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KIVU 56

Addendum to the Environmental and Social Impact Assessment

Final

October 2018

TITLE AND APPROVAL PAGE

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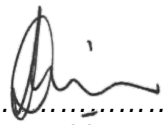

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AMENDMENTS PAGE

Date	Nature of Amendment	Amendment No.	Signature
01/10/2018	Draft for Client Review	0	
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ACRONYMS AND ABBREVIATIONS

AFDB	African Development Bank
EDCL	Energy Development Corporation Limited
EUCL	Energy Utility Corporation Limited
ESIA	Environmental and Social Impact Assessment
ESO	Environmental and Social Officer
GEF	Gas Extraction Facilities
GoR	Government of Rwanda
IFC-PS	International Finance Corporation's Performance Standards, 2012
IFC	International Finance Corporation
MW	Mega Watt [one million watts]
RAP	Resettlement Action Plan
RWF	Rwandan Franc
RNRA	Rwanda Natural Resources Authority
SPLKL	Symbion Power Lake Kivu Limited
USD	USD – United States Dollars

1 INTRODUCTION

1.1 Purpose of the Addendum

This document is an addendum to the Environmental and Social Impact Assessment (ESIA) that was carried out for the KIVU56 gas to power project.

Purpose is to augment the existing and approved ESIA to establish an overall environmental and social impact assessment for the Project, which complies with International Standards set out in International Finance Corporation (IFC) Performance Standards and African Development Bank (AFDB) Operational Safeguards.

1.2 Project Background

The KIVU56 Project is an integrated offshore methane extraction and onshore gas-to-power facility at Lake Kivu in Rwanda. Energy Utility Corporation Limited (EUCL), the Rwandan national electricity utility, will serve as the sole off-taker for the project and will make capacity and energy payments that are guaranteed by the government of Rwanda.

The project is developed by Symbion Power Lake Kivu Limited (SPLKL) as a result of a twenty-five-year concession granted by the Government of Rwanda.

The project is located on the eastern shores of Lake Kivu, Rwanda. The nearest significant town is Rubavu, which is on the border between Rwanda and the Democratic Republic of Congo. Lake Kivu on the Rwandan side of the border is divided into five districts. The district in which the off-shore facility is located straddles two districts: Rubavu and Rutisro. Each district is divided into sectors, as shown in Figure 1 below.

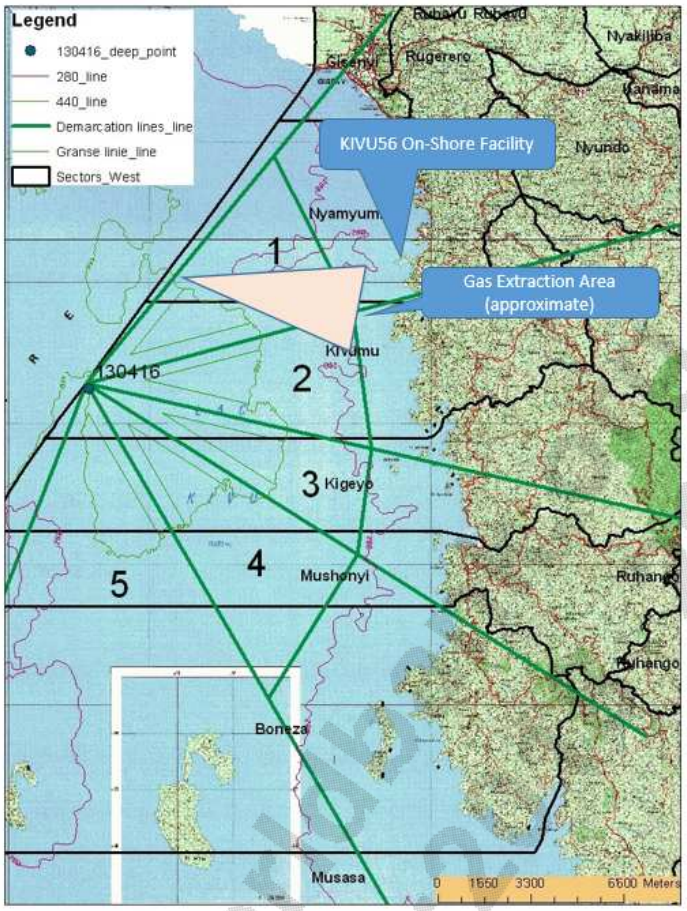

Figure 1: KIVU56 In Relation to Lake Kivu Sectors

The project straddles the Rubavu District, Nyambumba Sector and the Rutsiro District, Kivumu Sector.

The project comprises four key facilities that will be developed by Symbion Power Lake Kivu Limited:

- Four floating platforms, known as Gas Extraction Facilities (GEFs). These are located approximately five kilometers offshore and tethered to the lake bottom;
- Export pipelines, these connect the GEFs to the on-shore facility. The pipelines transport raw gas, with a 30% methane content, to the wash plant;
- An onshore facility – this facility comprises a wash plant, a power plant, a switching yard and ancillary infrastructure. The wash plant treats the raw gas where the methane concentration is increased to 70%. The gas is then used at the power plant to power reciprocating gas engines to produce electricity. The CO_2 rich wash water is discharged back into the lake at the bottom of the biozone as per the Lake Kivu Management Prescriptions (Expert Working Group on Lake Kivu Gas Extraction. 2010). The switching yard transforms and synchronizes the electricity for onward transmission to the Rwandan electricity grid; and
- A marine landing site (onshore) to assemble and launch the GEFs.

The project will be implemented in four phases: phase one will produce 14MW of power from one GEF; and the remaining three phases will each generate 14MW of power, with each phase being defined by the installation and commissioning of an additional GEF.

1.3 Environment and Social Assessment Background

The project has undergone environmental and social impact assessment, the result of which was an Environmental Impact Assessment Certificate issued by the Rwanda Development Board, dated 30 May 2017.

The EIA Certificate is the culmination of the EIA process that was carried out by Eco Design and Protection Limited for Symbion Power Lake Kivu Limited. The EIA process was captured in the final Environmental and Social Impact Assessment Report in 2016.

The project component scope of the ESIA is as follows:

- the offshore component;
- onshore component – gas plant, generators, step-up transformers;
- submerged pipelines.

The ESIA considered the project at two fixed nodes: the project site located in the Busoro cell at the Kabushongo Village, and the offshore extraction, which had not been determined by the time of ESIA submission to the Authorities. The final position of the offshore component is dependent upon the detailed bathymetry, to be completed at the detailed design phase. The ESIA noted that the offshore platforms would be constructed and maintained at an existing jetty known as Kitraco.

1.4 Lender Requirements

The project structure requires that funding be sought for a portion of the capital costs of the project. To this end, Symbion Power Lake Kivu Limited has approached lenders with a funding proposal. This proposal has been taken forward by the lender to the extent that a Lender's Technical Advisor has been appointed to the review the project on the lender's behalf. The lender is mandated to fund only those projects that meet the International Finance Corporation's 2012 Performance Standards on Environmental and Social Sustainability.

The Lender's Technical Advisor has reviewed the environmental and social body of project documents and has made comments on the areas in which the documents do not meet the requirements of the International Finance Corporation Standards. The review was conducted against the eight of the IFC Performance Standards as well as against the African Development Bank's Operational Safeguards.

This document aims to address the some of the comments made in relation to Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts.

The review identified the following areas for further assessment, in order to meet International Standards;

- Three associated facilities are identified; however, they have not been assessed. The facilities in question are: the access road; switchyard and transmission line construction; and land expropriation. The associated facilities are undertaken by the Government of Rwanda (GoR) and are linked with SPLKL's activities. Separate ESIA studies commissioned by the Ministry of Infrastructure (MININFRA) should have been conducted;
- The ESIA must include a cumulative impact assessment of all similar operational activities (e.g. oil and gas) on and within the zone of influence of the Lake.

The review concluded with suggested actions which would fulfil the requirements of the IFC Performance Standards. The actions that will be addressed in this document are as follows:

1. Update the licensed Environmental and Social Impact Assessment to comply with IFC Performance Standards and African Development Bank Operational Safeguards. This would involve:
    a. including the Associated Facilities;
    b. Include an indication of cumulative impact of the project based on general assumption of other developments. An example of such an impact was provided; oil and gas exploration on the lake; and
    c. Set up an ESMP. The ESMP must also include a capacity assessment of Symbion Power Lake Kivu Limited.
2. Carry out an Abbreviated Resettlement Action Plan (ARAP).

These requirements are addressed in the sections below. A lender requirements roadmap has been included as **Appendix C** of this addendum. This roadmap provides the reader with information on where each of the lender requirements can be found. In addition to the above, SPLK has undertaken further terrestrial baseline studies and these are reported upon in Section 7.

2 METHODOLOGY

2.1 Cumulative Impact Assessment

Cumulative environmental and social impacts result from different, often individually insignificant, changes. These changes may build until they cause impacts through accumulation. For example, the decrease of ground water quality and quantity, the deposition of toxic substances in aquatic sediments, the mobilisation of persistent or bio-accumulative substances, fragmentation and damage to habitats, loss of soil quality and the 'greenhouse effect' are cumulative environmental impacts. (Runge, 1998)

The significance of a cumulative impact can be assessed using a framework of significance of the change from the departure point. If the departure point is a zero impact for a particular aspect, then any negative change will create a negative impact for that aspect. Should this impact be aggravated by a similar impact from an anticipated future project, then the negative impact will grow. Adding a further aggravating impact from another future project will cause the cumulative impact to grow still further. The impact will build until it becomes significant. At this point, its effects will become visible to the surrounding population or in ecological degradation. Thus, the two key concepts are: the point at which the impact becomes significant (the threshold of significance) and the contribution of each action to create the significant impact. This discussion has been derived from work conducted by Charles H. Eccleston and his Significance Departure Principle.

