GREEN CITY KIGALI

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FINAL FEASIBILITY STUDY

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ABBREVIATIONS

BMZ	German Ministry for Economic Cooperation and Development
BRD	Development Bank of Rwanda
CoK	City of Kigali
CSO	Civil Society Organization
EDPRS2	Second Economic Development and Poverty Reduction Strategy (Later replaced by NST1)
EMIP	Environmental Management and Implementation Plan
ESIA	Environmental and Social Impact Assessment
ESMF	Environmental and Social Management Framework
ESMP	Environmental and Social Management Plan
EU	The European Union
FONERWA	Rwanda Environment and Climate Change Fund / Rwanda Green Fund
FS	Feasibility Study
GAP	Gender Action Plan
GCF	Green Climate Fund
GCK	Green City Kigali
GGGI	Global Green Growth Institute
GoR	Government of Rwanda
HH	Household
HtO	Help to Own Mortgage Assistance Programme
IFC	International Finance Corporation
JV	Joint Venture
KfW	Kreditanstalt für Wiederaufbau/German Development Bank
LDP	Land Development Plan
LGI	Local Government Institute
MINALOC	Ministry of Local Government
MINECOFIN	Ministry of Finance and Economic Planning
MININFRA	Ministry of Infrastructure
MoE	Ministry of Environment
MoU	Memorandum of Understanding
NDC Nationally	Determined Contribution

NST 1	National Strategy for Transformation (2017-2024)
PAP	Project Affected Person
PAH	Project Affected Household
PPF	GCF's Project Preparation Facility
RAP	Resettlement Action Plan
RFP	Request for Proposal
RPF	Resettlement Policy Framework
REMA	Rwanda Environment Management Authority
RIBA	Royal Institute of British Architects
RHA	Rwanda Housing Authority
RSSB	Rwanda Social Security Board
RwaGBO	Rwanda Green Building Organization
RWH	Rainwater Harvesting
SACCOs	Savings and Credit Cooperative Organisations
SESA	Strategic Environmental and Social Assessment
SPV	Special Purpose Vehicle
SWM	Solid Waste Management
ToR	Terms of Reference
UADC	Urban and Architectural Design Consultant
UNFCCC	United Nations Framework Convention on Climate Change
UN-Habitat	United Nations Human Settlement Programme
WB	The World Bank
WUF	UN-Habitat's World Urban Forum

EXCHANGE RATES

1 Euro (EUR) = 1.18 US Dollar (USD)

1 US Dollar (USD) = 950 Rwanda Francs (RWF)

(note that rates are liable to change and are noted as of April 2021, src : Bloomberg)

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1 INTRODUCTION

Figure 1: The future GCK Pilot (src. Confidential)

Table 1: Key Project Information Snapshot

Project location	Rwanda, Kigali, Kinyinya Hill (Gasabo district)
Project description	Realization of a 15.8 ha mixed-use affordable housing pilot (First phase) within a 600ha GCK green city planning area (Kinyinya Hill).
Lead executing agency	Rwanda's Green Fund, FONERWA (feasibility and masterplanning) Green City Kigali Company (implementation)
Supported by	German Federal Ministry for Economic Cooperation and Development (BMZ), implemented by KfW Development Bank, Green Climate Fund (GCF)
Time horizon for implementation	2018 – 2028 (Projected)
Organizational structure	Government owned vehicle acting as a developer for site with sale of land for development of housing and commercial by a private partner (PPP).
Target group	Middle Income Households earning less than 700k RWF/mo for affordable housing units (as per RHA Affordable Housing requirements and further World

	Bank Mortgage Assistance programme requirements for eligibility). Higher income households for purchase of market housing units (1.2m RWF/mo+).
Total estimated costs and financing	Total Costs excluding Financing, Management Consultants & Supervision 74 529 000 USD Sales receipts = construction cost plus 20% for affordable housing 30 mio. EUR financed by KfW infrastructure grant

1.1 Project goal

Rwanda's Green Fund (FONERWA) has secured funding from the German Development Cooperation through KfW Development Bank and the Green Climate Fund's Project Preparatory Facility (PPF), to prepare a feasibility study and to conduct an international design competition and tender process to select an Urban and Architectural Design Consultant (UADC) to undertake urban planning, infrastructure and architectural design services associated with the 'Green City Kigali'. In addition, funding was provided to support establishing a special purpose vehicle (SPV) that will serve as the central vehicle for the project's implementation. This SPV is known as the Green City Kigali Company (GCKC).

The GCK project seeks to develop a model community in the 600-ha Kinyinya Hill area (Planning Area) of Gasabo, a district in the capital city, Kigali. The model will provide affordable housing for target groups in sustainable and culturally compatible, climate-resilient urban communities, which establishes new standards that can be replicated elsewhere in Rwanda and beyond - setting a trajectory towards a Net Zero future. The first stage of this model community will be in the form of a mixed-use pilot situated on a 15.8-hectare parcel (Pilot Area) at the northwest of the Planning Area.

The project seeks to reflect the Rwandan context in terms of its current and future cultural and environmental climate. Doing so engages with the challenges of housing affordability and supply, vulnerability to climate change, and increasing urban sprawl.

A project vision or goal has been developed during the feasibility process to align all stakeholders toward achieving the objectives of the Green City Kigali project. The vision is the key point of reference for setting the targets and outcomes for the spatial and socio-economic development of the GCK planning area. This vision statement is as follows: "*Residents of Kinyinya Hill should be able to enjoy the social and economic benefits of urbanization while minimizing ecological footprints.*"

Pursuant to this GCK goal has been established a series of project outcomes or foundations that are referred to and used to identify how a project characteristic or output provides for the project's sustainability and, ultimately, its goal.

Throughout this report, these foundations are referred to and used to identify how a project characteristic or component provides for the Project's sustainability and, ultimately, its goal. The table below presents the project goal and outcomes, as well as key development outputs for the new mixed-use pilot (15.8ha).

Table 2: GCK Goals and Outcomes and Key GCK Pilot Development Outputs

GCK Goal
Residents of Kinyinya Hill should be able to enjoy the social and economic benefits of urbanization while minimizing ecological footprints
GCK Outcomes
Green City Kigali: A solutions-based pilot for green urbanization in Rwanda. an urban development model for increased resilience against the consequences of climate change and the ensured sustainable urban development of Rwanda through the development of a model community at Kinyinya Hill. via Four Foundations of Sustainability that serve as the project outcomes. (See Section 2.3). • An affordable and socially equitable development • Climate change adaptation and mitigation • Resource and land efficiency at the core of development • A culturally sensitive urban development
Key Development Outputs (GCK Pilot)
The feasibility study process, (as presented at Chapter 6 and 7) result in the following key outputs through the development of a 16ha model community (pilot project) which is based around the GCK livable city concept and which employs resource efficient and climate change mitigative building technology and infrastructure. Key outputs include: <u>Housing:</u> 1680 housing units in total, of which 1430 are affordable housing. Affordable unit sizes from circa 30m^2 to 80m^2 (Studio, 1 BD, 2 BD, 3BD) based within simple walkup multi-storey buildings of up to 5x floors (G+4), serving a population of circa. 7,728. Affordable units are designed be affordable to those earning incomes between 250k – 700k RWF/mo (See Section 7.3.1) Buildings developed using cost efficient and sustainable resources and employing environmental design features (see Section 6.5 and 6.7). All buildings achieve EDGE Advance certification (which applies to public buildings as well). A medium to high density development (approx. 108 DU/ha), while providing open spaces (public, semi-private and private) and maintaining a human scale through limiting building heights. <u>Physical infrastructure (refer to Section 6.8.10 for a more detailed summary):</u> Transport and mobility: A road network, developed using sustainable and low carbon materials and methods, which promotes the use of public and non-motorized transport modalities and draws upon the GCK transport vision (see Section 6.8.4)

Energy & ICT: Metered electrical connections supplied to all homes and businesses via the national grid (REG) and LPG cooking facilities made available (Chapter 6.8.7). All buildings are solar energy and water heating install ready, with key public buildings including install at outset (see Section 6.7.1).

Water supply: Metered water supply connections to all homes via the municipal WASAC network and supplemented by grey water sourced from rainwater harvesting (RWH), with RWH system also acting as retention and control point for sustainable urban drainage network. (See Section 6.8.5)

Sanitation: Simplified sewerage and treatment system serving all homes and businesses. Simplified sewerage with reduced embodied carbon compared to traditional systems and recommended semi-centralized system with lower energy requirements. (See Section 6.8.6)

Waste Management: Waste sorting space provided for each 60 HH and within 200m of HH to allow for sorting into organic, recyclable and residual waste. Employment of "waste ambassadors" to provide training to residents around waste separation. (See Section 6.8.8)

Climate resilient stormwater management: (See Section 6.3.3 and 6.8.9): The use of nature-based stormwater management systems for the local treatment, detention and infiltration of stormwater. Result is reduction of erosion and increase of groundwater recharge.

For a summary of roles and responsibilities regarding provision see Section 7.4

Public and Community Spaces: Pursuant to CoK Masterplan and Rwanda UPC requirements as regard community facilities, the following are proposed as part of the GCK Pilot Project in recognition of it as a neighborhood and forming part of the larger Ngaruyinka Village and Murama Cell: (see Section 6.5.4)

Commercial: Neighborhood Centre and Market Square (2,500 m^2)

Education: Primary and Nursery School (6,000m^2, including use of park and sports field for outside activities)

Socio-cultural: Community Hall (utilizing auditorium space of primary school with size to be determined in conjunction with UADC as part of overall school programming)

Socio-cultural: Religious, Youth and Social Space: 1,400m^2

Parks: Neighborhood Park and Sports Field (nearby to primary school, for cross use): 4,050m^2

Public Realm: Public plazas and squares using semi-porous materials for natural stormwater infiltration as part of nature-based system: 5,200m^2

Project Delivery and Implementation Arrangements:

Government owned special purpose vehicle in the form of a community benefit company (Green City Kigali Company) established and responsible for management of the project master planning, design and tender process, land transfer and development of the site with infrastructure, potential development of housing and commercial, and shared operations and maintenance (in conjunction with municipality and utilities – see Section 7.4) of infrastructure and public buildings/areas.

