Intended for

**Bugesera Airport Company Limited**

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**UK11-24483**

# NEW BUGESERA INTERNATIONAL AIRPORT

# ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT REPORT- GEOLOGY AND SOILS

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# 13. GEOLOGY AND SOILS

## 13.1 Introduction

This chapter of the ESIA Report considers the potential impacts of the Proposed Project on geology and soils. It predicts and evaluates the potential impacts of the Proposed Project and the associated likely impacts on geology and soils, arising from the construction works and operation of the completed Proposed Project.

## 13.2 Policy, Legal and Administrative Framework

### 13.2.1 Rwandan Policy

Rwandan policy specific to geology and soil is summarised within this section.

#### *13.2.1.1 The Rwanda Environmental Policy, 2003*

The Rwanda Environmental Policy (2003)[1] sets out the objectives and principles of the National Environment Policy. Most specifically, in relation to geology and soils a key objective is *"to conserve, preserve and restore ecosystems and maintain ecological and systems functioning, which are life supports, particularly the conservation of national biological diversity"*.

The National Environmental Policy does not include specific published standards or targets with regards to soil quality. However, the Proposed Project must take cognisance of the National Environmental Policy and ensure that improved development and wellbeing of the citizens of Rwanda are considered, while including environmental aspects in the decision-making process.

### 13.2.2 Legal Framework

#### *13.2.2.1 Organic Law Determining the Modalities of Protection, Conservation and Promotion of Environment in Rwanda, April 8 2005: No. 04/2005*[2]

The Organic Law No. 04/2005 ('Organic Law') governs the environment in the broadest sense of the term. The environment is defined in the Organic Law as 'natural environment' and 'human environment'. The natural environment includes soil and subsoil, water, air, biodiversity, landscape and areas of tourist/heritage significance. The human environment is split into human activities considered to be 'destructive' or non-destructive'. Destructive activities are those that create a negative effect on the environment (such as pollution of installation of a building or structure that destroys the natural environment. Non-destructive activities defined as *'aimed at enriching and reducing the adverse effects on the environment'* and examples include afforestation and adoption of technology that reduces human effect on the environment.

Soil is defined in the Organic Law as *"the surface land that hosts living things including plants, animals and people, buildings and resources that exist underground".* Pollutants, waste, hazardous waste, and pollution is specified as potentially destructive to the environment.

When considering potential impacts, the Organic Law requires that prevention is prioritised ahead of rehabilitation.

Article 11 to 14 of the Organic Law relates to soil and subsoil and promotes preservation through sustainable measures. It is specified that soil and subsoil constitute natural resources that are to be preserved from degradation. Article 81 prohibits damaging the quality of air, the surface or underground water and the Organic Law calls for careful consideration of soil materials

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

[2] Government of Rwanda,2005. Organic Law Determining the Modalities of Protection, Conservation and Promotion of Environment in Rwanda, April 8 2005 No: 04/2005.

management to avoid unnecessary degradation of soil as a resource. It is considered that this implies the need for documented procedures for activities such as soil transport, stockpiling and re-use of soil materials within a particular development project.

### 13.2.3 International Standards

#### *13.2.3.1 IFC General Environmental, Health and Safety (EHS) Guidelines*

<u>Contaminated Land</u>

In the absence of specific national guidance on contaminated land, this ESIA Report has been carried out in accordance with standards and guidelines for international financing. The relevant international guidelines for this assessment are the IFC General Environmental, Health and Safety (EHS) Guidelines[3] and the IFC EHS Guidelines – Airports[4]).

Section 1.8 of the IFC EHS Guidelines relates specifically to contaminated land and includes a summary of management approaches for land contamination due to anthropogenic releases of hazardous materials, wastes, or oil, including naturally occurring substances. The guidance states that *"releases of such materials may be the result of historic or current site activities, including, but not limited to, accidents during their handling and storage, or due to their poor management or disposal"*. In addition, the guidance specifies that:

- *"Contamination of land should be avoided by preventing or controlling the release of hazardous materials, hazardous wastes, or oil to the environment"*;
- *"When contamination of land is suspected or confirmed during any project phase, the cause of the uncontrolled release should be identified and corrected to avoid further releases and associated adverse impacts"*;
- *"Contaminated land should be managed to avoid the risk to human health and ecological receptors"*; and
- *"The preferred strategy for land decontamination is to reduce the level of contamination at the site while preventing the human exposure to contamination"*.

In order for risk management actions to be warranted, Section 1.8 of the IFC EHS Guidelines specifies that a 'Contaminant', 'Receptor' and 'Exposure Pathway' must either co-exist or be likely to co-exist to form a Contaminant-Pathway-Receptor (CPR) linkage. The following descriptions are provided for each of the CPR components:

- *"Contaminant(s): presence of hazardous materials, waste, or oil in any environmental media at potentially hazardous concentrations";*
- *"Receptor(s): actual or likely contact of humans, wildlife, plants, and other living organisms with the contaminants of concern";* and
- *"Exposure pathway(s): a combination of the route of migration of the contaminant from its point of release (e.g., leaching into potable groundwater) and exposure routes (e.g. ingestion, transdermal absorption), which would allow receptor(s) to come into actual contact with contaminants".*

The IFC EHS Guidelines set out an assessment approach that should be applied to establish whether the three risk factors of contaminants, receptors and exposure pathways co-exist, or are likely to co-exist. The assessment approach comprises a four-stage process including:

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[3] IFC, 2007. Environmental Health and Safety (EHS) Guidelines. World Bank Group.

[4] IFC, 2007. EHS Guidelines for Airports. World Bank Group.

1. Risk Screening: initial review of the potential for contamination followed by further assessment (e.g. collection of environmental samples) to determine the extent and significance);
2. Interim Risk Management: application of mitigation measures ("risk reduction") where a condition or situation with the potential to pose an imminent hazard has been identified;
3. Detailed Quantitative Risk Assessment: further consideration of the significance of an identified risk through quantification of the magnitude of health risks to human and ecological receptors. This step is used to assist in determining appropriate ways to address an identified risk; and
4. Permanent Risk Reduction Measures: Reduction, elimination or control of risks using the breakage of identified CPR linkages.

Hazardous Materials Management

Section 1.5 of the IFC EHS guidelines includes guidance for the storage and handling of any quantity of hazardous materials (*"Hazmats"*). Hazmats are defined as materials *"that present a risk to human health, property or the environment due to their physical or chemical characteristics"*. The guidance measures work towards reducing the potential for uncontrolled release of Hazmats and incorporate the need for engineering and management controls that aim to limit the magnitude and significance of a release event should it occur.

The IFC EHS Guidelines – Airports specify that during airport operation, bulk storage and handling of fuels (e.g. jet fuel, diesel and gasoline), together with use of fire suppression foams and powders used for firefighting drills could result in release to soil and groundwater. Hazardous material management measures specified in Section 1.5 of the IFC EHS Guidelines are referred to for best practice guidance. Guidance in IFC EHS Guidelines – Airports requires that operators develop spill prevention and control plans together with emergency preparedness and response plans that are specific to the nature of planes airport operations. This guidance document also requires that fire training takes place impermeable surfaces surrounded by a retaining dyke to prevent release direct to storm water and ground.

Topsoil

The Proposed Project includes the disturbance, or stripping, of topsoil during a number of construction related activities. The IFC EHS Guidelines for Mining[5] have been referenced with regard to mitigation measures for the protection of topsoil resources.

*13.2.3.2 African Development Bank Group Integrated Safeguard System[6]*

As specified in Chapter 2: Policy, Legal and Administrative Framework, the African Development Bank Group Integrated Safeguards System (AfDB ISS) includes the following safeguards considered directly applicable to geology and soils:

- Operational Safeguard 3: Biodiversity and Ecosystem Services, which aims to conserve biological diversity and promote the sustainable use of natural resources; and
- Operational Safeguard 4: Pollution Prevention and Control of Hazardous Materials and Resource Efficiency, which covers the industry-specific, regional and international standards regarding pollution, waste and hazardous materials.

Operational Safeguard 4 refers back to IFC EHS Guidelines as the recognised standard and good practice guidance for pollution prevention and control with a requirement for implementation of measures prevent discharge of pollutants into air, surface water, groundwater, land and soil.

[5] IFC, 2007. Environmental Health and Safety Guidelines for Mining. World Bank Group.
[6] African Development Bank Group, 2013. Integrated Safeguards System.

This Operational Safeguard also calls for emergency preparedness and response where there is a potential identified operational risk of accident and emergency events.

## 13.3 Assessment Methodology

### 13.3.1 Scope

The scope of the geology and soils assessment for the Proposed Project Area has been defined through a scoping process that identified potentially sensitive receptors and potentially significant impacts. The outcome of the scoping process was documented in the ESIA Scoping Report, dated July 2017.

The geology and soils section of the ESIA Scoping Report included a high-level overview of the existing Proposed Project Area environment to identify potentially sensitive receptors in the context of possible impacts during the construction phase and operation phase. Potential identified impacts are summarised in the Table 13-1.

**Table 13-1: Summary of Impact Scenarios Identified in the Scoping Report**

| Construction Phase | Operation Phase |
|---|---|
| *Disturbance of surface soils*: construction of structures and infrastructure, development of foundations, construction of roads, construction material storage. | *Contamination of soils through*: incorrect storage and handling of potentially contaminating substances. |
| *Contamination of soils through:* handling and disturbance of soil and vegetative cover, accidental spills or release of fuel/oil, loss of hydrocarbon from storage vessels, spills or leaks of water treatment chemicals, release of contaminated wastewater or stormwater. | *Contamination of soils through*: accidental fires during the operation phase, as well as contamination from firefighting activities onto the soil. |
| *Soil erosion*: due to exposure to wind and rain during site clearance, earth moving and excavation. | *Contamination of soils through*: contaminated surface runoff from firefighting and fire training areas that will infiltrate the ground. |

In addition to the impact scenarios identified in the ESIA Scoping Report operational activities that may potentially result in impact to soil and geology include:

- Potential release of foams and powders to ground due to either firefighting training, or fire mitigation;
- Release of hazardous substances to ground due to unplanned events such as natural disasters or accidents along the Expressway; and
- Disturbance of soil (soil erosion) due to vehicle movement on unsurfaced ground surfaces.