The best option for managing cumulative impacts is to carry out a strategic environmental assessment which analyses the impacts of a programme of projects, or the impact in a defined geographical area. The key impacts would then be identified and those impacts should be mitigated at project level for every project in the programme or every project taking place within the geographical area. Such a strategic environmental assessment has not been conducted for the resource exploitation of Lake Kivu, neither for the towns that the KIVU56 project will impact. Thus an alternative approach must be adopted.

In the absence of a strategic environmental assessment, the project impacts that will contribute to other potential impacts in the area were identified and a threshold of significance for such cumulative impacts are suggested in the report. Mitigation measures are proposed to slow the cumulative build-up of the impact until it reaches its level of significance. The cumulative assessment therefore considers the potential for otherwise insignificant effects from the present project to incrementally combine with those from other foreseeable, new, human activity elsewhere in the region.

2.1.1 Potential Cumulative Impacts Drawn from Existing Literature

According to Runge, 1998 the following cumulative impacts should be considered:

- decrease of ground water quality and quantity;
- the deposition of toxic substances in aquatic sediments;
- the mobilisation of persistent or bio-accumulative substances;
- fragmentation and damage to habitats;
- loss of soil quality; and
- the ‘greenhouse effect’ i.e air emissions.

In a 2009 Environmental and Social Management Framework, carried out for the Land Husbandry, Water Harvesting and Hillside Irrigation Project in Rwanda, the following cumulative impacts were identified (Government of Rwanda, 2009):

- Increased use of chemical fertilizer which may have downstream impacts;

- Attraction of immigrant populations to communities that have improved production systems and social infrastructure;
- Reduced water to downstream users due to the dams; and
- Increased sedimentation of the natural water bodies and valley.

A tourism workshop conducted to consider the impacts of tourism in the sensitive Antarctic region identified the following potential cumulative impacts on the marine environment (Hofman RJ, Jatko J. 2000):

- Landscape - topography, geology, and other physical characteristics of the sites may be changed in a number of ways over time as a consequence of many projects in an area;
- Terrestrial Fauna and Flora – impacts upon by many projects in the same area;
- The marine environment – impacts created by the increasing number of watercraft using an area; and
- Tourism impacts – natural vistas being disrupted by developments in an area.

In 2015, a Strategic Environmental Assessment was carried out for the Rwandan energy sector policy (Particip, 2015). The following cumulative impacts were identified by the report:

- Climate change impact mitigation measures include developing focusing on local and renewable fuels, of which methane was one such fuel;
- The use of methane as a fuel was tempered through the impact that methane would have on climate change if emitted directly into the atmosphere. Methane is a powerful greenhouse gas and such emissions should be mitigated by efficient utilization technologies in the electricity generation process; and
- In general, the report stated that power generation will cause negative trans-boundary impacts on the hydrological regime of watercourses on which hydropower plants, peat to power plants, methane to power plants will be built. Impacts cited include the loss of wetlands and associated ecosystems, the loss of biodiversity and ichthyofaunal as well as water, air and soil pollution; and
- The major positive impact was that energy sector development will contribute to the economic growth of Rwanda and will contribute to the achievement of objectives of Vision 2020;
- A further positive impact was that renewable energy generation projects will reduce the Rwandan population's reliance on biomass through the use of wood as a fuel. This will further reduce greenhouse gas emissions; promote adaptation to climate change; eliminate Household Air Pollution (HAP), and reduce mortality and morbidity associated with HAP.

2.2 Screening of Cumulative Impacts

Not all potential cumulative impacts are significant. Some impacts are geographically local in scope and will not translate to regional impacts, some are able to be completely mitigated at project level and thus will not generate a cumulative impact and others are minor project impacts that will too slowly build to form a significant cumulative impacts.

Hence an impact screening was conducted, using the following criteria:

1. Is the impact of regional concern? This assessment was made based on best professional judgement and will use an assessment of which environmental and social components are most valued in the project region;
2. Is the impact likely to extend beyond the project boundary? If the impact has a scale larger than the project boundary, it is eligible for further evaluation;
3. Will the activities which cause the impact also occur in other projects in the regional area? This will highlight project impacts that are likely to be caused in addition to existing similar impacts created by other projects in the area;
4. Over what timescale is the impact likely to develop; If the impact is slow developing, the impact will build up too slowly to become significant; and
5. Are other potential projects likely to generate the same, and intersecting, impacts.

The impacts that are of most potential significance were evaluated further, those of lesser concern will be listed and screened out and no further evaluation was carried out. The results are shown in Section 4.2 of this report.

2.3 Impact Management Quantification Framework

All impacts are analysed in the sections to follow with regard to their nature, extent, magnitude, duration, probability and significance.

ISO 14001-2004 defines impacts as “any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization’s environmental aspects”. For the purposes of this study, the authors have used the ISO 14001-2004 definition in the Impact Management Quantification Framework.

In considering the assessment of the impacts and their mitigation, the following definitions were applied.

Nature	The project could have a positive, negative or neutral impact on the environment.
Extent	**Local** – extend to the site and its immediate surroundings. **Regional** – impact on the district but within the province. **National** – impact on Rwandan scale. **International** – impact outside of Rwanda.
Magnitude	Degree to which impact may cause irreplaceable loss of resources: **Low** – natural and socio-economic functions and processes are not affected or minimally affected. **Medium** – affected environment is notably altered; natural and socio-economic functions and processes continue albeit in a modified way. **High** – natural or socio-economic functions or processes could be substantially affected or altered to the extent that they could temporarily or permanently cease.

Duration	**Short term** – 0-5 years. **Medium term** – 5-11 years. **Long term** – impact ceases after the operational life cycle of the activity either because of natural processes or by human intervention. **Permanent** – mitigation either by natural process or by human intervention will not occur in such a way or in such a time span that the impact can be considered transient.
Probability	**Almost certain** – the event is expected to occur in most circumstances. **Likely** – the event will probably occur in most circumstances. **Moderate** – the event should occur at some time. **Unlikely** – the event could occur at some time. **Rare/Remote** – the event may occur only in exceptional circumstances.
Significance	Provides an overall impression of an impact's importance, and the degree to which it can be mitigated. The range for significance ratings is as follows- **0** – Impact will not affect the environment. No mitigation necessary. **1** – No impact after mitigation. **2** – Residual impact after mitigation. **3** – Impact cannot be mitigated.
Mitigation	Information on the impacts together with literature from journals, case studies and field work will be used to provide mitigation recommendations to ensure that any negative impacts are decreased and positive benefits are enhanced.
Monitoring	Monitoring usually involves developing and implementing a monitoring programme to identify deviations from the proposed action and to manage any negative impacts. The recommended mitigation measures will also include monitoring measures.

A well-designed, well implemented, well managed project can bring significant benefits to the communities that it serves. If configured or operated in a way that ignores significant environmental and social needs or potential impacts, the project may have significant environmental and social costs or liabilities for the stakeholders and affected communities.

Therefore, assessing environmental and social impacts is a complex process due to the multi-dimensional nature of the human interactions. This occurs in situations where a particular impact affects a group of stakeholders differently. An inter-connection of impacts can also be encountered whereby a number of impacts are related and when assessed cumulatively their impacts may be of significance.

The impact assessment scores both before and after mitigation measure are implemented. The specialist team used a modified version of the Delphi technique, where the team discussed the scores, and through a process of iteration arrived at a consensus for each of the values. Where additional information was needed to decide, the technique was halted, the necessary information examined and included in the report.

3 ASSOCIATED FACILITIES

The Kivu 56 power project requires complementary infrastructure in order to bring the power to the national grid and to ensure the continued operations of the facility over the life of the concession.

The provision of such infrastructure is covered in the concession agreement between the Government of Rwanda and Symbion Power Lake Kivu Limited.

The associated infrastructure and its main purpose are as follows:

1. The upgrade of an access road running from Rubavu to the Kivu 56 site – this road provides access to the site for construction and operational purposes. This report describes the road in two segments: the Main Access road and the Site Access road;
2. Transmission Line and Switching Yard – the transmission line and switching supplied the electrical infrastructure to evacuate the power from the Kivu 56 project onto the national grid; and
3. Securing vacant occupation of the Kivu 56 Site.

3.1 Access Roads

3.1.1 Description

The public road between Rubavu and the Bralirwa Brewery was in place at the time of project initiation. The road from the Bralirwa Brewery, along the shoreline to the site, is a 4.8 km long gravel road, approximately six metres long, wide enough for two lanes, one travelling north and the other travelling south. Based on Google Earth imagery, the road was constructed between 2003 and 2010. For the purposes of this report, the Bralirwa Brewery Site Access Road is referred to as the Main Access Road.

A 0.6 km long, gravel road was constructed between August 2015 and January 2016 to connect the site to the Main Access Road. For the purposes of this report, this road is referred to as the Site Access Road.

Both, the Main Access Road and the Site Access Road are shown in Figure 2 below.