Enforcement and verification of project sustainability ambitions through use of contract covenants by GCKC (see Section 6.8.2)

GCKC enters into agreements with relevant utilities and municipal authorities as regards provision and operations of public infrastructure (See Section 7.4).

GCKC potentially enters into agreement with private developer counterparties for transfer of land for development of commercial and residential buildings.

1.2 Formal Project Information

The Government of Rwanda (GoR) has declared the development of sustainable urban areas to initiate a paradigm shift towards green urbanization a thematic priority area in the National Strategy for Transformation 1 (NST 1).

The foundations for Green City Kigali started 2017 when the Ministry of Environment and its partners signed a Memorandum of Understanding (MoU) to work towards integrated green concepts and the designation of the Kinyinya area Gasabo District as the project site. This project expects to serve as a blueprint and model for sustainable urban development in Rwanda.

FONERWA has commissioned a SWECO Joint Venture (JV) to undertake:

- Phase A (Feasibility Study)
- Phase B (Tender and Design Competition) of the project.

This document is the Final Feasibility Study, based upon a previous and expanded report issued in November 2020 and which follows the Mid-term Feasibility Study issued in October 2019.

1.3 Project Phasing

The activities undertaken under the Project are broadly divided into three main phases:

Phase A - Feasibility Study *(November 2018 – October 2019);* delivers an implementation framework for the Green City Kigali project.

Phase B – Tender and Design Competition *(November 2019 – September 2021);* delivers: i) tendering of Consulting Services for Urban, Infrastructure and Architectural Design Works, ii) establishing an overarching delivery vehicle, iii) preparation of the Green Climate Fund (GCF) funding proposal for submission by FONERWA (which continues into Phase C) and finally, iv) ongoing support to FONERWA with the management of the Feasibility Study.

Phase C - Detailed Design *(October 2021 – May 2023);* delivers design of a 600-ha concept masterplan including detailed masterplan, design and tender documents for a 16-ha mixed-use affordable housing pilot. This phase also anticipates the further development of the overarching delivery vehicle (Green City Kigali Company) ahead of the roll-out of the pilot project.

Phase D – Construction *(Projection, 2023-2028, 3 Phases)*; the construction of the first 16 ha mixed-use affordable housing pilot.

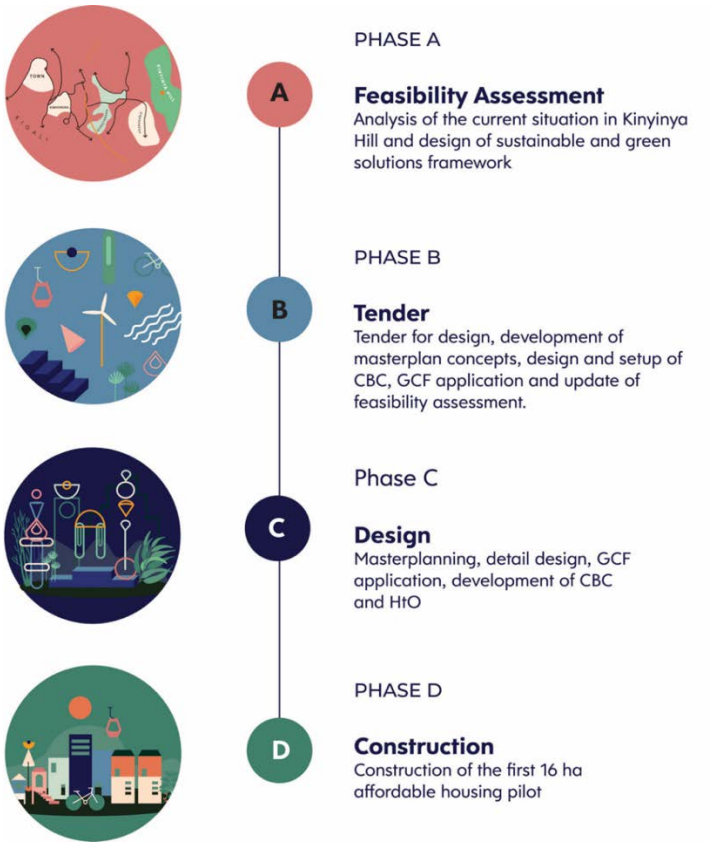

Figure 2: GCK Timeline, Phase A through D

1.4 Project Results

Project results refer to the specific deliverables to support the development of the Green City Kigali project. The project results referred to here are those developed by either the FS consultant (Sweco JV) or UADC. The expected results are:

1. A land development plan (masterplan) for the overall 600-ha Kinyinya Hill site for incorporation into the overall CoK Masterplan.
2. A detailed masterplan for a 15.8-ha mixed-use affordable housing pilot.
3. Construction ready design for the pilot development.
4. A land development plan for the urban upgrade of an existing 18ha community (Ngaruyinka) adjacent to the identified pilot project (*see Ngariyinka Upgrade Feasibility Study, Sweco 2020, for further information).*
5. A funding proposal submitted to the Green Climate Fund (GCF).
6. The design and establishment of an overarching delivery vehicle (SPV) for the development and management of the future pilot project.
7. Supporting environmental and social safeguard studies and frameworks.

In addition to project results above, a number of communication and outreach projects have been initiated.

1.5 Objectives of this report

This Final Feasibility Study aims to provide stakeholders with a comprehensive yet concise overview of the proposed Green City Kigali project, with a particular focus upon the mixed-use affordable housing pilot project, as a realized example of the overall project's goals. The report is presented in the form of a summary based upon an earlier and expanded version of the report (November 2020) and presents how the project aims to achieve its ambitions regarding green urbanization within the context of its site, demonstrates the business case for the development of the pilot, and indicates how we envision the implementation. Further, it presents the existing socio-economic and natural context, the main features required to carry out the project, risks, and outlook. The feasibility study was conducted with an objective, unbiased approach, providing reliable decision-making information.

For the purposes of this document, the term 'Planning Area' or 'Project Site' covers the totality of areas where project-related activities take place and areas influenced by project-related activities, including surroundings. In short, the 600-ha Kinyinya Hill site. The terms' Pilot Area', 'Pilot Site' or 'Pilot' refer to the 15.8-ha area (and commonly referred to as 16ha) where the planned mixed-use affordable housing project will take place (see below).

Figure 3: Boundaries of 600ha GCK Planning Area (Red) and 16ha Pilot Site (in green)

1.6 Guidance to the Reader

This Final Feasibility study was written to give stakeholders, investors, donors, and other interested parties a condensed account of the first 15.8-ha phase of Green City Kigali, and where relevant the larger 600-ha project. This report also includes elements from the winning proposal from the international design competition for the project, carried out in the spring of 2020. The contract with the winning Urban and Architectural Design Consultant (UADC) was not finalized at the time of writing this report, and why they are not listed in the report by name.

The report includes a short introduction and description of the project context, the basis for analysis that informed the project with focus on the 15.8ha first phase. The report also summarises identified green infrastructure relevant for the project, provides an outline of the financial model and implementation framework, and outlines the process going forward.

This report should read as a complete and stand-alone report. Should the reader be interested in more in-depth descriptions of the project, further project documentation is available at the Green City Kigali website (www.greencitykigali.org).

2 PROJECT OVERVIEW

2.1 Climate Change and Urbanization Challenges: A Snapshot

Figure 4: Rwanda, 'Land of a thousand hills'

2.1.1 Overview

Rwanda has seen significant economic development in recent years, with an average GDP growth rate of 7.5% during the past ten years and 9.8% in 2019. GDP per capita has increased significantly from 218 USD in 2001 to 802 USD in 2019[1]. Agricultural production has doubled since 2007, and industry and services are expanding. Development is supported by increasing access to electricity and fiber optics across the country. Fourteen years after joining the East Africa Community, Rwanda is now contributing positively to development in the region.

However, Rwanda's future socio-economic development is uncertain. Population growth and climate change causes increased demand for natural resources such as land, water, food, and energy. Rwanda has the highest population density in mainland Africa, and the population is growing at 2.8% per year. Forecasters predict the population will double from 11 million in 2019 to 26 million by 2050, with a population density of 987 people per square kilometre. The population of Kigali was estimated to 1.6 million in 2020 and projected to grow to 2.5 million by 2032. By this estimation, Kigali would have an average annual population growth rate of 4.0% per annum.[2]

If this rapid urbanization is managed correctly and coupled with the continued expansion of economic opportunity and services, Rwanda's cities can be instruments for wealth creation. Alternatively, Rwanda faces the risk of urban slums developing with associated health and social problems. Job creation, education, health care, and social protection are needed to address the challenges with population growth. At the same time, urban areas must use land more efficiently, provide quality, livability and be resource efficient to support a growing and skilled workforce.

1 World Bank - Data
2 International Growth Centre, July 2019

Rwanda has one of the lowest GHG emissions per capita globally, estimated at 0.65 tonnes CO2/person (including land-use change), compared to a global average of 4.63 tonnes CO2/person[3]. Other sources report slightly higher numbers 0.75-0.8 tonnes CO2/person[4]. Despite this low per capita emissions, Rwanda is one of the most vulnerable countries globally to climate change. The climate associated risk is primarily caused by carbon emissions emitted beyond its borders.