The Scoping Report specified that soil sampling for geotechnical purposes had been conducted across the Airport Area and that no additional soil sampling will be conducted within this area. Soil sampling will occur across the Expressway as a geotechnical assessment is currently being conducted by BAC. Due to the historic land-uses across the Proposed Project (i.e. subsistence farming), potential for large-scale contamination can be considered low. A summary of existing information relating to soil sampling is provided in the geology and soils baseline section below.

The identified potential impacts are to be further assessed for the Proposed Project over the planned lifespan and where possible mitigation measures to reduce the impact to underlying soil quality have been identified.

The key impacts to be considered as part of the impact assessment, during both the construction and operation phases, include:

- Soil contamination due to an unplanned release of hazardous substance;
- Presence of existing contamination and potential impact upon identified receptors; and
- Soil disturbance either due to construction or operational activities or due to erosion from wind or rain.

### 13.3.2 Baseline Characterisation

Baseline characterisation for geology, soils and topography has been carried out through desk based assessment of existing information and published publicly accessible records including:

- The Draft ESIA (2010) developed by GIBB Africa[7];
- Soil testing carried out by Geo Environmental Group (GEG) on behalf of Mota-Engil in 2017[8];
- Geological and topographical mapping; and
- Google Earth satellite imagery (accessed September 2017).

The minimum study area for conducting an ESIA Report for a project is defined as the 'Project Area of Influence', which is generally larger than the Proposed Project Area in order to address all possible relevant impacts. In this context, the Project Area of Influence is the geographic area that may experience impacts to the biological, physical or socio-economic environments from resettlement, earthworks, construction and operation of the project components. This area will include the lands permanently and temporarily affected by the Proposed Project features.

The Proposed Project Area and identified Area of Influence with respect to potential contaminant, exposure pathway and receptor identification are described in Chapter 6: The Proposed Project.

Consideration of the hydrological setting across the Proposed Project Area is documented in Chapter 12: Water Resources. Key hydrological and hydrogeological receptors will be also be referred to in this section of the report given their importance with regard to the assessment of overall soil and geology impact and CPR linkage.

### 13.3.3 Construction Phase Method of Assessment

The Impact Assessment Methodology is based on the principles of potential contaminant, exposure pathway and receptor identification as outlined within the IFC General EHS Guidelines[9]. The contaminant (or 'source') in this context has been identified in relation to the planned activity, or due to historical activity. Owing to the complexity of the Proposed Project, there are multiple sources. The receptor under consideration relates to soil as a resource. Indirect receptors that use soil, groundwater and surface water have also been considered (such as ecological receptors). Pathways that could link the sources and receptors have been identified. Only where the complete linkage of source, pathway and receptor are present can impacts potentially occur.

An overview of the process followed in compiling this ESIA Report and the general methodology adopted in assessing impact significance is presented in Chapter 3: Impact Assessment Methodology.

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

[8] GEG, 2017. Mota Engil Africa, Geological and Geotechnical Report, NBIA Airport, Detailed Design.

[9] IFC, 2007. Environmental Health and Safety (EHS) Guidelines. World Bank Group.

### 13.3.4 Operation Phase Method of Assessment

The Impact Assessment methodology for the operation phase of the Proposed Project is the same as adopted for the construction phase and requires assessment of the potential for project activities to result in a source-pathway-receptor linkage.

### 13.3.5 Significance Criteria

Owing to the complexity of the Proposed Project, there are multiple potential sources of contaminants, pathways and interconnected potential receptors. In the absence of detailed published quantitative criteria relating to potential contamination, Table 13-2 has been developed to assist with the assessment of receptor sensitivity.

**Table 13-2: Receptor Sensitivity**

| Sensitivity of Receptor | Criteria for Assessment |
|---|---|
| High | • Existing land that will be in use for residential purposes that is affected by existing contamination<br>• Aquifers used for potable water abstraction / public water supply<br>• Area of ecological significance<br>• Human health – construction workers (long term exposure to extensive areas if contamination)<br>• Surface watercourse (Non-ephemeral) located on or adjacent to the Proposed Project Area<br>• Located within the immediate catchment of an ecologically sensitive area |
| Medium | • Land used for residential purposes without growing food for human consumption<br>• Aquifers not used for public water supply but may be of strategic regional importance (e.g. for irrigation) and absence of pathway from ground surface to groundwater (e.g. presence of overlying impermeable layer)<br>• Human health – construction workers (short term exposure to localised areas of contamination)<br>• Livestock (as a direct receptor)<br>• Surface watercourses located less than 250 m from the Proposed Project Area but not situated within the Proposed Project Area, or surface water courses that are ephemeral in nature<br>• Not located in an ecologically sensitive area; however, located within influencing distance |
| Low | • Land to be used for commercial/industrial purposes<br>• Groundwater not used for public water supply, absence of pathway from ground surface to groundwater (e.g. presence of overlying impermeable layer)<br>• Not located within an ecologically sensitive area<br>• Surface watercourses located >250 m from the Proposed Project Area |

The significance of impact on the soils and geology is a result of a combination of receptor sensitivity and magnitude of change arising from the Proposed Project. Assessing magnitude includes consideration of:

- Extent: the spatial extent affected by soil contamination of disturbance;
- Duration: the period of time over which an impact will affect identified receptors;

- Frequency: consideration of how often an impact may occur; and
- Reversibility: whether the soil contamination or disturbance can be remediated to baseline conditions.

For the assessment of geology and soils the criteria adopted for determining extent, duration, frequency and reversibility as defined in Chapter 3: Impact Assessment Methodology. Overall impact magnitude has then been determined in accordance with the following criteria:

**Table 13-3: Impact Magnitude**

| Impact Magnitude | Criteria |
|---|---|
| Very Low | No discernible impact to geology and soils. Receptor change is essentially indistinguishable from natural background variation. |
| Low | Limited impacts to soil and geology which are:<br>**Extent:** local (e.g. small spillage or minimal area disturbance causing localised impact)<br>**Duration:** short term (e.g. a contaminant release that only occurred for a short period of time before being detected and stopped)<br>**Frequency:** infrequent (rare in nature – expected to occur <5 times during either construction or operation) to periodic (could occur multiple times, >5, during construction or operation phases)<br>**Reversibility:** reversible (e.g. remediation measures can be implemented to restore conditions to baseline levels) |
| Medium | Noticeable impacts to soil and geology which are:<br>**Extent**: regional (e.g. larger scale contaminant release or soil disturbance with the potential for migration to receptors causing an impact at a regional scale)<br>**Duration**: medium term (e.g. fuel release or exposure of existing contamination that is not detected for a long period of time such as ‘months’)<br>**Frequency:** periodic (could occur multiple times, >5, during construction or operation phases) to constant (will occur consistently throughout the project during either construction, operation, or both)<br>**Reversibility**: reversible (e.g. remediation measures can be implemented to restore conditions to baseline levels) |
| High | Prominent impacts to soil and geology which are:<br>**Extent**: national or transboundary (e.g. a catastrophic contaminant release event with sufficient volume released to allow possible source-pathway-receptor linkage and migration that affects receptors on a national or transboundary scale)<br>**Duration**: long term (e.g. soil contamination from a source that allows continued possibility of source-pathway-receptor linkage over the course of the construction phase and potentially continuing into the operational phase)<br>**Frequency**: constant (e.g. will occur consistently throughout the project during either construction, operation, or both).<br>**Reversibility**: irreversible (e.g. causes a permanent change and cannot be rectified by remediation or management measures) |

### 13.3.6 Assumptions and Limitations

The information contained within the baseline environmental section is based, in part, on information gathered from previous assessments undertaken by third party organisations, publicly available information and soil sampling by BAC. Reliance is placed on this information for the purpose of baseline characterisation. Previous intrusive assessments did not include chemical analysis for soil contamination across the Airport Area. This is due to the Proposed Project Area having historically comprised farm land with a low potential for significant contamination to have occurred. If evidence of potentially significant contamination sources are identified (e.g. during any part of construction or operation), targeted site investigations will be carried out to assess the contamination extent and potential risk to receptors.

Previous intrusive investigations have not encountered shallow groundwater. However, permanent monitoring well installations have not been installed and there remains the possibility of shallow groundwater that is likely perched rather than continuous in nature. Mitigation measures will take account of this identified limitation.

## 13.4 Baseline Conditions

Impacts to geology and soils are assessed in relation to the potential to encounter existing soil contamination, associated with past and current land use, or for new contamination to occur through accidental leaks or spills during the construction and operation phase. This may result in impacts on soils and the mobilisation of soil contamination that could impact a number of environmental receptors. In addition, the major cut to fill exercise to be undertaken along with subsequent re-profiling will result in change to the soil structure within the Project Area. Ground disturbance will occur during the construction phase due to earthworks activities including:

- Cut and fill;
- Development of foundations;
- Road construction;
- Water Pipeline installation;
- Building of structures;
- Vehicle movements on unsurfaced ground; and
- Material stockpiling and movements.