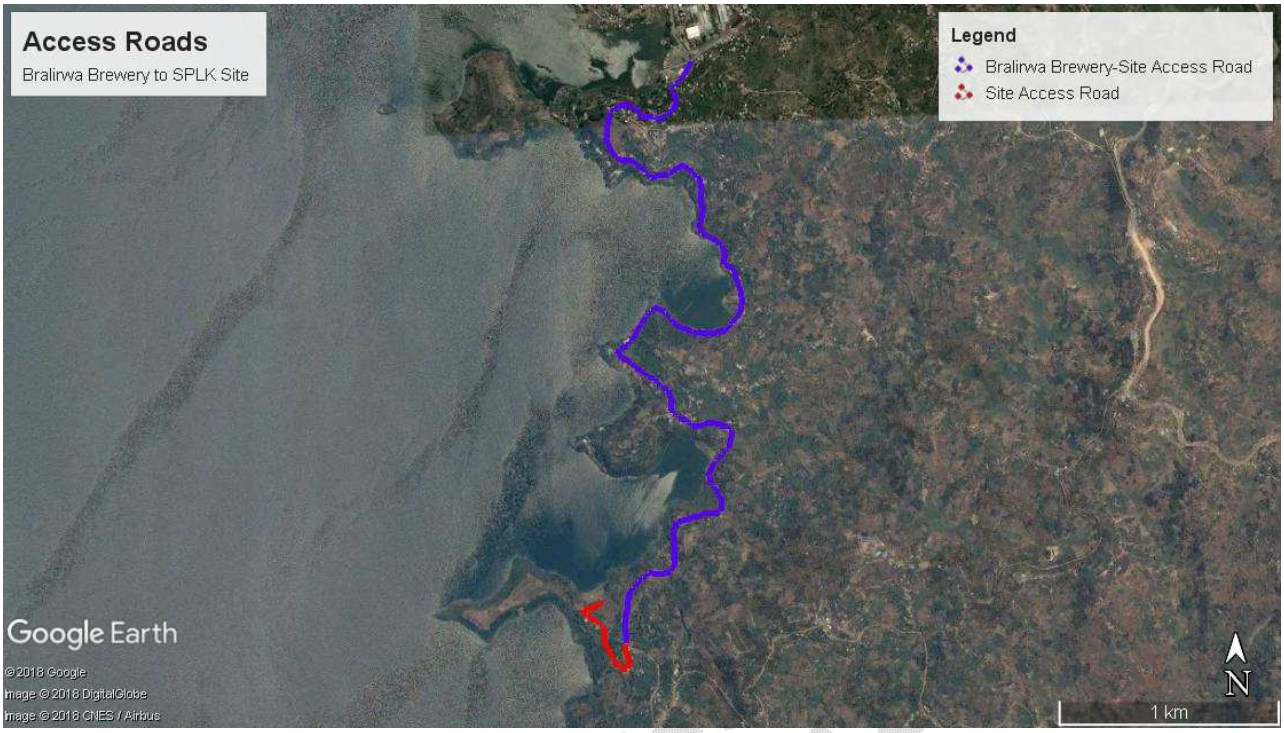

Figure 2: Access Road Routes

The Main Access road connects the many villages and homesteads to the economic hub surrounding the Bralirwa Brewery. This road will be upgraded to accommodate heavy vehicles required by the SPLKL project. The upgrade is to include:

- asphalting;
- grade improvements;
- strengthening the culverts; and
- widening in places.

The road improvements are to allow the transit of abnormal loads along the access road, they are not aimed at increasing the speed limit on the road.

3.1.2 Proponent

Both the Main and Site Access Roads were commissioned by the Government of Rwanda.

3.1.3 Environmental Permitting Status

No environmental and social impact assessment was conducted for the Main Access road. This is a public road and was not constructed in anticipation of the SPLKL project.

No environmental and social impact assessment was conducted for the Site Access road. The road was built by the Government of Rwanda between August 2015 and January 2016.

3.1.4 Key Environmental and Social Impacts Associated with the Access Roads

The key impacts for the access roads for the project are detailed in the section below.

3.1.4.1 Main Access Road

Although the environmental impacts of the Main Access road falls outside the scope of this addendum, as it is a public road which was constructed prior to the initiation of the SPLKL project, the improvements to the road required by the project will generate cumulative environmental and social impacts.

Improvements to this public road will increase the level of activity along the road. The environmental and social aspects are:

- Increased economic activity in the villages along the road;
- Increased volumes of traffic; and
- Increased traffic speeds owing to the road being converted from gravel to asphalt.

Economic Linkages

The improvement of the road will allow better access to the Bralirwa Brewery and the economic hub centred around the brewery. This better access will facilitate trade with Rubavu and then onto the wider region. It will allow freer movement of labour and other services such as health care and education along the road and will better connect the population living along with road with the wider region. These positive impacts do not require mitigation.

Community Safety

A higher volume of traffic, possibly travelling at faster speeds, will create community safety impacts. The road is used by pedestrians and dwellings front onto the road. There is an increased risk of traffic accidents.

To mitigate the SPLKL related impacts along the main access road, the Contractor must produce a Traffic Management Plan that contains appropriate strategies to ensure free flowing traffic on public roads with no inconvenience to other road users. The traffic management plan should address the speed of project related vehicles, their loading and permitted rest areas.

Due to increased volumes of heavy vehicles to site during the construction phase, there is a greater likelihood of road accidents occurring. A road safety campaign, in partnership with local authorities, should be developed. The campaign should target schools, businesses, road users, pedestrians, fish sellers and traders along the route.

Noise and vibration for dwellings along the route

The impact of larger traffic volumes, travelling at faster speeds, will create a noise and vibration impact for dwellings and other buildings along the route. This impact is considered of low

significance owing to the relatively few number of such dwellings along the route and the speed limit on the road is set at 40 km/hr going through towns.

3.1.4.2 Site Access Road

The Site Access road was constructed in anticipation of the SPLKL project, and an outline of the potential impacts of the road is provided below.

Land Acquisition

Land acquisition for the site access road was the major environmental and social impact and mitigation was conducted through compensation.

Land acquisition and compensation was carried out by the Rwanda Transport Development Agency. Eleven directly affected people were identified and compensation was paid for the land and property. The total compensation paid was RWF30 947 550 (equivalent to USD37 140 on 2018/09/25), the date of the payments is unknown.

Loss of Crops

The area through which the road was constructed ran through banana plantations. The loss of these crops was mitigated through the payment of compensation. This was carried out by the Rwanda Transport Development Agency and in included in the sums discussed in the section above.

Traffic Management to the Site

The Contractor must produce a Traffic Management Plan that contains appropriate strategies for moving materials and persons to, from and within construction areas, including abnormal loads.

The Traffic Management Plan should protect the safety of other road users, particularly pedestrians. Traffic speeds should be limited and monitored, as well as stopping areas demarcated. It must make provision for management of connection points between the Main Access road and the Site Access Road. Traffic should not be allowed to back up onto the Main Access Road hence inconveniencing other road users. Also, the Site Access Road must be managed in just a way that it can facilitate the movement of abnormal loads without posing a danger to the public or staff on site.

3.2 Transmission Line and Switching Yard

3.2.1 Description

The transmission line and switching yard are required to evacuate power from Kivu 56 to the Rwandan electricity grid.

A 220 kV transmission line connects Karongi, located in the south of Lake Kivu, to Rubavu and through to Goma in the DRC, and will allow for the evacuation of the energy from the facility to Kigali in the east, to the DRC in the west or Uganda to the north. The transmission line that forms part of the associated infrastructure for the project, will connect the facility to this Karongi/Rubavu line, a distance of some 4.5 km.

The transmission line has the following technical characteristics (EDCL, 2016:

- Double circuit, steel lattice towers;
- Two conductors per phase (horizontal bundle);
- One Optical Fiber Composite Overhead Ground Wire (OPGW) and one Guard wire; and
- Insulators on the towers.

The switching yard is located within the site boundary of the project and will comprise of the following components (EDCL, 2016):

- Two 15/220kV Step up transformers (To be supplied and installed by SPLKL);
- A 220kV double busbar system;
- Two transformer bays;
- Two 220kV overhead line bays;
- One 220kV bus coupler;
- A remote monitoring system with communication through the OPGW;
- An adapted protection and control monitoring system;
- Auxiliary equipment such as: the SCADA; a stand-by diesel generator; earthing and lightning protection system; auxiliary distribution system

Preparation of the site will include bulk earthworks, fencing, construction of control and access buildings, as well as an access road.

The route of the transmission line is shown in Figure 3 below. The servitude width is 30m, thus the land area required for the transmission line is 13.5 hectares. Approximately 15 steel lattice towers will be used along the transmission line.