According to the National Strategy on Climate Change and Low Carbon Development (Green Growth and Climate Resilience 2011) there are a few 'big wins' that, if implemented, will make a significant impact on adaptation, mitigation, and economic development. High-density walkable cities are identified as one of the three big wins. If this is not achieved Rwanda will face unprecedented levels of urban sprawl, partly due to hilly terrain. The sprawl will force people to travel greater distances than necessary, with motorized transport resulting in higher transport costs for the population, increased air pollution and GHG emissions. Reducing urban sprawl would also bring important benefits such as lowering housing pressure on steep slopes vulnerable to flooding and landslides. Environmentally sustainable, climate-resilient, and green economic growth is as a result an established development priority of the Government of Rwanda.

2.1.2 Challenges Illustrated

A concise way to illustrate climate change and rapid urbanization-related challenges in the Project Area and Kigali is through a Problem Tree. Through the metaphor of a tree, it presents relationships between a problem (trunk), its causes (roots), and its effects (canopy). Below we visualise the Problem Tree Analysis.

3 Rema (2018) Compendium of Environment Statistics, Rwanda
4 IGC 2018 (The Economics of Low Carbon Cities: Kigali, Rwanda), Global Carbon Project 2018.

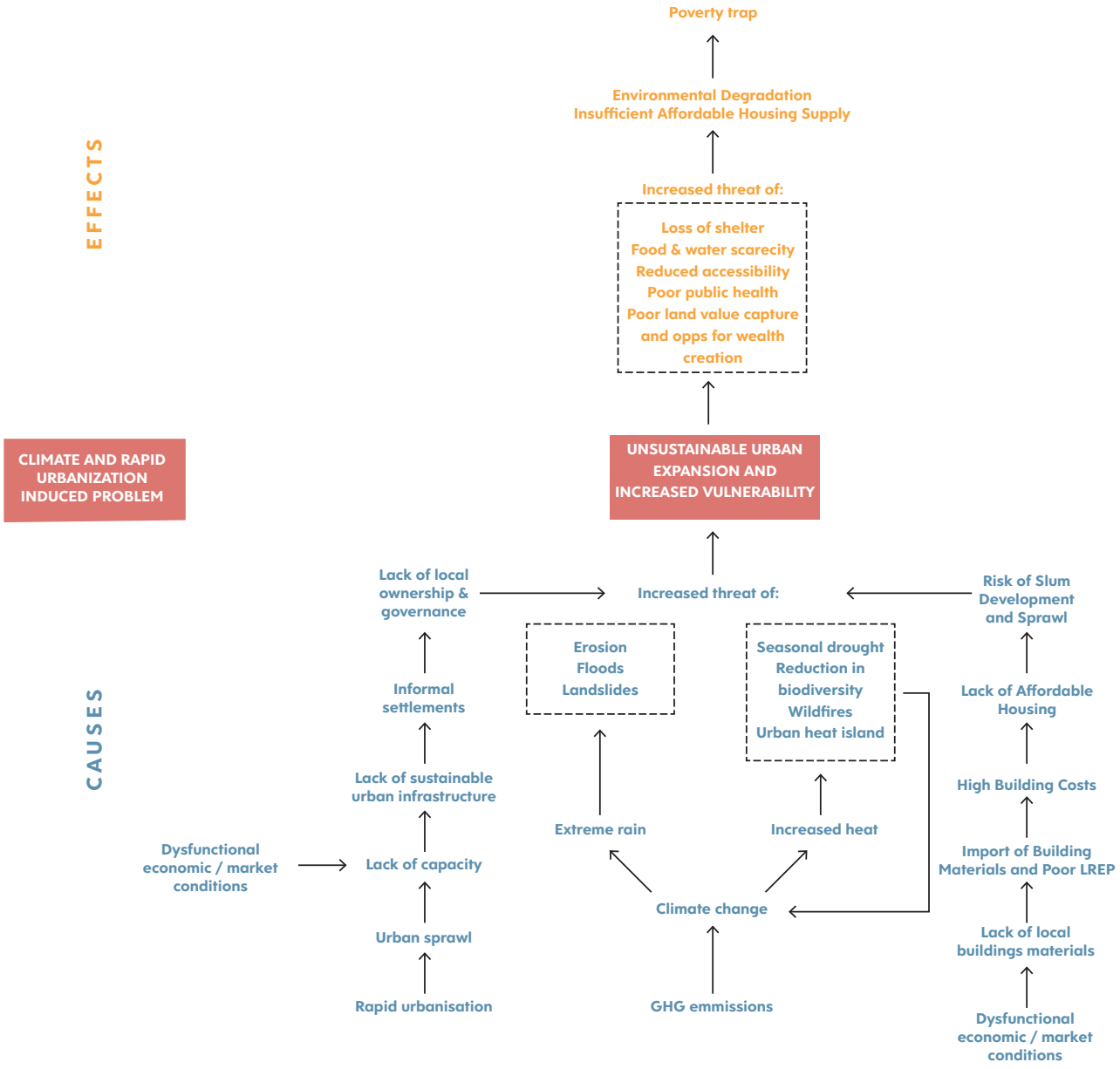

Figure 5: Problem Tree Analysis

2.1.3 Climate Risks

As indicated previously, Rwanda is one of the most vulnerable countries in the world to climate change. The country experiences high levels of climatic variability and natural hazards due to the current climate and the influence of El Niño – Southern Oscillation (ENSO) events.[5] It is particularly affected by heavy rainfall. The hilly terrain in Rwanda contributes to frequent floods and landslides. Droughts are also a recurring event in Rwanda, often leading to famines, loss of biodiversity, depletion of water resources, and increased disease rates.

Notwithstanding historical weather patterns, Kigali faces a changing climate with increasing average temperatures of 1.4-2.3 degrees Celsius coupled with an increasing frequency of heatwaves from an average of 7 days to 22 days per annum. Rainfall patterns are predicted to become more extreme with increased frequency of heavy rainfall and intensity contrasting with a likely increase in the duration of dry spells.

5 National Oceanic and Atmospheric Administration (NOAA), 2019

The consequences of these changing weather patterns for Kigali are likely to include periods of water shortage, decreasing water quality, increasing risk of vector-borne disease, and impact on biodiversity together with the risk of flooding and landslides.

2.1.4 Housing Market and Urbanization Risks

Due to rapid urbanization, Kigali faces three main challenges in terms of its housing market: housing affordability, housing supply and urban sprawl.

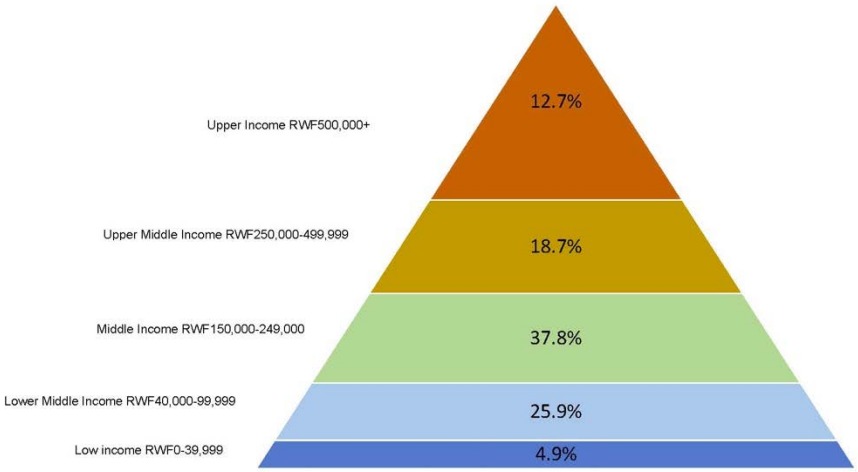

Figure 6: Income (Monthly) Distribution in Kigali 2017 (IGC), based upon data from EICV 5.

Housing Affordability

Rwanda has high housing costs compared to Gross National Income (GNI) per capita. This is primarily the result of housing development costs far outstripping income levels. The high costs are mainly linked to the scarcity of local building materials, the high price of imported materials (a consequence of Rwanda being a land-locked country), skills and the high cost of financing. As a comparison, around 85% of the population of Kigali earn less than $500 and about 31% live on less than $100 per month.[6]

This situation is compounded by the state of the capital and mortgage markets. Banks are undercapitalized, and household mortgage interest rates are very high (around 16% per annum), with typical deposits ranging about 20% and fees reaching 10% of the purchase price. Consequently, Rwanda's mortgage penetration rate is meager.

Although households are estimated to spend around 35% of household income on housing costs, at present good quality, affordable homes are generally out of reach at almost all levels of the income pyramid. This situation is aggravated by a demand for affordable housing that far outstrips supply.

Housing Supply

With the construction sector operating at full capacity, additional housing needs in Kigali will take time. As a result, the issues outlined above regarding affordability; Kigali housing needs are projected to over 30,000 new homes per annum. Less than 3,000 homes are likely to be completed a year given the current conditions, and most of these homes will only be affordable for the top 13% of households in the income pyramid (figure 6). The relatively high selling prices of the homes put on the market are due to the high costs for development, including high building material prises, high finance costs and lack of accessible mortgages as described above.

6 International Growth Centre, 2017

Figure 7: Lower density housing in Kigali

Rapid Urbanization, Population Growth and resulting Sprawl

Rwanda's current low-density housing development patterns threaten both the country's food security and environmental assets by encroaching on rural areas. In Kigali it also means expanding the city making transport distances long, and where the urban structure is not conducive to active mobility, walking and cycling.

