table 2-6.

Noise level standards are complete for many environments. Relevant noise standards are presented in Table 2-7, Table 2-8, and Table 2-9. Other noise standards can be found in the Environment Protection and Management Law- Noise Pollution Control and Standards Regulations, 2009.

Table 2-5 Ambient Air Quality Tolerance Limits (Environment Protection and Management Law- Air Quality & Standards Regulations, 2009)

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Time weighted Average</th>
<th>Industrial area</th>
<th>Residential, Rural &amp; Other area</th>
<th>Controlled areas***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur oxides (SOX)</td>
<td>Annual Average*</td>
<td>80 μg/m³</td>
<td>60 μg/m³</td>
<td>15 μg/m³</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>120 μg/m³</td>
<td>80 μg/m³</td>
<td>30 μg/m³</td>
</tr>
<tr>
<td></td>
<td>Annual Average</td>
<td></td>
<td>0.019 ppm/50 μg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Month Average</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 Hours</td>
<td></td>
<td>0.048 ppm /125 μg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Hour</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant Peak</td>
<td></td>
<td>500 μg/m³</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant Peak (10 min)</td>
<td></td>
<td>0.191 ppm</td>
<td></td>
</tr>
<tr>
<td>Oxides of Nitrogen (NOX)</td>
<td>Annual Average*</td>
<td>80 μg/m³</td>
<td>60 μg/m³</td>
<td>15 μg/m³</td>
</tr>
<tr>
<td></td>
<td>24 hours**</td>
<td>120 μg/m³</td>
<td>80 μg/m³</td>
<td>30 μg/m³</td>
</tr>
<tr>
<td></td>
<td>8 hours</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Annual Average</td>
<td></td>
<td>0.2 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Month Average</td>
<td></td>
<td>0.3 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>24 Hours</td>
<td></td>
<td>0.4 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>One Hour</td>
<td></td>
<td>0.8 ppm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Instant Peak</td>
<td></td>
<td>1.4 ppm</td>
<td></td>
</tr>
</tbody>
</table>
### Table 2-6 Liberian Drinking Water Quality Standards (Ministry of Health and Social Welfare)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>WHO</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-logH</td>
<td>-</td>
<td>6.5 - 8.0</td>
<td>6.0 - 9.0</td>
<td>5.5 - 9.0</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg Cl/l</td>
<td>350</td>
<td>≤ 250.0</td>
<td>≤ 350.0</td>
<td>≤ 450.0</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg SO4/l</td>
<td>250</td>
<td>≤ 150.0</td>
<td>≤ 200.0</td>
<td>≤ 250.0</td>
</tr>
<tr>
<td>Hardness</td>
<td>CaCO3: mg/l</td>
<td>100-500</td>
<td>≤ 190.0</td>
<td>≤ 300.0</td>
<td>≤ 600.0</td>
</tr>
<tr>
<td>Iron Total</td>
<td>Fe mg/l</td>
<td>0.1</td>
<td>≤ 0.1</td>
<td>≤ 1.5</td>
<td>≤ 2.0</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn mg/l</td>
<td>0.1</td>
<td>≤ 0.1</td>
<td>≤ 0.3</td>
<td>≤ 0.8</td>
</tr>
<tr>
<td>Zinc Total</td>
<td>Zn mg/l</td>
<td>5</td>
<td>≤ 1.0</td>
<td>≤ 2.0</td>
<td>≤ 5.0</td>
</tr>
<tr>
<td>Coliform Bacteria</td>
<td>n/ml</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>≤ 5</td>
</tr>
<tr>
<td>Bacteria Total</td>
<td>n/ml</td>
<td>0</td>
<td>0</td>
<td>≤ 10</td>
<td>≤ 50</td>
</tr>
<tr>
<td>Dissolved Substance</td>
<td>mg/l</td>
<td>500</td>
<td>≤ 500.0</td>
<td>≤ 1000.0</td>
<td>≤ 1200.0</td>
</tr>
<tr>
<td>Suspended Solids</td>
<td>mg/l</td>
<td>-</td>
<td>≤ 10.0</td>
<td>≤ 30.0</td>
<td>≤ 50.0</td>
</tr>
<tr>
<td>Ammonia</td>
<td>mg NH4/l</td>
<td>0.5</td>
<td>≤ 1.0</td>
<td>≤ 3.0</td>
<td>≤ 6.0</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg NO3/l</td>
<td>50</td>
<td>≤ 40.0</td>
<td>≤ 60.0</td>
<td>≤ 80.0</td>
</tr>
</tbody>
</table>

* Annual Arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days. The 24-hour limit may not be exceeded more than three times in one year.

*** Not to be exceeded more than once per year average concentration

Whenever and wherever two consecutive values exceed the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigations.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>WHO</th>
<th>Class I</th>
<th>Class II</th>
<th>Class III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrite</td>
<td>mg NO₂/l</td>
<td>-</td>
<td>≤ 0.1</td>
<td>≤ 0.5</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>Phosphate</td>
<td>mg PO₄/l</td>
<td>-</td>
<td>≤ 0.01</td>
<td>≤ 0.02</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td>Phenols</td>
<td>mg/l</td>
<td>0.001</td>
<td>≤ 0.001</td>
<td>≤ 0.02</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td>Detergents</td>
<td>mg/l</td>
<td>-</td>
<td>≤ 1.0</td>
<td>≤ 2.0</td>
<td>≤ 3.0</td>
</tr>
<tr>
<td>Fluoride</td>
<td>F mg/l</td>
<td>1.5</td>
<td>≤ 1.5</td>
<td>≤ 1.5</td>
<td>≤ 2.0</td>
</tr>
<tr>
<td>Cyanide</td>
<td>Cn mg/l</td>
<td>0.05</td>
<td>n.d.</td>
<td>≤ 0.02</td>
<td>≤ 0.05</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb mg/l</td>
<td>0.1</td>
<td>≤ 0.1</td>
<td>≤ 0.1</td>
<td>≤ 0.1</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg mg/l</td>
<td>0.01</td>
<td>n.d.</td>
<td>≤ 0.005</td>
<td>≤ 0.01</td>
</tr>
<tr>
<td>Copper</td>
<td>Cu mg/l</td>
<td>0.05</td>
<td>≤ 0.01</td>
<td>≤ 0.01</td>
<td>≤ 0.2</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cd mg/l</td>
<td>0.01</td>
<td>n.d.</td>
<td>≤ 0.001</td>
<td>≤ 0.01</td>
</tr>
<tr>
<td>Chromium Trivalent</td>
<td>Cr mg/l</td>
<td>0.05</td>
<td>≤ 0.05</td>
<td>≤ 0.1</td>
<td>≤ 0.1</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni mg/l</td>
<td>-</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
<td>≤ 0.1</td>
</tr>
<tr>
<td>Silver</td>
<td>Ag mg/l</td>
<td>0.05</td>
<td>≤ 0.01</td>
<td>≤ 0.01</td>
<td>≤ 0.01</td>
</tr>
<tr>
<td>Vanadium</td>
<td>V mg/l</td>
<td>-</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>Boron</td>
<td>B mg/l</td>
<td>-</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
<td>≤ 1.0</td>
</tr>
<tr>
<td>Arsenic</td>
<td>As mg/l</td>
<td>0.05</td>
<td>≤ 0.05</td>
<td>≤ 0.05</td>
<td>≤ 0.2</td>
</tr>
</tbody>
</table>

**KEY**

- mg: milligram
- L: Liter
- ml: milliliter
- n: count
- n.d.: non detectable

**Water Classification**

- **WHO** Class I: Drinking water for the population, Water Supply for industry requiring drinking water.
- **WHO** Class II: For Fisheries, Cultivated fisheries, Organized public bath, Recreational water sports.
- **WHO** Class III: Industry supply except for industry requiring drinking water, irrigation or agricultural land.

*Prepared for the Government of Liberia by UN Department of Technical Cooperation for UNDP New York 1987*

### Table 2-7 Maximum Permissible Noise Levels for General Environment (Environment Protection and Management Law- Noise Pollution Control & Standards Regulations, 2009)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Noise Limits B (A) (Leq)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DAY</td>
</tr>
<tr>
<td>Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites.</td>
<td>45</td>
</tr>
<tr>
<td>Residential buildings</td>
<td>50</td>
</tr>
<tr>
<td>Mixed residential (with some commercial and entertainment)</td>
<td>55</td>
</tr>
<tr>
<td>Residential + industry or small-scale production + commerce</td>
<td>60</td>
</tr>
<tr>
<td>Industrial</td>
<td>70</td>
</tr>
</tbody>
</table>

*Time Frame: use duration
Day: 6.00 a.m. 10.00 p.m.
Night: 10.00 p.m. 6.00 a.m.
The time frame takes into consideration human activity*
Table 2-8 Maximum Permissible Noise Levels (Continuous or intermittent noise) from a Factory or Workshop (Environment Protection and Management Law- Noise Pollution Control & Standards Regulations, 2009)

<table>
<thead>
<tr>
<th>Leq dB (A)</th>
<th>Duration (Daily)</th>
<th>Duration (Weekly)</th>
</tr>
</thead>
<tbody>
<tr>
<td>85</td>
<td>8 hours</td>
<td>40 hours</td>
</tr>
<tr>
<td>88</td>
<td>4 hours</td>
<td>20 hours</td>
</tr>
<tr>
<td>91</td>
<td>2 hours</td>
<td>10 hours</td>
</tr>
<tr>
<td>94</td>
<td>1 hour</td>
<td>5 hours</td>
</tr>
<tr>
<td>97</td>
<td>30 minutes</td>
<td>2.5 hours</td>
</tr>
<tr>
<td>100</td>
<td>15 minutes</td>
<td>1.25 hours</td>
</tr>
<tr>
<td>103</td>
<td>7.5 minutes</td>
<td>37.5 minutes</td>
</tr>
<tr>
<td>106</td>
<td>3.75 minutes</td>
<td>18.75 minutes</td>
</tr>
<tr>
<td>109</td>
<td>1.875 minutes</td>
<td>9.375 minutes</td>
</tr>
</tbody>
</table>

Noise Levels shall not exceed a Leq of -
(i) Factory/Workshops 85 dB (A)
(ii) Offices 50 dB (A)
(iii) Factory/Workshop Compound 75 dB (A).

Table 2-9 Maximum Permissible Noise Levels for Residential & Commercial Areas (Environment Protection and Management Law- Noise Pollution Control & Standards Regulations, 2009)

<table>
<thead>
<tr>
<th>Facility</th>
<th>Limit Value in dB(C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>For any building used as a hospital, school, convalescent home, old age home or residential building.</td>
<td>109 dB (C)</td>
</tr>
<tr>
<td>For any building in an area used for residential and one or more of the following purposes: Commerce, small-scale production, entertainment, or any residential apartment in an area that is used for purposes of industry, commerce or small-scale production, or any building used for the purpose of industry, commerce or small-scale production.</td>
<td>114 dB (C)</td>
</tr>
</tbody>
</table>

2.4 INTERNATIONAL STANDARDS

As a condition of accessing international financing sources as well as a way of committing to the development of the Project in way that manages environmental and social issues responsibly, the Project is committed to comply with international requirements. The requirements of the World Bank Safeguard Policies, and the applicable World Bank Group Environmental, Health and Safety Guidelines have been specifically considered as part of this assessment.

2.4.1 The EHS Guidelines

The World Bank Group’s EHS Guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP), as defined in IFC’s PS 3 on Pollution Prevention and Abatement. The Guidelines contain performance levels and measures that are generally considered to be achievable in new facilities at reasonable costs by existing technology (Box 2-1).
The EHS Guidelines for Electric Power Transmission and Distribution are the specific-sector guidance relevant to the Project, providing an overview of the key environmental, health and safety topics that are particularly relevant (Box 2-2). A summary of World Bank’s Safeguard Policies is available in Appendix B.

2.5 ENVIRONMENTAL IMPACT ASSESSMENT PROCESS IN LIBERIA

An EIA Process Flow Chart has been included as Figure 2-1. The main steps in the process are:

- Prepare Application for Environmental Impact License
- Prepare Notice of Intent (NOI)
- Submit Project Brief (allow 14 working days for EPA review and feedback)
- Conduct Scoping Process:
  1. Publish NOI in Media
  2. Prepare Terms of Reference (TOR)
  3. Conduct Meetings with EPA Environmental Committee and District Environmental Committees, as needed.
  4. Conduct Public Meetings with Potentially Affected Communities
  5. Submit Scoping Report to EPA
- Prepare Environmental Review
- Obtain EPA Approval of TOR and Environmental Review
- Prepare Environmental Impact Study and Report (included in EIA)
- Prepare Environmental Impact Statement (EIS) (included in EIA)
- Develop Comprehensive Environmental Mitigation Plan and Implementation Strategy (included in EIA)
- Agency Review of EIA (within 3 months)
- Public Consultation on EIA (within first 30 days of 3 months)
- Public Hearings (EPA to decide whether to hold these)
- Liberia Line Ministries Comment on EIA
- Review by EPA Environmental Assessment Committee
- Approval or Rejection by EPA (within 3 months of receiving EIA)
Box 2-1 Relevant General EHS Guidelines

1. **Environmental**
   a. Air Emissions and Ambient Air Quality
   b. Energy Conservation
   c. Wastewater and Ambient Water Quality
   d. Water Conservation
   e. Hazardous Materials Management
   f. Waste Management
   g. Noise
   h. Contaminated land

2. **Occupational Health and Safety**
   a. General Facility and Design and Operation
   b. Communication and Training
   c. Physical Hazards
   d. Chemical Hazards
   e. Biological Hazards
   f. Radiological Hazards
   g. Personal Protective Equipment
   h. Special Hazard Environments
   i. Monitoring

3. **Community Health and Safety**
   a. Water Quality and Availability
   b. Structural Safety of Project Infrastructure
   c. Life and Fire Safety (L&FS)
   d. Traffic Safety
   e. Transport of Hazardous Materials
   f. Disease Prevention
   g. Emergency Preparedness and Response

Box 2-2 Sector-specific Guidelines for Electric Power Transmission and Distribution

1. **Environmental Topics**
   a. Terrestrial Habitat Alteration;
   b. Aquatic Habitat Alteration;
   c. Electric and Magnetic Fields; and

2. **Health and safety topics**
   a. Live Power Lines;
   b. Working at height on poles and structures;
   c. Electric and magnetic fields; and
   d. Exposure to chemicals.
2.5.1 Public Consultation Requirements of the EIA Process

Involvement of the public in the EIA commences with the launch of the EIA process and continues throughout its course. Detailed below are the different requirements of the public involvement throughout the EIA process:
1. After the submission of an application for an environmental impact assessment permit, the project proponent should publish a “notice of intent” that states the information that may be necessary to allow the stakeholders or any interested party to identify their interest in the proposed project or activity. This information should include: the nature of the project, its related activities, its timeframe and its site of operation and the area that may be impacted.

2. Before preparing the EIA document, the project proponent should conduct public consultations with the potential affected stakeholders. This procedure is called the “scoping process” which aims to: 1) inform the stakeholders about the project’s details, its potential impacts on the physical, biological and socio-economic environments, and the mitigation measures that can be taken in order to minimize these impacts, and 2) get the stakeholders’ input on the various related issues. By achieving this, the scoping process is also a guiding tool for the project proponent and its consultants. It helps them in identifying the project’s impacts, mitigation measures and alternatives, which will form the essential part of the EIA document. The scoping process consists of publishing the project’s details in the affected district’s media, holding public meetings to consult directly with the affected communities and stakeholders, and incorporating the views of these stakeholders in the scoping report which is submitted to the EPA.

3. On the completion of the EIA study report, the public is invited again to participate in the EIA review through public consultation meetings. The public’s views on the EIA are taken into consideration by the EPA when deciding about approving or rejecting the project.

4. In some cases, the EPA also decides to hold a public hearing about the project in order to fortify the public participation. These cases include but are not limited to: requests by the public for a public hearing, controversy about the project or expiry of the period stipulated for receipt of comments.
3 PROJECT DESCRIPTION

The line will be completely rehabilitated and reconstructed including replacement of all towers, conductors, and hardware along the existing transmission line right-of-way. The towers will be designed as double circuit lattice steel structure outside of densely populated areas, and as tubular steel poles in densely populated areas.

![Paynesville Substation](image)

Figure 3-1: Paynesville Substation

3.1 PROJECT COMPONENTS

Electric transmission line projects normally consist of several components each with specific environmental and social aspects and associated potential impacts. The proposed project consists of the components discussed below.

3.1.1 Right of Way (RoW)

The RoW of a transmission line includes land set aside for the transmission line and associated facilities, land needed to facilitate maintenance, and to avoid risks of fires and other accidents. It provides a safety clearance between the high-voltage lines and surrounding structures.

It is intended that the final transmission line routing and design will follow the LEC’s previous line route to the maximum extent possible. The transmission line will be installed entirely within the existing 150-foot-wide (46-meter-wide) LEC RoW that includes the Kakata-Monrovia Highway between Paynesville and Kakata as shown on Figure 3-2. The standard distance between the outer boundary of the LEC RoW and the centerline of the
highway is 75 feet (23 meters). Preferably, the transmission line route (tower centerline) will be at least 10 feet (3 meters) from the edge of the roadway, and at least 25 feet (8 meters) from the outer boundary of the LEC RoW. Therefore, the maximum width of the intended transmission line corridor for construction will be 40 feet wide (12 meters) abutting the Kakata-Monrovia Highway. Figure 3-2 shows the typical LEC RoW cross section.

![Figure 3-2 Schematic Cross Section of LEC RoW](image)

### 3.1.2 Transmission Towers

Transmission towers are the most visible component of the power transmission system. Their function is to keep the high-voltage conductors (power lines) separated from their surroundings and from each other. Figure 3-3 shows typical tower and dimensions.
3.1.3 Conductors

Conductors are the cables that transport the electrical power from a power station to the consumers. Generally, three conductors for each electrical circuit are strung on a supporting structure. Conductors are fabricated primarily of twisted metal strands, but newer conductors may incorporate ceramic fibres in a matrix of aluminum for added strength with lighter weight.

The phase conductors for the 66 kV transmission line will consist of aluminum conductor strands with steel reinforced stranded core (ACSR).
3.1.4 Insulators

Insulator design will be based on the installation of polymer type insulators.

3.1.5 Grounding Rods and Wires

All structures will be permanently and effectively grounded. Individual structure grounding will be made with grounding rods, radial grounding cables or grounding coils. At structure sites with high ground resistivity, such as sand, gravel or rock formations, supplementary radiating grounding or ring shaped ground electrode may be installed.

It is anticipated that grounding rods will be solid, copper-clad steel rods with a minimum diameter of 16 millimeters (mm) and 3 m long with provision for coupling together with a suitable clamp for connection of grounding. Grounding wires will be of copper or 7 x 3.25 mm galvanized steel wire running from each support structure to the ground wire.

3.1.6 Foundations

Foundations will be designed for all the specified structure types for a variety of soil conditions, both in dry and fully submerged conditions and for rock. Foundations will be of concrete, with a minimum height aboveground of 400 mm. In flooded areas the height of concrete foundations for lattice structures will be at least 1,200 mm aboveground to ensure protection of the steel against corrosive water. The minimum depth of the foundations will be 1,200 mm for lattice structures. Using tower measurements of 4.5 m X 4.5 m at the base and footings of 3 meters x 3 meters x 2 meters deep under each corner, the diagonal corner distance from the center point of the tower is calculated at 5.3 meters plus 2.7 meters clearance for construction, a total of 8 meters is used as the estimated footprint for construction purposes.

3.1.7 Static Optical Ground Wires (OPGW)

Fiber optics will be used for all relaying, voice and data communications between the power plant and the substation. Static wire will be concentric lay stranded aluminum clad steel conductor according to ASTM including a 48 fiber single-mode optical ground wire (OPGW).
3.1.8 Access Roads

Access to the primary delivery point of the transmission line at the power plant site is by an existing approximately 56 km all weather road. The Paynesville Substation is accessible by an existing driveway off of the Kakata-Monrovia Highway. The re-installed transmission line will run approximately parallel to the existing Kakata-Monrovia Highway. Since the transmission line will be constructed parallel to the existing highway, temporary access points off the main highway will be needed to the proposed tower locations during construction and maintenance. Vegetation clearing and/or re-contouring of land may be required at some of these access points. Wherever possible, existing roads and tracks will be used for access roads, and installation of transmission lines will be mainly above existing low vegetation to avoid land clearing.

Due to the proximity of the transmission line to the Kakata-Monrovia Highway, no permanent access roads are needed during operation of the transmission line by LEC for maintenance of transmission lines, towers, substations vegetation management, and upgrades. Access roads to the Paynesville Substation and planned power plant site are existing.

3.1.9 Electrical Characteristics

The electrical characteristics of the Project shall be:

- Three-phase system with a nominal voltage of 66 kV
- Nominal Power rating of 36 MW throughout the length of the line
- Highest rated three-phase withstand voltage of 140 kV
- Rated lightning impulse withstand voltage of 350 kV
- Rated power frequency of 50 Hz
- Maximum normal operating conductor temperature 75°C (100°C maximum emergency rating)
- Transmission line transposition requirements shall be determined by the Contractor

3.1.10 Materials and Other Utilities

Structures and accessories that will be used temporarily or permanently during the project include towers, poles, guy lines, tensioning cables, conductors, insulators, grounding rods
and wires, static optical ground wires, etc.

Castings, carbon steel plates and shapes, forgings, fastenings (screws, bolts, studs and nuts), fabrics, cork, paper, wood, adhesives, rubber, cement, resin, corrosion inhibitors, paints, lubricants, rating plates, nameplates and labels, and other materials will also be used during the different phases of the project provided that they are designed to:

- meet internationally recognized safety standards;
- minimize the risk of fire and any consequential damage;
- prevent accidental contact with live parts; and
- be capable of continuous operation or as required with minimum attention and maintenance under the conditions prevailing in the tropical climate.

### 3.2 Project Activities

The project activities will consist of a range of operations that are aimed at ensuring that the 66 kV power transmission line from Kakata to Paynesville will be completed in time and will be operational as required to meet the power plant’s testing/commissioning schedule.

The main activities are described below.

#### 3.2.1 Mobilization Phase

Mobilization of equipment, materials, and construction personnel, together with final design will commence when all necessary permits and approvals have been obtained. The Mobilization Phase will include establishing offices and material storage areas in the project area, assembling equipment; and procuring construction workforce and materials. The Mobilization Phase is anticipated to last approximately three months.

It is anticipated that materials and equipment will be imported for the construction phase, through the Port of Monrovia and delivered to the storage areas by container trucks.

#### 3.2.2 Construction Phase

Construction of the transmission line, structures, and temporary facilities, will require the use of various types of equipment and manual labor. Activities can be described as follows:

- Tower Spotting;
• Clearing of Right-of-Way;
• Clearing and Excavation of Tower Base and Foundation;
• Clearing of Tower Track;
• Storage and Transportation of Equipment and Material;
• Erection of Towers and Stringing of Transmission Lines;

Construction of the proposed transmission line will utilize skilled, semi-skilled, and unskilled labor. A temporary workforce of approximately 80 workers is anticipated. The majority of the labor force will be recruited from within the country and will include the maximum use of qualified personnel from the local communities. It is anticipated that the construction phase will last approximately 12 months.

3.2.2.1 Tower Spotting

Tower spotting is the determination of the individual sites for the installation of the towers. It must be pointed out that the right-of-way of both transmission lines existed before the civil war and some towers are still seen along the route. Therefore, it is highly possible that all new towers will be installed at the same position of the old ones. In rare cases, there might be a need to select new locations that will replace the previous position of an old tower.

Activities that will be undertaken along with tower spotting include final survey and soil investigation. These activities necessitate intrusive access and some clearing of vegetation, leading to possible destruction of crops. Geotechnical survey and tower spotting are therefore activities that shall be carried out subsequent to the issuance of an environmental permit and disbursement of funds from the lending agencies to identify the optimum foundation design for each tower. The selection of the foundation design type will follow the collection and analysis of the data of each tower location after soil investigations. At this stage minor adjustments may be made to the final tower location, due to the vertical profile of the transmission line corridor, and to avoid buildings that may have been constructed subsequent to the collection of baseline data on structures in the proposed RoW. Such adjustments will be limited to a few meters in either direction.
3.2.2.2 Clearing of Right-of-Way

The construction and operation of the proposed lines will require a right-of-way for each line of approximately 75 feet on each side of the center line of the road. The right-of-way will therefore be 150 feet wide. This 150-foot wide corridor, which will run the total length of both of the transmission lines, shall be cleared of vegetation to a height of approximately 4 feet above ground level.

Trees considered potentially capable of threatening the proposed transmission line beyond the 75- feet width on each side of the center line of the road will be cut down or pruned as appropriate. These will be trees, which could damage the transmission lines if they fall on it or whose branches may grow so big as to affect function and safe operation of the transmission lines. All vegetation clearance will be done by physical means, and no chemicals will be used for the vegetation control.

3.2.2.3 Clearing and Excavation of Tower Base and Foundation

The proposed tower base areas will be cleared. These will be selected spots within the RoW for mounting the towers. The area to be cleared for a single tower will be made up of the dimensions of the tower base (5 m x 5 m). So the total tower base area will be approximately 25 m² per tower.

Tower foundations will vary according to the prevailing geology. The towers will have concrete footings with foundation depths of 2–3 m or more depending on the nature of soils at the selected tower spots. A majority of them will have footings of the pad and chimney type, which will be excavated mechanically. This method involves constructing a concrete pad at the base of the excavation area, after which each foot of the tower is erected within its own ‘chimney’ of steel reinforced concrete. After about two days, the formwork will be removed, and the excavation will then be backfilled to original ground level and consolidated.

The ground surfaces of the tower sites will be graded in order to provide gentle drainage away from the tower legs in order to avoid the collection of water at the tower bases which may lead to the development of stagnant water pools. Where necessary, particularly on hillsides, terracing, cribbing or riprap may be used to provide protection for tower
foundations.

In areas prone to flooding (swampy areas) a raft foundation for transmission line towers may be used. The raft foundation is similar in concept to the pad and chimney foundation except that all four feet of each tower would be set on a single raft of concrete.

3.2.2.4 Transportation of Equipment and Material

During construction, the materials will be transported to the site via public roads and access tracks. Vehicle movements will be minimal since the work camps will be sited close to the proposed sites.

3.2.2.5 Erection of Towers and Stringing of Transmission Lines

After transporting the steelwork and its components from storage facilities to the site, erection of the transmission towers will proceed. Once the towers are erected, the conductors and shield wires will be strung and appropriately ‘tensioned’ to provide the minimum clearance between ground level and the wires.

The proposed line is expected to cross over other power and transmission lines, highways, roads, and rivers and streams. Guard structures will be used when installing the conductor to ensure that the line does not cause hazards and nuisance to the public and construction staff alike. Due notification will be communicated to the appropriate authorities in cases where these lines will have to cross roads and utility lines.

Once the towers have been erected and the lines strung, tests and measurements shall be carried out to ensure that the line performs as expected. Minimum distances such as clearances between the lines and the ground level shall be checked and the lines shall be ‘tensioned’ as per specification. After the construction of the line, the soil conditions along the right-of-way will be assessed for such problems as compaction and erosion and mitigation action will be taken as appropriate. Areas of bare soil are expected to be re-planted with native cover flora to stabilize the soil, reduce erosion and prevent invasion by undesirable plant species.

The line will be fitted with an optic fiber cable (OPGW), which will be used for system
3.2.3 Operations Phase

The operational phase of the project will involve the commissioning of the line and maintenance of the RoW, the power lines and the towers.

The operation and maintenance of the transmission line will be based on internationally accepted standards, such as those of the International Electrotechnical Commission (IEC). The LEC has its own specific procedures for the operation and maintenance of its lines as set out in the ‘LEC Rules and Regulations’.

The main activities to be carried out during the operating life of the transmission line include surveillance of the condition of the transmission line, towers and RoW; routine and emergency maintenance and repairs; and vegetation control. Vegetation control measures will be done manually.

The LEC maintains a Transmission and Distribution (T&D) Department with headquarters in Monrovia that is responsible for the operation and maintenance of its transmission and distribution networks in Liberia.

3.2.3.1 Routine Running Maintenance

This consists of routine maintenance carried out by the maintenance department to ensure the integrity and safety of the lines. The maintenance activities carried out here include:

- **Foot patrol:** The Line Maintenance team carries out routine physical examination of the transmission line and its component parts to ensure the safety, security and integrity of the line. Such activities are carried out at least twice a year.

- **Security patrol:** This is done to check on segments of the line close to populated areas for signs of vandalism, tampering, and general security of the lines. It is to ensure an early detection of and rapid response to acts of vandalism and to rectify such situations as promptly as possible.

- **Tower auditing and repairs:** This provides a means of assessing the ageing process of towers. It starts one year after the commissioning of a line section and follows a
one-year cycle. In a cycle of tower auditing, 10% of all suspension towers and all dead-end towers are thoroughly examined. As the line ages, it is subjected to wear and tear resulting in fatigue which may not be noticeable by a distant visual inspection. Detection and tightening of loose bolts on supports and hardware can reduce premature wear and indicate for replacement of worn components before failure.

In the course of operation, defects that are identified are repaired. Such defects may include the replacement of defective conductors, flashed over insulators, defective dampers, vandalized components, and maintenance of access tracks and RoW.