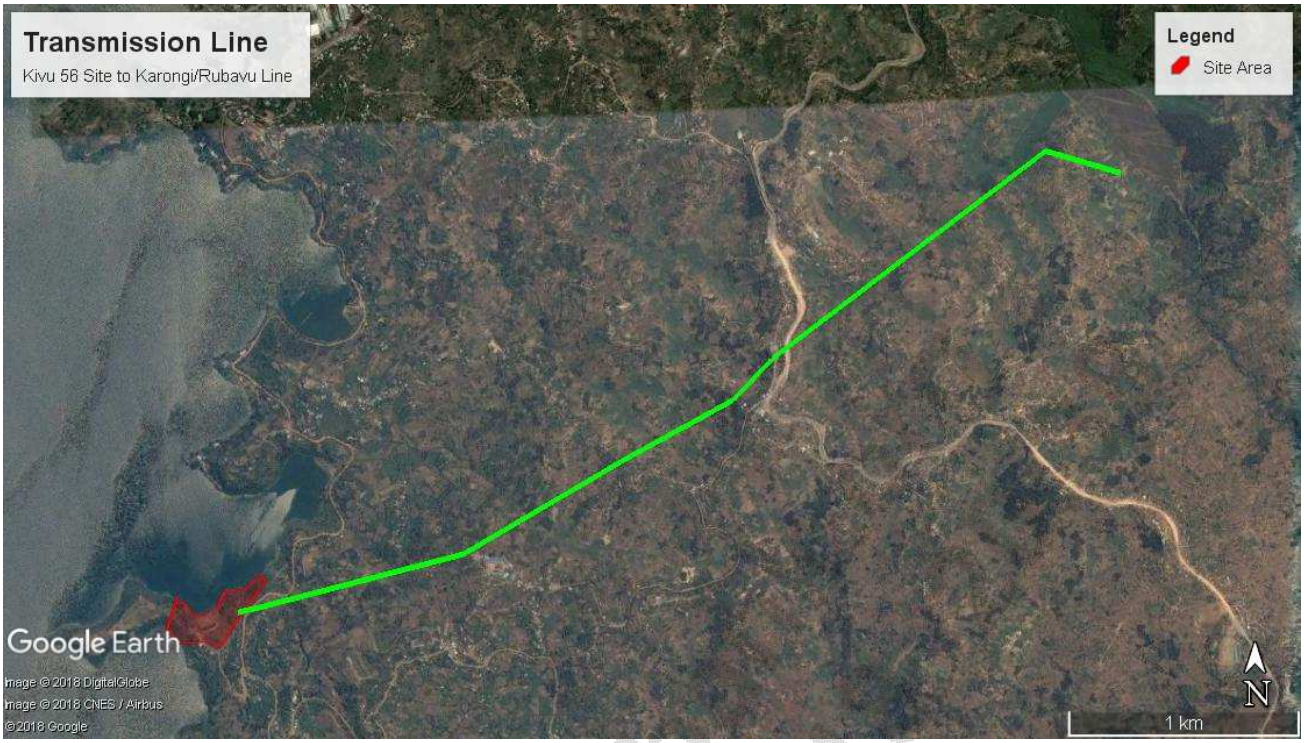

Figure 3: Transmission Line Route

The switching yard will be located in the northern most portion of the "Site Area" shown in Figure 3 above.

3.2.2 Proponent

The proponent for this associated infrastructure will be the Government of Rwanda, represented by the Energy Development Corporation Limited (EDCL).

3.2.3 Environmental Permitting Status

The transmission and switching yard line has undergone an environmental and social impact assessment. The assessment was completed with the issue of an Environmental Impact Certificate authorising the project to continue to construction.

The certificate was issued by the Rwanda Development Board on 15 March 2017. The Certificate Number is RDB/EIA/376/03/17, and EDCL is authorised to proceed with the construction of the transmission line within three years of the date of the certificate.

3.2.4 Key Environmental and Social Impacts

The key impacts considered by the ESIA for the project are (EDCL, 2016):

Positive Impacts

The positive impacts of the project were identified as follows:

- An increase in access to electricity by the country as a whole; and

- Employment creation.

These impacts did not require mitigation.

Land Acquisition

Land acquisition was the major negative environmental and social impact for this project and mitigation was conducted through compensation.

Land acquisition and compensation was will be carried out by EDCL and will be paid to compensate for the loss of 13 500m^2 of agricultural land. Compensation will be paid for all trees higher than 10m that had to be removed from the servitude. Categories of trees removed included: forest trees, agro-forestry trees, fruit trees and perennial crops. The total compensation to be paid for both of these categories of compensation was estimated in 2016 to be RWF93 582 000 (equivalent to USD112 300 on 2018/09/25).

Eight directly affected people were identified as having houses in the 30m wide servitude. Compensation will be paid for the loss of immovable property. The total compensation to be paid was estimated in 2016 to be RWF70 500 000 (equivalent to USD84 600 on 2018/09/25).

For safety purposes, no structure, trees or crops with a height within six metres of the transmission line is allowed to grow in the 30-metre-wide transmission line servitude. The minimum transmission line clearance from ground level is 10 metres, hence crops that grow to a maximum height of four metres will be allowed on the servitude.

Other Impacts

The other negative impacts that were analysed and mitigated in the EMP (EDCL, 2016) were:

- Clearance of vegetation from the servitude – this was mitigated through requiring only clearance of the servitude and the development of a reforestation plan; and
- Soil erosion whilst constructing on steep slopes – this was mitigated through planning for stormwater drainage, good construction practise and revegetation.

3.3 Securing Occupation of the Site

3.3.1 Description

The project site was identified by the Government of Rwanda as being suitable for the onshore infrastructure. The site had a number of landowners who resided on the site and who cultivated bananas, cassava, coffee and maize on the identified site. The directly affected people reside in the Rubavu District, Nyamyumba Sector, from the Busoro cell.

The figure below shows the Kivu 56 shore based site, along with the plots of land identified by the land acquisition process.

Figure 4: Kivu 56 Site and Directly Affected Plots

3.3.2 Proponent

The proponent of this aspect of the project is the Government of Rwanda, represented by Energy Development Corporation Limited (EDCL).

3.3.3 Environmental Permitting Status

Securing vacant occupation of the site did not undergo an environmental and social impact assessment. Information to hand at the time of this report indicates that none was required by the Government of Rwanda.

3.3.4 Key Environmental and Social Impacts

Land Acquisition

Land acquisition was the major environmental and social impact of securing vacant occupation of the site for SPLKL. This impact was mitigated through the payment of compensation to the directly affected members of the public.

The process of paying compensation to directly affected parties was as follows:

- EDCL appointed a certified property valuator to undertake the compensation task;
- The Government of Rwanda identified 34 plots that will be dedicated to the Kivu 56 project;
- The plots were identified and mapped.
- Compensation was paid to directly affected parties; and
- Land was formally transferred to EDCL/Government of Rwanda ownership.

The identified plots are located on a steep slope to the east of the site. The slope overlooks the flatter areas close to the shoreline, and the project infrastructure will be constructed on this flat portion of the site. The plots are therefore suitable only for cultivation and as such 30 of the 34 plots were only used for cultivation of bananas, coffee, cassava, soybean and maize. Four plots contained improvements in the form of houses. Compensation for the improvements was taken into account in the value of the compensation that was paid.

The table (Table 1) below provides details of the 34 properties that are affected as part of this process. The highlighted rows are parties with whom compensation negotiations have not started owing to their whereabouts not being established, or who have not yet accepted the compensation offer.

Table 1: Affected Parties on Kivu 56 Designated Land

Nº	Property ID [UPI]	Area [m^2]
1	3/03/09/02/190	
2	3/03/09/02/189	151
3	3/03/09/02/188	204
4	3/03/09/02/187	923
5	3/03/09/02/186	547
6	3/03/09/02/185	
7	3/03/09/02/184	427
8	3/03/09/02/183	1770
9	3/03/09/02/182	333
10	3/03/09/02/181	523
11	3/03/09/02/180	149
12	3/03/09/02/179	7210
13	3/03/09/02/178	226
14	3/03/09/02/177	466
15	3/03/09/02/176	816
16	3/03/09/02/175	63.6

Nº	Property ID [UPI]	Area [m²]
17	3/03/09/02/174	149
18	3/03/09/02/173	543
19	3/03/09/02/172	164
20	3/03/09/02/171	524
21	3/03/09/02/21	719
22	3/03/09/02/20	3210
23	3/03/09/02/19	597
24	3/03/09/02/18	640
25	3/03/09/02/17	1070
26	3/03/09/02/16	920
27	3/03/09/02/13	1270
28	3/03/09/02/12	276
29	3/03/09/02/10	2410
30	3/03/09/02/9	2750
31	3/03/09/02/8	2190
32	3/03/09/02/7	1140
33	3/03/09/02/6	6010
34	3/03/09/02/7775	864

Land acquisition and compensation was carried out by the EDCL. As at the time of writing, compensation has been paid for 27 of the plots on the list above. The total compensation paid to date was RWF145 520 570 (equivalent to USD174 600 at 2018/09/25). Negotiations and arrangements for payment are continuing.

At the time of writing, 16 of the 27 properties have been transferred to EDCL/Government of Rwanda ownership. Arrangements for the transfer of the remaining plots are ongoing.

4 CUMULATIVE IMPACT ASSESSMENT AND MITIGATION

4.1 Future Projects Taken into Account

A cumulative impact assessment requires an evaluation of the likely future impacts to be generated from other projects in the area, or existing activities which may be creating a similar impact and to that created by KIVU 56.

The analysis of the likely future impact landscape is presented in the two sections below.

4.1.1 Future Gas to Power Projects

Lake Kivu is the largest water body in the world with a methane resource trapped within its waters. As such there are projects similar to KIVU 56 on the lake and future project are likely to be developed. A study of these projects has been made in 2010 in a document entitled “Management Prescriptions for the Development of Lake Kivu Gas Resources” (Expert Working Group, 2010).

The report notes that the methane resource in the lake is shared between the Democratic Republic of Congo and the Republic of Rwanda. The geographical division of the resource is the international border between the two countries. The lake itself is approximately 90 km long and 50 km wide at its widest. The lake extends from Rubavu in the north, to Bukavu (in the DRC) and Cyangugu (Rwanda) in the south.

