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NEW BUGESERA INTERNATIONAL AIRPORT

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT-RESOURCE EFFICIENCY

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17. RESOURCE EFFICIENCY

17.1. Introduction

This chapter of the ESIA Report aims to identify the key resource demands (i.e. fuel, water and materials) associated with the construction and operation of the Proposed Project and outlines mitigation measures to reduce and adverse impacts and measures to opportunities for resource efficiency, based on current information available.

17.2. Policy, Legal and Administrative Framework

17.2.1. Rwandan Policy

Rwanda has a number of policies and strategies that deal with a range of environmental aspects. However, there are no specific guidelines or legislative requirements that target resource utilisation and efficiency specifically. A summary of national legislation and policy documents that cover different aspects of resource efficiency are indicated below.

As part of the second phase of the Economic Development and Poverty Reduction Strategy, Rwanda has a five-year strategic plan for the environment and natural resources covering 2014 to 2018 that was issued on May 2013[1]. This sets out the strategic priorities to be implemented through five sector policies, which relate to the environment and natural resources as follows:

- National Forestry Policy[2];
- National Land Policy[3];
- National Environment Policy[4];
- National Policy for Water Resources Management[5]; and
- Mining Policy[6].

In addition, the Rwanda Ministry of Lands, Resettlement and Environment has a Rwanda Environmental Policy 2003[7], which sets out a vision for the environment in Rwanda up to 2020 and includes elements on the natural environment, environmental issues and corresponding policy statements.

Further guidance on resource efficiency can be found in the Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development (2011)[8], Building Control Regulations (2012)[9] and Energy Efficiency Building Code (2014)[10]. Rwanda also has a strategic plan with the aim to address the issues of climate change and environment through strengthening links with existing international conventions and frameworks, namely: The Environment and Climate Change International Conventions[11] and Regional Frameworks.

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[1] Republic of Rwanda Ministry of Natural Resources, 2013. Five Year Strategic Plan for the Environment and Natural Resources Sector 2014 – 2018.

[2] Republic of Rwanda Ministry of Forestry and Mines, 2010. National Forestry Policy.

[3] Republic of Rwanda Ministry of Environment, Forests, Water and Mines, 2004. National Land Policy.

[4] Republic of Rwanda Ministry of Lands, Resettlement and Environment, 2003. Rwanda Environmental Policy.

[5] Republic of Rwanda Ministry of Natural Resources, 2011. National Policy for Water Resources Management.

[6] Republic of Rwanda, 2009. A revised Rwandan Mining Policy.

[7] Republic of Rwanda Ministry of Lands, Resettlement and Environment, 2003. Rwanda Environmental Policy

[8] Republic of Rwanda, 2011. Green Growth and Climate Resilience National Strategy for Climate Change and Low Carbon Development.

[9] Rwanda Housing Authority, 2012. Rwanda Building Control Regulations.

[10] Energy Water and Sanitation Authority, 2014. Energy Efficiency Building Code.

[11] United Nationals, 1992. United National Framework Convention on Climate Change (UNFCCC)

17.2.2. Legal Framework

There is no reference within the Rwandan legal framework, which relates to resource efficiency.

17.2.3. International Standards

International finance is widely used for large scale projects. In this regard, leading international financing institutions have developed standards and guidelines regarding environmental and social issues associated with the projects that they would support. Among these institutions, the World Bank Group has an important role in establishing environmental and social safeguards. The IFC, which serves the private sector projects in the World Bank Group, has established well developed performance standards and guidance regarding resource efficiency. The African Development Bank's Integrated Safeguard System also follows the IFC standards regarding resource efficiency.

The IFC has various social and environmental criteria, which include criteria specifically set for resource efficiency. Specifically, IFC Performance Standard 3 (PS3) Resource Efficiency and Pollution Prevention[12] recognises that increased human activity often results in the consumption of finite resources in a manner that may threaten people and the environment at the local, regional and global levels. The main requirements with regard to resource efficiency are contained within IFC PS3 and can be summarised as follows:

- During the project life-cycle, the client will consider ambient conditions and apply technically and financially feasible resource efficiency principles and techniques that are best suited to avoid or where avoidance is not possible, minimise adverse impacts on human health and the environment;
- Reference is to be made to the Environment, Health and Safety (EHS) Guidelines or other internationally recognised sources as appropriate, when evaluating and selecting resource efficiency;
- The client will implement technically and financially feasible and cost effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs, with a focus on areas that are considered core business activities;
- Climate change related risks, impacts and adaptation opportunities should be considered, including emissions of greenhouse gases; and
- When the project is a potentially significant consumer of water, the client shall adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others.

Further guidance on resource efficiency is provided in the following IFC documents:

- IFC Guidance Note 3: Resource Efficiency and Pollution Prevention;
- IFC Environmental, Health and Safety (EHS) Guidelines for Airlines[13]; and
- General EHS Guidelines[14].

The guidelines are technical reference documents with general and industry-specific examples of Good International Industry Practice (GIIP). The IFC EHS Guidelines for Airlines contain the performance levels and measures that are generally considered to be achievable in new

[12] IFC, 2012. Performance Standard 3 (PS3) Resource Efficiency and Pollution Prevention.
[13] IFC, 2007. Environmental, Health and Safety (EHS) Guidelines for Airlines.
[14] IFC, 2007. Environmental, Health and Safety (EHS) Guidelines, General EHS Guidelines: Environmental.

facilities. The IFC EHS Guidelines for Airports (2007)[15] refers to the general IFC EHS guidelines and makes no specific recommendation regarding energy and water use.