Culturally, Rwandans place a strong emphasis on privacy and prefer larger single-family homes with enclosed private outdoor spaces. The emphasis on privacy contributes to lower density urbanisation patterns despite national and local government policies promoting increased densification. However, the younger generations in Kigali see the benefits of medium to high-density ways of living, and evidence gathered through consultation has shown that even older Rwandans are positive about the need for this transition. Further, the new CoK Masterplan largely prohibits large plot sizes within the city in an effort to increase densification.

In Kigali, a further complexity occurs with informal or unplanned settlements. At the city scale, the key driver for the creation and growth of informal settlements is through rural to urban migration of persons searching for better economic opportunities. Informal settlements have a significant presence with varying degrees of housing quality, infrastructure, and connectivity. A particular issue is the lack of sanitation and social infrastructure, as settlements are often located far from municipal services.

In Kigali, there has been an effort to relocate inner-city informal settlement populations to new developments on the city periphery, see for example section 4.3.5. However, once resettled, people may sell or rent out these units and return to more central informal settlements. Because there is such large demand for housing the resettled families can sell/rent out the housing at a premium, contributing to that the resettlement initiatives have not decreased the informal settlements to the extent envisioned.

2.2 GCK as a Mechanism for Providing Solutions to Climate Change and Urbanization Challenges

2.2.1 Background

Environmentally sustainable, climate-resilient, and green economic growth is an established development priority of the Government of Rwanda. Since 2005, Rwanda has operationalized a sustainable financing mechanism to achieve these objectives, known as the Rwanda Green Fund, or locally as FONERWA[7]. FONERWA´s purpose is two-fold: to act as an instrument to facilitate access to an international donor environment and climate finance and to streamline and rationalise external aid and domestic finance. The fund invests in the best public and private projects that have the potential for transformative change and align with Rwanda's commitment to building a robust green economy.

The National Urbanisation Policy[8], published in 2015, is a main policy informing an integrated urban planning and management to achieve resource efficient and compact growth. It further underlines the efficient use of land and strategic investment based on green economic development principles. The National Strategy for Transformation (NST1), includes Priority Area 2, accelerating sustainable urbanization from 18.4% (2016/17) to 35% by 2024. Sustainable urbanization is delivered through six key strategic interventions which include the development of transformative projects in key urban areas.

In the 2013 Kigali Masterplan, Kinyinya Hill was explicitly identified as a 'Catalyst Project' for masterplan implementation priority Phase 1 and a 'nodal development location' within the Murama Cell of the 'Residential Township in Kinyinya Sector' Sub Area Plan. In the 2020 Kigali Masterplan, the site was targeted for the expansion of medium and high-density residential development through the introduction of R2 and R3 zoning (formerly R5 in the draft plan). A C3 zoned, higher density 'City Commercial Zone' is indicated where the existing community's centre is located. Overlaying the various residential zones are C2-O mixed use overlay zones.

In addition, the National Strategy for Climate Change and Low Carbon Development promotes, as part of its strategy, the development of higher density and walkable neighbourhoods.

2.2.2 Green City Kigali: A Solutions Based Pilot for Green Urbanization in Rwanda

As indicated previously, the Green City Kigali (GCK) project aims to provide an urban development model for increased resilience against the consequences of climate change and the ensured sustainable urban development of Rwanda through the development of a model community at Kinyinya Hill. GCK intends to provide this by integrating various solutions such as pilot developments that allow users to enjoy the social and economic benefits of urbanization while minimizing ecological footprints.

Below is presented a Solution Tree to help succinctly illustrate the solutions proposed by the Green City Kigali project to resolve the core problems described in the Problem Tree (Figure 5). The GCK Solution Tree, with regards to climate change and urbanization was created by mapping solutions relevant to the Planning Area which conform to national policy, regulations, and best practice, onto the Problem Tree framework. It is then followed throughout this report on how these solutions were arrived at, how they are measured, and how they might be implemented.

7 http://www.fonerwa.org/
8 Rwanda_National_Urbanization_Policy_2015.pdf

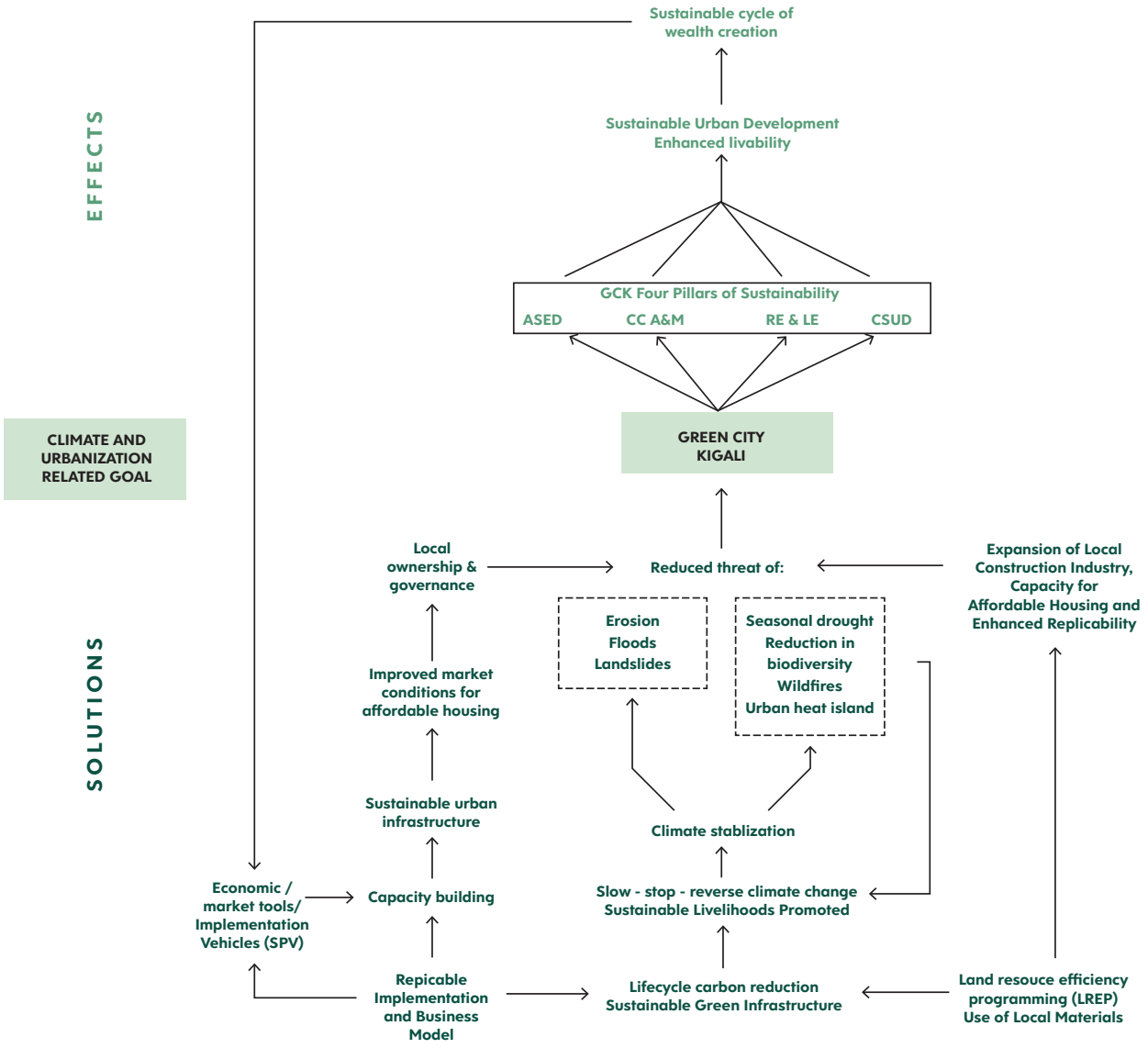

Figure 8: Solution tree

2.3 The GCK Four Foundations of Sustainability (Project Outcomes)

For Green City Kigali, to realize its ambition to be a transformative project that impacts urban development patterns within the Planning Area, and ultimately Kigali and Rwanda's secondary cities, will need to deliver on the country's climate change, sustainable urbanization, and affordable housing commitments[9]. In addition, the GCK project will need to contribute to the UN 2030 Sustainable Development Goals and the New Urban Agenda.

The GCK Four Foundations of Sustainability were developed with this in mind and to provide a measurable sustainability framework for delivering a socially, economically, and environmentally sustainable urban community and integrating the various solutions to problems outlined in previous sections. The Four Foundations of Sustainability

9 https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Rwanda%20First/INDC_Rwanda_Nov.2015.pdf

derive from global sustainability goals and the specific social, environmental, and economic conditions in Kigali and more widely throughout Rwanda. Throughout this report, these foundations are referred to and used to identify how a project characteristic or development output provides for the Project's sustainability and, ultimately, its goal.

Figure 9: The Four Foundations

These Four Foundations are:

Affordable and Socially Equitable Development: Tackling poverty and social and spatial inequalities through cost-effective and efficient sustainable development; offering a diverse range of housing types and sizes to enable low to medium income households to invest and thrive in vibrant, socially equitable communities and sustainable local economies.

Climate Change Adaptation and Mitigation: Significantly lowering carbon footprints compared to 'business as usual', through integrated and synthesized development planning which mitigates and adapts to the effects of climate change – especially atmospheric temperature increase and extreme weather events such as rainstorms and flooding.

Resource Efficiency: Design, construction, and strategies for long-term operation which makes efficient use of resources and creates circular economies in terms of land, water, energy sources, and ecosystem services.