The methane resource was estimated to yield between 160 MWe to 960 MWe total lake output, depending upon the efficiencies of the power conversion equipment used. This also assumes a fifty-year timeframe for extraction. The sustainable yield after the initial 50-year extraction period is 15-20% of the 50-year yield.

The report recommended the creation of conceptual concession areas in the lake, there are five concession areas within the Republic of Rwanda and six such areas within the DRC. The concession areas are conceptual, but illustrate a method of extraction that can be used for an analysis of future extraction projects. The concession areas are shown in Figure 5 below.

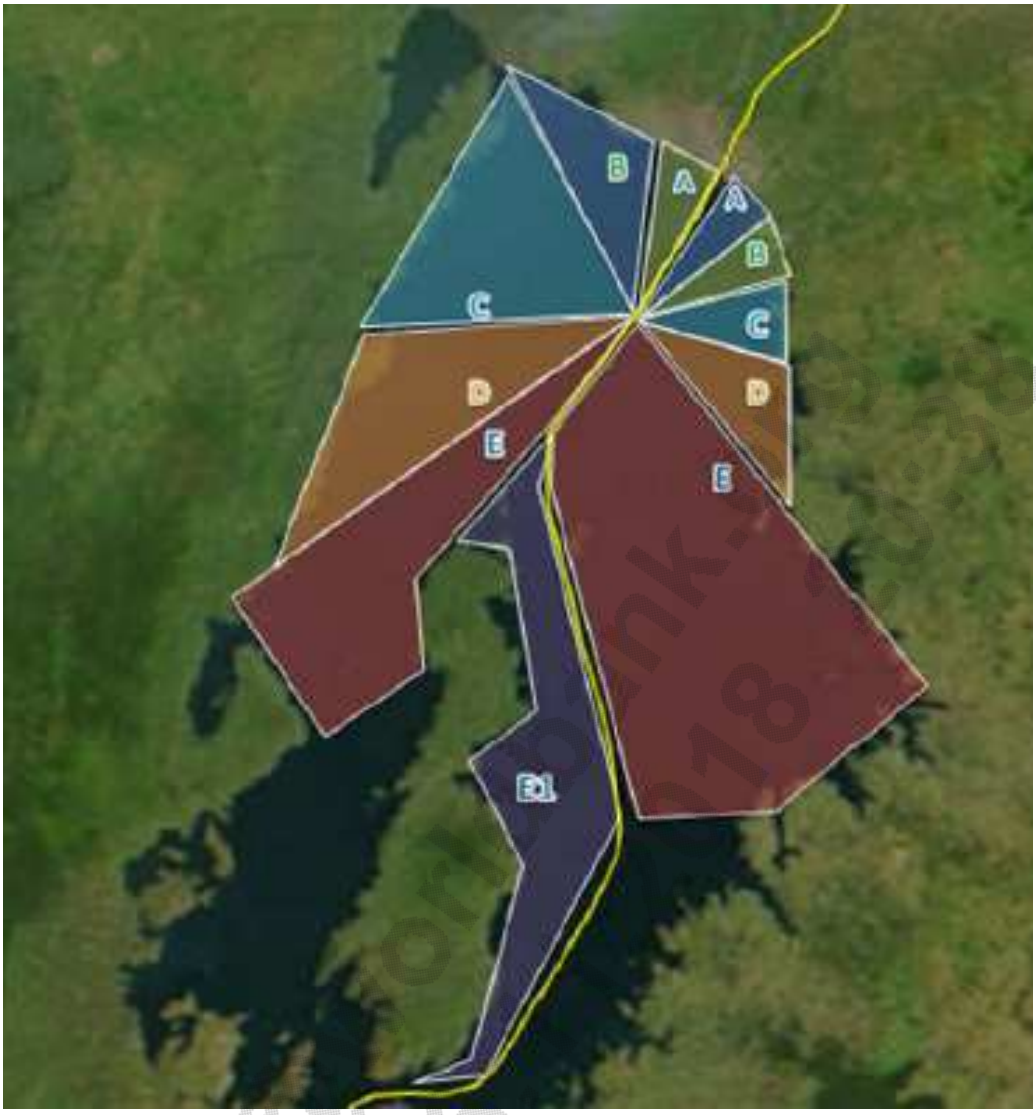

Figure 5: Lake Kivu Conceptual Concession Areas

The concessions are clustered in the north of the lake, since this is the deepest part of the lake with the highest extraction potential.

Using this concession diagram, methane extraction would be equally distributed across each concession, along a 50-year timescale. The shore-based facilities, such as power plant sites, utilities, road access and transmission lines used to evacuate the electricity power to national grids would be based on the shorelines for each concession shown in Figure 5.

In Rwanda, concessions A and B are located along the shoreline near Rubavu, with the shore based facilities for concession C being based in Karongi. Concessions D and E are based being based further south. Conceptually, the shore based facilities for each Rwandan facility would be located along the shoreline lengths listed in the table below. This table has been prepared without the benefit of electronic mapping aids, and in therefore an estimate.

Table 2: Shoreline Lengths for each Rwandan Concession Area

Concession Name	Shoreline Length [km]	Final Capacity	No. GEFs
A – Kivu Power Limited	6	50Mw	4
B – Symbion Power Lake Kivu Limited	10	50Mw	4
C – Not Active	14	Assume 50Mw	4
D – Not Active	27	Assume 50Mw	4
E – KivuWatt	109	100Mw	4
Total for all Concessions	**166**	**300Mw**	**20**

The table shows that the shore based facilities, as well as the offshore platforms, are likely to be widely distributed along the Rwandan shore of Lake Kivu. The highest density of concession activity is for concessions A, B and C, where three facilities are located along a 30 kilometre shoreline.

Using the KIVU 56 layout as an example, the four off-shore barges would, each with its one kilometre exclusion zone, occupy a lake surface area of five kilometres in length and two kilometres in width. Thus each off-shore facility occupies ten square kilometres.

Export pipelines link the GEFs to the shore and these pipelines are typically arranged in a triangular pattern, extending from each GEF, to a main export pipeline. The main export pipeline then runs to the shore. If the GEFs are located four kilometres from the shore, and setting the buffer zone along each pipeline at 500m to either side, then the zone of influence for the export pipelines is approximately six square kilometres. Thus the total zone of influence for the off-shore portion of each project is 16 km^2.

Five such facilities imply an exclusion zone of 80 km^2. The total area possible for the facilities to be located along the shoreline of 166 kilometres is 996 km^2. Thus 8% of the available shoreline is influenced by the five conceptual gas concessions.

In the area of concessions, A, B and C, the equivalent figures are; three such facilities along a shoreline of 30 kilometres. Thus a total zone of influence of 48 km^2 compared with a total possible area of 180 km^2. Thus 27% of the available shoreline is influenced by the conceptual gas concessions A, B and C. Potentially, there will be 12 offshore platforms along a shoreline of 30 kilometres; one every 2 500m, each four kilometres from the shoreline.

The same calculation can be carried out with regards the on-shore facilities. Assuming that each on-shore facility requires five hectares, within 150m of the shore. For all of the concessions, located along 166 kilometres of shoreline, a total of 25 hectares, out of a total possible 2 490 hectares. Thus an impact on 1% of the available shoreline.

Equivalent figures for concessions A, B and C are: three such onshore facilities along a shoreline of 30 kilometres. Thus a total area of 15 hectares compared with a total possible shoreline area of

450 hectares. Thus 3% of the available shoreline is influenced by the onshore facilities of the conceptual gas concessions A, B and C.

4.1.2 Future Port Expansion at Brewery

An investigation into the development of port facilities on Lake Kivu has been commissioned by Rwanda Transport Development Agency. Documents generated by the investigation include:

- Transport and Trade Connectivity on Lake Kivu – the work was carried out by a consortium of HPC Hamburg Port Consulting GmbH and Sellhorn Ingenieurgesellschaft mbH. The document provides the business case for development of water transport on Lake Kivu;
- A feasibility study – to assess the passenger and cargo traffic in Lake Kivu. The report generated passenger numbers indicating that the busiest port will the closest to Rubavu, located at the Bralirwa Brewery. The report stated that 1.4 million passengers could use the port annually in 2017, rising to 2.7 million passengers in 2036.

The intention of the development at the Rubavu Port would be to create a ferry port capable of handling two ferries, the warehousing capacity is to be expanded, immigration facilities are to be installed and other commercial facilities such as accommodation, restaurants, banking are to be provided. The preferred vessel configuration was two catamaran ferries with capacity for 120 passengers, expanding by a further two, 420 passenger capacity, ferries in 2022.

The potential impact of gas-to-power projects on this proposed development would create obstacles to navigation that would either increase route distances or route times.

4.1.3 Tourism Development

The Lake Kivu area has been targeted for development as part of the Rwanda Vision 2020 strategy. The goals are captured in the Rwanda Kivu Belt Tourism Sub-Master Plan, prepared for the Ministry of Trade and Industry Tourism in 2013.

The sub-master plan aims to develop and promote the Congo-Nile Trail, a 227-kilometre-long trail that can be accomplished by hiking, biking or via 4-wheel motorbikes. The trail passes the Kivu 56 site at the Kabushongo Village, approximately 500m from the eastern boundary of the site.

