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Bugesera Airport Company Limited

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NEW BUGESERA INTERNATIONAL AIRPORT ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT- TRANSPORT

RAMBOLL ENVIRON

CONTENTS

LIST OF TABLES

LIST OF FIGURES

8. TRAFFIC AND TRANSPORT

8.1 Introduction

This chapter of the ESIA Report considers the potential impacts of traffic and transport on environmental and social receptors. It predicts and evaluates the potential impacts of the Proposed Project and the associated likely impacts on traffic and transport, arising from the construction works, and operation of the completed Proposed Project.

This chapter is accompanied by the following technical appendices:

- Technical Appendix 8.1: NBIA ESIA Traffic Analysis; and
- Technical Appendix 8.2: NBIA Access Expressway Road General Plan.

8.2 Policy, Legal and Administrative Framework

8.2.1 Rwandan Policy

8.2.1.1 Rwanda Environment Policy, 2003[1]

The Rwanda Environment Policy outlines that the road network consists of pathways and roads, with the main modes of transport being vehicles of various types. The policy expresses concerns over the maintenance and repairs of the road network and the emission of gases with greenhouse effects due to the usage of hydrocarbon products in transportation.

Furthermore, the policy states the main negative effects of major roads on the environment are the impacts of unsurfaced roads (dust, noise, etc.) and the effect of vehicle emissions on the peoples' wellbeing.

Measures that need to be taken, as stated in the policy are as follows:

- To minimise land, lake and air transport pollution;
- To protect property and frontages bordering roads; and
- To protect the population against impacts such as noise and emissions from air, lake and land transport.

8.2.2 Legal Framework

8.2.2.1 The Roads Act, 2012[2]

The Roads Act provides for road network reserves, classification and management. It allows for the acquisition and protection of the necessary land for road developments. Additionally, it sets standards regarding road classifications or other utilities including water, electricity lines, etc.

Roads in Rwanda are classified into two categories; class one roads are the national, district and urban roads; class two are other roads in districts and urban centres. Dimensions for class one roads must have a 3.5 m lane width and 44 m road reserve, while class two roads need to have a 3 m lane width and 24 m road reserve.

According to the act, the responsibility for overall supervision of the transport sector agencies belongs to Ministry of Infrastructure (MININFRA), with the Rwanda Transport Development Agency (RTDA) being the implementing agency for road, water, rail and pipeline transport. The RTDA is responsible for all transport sector policies and project management but not for urban transport.

[1] Rwanda Environment Policy, Government of Rwanda, 2003
[2] The Roads Act, Government of Rwanda, 2012

The Rwanda Utilities Regulatory Agency (RURA) is responsible for improving the quality of services provided and ensure that operators comply with national transport service laws and regulations.

The Ministry of Local Government (MINALOC) is responsible for the planning, development and maintenance of transport infrastructure and services within local authorities, while enforcing traffic laws and regulations, and collecting road traffic accident data is the responsibility of the Ministry of Internal Security (MININTER).

Finally, the Ministry of Natural Resources (MINIRENA) reviews and approves ESIAs and monitors implementation of ESIA mitigation measures in transport infrastructure projects.

8.2.2.2 Organic Law No. 04/2005[3]

Organic Law No. 04/2005 contains a set of targets regarding the protection and conservation of the environment in Rwanda. In particular, in terms of transport, it is mentioned that:

- No permission for any construction work should be given when it may pose dangers to the environment (Article 29); and
- Any kind of public or private construction work needs to be subject to an impact assessment (as per references to Article 30 elsewhere).

8.2.2.3 Law N° 55/2011 of 14/12/2011 Governing Roads in Rwanda[4]

The Law deals with requirements when modifying roads in Rwanda. This is to be considered when RTDA upgrade the KK-15 Road in the future. Furthermore, this law will need to be considered when upgrading the Expressway from a two lane carriageway to a four lane class 1 road.

8.2.3 International Standards

8.2.3.1 IFC Performance Standards, 2012[5]

Applicable IFC standards and guideline requirements for the consideration of transport impacts by this assessment are provided in the following references:

- IFC General Environmental, Health and Safety General Guidelines;
- IFC Environmental, Health and Safety Guidelines for Airports; and
- IFC Performance Standards on Social and Environmental Sustainability.

8.2.4 African Development Bank Integrated Safeguards System, 2013[6]

This chapter accords with the African Development Bank guidance with specific reference to considering the impact of transport infrastructure on vulnerable members of society (children and the elderly) and vulnerable road users (pedestrians and cyclists).

8.2.5 Other Guidance

This assessment is primarily based on the following documents, in accordance with international and British best practice:

[3] Organic Law 04.2005, Government of Rwanda, 2005
[4] Law N°42/2015 of 29/08/2015 Modifying and Complementing the Law N° 55/2011 of 14/12/2011 Governing Roads in Rwanda
[5] International Finance Corporation, World Bank Group, www.ifc.org 2017
[6] Safeguards and Sustainability Series, Volume 1 – Issue 1, African Development Bank, 2013

- Guidelines for Environmental Assessment of Road Traffic[7]
- Airport Co-operative Research Programme reports (various)[8]; and
- UK Design Manual for Roads and Bridges (DMRB)[9].

8.3 Assessment Methodology

8.3.1 Scope

Landside access will be required to enable effective interchange between surface and airport modes of travel, which will be provided by the Expressway as described by the Master Plan[10]. This chapter considers the traffic and transport issues identified through a comparison of the baseline conditions against the construction and operation phases of the Proposed Project; an assessment of potential impacts; the definition of any additional mitigation measures that may be required and an assessment of residual impacts following additional mitigation.

The scope of this chapter is based on the following parameters, for the construction and operation phases of the Proposed Project:

- Environmental and social strategic landside access issues and risks;
- Traffic impacts on the existing quarry road during Phase 1 construction;
- The assessment network is defined as from the Airport Area to the KK-15 Road; and
- Road based transport modes (construction and operation).

The scope of this chapter does not include the internal Airport Area networks (parking areas, terminal forecourts, public transport hubs), any areas adjacent to the Proposed Project, or wider regional/national landside access networks.

8.3.2 Scenarios Considered

- Prior to 2020 Baseline;
- 2020 Operation of Phase 1;
- 2025 Operation of Phase 1/Construction of Phase 2;
- 2030 Operation of Phase 2/Construction of Phase 3;
- 2035 Operation of Phase 3/Construction of Phase 4;
- 2040 Operation of Phase 4/Construction of Phase 5; and
- 2045 Operation of Phase 5.

Note that construction for Phase 2 will only commence once Phase 1 has met the capacity of 1.77 million annual passengers. This is expected to commence in 2025; however, it depends on the date at which the airport will reach capacity (1.77 million passengers per annum).

8.3.3 Baseline Characterisation

Baseline characterisation for traffic has been carried out through desk based assessment of existing information and publicly accessible records including:

[7] Guidelines for Environmental Assessment of Road Traffic, IEA, 1993
[8] Airports Co-operative Research Programme (ACRP) at w.trb.org, 2017
[9] Design Manual for Roads and Bridges, UK Government, www.standardsforhighways.co.uk, 2017
[10] Airport Company Vienne, Master Plan for the New Bugesera International Airport, 2017

- African Development Bank Group, 2013: Rwanda Transport Sector, Review and Action Plan[11];
- Traffic Study and Projections[12];
- NBIA Expressway Road General Plan (Conceptual Design)[13];
- NBIA Expressway Road Conceptual Design Report[14];
- The Draft ESIA (2010) developed by GIBB Africa[15]; and
- Google Earth satellite imagery (accessed September 2017).

The Area of Influence considered for this study includes the length of the Expressway from the Airport Area to the junction with the existing KK-15 National Road, as well as the existing quarry road. Existing and proposed roads associated with the Proposed Project are illustrated in Figure 8-1.

The data from the above references and sources are considered sufficient for the purposes of this assessment, and no on-site baseline survey was required given the generally low levels of traffic in the Proposed Project Area.

8.3.4 Construction Phase Method of Assessment

The construction phase traffic assessment of impacts is based on the change in traffic flow between the baseline traffic flow and the addition of the estimated construction traffic flow for each scenario. Potential construction traffic impacts considered by this assessment are as follows:

- Severance (i.e. actual and perceived divisions that can occur within a community when it becomes separated by new transport infrastructure);
- Driver delay (i.e. time delay of traffic congestion on a road user);
- Safety of transport users (including condition of the roads); and
- Amenity for transport users (i.e. the quality of a place, the way it looks and feels. The design of the road affects amenity, as does the availability of rest stops, gas stations, and other needed services along the way, as well as the design of parking facilities at the destination).