Culturally Sensitive Urban Development: By taking into account Rwanda's modern, globally oriented green economy and tradition-conscious spatial planning and design, thereby increasing urban livability and desirability through community cohesion, unity and interaction, access for all, social equality, public safety, health, wellness and learning throughout the urban environment.

2.4 The GCK Pilot Project (15.8ha)

The first phase of implementation of the GCK is the delivery of a mixed-use affordable housing pilot, see figure 10 below. This project will be implemented on a 15.8ha site within a larger 130ha RSSB owned greenfield plot. The project will demonstrate the realization of the GCK's Four Foundations of Sustainability through the development by a specially established special purpose vehicle known as the Green City Kigali Company (GCKC), of a model community. Outlined below are the key components of this project:

- **Provision of affordable housing:** Approximately 1,680 housing units will be developed, of which 1,430 units are affordable to those earning less than 700,000 RWF per month.
- **Efficient land use:** Through optimization of land resources to reduce the plot area required per housing unit (in line with national policy goals), while also benefitting residents through lower unit costs and a more central city location.
- **Utilize local labor, skills, and materials:** The construction of the pilot will, where feasible, aim to build skills and capacity by utilizing local labor and local materials; thereby maximizing the benefit to the local economy while minimizing environmental impact.
- **Adopt passive design strategies together with the use of natural systems:** The design of the pilot will maximize the use of passive design strategies and create a pathway to a net-zero future, working within the site's

natural capacity while optimizing the use of natural systems such as sustainable urban drainage, rainwater harvesting, sewerage treatment, waste recycling, energy production, etc.

- **Work with nature in all its forms:** The city's layout will work with the natural topography of the site, utilizing ecosystem services while protecting and enhancing its natural environment and biodiversity.
- **Be resilient and climate change ready:** The pilot will adopt a range of strategies to mitigate climate change effects such as increased temperatures and water scarcity. These include nature-based solutions to mitigate stormwater run-off during heavy rains that will also contribute to shading and mitigating heat island effects.
- **A strong sense of community and ownership:** The pilot will provide a hierarchy of communities from the dwelling level to the quadrant with a socially mixed development based around high-quality public spaces that encourage social interaction and provide opportunities for incremental growth and economic development. It will create social infrastructure beyond a typical private development in Kigali, such as schools and community facilities with a health clinic nearby.
- **Well-connected and pedestrian-friendly:** The pilot and the GCK in general will connect with the local transport network reducing the need for motorized vehicles. Compact, mixed-use planning where the higher densities are oriented toward public transport corridors will help create walkable neighborhoods which enhance the viability of regular and quality public transport. At the same time, pedestrians and cyclists will enjoy a network of shaded routes throughout the city.
- **Stand-alone at every stage:** At each stage in its development (anticipated to be three phases, with further sub-phases) the GCK pilot will be stand-alone and not reliant on future phases to function.
- **Provide a catalyst for change in Kigali and beyond:** The pilot will create a best-practice example by setting a new standard for the provision of affordable homes and sustainable communities.

Figure 10: Pilot site overview (Source: confidential)

2.5 GCK Development Process

The below figure illustrates the Feasibility Study (FS) development process of GCK. For the project, this starts with first identifying the project's goal together with stakeholders and community and working backward to determine the necessary outcomes needed to achieve that goal. The necessary process outputs, processes and inputs required to achieve that ambition are then identified. This Executive Summary report starts with an outline of the inputs, the process and the outputs and thus provides a logical flow as to how the GCK goal is arrived at. The GCK's 16ha mixed use affordable housing pilot is a focus. This process is revisited at the conclusion to this report to show how project outcomes and process outputs feed into project development outputs for the 16ha pilot (see Chapter 8).

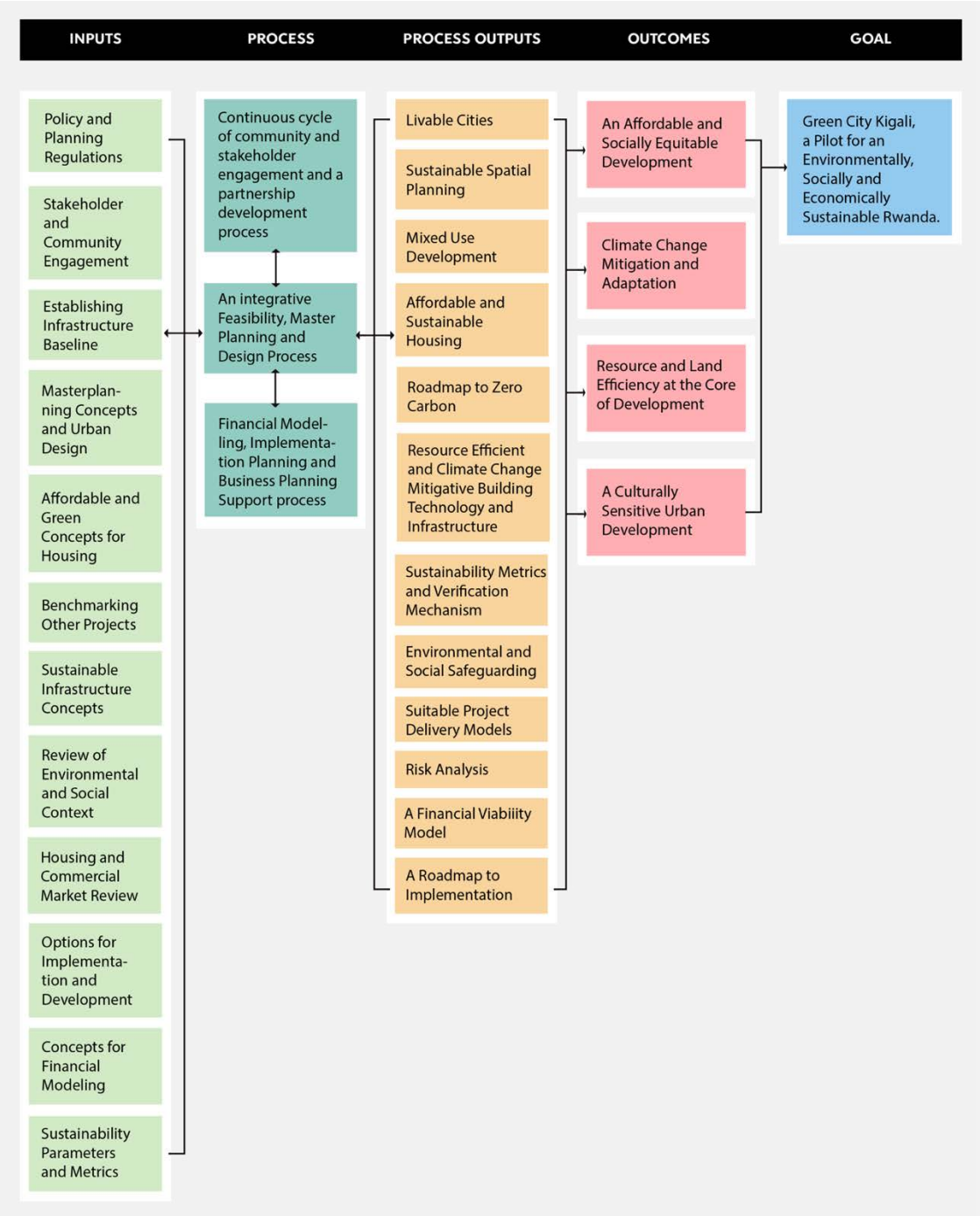

Figure 11: GCK Development Process

3 PROJECT CONTEXT AND CLIMATE PROFILE

3.1 The Project Site

This section provides a brief description of the Project Site (600ha) and the Pilot Site (15.8ha).

For more detailed information about the project site, refer to the GCK Final Feasibility Study, Sweco, 2020.

3.1.1 The Project Site (600ha)

The main 600ha project site is known as 'Kinyinya Hill', situated approx. 6.5 km or a 15-minute drive north-east of the central business district of Kigali, in the district of Gasabo. The hill has developable land available, including a sizable government-owned plot (RSSB), along with existing agricultural and village community areas. Currently, there are several planned and committed developments. The site is defined by its topography of the hill and its surrounding wetlands. Immediate access from the city to the site is from the south through the districts of Nyarutarama and Remera.

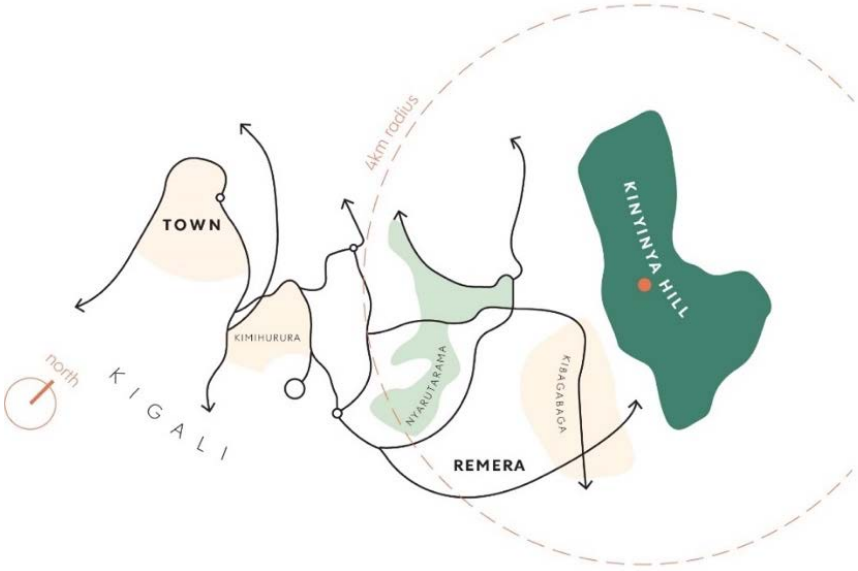

Figure 12: Relationship of Kinyinya Hill to central Kigali

Figure 13: Project Site (view from wetlands below)

The wetlands at the foot of the hill lie at 1,390m above sea level, rising to 1,495m at its highest point. Slopes at the base of the Kinyinya Hill commonly have inclines of 20-30% (and in some areas exceed 40%). The gradients on the sides of the hill range from 10 - 20%, which flatten out to around 10% closer to the hilltop.