Given the appreciable depth to bedrock (approximately 15 metres below ground level (mbgl) beneath the Proposed Project Area it is not anticipated that significant bedrock disturbance will occur during construction of the required airport buildings and associated infrastructure.

### 13.4.1 Topography

Rwanda lies on the great East African Plateau, with the divide between the water systems of the Nile and Congo rivers passing in a north to south direction through the western part of the country. To the west of the divide, the land drops sharply to Lake Kivu in the Great Rift Valley; to the east, the land falls gradually across the central plateau, characterised by its grassy highlands which are the core areas of settlement of Rwanda's population (marshes, wetlands and lakes on the country's eastern border).

Almost all of Rwanda is at least 1,000 m above sea level; the central plateau is between 1,500 and 2,000 m high. In the northwest on the border with the Democratic Republic of the Congo are the volcanic Virunga Mountains; the highest peak, Mt. Karisimbi (4,519 m), which is snow-capped. Lake Kivu, 1,460 m above sea level, drains into Lake Tanganyika through the sharply

descending Ruzizi River. The Kagera River, which forms much of Rwanda's eastern border, flows into Lake Victoria.

Bugesera District's relief is a succession of plateaus with rolling hills ranging between 1,300 m and 1,667 m. The Bugesera area is also characterised by a series of undulating hills with gentle slopes. Some mountains jut over low plateaus including Juru (1,667 m), Mount Nemba (1,625 m) and Mount Maranyundi (1,614 m). The topography comprises a succession of low plateaus with old mountains, hills and dry valleys, as well as marsh areas resulting from the presence of the eastern branch of the East African Rift (EAR) System.

The Airport Area lies over 2,500 ha of land that rises from approximately 1,400 m in the south, north and west and extends to a maximum elevation of 1,438 m at the centre of the site. The lower areas fall rapidly to the river valleys at slopes ranging from 2.5% in the northern quadrant, to 12.5% in the eastern quadrant. The Proposed Project Area is situated on a relatively flat, slightly undulating mesa that is surrounded by poorly drained, swampy rivers to the north and west while to the east are a number of small lakes. The topographical profile of the Airport Area is illustrated in Figure 13-1 (source: Google Earth, 2017).

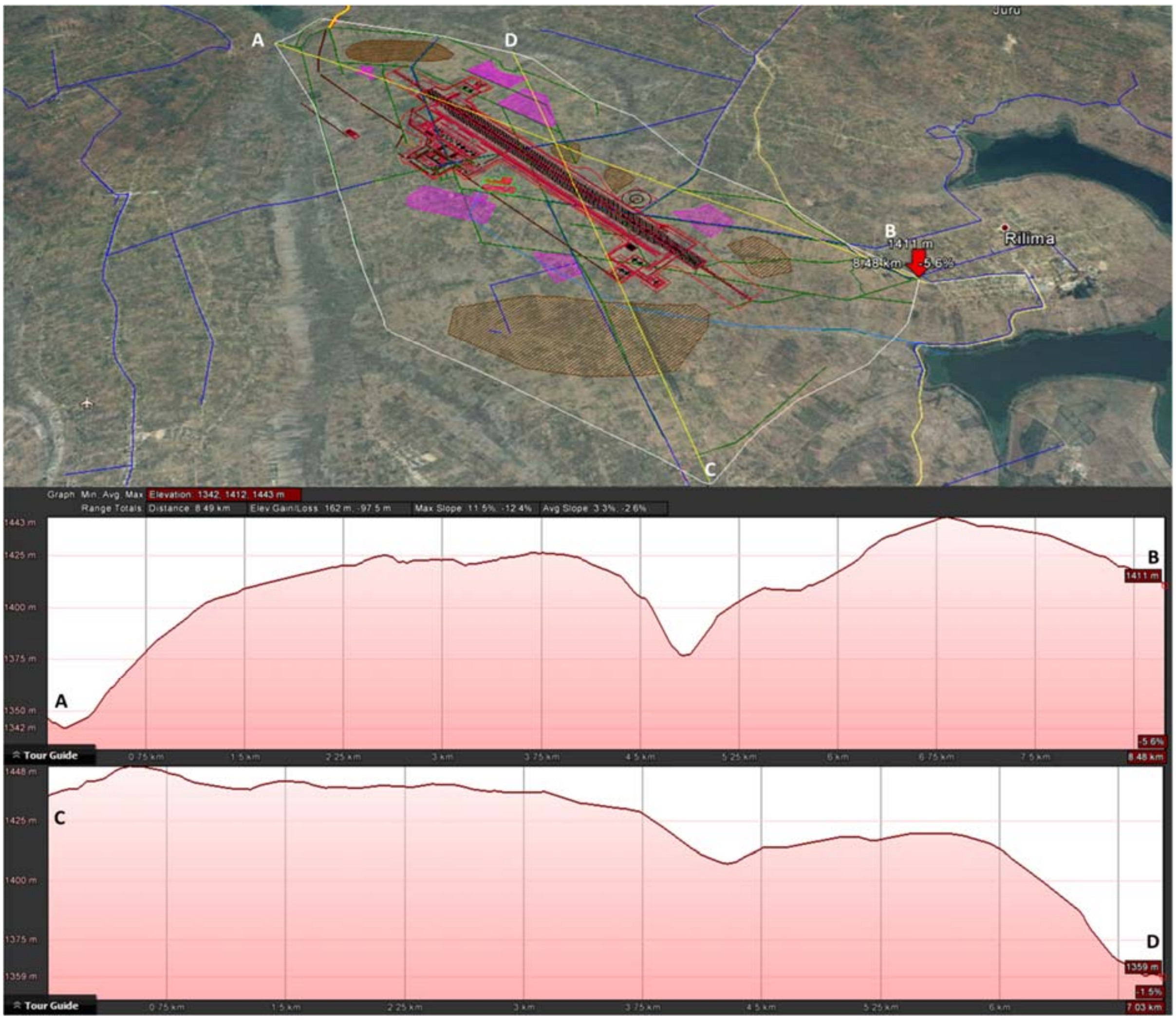


**Figure 13-1: Topographical Profile of the Airport Area (Source Google Earth)**

The Expressway route largely hugs the floodplain boundaries or rivers and the swampy areas of a wetland and covers a length of approximately 14.5 km. The elevation of the Expressway leaving the airport is 1,380 m and meets up with the KK-15 Road in Kigali city at an elevation of 1,345 m. The profile is relatively flat as illustrated in Figure 13-2 (source: Google, 2017).

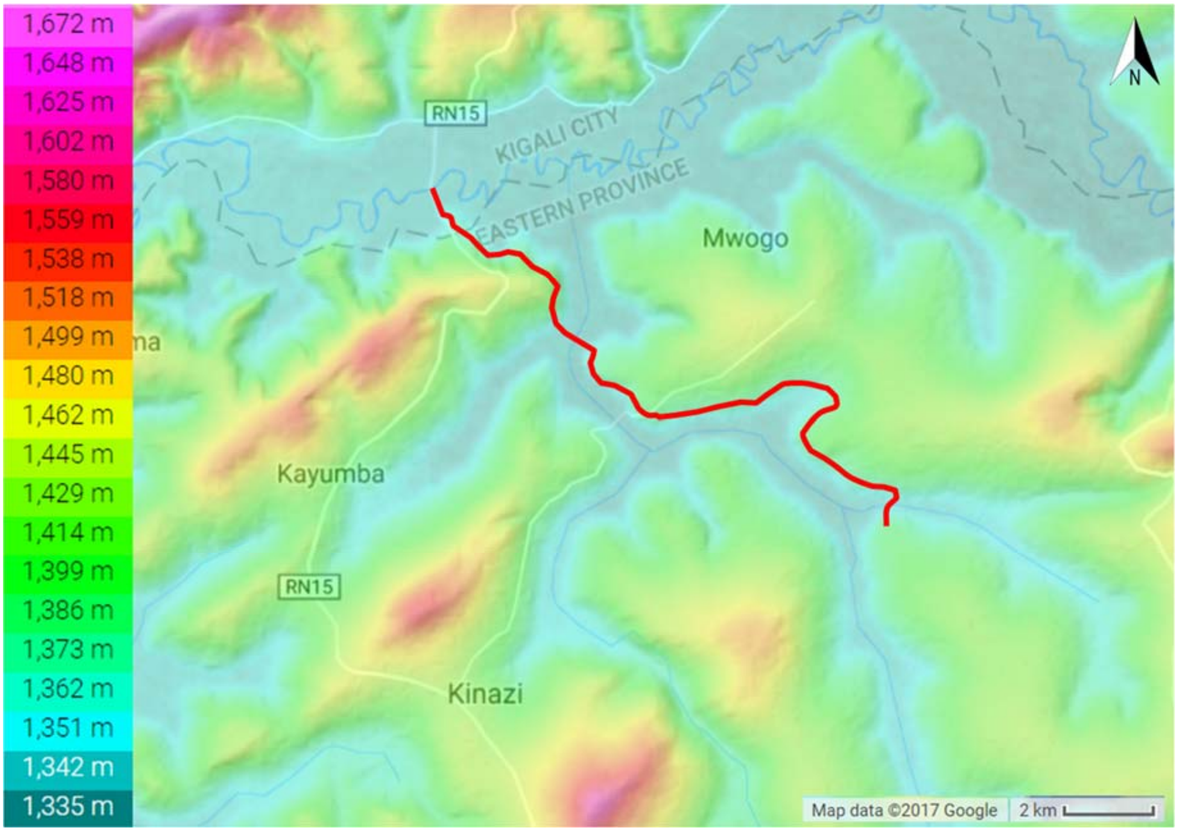


**Figure 13-2: Topography along the Expressway Route (Source Google)**

#### *13.4.1.1 Seismicity*

The East EAR System is an active continental rift zone in east Africa. The east and west branch of the EAR influence seismicity in Rwanda. According to the National Risk Atlas of Rwanda (2015)[10] the west branch of the rift system is the main source of seismic movements impacting the Rwandan territory with moderate or even small earthquakes turning out to be catastrophic in earthquake prone regions with poor construction practices. Based on hazard mapping complete for the National Risk Atlas of Rwanda (2015) the Proposed Project Area falls in a zone classified as follows:

- Zoning: Moderate – felt by nearly everyone, many awakened. Some windows broken. Unstable object overturned;
- Modified Mercalli Intensity Scale: V (moderate intensity); and
- Shaking: moderate.