In addition to this feature, the Rubavu Hub is relevant to the project. Aspects of the Rubavu Hub that are in the same vicinity as the project are the Rubavu Hotel Strip, which lies along the shore of Lake Kivu, near the Rubavu/Goma border. This strip is approximately fourteen kilometres along the shoreline from the project site.

Another potential tourism feature is the Nyambumba Hot Springs, which lie near the Bralirwa Brewery. This feature lies a distance of four kilometres, north of the project site, along the shoreline road.

In addition, an area of shoreline north of the Bralirwa Brewery has been designated for tourism use, as has the peninsula and shoreline on which lie the Nyambumba Hot Springs. This peninsula has been identified for the development of a leisure destination. This shoreline is a distance of between 4.5 and 6 kilometres north of the project site, along the shoreline road,

Along the same shoreline, and in the Rutsiro District, as future gas-to-power concessions are the proposed Cyimbiri and Kinunu Wharves for lake cruise boats and general watersports. This would affect concession areas C and D. The Cyimbiri wharf is approximately 15 kilometres from the project site, whilst the Kinunu Wharf is approximately 42 kilometres from the project site.

In the vicinity of gas-to-power concession E is the Karongi Hub. This hub is too far distant from Kivu 56 to consider further as part of the cumulative impact assessment on tourism.

The potential impact upon tourism during the operational phase would be two-fold. The influence of the on-shore facilities in terms of noise generation and the visual impact of a power generation facility in the neighbourhood of tourism features. The second potential impact on the tourism product through the visual impact of the GEFs. The GEFs would interrupt the natural vistas across the lake.

The impact during the construction phase would the additional traffic that the project will generate along the access roads to the site and the noise and disturbance this would create.

4.2 Cumulative Impacts

The cumulative impacts will be assessed first by screening impacts that are unlikely to create cumulative impacts on a regional scale. The impacts that are carried forward from the screening exercise have been evaluated for their impact and mitigation measures for the impact are proposed.

4.2.1 Cumulative Impact Screening

There are a number of potentially cumulative impacts generated by the project.

The KIVU 56 ESIA identified a number of project impacts and from that list the following impacts that are potentially cumulative have been extracted:

- Cultural impacts - impact upon local culture as a result of a migrant workforce;
- HIV/AIDs and Sexually Transmitted Diseases - spread of such disease through an influx of construction workers, truck drivers and prostitutes attracted to worker camps;
- Importing disease from sending areas to the project area;
- Impact if the compensation is insufficient replace current livelihoods;
- Traffic generated dust on the project site and along access roads;
- Noise pollution – noise generation during construction;
- Biological Environment Impacts on Flora – the loss of vegetation cover on the site;

- Fisheries – fishing grounds could be disturbed, reduced water quality influencing fish stocks and blocking of migratory paths;
- Greenhouse Gas emissions – emissions during gas generator operations, NOx
- Noise pollution – for onshore activities caused by the gas engines
- Wastewater discharge – sewage and oily water discharges
- Gas exploitation and depletion of the resource in the lake;
- Lake Kivu ecosystem and stability – impacts related to physical-chemical rupturing of the stability layers, which can lead to rapid outgassing of CO2. This will lead to human and animal mortality in the area surrounding the lake;
- Water quality – the impact of the return of wash water to the lake. The wash water has different temperature and chemical characteristics to the source water (wash water will be extracted from the biozone, above 70m from the surface).

In addition to the above, additional potential cumulative impacts can be added. These are as a result of professional judgement as well as through the literature survey. Only those impacts that are relevant to KIVU 56, other similar projects or to other projects in the area are added to the list below:

- Terrestrial fauna and flora – impacts upon by many projects in the same area, fragmentation and damage to habitats
- The aquatic environment – impacts created by the increasing number of watercraft using an area; and
- Tourism impacts – natural vistas being disrupted by developments in an area
- Vegetation: clearing of land resulting in the removal of a patch of regionally rare plant species; and
- Strengthening of the Rwandan electrical grid.

The following screening table indicates those cumulative impacts that will be taken forward for further evaluation.

Table 3: Screening of Cumulative Impacts

Impact	Is the impact of regional concern?	Is the impact likely to extend beyond the project boundary?	Will the activities occur in other regional projects?	Timescale of Impact	Other potential projects generating similar impacts?	Comment	Screening Result
Cultural impacts	Local	Yes	Yes	Short-Term	Yes	Any cultural impact is likely to be of small scale and limited duration	Unlikely to contribute to a cumulative impact
HIV/AIDs and Sexually Transmitted Diseases	Yes	Yes	Yes	Long-Term	Yes	The likelihood of the impact is greatest during the construction phase. As labour moves from place to place the spread of the disease becomes regional and long term.	Evaluate Cumulative Impact
Importing disease	No	Yes	Yes	Short-Term	Yes	The impact will be mainly during construction. It will be of small scale and limited duration	Evaluate Cumulative Impact
Insufficient livelihoods compensation	Yes	Yes	Project dependent	Medium-Term	Yes	The fishing community will be impacted. The impact will be evaluated later in the table	Evaluate Cumulative Impact
Traffic	Yes	Yes	Yes	Short-Term	Yes	This is a short duration impact, felt most heavily during construction	Unlikely to contribute to a cumulative impact
Noise pollution - construction	No	Yes	Yes	Short-Term	Yes	This is a short duration impact, felt most heavily during construction	Unlikely to contribute to a cumulative impact
Biological Environment – Fauna and Flora	Yes	Yes	Yes	Short-Term	Yes	This is a short duration impact, felt most heavily during construction	Unlikely to have a cumulative impact
Fisheries	Yes	Yes	Project dependent		Yes	The area of in-shore influence from the GEFs is significant	Evaluate Cumulative Impact

Impact	Is the impact of regional concern?	Is the impact likely to extend beyond the project boundary?	Will the activities occur in other regional projects?	Timescale of Impact	Other potential projects generating similar impacts?	Comment	Screening Result
Greenhouse Gas emissions	Yes	Yes	Project dependent	Long-term	Yes	The abstraction of methane gas from the lake is likely to have positive impact however the results from the air quality study will determine the air emissions impact from the plant	Evaluate Cumulative Impact
Noise pollution –onshore operations	No	Yes	Project dependent	Long-term	Yes	The prospective on-shore sites are located far from one another, thus the noise generated by one facility will not be compounded by another	Unlikely to contribute to a cumulative impact
Wastewater discharge	No	Yes	Yes	Long-term	Yes	The prospective on-shore sites are located far from one another, thus any waste discharge will not be compounded by another facility	Unlikely to have a cumulative impact
Gas exploitation and depletion of the resource	Yes	Yes	Project dependent	Long-term	Yes	The expert group has determined that a 50-year high yield scenario is sustainable, beyond that horizon extraction can continue at 15-20% of the 50-year level. Extraction is thus sustainable over the long term	Unlikely to contribute to a cumulative impact
Lake Kivu stability	Yes	Yes	Project dependent	Long-term	Yes	Long-term lake stability will be enhanced through extraction of methane. The risk to stability of the lake through improper return of CO_2 is increased as the number of projects increase. The risk of an extraction depth mismatch therefore increases.	Evaluate Cumulative Impact

Impact	Is the impact of regional concern?	Is the impact likely to extend beyond the project boundary?	Will the activities occur in other regional projects?	Timescale of Impact	Other potential projects generating similar impacts?	Comment	Screening Result
Water quality	Yes	No	Project dependent	Short-term	Yes	SPLKL is unlikely to have an impact on water quality that cannot be contained and addressed through onsite mitigation measures.	Unlikely to contribute to a cumulative impact
The aquatic (freshwater) environment	Yes	No	Project dependent	Long-term	Yes	SPLKL is unlikely to have an impact on the aquatic (freshwater) environment.	Unlikely to contribute to a cumulative impact
Tourism impacts	Yes	Yes	Yes	Long-term	Yes	The visual impact of GEFs along the shoreline in sensitive tourism areas	Evaluate Cumulative Impact
Vegetation: clearing	No	No	Yes	Long-term	Yes	The SPLKL on-shore sites is highly transformed and therefore unlikely to have a negative impact on indigenous vegetation	Unlikely to contribute to a cumulative impact
Strengthening of the Rwandan electrical grid	Yes	Yes	Yes	Long-term	Yes	This and similar projects could generate up to 300Mw for the Rwandan electricity grid	Evaluate Cumulative Impact
Road Safety	No	Yes	No	Short-term	Yes	Increased traffic on the road will impact road safety	Evaluate Cumulative Impact

In summary, the following cumulative impacts will be taken forward for evaluation and mitigation:

- The impact of projects on the livelihoods of the fishermen;
- The social impacts on community health and safety;
- The impact of Lake Kivu stability;
- An impact upon tourism;
- The impact on the Rwandan electricity grid; and
- Green House Gas Emissions.

4.2.2 Fisheries Livelihoods Impact

The possible cumulative impact of fisheries livelihoods in centred upon future projects gradually pushing subsistence fishermen out of their traditional fishing grounds, thereby depriving them of their livelihoods. This possible impact is cumulative in nature the gradual reduction in fishing grounds would occur incrementally with each successive project.