3.2.3.2 Major Maintenance

These are scheduled maintenance programs that are carried out on the transmission line to counteract the effects of the ageing of towers, lines and other accessories. The repairs may also arise out of the running maintenance activities. These maintenance programs usually become necessary as a result of the lines running through harsh environments. Some of the activities carried out under the major maintenance program include:

- Replacement of insulation of sections of the transmission line.
- Treatment of rust and re-painting of tower components.
- Replacement of corroded towers and transmission line components.
- Replacement of conventional bolts and nuts with anti-theft fasteners on older line sections.
- Rehabilitation of access roads and tracks.

3.2.3.3 Emergency Maintenance

These are activities relating to correction of sustained line faults. These could span a whole spectrum of minor faults (e.g. insulator failure) to such major defects as tower failures. Some of the activities carried out under this program include the construction of temporary by-pass line to replace collapsed sections of lines, reconstruction of the collapsed section, and aerial and ground patrols to locate sustained line faults.

3.2.4 Decommissioning

Operation of the transmission line is not limited and expected to continue.
Decommissioning of the transmission line infrastructure is not very likely, but rather a long-term repair or replacement of line components. Decommissioning of technical installations comprises dismantling, decontamination of materials and site, shipment and final disposal of materials as well as site rehabilitation. Disposal of materials can take place either by selling, re-use or depositing.

If required, LEC would develop a Closure Plan within two years prior to decommissioning for submittal to the EPA for review and approval. The Closure Plan would demonstrate that LEC (or the current operator if different) is fully aware of its responsibilities and the degree of planning and input required to protect the local and regional environment of the project area.

3.3 ANALYSIS OF ALTERNATIVES

Alternatives to the proposed transmission line were evaluated to determine whether they were reasonable and environmentally preferable to the proposed action. Alternatives considered include the no-action alternative, alternative systems, route alternatives, tower location alternatives, and design alternatives.

3.3.1 No-Action Alternative

Under the no-action alternative, the Project would not be constructed and all direct environmental and social impacts associated with construction and operation of the proposed electric transmission line would be avoided. The direct and indirect economic and social benefits that would have been accrued by the local communities because of an increase in electricity supply, and provision of labor opportunities would not be realized.

In addition without the electric transmission infrastructure, LEC would not be able to provide electrical energy to Kakata and surrounding communities. This would lead to escalating energy supply issues as the population grows, with continued dependence on imported fossil fuels to run diesel engines to provide energy into the near future until other alternative energy supplies are established.
3.3.2 System Alternatives

System alternatives are alternatives to the proposed actions that would make use of other existing, modified, or proposed electric transmission systems to meet the objectives of the LEC transmission line. A system alternative would make it unnecessary to construct all or part of the 56 km transmission line, although some modifications or additions to existing transmission systems may be required to increase existing capacity or provide the necessary delivery and receipt points, or another entirely new system may need to be constructed. Such modifications or additions would result in environmental and social impacts which could be less than, similar to, or greater than that associated with construction of the proposed project. The purpose of identifying and evaluating system alternatives is to determine whether potential environmental and social impacts associated with the construction and operation of the proposed transmission line could be avoided or reduced while still meeting the objectives of the project.

As outlined in Section 4, the transmission line is being developed to at least 64 MW of electricity from the Paynesville Substation to the existing another substation in to be built in Kakata in order to serve Kakata and surrounding communities. To duplicate the purpose and need of the proposed transmission line project, an electric transmission line that has available capacity beginning in the general area of the Paynesville substation in Monrovia power plant, and ending in the general area of Kakata would have to be operating or proposed. Existing and proposed transmission system alternatives evaluated by LEC included (1) the 225 kV line being constructed by the West African Power Pool (WAPP) to interconnect Liberia, Sierra Lone, and Guinea through the Ivorian network, and (2) the distribution network being constructed with funds from the Government of Norway.

3.3.3 Route Alternatives

No alternative transmission line routes were considered for this Project. The proposed transmission line will be reinstalled within an existing utility corridor owned by LEC, primarily in the same location as the previous transmission line, and will parallel an existing highway. Any alternative routes would require establishment of a new easement within
undeveloped areas, resulting in greater impacts to environmental resources. In addition, the existing ROW is a GOL/LEC ROW that was established for use by many Utilities and was in use for electricity transmission and distribution lines and substations before the approximate two decades of civil conflict in Liberia. Currently the ROW is being utilized by Utilities, for instance - the 2.5 km section of the Monrovia grid 66 kV transmission line, reconstructed and energized by LEC and the European Commission in Liberia.

3.3.4 Tower Location Alternatives

The LEC and its contractors evaluated tower locations for the preliminary route and considered non-environmental factors such as the preferred and maximum spacing between the towers, as well as, environmental factors including avoiding or minimizing impacts to the local communities or environmental resources, such as in areas of high residential congestion such as those near the Paynesville Substation in Redlight. In general the new and rehabilitated towers will be built upon the footprints of the old transmission towers unless a significant negative environmental impact would be projected occur from doing so.

3.3.5 Design Alternatives

Two types of transmission line systems, an underground cable system and overhead transmission line, were considered for the proposed 56 km transmission line between Kakata and Paynesville. An underground cable system, though visually appealing in the long run, will cause more disruption during construction and decommissioning as it will involve a larger area for excavation and hence greater negative environmental and socio-economic impacts.

It is also more difficult to locate trained manpower for continued maintenance of the underground cables. In addition, the cable systems are more expensive to operate and have higher maintenance costs as compared to overhead transmission lines.

The proposed design of the transmission line is an overhead transmission line system. Technically, this option is simple as compared to underground cable system as trained manpower is available. Economically, construction and operation & maintenance costs of
overhead transmission lines are lower. Socially, this system is problem free as it poses no threat to existing utilities (water supply, telephone lines, gas lines etc) as no large scale digging / excavation is involved. Overhead transmission line towers, during construction, could be susceptible to fall during severe weather conditions (high wind speed and heavy rains) potentially causing damage to life and property.

3.3.5.1 Comparison between Towers and Poles

- **Towers** - The conventional towers occupy more space. On the other hand, the monopole footprint is smaller than that of a lattice tower, but the amount of concrete required is substantially greater to withstand the bending moment at the ground anchor. On this criterion, the lattice tower is recommended.

- **Monopoles** - These have small footprint.

Figure 3-4 Steel Lattice tower (Liberia)
Figure 3-5 Monopole towers (Liberia) seen here in poor condition
4 DESCRIPTION OF ENVIRONMENT

Environmental baseline data is important to understand the physical, biological and socio-economic characteristics of the project’s environment. Such information sets the ground for analysis of the potential impacts of the project’s activities on the existing environment. Therefore, the collection of baseline data focuses on the information required to conduct an environmental and social impact assessment of a transmission line project.

4.1 GENERAL SETTING

The quadrangle of Liberia is located on the western side of the African Continent. It is positioned on the Atlantic coastline of Africa, and has a surface area of 111,370 km². It is bordered by Guinea on the north, Sierra Leone on the west and Côte d’Ivoire on the east. The border with Guinea is approximately 563 km, Sierra Leone 306 km, and Cote d’Ivoire 716 km. Generally, Liberia has low relief topography. Its studded coastline is approximately 560 km long characterized by unbroken sand strips, and is dominated by lagoons and marshes. However, the hinterland is made up of ill-defined and dissected plateaus and low relief mountains, few rising abruptly above the surface to an elevation of 400 m above sea level (a.s.l). The highest mountain (Mount Wutivi) is located in the northeast (Yekepa) and rises to an elevation of approximately 1,380 m a.s.l.

4.2 PROJECT LOCATION

The proposed transmission line will commence at LEC’s substation in Paynesville (Primary Delivery Point) and terminate at LEC’s planned substation in Kakata (Interconnection Point). It is intended that the final transmission line routing and design will follow the LEC’s previous line route to the maximum extent possible, or any new RoW set by the Ministry of Public Works based on the ongoing road rehabilitation taking place on the Monrovia-Kakata Highway. The transmission line will be installed entirely within the 150-foot wide transportation and utility corridor that includes the Kakata-Monrovia Highway between Paynesville and Kakata as shown on Figure 4-1. The standard distance between the edge of the RoW and the centerline of the highway is 75 feet. The transmission line route (pole centerline) will be at least 10 feet from the edge of the roadway, approximately 50 feet from the centerline, and at least 25 feet from the outside edge of the RoW. The power poles
and appurtenant facilities will be installed mainly on the right side of the road (as viewed from Monrovia to Kakata direction) in some sections and on the left side in other sections.

The planned line has a length of approximately 56 kilometers (km). The transmission line route will extend in a northeast-southwest (NE-SW) direction between the upper parts of Greater Monrovia District and the upper eastern section of the Todee District of Montserrado County, between coordinates 29 N 0348443 UTM 0721494 and 29 N 312613 UTM 693242. The line also crosses approximately 1.5 km of the Mamba-Kaba District in Margibi County between coordinates 29 N 321310 UTM 704768 and 29 N 322687 UTM 705339.

The project area is located within the coastal plain, and is generally flat with some undulating rises and an average elevation of approximately 75 meters above sea level. The landscape is supportive of small seasonal swamps, which naturally drain into the Du River. Moving towards SW from the power plant, elevation tends to decrease gradually from 100 m above sea level to 10 m above sea level (Figure 4-4).

Table 4-1 Counties, Districts and Villages along the Transmission Line Right of Way

<table>
<thead>
<tr>
<th>County</th>
<th>District</th>
<th>Village/Town</th>
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<tbody>
<tr>
<td>Montserrado</td>
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<td>Glahnzon</td>
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<td></td>
<td>Careysburg</td>
<td>Grayzohn, Wako, Kpequay Town, Grabo Town, Welleh Town, King Farm, Seward</td>
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<td></td>
<td></td>
<td>Junction, Kofdayealah, Urey Farm Community, Nelson Village, Careysburg, Boko</td>
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<td></td>
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<td>Morris Farm</td>
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<td>Margibi</td>
<td>Mambah Kaba</td>
<td>Bleyden Town</td>
</tr>
</tbody>
</table>
4.3 PHYSICAL ENVIRONMENT

4.3.1 Topography

Liberia can be divided into three distinct topographical areas. First, a flat coastal plain which extends up to 80 km inland, with creeks, lagoons, and mangrove swamps; second, an area of broken, forested hills with altitudes from 180–370 m, which covers most of the country; and third, an area of mountains in the northern highlands, with elevations reaching 1,384 m.

The project area is located within the coastal plain, and is generally flat with some undulating rises and an average elevation of approximately 75 meters above sea level (Figure 4-2). The landscape is supportive of small seasonal swamps, which naturally drain into the Du River. Moving towards SW from the power plant, elevation tends to decrease gradually from 100 m above sea level to 10 m above sea level (Figure 4-3 & Figure 4-4).
Figure 4-2 Various views showing topographic variations along the Transmission Line route
Figure 4-3: Elevation and Hydrology of Liberia. (UNEP, 2004. Desk Study on the Environment in Liberia)
Figure 4-4 Cross-sectional view along Transmission Line between Paynesville and Kakata Substation
4.3.2 Meteorological Setting

The climate of Liberia is determined by the equatorial position and the distribution of low and high-pressure belts along the African continent and the Atlantic Ocean. A fairly warm temperature throughout the year with very high humidity is common because of the moderating influence of the ocean and the equatorial position. Figure 4-5 gives a general idea about the evolution of the different meteorological parameters in the country throughout the year.

Meteorological data including primarily precipitation, ambient temperature, as well as wind direction and speed, are necessary for developing and understanding an important part of the environmental conditions in the region and consequently for adequately assessing environmental impacts in a comprehensive approach.

![Monrovia, Liberia Climate Graph](image)

Figure 4-5 Average Meteorological Parameters throughout the Year in Monrovia (www.climatetemp.info, retrieved on February 15, 2011)

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4.3.2.1 Precipitation

Liberia has two seasons: rainy and dry seasons. The dry season lasts from November to April and the rainy season is from May to October.

Average annual rainfall along the coastal belt is over 4,000 mm and declines to 1,300 mm at the forest-savannah boundary in the north. Monrovia, the capital, receives almost 4,572 mm of rain per year. The corridor of the eastward flowing Cavalla River, one of the driest areas of the country, receives over 1,778 mm of rain annually. The months of heavy rainfall vary from one part of the country to another, but are normally June, July and September. Observations concerning the diurnal distribution of rainfall prove that most of the rain received along the coast falls during the night and early morning between 18:00 and 07:00 hours.

Figure 4-6 presents the variation of the rainfall throughout the year in the four weather stations nearest to the project area. Those stations are, in a NE-SW direction:


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4.3.2.2 Temperature and Sunshine

Generally, temperature remains warm throughout the country and there is little change between seasons. The temperature over the country ranges from 27-32°C during the day and from 21-24°C at night. The average annual temperature along the coast ranges from 24-30°C. In the interior it is between 27-32°C. The highest temperature occurs between January and March and the lowest is between August and September.

The sun is overhead at noon throughout the year, giving rise to intense insolation in all parts of the country, thus resulting in high temperatures with little monthly variations. Temperature would be much higher without cloud cover, winds, humidity and rainfall, which are influenced by the vegetation cover of the country. The days with longest hours of sunshine fall between December and March. Daily sunshine hours are at a minimum during July, August and September.

Figure 4-7 shows average temperature variation throughout the year recorded by the Harbel and Robertsfield stations, the nearest stations to the project’s area with available data.

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3 UNDP, 2006
4.3.2.3 Wind

The seasons in Liberia mainly result from the movement of two air masses:

1. The Inter-Tropical Convergence Zone (ITCZ) from the northern hemisphere, and
2. Cool air masses over the South Atlantic Ocean from the southern hemisphere.

Pressure shifts between the air masses force the dry continental air mass and the moist south-equatorial maritime air mass to replace each other every six months.4 No specific wind data exist for the project’s area. The only available information about the wind direction and speed is for Robertsfield.

4.3.2.3.1 Wind Direction

Monthly mean wind direction shows southeast as the dominant direction and south as the second dominant direction (Figure 4-8).5

4.3.2.3.2 Wind Speed

Monthly mean wind speed shows maximum 10.3km/hrs in August, minimum 7.1km/hrs in January and average 9.3km/hrs.6 Total wind speed is greatest in the rainy season and lowest in the dry season, being lower in the interior, where high vegetation cover serves as a

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4 UNDP, 2006
6 JICA, 2009
windbreak. Along the coast, the average annual wind speed is 30 km/h.7

![Monthly Frequency of Wind Direction at Robertsfield](image)

Figure 4-8 Monthly frequency of wind direction at Robertsfield in 2000-2006 (JICA, 2009. The Master Plan Study on Urban Facilities Restoration and Improvement in Monrovia. The Republic of Liberia. Monrovia, Liberia)

### 4.3.2.4 Relative Humidity

Relative humidity is generally high throughout the year (Figure 4-9). A relative humidity of 90% to 100% is common during the rainy season. During the dry season it decreases to as low as 65%.8 Along the coast it does not drop below 80% and on the average is above 90%.

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8 UNDP, 2006
There is a wider variation in the interior and may fall below 20% during the Harmattan period characterized by dust laden wind from the Sahara Desert.

In Monrovia, the relative humidity shows a relationship with the existing air temperature and its variation depends on the prevailing season and the hour of the day. During the dry season it decreases to 80-85%. In January and February, the driest period of the year, relative air humidity may be as low as 65%. Regardless of the season, the relative humidity at night and in the early morning is usually in the range of 90-100%. Only the zone north of the Inter-Tropical Front, where the continental air masses prevail from mid-December to the end of January, exhibits arid conditions. At times, due to the extreme dryness of the Harmattan, the humidity may drop to below 50%.

Figure 4-9 shows average humidity variation throughout the year recorded by the Harbel and Robertsfield stations, the nearest stations to the project’s area with available data.

Figure 4-9 Average monthly relative humidity (in %) in Harbel and Robertsfield stations (1977-1982). (adapted from Liberian Hydrological Service, 1982, 1981)

### 4.3.3 Geological Setting

Geological investigations in Liberia have shown that nearly all of the terrain is underlain by Precambrian crystalline metamorphic rocks which form part of the West Africa shield known as the Guinea Shield. The rocks forming this crystalline shield are a series of granite, gneiss, and schist beds which have resulted from metamorphism by tectonic forces acting on

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a regional scale. The structural features of the rocks in this region are uniform over relatively large areas. Gneissic structure and schistosity dip at high angles in most places and are often vertical.

Geologically, the transmission line project is located in the central part of Monrovia Quadrangle extending from the Roberts Basin to the Pan African Province and ending in the Todi Shear zone. The Monrovia Quadrangle is within the Guinean Shield of West Africa which includes parts of the Liberian and Pan-African age provinces (Figure 4-10).

Figure 4-10 Geological provinces of Liberia showing the location of the study area (Tysdal and Thorman, 1983)
The geology of the study area, including subsurface stratigraphy and structure, was developed based on: 1) review of available maps and literature, 2) analysis of satellite images, and 3) geological surveys and site visits. The result was a better understanding of the geological formations and structures in the surrounding of the location of the project.

The outcropping units in the study area covering the length of the transmission line are mainly Precambrian and Jurassic rocks. Those units are covered in some places, especially in the coastal areas, with Quaternary and Tertiary deposits. However, due to the tropical weathering that has created a thick laterite and saprolite soil cover, which supported dense vegetation and rain forests were formed covering most of the rocks in Liberia (Tysdal and Thorman, 1983).

Geologically the transmission line route can be divided into three sections, depending on the geological nature. The lower section consists of Quaternary, Tertiary, Jurassic and Precambrian lithologies including Qb2, Dp, Jd and Te, middle section consists of Jurassic and Precambrian including Jd and gnm lithologies and upper section consists of Jurassic and Precambrian including Jd and gnl lithologies.

**Lower Section**

This section starts from Paynesville and ends in Geeglon Town passing through Wood Camp. It is in the Greater Monrovia District.

The first section covers a variety of lithologies that can be broadly divided into two (Figure 4-11). The surface deposits including Qb2 and Te deposits of Quaternary and Tertiary ages respectively. Both of which unconformably overlay Dp and Jd rock units of Devonian and Jurassic age (Table 4-2).

The Beach Deposits Unit (Qb2) deposits are nearly pure white quartz sand. They average one meter in thickness. They form large savannahs present in the early, middle and last parts of this first section. The sand layers, which are mostly quartz, dip toward the ocean at about 5°. The lower part of this unit contains clay and/or peat, which probably overlies bedrock.

The Edina Sandstone unit (Te) deposits are white to light-brown coarse- to medium-grained gritty sandstone. They are generally less than a few metres in thickness and are present in
the early parts of this first section.

The older underlying rocks include the Paynesville Sandstone unit (Dp) and Diabase and basalt sills and dike unit (Jd).

The Devonian Paynesville Sandstone (Dp) deposits are light-colored fine- to medium-grained well-rounded and well-sorted cross-bedded quartz sandstone. Cross-bedded reddish-brown siltstone and shale occur along the highway north of Paynesville village. These outcrops cover the middle part of this first section after Wood Camp.

In the middle part of this section and intruding in the Dp unit are Diabase Jurassic sills (Jd). These are dark and gray fine to coarse grained diabase rocks consisting primarily of calcic plagioclase and clinopyroxene.

The transmission line in this section also passes through one M/Jd fault intruded dikes in the last section before Geegln Town. This is a NW-SE fault that is intruded by Jurassic dark, gray fine to coarse grained diabase rocks similar in composition to the Jd sills.

Figure 4-11 Geological map outlining the formations along the TL route within the Lower Section
Middle Section

This section starts from Geeglon Town and ends in Nelson Village close to Careysburg village passing through Mount Barclay. It actually starts in Greater Monrovia District and it passes briefly through Manbah-Kaba District and then goes into Careysburg District where the longest part of this section lies.

This section mostly passes through malanocratic gneiss (gnm). It is Precambrian in age (Table 4-2). The outcrops of this formation, as observed on the geological map (Figure 4-12), extend in the NW-SE direction. This unit is distinguished by medium to dark-colored orthopyroxene and clinopyroxene-bearing hornblendic rocks that are mainly dioritic in composition. These rocks form discontinuous bodies interbedded with light colored gneiss that ranges from biotite-quartz diorite to granodiorite in composition. The gneiss makes up more than half the rock in the northwestern part of the unit, but dark rocks dominate the southeastern part of the unit.

The general inclination of the beds in this unit in this section is towards the S, SE and SW at an angle around 40 and 65 degrees.

The transmission line in this section also passes through two M/Jd fault intruded dikes in Mount Barclay and Walakor Town. Those NW-SE faults are intruded by Jurassic dark, gray fine to coarse grained diabase rocks consisting primarily of calcic plagioclase and clinopyroxene.
Upper Section

This section starts from Nelson Village close to Careysburg Village and ends at Morris Farm close to Kakata Village passing through Zinc Camp. This section actually starts with Careysburg district and ends in Todee district.

Geologically this section starts with gnl1 sub unit then passes through gnl sub unit and ends in gnl3 sub unit. All these units are considered sub units of the leucocratic gneiss unit (gnl) which is Precambrian in age (Table 4-2). It is formed of light-colored medium-grained commonly banded biotite-bearing granitic to quartz diorite gneiss. The gnl appears to contain more amphibolite than adjacent gng1. However, structural trends are more uniform and continuous than in adjacent gnl3 (Figure 4-13). Those units usually occupy low relief.

The general inclination of the beds in this unit in this section is towards the S, SE and SW at an angle around 25° and 80°.

The transmission line in this section passes through two M/Jd fault intruded dikes in Manah Town and between Philip Farm and Glee Town. Actually, the one passing between Philip Farm and Glee Town is a small anticline. The core of the anticline is the M/Jd fault intruded
dike which forms its axis trending NW-SE. The beds on either side dip approximately 30 degrees in the northeastern limb and 25 degrees in the southwestern limb.

Four other M faults trending also in the NW-SE direction cut this line into two before Zinc Camp and two after. These faults are actually part of the Todi Shear zone.

![Geological map](image)

Figure 4-13 Geological map outlining the formations along the TL route within the Upper Section

### 4.3.4 Hydrogeology Setting

The depth of groundwater varies from 1.5 meters to 2.5 meters between rainy and dry season. The water level may exceptionally vary in depressions between 0.5 and 1.0 meter. The unconsolidated sediments in the study area are recharged mainly by the high rainfall. During the peak of the wet season, when water levels are at their highest, discharge from the aquifer can reach as much as 30-40 mm per day.
## Table 4-2 Geological Composition of Study Area and Surrounding Area

<table>
<thead>
<tr>
<th>Era</th>
<th>Period</th>
<th>Symbol</th>
<th>Formation</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Quaternary</td>
<td>Qb2</td>
<td>Beach and Fluvial Deposit</td>
<td>Modern beach deposits (seashore sand), Older beach deposits (pure white quartz sand, buff to yellowish-brown sand and silt)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tertiary</td>
<td>Te</td>
<td>Edina Sandstone</td>
<td>Brownish yellow, light-brown, white, medium to coarse grained gritty to conglomeratic quartz sandstone</td>
<td>Generally less than a few meters thick</td>
</tr>
<tr>
<td>Mesozoic</td>
<td>Jurassic</td>
<td>Jd</td>
<td>Diabase</td>
<td>Dark-gray, fine to coarse grained rock, mainly diabasic but locally gabbroic in texture, chiefly dikes with north-west trending, partly forming sill-like bodies</td>
<td></td>
</tr>
<tr>
<td>Paleozoic</td>
<td>Devonian</td>
<td>Dp</td>
<td>Paynesville Sandstone</td>
<td>Light colored, fine to medium grained, well rounded and well sorted, cross bedded quartz sandstone, subordinate cross bedded reddish brown siltstone and shale</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>gnl</td>
<td>Leucocratic Gneiss</td>
<td>Light colored, medium to coarse grained, foliated, commonly banded, rock composition ranging from granite to granodiorite, locally quartz diorite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>gnm</td>
<td>Melanocratic Gneiss</td>
<td>Dark colored, medium grained, moderately foliated, rock composition ranging from diorite to gabbro, including amphibolites and granitic gneiss</td>
<td></td>
</tr>
</tbody>
</table>

### 4.3.4.1 Aquifers

The main types of aquifers identified from the feature of formations shown on Table 4-3 can be classified as shallow aquifers and deep aquifers.

Quaternary beach and Fluvial deposit has possibility of an aquifer for shallow well at sand and gravel portion. Devonian Paynesville sandstone is a major aquifer in the study area. Paynesville formation is not simple and monotonous stratum. It sometimes intercalates mudstone, siltstone, shale and alternation. The Paynesville sandstone receives the intrusion of Jurassic Diabase in many parts. The thickness of the formation is believed to exceed 1,000 m.
Table 4-3 Hydrostratigraphic table of the area shown in the geological map

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Formation</th>
<th>Feature as Aquifer</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Qb2</td>
<td>Beach and Fluvial</td>
<td>Quaternary deposit is supposed to be thinly deposited on the lowlands of the stable basin. Sand strata have possibility of an aquifer for shallow well.</td>
<td>Possible for shallow well</td>
</tr>
<tr>
<td>Te</td>
<td>Edina Sandstone</td>
<td>Tertiary sandstone has possibility of an aquifer. However, according to literature, this formation is as thin as several meters.</td>
<td>Possible for shallow well</td>
</tr>
<tr>
<td>jId</td>
<td>Diabase</td>
<td>Generally dike and intrusive rock has not possibility of an aquifer. However, Crackly zone or boundary portion with fissure sometimes storage groundwater.</td>
<td>Unsuitable for well</td>
</tr>
<tr>
<td>Dp</td>
<td>Paynesville Sandstone</td>
<td>Sandstone formation has high possibility of an aquifer. Sometimes mudstone and shale layer are intercalated.</td>
<td>Possible for deep well</td>
</tr>
<tr>
<td>gnl</td>
<td>Leucocratic Gneiss</td>
<td>Generally this formation is non-aquifer because of hard rock of a part of Precambrian craton. Highly weathered or fissure zone has possibility of ground water presence</td>
<td>Unsuitable for well</td>
</tr>
<tr>
<td>gnm</td>
<td>Melanocratic Gneiss</td>
<td>Generally this formation is non-aquifer because of hard rock of a part of Precambrian craton. Fissure zone nearby fault has possibility of ground water presence</td>
<td>Unsuitable for well</td>
</tr>
</tbody>
</table>

4.3.5 Water Resources

Communities existing between Kakata and the outskirts of Greater Monrovia including those existing along the transmission line, rely primarily on local waterbodies for their water needs. Shallow water wells are also used when surface water supply is low or due to inaccessibility.

4.3.5.1 Surface Water

Several perennial and seasonal creeks exist in the area crossed by the transmission line (Table 4-4). Two rivers drain the area: Du River in the upper part near Kakata and Ba River in the middle part of the study area close to Careysburg. The Ba River flows in a southeast direction and eventually joins with the Du River. Several streams and creeks crossing the transmission line route contribute to the Du and Ba Rivers. In addition to several unnamed creeks the Yokata Creek is a tributary of the Du River. The Yobrum Creek and the Bo Creek also cross the transmission line route and form tributaries of the Ba River. Moving from Careysburg to the Greater Monrovia District, several other creeks including the Muu Creek cross the transmission line route and eventually pour into the Bo River which is relatively far off the study area (Figure 4-14).

Water sampling and analysis addressing the water quality of these specific creeks crossed by the transmission line was not conducted.
Figure 4-14 Streams cross the transmission line route and wells along the route
### Table 4-4 Surface water bodies intersecting the Transmission Line route

<table>
<thead>
<tr>
<th>Name of River/Creek</th>
<th>Coordinates at Intersection with TL</th>
<th>District</th>
<th>Feeding</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unknown Creek (0)</td>
<td>29 N 345768 UTM 717813</td>
<td>Todee</td>
<td>Du River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Yokata Creek (1)</td>
<td>29 N 343185 UTM 714879</td>
<td>Todee</td>
<td>Du River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Yobrum Creek (2)</td>
<td>29 N 339327 UTM 712486</td>
<td>Todee</td>
<td>Ba River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Bo Creek (3)</td>
<td>29 N 334210 UTM 707724</td>
<td>Careysburg</td>
<td>Ba River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Muu Creek (4)</td>
<td>29 N 321275 UTM 704857</td>
<td>Careysburg</td>
<td>Bo River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Unknown Creek (5)</td>
<td>29 N 320234 UTM 705149</td>
<td>Careysburg</td>
<td>Bo River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Unknown Creek (6)</td>
<td>29 N 317599 UTM 702662</td>
<td>Greater Monrovia</td>
<td>Bo River</td>
<td>Perrenial</td>
</tr>
<tr>
<td>Unknown Creek (7)</td>
<td>29 N 317274 UTM 702410</td>
<td>Greater Monrovia</td>
<td>Bo River</td>
<td>Perrenial</td>
</tr>
</tbody>
</table>

#### 4.3.5.2 Well Survey

A comprehensive well survey was conducted as part of this ESIA study. Approximately 34 wells were identified, within the existing 150-foot-wide LEC RoW from Paynesville Substation to Kakata (Table 4-5).