The possibility of an earthquake of moderate intensity to occur within the Proposed Project Area has been factored into the impact assessment.

### 13.4.2 Hydrology and Hydrogeology

Regional hydrogeological and hydrological conditions are summarised in Chapter 12: Water Resources. However, a summary of issues relevant to this chapter is provided below.

#### *13.4.2.1 Hydrogeology*

Groundwater was not reported to have been encountered in the intrusive investigations reviewed as part of this baseline section. It is understood that groundwater within the localised area is present within deep aquifers situated within bedrock layers. A reasonable (>10 m)

[10] Ministry of Disaster Management and Refugee Affairs, 2015. The National Risk Atlas of Rwanda.

thickness of clays/silts (generally considered to be low permeability deposits) is understood to lie above the deeper groundwater and are likely to limit the infiltration or downward migration of contaminants if present within soils.

The maximum drilling depth achieved during the GEG (2017) investigation was 31.5 mbgl and groundwater was not recorded to have been encountered. However, groundwater monitoring wells were not installed. Therefore, shallow groundwater (likely perched rather than continuous in nature) could be present.

#### *13.4.2.2 Hydrology*

Three lakes are located in close proximity to the southeast of the Proposed Project, and include Lake Kidogo, Lake Gashanga and Lake Rumira. The identified water features are not situated within the Proposed Project Area.

A summary of the identified surface water receptors surrounding the Proposed Project Area is provided in Chapter 12 and the receptors that are located within 5 km of the Proposed Project site boundary are listed in Table 13-3.

**Table 13-4: Identified Surface Water Receptors within 5 km**

| Feature | Direction from Proposed Project | Distance |
|---|---|---|
| Mweza River (ephemeral stream) | North and east | Approximately 500 m |
| Kibilizi River (ephemeral stream) | West | Approximately 1 km |
| Kigogoma River (ephemeral stream) | West | Approximately 3.5 km |
| Lake Kidogo | Southeast | Approximately 2 km |
| Lake Gashanga | East | Approximately 4.8 km |
| Lake Rumira | Southeast south | Approximately 5 km |

### 13.4.3 Geology

According to the Draft ESIA (2010), the geology of Rwanda comprises of Mesoproterozoic[11] metasediments, largely comprising quartzites, sandstones, and shales of the Burundian Supergroup which are locally intruded by granite. There are four types of granite in the Kibaran Belt. In eastern Rwanda, there are *"older granites"* along with granitic-gneisses and migmatites of Palaeoproterozoic[12] age. In the northwest and southwest are Neogene volcanics, ranging in age from Cenozoic to recent. Alluvium and lake sediments of Quaternary[13] age occur in parts of the Western Rift and along rivers and in lakes throughout Rwanda.

The geology of Rwanda is similar to the geology of neighbouring Burundi and southern Uganda. The oldest rocks of Rwanda are migmatites, gneisses and mica schists of the Paleoproterozoic Ruzizian Basement overlain by the Mesoproterozoic Kibaran Belt.

[11] Geologic era that occurred c.1600 to 1000 million years ago.
[12] Geologic era that occurred c.1600 to 2500 million years ago.
[13] Spans from 2.6 million years ago to current day.

Based on the Bugesera geological map sheet, see Figure 13-3, the solid geology underlying the weathered granite (saprolite) in the Proposed Project Area consists of Precambrian granitic rock, metaquartzites, pegmatites, and mica schists (Bakundukize et al., 2016[14]).

The morphology and topography (i.e. the rounded and slightly undulating land) of the Proposed Project Area and nearby vicinity indicates an altered granite massif. Additionally, the relatively thick soil cover and the occurrence of lateritic deposits in the vicinity are indicators of deep alteration of the granite.

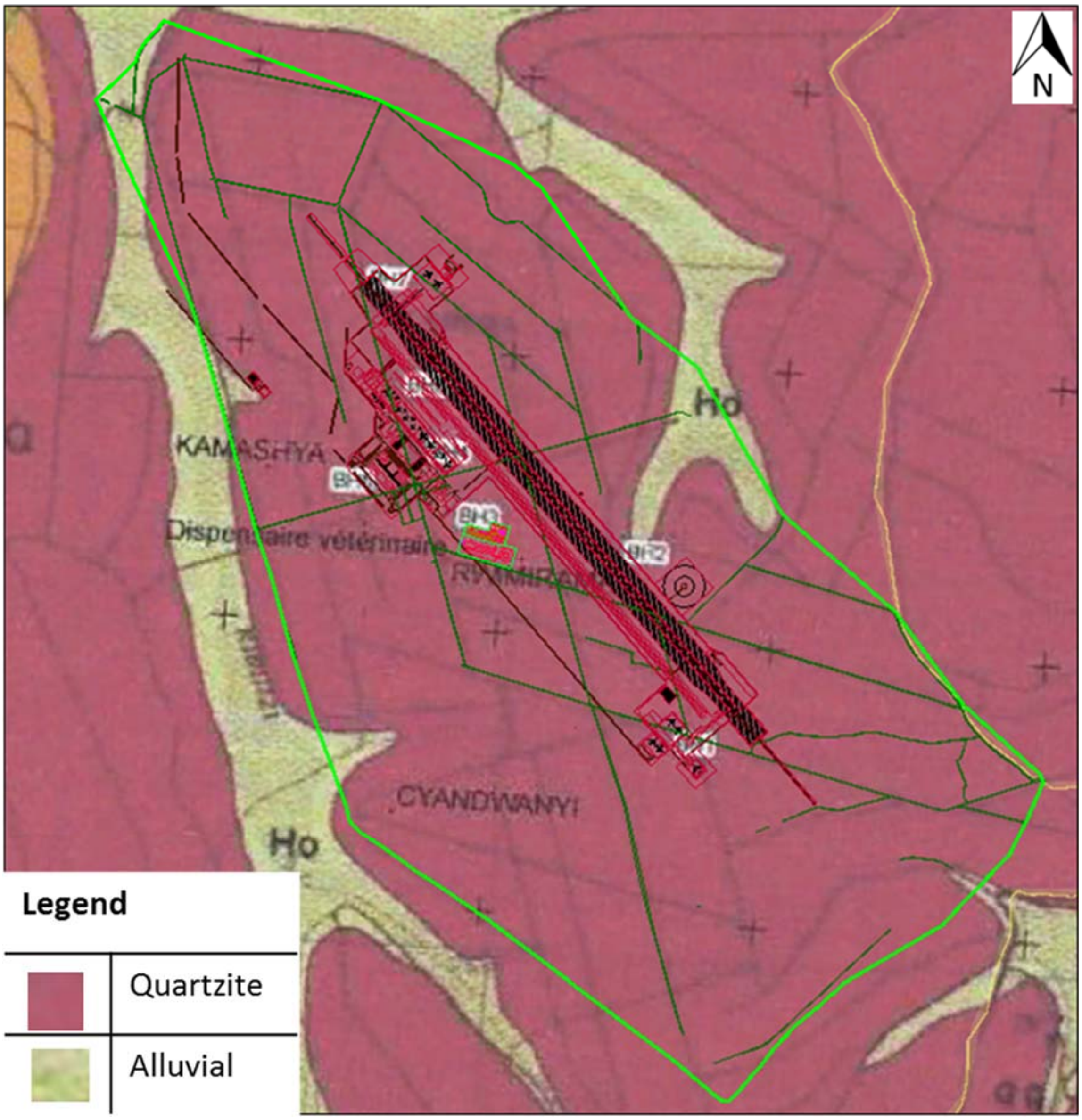


**Figure 13-3: Lithology of the Airport Area**

The GEG report (2017)[15] includes the results of a resistivity study, which determined that the depth of the bedrock beneath a portion of the Proposed Project Area varies from approximately 8 to 34 mbgl, see Figure 13-4.

[14] Bakundukize, C., Mtoni, Y., Martens, K., Van Camp, M., & Walraevens, K.,2016. Poor understanding of the hydrogeological structure is a main cause of hand-dug wells failure in developing countries: A case study of a Precambrian basement aquifer in Bugesera region (Burundi). Journal of African Earth Sciences.

[15] GEG, 2017. Mota Engil Africa, Geological and Geotechnical Report, NBIA Airport, Detailed Design.