Figure 14: Location of Project Site boundary, 10m topographical contours and the extent of existing wetlands (in green)

3.1.2 The Pilot Site (15.8ha)

The proposed site for the mixed-use affordable housing pilot project is 15.8ha in size and falls within a larger 130ha parcel owned by the Rwanda Social Security Board (RSSB). The greenfield site has no existing development or settlement and is located at the western end of Kinyinya Hill. The area is adjacent to Ngaruyinka Village to its north and east, a peri-urban settlement that has developed informally and organically on what was formerly the city's

outskirts but today increasingly central. Ngaruyinka is the target of a parallel urban upgrading study, proposed to form part of an upcoming GCF application.[10]

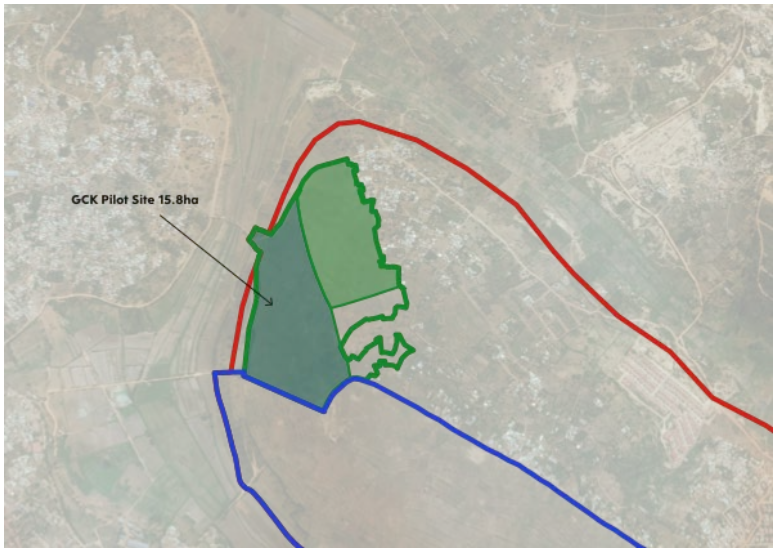

Figure 15: Location of pilot site

The site slopes gently downwards from its southeastern side, located near the hill ridge, toward the wetlands on its west and northwestern sides. The site is used by neighboring communities, informally, for the production of maize and sorghum and can be accessed via a short walk from an untarred road running along the hill ridge. WASAC, the Rwandan water and sanitation company, maintains a water mainline servicing the hill (it provides water to neighboring Ngaruyinka) and Rwanda Energy Group (REG) maintains electrical lines and a substation in the area.

Figure 16: Looking west from the top of the pilot site

A topographical survey was commissioned of the pilot site and a portion of the adjacent Ngaruyinka village in the spring of 2020.

3.2 Relevant Climate, Climate Change and Site Information

10 See Ngaruyinka Village Upgrade Feasibility Study, Sweco, 2020 for more information.

3.2.1 Local (Kigali) Climate Data, Anticipated Climate Change Impacts and Impact on Project Site

The climate in Kigali is characterized by two rainy seasons and stable temperatures throughout the year, with average temperatures ranging from 15 to 28 degrees Celsius. The mean annual rainfall for Kigali is around 1000mm a year. The highest rainfall is in April with 154mm, while the driest month is July with 11mm.[11]

Potential climate change impacts for Kigali were previously noted at Section 2.1.3, and those potential impacts are relevant to the project site.

The main considerations for climate change adaptation for Kinyinya Hill are related to the sloped topography and storm water drainage and climatic comfort. The slopes mean that storm water often does not have enough time to infiltrate and replenish the groundwater resource but instead creates high runoff speeds. The runoff, in turn, causes erosion and downstream flooding and siltation. Groundwater tables are also insufficiently replenished compared to flatter terrain, resulting in plant degradation, reduced baseflow in downstream rivers, and reduced ability to use groundwater as a potable water resource. Increasing global temperatures also place greater emphasis on finding solutions to tackle the urban heat island effect through zero-carbon means.

3.2.2 Rwanda National Climate Change Profile (Relevant Background Information)

Rwanda's capacity to adapt to climate change is low. Rwanda ranks 151 out of 181 countries in the ND-GAIN index[5] (2018) for climate vulnerability[12] and 98th in terms of readiness – meaning that it is highly vulnerable to climate change effects. Yet, its capacity[13] to combat these effects is modest. Due to its dense river network and extensive wetlands, Rwanda is prone to riverine floods. Major flood events occurred in 1997, 2006, 2007, 2008, and 2009, resulting in infrastructure damage, fatalities and injuries, displacement, landslides, loss and damage to crops, large-scale erosion and environmental degradation. There have been year-on-year increases in loss and damage from weather-related hazards. The impacts of climate change in Rwanda are exacerbated by a range of anthropogenic factors, including the loss of forest and vegetative cover, steep slopes and a high dependence on traditional rain-fed agriculture by the majority of the population.

Rwanda's high rate of urbanisation increases its overall vulnerability to climate change. Urban households are vulnerable to climate change due to Rwanda's hilly topography and many people living in unplanned settlements. Infiltration rates for storm water are low, creating high runoff speeds leading to erosion and downstream flooding and siltation. Less than 20% of the urban population that lives in areas covered by master plans had storm water considerations in 2016[14]. Moreover, low recharge rates for groundwater tables reduce groundwater availability as a potable water resource. These problems are accentuated by climate change. The rapid increase in rural-urban migration has resulted in the widespread growth of slums (particularly in Kigali, the most popular destination for rural migrants[15]).

Many informal settlements are located on sites most at risk from flooding and landslides with poor quality housing, less able to withstand extreme weather events and a lack of risk-reducing infrastructure. Furthermore, homes, possessions and assets for generating income are often not covered by insurance. This problem is most acute in Kigali where informal settlements account for more than 70% of housing[16] as most formal housing is too expensive for the average resident. When taking GNI per capita into account, Rwanda has the most expensive housing in Sub-Saharan Africa. Moreover, informal settlements tend to be very dense with very little open/public space and often with corrugated iron roofs and poor ventilation that contribute to higher indoor temperatures. The risks from rising temperatures are most significant for infants and young children, the elderly, expectant mothers, and those with health problems. Rising minimum temperatures with fewer cold days is also likely to extend the range and

11 WMO (2019) World Meteorological Organisation
12 *Vulnerability* measures the country's exposure, sensitivity, and ability to cope with the negative effects of climate change by considering vulnerability in six life-supporting sectors: food, water, ecosystem service, health, human habitat and infrastructure.
13 *Readiness* measures a country's ability to leverage investments and convert them to adaptation actions by considering economic, governance and social readiness.
14 MININFRA (2017). Water and Sanitation Sector Strategic Plan 2018 - 2024. Kigali: MININFRA.
15 In 2014, 57% of Rwanda's population had migrated to Kigali at some point in their lives in REMA (2019)."Assessment of climate change vulnerability in Rwanda - 2018", Rwanda Environment Management Authority, Kigali, 2019.
16 REMA (2019)."Assessment of climate change vulnerability in Rwanda - 2018", Rwanda Environment Management Authority, Kigali

activity of some disease vectors, including mosquito and tick-borne diseases, with populations at risk from malaria projected to increase by 150% by 2050[17]. Infants and young children vulnerable living in informal settlements are particularly vulnerable due to the lack of public health measures to control vectors.

42% of the country's area is classified as having a moderate to very high susceptibility to landslides. Rwanda's steep slopes are prone to landslides, which are predicted to increase due to the high-intensity rainfall events associated with climate change. 43% of Rwanda's health facilities[18], 25% of schools and 74% of district roads are exposed to landslides. Between 2010 (when systematic recording of landslides was established by MIDIMAR) and 2013, 74 people died, 22 persons were injured and over 573 houses were destroyed or damaged[19].

Rising demand for water is coinciding with periods of water stress due to a low capture and storage capacity, a high precipitation run-off rate[20]. There is a rising demand for water combined with low water availability and an increasing need for substantial amounts of water for its growing cities, irrigation and industry. Water demand is expected to increase rapidly by 2040 fueled by more homes connected to mains water supply (currently in Kigali, only 35% of households have piped water) and to meet the needs of agriculture and industries[21]. Residents in informal settlements experience more significant water constraints during prolonged dry spells. Rwanda's energy supply is also at risk from the increasing rainfall variability and prolonged dry periods as hydropower accounts for 50% of the power supply to the country[22].

Thousands of houses across the country that are vulnerable to landslides. Housing in Kigali City is especially vulnerable due to the hilly terrain, high population density, concentration of informal settlements, and low-quality construction materials. The vulnerability is the highest for houses made of sundried brick walls, which account for 64% of all housing. Followed by houses made of wood and mud walls that represent 30% of the housing stock. The remaining 667% exposed are with walls made of other materials i.e., burnt brick, timber, plastic, wood and cement, stone, and cement brick. The high rate of lower quality housing materials explains the large number of fatalities and injuries associated with landslide damage. Across the three districts of Kigali, there are 17,384 houses with walls made of sundried bricks and 8,442 houses with walls made of wood and mud[23]. The total potential losses [economic costs] which could be incurred nationwide are estimated to be over Rwf 9.2 billion (equivalent to approx. USD 9.7 million). The three districts of Kigali City are predicted to incur the highest potential losses due to the impacts of landslide to houses: Nyarugenge Rwf 1.2 billion (USD1.3m), Kicukiro Rwf 895 million (USD 0.94m), and Gasabo with Rwf 708 million (USD 0.74m)[24].