8.3.5 Operation Phase Method of Assessment

The operation phase traffic assessment of impacts is based on the change in traffic flow between the baseline flow and the addition of the estimated operation traffic flow, for each scenario. This is based on the characteristics defined in the sources listed in Section 8.2.3. Potential operation traffic impacts considered by this assessment are the same as stated for the construction phase impact assessment, namely severance, driver delay, safety of transport users and amenity for transport users.

[11] Rwanda Transport Sector, Review and Action Plan. African Development Bank Group, 2013

[12] Developed for Ramboll Environ by BAC. Internal document, 2017

[13] Drafted by GEG, Engineering Structures for Life, drawing number EXP-FS-HIG-100-00, May 2017

[14] GEG, Engineering Structures for Life, CONCEPTUAL DESIGN, 31 July 2017 NBIA-CD-A-1400-HIW-DR-001-R00

[15] GIBB Africa, 2010. Proposed New Bugesera International Airport (NBIA) for Ministry of Infrastructure (MININFRA) Government of Rwanda, ESIA.

8.3.6 Significance Criteria

In accordance with Good International Industry Practice (GIIP), the significance criteria, receptor groups and topics applied in this chapter were sourced from Institute of Environmental Assessment guidance: Guidelines for Environmental Assessment of Road Traffic[16].

The significance criteria adopted for potential traffic and transport impacts are based on the magnitude, extent, reversibility and sensitivity of the receptor, as set out in Chapter 3: Impact Assessment Methodology.

[16] Institute of Environmental Management and Assessment's (IEMA) 'Guidelines for the Environmental Assessment of Road Traffic' (January 1993)

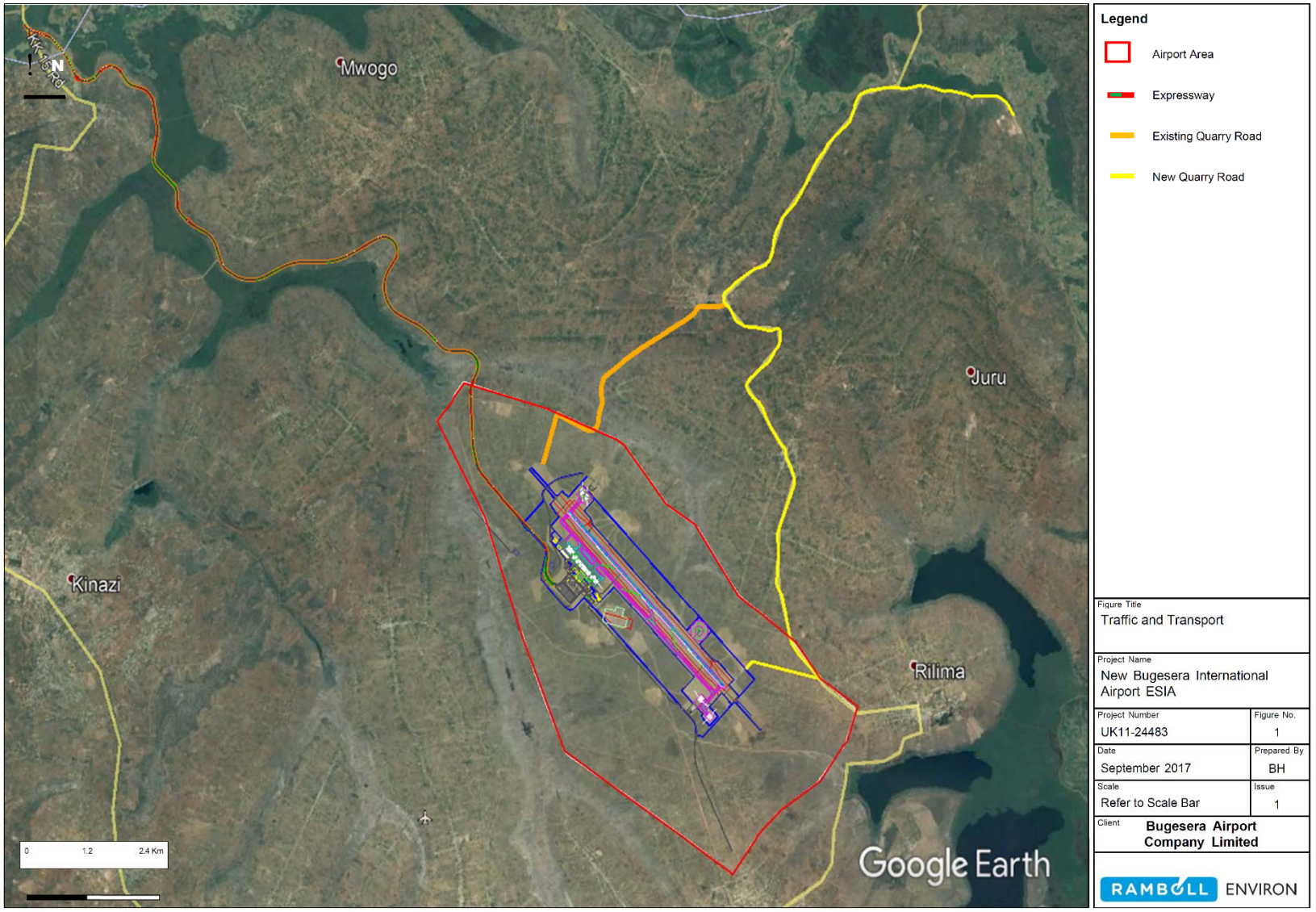

Figure 8-1: Existing and Proposed Transport Routes for the Proposed Project (Source: Google Earth, 2017)

The receptor groups relevant to this chapter are classified by sensitivity split by land use (activities around the airport and adjacent to transport links), infrastructure (the transport links) and transport users, as illustrated in Table 8-1. This table effectively hinges: receptor sensitivity as land use types to transport effects; receptor sensitivity as local community to transport effects due to infrastructure; or receptor sensitivity as transport users to transport effects.

Table 8-1: Receptor Groups Split by Land Use, Infrastructure and Transport Users

Receptor Sensitivity	Receptor Sensitivity as Land Use Types to Transport Effects	Receptor Sensitivity as Local Community to Infrastructure	Receptor Sensitivity as Transport Users to Transport Effects
Low	Tourist sites Historic buildings Places of worship	Local distributor roads River networks Informal cycle routes	General traffic occupants Fully segregated mode occupants and operators
Medium	Health facilities Parks and recreation Retail areas Residential areas Sites with narrow footways	Minor main roads Bus networks (on-road) Local segregated cycle routes	Cyclists (segregated) Road freight operators Road public transport occupants and operators
High	Education facilities Retirement homes Sites with no footways Accident black spots	Main roads and motorways Light rail, heavy rail and metro Segregated cycle highways	Pedestrians and cyclists (crossing/sharing the road) Children Elderly Those with physical or mental impairment

The Institute of Environmental Assessment guidance suggests a list of topics against which the significance criteria can be applied across the relevant receptors. These are listed in Table 8-2 together with a commentary on their relevance to the assessment of landside access to the Proposed Project Area (during the construction and operation phases).

Table 8-2: Selection of Relevant Traffic and Transport Topics

Topic	Summary Definition	Commentary	Relevance to this Chapter
Night Time Noise	Change in existing traffic noise with the airport	Upgraded existing main roads and new roads may increase night time noise	Not included in this chapter - to be assessed separately within Chapter 10: Noise and Vibration
Vibration	Change in existing traffic vibration with the airport	Upgraded existing main roads and new roads may increase vibration	Not included in this chapter - to be assessed separately within Chapter 10: Noise and Vibration.
Severance	An issue when neighbourhoods are cut-through by new infrastructure	Upgraded existing main roads and new roads may increase severance	Relevant to construction and operation.