With regard to greenhouse gases, IFC PS1 requires that "*…the risks and impacts identification process will consider the emissions of greenhouse gases, the relevant risks associated with a changing climate and the adaptation opportunities….*" (IFC PS1, clause 7). In IFC PS3, there is also the requirement '*for projects that are expected to or currently produce more than 25,000 tonnes of CO_2-equivalent annually, the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary*' (IFC PS3, clause 8).

In relation to waste and wastewater management, IFC PS3 states that waste is to be managed in accordance with the waste hierarchy, i.e. avoid>reduce>recover>re-use>treat/destroy/dispose. Any disposal sites used must be developed to an appropriate standard and authorised to accept waste. If this is not the case, alternative options, including developing a disposal site, must be considered. Hazardous waste must be disposed of in an environmental sound way.

With regard to cost-effectiveness, IFC PS3 requires projects *"…to implement technically and financially feasible and cost effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs, with a focus on areas that are considered core business activities."*

In relation to water consumption, IFC PS3 clause 9 requires that *"…when the project is a potentially significant consumer of water, the client shall adopt measures that avoid or reduce water usage so that the project's water consumption does not have significant adverse impacts on others."*

17.3. Assessment Methodology

17.3.1. Scope

The scope of this chapter has been informed by the requirements of IFC PS3, which states that *"…the client will implement technically and financially feasible and cost effective measures for improving efficiency in its consumption of energy, water, as well as other resources and material inputs with a focus on areas that are considered core business activities."*

From this, the scope of the resource efficiency assessment for the Proposed Project was defined through a scoping process, which identified potentially sensitive receptors and potentially significant impacts related to the Proposed Project. Key issues identified within the ESIA Scoping Report for this chapter comprised the following:

- The amount of energy, fuel and water required to support earthworks and construction will be identified and potential significant impacts assessed;
- Resource use will be assessed during earthmoving and construction operations;
- The amount of energy required to support the airport will be identified and potential significant impacts will be assessed; and
- Water consumption will be evaluated for the airport during the construction and operation phase and potential significant impacts will be identified.

This chapter aims to quantify resource use with respect to energy, water and materials where possible during the construction and operation phases of the Proposed Project, and to determine the options for the reduction of resource use.

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[15] IFC, 2002. Environmental, Health and Safety (EHS) Guidelines for Airports.

This chapter should also be read in conjunction with other technical chapters contained within this ESIA Report, and therefore does not address the following, which are covered in other chapters:

- Greenhouse gas emissions and climate change (Chapter 9: Air Quality);
- Production and management of waste (Chapter 16: Waste); and
- Management of pollution (Chapter 9: Air Quality, Chapter: 10 Noise and Vibration, and Chapter: 12 Water Resources).

The construction and operation of the Proposed Project will also result in the use of natural resources and other materials beyond the scope of the Proposed Project Area, which include the following:

- Embodied energy and water use during the sourcing, manufacture and process of materials during both construction and operation. These typically include direct material use (e.g. construction materials) as well as indirect material use (e.g. consumer goods);
- Additional fuel demand from associated activities to the Proposed Project under the management and control of third parties; and
- Additional fuel demand associated with the movement of passengers, staff, cargo and goods (e.g. private car, taxi, public transport, truck/HGV and possibly by sea).

Whilst it is acknowledged that the above fall within the Proposed Project Area this assessment has not sought to quantify these impacts within this chapter. However, where appropriate, mitigation measures that provide opportunities to further reduce resource use in the areas above have been identified within this chapter.

A documentation review was undertaken of existing and available information relevant to the Proposed Project to inform the scope of this chapter. An assessment of resource use was undertaken and quantified, where available, based on secondary sources comprising:

- The ESIA Scoping Report (Technical Appendix 2.1);
- NBIA Master Plan[16];
- NBIA Conceptual Design Parts A and B[17]; and
- NBIA Campsite Descriptive Memory[18].

It is understood that the Proposed Project will cause impacts to the immediate, surrounding and regional biophysical and socio-economic environment. Specific environmental and socio-economic impacts will occur at different phases of the Proposed Project during the life of the scheme.

The impacts associated with each of these phases will be specific to the biophysical and socio-economic context, spatial and temporal aspects of the Proposed Project. For the purpose of this Report, anticipated/potential impacts have been identified, via a desktop approach. This approach also took into consideration typical impacts previously identified from similar projects that Ramboll Environ has managed.

In order to identify potential impacts, the following were to be considered:

- Airport Area earthworks and construction;
- Construction Camp;

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[16] Airport Design Management (Airport Consulting Vienna and Mota-Engil), 2017. NBIA Master Plan (Version 06-00).

[17] Airport Design Management (Airport Consulting Vienna and Mota-Engil), 2017. NBIA Conceptual Design Report Part A and Part B (Version 01-00).

[18] Mota-Engil, 2017. NBIA Campsite Descriptive Memory.

- Construction of the airport buildings and infrastructure Passenger Terminal, Presidential Terminal;
- Temporary Water Pipeline; and
- The Expressway earthworks and construction.

17.3.2. Baseline Characterisation

The Proposed Project Area is currently predominantly unoccupied with little infrastructure and resources onsite. Therefore the expected resource use during the Proposed Project's construction and operation will primarily be based on the Masterplan and extrapolation from expected operational usage.

17.3.3. Construction Phase Method of Assessment

Table 17-1 below indicates the areas of assessment and the current and potential sources of information for the construction phase assessment.