Liberia Water and Sewer Corporation owns and operates two wells located in Paynesville with depths of 30-50 m and yield ranging between 200 m³/day and 60 m³/day. Groundwater pumped from these wells is supplied to industrial facilities and residents not only in Paynesville, but also around Greater Monrovia, through water trucks (Figure 4-14).
Table 4-5 Wells identified within the project area and along the Transmission Line route

<table>
<thead>
<tr>
<th>No.</th>
<th>Coordinates</th>
<th>Alt. (m)</th>
<th>District</th>
<th>Town</th>
<th>Description</th>
<th>Side of Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>701772.196</td>
<td>316797.429</td>
<td>26</td>
<td>Greater Monrovia</td>
<td>Mount Barclay</td>
<td>L</td>
</tr>
<tr>
<td>2.</td>
<td>702090.56</td>
<td>317026.504</td>
<td>23</td>
<td>Greater Monrovia</td>
<td>Mount Barclay</td>
<td>L</td>
</tr>
<tr>
<td>3.</td>
<td>702209.175</td>
<td>317228.898</td>
<td>40</td>
<td>Greater Monrovia</td>
<td>Mount Barclay</td>
<td>R</td>
</tr>
<tr>
<td>4.</td>
<td>703930.965</td>
<td>319271.722</td>
<td>25</td>
<td>Greater Monrovia</td>
<td>Jalzon</td>
<td>R</td>
</tr>
<tr>
<td>5.</td>
<td>704758.1</td>
<td>319819.315</td>
<td>21</td>
<td>Greater Monrovia</td>
<td>Cooper Farm</td>
<td>R</td>
</tr>
<tr>
<td>6.</td>
<td>705033.844</td>
<td>320505.046</td>
<td>17</td>
<td>Greater Monrovia</td>
<td>Fendell</td>
<td>L</td>
</tr>
<tr>
<td>7.</td>
<td>704966.038</td>
<td>320629.411</td>
<td>15</td>
<td>Greater Monrovia</td>
<td>Fendell</td>
<td>R</td>
</tr>
<tr>
<td>8.</td>
<td>705120.602</td>
<td>322398.703</td>
<td>26</td>
<td>Careysburg</td>
<td>Blacktown</td>
<td>L</td>
</tr>
<tr>
<td>9.</td>
<td>707757.049</td>
<td>329620.607</td>
<td>38</td>
<td>Careysburg</td>
<td>Careysburg</td>
<td>R</td>
</tr>
<tr>
<td>10.</td>
<td>707557.467</td>
<td>330423.479</td>
<td>57</td>
<td>Careysburg</td>
<td>Japan Community</td>
<td>R</td>
</tr>
<tr>
<td>11.</td>
<td>707826.773</td>
<td>333924.407</td>
<td>27</td>
<td>Careysburg</td>
<td>Boila Community</td>
<td>L</td>
</tr>
<tr>
<td>12.</td>
<td>707314.712</td>
<td>334931.133</td>
<td>29</td>
<td>Careysburg</td>
<td>Philip Town</td>
<td>L</td>
</tr>
<tr>
<td>13.</td>
<td>709546.273</td>
<td>336940.724</td>
<td>31</td>
<td>Careysburg</td>
<td>Fifteen Gate</td>
<td>L</td>
</tr>
<tr>
<td>14.</td>
<td>709632.094</td>
<td>337008.138</td>
<td>39</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>L</td>
</tr>
<tr>
<td>15.</td>
<td>710342.724</td>
<td>337387.306</td>
<td>43</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>L</td>
</tr>
<tr>
<td>16.</td>
<td>710572.428</td>
<td>337614.922</td>
<td>41</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>R</td>
</tr>
<tr>
<td>17.</td>
<td>710641.668</td>
<td>337642.88</td>
<td>41</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>L</td>
</tr>
<tr>
<td>18.</td>
<td>710673.866</td>
<td>337672.494</td>
<td>38</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>L</td>
</tr>
<tr>
<td>19.</td>
<td>710662.252</td>
<td>337689.131</td>
<td>36</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>R</td>
</tr>
<tr>
<td>20.</td>
<td>711215.902</td>
<td>338216.285</td>
<td>36</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>R</td>
</tr>
<tr>
<td>21.</td>
<td>711455.352</td>
<td>338439.285</td>
<td>38</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>R</td>
</tr>
<tr>
<td>22.</td>
<td>711576.654</td>
<td>338571.382</td>
<td>36</td>
<td>Careysburg</td>
<td>Number Seven</td>
<td>R</td>
</tr>
<tr>
<td>23.</td>
<td>715724.953</td>
<td>344494.557</td>
<td>88</td>
<td>Todee</td>
<td>Grand Farm</td>
<td>R</td>
</tr>
<tr>
<td>24.</td>
<td>718151.934</td>
<td>346111.198</td>
<td>91</td>
<td>Todee</td>
<td>Cooper Farm</td>
<td>L</td>
</tr>
<tr>
<td>25.</td>
<td>696772.526</td>
<td>314377.217</td>
<td>21</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>L</td>
</tr>
<tr>
<td>No.</td>
<td>Coordinates</td>
<td>Alt. (m)</td>
<td>District</td>
<td>Town</td>
<td>Description</td>
<td>Side of Road</td>
</tr>
<tr>
<td>-----</td>
<td>-------------</td>
<td>----------</td>
<td>----------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>26.</td>
<td>696713.402</td>
<td>314302.652</td>
<td>18</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Community Well</td>
</tr>
<tr>
<td>27.</td>
<td>696513.939</td>
<td>314172.976</td>
<td>13</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Community Well</td>
</tr>
<tr>
<td>28.</td>
<td>696491.882</td>
<td>314090.71</td>
<td>14</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Community Well</td>
</tr>
<tr>
<td>29.</td>
<td>696317.167</td>
<td>313742.869</td>
<td>20</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Hand Pump</td>
</tr>
<tr>
<td>30.</td>
<td>694244.668</td>
<td>312769.297</td>
<td>18</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Hand Pump</td>
</tr>
<tr>
<td>31.</td>
<td>701320.128</td>
<td>316640.957</td>
<td>12</td>
<td>Greater Monrovia</td>
<td>Mount Barclay</td>
<td>Old Pump</td>
</tr>
<tr>
<td>32.</td>
<td>695674.774</td>
<td>312937.148</td>
<td>21</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Reservoir</td>
</tr>
<tr>
<td>33.</td>
<td>695439.79</td>
<td>312916.158</td>
<td>19</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Old Reservoir</td>
</tr>
<tr>
<td>34.</td>
<td>694224.269</td>
<td>312794.201</td>
<td>13</td>
<td>Greater Monrovia</td>
<td>Paynesville</td>
<td>Reservoir</td>
</tr>
</tbody>
</table>
4.3.6 Soil

The climate tends to become the dominant soil-forming factor in Liberia, reinforced by the associated effects of the abundant and dense vegetation. The warm and humid climate conditions cause intensive mechanical and chemical weathering of the parent rock and leaching of the soil profile. As a result, Liberian soils share many important features, even though some minor variations reflect the more local influence of relief and geology. The bedrocks from which the rocks have formed are mainly of crystalline, igneous and metamorphic origin, consisting of granites, gneisses, gneissic sandstone and schists and shales. The three major groups of soil in Liberia can be identified: latosols, lithosols and regosols.

In the study area, latosols soils occupy about 75% of the total area. They are heavily leached, and silica, nutrients and humus are mostly washed out. Iron and aluminum minerals have accumulated as permanent residual materials, forming hardpans and cemented layers within the subsoil, while on the surface hard and rounded iron oxides can be observed. This process which is called laterization has a pronounced binding effect, making the soils impermeable and increasing the hazards of run-off and erosion. The prevalence of the iron oxides gives the laterites the characteristic brown and red color.

Alongside the stream and river beds rich alluvial soils are encountered. They contain a high amount of the necessary plant nutrients and are best for agricultural production.

No studies have been conducted to assess the soil quality in the study area. However, the area crossed by the transmission line is not an industrial area, which makes it less prone to soil contamination. Markets, agricultural activities and residences dominate the land use pattern along the transmission line route. But a considerable number of gas stations and garages are disseminated along the route, which are potential sources of contamination.

4.3.7 Noise

Background noise along the transmission line route is dominated by vehicular traffic along the highway. Other noise sources in the project vicinity are rubber tapping, charcoal production and subsistence farming; all of which are operations serviced by foot. Thus, mainly transient noise (intermittent with short duration) exists in the project area; with the
exception of the Redlight section where the noise is high and constant in day hours when the Redlight market is open. Sources of this latter noise are primarily: traffic congestion, market cycle, small industries and craft work.

![Soil Type Distribution in Liberia](image)

**Figure 4-15 Soil type distribution in Liberia**

### 4.3.8 Air Quality

There are no historic data for air quality available for the project area, and therefore, no baseline data per se have been developed. Owing to the rural character of a section of the project area extending between Kakata and Careysburg, there are limited sources of gaseous pollutants. The current principal source of air pollution throughout the entire project area is emissions from vehicular traffic (particulates and combustion emissions) along the highway, and dust from vehicles travelling on local roads, all of which are unsealed. A secondary
source is the Harmattan, the dry dusty trade winds that blow from the Sahara during the dry season.

Levels of gaseous pollution are very low in the country as the main source is vehicle emissions. The current principal source of dust pollution is expected to be from vehicles (in particular heavy lorries) travelling on the local roads, which are largely unpaved. During dry conditions, vehicle movements across these roads raise substantial dust plumes in their wake, which may affect both populations and vegetation close to the roads. Emissions from charcoal production, slash-and-burn activities and domestic cooking may also represent an important, localized source. Larger dust particles will be deposited within a relatively short distance (e.g. several hundred metres), but the finer dust particles may be transported much greater distances depending upon the weather conditions.

In the lower section of the project area, namely the Red Light neighborhood, combustion of diesel fuels to power small scale electrical generators in the absence of electrical supply, and burning of miscellaneous waste, emission from vehicles and small scale industries are the major sources of air pollution. Fuels used for combustion in automobiles and diesel electrical generators are rarely high-quality fuels, such as low sulfur diesel, and often consist of leaded gasoline and high sulfur diesel. These emissions can be compounded by the burning of waste such as old tires, plastics, and other combustible waste.

4.4 BIOLOGICAL ENVIRONMENT

Information obtained for this section was also based on interviews with the local residents along the transmission line route

4.4.1 Vegetation Cover

The transmission line crosses open lands, small streams and wetlands, small farming plots, and dwellings/huts for local squatters. Vegetation adjacent to the corridor is comprised mostly of weedy plant species, secondary growth trees, and agricultural crops.

Wetlands of the Du River close to Kakata contain secondary growth riparian forest, and include the herbaceous wetland species of arrowhead, pickle weed, bulrush, and water lilies. Along the Du River, secondary growth of riparian tree species and herbaceous wetland plant species are also present.
Rubber trees (*Heavea brasienliensis*), common grass and weedy species typically grow on the rubber plantations in the project area.

### 4.4.2 Wildlife

#### 4.4.2.1 Mammals

Mammalian species known to be prevalent in the project area include the opossum; greater cane rat (*Thryonomys swinderianus*), locally known as the ground hog; tree pangolin (*Manis tricuspis*) locally known as the ant bear; and yellow mongoose (*Cynictis penicillata*). Secondary information gathered from interviewing locals corroborated much of the direct survey data. Porcupines, African Climbing Mice (*Dendromus mesomelas*), and Red Legged Sun Squirrels (*Heliosciurus rufobraechium*) were also identified in the project area.

#### 4.4.2.2 Birds

Numerous avian species can be identified in the project area, most utilizing the open grasslands, scrub shrub, and wetland habitats. The red eye dove was the most abundant species within the project limits; however, the Senegal coucal (*Centropus senegalensis*), village weaver (*Ploceus cucullatus*), common bulbul (*Pycnonotus barbatus*), orange cheek waxbill (*Estrilda melpoda*), and cattle egret were all abundant in the project area. The ant bird, an understory species, was evident after rainfall events in the riparian areas, and Harrier hawks (*Polyboroides typus*) were noted during, field work, flying over the canopy of the adjacent forest.

#### 4.4.2.3 Herpetofauna

Herpetofauna include the species from the ectothermic (*cold-blooded*) animal families, amphibians and reptiles. Species from these families can be found on both land and in water/wetlands. The overall herptofauna population in the project area is poor, and only a few snakes, small lizards, and frog species were directly observed. Reptiles observed in the Project area included lizards (brown/green), Cassava snake, black snake, brown lizard and boa constrictor; amphibians observed included the spring frog and the toad frog. It is also anticipated that tadpoles would be found during the rainy season.

#### 4.4.2.4 Fish

Fish species listed by the residents were identified by the local names and included catfish,
crayfish, tilapia, bonny, sunfish, and mudfish. Locals also indicated that there were crabs in the Du River.

4.4.3 Rare or Endangered Species

No evidence of rare or endangered species were encountered along the right-of-way during field surveys. Since, the transmission line crosses mostly in urban and agricultural areas, no rare or endangered are expected to occur in its vicinity. However, a previous work done in the area for the Buchanan Renewables Power Inc.\textsuperscript{10} noted the possible presence of the Water Chevrotain near the previously proposed BR Power Power plant in Kakata. Although not included in the IUCN red list of endangered species, the Water Chevrotain (\textit{Hyemoschus aquaticus}) is an angulated mammal protected in Liberia by the Forestry Development Authority (FDA). The FDA is, by law, the authority responsible for establishing and maintaining lists of endangered species of Liberia. The Water Chevrotain is found mostly near rivers and creeks of closed-canopy, moist tropical lowland forest.\textsuperscript{11}

4.4.4 Nuisance Species, Pests, and Vectors

Nuisance species, pests, and vectors are all threats to the biodiversity of plants and animals of an area. Biodiversity provides the source of harvestable goods including food, medicines, and building materials; is necessary for the regulation of natural processes such as carbon sequestration, soil formation, and water purification; is essential for pollination; and helps control pest species and disease

4.4.4.1 Nuisance Species

Nuisance species are not dangerous or toxic, but can negatively disrupt ecosystems and environments. In Liberia, nuisance species are primarily alien invasive species (AIS) which have crossed natural barriers and entered ecosystems where they have not previously existed. AIS are currently the second biggest threat to biodiversity after habitat loss.\textsuperscript{12} The invasive alien species found in Liberia are summarized in Table 4-6.

AIS were not documented or observed in along the transmission line route; yet, those that


could possibly exist in the project area include: *Bidens pilosa*, *Chromolaena odorata*, *Eichhornia crassipes*, *Lantana camara*, *Solenopsis geminata* and *Vibrio cholerae*.

The Liberian Ministry of Agriculture is responsible for regulating and quarantining the entry of alien species. However due to the ministry’s limited capacity, an inventory of the alien and invasive species has not been conducted nor have techniques been developed to control the spread of these species.

Table 4-6 Invasive Alien Species of Liberia

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Bidens pilosa</em></td>
<td>Major crop weed, threat to native fauna, and a physical nuisance.</td>
</tr>
<tr>
<td><em>Chromolaena odorata</em></td>
<td>A fast-growing perennial shrub that is a nuisance agricultural weed.</td>
</tr>
<tr>
<td><em>Eichhornia crassipes</em></td>
<td>Water hyacinth; may choke slow moving to still water bodies and prevent beneficial use for fishing or navigation.</td>
</tr>
<tr>
<td><em>Hypnea musciformis</em></td>
<td>Marine algae that forms thick, unpleasant-smelling mats.</td>
</tr>
<tr>
<td><em>Lantana camara</em></td>
<td>Herb and serious agricultural weed.</td>
</tr>
<tr>
<td><em>Leucaena leucocephala</em></td>
<td>Agroforestry tree that can invade semi-natural or natural habitats which are of conservation interest.</td>
</tr>
<tr>
<td><em>Solenopsis geminata</em></td>
<td>Fire ant that destroys native ant communities, harms agriculture, and is a painful pest to humans.</td>
</tr>
<tr>
<td><em>Vibrio cholerae</em></td>
<td>Bacteria that causes cholera</td>
</tr>
</tbody>
</table>


### 4.4.4.2 Pests

The two major pest species found in the project area and throughout Liberia are the mosquito and variegated grasshopper (*Zonocerus variegates*).  

There are numerous species of mosquitoes known in Liberia, and while not all the species feed on humans, many do, creating welts on their victims. Mosquitoes need standing or stagnant water to reproduce, so human activities from damming or impounding water can increase mosquito numbers on a local level.

The variegated grasshopper is known to attack cassava fields and can cause substantial yield losses. Large destructive numbers of the grasshopper have been linked to the increase in suitable habitat and breeding space created by the invasive plant *Chromolaena odorata* (Table 4-7).

The low lying areas (seasonal wetlands) in the project area retain water during the wet
season and may provide stagnant water for mosquitoes.\textsuperscript{14}

### 4.4.4.3 Vectors

Vectors are an agent that carries or transmits disease. Mosquitoes are not only pests but are the primary vectors of diseases in humans such as malaria. In Liberia, malaria is the leading cause of morbidity and mortality, accounting for over 40\% of all outpatient consultations, 18\% of inpatient deaths, and approximately 21,000 deaths annually among children under the age of five. All mosquito species must have water in which to complete their lifecycle. While mosquitoes need stagnant water to lay eggs and for larval development, the quality and location of water can vary from water collected in tree holes, tidal pools in salt marshes, sewage effluent ponds, irrigation pastures, temporary rain water ponds, etc. Human development and increase in changing land use are the leading cause in creating more available reproductive locations for mosquitoes.

The low lying areas (seasonal wetlands) in the project area retain water during the wet season and may provide stagnant water for mosquitoes.

### 4.4.5 Protected Areas

#### 4.4.5.1 Ramsar Wetlands of International Importance

Liberia is endowed with wetlands that provide both subsistence and economic benefits to its many inhabitants. Like wetlands all over the world, they have become overburdened by human induced activities.

The National Environmental Policy of Liberia explains that the importance of wetlands are not fully understood, and that wetlands are threatened with degradation due to factors such as: pressure from firewood gatherers and charcoal producers, uncontrolled solid and liquid wastes, unregulated settlements near wetlands, agriculture production and industrial expansion and other constructions. Some strategic actions recommended by the National Environmental Policy (2003) include:

- Establishment of full protection status for wetlands of biodiversity significance
- Development of wetlands policy and management plans

• Inventory of wetlands

Part VI, sections 74 and 75 of the Environment Protection and Management Law of Liberia deal with management and protection of wetlands. The Law provides for a penalty of US$5,000.00 (Five Thousand United States Dollars) or imprisonment for a period not exceeding two years for violators.

Eight (8) wetlands have been identified in Liberia (Table 4-7), of which five are designated as Ramsar Wetlands of International Importance, these are: Lake Piso, Mesurado, Marshall, Gbedin and Kpatawee Wetlands.

Table 4-7 Wetlands of Liberia

<table>
<thead>
<tr>
<th>Wetland</th>
<th>Type</th>
<th>Size (acres)</th>
<th>Location</th>
<th>Conservation status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Piso</td>
<td>Coastal Lacustrine</td>
<td>76,091</td>
<td>Cape Mount County</td>
<td>Proposed Nature Reserve, RAMSAR Wetland</td>
</tr>
<tr>
<td>Marshall</td>
<td>Coastal Lacustrine</td>
<td>38,500</td>
<td>Margibi County</td>
<td>Proposed Nature Reserve, RAMSAR Wetland</td>
</tr>
<tr>
<td>Mesurado</td>
<td>Coastal</td>
<td>22,000</td>
<td>Montserrado County</td>
<td>RAMSAR Wetland</td>
</tr>
<tr>
<td>Bafu Bay</td>
<td>Coastal</td>
<td>11,900</td>
<td>Sinoe County</td>
<td>None</td>
</tr>
<tr>
<td>Lake Shepherd</td>
<td>Coastal</td>
<td>18,000</td>
<td>Maryland County</td>
<td>None</td>
</tr>
<tr>
<td>Cestos-Senkwehn</td>
<td>Inland Riverine</td>
<td>15,000</td>
<td>Sinoe County and Rivercess County</td>
<td>Proposed Nature Reserve</td>
</tr>
<tr>
<td>Gbedin</td>
<td>Inland Riverine</td>
<td>11,200</td>
<td>Nimba County</td>
<td>RAMSAR Wetland</td>
</tr>
<tr>
<td>Kpatawee</td>
<td>Inland Riverine</td>
<td>8,800</td>
<td>Bong County</td>
<td>RAMSAR Wetland</td>
</tr>
</tbody>
</table>


As shown in Figure 4-16, the transmission line does not cross the Ramsar Wetlands. However, Mesurado Wetland, home to many bird species, is less than 3 km away of the lower section of the line route.
4.4.5.1.1 Mesurado Wetlands

Located in the capital city Monrovia, Montserrado County, the Mesurado Wetlands (6,760 ha) are important for the protection of three mangrove species (*Rhizophora harrisonii*, *R. mangle* and *Avicennia africana*). It provides a favorable habitat and feeding ground for several species of birds including the African spoonbill (*Platalea alba*), common pratincole (*Glareola pratincola*) and Eurasian curlew (*Numenius arquata*). It also hosts the vulnerable African dwarf crocodile (*Osteolaemus tetraspis*), the Nile crocodile (*Crocodylus niloticus*) and the African sharp-nosed crocodile (*Crocodylus cataphractus*) and plays an important role in shoreline stabilization and sediment trapping. The site is currently threatened by: deforestation for fuel wood and charcoal collection, solid waste disposal, unregulated fishing (including the use dynamite), industrial pollution including paint factories. No management plan currently exists, but there are plans to put this wetland site under a
protected area management.

Figure 4-17 Mesurado Wetland (dark green area) in the vicinity of the transmission line (white line) (Google earth, 2011)

### 4.4.5.2 Nationally Protected Areas

Nationally protected areas of Liberia are shown on Figure 4-18. None occur within or in the vicinity of the transmission line route. The nearest Nationally Protected Area to the project area is the Kpelle which is a National forest located approximately within a 65 km distance northeast of the BR Power station.

Liberia’s protected areas are all terrestrial ecosystems with no protected marine areas. The country has two categories of protected areas, partially protected and fully protected. Currently there are 11 partially protected national forest reserves and two fully protected national parks/reserves.\(^{15}\) On partially protected lands, timber concessions can be leased out, but activities such as hunting, fishing, farming, and human settlements are prohibited. These partially protected areas are located primarily in southeast and northwest Liberia and comprise approximately 5.8 percent of the total area of Liberia. The two fully protected areas

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are the Sapo National Park and the East Nimba Nature Reserve. Sapo National Park is comprised of lowland forest and is located in southeastern Liberia. Mount Nimba Nature Reserve is located in northern Liberia within the Sanokole quadrangle, sharing a massif with Guinea and Cote d’Ivoire. This mountainous area is the wintering site for numerous species of migratory birds. Together these two fully protected areas comprise approximately 1.86% of Liberia.

![Liberia's National Forests](image)

**Figure 4-18 Protected Areas and Nature Reserves of Liberia (Source: Modified from Conservation International, Liberia Forest Re-assessment, 2004)**

### 4.4.5.3 Key Biodiversity Areas

In addition to national protection, Liberia remains an international priority area for conservation. For example, in December 1999 the Global Environmental Facility (GEF) funded the West African Conservation priority-setting exercise for the Upper Guinea Ecosystem. The project identified Liberia as a top priority country in West Africa for conservation purposes since 41% of its area is designated as being of exceptionally high biological importance. In September 2002, the West African chimpanzee conservation identified the southeastern Liberia forest block as one of the highest or top priority rainforest sites for chimpanzees.
In 2007, the International Union for Conservation of Nature (IUCN) identified Key Biodiversity Areas in Liberia (as shown in Figure 4-19)\(^\text{16}\). These areas are not legally protected, but are designated based on quantitative criteria based on manageable land units defined by local experts using global standards. Criteria include: presence of globally threatened species; significant populations of restricted range species; a representative sample of biome-restricted species; and, important congregations of species. This methodology was pioneered by Birdlife International, which also identified nine important bird areas in Liberia. These are: Cape Mount, Cestos-Senkwehn, Grebo, Lofa-Gola- Mano Complex, Nimba Mountains, Sapo National Park, Wologizi Mountains, Wonegizi Mountains, and Zwendru.

As Figure 4-19 shows, none of the key biodiversity and important bird areas occurs in the vicinity of the project site.

![Figure 4-19: Proposed National Parks and Key Biodiversity Areas in Liberia (Source: Birdlife International, Conservation International, IUCN, UNEP and WCMC. 2008. Integrated Biodiversity Assessment Tool)](image)

4.5 **RENEWABLE AND NON-RENEWABLE RESOURCES**

Liberia is richly endowed with renewable and non-renewable natural resources. Renewable

resources include: water, forests, renewable energy resources such as biomass and hydropower. Liberia has also a soil and a climate favorable for agriculture. Non renewable resources in Liberia are mainly mineral resources and petroleum.

4.5.1 Water

Rainfall is the principal contributor of water to surface waterbodies, feeding surface waterbodies through run-off. The waterbodies, including wetlands constitute about 12% of the surface area of Liberia. The principal rivers that support the watersheds are Mano, Lofa, St. Paul, Cestos, Cavalla and St. John rivers. Groundwater is also abundant throughout the country. Recharge of the groundwater is based on the heavy tropical rainfall as well as the network of watersheds. Groundwater in Liberia though of relatively high quality, has not been fully developed. 17

4.5.2 Forests

By the end of 2000 Liberia contained 42 % of the Upper Guinea Forest of West Africa; the largest portion possessed by a single country in the region. The Liberia Forest Re-assessment Project estimates that today the 4,3 million hectares of forest remaining in Liberia are being reduced by 0,3 percent every year. The two remaining dense forest areas are now found in the northwest (semi-deciduous forest) and southeast (evergreen forest) of the country separated and isolated from each other by a corridor extending from Monrovia to Nimba County. 18 In fact, the transmission line crosses in the middle of this corridor; hence it is very far from important forest areas of the country. Timber and rubber are the main products of the Liberian forests.

4.6 HUMAN ENVIRONMENT/ SOCIO-ECONOMICS

4.6.1 Demographics

4.6.1.1 Demographics of Montserrado County and its affected Districts

Home to the country’s capital Monrovia, Montserrado County presents the highest population of all the counties of Liberia although it is the smallest county. Regarding population density, the county is considered to be very dense with an estimated population density of 1,540 persons per square mile.\textsuperscript{19} According to the 2008 National Population and Housing Census, around one third (32\%) of the Liberian population live in Montserrado

County, of which more than 85% reside in Greater Monrovia. The Greater Monrovia District, the most populous district in the nation, has a population of 970,824 people. The distribution of the county’s population and its affected districts is described in Table 4-8.

Table 4-8 Distribution of Population in Montserrado and Margibi counties in 2008 (LISGIS, 2009)

<table>
<thead>
<tr>
<th>County/District</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Montserrado County</td>
<td>549,733</td>
<td>568,508</td>
<td>1,118,241</td>
</tr>
<tr>
<td>Careysburg District</td>
<td>15,048</td>
<td>14,664</td>
<td>29,712</td>
</tr>
<tr>
<td>Greater Monrovia District</td>
<td>476,473</td>
<td>494,351</td>
<td>970,824</td>
</tr>
<tr>
<td>Todee District</td>
<td>17,479</td>
<td>16,519</td>
<td>33,998</td>
</tr>
</tbody>
</table>

4.6.1.2 Demographics of Margibi County and Mambah Kaba District

Margibi County’s population is estimated at 209,923 with a population density of 200 persons per square mile, thus it is considered as a densely populated region in comparison to other counties of Liberia. The distribution of the county’s population and Mambah Kaba district is described in Table 4-9.

Table 4-9 Distribution of Population in Margibi county and Mambah Kaba District in 2008 (LISGIS, 2009)

<table>
<thead>
<tr>
<th>County/District</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Margibi County</td>
<td>105,840</td>
<td>104,083</td>
<td>209,923</td>
</tr>
<tr>
<td>Mambah Kaba District</td>
<td>22,586</td>
<td>22,395</td>
<td>44,981</td>
</tr>
</tbody>
</table>

4.6.2 Infrastructure

4.6.2.1 Water and Sanitation

On a national level, 25% of Liberians have access to safe drinking water and 15% have access to human waste collection and disposal facilities.

4.6.2.1.1 Water and Sanitation in Montserrado County

The Mount Coffee Hydro Electric dam (Mt. Coffee hydro dam) and the White Plains Water Treatment Plant, both in Careysburg District, ensured a constant supply of water to the Montserrado County before the war. However, the destruction of the Mt. Coffee hydro dam during the war halted the plant’s water supply. Thus the plant currently relies on onsite river intake from the St-Paul River. The plant currently supplies about 3 million gallons of water a day to parts of Monrovia so that the majority of the population relies on pumps and wells as their main source of water (Figure 4-21a).

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20 LISGIS, 2009
21 LISGIS, 2009.
The only functioning sewage system in the country is in Monrovia with an under-capacity sewage treatment plant that has not functioned consistently for more than ten years. Occasionally, the mains are fractured causing outflow on to the streets or into the sea and local rivers. Less than 30% of the residents have access to in-house or shared toilet facilities (Figure 4-21b).