Table 8-2: Selection of Relevant Traffic and Transport Topics			
			Relevant to local communities generally and pedestrians/cyclists specifically.
Fear and Intimidation	An issue for pedestrians should local roads experience increases in traffic and freight movements	It is understood that there will be pedestrian crossings and footway along sections of the Expressway	Covered largely by severance and safety topics, though the attitudes of local people on fear and intimidation due to traffic should be captured through the scheme consultation process.
Delay for Transport Users	An issue if there is impact on the local networks	Driver delay possible (assessment outputs not currently available), but pedestrian delay unlikely	Relevant to construction and operation. Relevant to road vehicle users.
Safety of Transport Users	Responds to potential changes in accident numbers	Increase in flows, likely to increase risk of accidents occurring	Relevant to construction and operation. Relevant to all transport users, and local community.
Amenity for Transport Users	Relates to pleasantness of the journey	Quality and smoothness of airport landside access is critical to airport operation	Relevant to operation. Relevant to all transport users generally and specifically to airport passengers.
Hazardous and Dangerous Loads	Relates to specific high-risk movements on road or rail, e.g. chemical or biological	No specific requirements for this type of transport identified for this Project	Not relevant, as an airport does not require such specific high-risk movements on road or rail, e.g. chemical or biological, during construction or operation. If ever required, this would be covered by a separate specific licence. Fuel, while considered hazardous, is within normal operating conditions for freight carried on the highway. On this basis this topic has not been selected as relevant for this assessment. Fuel transport will be covered as part of the airport operation management plan.
Dust and Dirt	Relates to temporary quarrying and construction activity	Upgraded existing main roads and new roads may increase dust and dirt during construction	Not included but assessed within in Chapter 11: Air Quality.

Table 8-2: Selection of Relevant Traffic and Transport Topics
Note: Pedestrian and cyclist related issues have been considered against each selected impact topic selected.

On this basis, the topics of severance, driver delay, safety of transport users and amenity for transport users have been selected as relevant for this assessment. A full definition of each selected topic and how impact significance is measured is described below.

8.3.6.1 Severance

Severance relates to the actual and perceived divisions that can occur within a community when it becomes separated by new transport infrastructure.

The measurement for assessing severance is difficult to predict definitively as the correlation between the extent of severance and the physical barrier is not clear and there are no predictive formulae which give simple relationships between factors and levels of severance.

However, a range of indicators has been used (based on guidance and expert judgement) to determine the significance of severance effects. The threshold for assessing severance adopted for this assessment is based on changes in peak hour traffic flows as set out in the Design Manual for Roads and Bridges (DMRB), which is a UK based best practice guideline referred for this study as no guideline or manual exists in Rwanda. Estimated peak hour traffic levels between the baseline and the various phases have been compared. These indicators have been used to calculate the magnitude of severance impact as set out in Table 8-3.

Table 8-3: Magnitude of Impact Classification for Pedestrian Severance	
Magnitude of Impact	**Change in Traffic Flow in Peak Hour**
Very low	< 30%
Low	30% - 60%
Medium	60% - 90%
High	> 90%

8.3.6.2 Driver Delay

Driver delay is only likely to be significant when the traffic on the network, local to the Proposed Project Area, is at capacity. Initially, the Expressway will operate as a two lane, single carriageway as defined by class one roads, defined in Section 8.1.2.1. The Expressway will be upgraded to a four-lane road with two directional traffic in the future.

When considering driver delay the assumptions listed in Table 8-4 were made.

Table 8-4: Significance of Impact on Driver Delay	
Significance of Driver Delay	**Change in Traffic Flow in Peak Hour**
Negligible	Where it is expected that the junction capacity results will show the junction to operate within capacity during the operation phase.
Low	Where it is expected that the junction capacity results will show the junction to operate over capacity during both the baseline and the operation phase.

Table 8-4: Significance of Impact on Driver Delay	
Medium	Where it is expected that the junction capacity results will show the junction to operate within capacity during the baseline, but over capacity during the operation phase.
High	Where it is expected that the junction capacity results will show the junction to operate over capacity during the baseline, and over capacity during the operation phase.

8.3.6.3 Safety of Transport Users

An increase in traffic flow can result in a higher frequency of, or more severe, accidents. This change is largely dependent upon the design of the infrastructure provided to manage the expected increase in traffic flow.

Rwanda has a road fatality rate of 32.1 per 100,000 inhabitants per year against an African average of 26.6 and against a European average of 9.3 (based on WHO Report 2015, Geneva, Switzerland: World Health Organisation)[17].

It is not expected that the Proposed Project will in itself change the road fatality rate per 100,000 inhabitants in the Proposed Project Area and surrounds. This is because, whilst the construction of the Proposed Project will result in an increase in traffic, at the same time the Expressway will be constructed to enable the flows to be managed more safely and upgrades will be made to the quarry road[18].

8.3.6.4 Amenity for Transport Users

The amenity of a transport user can best be described as the 'relative pleasantness of a journey'. It is affected by design, traffic flow and traffic composition. A high level qualitative view of this topic is given in this assessment in recognition of the importance of achieving the best customer experience for passengers arriving and departing from the Proposed Project via landside access modes, balanced against protecting the amenity of local community access.

8.3.7 Assumptions and Limitations

8.3.7.1 Baseline

In accordance with the scope of this chapter, baseline traffic impacts relate to the junction between the Expressway and KK-15 Road. Activities that have the potential to generate transport and traffic impacts relating to severance, driver delay and transport user safety during the construction and operation phases are provided below.

In terms of defining the existing baseline and the future baseline to give background traffic flow for the various scenarios, the following has been assumed based in relation to the available data:

- KK-15 Road has an Annual Average Daily Traffic (AADT) of less than 1,000 vehicles (total, two-way, baseline) (based on the Rwanda Transport Sector, Review and Action Plan report data);

[17] World Malaria Report 2015, World Health Organisation, December 2015

[18] Ramboll Environ considers that the design of the Expressway is fit for purpose based on international and Rwandan scrutiny, and therefore, the significance of impact of the Proposed Project on transport user safety is classed as minor (anticipated change in accidents as a result of the Proposed Project in the wider area).

- KK-15 Road AADT is comprised of 20% heavy vehicles and 80% light vehicles (applied to the baseline and future year background traffic flows);[19]
- Expressway AADT is estimated at 13% heavy vehicles and 27% light vehicles;
- Annual growth rates of 5% until airport operation and thereafter a growth of 7% (for both light and heavy vehicles) [20].

This chapter has been prepared independently to any transport assessment work (prepared separately by others for the purposes of permitting or consents). Therefore the scope of this chapter excludes assessment of transport network performance with the Proposed Project and the Expressway in place. Furthermore, the study does not include the road from the KK-15 into Kigali.

8.3.7.2 Construction Phase

In terms of construction traffic impact assessment, the following has been assumed:

- Phase 1 construction traffic will use the existing local road (class two road) to the south of the Airport Area connecting the KK-15 at Nyamata/Kinazi;
- Phase 1 construction traffic will comprise materials such as cement and steel from Kigali utilising the KK-15 Road at Nyamata/Kinazi;
- The existing quarry road will be used for the transportation of aggregate from the quarry to the Airport Area along an existing unpaved road. An existing unsurfaced road will be upgraded and used to shorten the travel distance of an overall one-way trip from approximately 16 km to approximately 10 km;
- Approximately 60 AADT light vehicles currently make use of a portion of the quarry road from Kabukuba and Rilima[20];
- The Expressway will commence construction in 2018 and will be operational in Phase 1 of the Proposed Project;
- Construction traffic for Phases 2-5 will use the quarry road, KK-15 and the Expressway;
- Construction volumes provided are inclusive of the requirements for the airport and Expressway;
- Muck-out, back-fill, removal of tree roots, cement, asphalt, granular backfill and sub-course materials are considered to be internal trips, and therefore will not make use of the quarry road or impact the baseline within the Proposed Project Area;
- There will be approximately 1,800 construction workers at the peak, with no on-site accommodation. Therefore all workers will travel to/from site every day via the KK-15 Road and existing, unsurfaced rural roads, by a fleet of 13 mini-buses, private vehicles[21] and the remaining employees either walking or cycling to the Construction Camp;
- Each of the five phases of construction is estimated to last approximately 36 months. Based on a 20 day working month, this equates to 720 working days per construction phase; and

[19] The African Development Bank Group, 2013: Rwanda Transport Sector, Review and Action Plan Report

[20] Based on Traffic Study and Projections –document (Traffic Study and Projections.docx) which stated that with the average elasticity of 1.15 the traffic should grow at the annual average rate of 7% per year from 2020 forward for all traffic (including HGV). This conservative approach aims at taking into consideration the probabilistic background of the abovementioned correlation and limited timespan (5 years) of the available macroeconomic data in the study.

[21] As per project information provided by BAC: Vehicle Traffic and Clearing.doc and NBIA Campsite Descriptive Memory ED01.pdf), and file: Traffic Study and Projections.doc, p21.

On this basis, this assessment of construction impacts has focused on road-based construction traffic only using Heavy Goods Vehicles (HGVs). These assumptions have been applied to derive estimated AADT and peak hour values for airport construction traffic for the quarry road and Expressway for each scenario/phase.