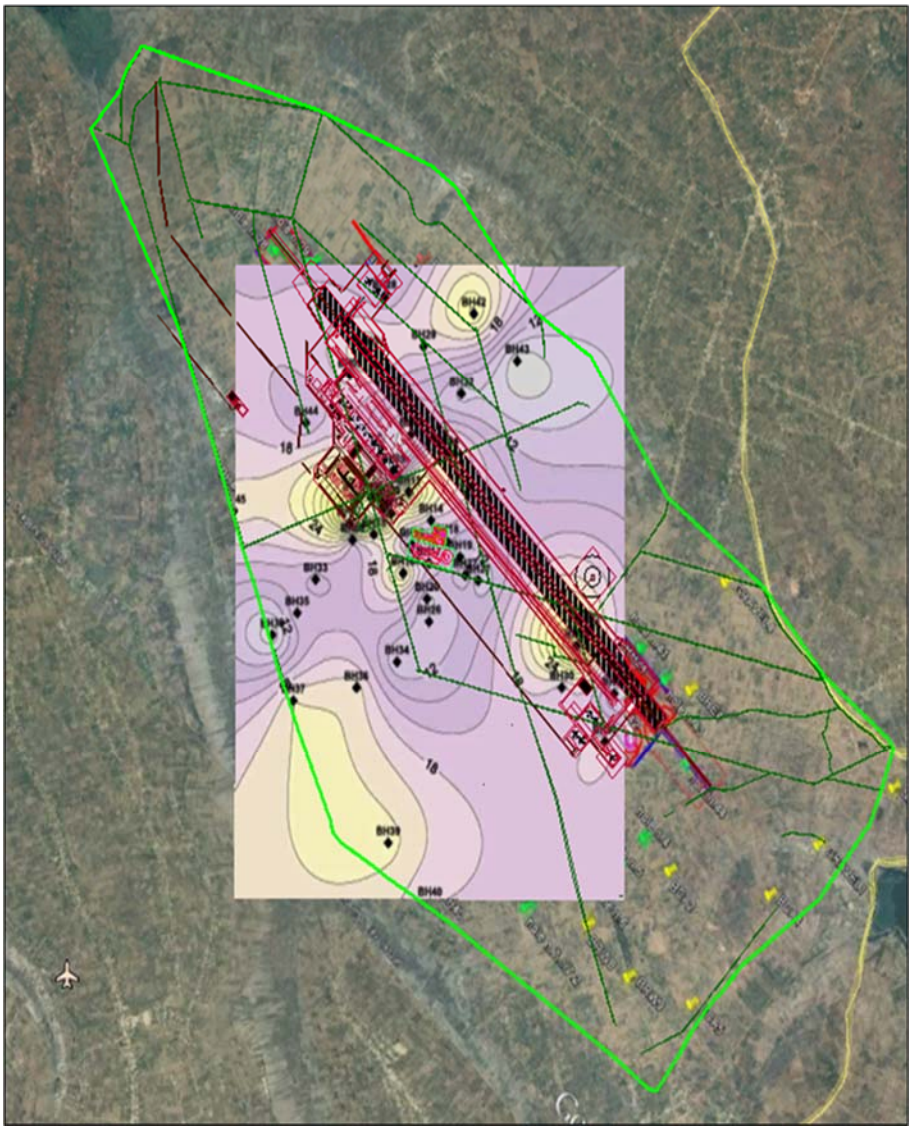

**Figure 13-4: Relative Depth of Bedrock Underlying the Airport Area**

Figure 13-5 and Figure 13-6 summarise the different geology types recorded in the logs for seven boreholes (BHC1 – BHC7) completed by GEG (2017) in order to further characterise ground conditions beneath the Proposed Project Area. Based on the findings reported in the GEG (2017) report, bedrock (decomposed granite) was only intercepted in borehole BHC2 at a depth of 13 mbgl. According to GEG (2017), soils were generally reported to comprise *"silty/clayey sand"*, overlying the decomposed granite, relate to weathering of the bedrock. The location of BHC1 to BH7 is shown on Figure 13-3.

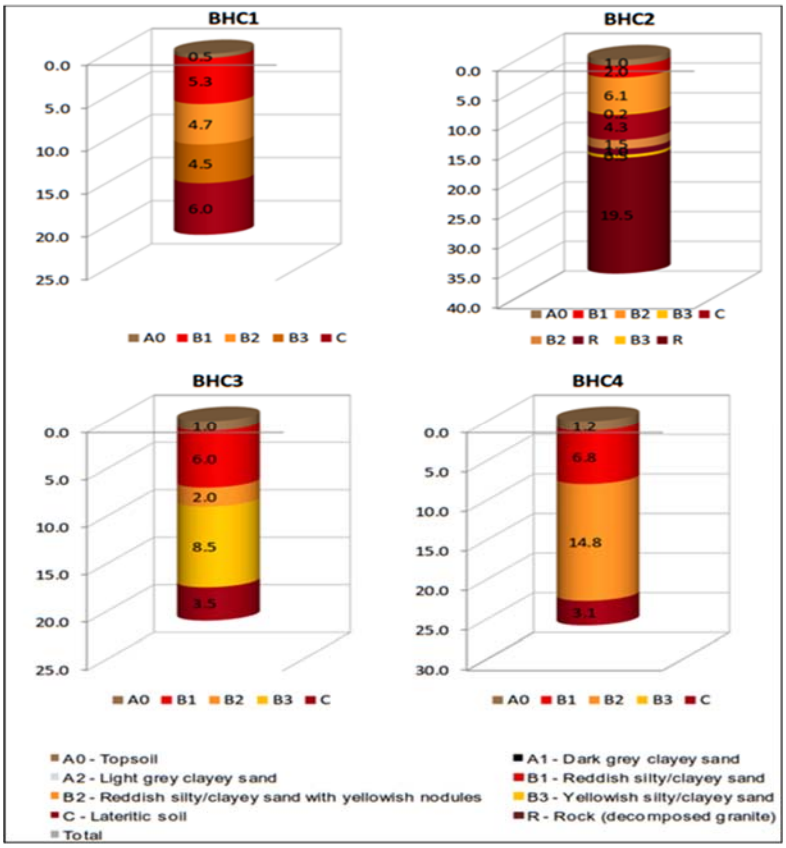


**Figure 13-5: Different Soil Layers Lengths (m) Representation for Each Borehole (BHC1, BHC2, BHC3 and BHC4), as per GEG 2017**

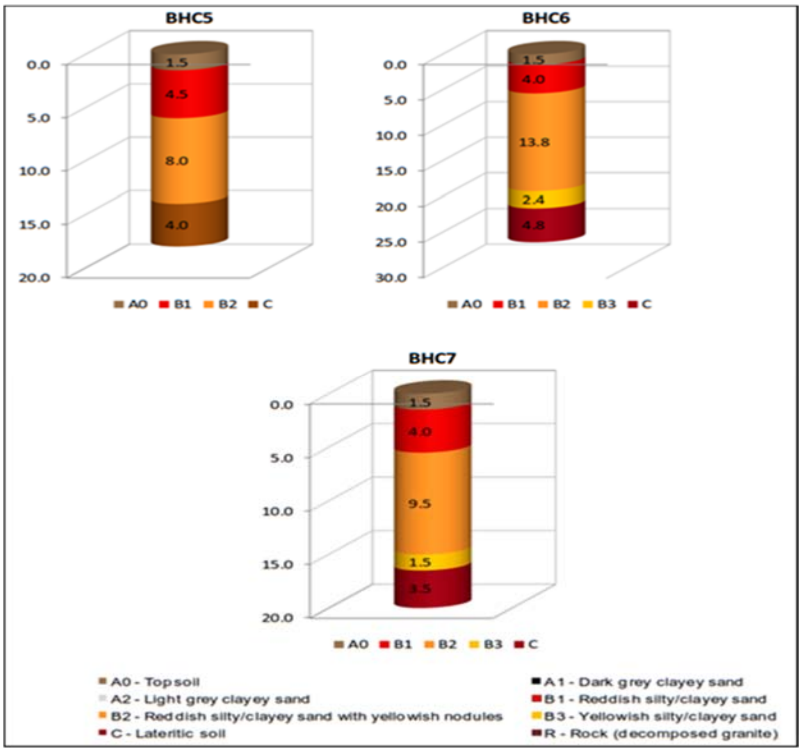


**Figure 13-6: Different Soil Layers Lengths (m) Representation for Each Borehole (BHC5, BHC6 and BHC7), as per GEG 2017**

Based on the lithologies observed during drilling, GEG (2017) inferred five geological-geotechnical ground types (referred to as GT1A and GT1 to GT4) based on recorded in-situ Standard Penetration Testing (SPT)[16] blow counts. The geological-geotechnical ground types reported by GEG are summarised in Table 13-4.

**Table 13-5: Geotechnical Ground Types (GEG, 2017)**

| Geological-geotechnical Ground Type | Described Lithology | SPT Count |
|---|---|---|
| None specified | Top soil (A0) | <10 |
| GT4 | Reddish clayey sand (B1) or Reddish clayey sand with yellowish nodules (B2) | 10-30 |
| GT3 | Reddish clayey sand (B1) or Reddish clayey sand with yellowish nodules (B2) | 30-50 |
| GT2 | Reddish clayey sand (B1) or Reddish clayey sand with yellowish nodules (B2) to Yellowish clayey sand (B3) | >50 |
| GT1 | Granite (highly weathered) | Refusal and first phase refusal |
| GT1A | Very hard lateritic soil | |

Groundwater was not reportedly encountered in the boreholes completed. However, groundwater monitoring well installations were not installed and there remains potential for shallow perched groundwater to be present. No structural intrusions (i.e. faults, dykes and sills) are present within the Proposed Project Area. The geology of the Expressway is expected to be similar as this is based on investigations carried out to date, which indicate that the lithology is uniform within the localised area.

### 13.4.4 Soils

According to the Rwanda State of the Environment and Outlook Report (2015)[17], Rwandan soils are naturally fragile. The rich volcanic soils in the northwest (highlands at more than 2,000 m) are generally fertile and allow cultivation of a wide range of food crops (for example, maize, potato, banana, beans, sorghum, green peas and wheat); acidic soils of Congo-Nile Crest (1,500 to 1,700 m) are suitable for other crops, such as tea, and soils in the larger river valleys and extensive wetlands are the most fertile. Most volcanic soils in naturally forested areas, such as the Volcanoes National Park and the Gishwati Forests, are high in nitrogen (Nzeyimana, Hartemink, & de Graaff, 2013)[18].