![Montserrado County](Image)

Figure 4-21 Distribution of households (a) by main source of drinking water and (b) by means of human waste disposal in Montserrado county (adapted from 2008 Population and Housing Census)

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4.6.2.1.2 Water and Sanitation in Margibi County

Prior to the war, most parts of Margibi County had water and sewage systems. These systems have since broken down, leaving the population even in the cities without improved water and sanitation facilities.23 The majority of the residents rely on available outdoor water pumps, wells, rivers, springs and lakes for their water (Figure 4-22a). Only 8.2% of the population uses in-house or shared toilets and about two-third use the bush for defecation (Figure 4-22b).

Figure 4-22 Distribution of households (a) by main source of drinking water and (b) by households by means

of human waste disposal in Margibi county (adapted from 2008 Population and Housing Census)

4.6.2.1.3 Water and Sanitation in Project Area

Communities within the project area rely primarily on local waterbodies for their water needs. Shallow water wells are also used occasionally when surface water supply is low and if access to the surface water source is restricted. Communities surrounding the project area obtain most of the water needed for domestic and agricultural uses from the various streams and creeks crossing the study area as well as shallow wells.

Sanitation services are limited in the project area; therefore, the majority of residents use pit latrines, toilets connected to septic tanks, open defecation, or dispose of feces in surface waterbodies or with domestic waste. These practices lead to contamination of ground and surface water which poses a risk to human health.

Wells and public toilets were counted and located along the LEC RoW. Survey results indicated that a total of 17 wells exist on the right side of the Monrovia-Kakata Highway, while 17 wells are located on the left side of the highway, within the 150-foot-wide LEC RoW. In addition, three water reservoirs were identified within the RoW, all located on the right side of the Monrovia-Kakata Highway, in Greater Monrovia District. The distribution of these structures on both sides of Monrovia-Kakata highway in the various affected districts is described in Table 4-10. On the other hand, no public toilets were identified within the RoW.

Table 4-10 Distribution of water sources within the LEC RoW

<table>
<thead>
<tr>
<th>Type of Structure</th>
<th>Careysburg</th>
<th>Greater Monrovia</th>
<th>Todee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wells</td>
<td>R* 7</td>
<td>L** 8</td>
<td>Total*** 15</td>
</tr>
<tr>
<td>Wells</td>
<td>R* 6</td>
<td>L** 8</td>
<td>Total*** 14</td>
</tr>
<tr>
<td>Wells</td>
<td>R* 1</td>
<td>L** 1</td>
<td>Total*** 2</td>
</tr>
<tr>
<td>Wells</td>
<td>R* 3</td>
<td>L** 0</td>
<td>Total*** 3</td>
</tr>
<tr>
<td>Wells</td>
<td>R* 0</td>
<td>L** 0</td>
<td>Total*** 0</td>
</tr>
</tbody>
</table>

*“R” refers to the number of structures on the right side of Monrovia-Kakata Highway
**“L” refers to the number of structures on the left side of Monrovia-Kakata Highway
***“Total” refers to number of structures on both sides of Monrovia-Kakata Highway

4.6.2.2 Energy Infrastructure in Project Area

Figure 4-23 describes the utilization of the different sources of fuel for lightning in Montserrado and Margibi households.

The 56 km of 66 kV transmission line is proposed to be re-installed on the GOL-LEC right-of-way along the Kakata-Monrovia Highway. During the survey the old transmission line
that existed before the war was not seen to exist along the highway with the exception of few locations. Also, the majority of the old poles along the highway are cut (Figure 4-24), while few stand untouched (Appendix C).

Figure 4-23 Distribution of Households by Source of Fuel for Lighting in Margibi County in 2008 (adapted from 2008 Population and Housing Census); Distribution of Households by Source of Fuel for Lighting in Montserrado County in 2008 (adapted from 2008 Population and Housing Census)
Figure 4-24 Photos Showing Old Poles Along The Kakata-Monrovia Highway. Most Of The Structures Seen Near The Poles Were Newly Constructed

4.6.3 Land Use Pattern

The territory and natural resources of Liberia face pressures from a number of competing sources, including forestry, mining, agriculture and human settlements with forests covering around 45% of the total land.24 Land-use planning and zoning regulations are virtually non-existent. Consequently, land is not classified based on productivity.25

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24 UNEP, 2004
25 UNEP, 2004
4.6.3.1 Land Use in Project Area

The transmission line right-of-way will follow the route of a previous GOL-LEC transmission line right-of-way that will continue to be owned by the GOL-LEC. Along the transmission line route, land is mainly used for agriculture and rubber farming. Cultivation of cash crops includes bananas, plantains, eddoes, cassava, okra, peppers, and bitter balls occur. Land not under cultivation consists of native grasses and shrubs as well as some stretches of secondary growth used for hunting and charcoal production.

The field survey conducted by Earthtime identified the different categories of land use along the LEC RoW. Results of these surveys are summarized in the different sections of this chapter and detailed in the appendices. In general, the land along the RoW showed to be exploited in different ways. Structures along the RoW included: farms, business centers, infrastructural structures, households, churches, grave yards, medical centers, bus stops, public places, educational centers and more.

4.6.4 Cultural and Historically Significant Resources in Project Area

Traditional and western lifestyles coexist. However, traditional values, customs, and norms influence the Western lifestyle characteristics considerably. In cities, both Western and African music and dancing styles are in vogue, but in rural areas traditional rhythms are favored. Schools instruct students in the legends, traditions, songs, arts, and crafts of African culture, and the government promotes African culture through agencies such as the National Museum in Monrovia and the Tubman Center for African Culture in Robertsport.

Africa's oldest republic, Liberia has a unique history that has always drawn foreigners to the small West African nation state. Africa's former "Grain Coast", has a wealth of mineral and natural resources, among which its virgin tourism industry represents a promising new source for economic and social development, including infrastructure development.

The Liberian culture is endowed with a wide variety of artisanal crafts that can be found anywhere across the length and breadth of the country, ranging from the intricately designed bamboo furniture to the well sculptured mahogany figurines depicting typical Liberian cultural themes.

Field survey revealed the existence of three graves on the right side and 4 graves on the left
side of the Monrovia-Kakata highway within the existing 150-foot-wide LEC RoW (Table 4-11).

Table 4-11: Locations of Graves within or near the LEC RoW.

<table>
<thead>
<tr>
<th>Y</th>
<th>X</th>
<th>District</th>
<th>Town</th>
<th>Distance from Road (m)</th>
<th>Side of Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>704706.3</td>
<td>321969.4</td>
<td>Careysburg</td>
<td>Blacktom</td>
<td>23</td>
<td>Right</td>
</tr>
<tr>
<td>707792.6</td>
<td>333189.6</td>
<td>Careysburg</td>
<td>NO DATA</td>
<td>20</td>
<td>Left</td>
</tr>
<tr>
<td>707096.2</td>
<td>324990.3</td>
<td>Careysburg</td>
<td>King Farm</td>
<td>20</td>
<td>Left</td>
</tr>
<tr>
<td>707830.1</td>
<td>333078.9</td>
<td>Careysburg</td>
<td>New Land Community</td>
<td>20</td>
<td>Left</td>
</tr>
<tr>
<td>709275.6</td>
<td>336789.4</td>
<td>Careysburg</td>
<td>Fifteen Gate</td>
<td>23</td>
<td>Left</td>
</tr>
<tr>
<td>699496.6</td>
<td>316167.2</td>
<td>Greater Monrovia</td>
<td>Bernard farm</td>
<td>23</td>
<td>Right</td>
</tr>
</tbody>
</table>

Some of the graves exist at a close distance to the poles of the previous transmission line. In addition to graves, churches also exist within the LEC RoW and close to the poles of the previous transmission line as shown Figure 4-25, and Figure 4-26.

![Figure 4-25 Distribution of graves along the route](image)

*Figure 4-25 Distribution of graves along the route*
Figure 4-26 Church (a), (b) Grave Yard along the RoW; (c) Grave near the LEC pre-existing transmission line pole
5 ENVIRONMENTAL IMPACT ASSESSMENT AND ANALYSIS

This chapter examines the potential environmental impacts associated with the proposed activities of the Transmission Line. The typical elements that are affected by the project’s activities are classified into two categories: the social environment and the physical environment (Figure 5-1). The social environment includes social concerns such as human resources, services, human attitude and adaptation that could have influences on social characteristics of surrounding communities. The physical environment is concerned with potential contamination of surface and/or groundwater contamination, visual intrusions, biodiversity, traffic, waste management, and soil all of which could lead to alterations in the abiotic and biotic environment.

![Diagram](image.png)

Figure 5-1 Typical elements that are affected by the project

The electric power transmission system includes the transmission line, towers, its right-of-way (RoW), switchyards, Paynesville Substation, access points, and material storage areas. The principle structures of the transmission line include the line itself, conductors, towers and supports. A map illustrating the transmission line route and proposed tower locations is presented in Appendix A.

Construction of the proposed transmission towers will require an 8 meter square temporary construction work area at each tower location. The permanent footprint of each tower will be approximately 6 square meters at each tower location.
5.1 IMPACT IDENTIFICATION

Impact identification involves documenting all possible events that could lead to hazardous incidents. It is a systematic process listing potential causes and consequences. Reference is also made to proposed operational and organizational safeguards (and their basis) that would prevent any possible hazardous events from occurring, or should they occur, that would mitigate the impact on the system, its equipment, community and the surrounding environment. This process enables the establishment, at least in principle, of the adequacy and relevancy of proposed safeguards.

The aim of the impact identification is to highlight all possible residual risks associated with the interaction of the project activities (as a whole) with the surrounding environment, so as to identify the worst case scenario. Whereas some impacts could be of short-term significance, others could be of long-term due to the cumulative impact of the projects operations over several years and across several hectares.

Table 5-1 presents a summary of the main activities and the potential receptors affected by the Project. The described impacts are potential impacts from the main activities during construction and operation of the Transmission Line. The likely significance and type of these impacts has been indicated based on professional judgment, field observations, as well as experience from similar facilities abroad as reported in the literature.

As the ESIA activities continue, these impacts will be further assessed to determine the likelihood and consequence of each. For those impacts that are found to be significant, a mitigation, management or monitoring measure will be implemented.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
<th>Receptor</th>
</tr>
</thead>
</table>
| Construction   | Short-term¹ | • Air Quality
                |           | • Soil Quality
                |           | • Biological Resources
                |           | • Water Quality
                |           | • Health and Safety
                |           | • Noise
                |           | • Socio-Economic

¹ Short-term:~6 month
## 5.2 Impact on Natural Environment

### 5.2.1 Water Resources

#### 5.2.1.1 Surface Water

Surface waters, such as rivers and swamps existing in the project area, may become polluted as a result of accidental spills of oil, runoff, erosion, and sediment transport. The latter impact is particularly significant when construction activities occur within or in close proximity to surface water. Sediment laden or polluted stormwater runoff flowing into surface waterbodies could impact the aquatic organisms and affect the quality of life of downstream users. In addition, a significant increase of sediment influx into surface waters may result in reduced reservoir capacities and increased flooding in downstream reaches of rivers and streams. The Contractor will be required to implement sediment and erosion controls to prevent sedimentation in storm water runoff and spill contingency measures to prevent spills and releases of oil and hazardous materials.

*Stormwater runoff from construction work areas will have minor short-term impacts on water quality. Waters disturbed by construction activities are likely to recover when sediment is controlled and natural processes are permitted to replenish marine life. Information regarding mitigation measures designed to reduce the impacts of construction on water quality, see Section 6. It is not expected that operation of the transmission line will impact surface water quality.*

#### 5.2.1.2 Ground Water

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
<th>Receptor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation &amp; Maintenance</td>
<td>Long-term²</td>
<td>• Soil Quality&lt;br&gt; • Biodiversity&lt;br&gt; • Health and Safety&lt;br&gt; • Landscape and Visual Amenity&lt;br&gt; • Socio-Economic&lt;br&gt; • Cumulative</td>
</tr>
</tbody>
</table>

² Long-term: longer than 2 years
Groundwater withdrawal will not be conducted as part of the Project construction or operations, therefore impacts to groundwater flow are not anticipated. The concrete foundations for the towers may result in minor impacts to the quantity, distribution, and time-related recharge of precipitation to groundwater. The concrete foundations will be installed at each corner of the towers rather than encompassing the entire base of the tower. Groundwater contamination may occur from percolation of oil and lubricants in soil. LEC will implement spill prevention measures to avoid contamination of the groundwater by fuel or chemicals.

*It is not expected that construction and operation of the transmission line will impact groundwater quality. Refer to Section 6 for mitigation measures.*

### 5.2.2 Soil

Grading at construction work areas will alter the topographic height, slope, relief intensity, degree of shaping, and exposure of soils. During construction activities, soil erosion may be caused by exposure of soil surfaces to rain and wind during site vegetation clearing, earth moving, and excavation and construction activities. The resulting soil particles may be transported into surface drainage networks thus affecting the quality of natural water systems and ultimately the biological systems using the waters.

Accidental spill of oil or lubricant from construction and maintenance activities may infiltrate and contaminate the soil. The soil may also become contaminated with pesticide residue used to maintain vegetation along the transmission line corridor during operations.

*The Project’s impacts on soils is considered short-term and minor. Refer to Section 6 regarding mitigation measures.*

### 5.2.3 Landscape & Visual Intrusion

During the construction phase, temporary material storage areas, vegetation clearing, soil piles and increased traffic will result in short-term visual intrusion on the landscape. The transmission line will be installed within the existing LEC RoW following the previous transmission line route to the maximum extent practical.

*Impact on landscape and visual intrusion during construction and operation of the transmission line*
5.2.4 Terrestrial Habitat Alteration

The construction of the transmission line right-of-way will result in alteration and disruption to terrestrial habitat, including impacts to avian species and an increased risk of forest fires. Right-of-way construction activities will transform habitats, depending on the characteristics of existing vegetation, topographic features, and installed height of the transmission lines. Examples of habitat alteration from these activities includes fragmentation of forested habitat; loss of wildlife habitat, including for nesting; establishment of non-native invasive plant species; and visual and auditory disturbance due to the presence of machinery, construction workers, transmission towers, and associated equipment. Vegetation clearing will be limited to the tower locations, access points, and material storage areas. The transmission line will be installed within the existing LEC RoW which is comprised of previously disturbed developed and undeveloped land. Vegetation within the undeveloped areas of the LEC RoW has been maintained; therefore limited clearing of mature trees will be required. No critical habitat exists within the project area.

Unchecked growth of tall trees and accumulation of vegetation within rights-of-way may result in a number of impacts, including power outages through contact of branches and trees with transmission lines and towers; ignition of forest and brush fires; corrosion of steel equipment; blocking of equipment access; and interference with critical grounding equipment. Regular maintenance of rights-of-way to control vegetation will involve the use of mechanical methods, such as mowing or pruning machinery that may disrupt wildlife and their habitats, in addition to manual hand clearing. Vegetation management within the transmission line corridor will focus on the selective removal of tall growing tress and plant growth that would negatively affect the transmission lines and equipment.

*Construction and operation of the transmission line will have minor direct short-term impacts on the terrestrial habitat in the project area. See Section 6 for mitigation measures to reduce these impacts.*

5.2.5 Alteration of Aquatic Habitats

The proposed transmission line route crosses several rivers and streams, such as Yokata Creek, Yobrum Creek, Bo Creek, Muu Creek and several other unnamed streams. Soil
erosion from construction and decommissioning activities may result in siltation of watercourses. This impact is however expected to be minimal and the removal of riparian vegetation temporary. At each tower site there will be four holes dug to a depth of approximately 5 m for the foundations; no major earthworks will be involved in this project. Impacts to aquatic habits may also result from accidental spills of oil, paint or hazardous material during the construction and operations and maintenance of the transmission line. This can result in pollutants entering nearby surface waterbodies, and may affect aquatic habitats detrimentally. However, the projected impact is very small and time-limited, and is of low significance.

Construction and operation of the transmission line will have minor direct short-term impacts on the aquatic habitat in the project area. See Section 6 for mitigation measures to reduce these impacts

5.2.6 Wildlife Species

The Project will not result in a major alteration to the surrounding ecosystems or impact the viability composition of the wildlife communities. Apart from the increased risk of collision of birds with the transmission line (discussed in section 5.2.7 below), the construction phase is not expected to have significant negative impact on wildlife owing to the limited area of vegetation clearing and low wildlife density in the transmission line corridor. The transmission line runs parallel to the Monrovia-Kakata Highway and does not cross through any protected areas. The behavior of wildlife species in this area precludes any significant negative impacts although some species may be affected during the construction phase. Noise from operation of construction equipment may alter some species behavior (i.e. cause to move away from the RoW). However, the relatively small footprint will allow for free movement around the construction work areas. Building raptors’ platforms on top of pylons for roosting and nesting where possible, will result in a small positive impact on wildlife avian species in the area of the transmission line.

Construction and operation of the Project will have minor direct and indirect short-term impacts on wildlife in the project area.

5.2.7 Collision of Birds with the Transmission Line
Collisions will be a major cause of unnatural mortality for several species of threatened birds. Recent studies found that collision risk will rise with the voltage and the number of conductor levels. The utmost highest collision risk will be for large terrestrial birds where the earth wires are mounted ahead of the conductors. Some 80% of bird collisions happen at the earth wire. Birds migrating nightly will be the most endangered, as they cannot see the earth wire and may collide with it when trying to avoid collision with conductors, which are more noticeable due to their electromagnetic field.

*Operation of the transmission line will have direct long-term impacts on avian species in the area. See Section 6 for mitigation measures.*

### 5.2.8 Hazardous Materials

Hazardous materials pose a severe risk to surface and ground water sources when released into the environment. Fuels and lubricant used for operation and maintenance of vehicles and machinery, insulating oils, and herbicides will be transported, stored and used during the construction and operation phases of the Project. These activities will pose a certain risk of accidental discharge of hazardous materials to the environment. Sites prone to such events will be the material storage areas with storage and maintenance facilities, as well as, the tower locations where construction and maintenance activities will occur.

*The potential for hazardous material spills which may impact environmental resources are greater during construction of the transmission line. The measures that will be implemented to reduce impacts resulting from hazardous material transportation, storage, and use during construction and operation of the transmission line are discussed in Section 6.*

### 5.2.9 Waste

The material storage area, construction offices, and construction sites will be sources of scrap metal, oil contaminated waste, household waste, cleared solid waste debris, backfill earthwork and other construction wastes. If the piling and transportation of these waste materials is not managed properly, the waste will block traffic and contaminate the surrounding environment. Long term random piling may also deteriorate the air quality due to the flying dust and could result in respiratory problems to the people living in nearby areas.
Used lubricants, paints, oils and other chemicals may also pose risks if improperly handled and/or disposed of, including soil and groundwater contamination and health and safety hazards.

As a "good practice", contractors must collect, recycle and dispose of these wastes at designated facilities. Sewerage systems are not commonly available in the villages affected by the transmission line, and pit latrines are hence more commonly used in the area. The temporal presence of 80 people in a larger village or smaller town will cause no relevant additional environmental pollution, if the contractors use the same method. Hence, there will be no relevant impact on environment from these potential pollution sources.

5.2.10 Air Quality and Dust

Transmission line construction may result in the release of fugitive particulate matter (PM) generated from land clearing, excavation, movement of earth materials, contact of construction machinery with bare soil, traffic movement on unpaved roads, and exposure of bare soil and soil piles to wind. In addition, the use of construction equipment and power generators is expected to release exhaust related pollutants such as carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), particulate matter (PM) and volatile organic compounds (VOCs).

Air emissions during the construction phase tend to be confined to the immediate vicinity of the site and are temporary in nature. The construction emissions associated with the transmission line will be intermittent and temporary with construction scheduled for approximate 12 month duration and are therefore expected to have insignificant impacts on the long-term air quality in the region.

Maintenance of the transmission line will have minor short-term combustion emissions from equipment and vehicles.

*Construction and operation of the Project will have minor, short-term impacts to air quality. For information regarding the mitigation measures designed to reduce the impacts of construction on air quality, see Section 6.*

5.2.11 Noise
During construction activities, noise may be caused by the operation of heavy-duty machinery, generators, and concrete mixers.

The increased noise level will impact construction workers and nearby residential areas. Nevertheless, the latter impact will be limited to the construction phase and will cease when the construction activities are complete. Table 5-2 shows typical noise levels encountered during construction activities.

The increase in vehicular traffic during construction will also result in a noise increase along the transmission line corridor.

Table 5-2 Noise levels during rehabilitation and construction works

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Typical maximum noise level at 15 m (dBA)</th>
<th>World Bank Guideline for acceptable noise level³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete pouring trucks</td>
<td>87</td>
<td>Residential / Institutional / Educational:</td>
</tr>
<tr>
<td>Cranes</td>
<td>86</td>
<td>• Daytime: 55 dBA</td>
</tr>
<tr>
<td>Air compressors</td>
<td>89</td>
<td>• Nighttime: 45 dBA</td>
</tr>
<tr>
<td>Excavation equipment</td>
<td>90</td>
<td>Industrial / Commercial:</td>
</tr>
<tr>
<td>Welders</td>
<td>73</td>
<td>• Daytime and nighttime: 70 dBA</td>
</tr>
<tr>
<td>Diesel locomotives</td>
<td>97</td>
<td></td>
</tr>
<tr>
<td>Dump trucks</td>
<td>87</td>
<td></td>
</tr>
</tbody>
</table>

The acoustic noise produced by transmission lines is greater with high voltage power lines; high voltage power lines (400-800kV) generate discharges producing what is known as a “corona effect” which in turn gives rise to crackling and frying noises that may even be audible in dry weather. With this project noise impact will be insignificant as it involves the installation of 66kV voltage lines.

Unusual noise from transformers may also occur where there is loss of core-bolts, core plates, coil clamps, loose external fittings and mechanical forces due to short circuits. Noise from transmission lines and humming around transformers can also occur and has a tendency to increase in times of rain and fog.

Construction and operation of the transmission line will have minor short-term impacts to existing noise levels in the project area, however, no adverse impact on the human population is anticipated

**5.3 IMPACTS ON HEALTH AND SAFETY**

5.3.1 Electrocution

Due to the nature of the transmission line project, employees risk electrocution during the operations phase especially should operation guidelines and safety measures not continuously be followed.

The transmission towers are often seen as a challenge for playing children. The extreme danger connected to this activity is often not understood or respected by adventurous youngsters. This impact is relevant to all places where the transmission line is found close to inhabited areas and in particular in areas where the population has a low level of literacy. On the other hand, it would be a major effort to climb up the towers near the conductors, even for adventurous youngsters.

The Liberia Water and Sewer Corporation in Paynesville has two elevated water tanks located within the LEC RoW near proposed Transmission Line (refer to Figure C-1 in Appendix C). Each of the tanks is about 8 meters high and will be located below the proposed transmission line wires which will have a minimum clearance of 4.3 meters. For a 66kV transmission line, the IFC Industry Specific Guidelines requires a minimum working distance of 0.91 meters. Since employees of the water company whom may be required to perform operations or maintenance on the water tank are not trained to work in close proximity to live power lines, the evaluated risk to workers based on the Occupational Safety and Health Administration (OSHA) regulations. OSHA regulations state that the safe distance to a 66 kV power line for unqualified workers is 3.25 meters (10 feet 8 inches). Based on the IFC guidelines and OSHA regulations, the risk of electrocution of the Water Company employees is unlikely due to the clearance between the top of the water tank and proposed transmission line.

Electrocution from operation of the transmission line poses a long-term impact to worker’s health and safety and the local community. A description of mitigation measures that will be implemented to reduce this impact are presented in Section 6.

5.3.2 Electromagnetic Fields

There has been a lot of public concern related to suspicion that the radiation of the
electromagnetic field (EMF) created by power lines and substations might cause serious health impacts on people living or working close to such structures. The focus has in particular been on the alleged excess frequency of leukemia with children living near power lines.

The IFC Environmental, Health, and Safety Guidelines for Electric Power Transmission and Distribution (April 30, 2007) provides insights and guidelines for EMF exposure to the general public due to electrical transmission lines. The document reinforces that “there is no empirical data demonstrating adverse health effects from exposure to typical EMF levels from power transmissions lines and equipment. However, while the evidence of adverse health risks is weak, it is still sufficient to warrant limited concern.”

The Guideline presents limits for to the general public to 5000 V/m (Electric field) and 100 μT (Magnetic field). Maintaining average and peak exposure levels below these limits is recommended, otherwise additional measures should be considered to minimize exposure. The expected exposure due to the 66 kV transmission line in Liberia are well below the established limits.

Electric and magnetic fields are separate phenomena and occur both naturally and as a result of human activity across a broad electrical spectrum. Naturally occurring electric and magnetic fields are caused by the weather (lightning) and the earth’s geomagnetic field. The fields caused by human activity result from technological application of the electromagnetic spectrum for uses such as communications, appliances, and the generation, transmission, and local distribution of electricity.

The frequency of a power line is determined by the rate at which EMFs change their direction each second. For power lines in the United States, the frequency of change is 60 times per second and is defined as 60 Hertz (Hz) power. In Europe and many other countries including the proposed transmission line in Liberia, the frequency of electric power is 50 Hz.

Electric power flows across transmission systems from generating sources to serve electrical loads within the community. The apparent power flowing over a transmission line is
determined by the transmission line’s voltage and the current. The higher the voltage level of the transmission line, the lower the amount of current needed to deliver the same amount of power. For example, a 115-kV transmission line with 200 amps of current would transmit approximately 40,000 kilowatts (kW), and a 230-kV transmission line requires only 100 amps of current to deliver the same 40,000 kW.

The results of studies and empirical field measurement data collected for similarly sized transmission lines reinforce the conclusion that exposure to the general public will remain below the established limits. A sample of these results is presented below.

Measurements taken in Australia to support the construction of a 132 kV transmission line indicated a maximum recorded field of 7.8 μT underneath a 220 kV transmission line, which is a larger capacity than the proposed 66 kV transmission line in Liberia. (Boco Rock Wind Farm Environmental Assessment, dated 2009).

Spot measurements taken in July 2006 to support the Viejo Project in the City of Mission Viejo, California, USA under a 66 kV 60 Hz transmission line were consistently below 4.5 μT.

*The above studies and measurements on similarly sized transmission lines substantiate the conclusion that EMF exposure to the public due to the Paynesville to Kakata 66 kV Transmission line will remain well below the ICNIRP exposure limits.*

### 5.3.3 Aircraft Safety

Power transmission towers can impact aircraft safety directly through collision or indirectly through radar interference. Robert International Airport is located 45 miles from Monrovia and it caters to large aircrafts while the Springs Payne Airport also located in the heart of Monrovia caters to smaller planes.

### 5.3.4 Public Health Issues

Much of the medical infrastructure outside of Monrovia was destroyed during the civil conflict. The Project will positively impact the area by providing electricity that will help restore this badly needed service to the major city, community, and the country. It is envisioned that, with the circulation of money in the community and city, together with
access to additional employment opportunities, and better health care, crime rates could actually decrease and that the impacts from construction and operation of the transmission line will have minor, but positive direct and indirect long-term impacts on local/regional culture.

5.3.5 Accidents and Other Hazards

Risks may arise during the construction and maintenance phases if community’s access to work areas is not controlled. People may be injured by construction machinery or by falls into open trenches, and there may be an increase in road traffic accidents due to increased traffic to and from the transmission line corridor, as well as an increased risk of accidents from using machinery during construction operations.

When considering safety of the employees, there is a risk of falls from elevated positions during construction and maintenance of the electricity pylons, as well as an increased risk of electrocution should activities not follow operation guidelines and safety measures.

Water may accumulate in excavated pits for tower foundations potentially leading to the breeding of insects and other infectious organisms thus increasing the risk of vector borne diseases at operation sites.

Sediments also pose a potential health and safety problem as silts and other fine materials may be toxic or the materials may act as transport media for adsorbed toxic materials such as heavy metals or organics.

The use of broadcast aerial spraying of herbicides for the purpose of RoW clearing may result in the contamination of surface waters and terrestrial food chains.

Positive impacts on health and safety will occur due to the provision of an on-site health care for employees in the form an on-site first aid facility, as well as due to the employment of a safety specialist to prepare, implement and maintain a comprehensive safety program.

During the operation phase and maintenance activities, the risk of falls from elevated positions remains, especially during activities such as maintenance and repair of the electricity pylons or transmission lines.
During operations, voltage power can cause a fire risk in the event of electrical faults with equipment. Fire hazards may also occur due to ignition of insulating oil in the oil filled switchgears and transformer units. Unchecked growth of tall trees and accumulation of vegetation within RoWs may also result in the ignition of forest fires.

Details on the specific measures for mitigating these occupational hazards are addressed in Section 6.

5.4 SOCIO-ECONOMIC IMPACTS

5.4.1 Housing

The most important negative social and economical impact will be the necessary removal of houses and other structures affected by the RoW. It is worth mentioning that road rehabilitation activities are currently undergoing along the route. Although LEC is preparing a Resettlement Action Plan (RAP), another RAP, along the RoW, has been prepared for the road rehabilitation and widening project by the Ministry of Public Works (MPW). The need for resettlement under this project might not be necessary if resettlement for structures along the RoW has already been implemented for the road project, knowing that RoW for road projects also cover other utilities such electricity lines, pipelines, etc.