8.3.7.3 Operation Phase

The operation phase traffic impact assessment is subject to future refinement based on the actual operational flight schedules and the travel market response to private versus public transport mode choices. Although information exists, this may need to be amended following the operation of Phase 1 of the airport. It is advised that this be reassessed in 2025. In terms of the operational traffic impact assessment, the following has been assumed:

- The Expressway comprises the length of road between the KK-15 Road and the Airport Area, and has no other network function apart from as an access road to the airport during Phase 1 airport operation;
- During Phase 1 airport operation, all airport traffic users will make use of the Expressway between the airport and junction with KK-15 Road;
- Forecast airport traffic includes arrivals and departures to the terminal only by road;
- HGV split following operation of Phase 1 will include 13% of AADT on the Expressway and 20% AADT on the KK-15[22];
- Annual passenger (PAX) forecasts include departures from the Airport Area by aircraft;
- The widening of the Expressway (i.e. to four lanes) will occur post Phase 4 operation;
- The Expressway widening scheme is due to be completed prior to operation of Phase 5 of the airport;
- The Expressway scheme excludes KK-15 widening (the KK-15 corridor plan) and any works on the KK-15 will be part of a separate corridor plan; and
- Similar traffic is expected on the road leading from the Expressway junction of the KK-15 to Kigali.

On this basis, this assessment of operational impacts has focussed on road based passenger traffic only using cars, taxis, mini buses, urban buses and coaches, together with heavy vehicles used for servicing and deliveries to the airport.

8.4 Baseline Conditions

Although an on-site survey of existing traffic conditions was not conducted, information contained in the sources listed in Section 8.2.3 has been utilised as baseline information. These data are considered to be similar to the existing baseline conditions and therefore have been utilised for the assessment.

[22] 20% based on the information in Traffic Study and Projections.docx and 13% based on the information from numbers presented in Volume 9 annex of the Feb 2017 version of the Master Plan.

Baseline traffic data for this assessment was obtained through a review of the African Development Bank Group, 2013: Rwanda Transport Sector, Review and Action Plan[23] , and the NBIA Traffic Study and Projections[24]. The Rwanda Transport Sector, Review and Action Plan indicated that roads in Rwanda with the highest traffic volumes of 2,000 to 4,000 per day are RN1 between Kigali, Muhanga and Ruhango and RN3 between Kigali and Rwamagana. Roads that have passenger traffic volumes of 1,000 – 2,000 vehicles per day including those between Kigali, Gicumbi and Rubavu; Rwamagana and Kibungo; Ruhango, Huye and Karongi; and Kayonza and Ryabega.

On this basis, and based on the traffic count made in Rwanda 2015 (NBIA Traffic Study and Projections), the assessment will assume that the AADT for the KK-15 Road at the future junction with the Expressway will be 1,021 vehicles (as baseline). This includes calculated growth rates of 5% per annum until 2020 (African Development Bank Group).

With respect to background traffic growth, the recent report by the African Development Bank Group and based on the NBIA Traffic Study and Projections document, traffic volumes are estimated to grow at the annual average rate of 7% per year following operation of Phase 1 for both light and heavy vehicles.

In summary, the baseline on KK-15 at the junction with the Expressway is defined as follows for the purposes of this assessment:

- 1,021 AADT 2020 baseline;
- 20% heavy vehicles and 80% light vehicles on the KK-15 Road;
- 13% heavy vehicles and 27% light vehicles on the Expressway (following 2020 operation of the Expressway);
- 5% growth per year to all vehicles (light and heavy vehicles) until operation of Phase 1; and
- 7% growth per year from operation of Phase 1.

The data from the above references and sources are considered sufficient for the purposes of this assessment.

The Expressway will have a reserve of 44 m which will be cleared of vegetation and maintained to ensure no shrubs, etc. develop within this reserve as illustrated in Figure 8.2.

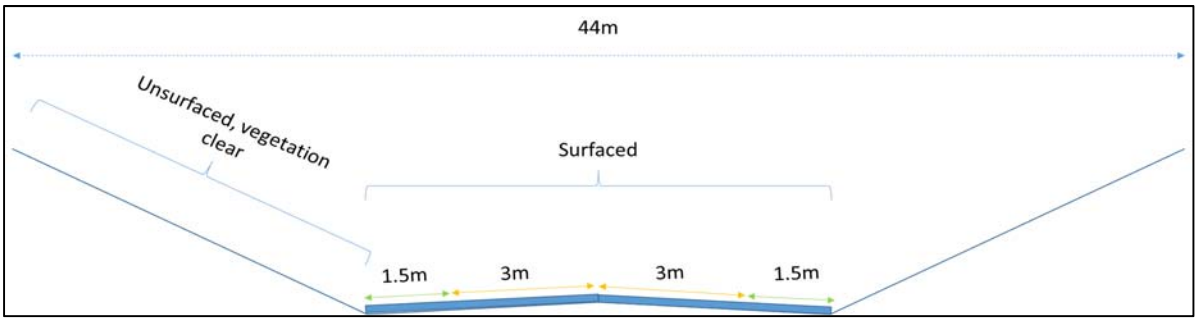

Figure 8-2: Schematic Illustration of the Expressway

Initially, the road will be 3 m in width with an outer shoulder of 1.5 m (either direction). The reserve will be used to lay services such as water lines and communication lines. Stormwater management will also be included in the Expressway construction. This is illustrated in Figure 8.3 (initial route conception) and Figure 8.4 (final future design).

[23] The African Development Bank Group, 2013: Rwanda Transport Sector, Review and Action Plan Report.
[24] Traffic Study and Projections.doc, Provided by NBIA

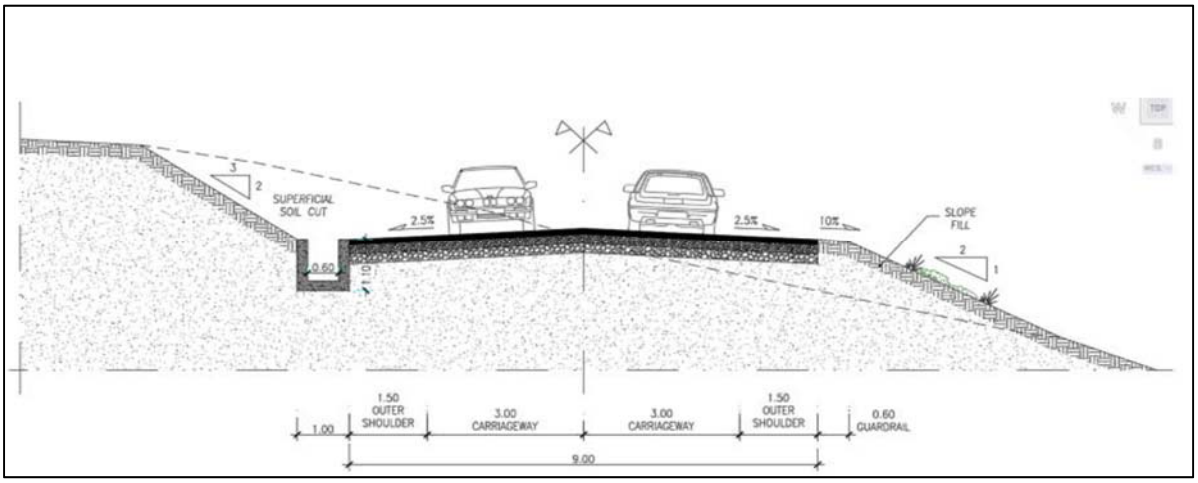

Figure 8-3: Conceptual Schematic Design of Expressway (initial design)

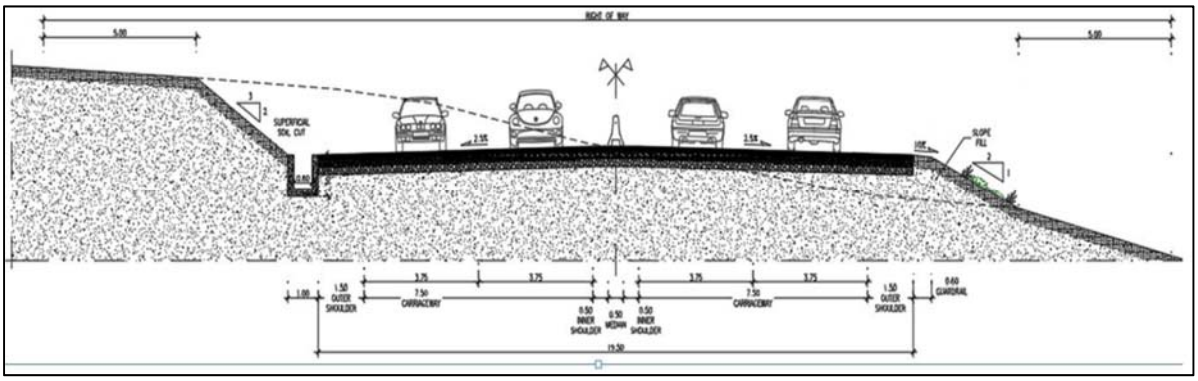

Figure 8-4: Conceptual Schematic Design of the Expressway (final future design)

The above data and assumptions have been applied to give the following estimated background traffic for the Proposed Project Area for the baseline and each scenario/phase. Table 8-5 summarises estimated AADT and Table 8-6 summarises estimated peak hour values for background traffic on the junction of the Expressway and KK-15 Road. The tables represent total AADT (all vehicles) of which 20% are HGV[25] (in brackets).