BAC also provided the following information:

- Estimated average daily water demand – 465 m^3

Estimated construction materials demand (Table 17-2)

Table 17-1: Resource Use Elements and Information Sources

Construction Phase		
Process	**Elements**	**Information Sources**
Earthworks	Earth moving and construction vehicles	Number of vehicles, size and frequency of trips for earthworks phase from construction Master Plan and Expressway Master Plan
	Movement of materials on site	Volumes and density of materials to be moved on site from construction Master Plan and Expressway Master Plan
Water use	For construction purposes, such as concrete production and dust suppression	Volumes of concrete expected to be poured from design plans and construction Master Plan Area and frequency of dust suppression from Dust Control Plan
	Potable water for welfare of site workers	Number of workers on site and number of man hours from construction Master Plan, including Expressway
Material demand	Groundworks and site levelling, such as aggregates, sand, spoil	Construction design and estimated material demands from construction Master Plan
	Road construction, such as aggregates, asphalt, paving and other materials	Construction design and estimated material demands provided by BAC Some information on detailed quantities available
	Building construction materials such as sand, cement, steel, timber, steel, cladding	Construction design and estimated material demands provided by BAC Some information on detailed quantities available
Construction Camp	Construction offices and support buildings	Construction Campsite Descriptive Memory document

Operation Phase		
Energy consumption	Building and services operation, including, lighting, cooling, and small power	Building design and expected operation business plan
Water use	During operation for site users, irrigation, maintenance and emergency fire suppression provisions	Annual passenger numbers predicted and number of staff taken from the business plan Estimated water use figures provided in Master Plan documents

17.3.4. Operation Phase Method of Assessment

BAC provided the following information:

- Water demand:
  - Average daily water demand - 675 m^3
  - Maximum daily water demand – 1,000 m^3
  - Maximum hourly water demand - 200 m^3/h
- Electricity demand:
  - 4 MW in 2020; and
  - 8 MW in 2045.

The figures for electricity demand have been compared with energy benchmarks that are available from other already constructed and operating airports.

Other resource impacts will be small and confined to the materials used to repair and replace elements of the airport that are subject to wear and tear e.g. internal building surfaces and runway repairs.

17.3.5. Significance Criteria

Significance criteria have been evaluated in accordance with the methodology set out in Chapter 3: Impact Assessment Methodology.

17.3.6. Assumptions and Limitations

Fuel use in the Construction Camp has been estimated on the basis of published benchmarks (CIBSE Guide F (2012)[19]) for comparative buildings located in the UK. These will only give a rough approximation of the energy used within the Construction Camp buildings.

The benchmarks used for the estimation of the airport operation are empirically based on data from other existing airports. They will not be directly comparable to the Proposed Project in terms of location, size, etc. but will give an indication of the scale of the energy resources required.

17.4. Baseline Conditions

The baseline conditions for the Proposed Project Area are unknown with respect to resources. However, the area was used for subsistence farming and hence there was no utility use within the area. Subsistence farmers will have used some fuel for transport and cooking but this is negligible in the context of the Proposed Project.

[19] Chartered Institution of Building Services Engineers (CIBSE), 2012. Guide F: Energy Efficiency in Buildings.

This chapter seeks to identify the resource demand relating to fuel, water and materials during the earthworks/construction and operation phases of the Proposed Project. It is noted that, given the current status of the Proposed Project Area and its existing uses, the Proposed Project will comparatively result in a significant use of natural resources and other materials at all stages of the Proposed Project.

17.4.1. Sensitive Receptors

The usage of non-renewable resources can have a direct impact on the receiving biophysical and social environment as a result of resource minimisation, generation of carbon dioxide, Volatile Organic Compounds (VOCs), etc., and potential impacts associated with the mismanagement of dangerous goods, fuels and chemicals.

The local receptors affected by resource efficiency will be local people living along transport corridors, as a result of increased air pollution and traffic noise, if fuel and materials that are required to be delivered to site are not kept to a minimum as a result of good resource efficiency practices.

In a wider context, poor resource efficiency will result in an increased contribution to greenhouse gas (GHG) emissions as a result of increased electricity and fuel use.

17.5. Potential Impacts

17.5.1. Construction Phase Impacts

17.5.1.1. Earthworks

During the construction phase, the topography of the Proposed Project Area will be levelled to provide an even surface for construction of the airport buildings, Expressway, runway and associated access. This will require cut and fill earthworks to be undertaken to even out any differences in topography across the Proposed Project Area. The volumes of earth and material to be moved will require a significant number of earth moving vehicles, to be powered by diesel engines. The movement of these vehicles will require the use of diesel fuel with corresponding carbon emissions and combustion pollutants, such as particular matter and nitrous oxides.

The volumes of cut and fill are approximately 9,000,000 m^3 and 7,000,000 m^3 respectively. Excess cut material (approximately 2,000,000 m^3) will be largely reused for filling borrow pits as well as miscellaneous onsite purposes such as landscaping. If there is any remaining excess cut material that requires disposal off site this will be done via licensed contractors in line with GIIP (Chapter 16: Waste Management).

17.5.1.2. Materials Demand

Table 17-2 presents the estimated approximate quantities of construction material required for the Proposed Project.