The eastern lowlands have relatively fertile soils, but because of the long dry season, crops require irrigation. In many highland areas, the deep soils are typically acidic (with a pH of less than 5.0) as nutrients have been leached away. Aluminium is soluble in soils with low pH levels, making the soil toxic to plants, inhibiting growth and often leading to high soil phosphorus fixation. Deforestation and tillage rapidly deplete organic matter in highland soils, threatening the viability of long term cultivation.

According to the Rwanda State of the Environment and Outlook Report (2015), it is thought that about three-quarters of Rwanda's soils are acidic, with a pH below 5.5. Soils in the central

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[16] An in-situ dynamic penetration test designed to provide information on the geotechnical engineering properties of soil.

[17] Rwanda Environment Management Authority, 2015. State of the Environment and Outlook Report 2015, Rwanda.

[18] Nzeyimana, I., Hartemink, A. E., & de Graaff, J, 2013. Coffee farming and soil management in Rwanda. Outlook on Agriculture, 42 (1), 47–52; Available at: http://www.alfredhartemink. nl/2013%20-%20Coffee%20Rwanda.pdf.

and southern regions are often deficient in nitrogen (Nzeyimana, Hartemink, & de Graaff, 2013). Nitrogen deficiency causes soil erosion and quick mineralisation (Nabahungu, 2013)[19]. In most soils, but particularly those resulting from volcanic deposits, phosphorus is the main limiting nutrient for crops. Approximately 87% of soils have a pH of <5.2 and are deficient in phosphorus (Nzeyimana, Hartemink, & de Graaff, 2013)[17].

According to the Draft ESIA (2010) developed by GIBB Africa[20] and based on the results of electrical resistivity logs of 31 onsite boreholes it can be deduced that the soil beneath the Proposed Project Area, and overlying the bedrock, is made up predominantly of clayey sand and sandy lean clay, based on the Unified Soil Classification System (USCS).

In addition to the seven deeper boreholes (BHC1 to BHC7), the GEG 2017 investigation also included the completion of 24 trial pits (TPC1 to TPC24) across the Proposed Project Area. The trial pits were excavated to depths in the range 2.7 mbgl to 4.3 mbgl. Soil samples were collected at select locations and submitted for geotechnical testing including:

- Particle size distribution;
- Atterberg limit (plasticity and liquid limit);
- Moisture content; and
- Compaction testing.

No chemical analysis was carried out to assess for potential contamination; however, the rational has been discussed previously within this chapter. However, the requirement for assessment of soil conditions in the event that an identified contamination source is identified during either construction of operation is further considered in the construction and operation phase impact assessment.

The lithology observed during the advancement of the trial pits generally comprised:

- Topsoil: described by GEG as reddish-brown or grey silty clayey sand in the region of 1.0 mbgl to 1.5 mbgl;
- Overlying: Silty clay / sand: described by GEG as reddish-brown or grey silty / clayey sand of fine grain size, depth unproven.

The borehole logs for BHC1 to BHC7 indicate that that the Proposed Project Area is generally underlain by the following sequence of lithologies, from ground surface to bedrock:

- Topsoil (A0) with an average thickness of 1.2 m;
- Dark grey silty/clayey sand (A1) with the average thickness specified by GEG as 0.01 m;
- Light grey silty/clayey sand (A2) with the average thickness specified by GEG as 0.01 m;
- Reddish silty/clayey sand (B1) with an average thickness of 4.7 m;
- Reddish silty/clayey sand with yellowish nodules (B2) with an average thickness of 7.5 m;
- Yellowish silty/clayey sand (B3) with an average thickness of 2.5 m;
- Lateritic soil (C) with an average thickness of 4.2 m, and;
- Decomposed granite (R) with an average thickness of 10.3 m.

An illustration of the soil profile encountered at each of the borehole locations is included in Section 13.3.1.

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[19] Nabahungu, N., 2013. Rwandan Soil Health Status for Sustainable Food Security and Economic Growth. Rome: Food and Agriculture Organisation of the United Nations (FAO).
[20] GIBB Africa, 2010. Proposed New Bugesera International Airport (NBIA) for Ministry of Infrastructure (MININFRA) Government of Rwanda, ESIA.

Soils present beneath the Proposed Project Area consist predominantly of silt and sand, with lesser gravel and clay.

Although no soil samples were taken to analyse potential for contamination, based on the initial information recorded in the GEG (2017) borehole and trial pit logs, there is reduced potential for contamination from foreign sources such as hydrocarbons, heavy metals, and other organics. This is further supported by the historical use, having predominantly comprised subsistence cattle and crop farming. Biological impacts from low-density informal housing could potentially have had an impact on the soils, although the extent of this is likely to be localised. In addition, there is potential that cattle burial sites may be present within select areas of the Proposed Project Area. It is understood that the majority of the Airport Footprint and Expressway will be covered with hardstanding, reducing the potential for existing contamination (if present) to migrate offsite to the receiving environment.

### 13.4.5 Sensitive Receptors

Potential primary receptors for soil contamination are considered to be human health, surface water, groundwater and ecological receptors. Each of these key receptors is further discussed below in terms of overall sensitivity associated contamination of soil:

**Table 13-6: Summary of Receptor Sensitivity**

| Receptor | Discussion | Receptor Sensitivity |
|---|---|---|
| Human Health | There is no current evidence to suggest significant soil contamination is present within the Proposed Project Area. However, there is still the possibility of finding unexpected areas of localised contamination. During the operation phase possible soil contamination could occur as a result of an unplanned release event. If such a release occurred it is considered that contamination will be localised in extent with the potential for only short term exposure for human health (e.g. clean-up and remediation will occur as a reactive measure). | Medium |
| Groundwater | Groundwater is understood to be at an appreciable depth (at least >20 mbgl based on the findings documented in the recent GEG (2017) report) and not routinely abstracted for potable use. It is understood that water supply in the localised area is generally from harvested rainwater. Furthermore, as per the findings of the GEG (2007) report there is presence of relatively impermeable silt/clay above the deeper bedrock in which groundwater is understood to be present. These factors reduce the potential for a complete source-pathway-receptor linkage associated with soil contamination. There is potential for groundwater use regionally for either irrigation or drinking water supply. | Medium |
| Surface Water | The closest identified surface water receptor (Mweza River) is ephemeral in nature and situated >250 m from the Airport Area indicating Low significance. However, the Expressway does cross the Nyabarongo River. Therefore, it is considered appropriate to assume surface water resources are of Medium overall significance. | Medium |
| Ecological Receptors | As detailed within Chapter 11: Biodiversity there are ecologically sensitive areas within influencing distance of the Proposed Project Area. | Medium |

In addition to the above it is also important to consider the sensitivity of soil as a resource. There will be soil disturbance and removal of surface soils within the Proposed Project Area. Soils support a number of habitats within the Proposed Project Area including grassland, wooded grassland, bush land and the swamp and aquatic vegetation within the Nyaborongo wetlands. The effect of localised disturbance upon surface soil as a resource is considered to be of overall medium significance when considering soil as a resource.

Impacts to surface water, groundwater and ecological receptors are also further considered in the associated ESIA chapters.

## 13.5 Potential Impacts

### 13.5.1 Construction Phase Impacts

There will be a number of construction activities which can be broadly summarised as follows:

- Construction and running of the Construction Camp;
- Earthworks including a large scale cut and fill operations and the use of borrow pits;
- General construction activities – highway construction, water and wastewater treatment plants, temporary pipeline connecting Lake Kidogo to the water treatment plant, temporary asphalt and concrete plants, and construction of airport infrastructure; and
- Aggregate supply from the Bugesera Quarry 10 km to the northeast of the Construction Camp and quarry road upgrades.

Each of the above activities are further summarised below.

#### *13.5.1.1 Construction Camp*

The Construction Camp, situated to the south of the proposed runway, covers approximately 9 ha and include three key operational areas including the Social Area, Support and Logistics Area, and Industrial Area. The key components of each of these areas is summarised in Table 13-6.

**Table 13-7: Key Components of the Construction Camp**

| Area | Key components |
|---|---|
| Social Area | Main offices, training centre, clinic, canteen, water supply, parking areas |
| Support and Logistics | Warehouses and workshops, laboratory, petrol filling area, facilities, power house, parking for heavy machinery (plant) and weigh bridge |
| Industrial Area | Steel yard, carpentry, two batching plants, cement warehouse |

The gas station includes bulk fuel storage in up to seven diesel tanks, each with a capacity of 75,000 litres. The Construction Camp is being powered by diesel generator units. All construction equipment is refuelled, maintained and parked within hardstand covered areas within the Construction Camp.

#### *13.5.1.2 Earthworks*

Five borrow pits are proposed for sourcing fill material for a large scale cut to fill exercise. Approximately 9,000,000 $m^3$ of cut will be excavated and approximately 7,000,000 $m^3$ of fill is required to create the balance needed to create the required surface levels. In addition, limited extent earthworks (shallow excavation and ground levelling) will also be required along the proposed route of the Expressway. A section of the quarry road will be limited to widening and grading and no large cut and fill volumes are anticipated.

#### 13.5.1.3 *General Construction*

To support general construction activities, there are a number of plant and heavy machinery movements together with the provision of temporary concrete and asphalt plants and water and wastewater treatment facilities. Bulk chemicals associated with temporary water treatment plant operation are stored locally to the plant. As previously specified, all heavy machinery is being refuelled and maintained within the Construction Camp areas. Wastes generated during the construction phase are being be managed in accordance with a Waste Management Plan developed by BAC specifically prepared for the construction phase. Temporary waste storage areas will be situated within an area of the Construction Camp.