Current estimates of traffic on the junction of the Expressway and KK-15 Road comprise 1,021 vehicles of which 204 are HGV (2020). Peak hour traffic on the junction of the Expressway and KK-15 are estimated to be 120 vehicles, of which 24 are HGV.

Table 8-5: Estimated Background AADT at the Junction of the Expressway and the KK-15 for Each Scenario/Phase

AADT (of which heavy vehicles)	2020 (Baseline)	2020 (Phase 1)	2030 (Phase 2)	2035 (Phase 3)	2040 (Phase 4)	2045 (Phase 5)
Junction of KK-15 and Expressway AADT (HGV)	1,021 (204)	1,276 (255)	3,243 (649)	4,035 (807)	5,146 (1,029)	6,704 (1,341)

[25] Based on HGV volumes in Airport Company Vienne, Master Plan for the New Bugesera International Airport, 2017, volume 9.

Table 8-6: Estimated Background Peak Hour Values at the Junction of the Expressway and the KK-15 for Each Scenario/Phase

Peak hour traffic	2010 (Baseline)	2020 (Phase 1)	2030 (Phase 2)	2035 (Phase 3)	2040 (Phase 4)	2045 (Phase 5)
Junction of KK-15 and Expressway Peak Hour Traffic (HGV)	120 (24)	153 (31)	389 (78)	484 (97)	618 (124)	804 (161)

Sensitive Receptors

The Airport Area and Expressway are surrounded by rural land, subsistence farming practices and a scattering of small settlements, connected by a network of tracks and minor roads. The existing settlements contain dwellings, schools, places of worship and health centres, which are considered sensitive in terms of traffic and transport impacts.

8.5 Potential Impacts

The Proposed Project will comprise a single runway and associated passenger terminals, freight handling, aviation services and maintenance together with landside parking, interchange and the Expressway. From a landside access perspective, the Proposed Project can be separated between:

- Landside (within the Airport Area): terminal forecourt, parking (staff, passengers/customers), public transport modes (express coaches, urban buses, taxis), ancillary services, emergency facilities;
- Traffic impacts associated with transportation activities on the quarry road; and
- Landside (outside the Airport Footprint but still within the Proposed Project Area): the Expressway to the junction of the KK-15 Road.

Traffic to and from the quarry and the landside access outside the Airport Area (but within the Proposed Project Area) is the focus of this assessment.

8.5.1 Construction Phase Impacts

Construction traffic impacts relate to off-site access, not movements within the Airport Area. During construction, the following activities have the potential to generate transport and traffic impacts relating to severance, driver delay, transport user safety and amenity in relation to the following:

- Additional heavy vehicle trips on the road network including the KK-15 and the road to the Airport Area from Nyamata;
- Temporary and permanent closure of pedestrian footways; and
- Travel to/from the Construction Camp by construction workers.

Impacts such as noise, dust and vehicle emissions are also likely. However, these have been assessed in Chapter 10: Noise and Vibration and Chapter 11: Air Quality.

8.5.1.1 Design Controls

The design of the Expressway will take cognisance of safety aspects such as traffic lights, stop signs, speed humps, traffic calming zones, street lights, etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP.

The quarry road will be shortened with the upgrade of an existing link to the road, which will result in shorter distances travelled and will alleviate transport through the centre of the Kabukuba Village and in the minimisation of potential accidents to the surrounding community and cattle.

8.5.1.2 Impact Assessment Prior to Mitigation

Construction is programmed to occur in five phases. With respect to construction, the volumes summarised in Table 8-7 have been estimated and based on information provided by BAC to be transported for the Proposed Project.

Table 8-7: 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
Aggregate	tonnes	234,281	17,423	39,028	16,988	12,719
Cement/steel	tonnes	49,322	3,668	8,216	3,576	2,678

Based on typical HGV specifications provided by BAC, the following payloads per HGV are estimated per vehicle:

- 13.5 m^3 of backfill material;
- 27 tonnes of asphalt;
- 6.1 m^3 of concrete;
- 27 tonnes of aggregate; and
- 27.6 tonnes of cement/steel.

Note that materials such as cement, asphalt, granular backfill and sub-course materials are considered to be internal trips, and therefore will not make use of the quarry road or impact the baseline within the Proposed Project Area.

This equates to the estimates presented in Table 8-8 of total two-way HGV movements from the Proposed Project (each load requires two vehicle movements, of which one is loaded). This includes the estimated volume of materials being transported from Kigali (i.e. steel and cement) that will make use of the KK-15 Road and Nyamata road during Phase 1 construction. Thereafter, the Expressway will be used to transport these materials for construction of Phases 2 – 5.

Table 8-8: Estimated Two-Way HGV Construction Movements per Phase

Activity	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Granular Backfill	42,249	1,928	2,647	4,614	2,194
Sub-course	69,382	3,641	5,173	8,528	3,693
Aggregate	17,354	1,291	2,891	1,258	942
Cement/steel	3,574	266	595	259	194

Each of the five phases of construction is estimated to last approximately 36 months. Based on a 20-day working month, this equates to 720 working days per construction phase. This gives the estimated average number of loaded trucks or truck movements between the quarry and the Proposed Project Area per working day and peak hour, based on a typical 10-hour working day presented in Table 8-9. The peak hour value for construction traffic is based on a constant flow over a typical 10-hour day.

Table 8-9: Estimated Average Day and Peak Hour Two-Way HGV Construction Movements (Airport Area and Quarry Road)

Activity	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Airport Area (internal movements)					
Granular Backfill	118 (12)	6 (1)	8 (1)	12 (1)	6 (1)
Sub-course	192 (19)	10 (1)	14 (1)	24 (2)	10 (1)
Quarry Road (external movements)					
Aggregate	48 (4)	4 (0)	8 (1)	4 (0)	2 (0)

Table 8-9 illustrates the anticipated construction traffic volume on the KK-15 and Nyamata road during Phase 1 construction, and traffic volume on the Expressway for the construction of Phases 2 – 5.

Table 8-10: Estimated Average Day and Peak Hour Two-Way HGV Construction Movements (KK-15 Road and Expressway)

Activity	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5
Cement/ steel	5 (1)	0 (0)	1 (0)	0 (0)	0 (0)
Note: Phase 1 construction will make use of the KK-15 and Nyamata road whereas construction for Phases 2 – 5 will make use of the Expressway.					

These estimated construction HGV traffic flows have been applied to the baseline to identify the level of impact, relating to severance, driver delay, transport user safety and amenity.

Table 8-11 and Table 8-11 consider data from Table 8-5 and Table 8-6 to estimate the anticipated changes to the peak hour flows as a result of the addition of construction vehicles to baseline/previous phase flows. All flows are average weekday peak hour two-way.

The percentage change shown in Table 8-11 and Table 8-11 illustrates the impact of construction traffic per activity compared to non-construction traffic at each phase on the quarry road and Expressway. It is noted that the percentage change is generally low per activity. This is in response to relatively high airport operations or background flow against a modest construction flow volumes.

Table 8-11: Estimated Change in Two-Way Traffic Flows with Construction Traffic on the Quarry Road

Activity	Phase 1 Works (Construction traffic Phase 1)		Phase 2 Works (Construction traffic Phase 2)		Phase 3 Works (Construction traffic Phase 3)		Phase 4 Works (Construction traffic Phase 4)		Phase 5 Works (Construction traffic Phase 5)	
	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change
AADT HGV	48	100%	4	0.08%	8	50%	4	0.50%	2	0.50%
AADT light vehicles	4	6.67%	4	6.67%	4	6.67%	4	6.67%	4	6.67%

The above calculations consider the following:

- No. of vehicles = construction (for Quarry Road); and
- % change = construction as a percentage of the number of vehicles;
- Existing AADT light vehicles utilising portions of the quarry road are estimated at 60; however, are not considered construction vehicles;
- Construction light vehicle AADT have been considered as 4 per 10-hour day, which will not impact on quarry road peak hour traffic.