Table 17-2: Construction Quantities

Activity	Unit	Quantities				
		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Granular backfill	m^3	285,182	13,011	17,869	31,145	14,811
Sub-course	tonnes	468,327	24,580	34,915	57,564	24,931
Asphalt	tonnes	420,678	17,745	370,243	153,003	21,094
Concrete	m^3	123,306	9,170	20,541	8,941	6,694

Table 17-2: Construction Quantities

Activity	Unit	Quantities				
		Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**
Cement	tonnes	49,322	3,668	8,216	3,576	2,678
Aggregate	tonnes	234,281	17,423	39,028	16,988	12,719

17.5.1.3. Aggregates

Aggregate for the Proposed Project will be sourced from a quarry located 10 km northeast of the Proposed Project Area. The quarry underwent an EIA, which was approved in accordance with Rwandan regulations and it is licensed by the Rwanda Development Board (RDB) and the Ministry of Natural Resources. It has the capacity to produce 30,000 tonnes per annum of aggregate. Aggregate will be transported via the quarry road to the Airport Area.

In addition to the direct impacts from the operation of the earth moving vehicles, there will be associated dust and particulate impacts on both the local atmosphere and water resources through the consequence of disturbing and moving the materials. It is also expected that there will be an excess of material produced during the 'cut' operations, which will exceed the required volumes of materials needed during the 'fill' operations. Therefore there is expected to be a need for safe disposal or reuse of removed material elsewhere off-site or onsite.

Furthermore, the construction of the Expressway will require additional earthworks with associated impacts, as discussed above, in addition to the importation of aggregate materials for the construction element.

Aggregate materials for the Proposed Project will be sourced from the quarry identified above and transported by road, following appropriate road widening and surface upgrades, where required, within the Proposed Project Area. The use of virgin quarried materials will have negative impacts during both the quarrying stage and from the transportation of materials. It is expected that through careful management of material needs across site and reuse of materials onsite, the amount of quarried material can be kept to a minimum.

During construction, there will be a need for the use of a variety of construction materials. The greatest volume of which will be concrete and steel. The production of concrete will require the use of cement, sand and aggregates. Due to the attributes of sand required in the production of concrete, this will need to be sourced from a source with sufficient quality and correct characteristics for use in construction.

17.5.1.4. Construction Vehicle Fuel Use

The process of construction will require the use of energy for machinery, vehicles and workers' welfare, all of which have an environmental impact.

All construction vehicles and machinery will be operated using diesel fuel. It is expected that the following construction equipment will be used to load material across all five development phases:

- Excavators: Model CAT 329D and Doosan DX520L;
- Front Loaders: Model CAT 980H and Doosan DL420; and
- Motor-Scrapers: Model 621G and 627G.

There will be approximately 20 bulldozers and 13 tractor-scrapers in use at any one time during construction of the Proposed Project.

Equipment used to transport material:

- Tipper Trucks 26 ton; and
- Dump Trucks 40 ton.

There will be approximately 55 tipper trucks and 21 dump trucks in use at any one time during construction of the Proposed Project.

17.5.1.5. Water Demand

The construction phase water consumption requirement is estimated to be 465 m^3 per day. Water is required directly for construction purposes, such as in concrete production and for dust suppression. In addition, water will be required for wash down activities and that of welfare considerations of the workforce onsite.

The water resources will be sourced via an over-ground 5 km Water Pipeline from Lake Kidogo, located to the southeast of the Airport Area. A recent analysis conducted by BAC concluded that based on expected water consumption of NBIA Project and on the estimated Lake Kidogo resources, the lake renewal capacity is much higher than the expected consumption for the NBIA project. The construction phase is therefore not expected to have a significant impact on the water source at Lake Kigodo. This is discussed in further detail in Chapter 12: Water Resources.

Water from the pipeline will pass through a water treatment plant prior to being used onsite. The volume of water used in concrete production is determined by the total volumes of concrete in the Proposed Project. Concrete needs to be used within a certain period of time after mixing.

17.5.1.6. Energy Demand for the Construction Camp

The Construction Camp consists of a number of buildings, which are listed in Table 17-3 below. The buildings will be provided with electricity from diesel fuelled generators. Energy benchmarks from CIBSE Guide F (2012)[20] and CIBSE TM46[21] are used to estimate the approximate annual electricity use. The diesel generators are approximately 30% efficient, hence the volume of diesel fuel to be used in a year is approximately 315,000 litres.

Additional fuel will be required for dedicated generator sets for the batching plants, sand wash plant and asphalt plant.

Table 17-3: List of Construction Camp Buildings

Building	Floor area (m^2)	Benchmark ($kWh/m^2/year$)	Electricity Use (kWh/year)
Offices	800	224	179,200
Training	65	224	14,560
Client	150	224	33,600
Canteen	570	420	239,400
Laboratory	335	320	107,200
Workshop	1050	215	225,750
Warehouse	2500	63	157,500
WC/shower	150	224	33,600

[20] Chartered Institution of Building Services Engineers (CIBSE), 2012. Guide F: Energy Efficiency in Buildings.
[21] Chartered Institution of Building Services Engineers (CIBSE), 2008. Energy Benchmarks CIBSE TM46: 2008.

Total electricity kWh	990,810
Diesel use in litres/annum at assumed generation efficiency of 30%	315,000

All the Construction Camp buildings referred to above are to be built with STRAWTEC panels and/or LSF (Light Steel Frame), which allows a fast assembly and minimum waste of construction materials.

17.5.1.7. Design Controls

The majority of the construction materials will be sourced from the quarry to the northwest in relatively close proximity to the Proposed Project Area.