Fishery in Lake Kivu is characterised by five types (Hanek et al, 1991):

- Trimaran – a non-motorised vessel made by lashing three canoes together. The vessels operate at night using lamps to increase fish density. Lifting devices on the vessels lift nets that reach to 74m depth. This is the most productive of the fishing methods on the lake and yield approximately 3 300 tons/annum. This fishery yields a market product known as Isambaza, which is a sought after product in the markets of Kigali. There were 239 trimarans operational on the lake in 1991, operating with a profit margin of 34%;
- Beach Seine – these are seine nets that are set from the beach in a semi-circle by a canoe. The net is then pulled onto the beach. Fishing occurs during the day and yields approximately 2 200 tons/annum. This fishery yields fish for the Isambaza product. There were 1 419 beach seine fisheries operational on the lake in 1991, operating with a profit margin of 34%;
- Gill net – this method uses a gill net deployed from a single canoe, up to a depth of 12m. Fishing is done by day and night. The yield from this method of fishing is approximately 560 tons/annum. Gill net fishing aims for Tillapia. There were 213 gill net fisheries operational on the lake in 1991, operating with a profit margin of 64%;
- Pole or hand line – this fishery is mainly based near the Bralirwa Brewery where pole or handline fishing is carried out from canoes. The yield from this method is approximately 445 tons/annum. There were 412 hand line fisheries operational on the lake in 1991, operating with a profit margin of 4 300%; and
- Bottom Longline – this fishery is carried out by pole or handline fishing is carried out from canoes. The lines are longer than 100m and the fishing takes place at night, yield was calculated to be 30 tons/annum. There were 30 beach seine fisheries operational on the lake in 1991, operating with a profit margin of 2 500%.

In 1991, such fishing was calculated to be 70% based from Rwanda and 30% based in the Democratic Republic of Congo. There is no evidence to suggest that this proportion has changed. The 1991 estimate of employment was a total of 6 563 people directly employed by the fisheries, with 3 027 employed by trimarans.

In a consultation session held in June 2018 with project affected people in the fisheries section, the following points were made. The fisheries all below to one of two cooperatives, one focusses on Tillapia products and the other on Isambaza products. The peak fishing season is August to September. There is no fishing in the lake during June and July to enable the fish stocks to recover. The catch is landed at landing sites all along the shoreline and fish is either gutted and sold fresh, or dried and sold as Isambaza. Fresh fish sales are made to hotels, restaurants and passers-by.

The employment estimate made at the consultation sessions was made for Rwandan trimarans only. It was stated that 23 units were active in each of five districts. Each trimaran has a crew of 11, so the total direct employment was estimated at 1 265. Using the 1991 ratio of 70% of fishing activity being on the Rwandan side of the lake, this indicates that total trimaran employment is in the order of 1 800 people. This is a decline of 58% when compared to the employment estimate made in 1991 of 3 067 people directly employed.

Livelihoods are sustained through the low and off seasons by taking additional jobs in town or by going to fish on the DRC side of the lake where there are not the same levels of control over fishing.

It was noted at the consultation session that fishing takes place in the dam at levels generally above 55m depth and are densest at depths of 20m to 35m when the lake is calm.

The cumulative impact on these fisheries by similar projects to Kivu 56 is caused by the following considerations:

- Landing areas placed off limits by the projects; and
- Fishing grounds placed off limits by the projects.

It is not anticipated that landing areas will be impacted by similar projects on Lake Kivu. Landing areas are located near population centres which have markets and similar projects not located very near to such population centres. Landing areas are more flexible for gill net and beach seine fishermen since they fish during the day. As such their landing areas can move is accordance with the fish yield and market demand.

Landing areas for trimarans, bottom line fisheries are based on market location and home bases of the trimaran. It is not anticipated that such landing areas will be affected by similar future projects.

Landing areas for pole/hand line fishing are based on proximity to the Bralirwa Brewery, given that this is their dominant fishing ground. It is not likely that future, similar projects will be placed in this bay.

Fishing grounds for trimarans and bottom longline fisheries are likely to be impacts upon by future, similar projects. The depth of the export pipelines running from the GEFs to the shore-based facilities may be 20m deep and as such these lines will interfere with free fishing within five kilometres from the shore. This, combined with the one kilometre exclusion zone around each GEF,

will reduce the potential fishing grounds of such fishing units. None of the fishing units are motorised, and are therefore not able to move large distances to avoid exclusion zones.

Mitigation measures to resolve this impact are to focus on making exclusion zones as small as possible and by marking the positions of the export pipelines. The zones can be made smaller through the layout of each project's GEFs to reduce the overall footprint, especially near trimaran bases. The marking of export pipelines will allow vessels to fish between, and in the vicinity of the pipelines, without getting nets and lines entangled in the infrastructure. These mitigation measures will serve to remove a potentially blanket, block-like exclusion of fisheries in the vicinity of similar projects.

Table 4 below provides an analysis of the cumulative impact discussed above.

Table 4: Cumulative Impact Analysis - Fisheries

Environmental Feature	Fisheries Livelihoods
Project life-cycle	Operations phase
Potential Impact	Proposed Management Objectives / Mitigation Measures
Exclusion from landing areas	• Placement of future onshore facilities, or the placement of future projects should avoid established landing areas used by fishery units. It should be noted that the closest landing area to the Kivu56 project is near the Bralirwa Brewery. This landing area will not be affected by the project.
Reduction in fishing area owing to exclusion zones for similar gas extraction projects	• Consider the layouts of GEFs to reduce the hazard related exclusion zone to the smallest possible footprint • Mark the export pipelines from GEFs to on-shore facilities. Markings should be visible at night
Night light	• Reduce (to zero if possible) the night lights on GEFs, to ensure that these platforms do not detract from trimaran fishing in the area of the platforms • Marked pipelines should not use bright lights. These lights would detract from the fishing methods employed by trimarans which use light to increase fish densities

	Nature	Extent	Magnitude	Duration	Probability	Significance
Before Mitigation	Negative	Regional	Medium	Long Term	Likely	3
After Mitigation	Negative	Local	Low	Long Term	Moderate	2

4.2.3 Lake Kivu Stability and Use of the Lake

The stability of Lake Kivu depends mainly upon two layers of water at differing depths. The layers are formed by differing water density at various depths. The layers are known as pycnoclines. There are two critical pycnoclines with regards Lake Stability. The upper pycnocline and the lower pycnocline. (Expert Committee, 2006)

The upper pycnocline is located between -60 and -80m below surface level and separates the biozone (which is oxygen rich and nutrient poor) at the top, and an oxygen poor, nutrient rich layer below. The lower pycnocline is located at -260 to -270m below the surface. This layer separates the oxygen poor, nutrient rich layer above from a resource layer, which is rich in methane and carbon dioxide.

Any disturbance to the upper pycnocline will result in mixing between the two adjacent layers, which will result in rapid eutrophication of the lake. Mixed at the lower pycnocline will result in the resource layer dissipating gas, either through a slow process or by a more rapid, self-sustaining eruption.

Resource utilisation for all gas-to-power projects on the lake depend upon a conceptual scheme whereby gas rich water is extracted from the resource layer, gas is then separated from the water at or near the surface, and the degassed water is returned (or reinjected) to the lake. The gas is then washed to separate the methane from other gases such as carbon dioxide and hydrogen sulphide. This wash water, rich in carbon dioxide and hydrogen, is also returned (or reinjected) to the lake.

There are two factors affecting lake stability; the density of the return water and the nature of the extraction and the return.

The density of the reinjected water must be matched with the density of the lake layer into which it is returned. If the density of the reinjected water is too low for the surrounding water, it will rise until the surrounding water density matches the return water density. The opposite occurs for reinjected water that has a higher density than the surrounding water. The movement of reinjected water vertically is undesirable for lake stability.

The nature of the extraction and the re-injection should be matched to the nature of the layers in the lake. The layers are formed and defined horizontally, so the extraction and the re-injection must take place horizontally. Vertical extraction and re-injection will impact upon the stability of the pycnoclines.

The lake is used by fisheries and by surface water craft. The cumulative impact of a gas release in the biozone, which is the fish habitat, will be large. Fish yields will decrease, affecting the livelihoods of all who rely on fish; in the chain from the fishery to the retailer. Use by surface craft for trade will be affected should the gas-to-power facilities create navigation hazards that sterilize large sections of the surface water. Both of these impacts can be mitigated through pipeline design and placement.

The impact that gas-to-power projects will have on lake stability increases with the number of operations on the lake, hence a small impact by one GEF would be multiplied across many GEFs. The risk associated with the cumulative impact was not quantified by the Expert Committee, however, prescriptions for the management of lake stability were issued in 2010 (Expert Working

Group, 2010). These prescriptions are included in the impact and mitigation measures table (Table 5) below.

The Lake Kivu Monitoring Programme has been as part of the lake-wide Bilateral Regulatory Authority which was proposed by the Expert Committee. The programme is entrusted with overall monitoring of, and compliance enforcement, for all methane extraction facilities on Lake Kivu. The monitoring programme is established and active.