5.4.2 Land Acquisition and Resettlement

The proposed transmission line tower locations will lead to physical displacement of people, loss of shelter, assets, income sources and livelihood, and restriction of access to economic resources. The proposed transmission line will be installed within the existing LEC RoWs, which have become inhabited in some areas by squatters. If construction of the transmission line results in involuntary resettlement, resettlement procedures will occur in conformance with World Bank’s Safeguard Policy (OP/BP 4.12) –Involuntary Resettlement It is, therefore, incumbent the construction and O&M of the proposed transmission line will be carried out in a timely manner and in accordance with Liberian Law, EPA regulations and the World Bank/IFC Guidelines and relevant Performance Standards.

5.4.3 Landuse

Clearing for the tower locations and access points will result in change of land use including agricultural, residential and forested land. Since the transmission line will be installed in the
existing LEC RoW, there will be no interference with, or fragmentation of existing land uses, due of the need to keep a strip of clear for continued maintenance.

5.4.3.1 Settlement Areas

The selected transmission line route is within the existing LEC RoW and runs parallel to the Monrovia-Kakata Highway. Most settlements within the LEC RoW were established during or after the Civil War, and the inhabitants do not have legal title to the land.

It is not anticipated that the land will be dissected between linear structures due to the fact that the line will follow the old LEC transmission line path which is in general approximately 15 meters off the centerline of the Monrovia-Kakata Highway.

5.4.3.2 Cultivated Areas

Agricultural use of the existing LEC RoW area is generally tolerated (but not formally allowed), as long as the height of plants does not exceed 4.5 m. Hence, the area lost for cultivation will be limited to areas needed for tower foundations and access points for inspection and maintenance along the line.

5.4.3.3 Cultural Heritage

Improperly sited projects can damage physical cultural resources and diminish their value. Moreover, unregulated and careless excavation works may destroy potential buried archeological remains. Damage to physical cultural resources constitutes a threat to social cohesion and eliminates the potential for their use in tourism business. If properly planned and sited, developments related to the power generation sector will have no impact on the country’s physical cultural resources.

Many graves and even family/community graveyards, have been found within the existing LEC RoW; however, the proposed transmission line towers were sited to avoid impacts to any of these graveyards. Based on field surveys, no cultural or archaeological resources were identified in the proposed transmission line corridor. LEC will make provision for the possibility of any unanticipated discovery of material remains of archaeological or historical significance during construction of the transmission line by implementation of its Chance Find Procedures (refer to Section 6).
5.4.4 Impacts on Economic Activity

5.4.4.1 Employment

Employment opportunities will be ample in the short term during the construction and phase, and the local contractor will give preference to skilled and semi-skilled workers from the local communities.

Employment will include opportunities for both men and women. A written statement in the CSR Policy will include commitment to adherence to the prohibition of child labor according to Minimum Age Convention, 1973 (No. 138) which sets the general minimum age for admission to employment or work at 15 years (13 for light work) and the minimum age for hazardous work at 18 (16 under certain strict conditions).

5.4.4.2 Other Economic Impacts

Although the construction phase will generate several job opportunities for the local people, minor negative implications on the socio-economic will occur and will mainly be related to potential loss of land or land use and interruptions to means of livelihood. Local road side kiosks and businesses may be negatively impacted due to the need for clearance for access points and tower construction.

The construction of the power transmission lines and towers in agricultural lands during harvest period may also cause temporary damage to the cultivated crops.

The transmission line installation may also result in the depreciation of the price of immediately adjacent lands and properties. Nevertheless, the increased availability of power supply in areas facing previous electricity shortage and/or absence of supply will open up the latter areas for new settlements and economic developments and improve the standard of living.

Positive economic impacts will also include secondary and multiplier effects resulting from the increase in local purchasing power.

5.4.5 Increase in Volume of National Electricity Grid

An electrical grid is an interconnected network for delivering electricity from suppliers to
consumers. When referring to the power industry, “grid” is a term used for an electricity network, which may support all or some of the following three distinct operations:

- Electricity generation
- Electric power transmission
- Electricity distribution

The sense of grid is as a network, and should not be taken to imply a particular physical layout, or breadth. "Grid" may be used to refer to an entire continent’s electrical network, a regional transmission network or may be used to describe a sub network such as a local utility's transmission grid or distribution grid. The electric power, which is generated, is stepped up to a higher voltage at which it connects to the transmission network. The transmission network will move (wheel) the power long distances often across state lines, and sometimes across international boundaries until it reaches its wholesale customer (usually the company that owns the local distribution network). Upon arrival at the substation, the power will be stepped down in voltage from a transmission level voltage to a distribution level voltage. As it exits the substation, it enters the distribution wiring. Finally, upon arrival at the service location, the power is stepped down again from the distribution voltage to the required service voltage(s).

Locally, the Project will facilitate electricity supply to surrounding areas indirectly promoting social development, and decreasing the domestic work load, especially on women and children.

5.4.6 Impacts on Traffic & Road Network

Construction of the transmission line will temporarily increase traffic flow along the Monrovia-Kakata Highway. Heavy transport vehicle traffic associated with the mobilization and construction phases may result in deterioration of road surfaces due to increased wear and tear. The long-term increase in traffic during operation and maintenance periods should be minimal. New access roads built may allow access to previously inaccessible land areas.

5.5 SUMMARY OF IMPACTS

Potential impacts from the main activities of the proposed Project have been described above and summarized in Table 5-3 and Table 5-4. Impacts are measured based on their type
as they could be directly or indirectly affected by the Project; the nature of the impact reflects if the impact is positive or negative; duration emphasizes if the impact is permanent or temporary within the project time duration; and magnitude is the power of the impact on a certain component.
Table 5-3 Summary of Impacts

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Type of Impact</th>
<th>Positive or Negative</th>
<th>Temporary/Permanent</th>
<th>Magnitude</th>
<th>Significance</th>
<th>Timing of Impact Occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NATURAL ENVIRONMENT</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>Indirect</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Soil</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Landscape and Visual Intrusion</td>
<td>Direct</td>
<td>Negative</td>
<td>Temp/Permanent</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Terrestrial Habitat Alteration</td>
<td>Direct</td>
<td>Negative</td>
<td>Temp/Permanent</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Alteration of Aquatic Habitat</td>
<td>Indirect</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Wildlife Species</td>
<td>Indirect</td>
<td>Positive/Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Collision of Birds with Transmission Lines</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Moderate</td>
<td>Moderate</td>
<td>✓</td>
</tr>
<tr>
<td>Hazardous Materials</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Moderate</td>
<td>✓</td>
</tr>
<tr>
<td>Waste</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Moderate</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td><strong>HEALTH AND SAFETY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air Quality and Dust</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Noise</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Electrocution</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Moderate</td>
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</tr>
<tr>
<td>Electromagnetic Fields</td>
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<td>Negative</td>
<td>Permanent</td>
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<tr>
<td>Aircraft Safety</td>
<td>Indirect</td>
<td>Negative</td>
<td>Permanent</td>
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<td>Low</td>
<td>✓</td>
</tr>
<tr>
<td>Accidents and other Hazards</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Moderate</td>
<td>Moderate</td>
<td>✓</td>
</tr>
</tbody>
</table>

Earthtime 5-19
Table 5-4 Summary of Socio-Economic Impacts

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Type of Impact</th>
<th>Positive or Negative</th>
<th>Temporary/Permanent</th>
<th>Magnitude</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Housing</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Land Acquisition</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Public Infrastructure and Services</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Land Use</td>
<td>Direct</td>
<td>Negative</td>
<td>Permanent</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Economic Activity</td>
<td>Direct</td>
<td>Negative/Positive</td>
<td>Temp/Permanent</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Social Relations</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Human Rights</td>
<td>Direct</td>
<td>Positive</td>
<td>Temporary</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Increase in Electricity Grid</td>
<td>Direct</td>
<td>Positive</td>
<td>Permanent</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Traffic and Road Network</td>
<td>Direct</td>
<td>Negative</td>
<td>Temporary</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
</tbody>
</table>
6 ENVIRONMENTAL AND SOCIAL MITIGATION MEASURES

LEC acknowledges the need for mitigation measures to minimize or eliminate the negative impacts resulting from construction and operation of the proposed transmission line. Potential adverse environmental impacts during construction and operation of the transmission line may include, as described in the previous section (a) temporary degradation of air quality from construction dust emissions, (b) impacts on water quality from pollutants and sediment in stormwater runoff, (c) soil quality degradation (d) temporary generation of noise from construction traffic and machinery (f) impacts on biological resources (g) temporary generation of solid waste, and (f) socio-economic impacts.

Mitigation measures should be monitored on a continuous basis in order to achieve the highest control with minimum risks. LEC’s management personnel will be responsible for ensuring that mitigation measures are implemented correctly.

6.1 AIR QUALITY

Control techniques for minimizing temporary particulate matter (PM) emissions during construction will involve watering of surfaces, chemical stabilization, or reduction of surface wind speed with windbreaks or source enclosures. Furthermore, surface improvements offer long-term control techniques. These include covering the road surface with a new material of lower silt content, such as covering a dirt road with gravel or slag. Also, regular maintenance practices, such as grading of gravel roads, help to retain larger aggregate sizes on the traveled portion of the road and thus help reduce emissions. The amount of emissions reduction is tied directly to the reduction in surface silt content.

Other mitigation measures include, maintaining good housekeeping practices throughout the construction phase. These low cost measures include:

- Proper site enclosure through appropriate hoarding and screening.
- On-site mixing and unloading operations.
- Proper handling of cement material.
- Maintain minimal traffic speed on-site and on access roads to the tower construction site.
• Covering all vehicles hauling materials likely to give off excessive dust emissions.
• Ensure adequate maintenance and repair of construction machinery and vehicles.
• Avoid burning of material resulting from site clearance.
• Cover any excavated dusty materials or stockpile of dusty materials entirely by impervious sheeting.
• Proper water spraying when necessary.

In addition to PM generation, emissions will consist of combustion emissions from diesel engine-driven electrical generators and diesel-driven mobile construction equipment (such as concrete trucks, dump trucks, excavators and backhoes. The engines emit primarily CO₂, CO, NOx, SOx, and HC. Measures to reduce combustion emissions include proper truck maintenance, adoption of a traffic management plan while avoiding congested routes, proper maintenance of construction equipment, and the quality of diesel fuel used. In addition, equipment will be turned off when not in use, which would reduce power needs as well as emissions of pollutants. The supervising consultant will have the responsibility of ensuring the implementation of these measures by the Contractor.

6.2 WATER QUALITY

The removal of vegetation in the construction work areas may result in erosion and sedimentation causing increased turbidity in waterbodies within the project area. Additionally, degradation of water quality may occur from pollutants in storm water runoff from material and equipment storage areas and spills and leaks from construction equipment.

Prior to commencement of construction activities, LEC require its contractors to prepare and implement an Erosion and Sediment Control Plan. Its purpose will be to assist LEC, its Contractor, and subcontractors in the implementation of control measures for storm water runoff from the transmission line corridor and material storage areas to prevent degradation of water quality. The Plan will achieve this purpose by specifying the best management practices required to assess the effectiveness of construction stormwater management practices, especially during the rainy season. LEC will demonstrate, to the satisfaction of the EPA, that any substantial risk of increased sediment discharges from the transmission line
route will not occur during any stage of construction. Briefly, the erosion and sediment control measures to be implemented during the construction phase of the project include:

- Minimizing land clearing activities to the tower location work areas, access points, and material storage areas.
- Minimize the time of exposure of erodible land exposed to stormwater runoff during the rainy season.
- Maintaining a Riparian Management Zone (RMZ) (width 15m\(^1\)) between the construction work areas and surface waterbodies to filter sediments in stormwater runoff.
- Covering open stockpiles of construction materials with tarpaulin or similar fabric during rainstorm events to prevent erosion and resultant sedimentation of receiving waters.
- Compacting soil as soon as the tower foundations are formed to prevent erosion, especially during the wet season.
- Restoring the construction work areas as soon as possible once construction is complete at each tower location.

LEC will develop and implement a Spill Contingency Plan to prevent and mitigate spills of oils or hazardous materials to surface water bodies and groundwater. Oil leakage or spillage will be contained and cleaned up immediately. Spent oil and lubricants will be collected and stored for recycling or proper disposal. In addition, all fuel tanks and chemical storage areas will be provided with locks and located within secondary containment structures.

6.3 **SOIL CONTAMINATION AND EROSION**

During the construction phase, accidental discharge of chemicals can adversely affect soil in the area. Mitigation measures include proper storage of chemicals and the installation of natural or synthetic liners beneath chemical storage tanks. Equally important measures include proper surface drainage during both the construction and operation phases,

http://enrpolicy.forestry.umn.edu/prod/groups/cfans/@pub/@cfans/@forestry/documents/asset/cfans_asset_184496.pdf
minimization of water and chemical usage (oil, lubricants and fuel), as well as limiting the exposure of the soil to accidental releases of pollutants. Chemicals used on-site should preferably be non-toxic and readily biodegradable.

Clearing of vegetation will be limited to where it is strictly needed so as to decrease the risk of soil erosion. Unpaved roads will be graded so that to decrease the risk of erosion during rainstorms.

Further measures include:

- Soils excavated for tower foundations will be used for re-filling and will not be left exposed to wind or water for long periods.
- The contractor will avoid steep terrain during the transportation of construction material by using alternative routes or use light vehicles where appropriate.
- Heavy machinery will be used as needed in the clearance of construction work areas in order to minimize soil compaction, which makes the soil susceptible for erosion.
- Riverine vegetation will be minimally disturbed during the construction phase to reduce soil erosion and safeguard riverbank protection.
- Disturbed areas will be replanted with local species common in the area to complement natural vegetation regeneration to improve ground cover.
- Gabions, instead of stonewalls, will be used. Stonewalls will often increase the erosion risk nearby and may become instable, whereas gabions will be covered with vegetation in the long run.
- In areas prone to soil erosion, suitable sediment binding grasses will be planted in degraded substrates.

6.4 Noise

Typical mitigation measures that will be enforced during construction to minimize noise levels are:

- Effectively utilizing material stockpiles and other structures, where feasible; to reduce noise from on-site construction activities.
- Choosing inherently quiet equipment.
- Operating only well-maintained mechanical equipment on-site.
• Keeping equipment speed as low as possible.
• Shutting down or throttling down to minimum equipment that may be intermittent in use, between work periods.
• Utilizing and properly maintaining silencers or mufflers that reduce vibration on construction equipment during construction works.
• Restricting access to the site for truck traffic outside of normal construction hours.
• Utilizing proper site logistics and planning.
• Limiting site working hours if possible.
• Scheduling noisy activities during the morning hours.
• Consulting with local communities and informing the locals when noisy activities are planned.
• Enforcing noise monitoring.

In addition ear protection will be provided to workers as personal protection in high noise level construction areas for workers exposed to noise levels exceeding 90 dBA. The noise control measures will be included within the construction contracts and be considered as requirements from contractors. The supervising consultant will have the responsibility of ensuring the implementation of these measures.

6.5 Biological Resources

6.5.1 Terrestrial Habitat Alteration

The clearing of vegetation in the construction work areas may have a significant impact on terrestrial habitats especially in forested areas. Recommended mitigation measures include:

• Locating access roads and construction work areas in areas not designated as critical habitat.
• Limiting vegetation clearing to the tower locations, access points, and material storage areas. The transmission line will be installed within the existing LEC ROW
• Installing transmission lines above existing vegetation to avoid land clearing to the maximum extent possible.
• Avoiding construction activities during the breeding season and other sensitive seasons or times of day.
• Re-vegetating disturbed areas with native plant species.
• Minimizing vegetation management to selective removal of tall growing trees and plant growth that would negatively affect the transmission lines and equipment.
• Utilizing hand clearing rather than mechanized clearing whenever practicable.
• Removing invasive plant species, whenever possible, and cultivating native plant species.
• Avoiding use of machinery in the vicinity of watercourses.
• Retaining a Riparian Management Zone between construction work areas and surface waterbodies.
• Providing the community priority on use of the removed vegetation for wood-fuel, construction or any other purpose.
• Following manufacturer specifications when using pesticides.

6.5.2 Aquatic Habitat Alteration

To minimize stream pollution by sediments, LEC and its Contractor will implement the following mitigation measures:

• Locating transmission line to avoid critical aquatic habitat and riparian areas;
• Scheduling construction to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical.
• Re-vegetating areas promptly.
• Designing channels and ditches for post-construction flows (e.g. at sides of newly built access roads).
• Maintaining a Riparian Management Zone around streams to decrease sediment influx into aquatic environments.
• Limiting use of pesticides and herbicides to what is strictly necessary and avoid aerial spraying of herbicide near surface waterbodies. Biodegradable pesticides that do not result in bioaccumulation should be used where possible.

6.5.3 Avian and Collisions

Mitigation measures that will be implemented to minimize avian and bat collisions include:

• Aligning transmission corridors to avoid critical habitats (e.g. nesting grounds,
heronries, rookeries, bat foraging corridors, and migration corridors).

- Maintaining 1.5 meter spacing between energized components and grounded hardware or, where spacing is not feasible, covering energized parts and hardware;
- Installing elevated perches, insulating jumper loops, placing obstructive perch deterrents (e.g. insulated "V’s"), changing the location of conductors, and / or using raptor hoods.
- Installing visibility enhancement objects such as marker balls, bird deterrents, or diverters if deemed necessary.
- Minimizing the vertical distance between shield wire and the highest conductor to the maximum extent.

6.6 **HAZARDOUS MATERIALS MANAGEMENT**

LEC will require its Contractor to prepare and implement a Spill Contingency Plan that identifies the procedures to prevent, contain, cleanup, and report spills and releases of oil and hazardous materials. Mitigation measures to prevent contamination from hazardous materials are primarily aimed at preventing their release into the environment in the first place and will include:

- Storing oil and hazardous materials within secondary containment structures in designated areas.
- Using portable oil collection pans during refueling operations.
- Keeping equipment maintained.
- Inspecting equipment and containers for spills and leaks, corrosion, or other signs of deterioration.
- Maintaining spill response equipment near material storage areas and on heavy equipment.
- Ensuring all workers dealing with such substances are adequately informed about the risks.
- Training employees on material storage, transfer, and transportation procedures, spill response procedures, and reporting requirements.

LEC will keep an accurate inventory of all oil, hazardous materials, and waste stored on site, and Material Safety Data Sheets will be available for these materials. Additionally, all fuel
will be trucked to the site by a fuel supplier and transferred into fuel storage tanks located within concrete-bermed (embankment) enclosures sized to retain 110% of the tank content in the event of tank failure. The volume of fuel stored onsite at any time during the construction and operation of the facility is not expected to exceed the maximum tank and secondary containment capacity.

If a fuel/oil spill occurs at the project site, on any of the access roads to the site, or into a waterbody or wetland, prompt action will be taken to contain the leakage or spillage. In the event of a spill or leak, all combustibles, flammables, and ignition sources (such as running engines) likely to result in a fire will be removed from the vicinity of the spill and anyone in the area will be advised to stay upwind. Spill kits will be kept at the project site and on the transport vehicles to readily clean up small spills. Large spills will be contained by constructing a berm around the spill area to control runoff to surface water, or deploying a spill boom if the spill is in a waterbody. All soil contaminated by the spills will be excavated and disposed of in accordance with the LEC’s hazardous waste management procedures.

6.7 Waste Management

During the construction and maintenance phases, there will be generation of construction debris as a result of various construction activities. The generated materials will be used for reclamation purposes whenever applicable. Nevertheless, care will be taken to ensure the absence of contaminated fill material and the adequacy of the physical and chemical properties of such material to limit potential adverse impacts on water and soil and ensure the safety of the Project. Construction wastes will also be minimized through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials to decrease waste generation and reduce project costs (cost of surplus materials). Sorting of construction and demolition wastes will be encouraged, as well as, adoption of a re-use/recycle program on site whenever deemed feasible.

Chemical wastes generated during the construction phase include containers that were used for storage of chemical wastes on site, the chemical residue as well as contaminated material. These materials will be segregated and properly stored and disposed of as hazardous waste. Storage will be placed in a separate area that has an impermeable floor, adequate ventilation
and a roof to prevent rainfall from entering. In addition all chemical wastes must be clearly labeled in English, stored in corrosion resistant containers and arranged so that incompatible materials are adequately separated. There will be a prior agreement with the EPA for the disposal of hazardous waste generated.

General refuse generated during the construction phase will be stored in enclosed bins or compaction units separate from construction and chemical wastes. An agreement will be drafted with a solid waste collector certified by the EPA to identify collection sites and schedule the removal to minimize odor, pest infestation and litter buildup. The burning of refuse on the construction site will be strictly prohibited and penalized. General refuse is generated largely by food service activities on site, so reusable rather than disposable dishware will be promoted if feasible. Aluminum cans will be recovered from the waste stream by individual collectors if they are segregated and made easily accessible, so separate, labeled bins for their storage should be provided if feasible. Janitorial services will be assigned for upkeep of project site during construction phase.

6.8 OCCUPATIONAL HEALTH AND SAFETY

6.8.1 General Facility Design and Operation

The Transmission Line Project will be constructed and operated in a manner, which will eliminate, control, or minimize occupational hazards, which could impact employee health and safety. A Health and Safety Plan will be prepared for both the construction and operation phases of the Project to ensure compliance with the Ministry of Health’s Guideline for Occupational Health and Safety and the IFC guidelines. In accordance with contractual requirements, LEC’s contractor is required to comply with Liberia and IFC occupational health and safety requirements.

To ensure its employees health and safety, LEC will provide the following:

- Safety devices to protect employees from injuries or hazardous conditions;
- Safe drinking water;
- Immunizations, as applicable;
- Clean eating area;
- First aid facilities;
• Bathroom facilities;
• Sanitary conditions;
• Waste management and proper disposal procedures;
• Appropriate signage;
• Fire prevention facilities, training, and awareness; and
• Personnel Protective Equipment (PPE).

A safety specialist will be responsible for the preparation, implementation and maintenance of a comprehensive safety program, which will be periodically evaluated. The safety specialist will be provided with written safety instructions including instructions on correct storage, handling and disposal of hazardous waste, and written contingency plans/guidelines of action for accidents, spills, and fire. The responsibility of the safety specialist includes performing safety training and conducting safety inspections, sessions and practice. She/he will also be responsible for the investigation of accidents. A safety committee should be formed and regular safety meetings should be organized.

General mitigation measures aimed at employees include the following:

• Provision of training about the fundamentals of occupational health and safety procedures.
• Provision of appropriate PPE (example: impermeable latex gloves, working overalls, safety boots, safety helmets, hearing protection).
• Ensuring that especially sensitive or dangerous areas (like areas exposed to high noise levels, areas for especially hazardous work etc.) are clearly marked.
• Ensuring that all maintenance work necessary for keeping machines and other equipment in a good state will be regularly carried out.
• Ensuring that the workers (and especially those doing hazardous work or otherwise exposed to risks) are qualified, well trained and instructed in handling their equipment, including health protection equipment.
• Provision of adequate loading and off-loading space.
• Development of an emergency response plan.
• Provision of appropriate lighting during night-time works implementation of speed limits for trucks entering and exiting the site.
6.8.2 First Aid Program

A basic first aid program will be extended to all employees and will ensure that in the event of an accident or injury, someone with first aid knowledge will be present to render initial assistance until further medical attention can be made available. Qualified personnel will run seminars to provide the necessary theoretical as well as practical skills required. The advanced first aid program will be an extension of the basic first aid program attended by selected employees, including supervisors and the Health and Safety Officer, and will train participants in the recognition and initial management of serious injuries and illnesses. Employee health and safety orientation will train all employees on the basic rules of work, safety procedures, site-specific hazards, and emergency procedures. A visitor orientation and control program will be implemented if visitors will be entering areas of the site where hazardous conditions or substances are present. Supervisory personnel and safety representatives will attend training on accident investigation and reporting procedures.

6.8.3 Employee Health and Safety Orientation

New employees and contractor personnel will be provided health and safety training prior to commencing work or a new assignment. The training will consist of basic hazard awareness, identification of site-specific hazards and how they are controlled, safe work practices, potential risks to health and precautions to prevent exposure, hygiene requirements, PPE requirements and proper use, equipment labeling, accident prevention and reporting, and emergency procedures for fire, evacuation, or natural disaster.

All employees will be informed of their responsibility to participate in the creation of a healthy and safe environment by reporting unsafe and hazardous conditions when detected and performing work in a safe manner by following the correct work procedure. It is expected that a brief daily health and safety meeting will be conducted each day prior to the commencement of work.

6.9 HAZARD COMMUNICATION

Hazardous areas will be marked with appropriate signs that identify the hazard and associated safety measures. All signs will conform to international standards and will be designed to be understood by all employees and visitors. Signs may contain both text and
pictures, as necessary, to ensure that any illiterate employees or visitors would be made aware of the hazard.

Containers of hazardous materials will be labeled with the contents and associated hazards. A color-coding system will be implemented to allow immediate visual identification of containers or equipment, which contains hazardous substances.

Emergency personnel should be made aware of the types of hazardous materials, typical amounts stored onsite, and storage locations to expedite emergency response. If possible, local emergency response personnel will be invited to inspect the site periodically to ensure familiarity with potential hazards present.

6.10 PHYSICAL HAZARDS

The physical hazards identified for construction and operation of the project include noise, electrical, electromagnetic field (EMF), welding/hot work, work at height, fire explosion.

6.10.1 Noise

LEC and contractor employees will have exposure to high noise levels from operation of equipment during construction and maintenance activities. To minimize the impacts of noise hazards, LEC and its Contractor will:

- Enforce the use of hearing protection actively when the equivalent sound level over 8 hours reaches 85 dB(A), the peak sound levels reach 140 dB(C), or the average maximum sound level reaches 110 dB(A).
- Install warning signs in areas of high noise levels.
- Consider the use of acoustic insulating materials, isolation of the noise source, and other engineering controls to minimize noise impact.

6.10.2 Electrical Hazard

Energized equipment and power lines can pose electrical hazards for workers. To prevent, minimize, and control electrical hazards, LEC will:

- Consider installation of hazard warning lights inside electrical equipment enclosures to warn of inadvertent energization.
- Use voltage sensors prior to and during workers' entrance into enclosures containing electrical components.
- Deactivate and properly ground live power equipment and distribution lines according to applicable legislation and guidelines whenever possible before work is performed on or proximal to them.
- Use of signs, barriers (e.g. locks on doors, use of gates, use of steel posts surrounding transmission towers, particularly in urban areas), and education / public outreach to prevent public contact with potentially dangerous equipment.
- Only allowing trained and certified workers to install, or repair electrical equipment.
- Ensuring that live-wire work is conducted by trained workers with strict adherence to specific safety and insulation standards.
- Instructing workers to not approach equipment until properly insulated from the energized part with gloves or other approved insulation; or, the energized part is properly insulated from the worker and any other conductive object; or, the worker is properly isolated and insulated from any other conductive object.
- Provide specialized electrical safety training to workers working with or around exposed components of electric circuits in accordance with IFC guidelines.
- Follow general IFC guidelines regarding electrical devices and overhead wires.

Risk to the local population (especially children) from electrocution due to climbing, will be mitigated by design features that preclude climbing up the transmission towers.

6.10.3 Electromagnetic Fields (EMF)

Exposure to EMF from the proposed Transmission Line Project is not anticipated to impact the local communities. Electric utility workers typically have a higher exposure to EMF than the general public due to working in proximity to electric power lines. Occupational EMF exposure will be prevented or minimized through the preparation and implementation of an EMF safety program including the following components:

- Identifying potential exposure levels to electric and magnetic fields (EMF) in the workplace, including surveys of exposure levels in new projects.
• Using personal monitors during working activities with the potential for high exposure to EMF.
• Training workers in the identification of occupational EMF levels and hazards.
• Establishing and identifying safety zones to differentiate between work areas with expected elevated EMF levels compared to those acceptable for public exposure, limiting access to properly trained workers.
• Implementing action plans to address potential or confirmed exposure levels that exceed reference occupational exposure levels developed by international organizations. Action plans may include limiting exposure time through work rotation, increasing the distance between the source and the worker, when feasible, or the use of shielding materials.
• Build raptors platforms on top of pylons for roosting and nesting.

6.10.4 Welding/Hot Work

Welding activity creates extremely bright light and noxious fumes, which, with prolonged exposure, can cause serious eye injury and chronic diseases. To ensure the safety of workers performing welding activity LEC will:

• Require the use of eye protection such as welder goggles and full-face eye shields for all personnel involved in welding operations.
• Implement the use of devices to extract and remove noxious fumes at the source.
• Develop and implement SOPs for special hot work and fire prevention precautions if welding outside of established welding work stations.

6.10.5 Working at Heights

LEC employees may be exposed to heights during construction and maintenance of the transmission line, which could pose the potential hazard of falling. Implementation of a fall protection program will be implemented that includes training in climbing techniques and use of fall protection measures; inspection, maintenance, and replacement of fall protection equipment; and rescue of fall-arrested workers, among others. In order to prevent and protect against these hazards LEC will:

• Train employees in the proper use of necessary PPE used when working on
equipment at greater heights.

- Require the use of fall prevention devices, including safety harnesses in areas of potential fall hazards.

- Establish criteria for use of 100 percent fall protection (typically when working over 2 meters above the working surface, but sometimes extended to 7 meters, depending on the activity). The fall protection system should be appropriate for the tower structure and necessary movements, including ascent, descent, and moving from point to point.