#### 13.5.1.4 *Aggregate Supply*

Aggregate for the Proposed Project will be sourced from the Bugesera quarry which is licensed by the Rwanda Development Board, as well as the Ministry of Natural Resources. Aggregate will be carried via an existing quarry road to the Proposed Project Area. However, the existing 18 km unpaved quarry road will be subject to alteration and upgrade (including widening and grading of the ground surface) to support the construction phase.

Quarrying activities are not factored into the impact assessment associated with soil and geology, other than potential cumulative impact, given that the operation is already licensed and approved. However, the transport of quarried materials to the Proposed Project Area, road re-routing/upgrades and subsequent stockpiling and storage will be considered in terms of potential impact.

#### 13.5.1.5 *Design Controls*

Mitigation through management measures required during construction will include the development of the following documentation:

- Occupational Health and Safety Management Plan;
- Pollution Prevention Plan;
- Spoil Areas and Borrow Pit Management Plan;
- Emergency Spills and Abatement Management Plan;
- Emergency Response Plan;
- Environmental Induction and Training Plan;
- Hazardous Substance Management Plan;
- Health and Safety Management Plan; Site Clearance, Excavations and Earthworks Management Plan;
- Disaster Management Plan;
- Soil Management Plan;
- Emergency Spills and Abatement Management Plan;
- Stormwater Management Plan;
- Traffic Management Plan; and
- Waste Management Plan.

The management plans are required to meet the requirements of overarching national and international standards. The documents will serve to outline methodology and control measures to avoid, minimise (and where this is not possible) mitigate the magnitude of potential environmental impacts, and hence the overall severity. Key mitigation measures to be incorporated into the management plans with respect to prevention of significant impact to soil and geology include:

- Storage of potentially hazardous liquids and solids (including diesel, oils, lubricants etc.) in appropriate containers with a minimum of secondary containment. In accordance with IFC General EHS Guidelines, appropriate secondary containment structures must be capable of containing the larger of 110% of the largest tank or 25% of the combined tank volumes in areas with above-ground tanks with a total storage volume equal or greater than 1,000 litres and will be made of impervious, chemically resistant material (e.g. implementation of the Hazardous Substance Management Plan and Pollution Prevention Plan);
- Plant storage and refuelling in designated areas that have impermeable surface covering to prevent potential migration of spillages to ground as per the Pollution Prevention Plan;
- Provision of spill containment kits where potentially hazardous liquids and solids are in use together with training of key personnel in relation to implementation of documented spill response measures (e.g. implementation of the Emergency Spills and Abatement Management Plan and Emergency Response Plan);
- Appropriate storage and transfer of waste materials in accordance with local waste management regulations (e.g, implementation of the Waste Management Plan);
- Inclusion of an unexpected finds protocol in the Site Clearance, Excavation and Earthworks Management Plan and completion of awareness training sessions for all key project personnel that may need to react to an unexpected find, in particular, for potential soil impacts the unexpected finds protocol will need to consider reactive measures in the event of the potential discovery of previously unidentified localised areas of soil contamination;
- Preparation of the Soil Management Plan to allow for appropriate material stockpiling, procedures for verification of the quality of imported materials, documented procedures for assessment of material suitability for use classification, material movement tracking, material storage procedures and signage clearly stating material type, material origin and potentially hazardous status (in the event that contaminated soils are present and need to be managed);
- Implementation of procedures that allow for reactive response to emergencies and incidents that have the potential to adversely impact environmental receptors. Through adopting the procedures there will be a reduction in the timeframe over which a particular contaminant source can affect receptors and the extent of the impact leading to an overall reduction in the severity of the impact; and
- Documentation of measures to control dust generation during earthworks and construction activities (e.g. Dust Control Plan).

The unexpected finds protocol to be implemented as part of the Site Clearance, Excavation and Earthworks Management Plan is a key management measure with respect to impact associated with potential soil contamination. The protocol will take account of measures to reduce the short term risk to earthworks and construction works and prevent construction related activities from mobilising contaminants in the event that they are identified in localised previously unidentified areas of the Proposed Project Area. Through implementation of the unexpected finds protocol the risk to human health and environmental receptors can be mitigated through:

- Use of suitable personal protective equipment (PPE);
- Deployment of immediate control measures to limit the potential mobilisation of contamination including:
  - Isolation of the area affected from worker access and traffic movement;
  - Isolation of potential pathways to sensitive environmental receptors (e.g. preventing rainwater run-off towards streams);

- Coverage of an area to prevent contaminant migration through wind erosion or rainwater infiltration;
- Installation of appropriate signage to alert people of the identified hazard; and
- Characterisation of the material to facilitate assessment of the most appropriate remedial approach.

In addition, as outlined in IFC EHS Guidance - Mining, mitigation measures to protect soil resources, such as topsoil, will be incorporated in the Soil Management Plan and will include:

- Where topsoil is pre-stripped, it will be stored for future site rehabilitation activities. Topsoil management will include maintenance of soil integrity in readiness for future use. Storage areas shall be temporarily protected or vegetated to prevent erosion; and
- Soil conservation measures (e.g. segregation, proper placement and stockpiling of clean soils and overburden material for existing site remediation) will be implemented. Key factors when confirming the measures include placement, location, design, duration, coverage, reuse, and handling procedures.

#### *13.5.1.6 Impact Assessment Prior to Mitigation*

The following potential impacts could occur in the absence of mitigation measures being in place:

- The Proposed Project is situated within an area that has reportedly historically been used predominantly for subsistence cattle and crop farming. The soils in general structure and lithological type do not support intensive agriculture nor have a high natural level of fertility and so are not a highly sensitive receptor to potential impacts in this respect. Generally, the soils in the project area generally comprise topsoil (silty clayey sand) over natural superficial silty clayey sand considered to comprise weathered bedrock. Although no specific phase 1 or phase 2 ground contamination surveys have been undertaken to date, there has been no reported evidence of significant contamination in the assessments referenced in the geology and soil baseline conditions. There remains potential for previously unidentified localised pockets of soil contamination to be present within the Proposed Project Area, though given previous land uses (i.e. low-level subsistence agriculture) these are considered to be either absent, or likely to be extremely localised in nature and/or of a very low level of contamination, probably limited to animal or human organic wastes. Earthworks, heavy machinery movement and general transport activities may disturb localised areas of soil contamination which could affect human health or ecological receptors under certain exposure scenarios, but these are considered to be extremely limited in extent or severity;
- Potential contaminants that will be used in bulk quantities during construction include fuels, lubricants, water treatment chemicals and additives, asphalt, cement, concrete, grout and slurry additives and metals. Contamination of the soil may result through accidental leaks or spills during construction (e.g. during refuelling or waste handling). Depending on the size and nature of the spillage, and the physical properties of the soil (including soil porosity, permeability, particle size and clay/cation exchange capacity), this could lead to contamination of the soil resource in the vicinity of the project. The possibility of an earthquake of moderate intensity to occur within the Proposed Project Area, whilst relatively rare, also presents another potential release scenario for hazardous materials;
- Earthworks and soil stockpiling can lead to the mixing of different soil types, and also the changing of the soil structure which may influence overall fertility with implications for agricultural use and or habitat degradation. Similarly, mixing of excavated soil types can

result in the contamination of previously clean soils by contaminated soils should any contamination be encountered;

- Vegetation clearance and earthworks can lead to the exposure of surface soils to erosion and compaction resulting in potential changes to ecosystem habitats and interactions between stormwater and surface water receptors. Furthermore, in the unlikely event that disturbance of unidentified localised areas of contamination construction activities may result in mobilisation of contaminants;
- Land gas and/or residual volatile contaminants (if present) could pose a risk to construction workers within confined spaces (such as excavations for installation of new drainage/buried utility service lines). Given the absence of evidence to suggest significant ground contamination is present this scenario is only likely to occur in the event that localised unidentified and significant areas of contamination are present;
- In the event that soils excavated as part of the cut and fill works are unsuitable to be re-used as part of the Proposed Project or surplus to requirements, removal of excess materials may be required. Waste materials handling, which includes surplus cut material, is discussed in Chapter 16: Waste Management; and
- Dust emissions created by construction activities (especially vehicle movements) may include mobilisation of soil particles that are potentially contaminated (e.g. in the unlikely event that there is an unidentified localised and significant source of contamination that has been disturbed). Migration of potentially contaminated dust particles could present a potential health risk to construction workers and other human health receptors situated in the vicinity of the Proposed Project Area, though such a high level of potential contamination is considered unlikely at this site.

The likelihood of identification of previously unidentified areas of contamination during construction are considered ‘Unlikely’. Based on the above potential adverse impacts, and taking account of the design controls stated in the design controls section above, unidentified localised areas of land contamination (if present) has the potential to cause possible short term, infrequent, reversible impacts of a local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance.

Unplanned releases of contaminants during construction are considered to be of ‘Possible’ likelihood. With respect to the contamination of soil resources due to construction activities, and taking account of incorporated mitigation measures/design controls, there is considered to be the potential for short term, infrequent to periodic, reversible impacts of local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance.

In relation to soil disturbance and loss of topsoil resource across the Proposed Project Area, taking account of incorporated mitigation measures/design controls, there is considered to be the potential for short term, infrequent to periodic, reversible impacts of local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance.