The threat to Rwanda's economy from climate change is already being felt, and it is serious. The average temperature in Rwanda has increased at a higher rate than the global average. Its rainfall patterns are becoming more irregular and unpredictable, with shorter rainy seasons, which has had a major impact on food production. Rwandan agriculture is mostly rain-fed (less than 10% of cultivable land is irrigated), which is why crop production is highly vulnerable to climate and weather-related risks.

3.2.3 Ecology and Biodiversity

The 600ha Kinyinya Hill includes the former Deutsche Welle site, a 70ha biodiverse and forested area (see Figure 17) occupying the relatively flat hillcrest. The area has many mature trees and is home to more than 50 species of birds and other small wild animals rarely seen in proximity to the capital. In addition, many of the surrounding wetlands provide important ecosystem services in terms of habitat, biodiversity and food production. Elsewhere, Kinyinya Hill's

17 SEI (2009): Economics of Climate Change in Rwanda
18 Health facilities include health posts, health centres, VCT centres, community-owned health facilities, private clinics, private dispensaries, prison dispensaries, police/military hospitals, district hospitals and national referral hospitals.
19 MIDIMAR (2015). National risk atlas of Rwanda.
20 The current water availability per capita has been reduced to 504 m3/annum (CM/annum), which is close to the definition of absolute water scarcity. Almost all of the country's water resources are lost through evaporation or run-off to downstream countries. RWFA's Baseline Study: Water Users and Water Uses in Level 2 Catchments in Rwanda, 2017 and RWFA (2015) Rwanda's National Integrated Water Resources Master Plan
21 EICV (2017). The Fifth Integrated Household Living Conditions Survey, EICV5 (2016/17).
22 Droughts reduce the generating capacity of hydroelectric dams, while floods increase soil erosion and siltation, which can damage dams. The drought in 2004 reduced hydropower capacity so much that the government was forced to rent diesel power plants to meet domestic demand in Republic of Rwanda (2011): Green Growth and Climate Resilience. http://www.uncsd2012.org/content/documents/364Rwanda- Green-Growth-Strategy-FINAL.pdf.
23 MIDIMAR (2015). National risk atlas of Rwanda.
24 MIDIMAR (2015). National risk atlas of Rwanda.

natural flora has been depleted and is being progressively replaced with non-native species, including eucalyptus trees. Little natural vegetation remains outside of the former Deutsche Welle site and uncultivated areas of the wetlands.

In addition to their importance noted above, the wetlands which lie at the foot of Kinyinya Hill provide a critical ecosystem service. They act as a filter of waste from the different hilltop areas and help regulate flooding.

For more information refer to the Project Site High Level ESIA (ERM, 2021)

3.2.4 Geology and Hydrology

The geology underlying Kinyinya Hill is dominated by granite and pegmatite, which indicates average storage and transmission properties resulting in low groundwater recharge rates and baseline flows. The soil on Kinyinya Hill consists mainly of Cambisols and Alisols which are moderately deep and more fertile than Ferrasols. On steep slopes the soil is susceptible to erosion. Along the bottom of the hill the wetlands manly consist of clay soils with moderate fertility and low infiltration capacity.

Rwanda has seismically active zones[25], the areas most impacted by seismic hazards are in the western and northern provinces, causing deaths and damage. Earthquakes in the western and northern provinces are sometimes felt in Gasabo District and Kinyinya sector at lower levels. These seismic activities are not likely to cause damages of well-constructed buildings.

While no hydrology study of the site has been undertaken thus far, the groundwater table is estimated at a depth of 0-25 m.

3.2.5 Existing Settlements

The site comprises vacant land areas, a sizeable government-owned forested parcel, agricultural land, and existing housing communities and neighborhood centers.

The 130ha RSSB site is located on the south-facing slope of the hill in the western half of the overall site (see figure 17). The location of the 16ha first phase development is in this area.

25 National_Risk_Atlas_of_Rwanda_electronic_version.pdf

To the south of the Deutsche Welle site lies the moderately sloped plot proposed for the CACTUS development (13.7ha). An existing social housing scheme, occupying approximately 11ha, lies on the central northern slope of the hill and, in common with much of the current housing on Kinyinya Hill, it is comprised of single-story buildings.

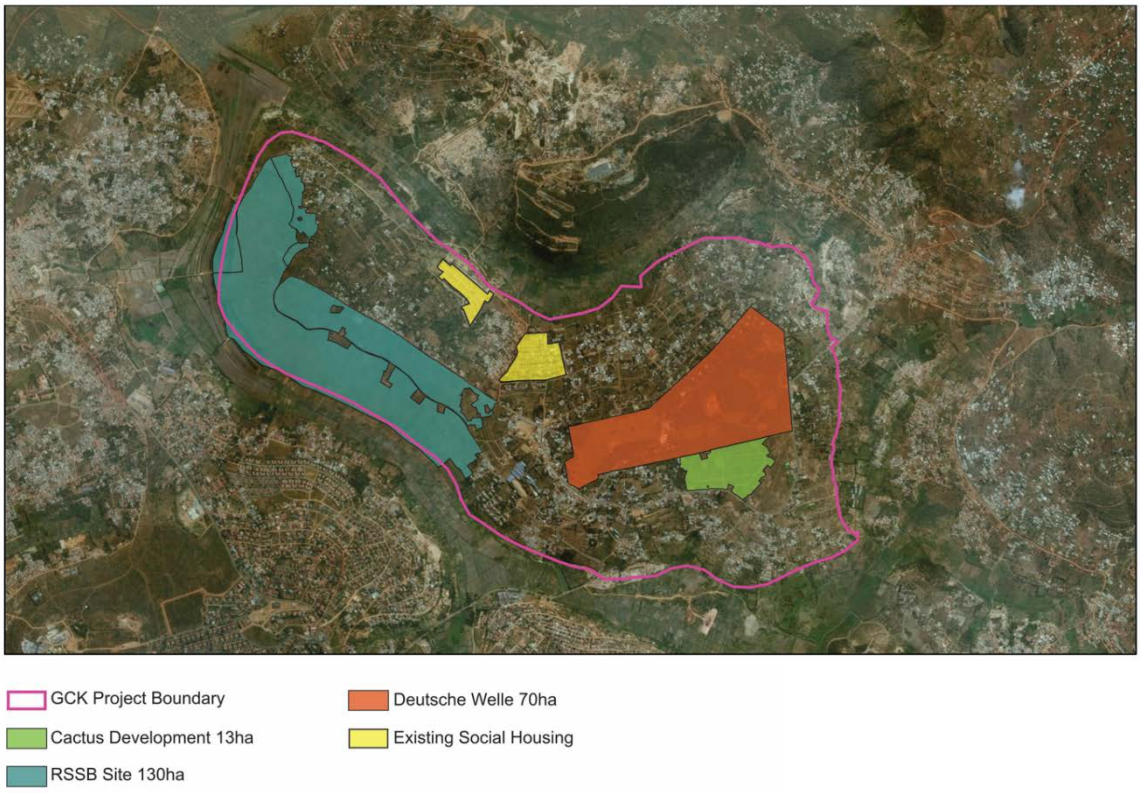

Figure 17: Notable sites at Kinyinya Hill

The IFC, RSSB and private developers plan to develop an approximately 22ha housing and mixed-use development on a plot adjacent to the pilot site.

In addition, 8ha of the RSSB land, southeast of the pilot site, has been deeded to the Kigali International Community School (KICS) to develop a new academic campus. A further 10ha of the site, northeast of the pilot site has been deeded to a private buyer.

3.2.6 Prevalent Land Tenure

It should be noted that there are a variety of forms of land ownership within the planning area, from small-scale informal leaseholds to large-scale and formal titles such as the two titles owned by the Rwanda Social Security Board.

The 2005 Organic Land Law created a land tenure regularization process and formalization of land ownership in Rwanda through leasehold titles. Therefore, properties are generally noted as informal by local authorities because the buildings are not compliant with planning or building guidelines or codes (unplanned). This contrast with the experience in many other countries, where *informal* often refers to lack of a legal title. Further, upon developing a property and legal occupancy permits are received, a leasehold may be converted to a freehold upon application.

For more information on what defines a property and the difference between formal and informal status in Rwanda, please see the MTFS Part II, Housing and Building Technology Report (2019). The World Bank's Land Governance Assessment Framework for Rwanda (2016) is also a good source for further information on the subject.