- Provide adequate work-positioning device system for workers.

- Ensure connectors on positioning systems are compatible with the tower components to which they are attached.

- Use properly rated and maintained hoisting equipment.

- Train hoist operators properly.

- Ensure safety belts are not less than 16 mm two-in-one nylon or material of equivalent strength. Rope safety belts should be replaced before signs of aging or fraying of fibers become evident.

- Require workers to use a second (backup) safety strap when operating power tools at height.

- Remove signs and other obstructions from poles or structures prior to undertaking work.

- Use an approved tool bag for raising or lowering tools or materials to workers on structures.

6.10.6 Fire and Explosions

LEC employees working in close proximity to flammable materials may have a higher risk of injury due to fire or explosion. In order to prevent and control these risks LEC will:

- Ensure that flammable materials are stored away from ignition sources and oxidizing materials.

- Establish storage areas for flammable materials which are away from facility intakes, are equipped with fire extinguishing devices, have adequate venting, and are remote from entry and exit points into the facility.
• Install sprinkler systems or quenching devices in areas where flammable substances are stored and install alarm systems to alert employees in the event of a fire emergency.

• Label all containers storing flammable material with fire hazard signs to warn employees of special rules for handling the material.

• Provide training for proper handling of flammable materials, fire prevention, and fire suppression.

Regarding the risk of fires during the operation phase, the following mitigation measures are recommended:

• Monitoring right-of-way vegetation according to fire risk.

• Removing fallen leaves and branches, and other high-hazard fuel accumulations.

• Time thinning, slashing, and other maintenance activities to avoid forest fire seasons.

• Disposal of maintenance slash by truck or controlled burning. Controlled burning should adhere to applicable burning regulations, fire suppression equipment requirements, and typically must be monitored by a fire watcher.

• The burning of refuse in the ROW should be strictly prohibited.

6.11 CHEMICAL HAZARDS

Occupational exposures to chemicals in this sector primarily include handling of pesticides, and herbicides used for right-of-way maintenance. Recommendations specific to the use of pesticides include:

• Train personnel to apply pesticides and ensure that personnel have received the necessary certifications or equivalent training where such certifications are not required.

• Respect post-treatment intervals to avoid operator exposure during reentry to crops with residues of pesticides.

• Ensure hygiene practices are followed to avoid exposure of family members to pesticides residues.

• Decreasing the use of chemicals by utilizing mechanical clearing techniques, grazing and/or selective chemical applications.
- Selecting herbicides with minimal undesired effects.
- Not applying herbicides with broadcast aerial spraying wherever possible.
- Maintaining natural low-growing vegetation along the RoW.

6.12 BIOLOGICAL HAZARDS

Biological hazards associated with biological agents, wildlife, and insects may pose a potential risk to LEC employees working with or around these hazards. In order to protect and prevent against potential injury caused by biological hazards LEC will:

- Take precautions to ensure that the risk of exposure to harmful biological agents is as low as possible.
- If possible avoid or replace harmful biological agents with an agent that is less dangerous to workers.
- Design engineering and administrative controls to avoid or minimize the release of biological agents into the working environment and install signs indicating the location of potentially hazardous biological agents.
- Provide insect repellant for employees working in areas where there is a risk of injury from insect bites.
- Provide snakebite and first-aid kits for employees in the event that an employee has come into contact with a wildlife hazard.

Regarding waterborne and water-related diseases substances, the following measures should be implemented:

- The adoption of good housekeeping practices for ensuring hygiene on site.
- The elimination of pools of stagnant water, which could serve as breeding places for mosquitoes.
- The provision of bed nets for workers living on site. Ideally, these nets should be treated with an insecticide.
- The appropriate elimination of waste of all types, including wastewater.
- Provision of onsite food/water for employees to ensure good nutrition and decrease risk of food/waterborne diseases.
6.13 PERSONAL PROTECTIVE EQUIPMENT (PPE)

PPE is equipment worn by a worker to minimize exposure to specific occupational hazards. When the hazard cannot be eliminated or controlled, then PPE must be worn to reduce or minimize the exposure or contact with physical, chemical, or biological hazards.

The PPE that will be used to protect against the Project’s occupational health and safety hazards include gloves, ear plugs, ear muffs, dust masks, respirators, fall protection, protective clothing, hard hats, goggles, safety glasses, and safety boots. It will be mandatory for all employees to wear hard hats, safety glasses (or goggles), and safety boots at all times while in the construction work areas.

LEC and its contractors will review work practices, job procedures, equipment, and the construction work sites to determine the degree of protection and proper PPE to match the hazard. Physical comfort, costs, and compliance with internationally recognized standards will be considered when selecting PPE. Workers will be instructed on the proper use, maintenance, and inspection of their PPE.

6.14 MONITORING

LEC will monitor occupational health and safety of its employees to verify the effectiveness of prevention and control strategies through the following programs:

- Conducting pre-employment medical exams of employees for medical certificates of health.
- Performing safety inspections in and around the construction and maintenance sites for the detection of unsafe conditions or any potential hazards.
- Reporting any hazards found during safety inspections to management.
- Recording all minor and non-fatal accidents in a ledger as required by the Ministry of Labor.
- Reporting industrial accidents or fatalities to the Ministry of Labor when required.

In the event of an industrial accident, the following protocol will be followed:

- A person trained in basic first aid (first responder) will be summoned if not already present at scene of accident.
• The first responder will render first aid care.
• The first responder will summon a person trained in advanced first aid who will administer further care if necessary and evaluate the necessity for removal to the first aid station.
• The advanced first aider will summon the ambulance and supervise the removal of the injured to the first aid station.
• The employee’s immediate supervisor must be notified.

A first-aid facility will be located near the project site, together with trained staffing. Serious injuries or medical emergencies will be referred to an appropriate medical practitioner and medical institution chosen from the nearest town/city to the project site. Contact will be maintained by radio/radiophone at all times. The employee’s supervisor will make contact with the identified medical practitioner and institution and inform them of the time of arrival of the injured employee. The supervisor will complete the accident form and forward it along with the injured to the medical institution for completion by the medical practitioner.

6.15 COMMUNITY HEALTH AND SAFETY

LEC will institute a community relations program that will seek to identify and address community concerns as well as to ensure their safety and protection from hazards associated with the Project. The LEC Community Relations Department will notify residents within 200 meters of the tower locations of upcoming activities at least 72 hours prior to commencement of construction and operations.

Public safety measures that will be implemented include:

• Restriction of access to the tower construction site.
• Establishment of buffering areas around the site.
• Provision of guards on entrances and exits to the site.
• Installation of warning signs at appropriate locations to discourage intrusion from passers-by or individuals trespassing in active construction and maintenance areas.
6.16 **Emergency Preparedness and Response**

An Emergency Preparedness and Response Plan (EPRP) will be prepared by LEC to assist Project staff in effectively responding to emergencies associated with Project hazards. The EPRP for the construction and operational phases of the Project will comply with the IFC Occupational Safety Guidelines and Performance Standards. The EPRP will include:

- Roles and responsibilities of emergency personnel;
- Emergency contacts and communications systems/protocols, including procedures for interaction with local and regional emergency authorities;
- Specific emergency response procedures;
- Identification of supplies and resources to be utilized during an emergency event, including emergency equipment, facilities, and designated areas; and
- A training plan, which includes specific training and drill schedules for personnel who are responsible for rescue operations, medical duties, spill response, and fire response.

If an emergency develops, all persons on the project site will be notified immediately and efforts will be coordinated with others in the vicinity surrounding the project area in order to reduce impacts, if applicable. The EPA, the County Superintendent, local police, firefighting service and all other authorities will be immediately notified. If an emergency is imminent, but has not yet begun, steps will be initiated to immediately advise persons in the vicinity of the emergency to evacuate and notifications will be made to the EPA, the County Superintendent, local police, and all other authorities which have responsibility regarding the emergency.

If there is a slowly developing emergency or unusual situation where an emergency is not imminent, but could occur if no action is taken, project personnel will notify the EPA, the County Superintendent, local police, and all other authorities of the potential problem and keep them advised of the situation. These agencies will be requested to indicate if there are any immediate actions that should be taken to reduce the risk of the emergency and if necessary, preventative actions will be implemented. In an emergency situation, equipment and supplies will be needed on short notice. Therefore, LEC will maintain an accurate inventory of emergency response equipment and supplies.
The EPRP will include an evacuation plan, which will be read and practiced by all employees. The evacuation plan will include emergency escape routes, procedures for accounting for employees after an evacuation, and roles and responsibilities of personnel during an evacuation. In general, the following evacuation procedures should be followed:

- Alert the Emergency Response Team to assist in the evacuation.
- Use communications tools that are appropriate for the type of incident and the time of occurrence, such as alarms or loud speakers.
- When communicating an evacuation, speak clearly and succinctly: “We have a [state the type of emergency]. Evacuate to [state the assembly point]”.
- Turn equipment off, if possible.
- Take emergency supplies and staff rosters, if possible.
- Account for personnel.
- Wait at the assembly point for further instructions.

The EPRP will have specific information on fire safety and response, which will provide additional details specific to these emergencies.

### 6.17 FIRE PREVENTION AND RESPONSE

The Fire Prevention and Response chapter of the EPRP will outline prevention measures and procedures related to fire emergencies in compliance with the International Fire Code. Fire risks and ignition sources associated with construction and operation of the Project will be identified during the final design phase of the Project. A summary of the fire prevention and response provisions that will be addressed in the EPRP are presented below.

### 6.18 FIRE PREVENTION

Fire prevention measures will be implemented to limit the potential for fire development and will adhere to International Fire Code requirements.

Good housekeeping and maintenance practices will be utilized during construction and operation of the Project to prevent the accumulation of combustible waste material such as...
trash and vegetation. Smoking will be prohibited in areas where conditions exist that would make smoking a hazard, and “No Smoking” signs will be posted in these areas.

To decrease the potential for fuel-related fires, fuel oil storage areas will be located well away from areas of fire hazard such as where welding operations will be performed. Waste oil and flammable materials will be stored in suitable containers at designated areas selected based on proximity to water, migration routes, fire risks and access.

6.19 FIRE EMERGENCY PROCEDURES

A fire emergency exists whenever there is smoke or a burning smell, an uncontrolled fire or fire hazard in the project area, or abnormal heating of any material. Assembly points will be designated and information provided to all staff to enable them to assemble at these points during a fire emergency for further action as might be required.

LEC will establish a rapid response fire team for each operating shift under the direction of the shift supervisor to respond to fire emergencies occurring within the project area within a reasonable time. Team personnel will be selected from nonessential operations personnel. The fire team will be trained by the certified firefighter retained on staff. Fire training will include the locations and proper use of firefighting equipment and procedures for fighting solid and liquid fuel and electrical fires. Roles and responsibilities for firefighting duty and maintenance and operation of equipment and alarm systems are outlined in further detail in the EPRP. In the event of a fire, all plant personnel shall be trained to sound the alarm either through the use of the fire alarm system or the plant communications system. Upon receipt of a fire alarm the rapid response fire team will form at a predetermined rally point and await instructions of the shift supervisor. The shift supervisor will identify the location and type of fire and deploy the fire team accordingly. The team will use hand held radios for communication during the fire event. In the event that the shift supervisor is not available or has been injured, the next rapid responder in the designated chain of command will take charge of the fire response team.

6.20 DISEASE PREVENTION

Communicable and vector-borne diseases can pose significant health hazards to workers.
To reduce the impact of disease, LEC will implement the following strategies:

- Provide disease surveillance and active screening of workers;
- Provide health awareness education and disease treatment training; and

Utilize proper sanitation and vector control programs to reduce mosquito and other disease vector populations.

6.21 SOCIO-ECONOMIC IMPACTS

To minimize the socio-economic impacts of the Project, extensive public consultation during the planning stages for the power transmission line was undertaken and the Project located within the existing LEC ROW.

LEC will develop a public relations program that promotes respect for the rights of indigenous peoples. The Company will actively recruit employees from the surrounding communities and encourage community involvement in environmental monitoring programs to ensure compliance with accepted standards. LEC will establish a method of response for the community to relate concerns that arise from the Project. A committee comprised of community members, county officials, and LEC representatives will meet periodically to discuss issues and concerns of the community, government, and the company and identify evolving interests and issues.

LEC will establish an equal employment opportunity (EEO) policy that will not discriminate against residents in the surrounding communities, will meet or exceed Liberian discrimination standards, and is consistent with the standard specified under International Labor Convention No. 111. LEC will provide company employees with a copy of the EEO policy upon hiring and any approved supplements, modifications, or amendments to the policy.

The Company will implement on-the-job education programs, and will sponsor skills training programs and other educational programs for area residents to enhance the skills of the local employment pool.

6.21.1 Residents and Public Infrastructure and Services
In order to mitigate negative impacts of the Project on settlement areas, the transmission line towers will be located to minimize impacts to residences, commercial businesses, and public infrastructure and services to the maximum extent possible. LEC will comply with IFC Performance Standard 5 that addresses measures to reduce impacts to the local community.

Additionally, mitigation measures to reduce negative impacts from the Project on cultivation include ensuring that project timing does not intrude on planting or harvest times, and that Project construction work areas result in the least amount of disturbance of cultivated land as possible.

6.21.2 Cultural and Archaeological Resources

LEC will implement, in accordance with IFC Performance Standard 8, its Chance Fide Procedures (Appendix D) in the event that previously unreported and unanticipated cultural resources are found during construction and operations of the transmission line. Prior to commencement of site disturbance activities, LEC personnel will receive environmental training that will include guidance on identifying potential cultural resources.

The Chance Find Procedures will be appended to the EMMP for this Project. In summary, in the event of an unanticipated discovery of cultural heritage, archaeological materials or human remains, the following will occur.

- Work will be stopped in the immediate area.
- The Resident Project Representative/Environmental Officer will be notified and will notify all other appropriate authorities.
- The find will be protected.
- Construction will be directed elsewhere along the transmission line route.
- A cultural heritage specialist or professional archeologist will be contacted to identify the find.
  - If it is determined to be archaeological or of cultural significance, additional notifications will be provided to Governmental agencies, the Ministry and appropriate local indigenous community leaders and the find will be documented appropriately.
o If not determined to be archaeological or of cultural significance, work will continue in the area.

6.21.3 Demographics

Demographic impacts can be limited by ensuring a high rate of local employment to decrease the influx of workers from other areas. Demographic shifts will be mitigated through the use of local labor. Should demographic shifts occur, the GOL/LEC should address them in the requisite Resettlement Action Plan (RAP).

6.21.4 Traffic and Road Network

Access to the construction work areas for transmission line construction will be off of the Monrovia-Kakata Highway. Traffic on the highway will be heaviest during the construction phase, which is anticipated to last 12 months. The primary measures that LEC and its Contractor will adopt to mitigate road traffic impacts during the construction phase include the proper dissemination of information regarding the construction schedule, as well as providing alternate routes when needed and when feasible during all phases of construction. In this respect, proper planning and development of a traffic control plan that takes into account the reservations and inputs of local stakeholders is essential to minimize the effects and inconvenience of construction activities on commuters as well as ensure the safety of motorists, pedestrians and workers in the vicinity of construction zones.

The basic principle in the development of traffic control plans is that motorists should be guided through construction zones in a clear and safe manner. This should be done through adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the construction site. These measures will provide motorists with positive guidance prior to and through the work zone.

Preliminary routing schemes covering various construction phases must be developed and communicated early on to the public. In addition, limiting the movement of heavy machinery during the construction phase to off-peak hours and providing prior notification are crucial measures to minimize the potential negative impacts of traffic.
Without compromising safety of workers, pedestrians, or vehicles, traffic roads will be re-opened as early as possible in order to minimize the impact on traffic during the construction period.

Any road damage sustained by increased traffic and transport of heavy equipment associated with the transmission line construction will be repaired. In addition, unpaved roads will be paved in areas of heavy use, as needed.

6.22 SUMMARY OF MITIGATION MEASURES

Table 6-1 presents a summary of the proposed mitigation measures for the potential environmental and social impacts arising from the implementation of the 66 kV transmission line project. As for the cost of the mitigation, it will be allocated as such:

- During the design phase, mitigation cost will be included in the final design preparation;
- During the construction phase, mitigation cost will be included with construction costs;
- During operation, mitigation costs will be part of the operation costs.

The schedule of implementation of the mitigation measures will be consistent with the project execution phases.

Table 6-1 Summary of proposed mitigation measures for construction and/or maintenance activities

<table>
<thead>
<tr>
<th>RECEPTOR</th>
<th>MITIGATION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Environment</td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>• Cover open stockpiles of construction materials on site with tarpaulin or similar fabric during rainstorm events to prevent the washing away of construction materials</td>
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<tr>
<td></td>
<td>• Compact earthworks as soon as the final surfaces are formed to prevent erosion especially during the wet season</td>
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<tr>
<td></td>
<td>• Follow guidelines and procedures for immediate cleanup of spillage of oil, fuel or chemicals</td>
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<tr>
<td></td>
<td>• Install natural or synthetic liners beneath chemical storage tanks</td>
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<tr>
<td></td>
<td>• Use Oil and Bar traps</td>
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<tr>
<td></td>
<td>• Install sediment and erosion controls</td>
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<tr>
<td>Soil</td>
<td>• Grade unpaved roads</td>
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<tr>
<td></td>
<td>• Schedule construction/ rehabilitation to avoid heavy rainfall periods (i.e., during the dry season) to the extent practical</td>
</tr>
<tr>
<td></td>
<td>• Install natural or synthetic liners beneath chemical storage tanks</td>
</tr>
<tr>
<td></td>
<td>• Use non-toxic and readily biodegradable chemicals on-site whenever possible</td>
</tr>
<tr>
<td></td>
<td>• Install sediment and erosion controls</td>
</tr>
<tr>
<td>Landscape and Visual</td>
<td>• Prohibit the parking of construction equipment, construction materials, and</td>
</tr>
<tr>
<td>RECEPTOR</td>
<td>MITIGATION MEASURES</td>
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<td>----------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
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<tr>
<td>Intrusion</td>
<td>transport vehicles outside the fenced boundary of the material storage area</td>
</tr>
</tbody>
</table>
| Terrestrial Habitat Alteration   | • Select right-of ways to avoid important natural areas such as wild lands and sensitive habitats  
|                                  | • Utilize appropriate clearing techniques (hand clearing vs. mechanized clearing)     |
|                                  | • Maintain low native ground cover beneath lines                                     |
|                                  | • Replant disturbed sites                                                           |
|                                  | • Manage RoW to maximize wildlife benefits                                          |
| Aquatic Habitat Alteration       | • Schedule construction activity to avoid heavy rainfall, where possible             |
|                                  | • Limit use of herbicide to what is strictly necessary and avoid use near watercourses |
|                                  | • Maintain RMZ                                                                      |
| Wildlife Species                 | • No significant impacts expected                                                  |
| Collision of Birds with          | • Avoid critical habitats and flight paths where possible                           |
| Transmission Lines               | • Consider use bird diverters on transmission lines, if deemed necessary             |
| Hydrocarbons                     | • Ensure correct storage of fuels and lubricants                                     |
|                                  | • Use oil traps                                                                     |
|                                  | • Carefully fuel/refuel vehicles and machinery                                       |
| Waste and Wastewater             | • Use generated construction debris materials for reclamation purposes whenever possible |
|                                  | • Minimize construction and demolition wastes through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials |
|                                  | • Sort construction and demolition wastes into various categories and adopting reuse |
|                                  | • Recycle on site whenever deemed feasible;                                        |
|                                  | • Segregate chemical wastes and properly storing and disposing of it as hazardous waste |
|                                  | • Store chemical wastes in a separate area that has an impermeable floor, adequate ventilation and a roof to prevent rainfall from seeping |
|                                  | • Clearly label all chemical waste in English and Liberian, storing it in corrosion resistant containers and arranging so that incompatible materials are adequately separated |
|                                  | • Secure a prior agreement with the EPA for the disposal of hazardous waste generated on-site |
|                                  | • Draft an agreement with the solid waste collector in the county where the Project is being implemented to identify collection sites and schedule the removal to minimize odor, pest infestation and litter buildup |
|                                  | • Prohibit the burning of refuse on the construction site                           |
|                                  | • Promote recycling and reuse of general refuse                                      |
|                                  | • Contain sewage from toilets, kitchens and similar facilities in sanitary cesspools before being transported by trucks to a nearby wastewater treatment plant |
|                                  | • Adopt good housekeeping practices for ensuring hygiene on site                    |
| Health & Safety                  | • Water surfaces to control dust emissions                                           |
|                                  | • Cover the road surface with a new material of lower silt content                  |
|                                  | • Grade gravel roads                                                                |
|                                  | • On-site mixing and unloading operations                                            |
|                                  | • Properly handle cement material                                                   |
|                                  | • Maintain minimal traffic speed on-site and on access roads to the site            |
|                                  | • Cover all vehicles hauling materials likely to give off excessive dust emissions |
|                                  | • Ensure adequate maintenance and repair of construction machinery and vehicles     |
|                                  | • Avoid burning of material resulting from site clearance                           |
|                                  | • Cover any excavated dusty materials or stockpile of dusty materials entirely by impervious sheeting |

**Earthtime**
<table>
<thead>
<tr>
<th>RECEPTOR</th>
<th>MITIGATION MEASURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain trucks and equipment properly</td>
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<tr>
<td>Adopt a traffic management plan while avoiding congested routes</td>
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<tr>
<td>Adopt proper maintenance procedures for on-site construction equipment and the use of diesel fuel of acceptable quality</td>
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<tr>
<td>Turn off equipment when not in use</td>
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<tr>
<td>Noise</td>
<td>Effectively utilize material stockpiles and other structures to reduce noise from on-site construction activities</td>
</tr>
<tr>
<td>Choose inherently quiet equipment</td>
<td></td>
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<tr>
<td>Operate only well-maintained mechanical equipment on-site</td>
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<tr>
<td>Keep equipment speed as low as possible</td>
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<tr>
<td>Shut down or throttle down to a minimum equipment that may be intermittent in use</td>
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<tr>
<td>Utilize and properly maintain silencers or mufflers that reduce vibration on construction equipment</td>
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<tr>
<td>Restrict access to the site for truck traffic outside of normal construction hours</td>
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<tr>
<td>Proper site logistics and planning</td>
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<tr>
<td>Limit site working hours if possible</td>
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<tr>
<td>Schedule noisy activities during the morning hours</td>
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<td>Inform the locals when noisy activities are planned</td>
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<tr>
<td>Enforce noise monitoring</td>
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<tr>
<td>Electrocution</td>
<td>Use signs and barriers</td>
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<tr>
<td>Disseminate information</td>
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<tr>
<td>Ground conducting objects</td>
<td></td>
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<tr>
<td>Only allow trained employees to install, maintain or repair electrical equipment</td>
<td></td>
</tr>
<tr>
<td>Only allow fully trained employees to do live-wire work</td>
<td></td>
</tr>
<tr>
<td>Electromagnetic Fields</td>
<td>Site facility to minimize exposure to public</td>
</tr>
<tr>
<td>Use ICNIRP reference levels to evaluate potential exposure to public</td>
<td></td>
</tr>
<tr>
<td>Use engineering techniques to decrease exposure to public</td>
<td></td>
</tr>
<tr>
<td>Train employees to identify EMF levels and hazards</td>
<td></td>
</tr>
<tr>
<td>Develop action plan to address exposure levels that exceed reference occupational limits</td>
<td></td>
</tr>
<tr>
<td>Aircraft Safety</td>
<td>Avoid siting of transmission line at known flight paths</td>
</tr>
<tr>
<td>Consult with air traffic authorities prior to installation</td>
<td></td>
</tr>
<tr>
<td>HIV/AIDS and otherSTD’s as well as Ebola</td>
<td>Provide surveillance and active screening</td>
</tr>
<tr>
<td>Conduct health awareness initiative</td>
<td></td>
</tr>
<tr>
<td>Provide health care to employees</td>
<td></td>
</tr>
<tr>
<td>Accidents and other Hazards</td>
<td>Provide a safety specialist responsible for the preparation, implementation and maintenance of a comprehensive safety program</td>
</tr>
<tr>
<td>Provide nearby first aid facility</td>
<td></td>
</tr>
<tr>
<td>Restrict access to the camp sites by proper fencing</td>
<td></td>
</tr>
<tr>
<td>Provide guards on entrances and exits to the site</td>
<td></td>
</tr>
<tr>
<td>Install warning signs at the entrance of the site to prohibit public access</td>
<td></td>
</tr>
<tr>
<td>Train employees on the fundamentals of occupational health and safety procedures</td>
<td></td>
</tr>
<tr>
<td>Provide appropriate personal protective equipment (PPE) (impermeable latex gloves, working overalls, safety boots, safety helmets, hearing protection)</td>
<td></td>
</tr>
<tr>
<td>Ensure that the protective material is being used wherever it is required</td>
<td></td>
</tr>
<tr>
<td>Ensure that especially sensitive or dangerous areas (like areas exposed to high noise levels and areas for especially hazardous work etc.) are clearly designated</td>
<td></td>
</tr>
<tr>
<td>Ensure all maintenance work necessary for keeping machines and other equipment in a good state will be regularly carried out</td>
<td></td>
</tr>
<tr>
<td>Ensure that the workers are qualified, well trained and instructed in handling their equipment, including health protection equipment</td>
<td></td>
</tr>
</tbody>
</table>
### RECEPTOR | MITIGATION MEASURES
--- | ---
**Socio-Economic Impacts** |  
**Housing** | • Locate Project away from areas with high density housing wherever possible;  
• Utilize alternative siting, and designs to reduce land and RoW width requirements to minimize housing impacts  
• Perform field survey and public consultation  
**Land Acquisition and resettlement** | • Locate Project to avoid important areas of human activity where possible;  
• Utilize alternative designs to reduce land and RoW width requirements and minimize impacts  
• Work with GOL on any resettlement issues as required  
**Public Infrastructure and Services** | • Locate the Project to avoid areas of commercial activity where possible  
• Utilize alternative designs to reduce land and RoW width requirements and impacts  
**Landuse** | • Conduct appropriate project siting at the planning stage to avoid important environmental and community features  
• Time project so that not to intrude on planting or harvest times  
• Adopt Chance Find Procedures for unanticipated discovery of findings of archaeological or historical significance  
• Utilize alternative designs to reduce land and RoW width requirements and minimize landuse impacts  
**Economic Activity** | • Ensure high rate of local employment  
**Demographic impacts** | • Ensure high rate of local employment  
• Site transmission line to minimize impacts to residences  
**Social Relations** | • Ensure high rate of local employment to minimize influx of foreign workers  
**Human Rights** | • Ensure equal opportunity employment  
• Adhere to prohibition of child labor according to Minimum Age Convention  
**Increase in Electricity Grid** | • No significant negative impact expected
**RECEPTOR** | **MITIGATION MEASURES**  
--- | ---  
Traffic and Road Network | • Properly plan and develop a traffic control plan  
• Proper disseminate information regarding the construction schedule  
• Provide alternate routes when needed and when feasible during all phases of construction  
• Ensure safety of motorists through adequate warning, signing, delineation and channeling at least 500 m down and up-gradient from the construction site  
• Limit the movement of heavy machinery during the construction phase to off-peak hours and providing prior notification  
• Provide a traffic re-routing plan for the construction phase  
• Repair any road damage caused by increased traffic due to operations  
• Pave roads where heavy use is expected
7 ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (EMMP)

LEC will prepare a standalone Environmental Management and Monitoring Plan (EMMP) for both the construction and operations phases of the Project. The EMMP for the construction phase will be finalized by LEC during final design. LEC will prepare the EMMP for operations prior to completing construction and beginning operation of the transmission line. Each EMMP will be prepared in accordance with EPA, and IFC Performance Standard 1 requirements and will include:

- Applicable regulatory standards and guidelines;
- Environmental management measures;
- Management structure; Training requirements;
- Monitoring and reporting procedures;
- Environmental reporting; and
- Environmental compliance audits and reviews.

The EMMP is essential to ensure that identified and potential impacts are maintained within the allowable levels, unanticipated impacts are mitigated at an early stage (before they become a problem), and the expected project benefits are realized. The EMMP will include a description of the technology and methodology that LEC and its contractors will use to monitor the actual impacts of the project on the environment and the standards and procedures for adjusting mitigation measures as necessary to maintain impacts within an acceptable range (Appendix E).

7.1 OBJECTIVES OF ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN

Implementation of the EMMP will ensure that LEC complies with the environmental standards set by the EPA and IFC or the World Bank, thereby protecting the environment for future generations. Through the implementation of the EMMP, LEC’s objective will be to ensure that its operations are integrated harmoniously into their host environments, and that the Project will play an active part in the local and national development. The company will provide necessary training to staff to achieve the following objectives:

- Propose management rules and specific measures that are compatible with
biodiversity protection while allowing the operation of the transmission line at competitive costs;

- Promote awareness by its employees and the general public regarding biodiversity protection, particularly in areas used by indigenous people;
- Propose concrete means of applying the EPA’s biodiversity strategy and action plan;
- Ensure that construction and operation are carried out in accordance with the goals and requirements presented in the EMMP;
- Ensure that construction and operation are carried out in such a way as to minimize the likelihood of environmental degradation;
- Ensure that construction and operation are carried out in such a way as to minimize the impact on neighboring properties;
- Ensure that employees engaged in the construction and operation comply with the terms and conditions of the EMMP;
- Provide clear procedures for management of environmental impacts including corrective actions; and
- Identify management and reporting requirements to demonstrate compliance with the EMMP.