Table 5: Cumulative Impact Analysis – Lake Stability and Use

Environmental Feature	Lake Stability and Use
Project life-cycle	Operations phase
Potential Impact	Proposed Management Objectives / Mitigation Measures
Eutrophication of the lake	• The re-injected water must re-stratify as close as possible to the lower margin of the main density gradient (at 270 m depth in 2004) and well above the upper margin of the 310 m gradient (at 300 m depth in 2004) • Water re-injection must be done horizontally • Washing water containing hydrogen sulphide and discharged into the biozone must be injected below depths inhabited by fish to prevent fish-kill in the biozone (now down to about 60 m depth) and so as to restratify above the centre of the density gradient below (now at about 80 m depth). The prescribed re-injection depth is 80m • The exit velocity at re-injection shall be so small that vertical displacement of the isopycnals (surfaces of equal density) shall be significantly smaller than the re-injection lens thickness
Eruption of the lake	• The re-injected water must re-stratify as close as possible to the lower margin of the main density gradient (at 270 m depth in 2004) and well above the upper margin of the 310 m gradient (at 300 m depth in 2004) • Water extraction and re-injection must be done horizontally • The exit velocity at re-injection shall be so small that vertical displacement of the isopycnals (surfaces of equal density) shall be significantly smaller than the re-injection lens thickness • The design of deep-water extraction systems must prevent any self-sustaining gas-lift effect should a pipe-break or rupture occur (e.g. in a riser pipe or return water line) and result in the following dangerous combination: An open-ended pipe length remaining suspended or standing; with the lower end in the Resource Zone; and c) the upper end close enough to the surface to sustain gas-lift. • In order to be able to react to changes in pycnocline depths, the proponent must include in the design the capability to be able to adjust the extraction and re-injection levels from time to time, or to be able to re-inject at multiple levels, simultaneously if required
Use of the lake	• Methane gas produced offshore must not be transported to the shore in a way that might affect the surface use of the lake, or risk a gas outburst below the biozone. • Gas export pipelines must be located below -10 m depth • The location of gas extraction platforms and associated satellite facilities shall all be located at least 500 m inside the specific concession boundary. This margin shall allow sufficient distance for all anchor systems to remain fully within the concession boundaries

	Nature	Extent	Magnitude	Duration	Probability	Significance
Before Mitigation	Negative	Regional	High	Long Term	Probable	3
After Mitigation	Negative	Regional	High	Long Term	Unlikely	1

4.2.4 Tourism

The cumulative impact of tourism on the lake will be analysed through the lens of future proposed developments in the tourism sector along the lake shore. It should be noted that the impacts cannot be determined with accuracy given the following uncertainties:

- whether the proposed tourism products stated above reach fruition; and
- once the tourism products have been developed, it is uncertain to what extent the product will rely upon its success on a pristine natural environment. In this regard, the significantly transformed natural environment along the lake shore will mitigate against the marketing of a product whose sole appeal is the natural environment.

Cumulative impacts of gas-to-power projects on tourism products will be most felt along the first 30 kilometres of shoreline. This is the shoreline that will host the most gas-to-power projects and has been targeted for at least four tourism developments, namely:

- Congo-Nile Trail;
- Nyambumba Hot Springs;
- The shoreline north of the Bralirwa Brewery; and
- Cyimbiri Wharf.

All of these tourism products would be impacted to some extent by the visual effect of the GEFs. This impact will be created by the proximity of the GEF to the shore, and the profile of the GEF. The profile of the GEF will be increased if it includes infrastructure such as separation towers and flare towers. The higher the profile of the GEF, the more visible the GEF will be from the shore. The GEFs proposed by SPLKL do not have high structures such as separation towers or flare towers, and as such would be considered low profile GEFs.

Gas-to-power projects will impact upon the increased recreational use of the lake surface by the development of the shoreline north of the Bralirwa Brewery and the Cyimbiri Wharf. In these areas, the project may create navigation hazards and exclusion zones that increase journey times and reduce the number of shoreline stops for such craft. This impact is created by the scope of the exclusion zones around the gas-to-power projects.

The following impact-mitigation table can be developed for the cumulative impacts of gas-to-power projects on tourism development in the region.

Table 6: Cumulative Impact Analysis - Tourism

Environmental Feature	Tourism
Project life-cycle	Operations phase
Potential Impact	Proposed Management Objectives / Mitigation Measures
Visual impacts	• Reduce the profile of GEFs along the shoreline. If possible separation towers and flare towers should be removed to shore-based facilities to reduce the visual impact.

Environmental Feature		Tourism				
Project life-cycle		Operations phase				
Potential Impact		Proposed Management Objectives / Mitigation Measures				
		• Increase the anchoring distance that GEFs are anchored from the shoreline				
Surface water interruptions		• Gas export pipelines must be located below -10 m depth • Consider the layouts of GEFs to reduce the hazard related exclusion zone to the smallest possible footprint • Mark the export pipelines from GEFs to on-shore facilities. Markings should be visible at night				
	Nature	Extent	Magnitude	Duration	Probability	Significance
Before Mitigation	Negative	Regional	Medium	Long Term	Likely	2
After Mitigation	Negative	Local	Low	Long Term	Moderate	2

4.2.5 Rwandan Electricity Grid

Infrastructure development is a key aspect of the Republic of Rwanda's Vision 2020, Revision 2012 document. In this national strategic plan, in adequate and expensive electricity is cited as a development constraint. The 2012 revision of Vision 2020 highlights the gas resource in Lake Kivu as a key means of electricity generation and aims to have 75% of the population connected to the electrical grid by 2020. By 2012 the Rwandan grid generates almost 100Mw.

Rwanda uses the following sources of energy (MININFRA, 2018):

- hydropower plants – 47%;
- thermal power plants (Diesel and Heavy fuel generators) – 27%
- methane gas – 14%;
- peat - 7%; and
- solar energy – 5%.

Taking into account that KivuWatt is the only methane facility currently operational, any increase in gas-to-power generation will make a significant contribution to the Rwandan National Electricity Grid. This contribution will have an impact on achieving the goals set in Vision 2020.

The following impact-mitigation table (

Table 7) can be developed for the cumulative impacts of gas-to-power projects on the Rwandan Electricity Grid.

Table 7: Cumulative Impact Analysis – Rwandan Electricity Grid

Environmental Feature		Rwandan Electricity Grid				
Project life-cycle		Operations phase				
Potential Impact		Proposed Management Objectives / Mitigation Measures				
Increased Availability of Electricity		• Generation capacity to be maximised • Maintain high levels of generator availability				
	Nature	Extent	Magnitude	Duration	Probability	Significance
Before Mitigation	Positive	National	High	Long Term	Certain	3
After Mitigation	N/A	N/A	N/A	N/A	N/A	N/A

4.2.6 Green House Gas Emissions and Air Quality

The Greenhouse Gas Emissions and Air Quality assessment has been attached as Appendix D.

5 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The Environmental and Social Management Plan (ESMP) is attached as Appendix A.

6 ABBREVIATED RESETTLEMENT ACTION PLAN

The Abbreviated Resettlement Action Plan is a separate document prepared by SPLKL.

7 ECOLOGICAL BASELINE REPORT

The Ecological Baseline Report is attached as Appendix B.

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APPENDIX A

ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

APPENDIX B

ECOLOGICAL BASELINE REPORT

APPENDIX C

LENDER REQUIREMENTS ROADMAP

Item No.	Performance Standard Reference	Description	Location in Environmental Body of Documents
1	1.5	Update the licensed ESIA to comply with IFC PS and AfDB OS: • Include the Associated Facilities; • Include an indication of accumulation of impact based on general assumption of other developments (e.g. oil and gas exploration) on the lake.	ESIA Addendum
2	1.5	Set up an Environmental and Social Management System	To be finalised
3	1.5	Set up Environmental and Social Management procedures	To be finalised
4	1.5	Set up an Environmental and Social Management Plan (ESMP). The ESMP must also include the capacity assessment of Symbion Power to effectively implement the designed management plans	ESMP, Appendix A of this document
5	1.5	Carry out an Abbreviated RAP (ARAP) Include, where relevant, Rwanda civil war context.	Abbreviated Relocation Action Plan
6	1.20 to 1.21	Define an Emergency Preparedness and Response Plan (EPRP)	To be finalised
7	2	Define a HRM Policy, Plan and Management System	To be finalised
8	1.6	Finalize Symbion Policy statement and disclose it with the relevant shareholders	To be finalised
9	1.6	Include in the EPC contract the obligation to set up a Construction Environmental Management Plan (CEMP).	To be finalised
10		Obtain all required licences and approvals. Before the start of construction	To be finalised
11	1.22 to 1.24	Define set of monitoring parameters including their frequency	To be finalised
12	1.25 to 1.33	Define a Social Engagement Plan (SEP)	SEP
13	1.25 to 1.33	Define a Community Development Plan (CDP)	CDP

Item No.	Performance Standard Reference	Description	Location in Environmental Body of Documents
14	1.34 to 1.35	Symbion will be expected to start up with a project specific Grievance Redress Mechanism (GRM) prior to commencement of the plant construction activities so as to promote socially inclusive growth.	GRM
15	1.36	Symbion Power must develop its own Community Liaison Officer (CLO) strategy, aligning what is being developed by Symbion Power.	To be finalised
16	2 / OS 5	Labour standards to be fully reviewed against PS 2 / OS 5. Symbion Power must pay special attention to housing of workers/labour camp, and subcontractors	To be finalised
17	4	Impacts on community needs to be further determined (e.g. health and safety during construction phase: traffic, influx, diseases, theft, prostitution)	ESIA Addendum
18	4	Impacts on community needs, extra emphasis is need on security, as it is regarded as a critical component (contextual Rwanda situation)	To be finalised
19	6 / OS 3	Symbion Power should update the baseline data on Benthic fauna.	To be finalised
20	6 / OS 3	Symbion Power should draft a concise Biodiversity Action Plan (BAP) commensurate to what was identified in the ESI	To be finalised

APPENDIX D

GREEN HOUSE GAS EMISSIONS AND AIR QUALITY ASSESSMENT