17.5.1.8. Impact Assessment Prior to Mitigation

Fuel demand for the Construction Camp and the construction vehicles will have impacts in terms of increased traffic flow and GHG emissions if high levels of resource efficiency are not maintained. Traffic flow will increase as a result of the need for fuel delivery vehicles to come to site. However, the increase in traffic flow will be low relative to the absolute value. The effect of GHG emissions will be very small in both a local and national context. Air quality and other impacts are dealt with in other chapters. Overall the magnitude of impact is considered to be low and the receptor sensitivity is medium. As a result, the significance of impact is considered to be **Minor Adverse.**

As detailed above, Lake Kidogo has sufficient renewal capacity to support water supply during construction. Hence the magnitude of impact is estimated to be low. The receptor sensitivity being medium, the significance of the impact on the water source, Lake Kidogo, will be **Minor Adverse.**

Table 17-4 presents the significance of impacts.

If good resource efficiency is not practiced, then the increase in material demand for the construction will have impacts in terms of increased material movement and impacts at source e.g. the quarry. However, the increase in these factors will be low relative to the absolute value and the impacts will be small in both a local and national context.

Table 17-4: Impact Significance Construction Stage

Impact	Magnitude of Impact	Receptor Sensitivity	Impact significance
Increase fuel demand associated with construction vehicles, equipment and welfare facilities	Low	Medium	**Minor Adverse**
Increase water demand associated with construction vehicles, equipment and welfare facilities	Low	Medium	**Minor Adverse**
Increase material demand associated with earthworks and construction of the Proposed Project	Low	Medium	**Minor Adverse**

17.5.2. Operation Phase Impacts

The operation phase of the Proposed Project will require on-going use of resources, with associated impacts on finite resources, emission of pollutants and climate change impacts. Of most significance are the energy requirements for cooling, lighting and small power use within

buildings; fuels for powering the airport operational vehicles and aviation fuel for use in refuelling aircraft.

The Rwanda Water and Sanitation Corporation (WASAC) and Rwanda Energy Group (REG) will be responsible for supplying water and power respectively for the operation phase.

The existing water supply infrastructure in the region comprises three reinforced concrete ground reservoirs: Bugesera Reservoir (with 5,000 m^3 storage capacity), Gahanga Reservoir (with 7,500 m^3 storage capacity) and Kagarama Reservoir (with 7,500 m^3 storage capacity). The Bugesera Reservoir is connected to the Bugesera Area Water Distribution Network, whilst the other two are connected to the Kigali Water Distribution Network.

A new water treatment plant is planned in the vicinity of the Proposed Project Area that will supply water to NBIA. It is understood that the water treatment plant will treat water coming from the Kanzenze Well Fields and then distribute the water to the three reservoirs mentioned above. A connection point from the Airport Area to the Kigali Water Distribution Network is foreseen. Further details of the exact location and capacity of the water treatment plant and the pipeline route to the Airport Area are not currently available. A permanent Water Pipeline to the Airport Area will be an Associated Facility to the Proposed Project. The definition of Associated Facilities and how they will be assessed by the Project is discussed further in Chapter 6: Proposed Project Description. A back-up supply within the Airport Area is also foreseen.

An estimated average of 675 m^3 and a maximum of 1,000 m^3 of water per day will be required during operation of the Proposed Project. There are also plans to install a rainwater capture system for re-use at NBIA.

The source of electricity has yet to be confirmed. Power will likely be provided from two sources; the new Mamba peat power plant (80 MW installed capacity which is expected to be commissioned in 2019) located in Gisagara District in the Southern Province and/or the Rusumo HEP project (80 MW installed capacity) on the border between Rwanda, Tanzania and Burundi. The overhead power line to NBIA will be an Associated Facility and assessed in a similar way as the permanent Water Pipeline discussed above.

The amount of electricity to be consumed during operation is estimated at 4 MW for Phase 1 rising up to 8 MW for Phase 5.

17.5.2.1. Design Controls

The airfield operational concept and layout have been developed to help reduce flight times and distances (runway allocation/terminal location) and ground movements (runway separations, taxiway layout and terminal location) to minimise fuel use.

Good building design factors, such as insulation, building envelope construction, air tightness, reducing thermal bridging, maximising passive solar gains, availability of natural light and passive cooling, along with the potential inclusion of low and zero carbon technologies, can all help to reduce the primary energy demand of the proposed buildings reducing the reliance on fuels for heating and electricity for cooling and lighting.

Through good building design, operational procedures, awareness campaigns and site wide management, the Proposed Project development can minimise the total resource used during the operation phase.

The NBIA Conceptual Design Report[22] contains guidance of the resource efficiency mitigation principles and measures that will be incorporated in the airport design and followed throughout the Proposed Project and these are described below.

Materials Strategy

Section 7.2 of the Concept Design Report Part A gives guiding principles for resource efficiency that will be followed throughout the Proposed Project and states that: *"Materials and construction are optimized to balance durability with sustainability and energy costs, which includes production and transportation. It is especially important to minimalize the unnecessary wasting of natural resources and the transportation."*

Façade

Measures to shade and restrict solar gain are a foundation of the design concept. In order to optimise energy use, sun shading elements will be put on the outside of the building to reduce overheating of the interior and hence minimise energy use for cooling.

Solar gain and sun shading simulations have been carried out in order to determine the optimal shading solution. The design therefore will:

- Consist of modular elements that ensure flexibility and ease of construction and future repair;
- Utilise known technology;
- Contain recyclable materials;
- Reduce solar gain through sun protection/shading measures; and
- Have high performance glazing.