Table 8-12: Estimated Change in Two-Way Traffic Flows with Construction Traffic at the KK-15 Road

Activity	Phase 1 Works (Construction traffic on existing road network Phase 1 + background)		Phase 2 Works (Traffic on KK-15 Road during Phase 2 Construction)		Phase 3 Works (Traffic on KK-15 Road during Phase 3 Construction)		Phase 4 Works (Traffic on KK-15 Road during Phase 4 Construction)		Phase 5 Works (Traffic on KK-15 Road during Phase 5 Construction)	
	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change
AADT HGV	209	2.39%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
AADT Light Vehicles	1,022	0.1%	0	0.00%	0	0.00%	0	0.00%	0	0.00%

The above calculations consider the following:

No. of vehicles = background + construction (for the KK-15 Road);

AADT HGV is calculated at 204 and 1,021 light vehicle on KK-15 Road (background);

Table 8-12: Estimated Change in Two-Way Traffic Flows with Construction Traffic at the KK-15 Road

Construction HGV utilising the KK-15 Road during Phase 1 construction activities is 5 AADT;

Construction light vehicles utilising the KK-15 Road during Phase 1 construction activities is 10 AADT; and

% change =construction as a percentage of the number of vehicles.

Table 8-13: Estimated Change in Two-Way Traffic Flows with Construction Traffic at the Expressway

Activity	Phase 1 Works (Construction traffic on existing road network Phase 1 + background)		Phase 2 Works (Traffic on Expressway during Phase 2 Construction + Phase 1 Operation)		Phase 3 Works (Traffic on Expressway during Phase 3 Construction + Phase 2 Operation)		Phase 4 Works (Traffic on Expressway during Phase 4 Construction + Phase 3 Operation)		Phase 5 Works (Traffic on Expressway during Phase 5 Construction + Phase 4 Operation)	
	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change	No. of Vehicles	% Change
AADT HGV	-	-	606	0%	1,295	0%	1,755	0.001%	2,302	0%
AADT Light Vehicles	-	-	4,671	0.01%	9,971	0.01%	13,505	0.01%	17,706	0.01%

The above calculations consider the following:

No. of vehicles = background + construction + operation (for the Expressway);

Construction light vehicles utilising the Expressway during construction activities is 10; and

% change =construction as a percentage of the number of vehicles.

Severance

The above estimates suggest that for Phase 1, with these construction flows, the severance effect along KK-15 and quarry road varies depending on the phase and activities being considered (i.e. Phase 1 compared to Phase 3 for instance). The Expressway will be used to transport HGV during the construction of Phase 2 operations; however, the quarry road will be used as the primary route for all construction activities (obtaining aggregate). The change of flow due to construction varies between over 90% and less than 30%, giving a range of magnitude of impact, however the highest construction flow in the peak hour is comprised of HGV vehicles from the quarry and the airport.

As the quarry road is existing, the impact of construction phase vehicles on the quarry road is considered to have a **Minor Adverse** effect, based on high receptor sensitivity and very low magnitude.

The total estimated construction flows for Phases 3, 4 and 5 are lower than Phases 1 and 2 and generally (except for the staff flows) construction traffic is low compared to the background traffic which is inclusive of operational airport traffic flows forecast on junction of the Expressway and KK-15 Road. Therefore the severance effect of construction traffic across all phases is considered overall to be a **Minor Adverse** significance, based on a high receptor sensitivity and very low magnitude of impact.

Driver Delay

As per estimated baseline flows for 2020, the local state road network at the junction between KK-15 and the Expressway is considered to operate within capacity (based on a theoretical lane capacity of 1,500 vehicles per hour), in response to the flows of 120 vehicles in the peak hour reported.

The total estimated construction flows for Phases 3, 4 and 5 are considered to be lower than for Phase 1 and 2. Generally, construction traffic will be lower compared to background traffic together with operational airport traffic flows forecast on the junction of the Expressway and KK-15 Road. Therefore the driver delay effect of construction traffic across all phases is considered overall to be of **Negligible** significance, based on a low receptor sensitivity and low magnitude of impact.

Additional construction vehicles will occur during the construction phases of the Proposed Project which will result in an increase in the volume of traffic on the quarry road. The quarry road is considered a class two road and therefore can accommodate the increased vehicle traffic associated with the construction phase activities. Although receptor sensitivity is anticipated to be high, the magnitude of the impact is considered very low resulting in a **Minor Adverse** impact on driver delay.

Safety of Transport Users

With increased traffic flow, it is expected that there will be a rise in numbers, and potentially severity of accidents; although there is no known set rate change to reference. Cognisance must be taken on the safety for transport users making use of, or seeking to cross at-grade, the KK-15 Road during peak period of Phase 1 construction, or seeking to cross at-grade the Expressway during the Phase 2 – 5 periods of construction. This will result in a potential change in road fatality rates per 100,000 inhabitants.

The total estimated construction flows for Phases 3, 4 and 5 are lower than for Phases 1 and 2, and generally, construction traffic is low compared to the background traffic along the KK-15 Road and Nyamata road. Similarly, estimated construction flows on the quarry road will be highest during Phase 1 construction; however, potential to road fatality rates will remain. Therefore, the likely change in road fatality rates per 100,000 inhabitants resulting from the estimated construction phase traffic is considered to be **Minor Adverse**. This is based on a low magnitude of impact (of change in accident rate) and high receptor sensitivity.

Amenity for Transport Users

Amenity will vary depending on mode of use, trip purpose, time of travel and route considered. Based on the peak period during construction, the focus of amenity is on local trips which is not included with airport construction. Owing to the volume of construction traffic flow across all project phases, it is expected that the impact on amenity for transport users utilising, or seeking to cross at-grade the quarry road, the KK-15 Road, and from 2025 at the Expressway, in the peak periods, is of **Minor Adverse** significance considering a low magnitude of impact and high receptor sensitivity.

8.5.2 Operation Phase Impacts Prior to Mitigation

Operation phase traffic impacts relate to off-site access, as opposed to movements within the Airport Area. During operation, the following activities have the potential to generate transport and traffic impacts relating to amenity, severance, driver delay and transport user safety:

- Additional traffic comprising heavy and light vehicle trips on the road network; and
- Permanent closure and relocation of pedestrian paths and footways.

Impacts such as noise, dust and vehicle emissions have been assessed in Chapter 10: Noise and Vibration and Chapter 11: Air Quality. Note that no additional impacts are anticipated on the quarry road as all vehicle movements are included and considered in the construction phase.

8.5.2.1 Design Controls

The design of the Expressway will take cognisance of safety aspects such as traffic lights, stop signs, speed humps, traffic calming zones, street lights, etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP. Regular maintenance to the Expressway will be conducted during operation of the airport. Furthermore, an Airport Traffic Management Plan will be developed to manage traffic and vehicles within the Airport Area.

8.5.2.2 Impact Assessment Prior to Mitigation

Table 8-14 shows the estimated peak hour flows resulting from background traffic on the existing KK-15 Road (baseline + traffic growth), and road traffic forecast at different future airport operation phases. The KK-15 Road is used as a baseline standard as the Expressway has yet to be constructed. Background and operation forecasts are introduced at this point as comparators against which to assess the impact of construction traffic (i.e. baseline versus construction flow volumes).

Table 8-14: Estimated Total Vehicles during Normal Airport Operations (Peak Hour, Two-Way)

Assessment Period / Year	Background Traffic (Baseline + Growth on Expressway junction with the KK-15 Road)	Operation Phase Airport Traffic Forecast on Expressway	Total Traffic on Expressway junction with KK-15 (Airport + Background)
Prior to 2020 (baseline)	120	n/a*	120
2020 Phase 1	153	559	712
2030 Phase 2	389	1,195	1,584
2035 Phase 3	484	1,619	2,103
2040 Phase 4	618	2,125	2,743
2045 Phase 5	804	2,708	3,512

* There will be no Expressway traffic in 2020 as this is considered baseline conditions and the Expressway will still be in the construction phase.

The operation forecasts are assumed to be cumulative (i.e. the 2035 figure is the total forecast and are not to be added from the 2030 figure to 2035 volume). Growth in background traffic from the baseline is assumed to be in accordance with the assumptions stated previously.

The following tables outline the estimated traffic during airport operation associated with the Expressway for each phase. Table 8-15 summarises AADT and Table 8-16 summarises estimated peak hour values for airport operation phase traffic on the Expressway. The traffic volumes consider AADT of all vehicles, of which HGV is illustrated in brackets.