The execution of the EMMP will facilitate efficient implementation of mitigation measures to minimize impacts, accident prevention, effective operation and maintenance of the transmission line, and proper training, awareness and information diffusion among LEC’s and the contractor’s personnel. A copy of the EMMP will be retained on site at all times for reference.

7.2 ENVIRONMENTAL MANAGEMENT MEASURES

Local standards and regulations for monitoring air quality, water quality, soil contamination, natural resources, biological resources, occupational health and safety, public health and safety, and cultural and archaeological resources have not yet been set. Therefore, reference will be made to international standards for guidance until the concerned authority in Liberia sets and publishes such standards and regulations.

To ensure compliance with the EMMP, LEC will hire and retain qualified and experienced professionals and consultants responsible for implementing the EMMP. The personnel
involved in construction and operations of the LEC transmission line, as well as, implementing the EMMP will be required to attend environmental and social training workshops as applicable to their role. The objective of these workshops is to ensure appropriate environmental and social awareness, knowledge, and skills for implementation of the environmental and social mitigation monitoring measures. The workshops will increase environmental and social awareness of the participants by covering at least the following topics:

- Environmental laws, regulations, and standards
- Labor laws, regulations and standards
- Pollution health impacts
- Pollution prevention and mitigation measures
- Sampling techniques and environmental and social monitoring guidelines
- Integrated solid waste management (source reduction, separation, processing, etc.)
- Health and safety measures

In addition to the EMMP, LEC will develop and implement the following plans and programs as applicable during construction and operations:

- Health and Safety Plan
- Erosion and Sediment Control Plan
- Emergency Preparedness and Response Plan
- Spill Contingency Plan
- Chance Find Procedures
- Community Relations Program

7.3 ENVIRONMENTAL MONITORING MEASURES

7.3.1 Air Quality and Dust Emissions

The local ambient air quality in the vicinity of the transmission line will be temporarily impacted during construction as a result of air emissions produced by construction activities. Construction emissions will consist primarily of fugitive emissions of particulates from the operation of mobile construction equipment and land clearing. The fugitive emissions will be minimized during land clearing activities for the tower construction work
areas, access points, and material storage areas. Continuous visual monitoring will occur during land clearing activities and water will be sprayed on piles of cleared debris/loose soil during the dry season, as needed.

7.3.2 Noise

During construction of the transmission line, the most significant noise contributors will be heavy-duty machinery operation and related vehicular traffic. Prior to commencing construction activities, noise monitoring will be conducted to establish the existing ambient noise levels at specified intervals along the transmission line route. During construction, one hour noise monitoring will be conducted as needed whenever the highest impacts are likely to occur to ensure noise impacts do not exceed the levels in Table 7-1 or result in a maximum increase in background levels of 3 dB at the nearest receptor location.

Table 7-1 Noise level guidelines. Source: WHO 1999 & IFC, 2007

<table>
<thead>
<tr>
<th>Area Classification</th>
<th>One Hour LAeq (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Daytime 07:00 – 22:00</td>
</tr>
<tr>
<td>Residential; institutional; educational</td>
<td>55</td>
</tr>
<tr>
<td>Industrial; commercial</td>
<td>70</td>
</tr>
</tbody>
</table>

Sound level meters will be used to measure noise levels in terms of Leq in dBA. Calibration of the meters will be conducted before and after each monitoring round, using a portable calibrator or similar. Calibrated hand-held anemometers will be used for the measurement of wind speed during noise monitoring periods. Noise monitoring will be carried out for at least one hour in order to determine the average noise level.

Noise measurements will not be made in the presence of fog, rain, and wind with a steady speed exceeding 5 m/s or wind gusts exceeding 10 m/s. The monitoring locations will be at a point located 3 m from any reflecting surface and at a height of approximately 1.5 m aboveground. Relevant data including temperature, pressure, weather conditions, elapsed-time meter reading for the start and stop of the sampler, data and time of sampling, and work progress of the concerned area will be recorded concurrently with noise measurements.
7.3.3 Water Quality

Degradation of ambient water quality in the project area will be temporary during construction causing increased turbidity from sediment and erosion and stormwater runoff from the removal of vegetation, as well as, potential pollutants in storm water runoff from material storage areas and spills/leaks from construction equipment.

The Contractor will be required to implement sediment and erosion controls to prevent sedimentation in storm water runoff. Visual inspections of the sediment and erosion controls and nearby streams will be required to assess if additional measures are needed.

Additionally, the contractor will inspect accumulated rainwater in secondary containment areas for evidence of pollution prior to discharge. Equipment will be inspected prior to use for evidence of spills or leaks. If a spill or leak occurs, the flow will be immediately stopped and the spilled material cleaned up.

7.3.4 Solid Waste Generation

Following the initiation of construction activities, construction spoils and construction-related materials will be monitored on a weekly basis during the entire construction phase. Furthermore, site audits on the general refuse streams will be conducted to examine existing waste management and handling procedures that include storage, segregation, recycling, transport, as well as disposal. The objectives of the audit are to ensure that the generated wastes are accounted for and to ascertain that they are handled in an environmentally sound manner that complies with proposed mitigation measures. Quantities, photographic documentation, and interviews are essential elements of the audits. It is also necessary to implement waste consignment notes indicating source/dates/quantities of generation along with periodic analysis of constituents. Monitoring will also include:

- Disposal route.
- Visual inspection of waste storage, collection and disposal areas. Records to be maintained for inspection

7.3.5 Health and Safety
During the construction and operation phases, continuous monitoring of health and safety indicators will be conducted to ascertain the application of mitigation measures and health and safety guidelines. The proper use of personal protection equipment (PPE) will be checked in addition to the presence of signs, first aid kits, fire fighting devices, etc. Recordkeeping of injuries/illnesses and major occupational accidents will be conducted and maintained by LEC. Traffic signs, safety instruction signals along ROW, security fencing, as well as firefighting equipment will be monitored through systematic inspections on a semi-annual basis.

The environmental officer, and the Human Resource Department will implement the following monitoring scheme on a daily basis:

- Ensuring that all vehicles have fire extinguishers and that drivers have the training to properly use them.
- Ensuring that vehicle maintenance is being regularly done to prevent risks of accidents.
- The proper use of PPE should be checked in addition to presence of signs, first aid kits, fire fighting devices, etc.
- Ensuring that health awareness signs and posters are displayed, health awareness lectures are being conducted, and that mosquito nets in malarial areas are available for each worker.
- Ensuring that each employee has undergone his or her health checks.

In case of an accident, a mechanism for proper reporting will be required. The description of the accident, duration for clearing the risk, and final conclusions will be recorded. Proper corrective actions will be studied and implemented to reduce the probability of the accident re-occurrence.

Continuous awareness lectures are important to be given to all workers. This would help provide an understanding why safety measures must be taken and inform them on all safety measures and their locations. Properly trained workers will know how to act faster in case of any accident.

7.3.6 Biological Environment
Field investigation and surveys with photographic documentation will be conducted within the site and its surrounding environment prior to and upon completion of construction activities. This will ensure the use of recommended plant species on site for revegetation of cleared areas, as well as provide a visual assessment of the overall success of restoration of construction work areas. Heavy machinery will not be used in sensitive areas.

7.3.7 Soil Quality

Monitoring will be undertaken to ensure recommended mitigation measures are being implemented and are performing adequately to prevent soil contamination. In the event a spill occurs to the ground, the contaminated soil will be excavated, stored on plastic sheeting or within a closed container, and disposed properly.

Additionally soil will be tested for pesticide and herbicide residues at baseline, after site preparation and construction activities, and at any time afterwards should herbicide be used for clearing during the operation phase.

7.3.8 Socio-Economics

Monitoring of socio-economic indicators such as employment generation will be conducted on a regular basis through employment records. Monitoring of social indicators such as population perception, will be conducted annually during project construction and operation through field questionnaires, interviews, and public meetings. The monitoring data will be compiled and archived at LEC.

7.4 SUMMARY OF MONITORING PLAN

A summary of the monitoring parameters with corresponding location, and frequency is presented in Table 7-2 and Table 7-3.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>Monitoring means</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air quality</td>
<td>Construction site and selected receptors</td>
<td>Visual inspection</td>
<td>Continuous</td>
</tr>
<tr>
<td>Noise levels</td>
<td>Construction site and selected receptors</td>
<td>Inspection and measurement of noise level (Leq) at selected receptors</td>
<td>As needed</td>
</tr>
<tr>
<td>Solid Waste Generation and Disposal</td>
<td>Construction site Disposal site</td>
<td>Visual inspection and photographic documentation</td>
<td>Continuous</td>
</tr>
<tr>
<td>Surface water</td>
<td>At nearby surface water body</td>
<td>Visual Inspection</td>
<td>As needed</td>
</tr>
<tr>
<td>Soil Quality</td>
<td>At construction site</td>
<td>Visual inspection of soil surfaces.</td>
<td>As needed</td>
</tr>
<tr>
<td>Biological Environment</td>
<td>Project site and surrounding areas</td>
<td>Occurrence of key species at start of the project and initiate annual follow-up</td>
<td>Prior to and upon completion of construction activities</td>
</tr>
<tr>
<td>Traffic</td>
<td>Construction site and nearby road network</td>
<td>Inspection</td>
<td>Upon complaints</td>
</tr>
<tr>
<td>Health and safety</td>
<td>Project site</td>
<td>Visual inspection, photographic documentation, review of records</td>
<td>Continuous Daily</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>Project site and surrounding areas</td>
<td>Jobs created for local people The effectiveness of acquisition procedure and of compensation disbursement</td>
<td>Continuous</td>
</tr>
<tr>
<td>Land resources</td>
<td>Along the constructed line</td>
<td>Visual inspection</td>
<td>As the line is being constructed</td>
</tr>
<tr>
<td>Physical cultural resources</td>
<td>All vulnerable sites adjacent to project</td>
<td>Disturbance of known sites Document chance findings</td>
<td>Annually</td>
</tr>
</tbody>
</table>
Table 7-3 Summary of Monitoring Activities During Operation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Location</th>
<th>Monitoring means</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land resources</td>
<td>Along the constructed line</td>
<td>Visual inspection</td>
<td>Annually</td>
</tr>
<tr>
<td>Noise levels</td>
<td>Constructed line</td>
<td>Inspection and measurement of noise level upon complaints</td>
<td>As needed</td>
</tr>
<tr>
<td>Biological Environment</td>
<td>Project site and surrounding areas</td>
<td>Presence of key species</td>
<td>Annually</td>
</tr>
<tr>
<td>Community health and safety</td>
<td>Project site and surrounding areas</td>
<td>Visual inspection, photographic documentation and review of records</td>
<td>Biannually</td>
</tr>
<tr>
<td>Occupational health and safety</td>
<td>Project Operation and maintenance sites</td>
<td>Visual inspection, photographic documentation and review of records</td>
<td>Continuous</td>
</tr>
<tr>
<td>Avian traffic</td>
<td>Constructed lines</td>
<td>Inspection</td>
<td>Continuous</td>
</tr>
<tr>
<td>Socio-economic</td>
<td>Project site and surrounding areas</td>
<td>Jobs created for local people</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Increased production in sectors and added industries from project implementation</td>
<td></td>
</tr>
</tbody>
</table>
8 PUBLIC PARTICIPATION

Environmental and Social Impact Assessment (ESIA) is an instrument of environmental policy defined as a study to assess the environmental and social impact of planned activity as well as a tool for decision making about the perceived feasibility of the planned activity. The purpose of the assessment should not be just to assess impacts and complete an environmental and social impact statement (ESIA); it is to improve the quality of decisions and to inform the public of the projects objectives and components and potential impacts.

Public involvement and consultations are important components in projects such as the described transmission line project by LEC, in order to ensure information is properly conveyed and that cooperation and acceptance from the public is secured. Public participation should also aim to increase general environmental and social awareness among the public and various stakeholders in regards to the proposed Project and thereby addressing their concerns. Additional reasons for involving the public in the ESIA process include:

- Public participation is regarded as proper and fair conduct in public decision-making activities.
- Public participation is widely accepted as a way to ensure that projects meet the stakeholders’ needs and are suitable to the affected public.
- The project carries more legitimacy, and less hostility, if potentially affected parties can influence the decision-making process.
- The final decision is ‘better’ when local knowledge and values are included and when expert knowledge is publicly examined.
- The effectiveness of public participation is measured by the degree of communication, the intensity of contact and the degree of influence for decision making.

Table 8-1 represents some example of effective public participation techniques that can be utilized by the contractor.
Table 8-1: Recommended techniques for public participation

<table>
<thead>
<tr>
<th>Technique</th>
<th>Objective(s)</th>
<th>Scope</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Displays</td>
<td>• To inform about the project</td>
<td>Informative</td>
<td>Affected people and other relevant interests</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public Meetings</td>
<td>• To identify issues and to solicit feedback</td>
<td>Consultative</td>
<td>Affected people consisting of village officials, informal leaders and local people as well as rubber farmers associations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Focus Group / Discussion</td>
<td>• To identify issues and to solicit feedback</td>
<td>Informative</td>
<td>Affected people</td>
</tr>
<tr>
<td></td>
<td>• To get ideas for environmental and social management</td>
<td>Consultative</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Environmental &amp; Social Management</td>
<td></td>
</tr>
</tbody>
</table>

Moreover, in accordance with the requirements of the Environmental Protection and Management Law and the EPA for public consultation on major development projects’ related activities and disclosure of the findings of the ESIA report, Earthtime and LEC have recognized the need for an effective public consultation and disclosure program. As such, consultation with relevant stakeholders commenced during the preparation of the ESIA report.

8.1 Regulations and Requirements

Sections 17 and 18 of the Environmental Protection and Management Law require that the project sponsor should disclose the findings of the EIA to the relevant stakeholders when the draft EIA has been completed. This requirement is also in line with the Guidelines for EIA Administrative Procedures set by the EPA.

On June 9, 10, 11 and 12, 2014, a Notice of Intent (NOI) was published to inform the public about the Project and the availability of the Project Brief for review. The announcement was presented in two newspapers for three days. To date, no response has been received from the public to the NOI.

The following stakeholders were consulted as part of the required program for Scoping:

- Environmental Protection Agency (EPA),
- Ministry of Lands, Mines & Energy (MLME),
- Ministry of Public Works (MPW),
- Liberia Petroleum Refining Company (LPRC),
- Paynesville City Mayor
Meetings were held with these stakeholders on June 18, 2014. Records of the meeting minutes are included as Appendix F. A PowerPoint presentation shared with stakeholders is also included in Appendix H.

8.2 Public Participation Program

The aim was to provide information on the Project, its expected environmental and socio-economic impacts and the proposed mitigation measures and monitoring plan in addition to obtaining and documenting recommendations, opinions and concerns by the various stakeholders. The meeting included:

- An introduction about LEC and its Project and related activities in Liberia;
- An introduction on the ESIA process;
- Detailed discussion with the stakeholders on the proposed project and its environmental impacts as well as proposed mitigation measures to be implemented during construction and operation phases; and
- Highlighting the importance of the participation of the local people in the decision making process.

The forum provided a platform for all the relevant stakeholders to raise their concerns, highlight project related social, environmental and economical issues of significance and reach a common understanding on the way forward to address all significant issues of concern. These concerns are discussed in the following section and detailed minutes of meeting are presented in Appendix F. The relevant feedback from the public consulting meeting will be incorporated in the Environmental Management and Monitoring Plan (EMMP) to the extent possible.
It is recommended that stakeholder engagement with the local communities directly affected by the Project should continue throughout the project life cycle.

8.3 ISSUES ARTICULATED DURING CONSULTATIONS

Stakeholders raised concerns related to compensation in case there are structures within the existing LEC ROW that should be demolished. Social, health and safety, and environmental impacts of the Project were also issues raised by the stakeholders. Several suggestions were made to appropriately handle solid waste generated during the project activities. The stakeholders also stressed the need to appropriately compensate affected people along the ROW, as well as taking into consideration avoiding activities that could have unfavorable impacts on cultural sites or structures.

The stakeholders also acknowledged the fact that the proposed route for the proposed transmission line is of fewer impacts on their livelihood when compared to the alternative routes. Some suggested implementing appropriate health and safety measures in terms of types of poles to be installed as well as number of transformers (if any) installed on each pole.

Most of the participants emphasized the Project should be a source of job opportunities for the people of the various communities along or close to the route. They requested that those communities are given priority when hiring or recruiting workers for the Project.
9 REFERENCES


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APPENDIX A     TRANSMISSION LINE MAP
APPENDIX B  LAYOUT PLAN
APPENDIX C  PHOTOGRAPHS
Figure C-1 Liberia Water & Sewer Water Tank within the ROW - Paynesville Area

Figure C-2 Swamp along the ROW

Figure C-3 Fence on the right side of the road looking northeast
Figure C-4 Farm along the ROW on the left side of the road looking northeast

Figure C-5 Old transmission line pole on the left side of the road

Figure C-6 Farm on the right side of the road looking northeast
Figure C-7 Rubber Plantation. Mount Barclay

Figure C-8 Bridge crossing over creek on along the ROW

Figure C-9 Church along the ROW
Figure C-10 Church & School compound along the ROW; on the left side of the road

Figure C-11 Old transmission line pole

Figure C-12 Grave yard along the ROW
Figure C-13 Houses and business structures along the ROW, near Gate 15

Figure C-14 Vegetation along the ROW

Figure C-15 Graves, and old transmission line pole
Figure C-16 Farm and old transmission line poles
APPENDIX D  CHANCE FIND PROCEDURE
**Chance Find Procedure**

Chance finds are defined as physical cultural resources encountered unexpectedly during project implementation. Chance find Procedures includes provisions for managing aforementioned encountered chance finds. These include the following:

- In the case of chance find of any sites or artifacts of historical, cultural, archeological or religious significance all construction activity in the vicinity of the find/feature/site will cease immediately.
- The discovery will be clearly delineated and secured, and all found remains will be left in situ.
- An LEC assigned archaeological consultant will assess, record and photograph the find/feature/ site.
- In consultation with the Ministry of Information, Culture and Tourism, the assigned Archaeologist will complete a report on the findings and determine the appropriate course of action to take.
- An on-site finds storage area will be provided, allowing storage of any artifacts or other archaeological material recovered during the process.
- A conservator will be made available to the project, if required, and will decide on the disposition of any found samples or relics.
APPENDIX E  STANDARDS FOR EMMP

STANDARD FOR SAFETY GEAR PROVISION TO CONSTRUCTION AND OPERATION SITE STAFF AND WORKERS

- The Contractor shall supply high quality personal protective equipment (PPE) meeting international standards, as appropriate to the needs for each work site and worker’s task. The necessary equipment is to be provided to all staff and workers on the construction site, or during maintenance activities irrespective of rank and level of seniority. The equipment is to be comfortable for prolonged use, and is to be replaced as soon as it loses its effectiveness.

- The Contractor is responsible for ensuring that all staff and workers use appropriate safety gear during all hours of work on each site.

- Fluorescent jackets shall be worn when in the proximity of other workers operating machines or tools, or engaged in potentially dangerous activities such as erecting the transmission line poles or other structures.

- Helmets shall be worn whenever there is a danger of head injury from falling or moving items, such as loose formwork, unsecured overhead structures and the tools of other workers.

- Goggles shall be worn whenever there is a risk of flying debris, from the use of hammers, drills or other fast-moving or impact-creating tools and machines.

- Gloves shall be worn whenever there is a risk of hand injury from hard or sharp materials such as wood or metal, or sparks; they shall also be worn when handling caustic materials such as cement.

- Boots shall be worn whenever there is a risk of foot injury from fast-moving or impact-creating tools and machines, such as drills, sledge hammers and pick axes.

- Ear protection shall be worn whenever the equivalent sound level over 8 hours reaches 85 dB (A), the peak sound levels reach 140 dB(c), or the average maximum sound level reaches 110 dB (A).
STANDARD FOR THE STORAGE, DISPENSING & DISPOSAL OF HAZARDOUS MATERIALS

- The Contractor shall take full responsibility for the use and effects of any hazardous materials that are required for construction and operations that are part of the Transmission Line Project. The Contractor is further responsible for complying with the LEC’s policies and procedures and will ensure that all aspects of the Spill Contingency Plan are followed in the event of a spill.

- All materials that are potentially hazardous to the environment must be stored or disposed of in accordance with this standard. Hazardous materials include, but are not limited to, substances such as fuels, lubricants, herbicides, pesticides, or other chemicals, in solid or liquid form.

- Neither contractor’s responsibility to prevent all leaks and spillages, nor his liability to remedy the damages which may be caused should incidents occur shall be reduced by LEC’s approval for the use, storage and disposal of hazardous materials.

- **Prevention:** Every effort will be made to prevent spills and leaks of any kind. All hazardous materials will be stored in appropriate ways, in line with international safety practices. All operators and supervisors will be trained in appropriate inspection procedures and checks. All problems detected during monitoring and inspection must be passed on to the relevant superior officer. Appropriate repairs will be made immediately.

- **Storage:** Hazardous materials shall be stored at least 30 meters from a water course, spring, swamp, drain or well, and at least 30 meters from a dwelling. Storage areas shall have barriers and impervious surfaces preventing leakages of spilt material outside the storage area or into the underlying soils. They shall be protected from rainfall and secured against intrusion by people other than the Contractor’s personnel.

- **Fuelling operations:** Fuel tanks will be bunded: i.e. there must be secondary containment for the full capacity of the tank in the event of a leak from the tank. A trained attendant will always be in control of fuelling nozzles during refuelling operations. Designated fuelling areas will be bunded (diked) and lined to capture any unexpected releases of fuel. Oil and lubricant dispensing drums will have spill
containment trays and liners, or both, to catch and contain material. Refer also to the specific standards for the bunding of tanks and dispensing of fuel.

- **Disposal:** All used oils, lubricants, solvents, and filters will be recycled whenever possible. Where excess quantities of a hazardous material need to be disposed of, then the contractor shall prepare a disposal plan and seek the approval of LEC before implementing it. In general, hazardous materials will be disposed of at LEC and EPA-approved locations.

- **Fuel contamination of water:** Where there is a significant risk of water becoming contaminated with any form of fuel, then appropriate containment equipment (e.g., floating bunds or barriers, absorbent pads etc) will be kept in readiness at fuel dispensing areas to assist in cleaning up any spills that may occur.

- **Cleaning up spills:** In the event of a spill or release of any material, the spill will be stopped and the incident reported to the nearest representative of LEC. The substance will then be cleaned up immediately, disposed of in an approved manner and the contaminated environment cleaned to the satisfaction of the Company.

### STANDARD FOR BUNDING FUEL TANKS

- All fuel tanks placed aboveground shall be fully bunded. This means that they will be provided with secondary containment in the event of a leak or rupture in the primary containment structure. The secondary containment shall have a capacity adequate to contain the entire contents of the tank.

- The contractor is responsible for installing and maintaining any fuel storage tank and bunding arrangement to supply fuel for his operations. The contractor will ensure that tanks are bunded and will submit a Spill Contingency Plan for approval by LEC before using the tank. In the event of a spillage, the contractor is responsible for taking all action as described in the approved Spill Contingency Plan.

- Bunding shall consist of a strong structure that is well founded and built without joints, around the entire tank. On land this might typically be a masonry wall of 150 mm minimum thickness around the tank being bunded; the ground inside the tank needs to be cleared of topsoil or other loose material, and given a thick concrete screed, and the bunded area must be lined throughout, floor and sides, with waterproof cement plaster or a similar coating to contain liquids.
STANDARD FOR CLEAN-UP OF POLLUTION BY HAZARDOUS MATERIALS

This standard covers the action to be taken in the event of the leakage or spillage of any environmentally hazardous material, such as fuel, oil, chemicals of any kind, into either a water course or standing waterbody, or into soil. Before bringing any hazardous materials to the site, the contractor must prepare a Spill Contingency Plan in accordance with this standard and gain the approval of LEC.

The purpose of a Spill Contingency Plan is to provide guidelines to prevent environmental contamination, and the procedures to be followed should hazardous materials enter the environment. It applies to all working areas of the Transmission Line Project.

The contractor must prepare a Spill Contingency Plan for the material storage areas. This is a regulatory requirement of the Government of Liberia, and the minimum details that must be in the plan are as follows: (a) how incidents will be contained and controlled so as to minimize the effects and to limit danger to persons, the environment and property; (b) how the necessary measures will be implemented to protect people and the environment; (c) a description of the actions that will be taken to control the conditions and to limit their consequences, including a description of the safety equipment and resources available; and (d) arrangements for training staff in the duties they will be expected to perform. The Spill Contingency Plan shall be simple and straightforward.

The following principles must be included in the plan: (a) the source of the leak or spill must be stopped immediately once discovered; (b) the alarm must be raised throughout the site; (c) work on the site must be stopped and all available resources directed into resolving the problem; (d) emergency measures must be taken to contain all remaining material; (e) where appropriate, measures must be taken to neutralize hazardous substances; (e) LEC shall be informed immediately; and (f) site-specific and material-specific details will be given for the disposal of contaminated soil and water, and mitigation of the damage caused.

The contractor shall ensure that all site supervision staff is aware of the plan and capable of implementing it. In the event of a leak or spillage, the contractor shall bear all liability whether the plan is implemented or not.

**Spill response procedure:** Every Spill Contingency Plan must contain, as a minimum,
details of the following emergency procedures:

a. The person who discovers any spill must notify fellow workers and inform the supervisor that a spill has occurred. If anyone is injured or in danger, they must be rescued if it is safe to do so, and appropriate rescue and medical assistance called if required. All site staff must be informed if there is a risk of fire or explosion, or of a collapse of infrastructure, and in these cases all unnecessary personnel must be evacuated to a safe location.

b. All trained contractor staff will react promptly to all spills, no matter how insignificant they may appear. Whatever resources are at the contractor’s disposal will be diverted immediately to assist in resolving the spill.

c. LEC’s management will be notified immediately if any spill or release occurs, however small. As much information as possible should be provided about the spill location, type of material, approximate quantity, and extent of damage.

d. The area surrounding the spill will be secured and contained to minimize additional contamination, for example by building an earth bund. Emergency containment should be started as soon as possible. This will give time for a full pollution-control strategy to be designed, agreed and implemented.

STANDARD FOR PIT LATRINES

Where temporary toilets are required on site, earth pit latrines are the preferred option. These shall consist of a simple pit with a well-ventilated shelter over the top. Pit latrines shall be sited in locations that meet the following criteria:

a. At least 50 meters from a water course or waterbody of any description.

b. At least 100 meters from a drinking water source. This shall be determined by asking members of local communities to show their sources of drinking water before siting a latrine.

c. At least 50 meters from a house.

d. Where neither surface nor ground water is likely to collect in the pit.

Holes should be around 1.5 meters deep, and certainly not less than 1 meter, and approximately 1 meter in diameter. They shall be completely enclosed by a sound wooden platform over the top, apart from:
a. A small hinged cover that allows use of the latrine but can be closed when not in use; and

b. A vertical vent pipe at least 2 meters long, with mosquito mesh over the top, made of bamboo or plastic.

A short burst (10 seconds) of Copper treat should be sprayed into the latrine every 2 to 3 days, to stop mosquitoes from breeding in water collected in the pit.

The latrine shall be moved to a new location if it becomes unpleasant to use due to excessive smell, becomes full, or a month of use time elapses. When this is done, the pit must be carefully backfilled and the soil compacted. The ground surface over and around the pit shall be re-graded and made good, and if necessary re-vegetated.

**STANDARD FOR DISPOSAL OF WASTE FROM CHEMICAL TOILETS**

When full or nearly full, chemical toilets shall be transported to the approved emptying point for careful disposal under proper supervision. There are two main risks involved: (a) damage to soils, plants and animals from the chemicals used in the toilets; and (b) health dangers to people in the vicinity from the sewage being disposed.

Disposal holes must be dug, and the waste from the chemical toilets emptied into them. The holes must be situated at least 100 meters from any dwelling and at least 100 meters from a water course, spring or well. Wherever possible, they should be on a permeable but not sandy soil. Holes shall be two meters deep when first excavated.

Each time a toilet is emptied into the hole, the waste shall be covered with 100 mm of soil. When the hole has only 0.5 meter of depth remaining, it shall be completely filled and a new hole started.

**STANDARD FOR DISPENSING FUEL AT MATERIAL STORAGE AREAS**

This standard shall apply only to the dispensing of diesel fuel at material storage areas. An area shall first be designated that is as far as possible from living and eating areas. It shall also be as far as possible from water courses and swamps. The surface of the area for dispensing fuel shall be graded so that it has a very gentle slope (2 to 3 degrees).

A thick polythene sheet shall be laid over an area of approximately 50 square meters. The sheet shall then be covered with sand or gravel to a depth of 80 to 100 mm. Vehicles and
machines shall be parked with their tanks over this area when being filled.

A self-closing nozzle shall be fitted on the fuel pump. The pump nozzle shall be placed on a portable spill containment tray when not in use (if it does not hook back up to the pump).

If the sand or gravel becomes badly contaminated through spillages, and when the site is restored, it shall be removed and collected by an EPA certified solid waste contractor and buried in an appropriate landfill site.