Roof

The roof will be an energy efficient and durable design that is intended to balance optimal use of daylight while minimising solar gain.

Flooring

The flooring will consist of concrete and stone floor in order to enable simple and easy maintenance. The surface is chosen to be robust and durable. The materials selected will be sourced locally, where possible and be a known technology for local contractors.

Interior Walls

Interior walls will be of lightweight flexible construction made from simple materials, such as gypsum, paper or straw. The materials will be sourced locally, where possible.

Natural / Artificial Lighting

The roof and façade will be designed to optimise the use of natural lighting and hence reduce the need for artificial lighting while still minimising solar gain. The building design will facilitate the use of natural light in internal areas.

Energy Supply / Combined Heat and Power

There will be a grid connection for electricity; however, in order to increase resilience, it is planned to generate the required energy (electrical power, cooling water, heating, water) in a central energy supply station and distribute it on the whole Airport Area.

[22] Airport Design Management (Airport Consulting Vienna and Mota-Engil), 2017. NBIA Conceptual Design Report Part A and Part B (Version 01-00).

The Proposed Project Concept Design indicates that it is planned to install diesel (or kerosene) fired cogeneration combined heat and power (CHP) units, which would meet the electric and heating demand of the whole airport. Further design detail will be developed in later stage of the design evolution.

Ventilation and Air Conditioning Systems

The concept design indicates that it is intended to use a desiccant dehumidification system in order to optimise the use of waste heat from the combined heat and power (CHP) engine. This is in addition to the absorption chiller. The desiccant system uses two rotary wheels within an air handling unit (AHU). Therefore, one wheel is only transferring sensible heat and the second one latent heat. The extract air stream of the building will be heated to approximately 75°C, using a heat exchanger and excess thermal energy from the CHP power plant. This air stream will regenerate the desiccant wheel and the incoming air stream (outdoor air conditions) is dried and heated. This air stream is the furthermore cooled with the other wheel, which transfers heat from extract to supply air. In the optimal scenario, the system does not need any further dehumidification.

Energy simulations have been carried out by the BAC design team which show that, by using these wheels, almost no additional dehumidification is required and consequently the chiller in the power plant can operate at higher efficiency. Furthermore, the distribution losses within the cooling network can be reduced and this will improve the overall efficiency of the CCHP plant. Further design detail will be developed in later stage of the design evolution.

Other features in the NBIA concept design are:

- Partial air conditioning of baggage hall by using exhaust air from terminal air conditioning; and
- Heat recovery by thermal wheels.

Photovoltaic System

The concept design includes a treatment of photovoltaic systems. It indicates that this is a technology that could be deployed at the airport and that local solar conditions are such that the technology will be highly effective.

17.5.2.2. Impact Assessment Prior to Mitigation

Table 17-5 presents the significance of impacts.

Table 17-5: Impact Significance Operational Stage

Impact	Magnitude of Impact	Receptor Sensitivity	Impact significance
Increase fuel demand associated with the operation of the airport (i.e. aviation fuel and within buildings)	Low	Medium	**Minor Adverse**
Increase water demand associated with operation of airport (welfare facilities)	Low	Medium	**Minor Adverse**
Increase material demand associated with operation of the Proposed Project	Low	Low	**Negligible**

17.6. Mitigation Measures

17.6.1. Earthworks/Construction

17.6.1.1. General

Across all areas subject to mitigation:

- Awareness will be increased through implementation of the Environmental Induction and Training Plan; and
- Resource efficiency practices and procedures will be communicated and integrated into the relevant topic specific Environmental and Social Management Plans and Procedures as appropriate.

17.6.1.2. Fuel and Energy Demand

In line with GIIP, an energy management programme will be adopted within the relevant topic specific Environmental and Social Management Plans and Procedures (such as the Pollution Prevention Plan), which will:

- Use equipment and machinery that is in good running condition and perform regular maintenance;
- Ensure that machinery is not kept running while it is not in use;
- Identify, regularly measure and monitor the principal energy uses associated with both construction vehicles and equipment onsite;
- Adopt transport measures, such as, regular inspection of vehicles and equipment, adoption of speed restrictions to optimise fuel efficiency of vehicles; and
- Regularly compare energy use with performance targets to identify where action should be taken to reduce energy use.

17.6.1.3. Materials Demand

The construction of the Proposed Project will ensure that vulnerable or exposed internal and external areas of the Proposed Project are protected, as far as practicable, to minimise the frequency of replacement and maximise materials optimisation. As such, suitable durability and protection measures or designed features/solutions to prevent damage will be adopted, such as:

- Selection of materials (e.g. flooring) to protect against the effects of high pedestrian traffic in main entrance, public areas and thoroughfares;
- Protection against any internal vehicular/trolley movements within 1 m of the internal building fabric in storage, delivery, corridor and service areas;
- Design to prevent any potential vehicular collisions in vehicular parking and manoeuvring in all air side vehicle movement and parking areas, car parking and delivery areas; and
- Selection of building elements for minimisation of material degradation effects from environmental factors (e.g. precipitation, wind, temperature variation, solar radiation and extreme weather conditions).

Where possible, the material specifications and product selection process will be informed by whether materials:

- Have low embodied energy that require little processing during manufacturing;
- Are locally sourced to minimise transport impacts (e.g. crushed aggregates);
- Comprise high recycled content, particularly for steel, glass, cladding and flooring products;

- Include reclaimed materials including cut-fill material;
- Are durable and resistant to climate change impacts and pedestrian/vehicular/trolley movements;
- Are re-used, recycled, refilled, recharged or reconditioned; and
- Are certified to environmental standards or are responsibly sourced, where possible, including the sourcing of aggregates and road asphalt from nearby quarries, borrow pits, crushing plants and asphalt plants with valid environmental and other operating permits.