Table 8-15: Estimated Airport Operations AADT for the Expressway per Phase

AADT of Vehicles (of which 13% of HGV)	2020 (Phase 1)	2030 (Phase 2)	2035 (Phase 3)	2040 (Phase 4)	2045 (Phase 5)
Expressway Traffic	4,661 (606)	9,961 (1,295)	13,495 (1,754)	17,706 (2,302)	22,563 (2,933)

Table 8-16: Estimated Airport Operations Peak Hour Values for the Expressway per Phase

AADT of Vehicles (of which 13% of HGV)	2020 (Phase 1)	2030 (Phase 2)	2035 (Phase 3)	2040 (Phase 4)	2045 (Phase 5)
Expressway Traffic	559 (73)	1,195 (155)	1,669 (276)	2,125 (276)	2,708 (352)

On the basis of the tables above, the following topics of severance, driver delay, safety of transport users and amenity for transport users were selected as relevant to landside access to airport operations.

Table 8-17 indicates the estimated changes in peak hour flows, between the baseline (2020) and various operation phases on the junction between the KK-15 and the Expressway. The baseline network flow is based on an estimated road traffic mode split as presented by the Proposed Project developer volumes (Appendix 8.1).

Table 8-17: Estimated Change in Traffic Flow during Operation (Peak Hour Two-way)

Assessment per Phase	Total Traffic on Expressway (Airport Traffic only)	Percent Change	Total Traffic in KK-15 Road (Background and Airport operation)	Percent Change
2020 Prior to Baseline	–	–	120	–
2020 Phase 1	559	–	712	465 %
2030 Phase 2	1,195	214 %	1,584	222 %
2035 Phase 3	1,619	24 %	2,103	33 %
2040 Phase 4	2,125	31 %	2,743	30 %
2045 Phase 5	2,708	27 %	3,512	28 %

Severance

Based on the vehicle movements estimated above, the effect on severance during operation Phases 1 and 2 on the junction of the KK-15 and the Expressway will be of **Major Adverse** significance, based on a high magnitude of impact and high receptor sensitivity.

The forecast for subsequent operation phases are significantly lower and therefore the impact of severance on Phases 3 to 5 is of **Moderate Adverse** significance based on a low magnitude of impact and high receptor sensitivity.

On this basis it is considered that the severance effect from the Expressway overall during operation will be of **Moderate to Major Adverse** significance in response to the scale of change in traffic flow forecast in peak hour.

Driver Delay

As per estimated baseline flows for 2020, the local state road network at the junction between KK-15 and the Expressway is considered to operate within capacity (based on a theoretical lane capacity of 1,500 vehicles per hour), which includes the 2020 baseline flows of 120 vehicles in the peak hour reported.

The increase in vehicle movements during Phases 1 to 4 will be within the theoretical capacity until Phase 5 when this capacity is exceeded. Therefore, impact on driver delay for drivers on, or seeking to cross at-grade, the Expressway in the peak periods during airport operation is of **Moderate Adverse** significance, based on a high magnitude of impact and low receptor sensitivity, in Phase 1.

During Phases 2 to 4, forecast changes in operational flows are to increase by 2.3% annually, but the scale of change will be noticeable. This is expected to be of **Minor Adverse** significance based on a medium magnitude of impact and low receptor sensitivity.

Phase 5 would likely see delay in the peak hour flow as demand exceeds theoretical capacity leading to increased driver delay. This is expected to be of **Moderate Adverse** significance based on a high magnitude of impact and low receptor sensitivity.

On this basis, it is considered that the effect on driver delay on the junction of the KK-15 Road and Expressway, as well as on the Expressway, overall during operation, will be of **Minor to Moderate Adverse** significance in response to the scale of change in traffic flow forecast in peak hour.

Safety of Transport Users

Increased traffic will result in an increase of vehicles on the roads (Expressway, KK-15 Road and surrounding transport routes) and ultimately, an increase of severity of accidents.

The change in traffic flows during operation is greatest in Phases 1 and 2 but will continue to be noticeable in the subsequent phases, compared to the background traffic on KK-15 or the new flows on the Expressway. Therefore, with likely changes in road fatalities per 100,000 inhabitants associated increased traffic volumes, the impact on the safety of transport users is considered to be **Moderate Adverse**. This is based on low magnitude of impact (of change in accident rate) and a high receptor sensitivity.

Amenity for Transport Users

Amenity will vary depending on mode of travel, trip purpose, time of travel and route taken.

Traffic flows will increase the greatest during Phases 1 and 2 on the Expressway, with Phase 5 estimated to be at capacity. The significance of impact on amenity for operational phase transport users, either using or seeking to cross at-grade the junction of the KK-15 Road and Expressway during peak periods, is considered to be **Moderate Adverse**, based on a low magnitude of impact and high receptor sensitivity.

During Phases 3 to 4, the change in forecast traffic flow is less than Phases 1 and 2. Therefore the significance of impact on the amenity for transport users is considered to be **Minor Adverse** based on a low magnitude of impact and high receptor sensitivity.

Therefore, the effect on transport users on the Expressway and junction to the KK-15 Road during operation phases is considered to be **Minor to Moderate Adverse** impact based on the scale of change in traffic flow forecast during peak hour.

8.6 Mitigation Measures

8.6.1 Construction Phase

Based on an understanding of project data and good practices, it is noted that construction staff vehicles are the primary contribution within the forecast total construction traffic flow in peak hours, across all phases of construction. In terms of effective mitigation, contractors must provide staff shuttles at specific locations surrounding the Proposed Project Area. Transport and vehicle traffic awareness must be provided to all contractors and staff to minimise potential accidents associated with construction activities.

In response to the identified construction impacts, the Proposed Project will incorporate the following construction techniques or measures:

- Consolidate loads to reduce empty trailer movements where possible;
- Reduce construction worker travel impact by managing non-car access options, e.g. worker shuttles;
- Prepare a detailed Construction Traffic Management Plan detailing the specific number and routeing of vehicles to and from the Construction Camp;
- Ensure all vehicles are maintained regularly and are road worthy; and

- Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads.

8.6.2 Operation Phase

Mitigation measures to be implemented during the operation phase to prevent, minimise, and control transport and traffic impacts will include:

- A plan to monitor the Expressway structures and infrastructure such as paved surfaces, drainage systems, signs, guardrails, footpaths, embankments and other right-of-way features must be developed and implemented; and
- Ensure that all non-road worthy airport vehicles (i.e. transport shuttles, refuelers, container loaders, tugs and tractors, etc.) do not make use of public roadways.

Other specific mitigation measures include the following:

Severance

- Suitably designed pedestrian, vehicle and animal crossing points will be developed at regular intervals along the Expressway;
- Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads; and
- Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders for pedestrians and non-motorised transportation.

Driver Delay

- The identified impact on driver delay during airport operations will be mitigated through infrastructure upgrades in terms of junction design at the intersection between the Expressway and KK-15. Infrastructure upgrades must be identified when finalising the Expressway design and implemented in specific locations;
- Shuttles will be employed from the airport to Kigali to reduce traffic congestion.

Transport User Safety

- The impact on transport user safety of increased traffic flows is balanced by the new Expressway designed to carry the increased flows safely, efficiently and in accordance with airport access expectations.
- Monitor Expressway use and safety to identify the need for improvements to paved surfaces, drainage systems, signs, guardrails, footpaths, embankments and other right-of-way features.

Amenity

- Through quality of design of the new junction with KK-15 and crossing points, signage and traffic controls on the Expressway, this will produce an amiable travelling environment for motorists; and
- Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders of the Expressway.

8.7 Residual Impact Assessment Conclusions

8.7.1 Construction Phase Residual Impacts

The above construction phase assessment identified a range of negligible to minor adverse impacts, with minor impact significance identified for severance, safety and amenity. Considering the implementation of the design controls and mitigation measures, the following residual impacts are expected to occur:

Regarding severance; reducing the number of construction staff vehicles will assist in reducing the magnitude of construction traffic to very low, with high receptor sensitivity resulting in a **Minor Adverse** impact significance.

As stated above, the driver delay effect of construction traffic across all phases is considered overall to be of **Negligible** significance, based on a low receptor sensitivity and low magnitude of impact.

Reducing construction vehicle flows within the Proposed Project Area will be insufficient to reduce the overall fatality rate per 100,000 inhabitants; however, erecting visual signage of hazardous construction activities will create awareness for vehicle users and pedestrians, thereby reducing the magnitude of impact (scale change in accident rate, resulting in low magnitude) against high sensitivity receptors to give a **Minor Adverse** impact significance.