### 13.5.2 Operation Phase Impacts

The following potential indirect and direct adverse impacts could occur when the Proposed Project reaches the operation phase:

- Uncontrolled release of fuels, liquids and chemicals stored at the airport due to unplanned events;
- Uncontrolled release of hazardous materials (including fuels) due to accidents along the Expressway;
- Accidental release of jet fuel during aircraft refuelling operations;

- Release of firefighting foam/powder due to emergency use for firefighting and/or use during practice drills;
- Potential release of contaminants to underlying ground as a result of aircraft/support vehicle accidents and maintenance activities;
- Uncontrolled release of hazardous materials due to waste storage and handling;
- Release of chemicals associated with water/wastewater treatment plants;
- Maintenance worker exposure to residual soil contamination (if present at previously unidentified localised areas of soil contamination); and
- Disturbance of soil due to vehicle movements on unsurfaced ground.

#### *13.5.2.1 Design Controls*

Mitigation measures required during the operation phase of the Proposed Project will be documented in the Occupational Health and Safety Management Plan, Hazardous Substance Management Plan, Pollution Prevention Plan, Emergency Response Plan and Emergency Spills and Abatement Management Plan. Management and control measures will take account of:

- Adoption of Good International Industry Practice (GIIP) for delivery, storage and containment of fuels and other hazardous materials, including bulk liquid storage, in accordance with the requirements IFCs Performance Standard 3: Resource Efficiency and Pollution Prevention (2012)[21] (to be incorporated in the Hazardous Substance Management Plan and Pollution Prevention Plan);
- Adoption of appropriate waste management procedures in accordance with guidance specified in Chapter 16: Waste Management (to be incorporated in the Waste Management Plan);
- Incorporation of Emergency Spills and Abatement Management Plan that covers the airport operations and potential release associated with vehicle movements along the Expressway;
- Use of firefighting foam/powder in a training environment in accordance with measures specified in IFC EHS Guidelines – Airports (to be incorporated in the Hazardous Substance Management Plan and Pollution Prevention Plan);
- Carryover of the unexpected finds protocol for contaminated soils to the operation phase Occupational Health and Safety Management Plan associated with the operation phase; and
- Soil materials management to be factored into Soil Management Plan.

#### *13.5.2.2 Impact Assessment Prior to Mitigation*

Based on the identified potential direct and indirect adverse impacts identified during the operation phase, with respect to unplanned contamination of soil resources during airport operation, it is considered that assuming incorporated mitigation measures, there is the potential for short term, infrequent, reversible impacts of local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance and the likelihood of an unplanned event occurring is considered to be ‘Possible’.

The likelihood of identification of previously unidentified areas of contamination during airport operation are considered ‘Unlikely’. However, in light of the above, taking account of incorporated mitigation, unidentified localised areas of land contamination (if present) encountered during the operation phase has the potential to cause possible short term, periodic, reversible impacts of a local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance.

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[21] IFC, 2012. Performance Standards on Environmental and Social Sustainability.

In relation to soil disturbance and loss of topsoil resource across the Proposed Project Area, taking account of incorporated mitigation measures/design controls, there is considered to be the potential for short term, infrequent to periodic, reversible impacts of local extent upon medium sensitivity receptors. These impacts would be of overall **Minor Adverse** significance.

## 13.6 Recommended Mitigation Measures

Further mitigation measures (in addition to assumed incorporated mitigation) include the following operational controls:

- Targeted assessment of identified potential localised sources of contamination (if present) ahead of construction to allow assessment and if management/remediation if required;
- Installation of boreholes to assess the potential for perched groundwater to be present and allow for improved conceptual understanding of potential pathways for soil contamination (if present);
- Implementation of an Environmental and Social Management System (C-ESMP) and overarching construction and operation Environmental and Social Management Plans (C-ESMP and O-ESMP);
- Implementation of procedures and defined schedules for maintenance of assets and ageing asset replacement criteria, in particular for; fuel storage and distribution assets, interceptors and drainage and hazardous material containment measures; and
- The addition of permanent or temporary barricading and appropriate signage to prevent traffic movements on unsurfaced ground during airport operation.

## 13.7 Residual Impact Assessment Conclusions

Assuming that recommended mitigation measures have been applied the overall significance for each of the identified adverse construction and operation phase impacts is still considered to be **Minor Adverse**. This outcome is driven primarily by receptor sensitivity which remains medium.

## 13.8 Summary of Mitigation and Residual Impacts

Table 13-7 provides a summary of the impacts and mitigation measures associated with impacted soils 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 13-8: Summary of Findings**

| Impact | Receptor | Phase | Impact Magnitude | Receptor Sensitivity | Pre-mitigation Impact Significance | Design, Enhancement or Mitigation Measures | Management Plan | Residual Significance |
|---|---|---|---|---|---|---|---|---|
| Contamination of soil resources due to unplanned release event (e.g. release of hazardous substance due to spillage or catastrophic tank failure) | Soil resources (other environmental receptors such as water resources, and ecology are discussed in the associated chapters), Human Health | Construction | **Impact magnitude:** Low<br>**Extent:** Local<br>**Duration:** Short term<br>**Frequency:** Infrequent to periodic<br>**Reversibility:** Reversible | Medium | **Minor Adverse**<br><br>*Likelihood (as unplanned event): 'Possible'* | • Adoption of management plans (as detailed in the next column);<br>• Implementation of procedures and defined schedules for maintenance of assets and ageing asset replacement criteria, in particular for fuel storage and distribution, interceptors, drainage and hazardous material containment measures;<br>• Installation of boreholes to assess the potential for shallow perched groundwater to | • C-ESMP<br>• Pollution Prevention Plan<br>• Hazardous Substance Management Plan<br>• Occupational Health and Safety Management Plan<br>• Emergency Spills and Abatement Management Plan<br>• Emergency Response Plan<br>• Waste Management Plan<br>• Soil Management Plan<br>• Site Clearance, Excavations and Earthworks Management Plan | **Minor Adverse** |

**Table 13-8: Summary of Findings**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | be present, allowing for improvement conceptual understanding of potential pathways for soil contamination. | | |
| Identification of previously unidentified soil contamination | As above | Construction | **Impact magnitude:** Low<br>**Extent:** Local<br>**Duration:** Short term<br>**Frequency:** Infrequent<br>**Reversibility:** Reversible | Medium | **Minor Adverse**<br><br>*Likelihood (as unplanned event): 'Unlikely'* | • Adoption of management plans (as detailed in the next column);<br>• Targeted assessment of areas of identified contamination (if identified as an unexpected find or through further site walkover and assessment); and<br>• Development of unexpected find protocol and education of staff implementing reactive control measures. | • C-ESMP<br>• Occupational Health and Safety Management Plan<br>• Site Clearance, Excavations and Earthworks Management Plan<br>• Environmental Induction and Training Plan | **Minor Adverse** |

**Table 13-8: Summary of Findings**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Soil disturbance and loss of top-soil resources | Soil resource | Construc-tion | **Impact magnitude:** Low<br>**Extent:** Local<br>**Duration:** Short term<br>**Frequency:** Infrequent to periodic<br>**Reversibility:** Reversible | Medium | **Minor Adverse** | • Adoption of materials management measures; and<br>• Control of areas in which vehicle trafficking can occur through the addition of temporary or permanent barricading and application of good industry practice when handling soil resource and trafficking in proximity to soil stripping/storage areas. | • C-ESMP<br>• Soil Management Plan<br>• Site Clearance, Excavations and Earthworks Management Plan<br>• Traffic Management Plan | **Minor Adverse** |
| Contamination of soil resources due to unplanned release event (e.g. release of hazardous substance due to spillage or catastrophic tank failure) | Soil resources (other environmental receptors such as water resources, and ecology are discussed in the associated chapters), Human Health | Operation | **Impact magnitude:** Low<br>**Extent:** Local<br>**Duration:** Short term<br>**Frequency:** Infrequent<br>**Reversibility:** Reversible | Medium | **Minor Adverse**<br><br>*Likelihood (as unplanned event): 'Possible'* | • Adoption of management plans (as detailed in the next column)<br>• Implementation of procedures and defined schedules for maintenance of assets and age- | • O-ESMP<br>• Occupational Health and Safety Management Plan<br>• Emergency Spills and Abatement Plan<br>• Emergency Response Plan | **Minor Adverse** |

**Table 13-8: Summary of Findings**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | ing asset replacement criteria, for fuel storage and distribution, interceptors, drainage and hazardous material containment measures. | • Waste Management Plan<br>• Hazardous Substance Management Plan<br>• Pollution Prevention Plan | |
| Identification of previously unidentified soil contamination | As above | Operation | **Impact magnitude:** Low<br>**Extent:** Local<br>**Duration:** Short term<br>**Frequency:** Periodic<br>**Reversibility:** Reversible | Medium | **Minor Adverse**<br><br>*Likelihood (as unplanned event): 'Unlikely'* | • Adoption of management plan (as detailed in the next column);<br>• Targeted assessment of areas of identified contamination (if identified as an unexpected find or through further site walkover and assessment); and<br>• Clean up and remediation as appropriate. | • O-ESMP<br>• Occupational Health and Safety Management Plan (to include unexpected finds protocol) | **Minor Adverse** |
| Soil disturbance and loss of topsoil resources | Soil resource | Operation | **Impact magnitude:** Low<br>**Extent:** Local | Medium | **Minor Adverse** | • Adoption of permanent or temporary barricading and | • O-ESMP | **Minor Adverse** |

**Table 13-8: Summary of Findings**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | **Duration:** Short term<br>**Frequency:** Infrequent to periodic<br>**Reversibility:** Reversible | | | appropriate signage to prevent traffic movements on unsurfaced ground;<br>• Soil materials management to be factored into the Pollution Prevention Plan; and<br>• Application of good industry practice in handling and management of soil resource during operations. | • Pollution Prevention Plan<br>• Traffic Management Plan | |