If fuel is to be dispensed from a mobile tanker, a portable spill tray shall be placed below the pump and the tank of each vehicle or machine being filled.

Any spillage shall be collected from spill containment trays in a suitable container for filtration and re-use. Contractors are encouraged to consider using a semi-rigid containment tray and a fuel-water separator as an alternative to the simple procedures given in this standard.

ENVIRONMENTAL BRIEFING FOR SITE CREWS

All site crews of the company or contractors shall be briefed on key environmental issues before starting work in the field. This shall be done at the start of each package of work and at the beginning of each working week. It is expected to take only about ten minutes.

The environmental awareness messages shall also be displayed in notices on the site, which shall be painted or laminated, and maintained for the duration of site works. As a minimum, the following issues shall be raised:

Environmental Rules

- No employee or contractor is allowed to hunt or deal with bush meat on site.
- Vegetation (brushes and shrubs) may only be burned in piles where specified. Otherwise, it shall be used to mulch (cover) the surface of the cleared site. This is important because it helps prevent soil erosion.
- No smoking or lighting of fire in the forest; this could cause forest fires that can destroy important animals and plants.
- Do not cut down any tree with a trunk thicker than the length of a foot without prior notice.
- Do not fish in sacred streams: we must respect our culture.
Safety Rules

- All employees and contractors must wear all appropriate safety gear (PPE or personal protective equipment) during all hours of work on each site. This is important to prevent any possible harm to you.
- You must wear fluorescent jackets when you are close to workers operating machines or tools, or engaged in potentially dangerous activities.
- You must wear helmets whenever there is a danger of head injury from falling or moving items.
- You must wear goggles whenever there is a risk of flying debris, from the use of hammers, drills, etc.
- Gloves should be worn whenever there is a risk of hand injury from hard or sharp materials such as wood, metals or sparks. Also when handling any type of chemical.
- You must wear boots whenever there is the risk of foot injury from dropped heavy items, fast-moving or impact-creating tools and machines. Examples: drills, sledge hammers and pick axes.
- Ear protection must be worn whenever you are 20 m or less from any machine making a loud noise. Examples: generators, drills, compressors, power saws, grinders, etc.
- Always keep a full first aid kit on all work sites. There should be at least two persons on each work site who know what to do if there is an accident.

Pollution Control Rules

- Where latrines or toilets are provided at work sites, you must use them and not the forest.
- Latrines must be filled in when abandoned. Chemical toilets must only be emptied in the specified and approved location.
- All workers must ensure that all potentially hazardous materials (i.e. fuel, oil, other chemicals) are stored or disposed of in appropriate ways and specified locations.
- No contractor or worker should leave litter (plastic bag, paper, etc) on the RoW, roads or other work sites. Carry it back to the camp for disposal.
- Do not dispose of hazardous materials in streams, water courses and soil.
- In the event of an accident, damage or pollution, contact the nearest LEC office immediately. DO NOT TRY TO HIDE OR COVER IT UP.
APPENDIX F  MINUTES OF STAKEHOLDERS CONSULTATION
MINUTES OF MEETINGS

Stakeholder Consultation – (EIA) - Environmental Impact Assessment for HFO Pipeline and Paynesville-Kakata Transmission Line, part of Liberia Accelerated Electricity Expansion Project (LACEEP)

Meeting: HFO pipeline and Paynesville-Kakata Transmission line.

Date: June 18, 2014 (Start 10:30 AM – End 12:45PM)

Venue: LEC Conference Room, Water Side, Monrovia, Liberia

Attendants:

<table>
<thead>
<tr>
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<th>Organization</th>
<th>Position</th>
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<td>China Union</td>
<td>Environmental Management</td>
<td>+231774243441 <a href="mailto:Dmborzie@yahoo.com">Dmborzie@yahoo.com</a></td>
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Summary:

A meeting was held between Liberia Electricity Corporation, Environmental Protection Agency, Liberia Petroleum Refining Company, Ministry of Transport, National Port Authority, Earthtime and other relevant Ministries and Agencies. The purpose of the meeting was to brief attendees on two projects that fall under the LACEEP Project:

- Proposed installation of a heavy fuel oil (HFO) pipeline from the feed point within the Freeport of Monrovia to the Liberia Electric Company (LEC) property on Bushrod Island, and construction of storage terminals for the HFO and other liquids on the LEC property.
- Proposed 66-kilovolt (kV) transmission line that will run for 56 kilometers between Kakata-Paynesville.

A short presentation (attached) on the projects was provided. Concerns were voiced and questions asked. Generally, attendees were attentive and interested.

Presentation:

Wassim Hamdan, Managing Director Earthtime, presented the two projects. The presentation included a short projects description and location and a brief on the EIA process in Liberia, where Mr. Hamdan stated that the process is a requirement by the EPA and Environmental Protection and Management Law of Liberia. He also mentioned the current status of the projects in the EIA process. The presentation also included some of the main environmental impacts of the projects and main mitigation measures that can be used to minimize these impacts.
Questions and Concerns Session:

The purpose of this section was to focus on the concerns of the major stakeholders on the project. Some concerns were discussed in the meeting, but mainly answers to the raised questions and concerns will be studied and addressed in the ESIA, as well as any other concerns communicated to LEC or Earthtime before the ESIA deadline.

The questions, concerns and comments raised during the meeting are presented in the below table.

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<th>Institution</th>
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| Environmental Protection Agency (EPA) | Jerry T. Toe (Manager/C&E) | • Mr Toe thanked LEC for doing this stakeholders meeting, mentioning that LEC is on the right track and going the extra mile towards environmental awareness. He also mentioned that this process doesn’t stop here; as shown in the presentation EPA will be doing another public participation meeting when the EIA document is presented to make sure that the public and the related entities are aware of the project and that all their concerns are taken into consideration.  
• Comparing slides 11 and 12 in the presentation, Mr. Toe mentioned that the picture in slide 12 is what they expect a transmission line route to be, where there is a considerable space in terms of right-of-way around the towers for work and later maintenance. Slide 11 portrayed a picture of red light area where structures are all around the transmission line towers and Mr. Toe asked if this status is the result of encroachment. He added that this status will lead to resettlement and that a resettlement action plan (RAP) is very important to EPA as per the laws and regulations, and it is very important to know how the compensation levels will be determined. He also emphasized that EPA has a regulatory role to ensure the social rights of the people that will be affected in the project area.  
• Health and safety and environmental issues should be taken seriously. Awareness for these issues should be obvious in the submitted documents and projects implementers should adhere to the permit conditions.  
• EPA encourages LEC and all organizations to have an environmental unit.  
• EPA’s responsibility is to enforce the implementation of environmental laws and regulations, and to do so it needs the help of the countries capacities like the various entities and ministries to share their opinion in their areas of expertise.  
• EPA does not compromise on the review of documents and performing site visits, sending samples to local or oversees laboratories when required and taking the opinions of local or international experts where EPA doesn’t have the required expertise in the topic, and all that is on EPA’s expenses which makes EPA’s fees a bit higher.  
• Mitigation measures should be taken very seriously and should be based on scientific methodologies, experiences and expertise. Projects might be rejected based on inappropriate mitigation measures.  
• EPA tries to make sure that the mitigation measures are implemented and they do this through site visits and fine the
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| STEG Int. Services | Mohamed Tarawel (Consultant) | - Air Quality and Noise monitoring and implementation of mitigation measures for these impacts during project construction and implementation is a very important issue, as these can have a long term effect on health and safety and these effects might rise long after the project when the workers will not have any social security benefits and health insurance etc.  
- High fines should be issued over and over again to proponents that do not comply with permit conditions, until everyone complies.  
- Mr. Tarawel shared experience of neighboring countries in terms of solid waste and hazardous waste management, where various mining and oil and gas companies are using incinerators to burn the used oil and contaminated solid waste. |
| China union | D. Mayango Borzie, Sr. (Environmental Management) | - Would LEC be informing China Union ahead of time when the work on the HFO line will begin, as part of this line is passing through China Union properties.  
- Will the transmission line poles be Wooden or steel poles? |
| Liberia Petroleum Refining Company (LPRC) | Benjamin Karnga (Actg. Oprs. Man.) | - In the presentation, Wassim Hamdan mentioned a concern regarding solid waste disposal. This is a very important topic that needs more elaboration. |
| Monrovia City Corporation (MCC) | Abraham By Susu Garneo (Technical Advisor) | - Hazardous wastes disposal is a major issue and has been a major challenge for MCC as well. MCC currently outsources waste collection to EPA certified contractors. Cooperation is needed with EPA to sort out the type of wastes generated in the country and try to open a facility that can accommodate these types of wastes like Ghana and Nigeria. MCC encourages recycling, sorting and segregation of wastes. |
| Ministry of Transport (MoT) | Albert M. Sherman (Asst. Dir. Met) | - Mr. Sherman raised a question about the drainage that passes through LEC premises and if this drainage is connected to the local sewer system when it goes out of LEC or does it reach the ocean.  
- RAP is a challenging issue and should be comprehensively studied for each project when passing through populated areas in order to get to a fair and right decision. |
<p>| Liberia Electric Corporation (LEC) | Joseph T. Mayah (DCEO) | - LEC understands the importance of meeting environmental standards and implementing mitigation measure and health and safety measures to reduce environmental impacts and try to implement environmental rules and regulations to the best extent possible. Furthermore, meeting environmental standards is a major requirement for the financing institutions that LEC work with like the World Bank. These financing institutions make sure that all the environmental issues of the projects are documented and approved by the countries EPA. Financing the project will not get through if these |</p>
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<td>requirements are not met. LEC support this requirement as this is for the countries environmental future protection and we will continue to improve through mitigation measures and monitoring conditions.</td>
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<td>• The Right of Way that was assigned for utilities was heavily encroached on during the war due to the absence of utilities for 20 years. It is a challenge to get to the state shown in slide 12, as in order to do this we need to buy the lands along the transmission line and this will add to the cost of the end product that is Kilowatts cost. LEC should take this into consideration and try to work as environmentally and safely as possible with the limits provided to it, as these are government decisions and not only LEC’s decisions to make. LEC is trying its best to make things look like slide 12 and one of the projects that LEC is working on will soon hopefully look like this as this is an 1349km electric line that will run between Ivory Coast, Liberia, Sierra Leone and Guinea under the CLSG project and that is funded by World Bank, EU, African development bank and contributions from the concerned countries governments. The cost of RAP for this project was 22 million dollars of which 3 million for RAP in Liberia.</td>
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<td>• LEC is Keen on health and safety issues and make sure safety equipment and PPE are used on all its working/ construction sites.</td>
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<td>• The transmission line poles will be either lattice or tubular poles. The two options are mentioned in the specifications for the bidders/ designers to choose what to include in their proposals. Tubular poles have advantage of occupying less space and there is no significant difference in the cost aspect between these two pole types. Wooden poles are out of option not because it is bad but because it needs more treatment and maintenance.</td>
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<td>• The water and sewer system in Liberia stopped working during the work and is still not operational. Currently water and sewer department are selectively pumping the sewage out of the lowest collection point, but we do not know if there is a pumping point around LEC premises in Bushrod Island.</td>
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<td>• LEC makes sure to follow the regulation when it comes to the RAP issue and is bounded by the rigid rules of environmental bureau of the World Bank.</td>
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<td>Earthtime</td>
<td>Wassim Hamdan</td>
<td>• LEC are in contact with Tony from China Union and have an agreement that both party will meet and discuss the work that will be done on the HFO pipeline part passing through China Unions properties prior and during work activities.</td>
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<td></td>
<td>(Managing</td>
<td>• A report was raised to EPA in February regarding the drainage problem with star base.</td>
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<td></td>
<td>Director)</td>
<td>• In the Paynesville - Kakata transmission line project, an analysis of alternatives was done to find a better route for the transmission line where congested areas can be avoided. Unfortunately, the existing route was found to be the best route to go with, as all the other possible routes are more congested and will require more resettlement and higher RAP costs, besides the fact that the selected route was being used by LEC prior to the War.</td>
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<td>• Solid wastes/ Hazardous waste disposal will be a critical issue</td>
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for the contractor. The difficulty arises as Liberia does not have any facility to accommodate these types of wastes. So it will be LEC’s decision but in this case we see two available options:
  - Store the contaminated materials in a contained area.
  - Transport the contaminated material out of the country.

- The drainage that passes through LEC is facing a problem as a nearby military base is discharging its sewage in it. As for the responsible of the drainage when it goes out of LEC premises, laws should be checked to assign if LEC or the Liberia Water and Sewer Corporation is responsible for that section.

- From previous experiences on transmission line projects with LEC financed by the World Bank, the RAP issue is taken very seriously and comprehensive studies are made to check all the structures along the projects area. Different types of surveys are used to assure that all the structures in the area were noted, these surveys include, field GPS survey, satellite images and LIDAR survey. Exact location for the transmission line towers should also be presented. Based on all these methods a decision is made for every structure to see if it needs resettlement or if the towers location can be adjusted in a way that will remove and minimize any potential impact.

<table>
<thead>
<tr>
<th>Institution</th>
<th>Name &amp; Position</th>
<th>Concerns/ Questions/ Comments/Responses</th>
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<td>for the contractor. The difficulty arises as Liberia does not have any facility to accommodate these types of wastes. So it will be LEC’s decision but in this case we see two available options:</td>
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<td>- Store the contaminated materials in a contained area.</td>
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<td>- Transport the contaminated material out of the country.</td>
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APPENDIX G  NOTICE OF INTENT
**Notice of Intent**

**Environmental and Social Impact Assessment for Liberia Electricity Corporation**

**Proposed 66 kV Power Electric Transmission Line Project**

The general public and all concerned or interested parties are hereby informed that Liberia Electricity Corporation (LEC) (the Applicant) has commissioned Earthtime to prepare an Environmental and Social Impact Assessment (ESIA) for the proposed 56 kilometers of 66 kV transmission line to be re-installed on the Government of Liberia – Liberia Electricity Corporation (GOL-LEC) right-of-way along the Kakata-Monrovia Highway to LEC’s existing grid substation at Paynesville, on the outskirts of Monrovia (Margibi and Montserrado Counties respectively). This new power line will link the planned LEC’s Power Plant in Kakata to LEC’s power station in Paynesville.

Liberia Electricity Corporation (LEC), a 100% public enterprise owned by the Government of Liberia established in 1973 with the sole provision of producing electrical energy and distributing it throughout Liberia. This process will help the Applicant manage any associated environmental and socioeconomic issues in accordance with company policies, the laws of the Republic of Liberia including the Environmental Protection and Management Law, and international expectations.

In keeping with Section 11 of the Environmental Protection and Management Law of the Republic of Liberia (2003), Applicant's consultants are preparing an ESIA. The ESIA process will help the Applicant manage any associated environmental and socioeconomic issues in accordance with company policies, the laws of Liberia and international expectations.

In the process of identifying potential environmental and social impacts that may result from activities of the process, the Applicant’s consultant (Earthtime Inc.) and Applicant will request and receive inputs from the public, including interested and affected parties. All persons having views, comments or concerns regarding the proposed project are encouraged to contact the Applicant’s consultants as follows:

- Applicant’s email: tambamayah@yahoo.com
- Applicant’s Consultant email: whamdan@earthtimegroup.com

Your participation or input in this assessment will be highly appreciated in order to guide decision making relevant to the proposed project.
APPENDIX H   POWER POINT PRESENTATION
Liberia Electricity Corporation (LEC)

ENVIRONMENTAL & SOCIAL IMPACT ASSESSMENT
LIBERIA ACCELERATED ELECTRICITY EXPANSION PROJECT (LACEEP)

Public Consultation Meeting
June 18, 2014
Introduction & Experience

Earthtime Project Staff

- Wassim Hamdan – Project Director
- Yasmin El Helwe – Social Consultant
- Nabil El Mosti – GIS & Environmental Consultant
- Di Karanouh – Environmental Consultant
- Baima Shamas – Baseline Data
- Dunchard Stanely – Stakeholder Consultation Support

Acorn International Project Staff

- Dean Slocum – Technical Support
- Atma Khalsa – Technical Support

Earthtime Experience and Qualifications

- Specialize in Applied Earth and Environmental Sciences
- Certified EIA Practitioner with EPA
- Currently working with Acorn International on several EIAs
- EIAs in a wide range of infrastructure and industry development projects in Liberia

Acorn International Experience and Qualifications

- Partnering and Consulting – Local Content & Global Assurance
- Completed >80 EIAs, >50 offshore oil and gas
- Conducted EIA Training with World Bank in Brazil
- Managed more than 3 offshore EIAs in Liberia with Earthtime.
Project Description

- Liberia Accelerated Electricity Expansion Project (LACEEP)
- Funded by the World Bank
- The World Bank has been working very closely with the Ministry of Lands, Mines and Energy (MLME) and with the Liberia Electricity Corporation (LEC) to rehabilitate and extend the network and expand electricity services in the country.
- Following up on this work that started with the LESEP (Liberia Electricity System Enhancement Program) and LESEP Additional Financing, the Bank is now preparing a third project that will continue this support to LEC and to the development of the electricity sector in general, the Liberia Accelerated Electricity Expansion Project (LACEEP)
Project Description

- Activities supported under the new LACEEP
  - rehabilitation and expansion of transmission and distribution networks,
  - rehabilitation of facilities for off-loading, transport and storage of heavy fuel oil (HFO)
Project Description & Location - Pipeline

Pipeline

- Rehabilitation of facilities for off-loading, transport and storage of heavy fuel oil (HFO)
- Located on Bushrod Island, LEC Ste.
- The Study Area is predominantly industrial and/or commercial enterprises, although there are residential developments north of LECs property.
Project Description - Pipeline

- Offloading will be done at or close to China Union Jetty.
Project Description - Pipeline

• HFO will be transported by pipe to Tank Farm at LEC’s site.
• Pipeline will cross through China Union’s facilities.
Project Description - Pipeline

- Pre-existing pipeline.
Project Description - Pipeline

- Existing Tank Farm – abandoned and oil spill.
Project Description & Location – Transmission Line

- Transmission line will commence at LEC’s Paynesville substation (Interconnection Point) in Monrovia and terminate at substation in Kakata.

- The planned line has a length of approximately 56 kilometers (km).
Project Description

- It is intended that the final transmission line routing and design will follow the LEC’s Right-of-Way (RoW).

- The standard distance between the edge of the RoW and the centerline of the highway is 75 feet.
Project Description & Location

- The area where transmission lines located must be kept clear of trees and other obstacles. This area is called a “right-of-way”.

- The right-of-way must have a minimum width to ensure safe separation from other development and to allow access for construction and maintenance.
Project Description

- Transmission line structures consist of:
  - Certain number of towers (number of towers not finalized yet)
  - Towers located at regular 100-200 metre intervals along the selected route
  - Insulators to the towers and the connection of the conductors.
  - Wires
- Other materials that will be used during the difference phases include:
  - Carbon steel plates and shapes,
  - Screws, bolts, studs and nuts,
  - Fabrics, paper, wood, adhesives, rubber, cement, resin, corrosor, paints, lubricants.
Project Activities

- The main activities will occur in five different phases:
  - Demolition;
  - Site Preparation;
  - Construction Phase;
  - Operation Phase; and
  - Decommissioning Phase.

- The project activities will consist of a range of operations that are aimed at ensuring pipeline, storage tank, and Transmission Line construction/installation are developed and operated according to schedule while complying with relevant environmental legislation, standards and regulations of Liberia; in particular, with requirements of the Environmental Protection Agency of the Republic of Liberia, relevant industry best practices, and World Bank guidelines.
Project Duration

The project should take approximately 10 months from start to finish, with a majority (8 months) consisting of construction activities, in which LEC intends to start the project in mid-2014.
Project Activities - Construction

Construction and Installation
- Construction activities will require raw material such as steel, cement, gravel, sand, water (for concrete, drinking and dust suppression).
- The majority of raw material will be sourced from Liberia.
- Specialty components will be required, such as pipelines and tanks. These components will be fabricated outside Liberia and shipped to Liberia for installation.
- During construction civil works will include, but is not limited to:
  - Structures and buildings
  - Concrete foundations
  - Site leveling
  - Mass excavation and backfill on the pipeline route and tank areas
  - Drainage
  - Possibly removal of existing foundation
  - Parking/turning area for fuel trucks
  - Spill-containment pools for storage tanks
  - Site roads
  - Environmental protection equipment, i.e. fire protection and spill recovery
  - Electrical service and lighting
  - Pipeline
  - Storage tanks
- No onsite accommodation for workers will be necessary during construction.
Project Activities - Operation

Operation

- LEC will adopt appropriate initiatives during the operational life of the Project to ensure there will be no deterioration of the site. For example, LEC will have an Oil Spill Contingency Plan in place and will ensure all staff are trained how to respond in the event of an emergency.

- If any instances arise during the course of operation that impact the state of the site, LEC will record these instances, and any investigation or remediation work that is carried out.

- Various steps will be taken to minimize the potential for soil and groundwater contamination including the appropriate use and storage of chemicals, lubricants and fuel oil.

- No on site accommodation for employees will be provided, and it is anticipated that operational staff will live in the immediate area, or in Monrovia or other nearby towns.
Project Activities - Decommissioning

Decommissioning

- The LEC Project is expected to have an operational life of approximately 25 years.
- This may well be extended for a longer period should the need for this type of power generation remain at that time.
- LEC does not foresee any significant environmental or social impacts arising from the eventual decommissioning of the Project infrastructure.
- Notwithstanding this view, the Project will be subject to the requirements of a Site Closure and Restoration Plan (SCRP), which will be developed prior to commencement of operation.
- The SCRP should ensure that LEC leaves the site in the same environmental condition than when it was first occupied and thereby having no significant environmental impacts during decommissioning.
Liberia EIA Regulation

- Liberia EIA Regulation:
  - Environmental Protection & Management Law (November 2002)

- LACEEP falls within categories 7 & 8 of Annex I (Section 6) of the Environmental Protection and Management Law, 2003 (EPML), which mandates EIA for projects requiring an Environmental License. Annex I of the EPML requires the following activities, among others, to prepare EIAs:
Liberia EIA Regulation

- Annex I of the EPML requires the following activities, among others, to prepare EIAs:

“7) Energy Industry
- Production and distribution of electricity, gas, steam and hot water
- Storage of natural gas
- Hydro-electric power - electric power
- Bio-mass power development
- Wind-mills power development
- Solar (i.e. impact due to pollution during manufacture of solar devices, acid battery spillage and improper disposal of batteries).

“8) Petroleum Industry
- Oil and gas exploration and development, including seismic survey
- Construction of offshore and onshore pipelines
- Construction of oil and gas separation, processing, handling and storage facilities
- Construction of oil refineries
- Construction of product depots for the storage of petrol, gas, diesel, tar and other products within commercial, industrial or residential areas
- Transportation of petroleum products
Other EIA Regulations

Environmental & Social Management Framework (ESMF) for
- Liberia Electricity System Enhancement Project, and
- Liberia Accelerated Electricity Project

ESMF requires Environmental Assessments for:
- Expansion of or rehabilitation of transmission lines;
- Rehabilitation of electricity substations;
- Rehabilitation of the HFO off-loading facility and HFO pipeline and storage;
- Construction or rehabilitation of fuel tanks;
- PCB (Polychlorinated Biphenyl) issues rising from old facilities to be rehabilitated;
- Construction and Rehabilitation of micro-hydropower stations; and
- Any other energy sector projects in urban or rural Liberia to be financed by the World Bank
An Environmental and Social Impact Assessment (EIA) is a decision making tool to systematically identify, evaluate and mitigate impacts of project.
Environmental Impact Assessment – Current Stage

- **Project Brief & Letter of Application**
  - Submitted to EPA or 27th of May, 2014
- **Publication of NOI**
  - NOI published in two newspapers on the 9th, 10th, 11th, & 12th of June, 2014
- **Scoping Ongoing**
  - Site visits along with consultation with various stakeholders
  - Baseline Data Collection
- **Scoping Report & TOR**
  - Scoping report including EIA ToR will be submitted to EPA
- **EPA Review**
  - EPA will review scoping report and advice on whether to proceed with suggested ToR
- **Proceed to EIA**
  - Upon EPA approval of ToR, our team will proceed with EIA preparation
Environmental Impact Assessment - Baseline

- To define baseline conditions prior to permit application, and project implementation.
- To identify environmental parameters and assess their current conditions prior to permit application and project implementation.
- To meet data quality objectives for risk assessment.
- To adequately predict and assess extent of project’s impact on environment.
- To set reference conditions for evaluation of projects performance, after permit approval, in terms of compliance and impact detection monitoring.
- To enable regulatory agencies (such as EPA) to scientifically evaluate environmental conditions, provide recommendations to decision makers, and efficiently monitor performance of project proponents.
- Most Important: to ensure long term protection of environmental parameters.
Why Environmental Baseline Data

Environmental Baseline Data

Physical
- Water
- Topography
- Noise

Biological
- Soil
- Geology
- Air
- Terrestrial & Aquatic Ecosystems
- Flora & Fauna

Socio-Economic
- Demography
- Development Need
- Infrastructure
- Economic Activities

Cultural
- Archeology
- Historical Sites
- Religious Sites
Potential Environmental and Social Impacts

- **Air Quality** from Use of Equipment and Movement of Soils during Demolition & Construction.
- **Noise** from Construction Vehicles and Activities
- **Solid Waste** Generated during Demolition, Construction & Operation
- **Surface Water** from Activities during Construction & Operation
- **Soil & Groundwater** from Activities during Construction & Operation
- **Traffic** from Construction Activities
- **Health & Safety** from Demolition, Construction & Operation Activities
- **Landscape & Visual Impacts** from Construction Activities
Key Potential Impacts & Proposed Mitigation Measures

Air Quality
- Wtering of bare soil to control dust.
- Enclosing construction camp sites through appropriate fencing and screening.
- Proper handling of cement material.
- Covering all vehicles hauling materials likely to give off excessive dust emissions.
- Ensuring adequate maintenance and repair of construction machinery and vehicles.
- Avoiding burning of material resulting from site clearance.
- Installing appropriate tank venting technologies, including pressure/vacuum vent valves.

Noise
- Providing all workers working in noisy areas or operating noisy equipment with hearing protection.
- Limiting site working hours if possible.
- Enforcing noise monitoring.
- Scheduling noisy activities
Key Potential Impacts & Proposed Mitigation Measures

Solid Waste

- Using generated demolition & construction debris materials for reclamation purposes whenever applicable after ensuring the absence of contamination and the adequacy of the physical and chemical properties of such material.
- Minimizing construction and demolition wastes through careful planning during the design stage, whereby reducing or eliminating over-ordering of construction materials.
- Sorting construction and demolition wastes into various categories and adopting reuse.
- Recycling on site whenever deemed feasible.
- Segregating chemical wastes and properly storing and disposing of it as hazardous waste.
- Storing chemical wastes in a separate area that has an impermeable floor, adequate ventilation and a roof to prevent exposure to rainfall.
- Labeling all chemical waste clearly in English, storing it in corrosion resistant containers, and arranging so that incompatible materials are adequately separated.
- Securing a prior agreement with the EPA and EPA-certified solid waste management contractor for the disposal of hazardous waste generated on-site.
- Drafting an agreement with the solid waste collectors in the counties crossed by the project to identify collection sites and schedule routine removal of waste to minimize odor, pest infestation and litter buildup.
- Prohibiting the burning of refuse on the construction site.
- Providing receptacles for waste storage prior to collection.
Key Potential Impacts & Proposed Mitigation Measures

**Surface Water & Groundwater:**

- Storing chemicals on site in closed containers at designated areas with secondary containment.
- Installing natural or synthetic liners beneath chemical storage tanks.
- Cleaning up spills and releases immediately, including excavating contaminated soils as needed.
- Storing contaminated soils on plastic sheeting and keeping it covered until disposed of properly.
- Using non-toxic and readily biodegradable chemicals on-site.
- Using drip pans or plastic sheeting when performing vehicle and equipment maintenance.
Key Potential Impacts & Proposed Mitigation Measures

Soil Erosion

- Scheduling construction/ rehabilitation to avoid heavy rainfall to the extent practical.
- Designing channels and ditches for post-construction flows.
- Using erosion controls in sloped areas during soil disturbance.
Key Potential Impacts & Proposed Mitigation Measures

Traffic

- **Proper planning** and development of a traffic control plan that takes into account the reservations and inputs of local communities.
- **Notifying the affected communities** regarding the construction schedule.
- **Providing alternate routes** when needed and when feasible during all phases of construction.
- **Limiting the movement of heavy machinery** during the construction phase to off-peak hours and providing prior notification.
- **Providing a traffic re-routing plan** for the construction phase.
Key Potential Impacts & Proposed Mitigation Measures

**Land Clearing for RoW**

- Selecting right-of-ways to avoid important natural areas such as wetlands and sensitive habitats.
- Utilizing appropriate clearing techniques (i.e. hand clearing vs. mechanized clearing).
- Maintaining native ground cover above pipeline.
- Replanting disturbed sites.
- Managing right-of-ways to maximize wildlife benefits.
Key Potential Impacts & Proposed Mitigation Measures

Landscape & Visual Impacts

- Enclose the construction camp sites with non-transparent fencing to minimize the visual impacts on nearby areas.
- Prohibiting the parking of construction equipment, construction materials, and transport vehicles along the highway to the extent practical.
Thank you