In terms of amenity, reducing the number of construction vehicle flows will minimise the magnitude of the impact of construction traffic within the Proposed Project Area resulting in **Minor Adverse** impact significance.

8.7.2 Operation Phase Residual Impacts

Operation phase activities identified a number of severance, traffic safety, driver delay and amenity impacts for the Proposed Project ranging from Major Adverse to Minor Adverse as a result of the magnitude of the impact and sensitivity of the receptor.

Severance resulting from the Proposed Project can be mitigated through design controls and management commitments contained in the Construction Traffic Management Plan, developing and implementing pedestrian, vehicle and animal crossing points along the Expressway, and ensuring that adequate maintenance of these crossings is conducted. Although receptor sensitivity will remain, the magnitude of the impact can be considered as very low.

Therefore, severance from Phase 1 operation activities can be deemed as **Minor Adverse** impact. Similarly, severance associated with Phases 2 – 5 operation activities can also be defined as having **Minor Adverse** impacts within the Proposed Project Area.

It is understood that traffic will increase within the Proposed Project Area as a result of the operation of the airport; however, upgrades to the Expressway and junction of the KK-15 Road will result in the capacity increase of the routes to accommodate additional traffic volumes/flows. Additionally, providing shuttles from Kigali to the airport will minimise the volume of private vehicles utilising the Expressway. These will lower the magnitude of traffic resulting in a **Minor Adverse** impact significance on driver delay.

Similarly, the upgrades to access routes such as the Expressway as well as the implementation of a monitoring programme to assess safety aspects along the Expressway will result in ability to reduce the accident rate and minimise the magnitude of an accident thereby resulting in a **Minor Adverse** transport safety impact.

The significance of impact on amenity for transport users during operational Phases 1 and 2, either using or seeking to cross at-grade and Expressway during peak periods, was considered to be **Moderate Adverse**. During Phases 2 to 4, the change in forecast traffic flow is less than Phases 1 and 2 and therefore the impact was considered to be **Minor Adverse**. Maintaining crossing signals, slow traffic lanes and paved shoulders of the Expressway will lower the residual magnitude resulting in a **Minor Adverse** amenity impact.

8.8 Summary of Mitigation and Residual Impacts

8.8.1 Summary of Findings

Table 8-18 provides a summary of the impacts and mitigation measures associated with traffic and transport during the construction and operation of the Proposed Project. When taking account of incorporated mitigation measures, there is an overall Minor Adverse impact significance during construction and operation for identified impact scenarios. With the implementation of further recommended mitigation the overall residual impact significance remains **Minor Adverse.**

Table 8-18: Summary of Traffic and Transport Impact Assessment

Impact	Receptor	Phase	Impact Magnitude	Receptor Sensitivity	Pre-Mitigation Impact Significance	Design Enhancement or Mitigation Measures	Management Plan	Residual Significance
Severance	Local community, vulnerable road users	Construction	**Impact Magnitude:** Very Low **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Short Term **Frequency:** Week days **Reversibility:** Reversible	High	**Minor Adverse**	• The design of the Expressway will take cognisance of safety aspects such as traffic lights, stop signs, speed humps, traffic calming zones, street lights, etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP; • The quarry road will be shortened with the upgrade of an existing link to the road, which will result in shorter	• Construction Traffic Management Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

						distances travelled and will alleviate transport through the centre of the Kabukuba Village and in the minimisation of potential accidents to the surrounding community and cattle; • Ensure all vehicles are maintained regularly and are road worthy; and • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads.		

Table 8-18: Summary of Traffic and Transport Impact Assessment

Driver Delay	Local community, road users on KK-15 and Expressway	Construction	**Impact Magnitude:** Low **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Short Term **Frequency:** Week days **Reversibility:** Reversible	Low	**Negligible to Minor Adverse**	• The design of the Expressway will take cognisance of safety aspects such as traffic lights, stop signs, speed humps, traffic calming zones, street lights, etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP; • The quarry road will be shortened with the upgrade of an existing link to the road, which will result in shorter distances travelled and will alleviate transport through the centre of the Kabukuba	• Construction Traffic Management Plan	**Negligible**

Table 8-18: Summary of Traffic and Transport Impact Assessment

						Village and in the minimisation of potential accidents to the surrounding community and cattle; • Ensure all vehicles are maintained regularly and are road worthy; and • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads.		
Transport User Safety	Local community, road users on KK-15, and Expressway	Construction	**Impact Magnitude:** Low **Nature:** Adverse **Type:** Direct	High	**Minor Adverse**	• The design of the Expressway will take cognisance of safety aspects such as traffic	• Construction Traffic Management Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

			Extent/Scale: Local **Duration:** Short Term **Frequency:** Week days **Reversibility:** Reversible			lights, stop signs, speed humps, traffic calming zones, street lights, etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP; • The quarry road will be shortened with the upgrade of an existing link to the road, which will result in shorter distances travelled and will alleviate transport through the centre of the Kabukuba Village and in the minimisation of potential accidents to		

Table 8-18: Summary of Traffic and Transport Impact Assessment

						the surrounding community and cattle; • Ensure all vehicles are maintained regularly and are road worthy; and • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads.		
Transport User Amenity	Local community, road users on KK-15 and Expressway	Construction	**Impact Magnitude:** Low **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Short Term	High	**Minor Adverse**	• The design of the Expressway will take cognisance of safety aspects such as traffic lights, stop signs, speed humps, traffic calming zones, street lights,	• Construction Traffic Management Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

			Frequency: Week days **Reversibility:** Reversible			etc. The Expressway design will be developed and approved by engineers as per Rwanda requirements and GIIP; • The quarry road will be shortened with the upgrade of an existing link to the road, which will result in shorter distances travelled and will alleviate transport through the centre of the Kabukuba Village and in the minimisation of potential accidents to the surrounding community and cattle;		

Table 8-18: Summary of Traffic and Transport Impact Assessment

						• Ensure all vehicles are maintained regularly and are road worthy; • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads;		
Severance	Local community, vulnerable road users	Operation	**Impact Magnitude:** Low to High **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Long Term **Frequency:** Daily	High	**Moderate to Major Adverse**	• Ensure that all non-road worthy airport vehicles do not make use of public roadways; • Suitably designed pedestrian, vehicle and animal crossing points must be developed at regular	• Airport Traffic Management Plan • Expressway Maintenance Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

			Reversibility: Reversible			intervals along the Expressway; • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads; and • Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders for pedestrians and non-motored transportation.		
Driver Delay	Local community, road users on KK-15 and Expressway	Operation	**Impact Magnitude:** Medium to High **Nature:** Adverse **Type:**	Low	**Minor to Moderate Adverse**	• Ensure that all non-road worthy airport vehicles do not make use of public roadways;	• Airport Traffic Management Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

			Direct **Extent/Scale:** Local **Duration:** Long Term **Frequency:** Daily **Reversibility:** Reversible			• Suitably designed pedestrian, vehicle and animal crossing points must be developed at regular intervals along the Expressway; • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads; • Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders for pedestrians and non-	• Expressway Maintenance Plan	

Table 8-18: Summary of Traffic and Transport Impact Assessment

						motored transportation; and • Shuttles will be employed from the airport to Kigali.		
Transport User Safety	Local community, road users on KK-15 and Expressway	Operation	**Impact Magnitude:** Low **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Long Term **Frequency:** Daily **Reversibility:** Reversible	High	**Moderate Adverse**	• Ensure that all non-road worthy airport vehicles do not make use of public roadways; • Suitably designed pedestrian, vehicle and animal crossing points must be developed at regular intervals along the Expressway; • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by	• Airport Traffic Management Plan • Expressway Maintenance Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

						construction interference with existing roads; and • Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders for pedestrians and non-motored transportation.		
Transport User Amenity	Local community, road users on KK-15 and Expressway	Operation	**Impact Magnitude:** Low **Nature:** Adverse **Type:** Direct **Extent/Scale:** Local **Duration:** Long Term **Frequency:** Daily **Reversibility:** Reversible	High	**Minor to Moderate Adverse**	• Ensure that all non-road worthy airport vehicles do not make use of public roadways; • Suitably designed pedestrian, vehicle and animal crossing points must be developed at regular intervals along	• Airport Traffic Management Plan • Expressway Maintenance Plan	**Minor Adverse**

Table 8-18: Summary of Traffic and Transport Impact Assessment

						the Expressway; • Signs and lights are to be provided to warn motorists of hazardous driving conditions created by construction interference with existing roads; and • Provide adequate maintenance of crossing signals, slow traffic lanes and paved shoulders for pedestrians and non-motored transportation.		