In addition, a Waste Management Plan will be adopted, which will set out the principles of the waste hierarchy and promote more sustainable material use through reduction of waste, reuse and recycling of materials, where possible, to divert waste from landfill.

17.6.1.4. Water Demand

In line with GIIP, the supply and use of water will be managed through the following:

- Identify and monitor the principal flows within construction works;
- Define and regularly review performance targets adjusted to account for the type of construction activity;
- Regularly compare water flows with performance targets to identify where action should be taken to reduce water use; and
- Rainwater will be harvested for use onsite.

17.6.2. Airport Operation

17.6.2.1. Fuel and Energy Demand

The utility strategy will take into account the significant energy demands associated with the operation of the airport terminals. The selection of machinery and equipment for energy generation and cooling will be such as to reduce both the environmental impact and whole life cost to ensure that the design of the terminal building and airfield infrastructure (i.e. building fabric, plant and equipment, lighting technology and control systems) take advantage of the latest design practices to minimise energy use and emissions.

In addition to the measures covered by the design guide additional measures will be adopted which include the following:

Reducing energy demand by the building from:

- Maximise daylight and energy using roof lights where remote from facades; and
- Airtight roof and façade to minimise air leakage.

Reducing energy demand by use of efficient systems:

- All air conditioning to be air displacement systems;
- Air intake from roof level to avoid use of energy intensive carbon filters;
- Fan energy reduced by minimising duct lengths with low air velocities;
- Pump energy reduced by minimising pipe lengths with low water velocities;
- Recycling of condensate from air handling units;
- Lighting control system;
- High efficiency light sources and lighting designs, e.g. LED;
- Variable speed drives on fans and pumps; and
- Electronic passenger control on escalators and travellators.

In addition, the following measures will be adopted to further reduce fuel and energy demand:

- Regular inspection, maintenance and repair of any distribution system leaks;
- Insulation of all distribution pipework in addition to insulation of all chilled and hot water valves and flanges, where appropriate;
- Demand/load side management by reducing loads on the energy system;
- Monitoring of principal energy flows within the terminal building; and
- Setting and review of and energy consumption performance targets.

17.6.2.2. Materials Demand

The same measures outlined for the construction phase apply for the operation phase.

17.6.2.3. Water Demand

BAC will require third parties (tenants and concessionaries) to fit-out the following water-saving features as part of the fit-out programmes:

- Increase awareness of employees through training;
- Use of the best international technologies;
- Regular maintenance of plumbing to identify and repair leaks;
- Shut off water to unused areas (e.g. WC areas);
- Installation of water-efficient appliances including self-closing taps, automatic shut-off valves, spray nozzles, and water conserving sanitary fittings (e.g. taps, shower heads, toilets, urinals) and white goods;
- Operation of any commercial dishwashers and laundries on full loads where possible;
- Reuse of treated wastewater for appropriate purposes, such as irrigation of landscaped areas; and
- Setting and review of water consumption performance targets.

17.7. Residual Impact Assessment Conclusions

17.7.1. Construction Phase Residual Impacts

The materials, fuel, energy and water used in construction, once consumed, will leave little residual impact and the residual impact significance is judged to be **Negligible** (Table 17-6).

Table 17-6: Residual Impact Significance

Impact	**Magnitude of Impact**	**Receptor Sensitivity**	**Residual Impact significance**
Residual fuel and energy demand associated with construction vehicles, equipment and welfare facilities	Very Low	Medium	**Negligible**
Residual effect of water demand associated with construction vehicles, equipment and welfare facilities	Very Low	Medium	**Negligible**
Residual effect material demand associated with earthworks and construction of the Proposed Project	Very Low	Medium	**Negligible**

17.7.2. Operation Phase Residual Impacts

The residual impacts with respect to resources are in effect the operation phase impacts described and evaluated above. NBIA will continue to use fuel, energy and water throughout its life. The incorporated design controls and the mitigation measures will ensure that these are efficiently consumed. The residual impact significance of this consumption should continue to be **Minor Adverse** both within a local and national context. The small material demand associated with maintenance and repair will have a **Negligible** impact significance (Table 17-7).

Table 17-7: Operation Phase Impact Significance

Impact	Magnitude of Impact	Receptor Sensitivity	Residual Impact significance
Increase fuel and energy demand associated with the operation of airport (i.e. aviation fuel and within buildings)	Low	Medium	**Minor Adverse**
Increase water demand associated with operation of airport (welfare facilities)	Low	Medium	**Minor Adverse**
Increase material demand associated with operation of the Proposed Project	Low	Low	**Negligible**

17.8. Summary of Mitigation and Residual Impacts

Table 17-8 provides a summary of the impacts and mitigation measures associated with Resource Efficiency during the construction and operation of the Proposed Project.

The main impacts relating to resource efficiency are:

- Increased fuel demand associated with construction vehicles, equipment and welfare facilities;
- Increase water demand associated with construction, vehicles, equipment and welfare facilities;
- Increase material demand associated with earthworks and construction of the Proposed Project;
- Increase fuel demand associated with the operation of airport (i.e. aviation fuel and within buildings);
- Increased water demand associated with operation of airport (welfare facilities); and
- Increase material demand associated with operation of the Proposed Project.

Table 17-8: Summary of Findings

Impact	Receptor	Phase	Impact Magnitude	Receptor Sensitivity	Pre-Mitigation Impact Significance	Design, Enhancement or Mitigation Measures	Management Plan	Residual Significance
Increase fuel and energy demand associated with construction vehicles, equipment and welfare facilities	Local communities and land-users	Construction	**Impact Magnitude:** Low **Type:** Negative **Duration:** Short Term **Extent:** Regional/ National **Reversibility:** Reversible	Medium	**Minor Adverse**	Adoption of ESMP to include the following measures: • Implement staff training; • Use of equipment and machinery that is in good condition and perform regular maintenance; • Ensure that machinery is not kept running while in use; • Identify, regularly measure and monitor the principal energy uses associated with both construction vehicles and equipment onsite; • Define and regularly review performance targets adjusted to account for the type of construction activity;	• C-ESMP and relevant topic specific ESMPs	**Negligible**

Table 17-8: Summary of Findings

						• Adoption of transport measures such as regular inspection of vehicles, adoption of speed restrictions to optimise fuel efficiency of vehicles; and • Regularly compare energy use with performance targets to identify where action should be taken to reduce energy use.		
Increase water demand associated with construction, vehicles, equipment and welfare facilities	Local communities and land-users	Construction	**Impact Magnitude:** Low **Type:** Negative **Duration:** Short Term **Extent:** Local/ Regional **Reversibility:** Reversible	Medium	**Minor Adverse**	Adoption of ESMP to include the following measures: • Implement staff training; • Identify, regularly measure and monitor the principal flows within construction works; • Define and regularly review performance targets adjusted to account for the type of construction activity; and	• C-ESMP and relevant topic specific ESMPs	**Negligible**

Table 17-8: Summary of Findings

						• Regularly compare water flows with performance targets to identify where action should be taken to reduce water use.		
Increase material demand associated with earthworks and construction of the Project	Local communities and land-users	Construction	**Impact Magnitude:** Low **Type:** Negative **Duration:** Short Term **Extent:** Regional/ National **Reversibility:** Reversible	Medium	**Minor Adverse**	• Adoption of Waste Management Plan; • Sourcing of materials that have low embodied energy use, are locally sourced, are durable, etc.; and • Adoption of a Traffic and Transport Management Plan to minimise traffic movements associated with importation of building materials, concrete and aggregate from off-site sources.	• C-ESMP and relevant topic specific ESMPs (i.e. Waste Management Plan, Traffic Management Plan)	**Negligible**
Increase fuel and energy demand associated with the operation of airport (i.e. aviation fuel	Local communities and global communities	Operation	**Impact Magnitude:** Low **Type:** Negative **Duration:**	Medium	**Minor Adverse**	Adoption of O-ESMP to include the following measures: • Implement staff training; • Reducing energy demand by use of	• O-ESMP and relevant topic specific ESMPs	**Minor Adverse**

Table 17-8: Summary of Findings

and within buildings)			Long Term **Extent:** National **Reversibility:** Irreversible			efficient systems and through building design; • Regular inspection, maintenance and repair of any distribution system leaks; • Insulation of all distribution pipework, in addition to insulation all valves and flanges, where appropriate; • Demand/load side management by reducing loads on the energy system; • Identification, regular measurement and reporting of principal energy flows within the terminal building; • Setting and review of energy performance targets, adjusted to account for major influencing factors on energy use;		

Table 17-8: Summary of Findings

						• Regular comparison and monitoring of energy flows with performance targets to identify where action could be taken to reduce energy use; and • Regular review of targets, which may include comparison with benchmark data to confirm that targets are set at appropriate levels.		
Increased water demand associated with operation of airport (welfare facilities)	Local communities and land-users	Operation	**Impact Magnitude:** Low **Type:** Negative **Duration:** Long Term **Extent:** Local/Regional **Reversibility:** Irreversible	Medium	**Minor Adverse**	• Implement staff training; • Regular maintenance of plumbing to identify and repair leaks; • Shut off water to unused areas (e.g. WC areas); • Installation of water-efficient appliances including self-closing taps, automatic shut-off valves, spray nozzles, and water conserving sanitary fittings (e.g. taps,	• O-ESMP and relevant topic specific ESMPs	**Minor Adverse**

Table 17-8: Summary of Findings

						shower heads, toilets, urinals) and white goods; • Operation of any commercial dishwashers and laundries on full loads where possible; • Re-use of treated wastewater for appropriate purposes, such as irrigation of landscaped areas; and • Setting and review of water consumption performance targets.		
Increase material demand associated with operation of the Project	Local communities and land-users	Operation	**Impact Magnitude:** Low **Type:** Negative **Duration:** Long Term **Extent:** Regional/ National **Reversibility:**	Low	**Negligible**	• Implement staff training; • Selection of materials (e.g. flooring) to protect against the effects of high pedestrian traffic in main entrance, public areas and thoroughfares;	• O-ESMP and relevant topic specific ESMPs	**Negligible**

Table 17-8: Summary of Findings

			Irreversible			• Protection against any internal vehicular/trolley movements within 1 m of the internal building fabric in storage, delivery, corridor and service areas; • Design to prevent any potential vehicular collision in vehicular parking and manoeuvring in all car parking and delivery areas; and • Selection of building elements from material degradation effects from environmental factors (e.g. precipitation, wind, temperature variation, solar radiation and extreme weather conditions).		