3.2.7 Existing Land Uses

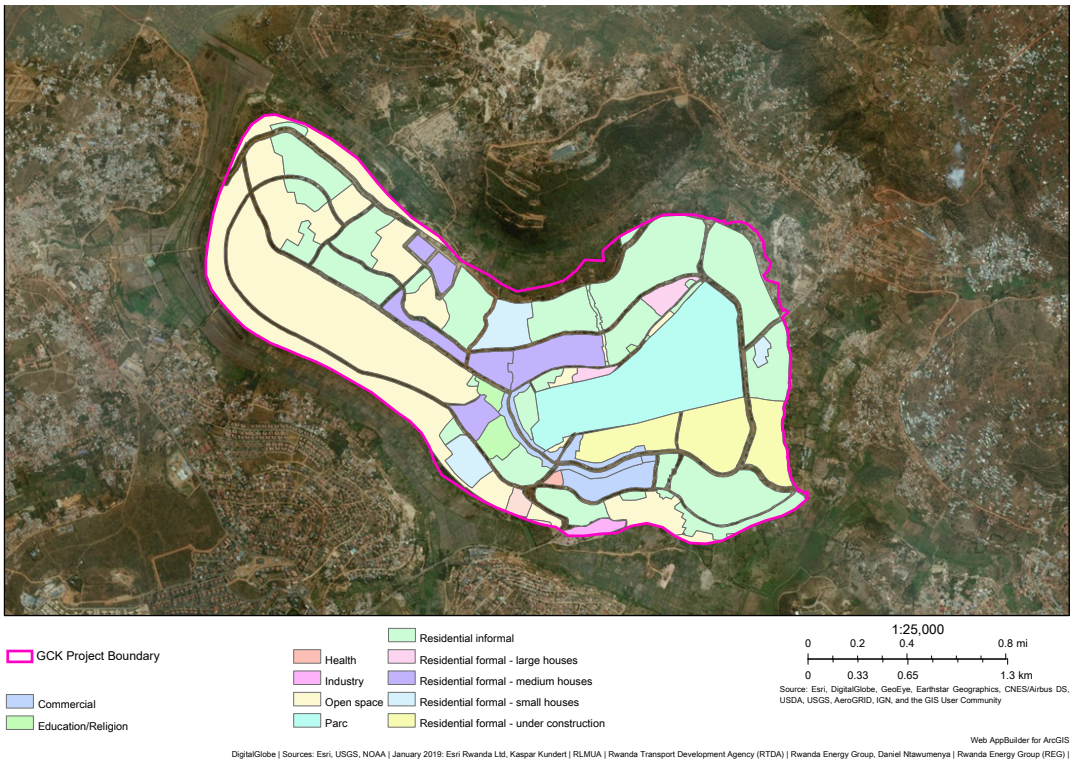

Figure 18: Existing land usage within the planning area

The existing land use allocation per the Kigali City Masterplan 2020 is understood to be as follows:

Table 3: Existing land use allocation, GCK Planning Area

Land Use – Kinyinya Hill Planning Area	Area (rounded to the nearest ha)
Residential	81ha
Agriculture	225ha
Industry	5ha
Public Facilities	9ha
RSSB Site (planned / committed residential development)	130ha
Infrastructure	69ha
Deutsche Welle	70ha
Cactus (planned / committed residential development)	13ha

The planning area features a mix of formal and informal residential communities. Formal residential areas are generally clustered toward the ridge, neighborhood center and Deutsche Welle site, with informal settlements based away from the ridge and toward the wetlands (in particular the north side of the hill). All current residential housing is low rise, single-family units with little to no multistory development identified. However, the 2020 CoK Masterplan has re-zoned most undeveloped areas of the planning area as R2 and R3, with a C2 mixed-use overlay. The proposed pilot site has been zoned as medium density residential (R3, formerly R5 at the interim plan) with a minimum density of 50 – 90 du/ha.

3.2.8 Transport

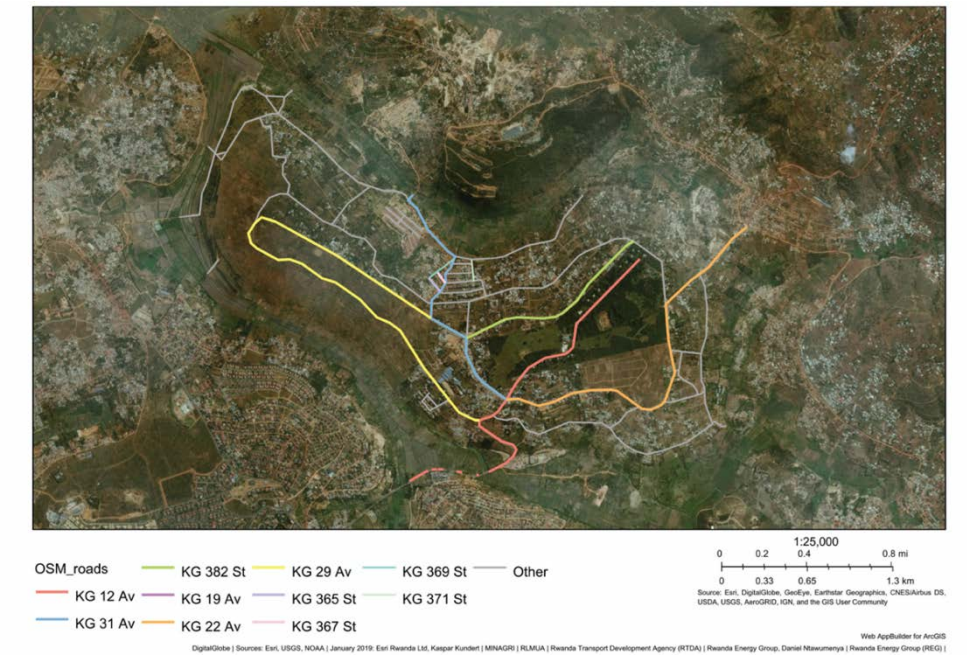

Figure 19: Existing roads in the planning area.

Figure 19 presents the existing roads present within the Planning Area. The current modal split on Kinyinya Hill is divided approximately as follows: 71% walking, 20% public transport, 6% motorcycle taxi and 3% car, with a small proportion of bicycle use both for personal and commercial use. Car ownership is low due to low income levels and lack of affordability. The high ratio of walking reflects income levels and indicates that daily activities are mostly undertaken locally or in close vicinity to the Hill. The Hill's road network is under-developed and comprises a mixture of paved and unpaved roads, many in poor condition. A local bus terminus serves the community at the project area and a motorcycle taxi service that operates throughout Kigali.

3.2.9 Existing Public Utilities

Public utilities and municipal services at the Planning Area are limited and patchy, offering considerable scope for improvement. Mains electricity is generally available but not all houses are connected to the grid. The central water distribution system serves parts of the area. Households that are not connected typically purchase water from kiosks. Rainwater harvesting is common, as pictured below. Wastewater and sewerage are managed via pit latrines and septic tanks, creating a risk of groundwater contamination. Solid waste is collected but there is no provision for waste treatment or recycling. Cooking is still largely undertaken using charcoal, creating both environmental and health risks. Mobile telephone coverage is available (as well as mobile 4G internet) and Liquid Telecom has recently extended fiber optic internet connections to the Planning Area (John Dubai Estate).

Figure 20: Images of rainwater harvesting that is common throughout the villages. Roofs often have gutters, and residents use small containers to collect water.

4 INPUTS

4.1 Feasibility Study

The feasibility study has followed an iterative and continuous process of analysis and synthesis of various inputs that include:

- National and International Policy and Planning Regulations: A comprehensive understanding of relevant international, national and local policy and planning regulations as relate to urban planning, urbanization, green growth, infrastructure and housing and aligning the goals and objectives of the overall project to these.
- Stakeholder and Community Engagement: At all levels from international organizations, national government, the municipality and local government, NGOs, private sector and local communities and reflecting the inputs obtained from this engagement into the outputs. These have included interviews, site visits, surveys, focus group meetings and an urban lab. *A list of relevant engagements is provided in annex to this report.*
- Infrastructure Baseline: Establishing an infrastructure baseline, through an understanding of business as usual (BAU) development at or around the site.
- Master Planning Concepts and Urban Design: The introduction of innovative and relevant master planning and urban design concepts that are appropriate to the site, reflect the context at the macro, meso and micro scale and which promote the development of sustainable, land efficient and livable communities from the block to the city level.
- Affordable and Green Concepts for Housing: The introduction of best practices for the development of affordable, land efficient, resilient, and sustainable housing through the filter of the local context. This includes the understanding of local materials available, construction methods, technologies, climate and cultural preferences.
- Benchmarking Other Projects: As part of the stakeholder engagement and secondary research process an understanding of similar planned (in process) or completed projects. The extraction of relevant data, structures and lessons learned (both successes and failures) are used as inputs to the feasibility process.
- Sustainable Infrastructure Concepts: Similar to housing, the introduction of innovative yet site and context relevant concepts for sustainable infrastructure that draw on natural site features and ecosystem services and use where possible nature-based solutions.

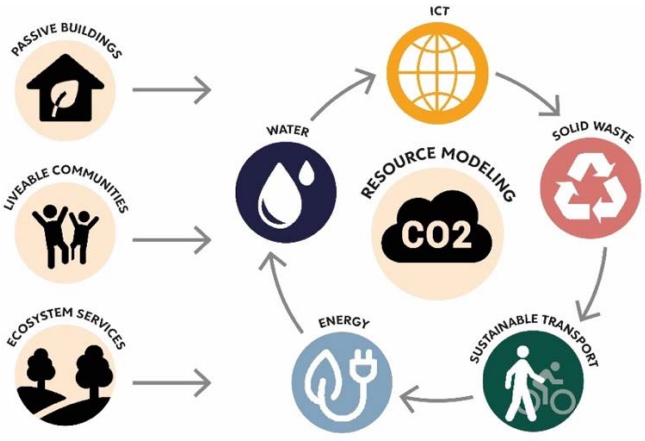

Figure 21: Sustainable Infrastructure

- Review of the Environmental and Social Context: An assessment of the environmental and social context at the project area, and an understanding of the potential environmental and social impacts of proposed concepts and solutions as well as the consideration of the needs and aspirations of women and youth.

- Housing and Commercial Market Review: An analysis of the existing markets in Kigali and the current constraints on delivery of affordable housing in communities, along with key recommendations. This includes a review of comparable case study developments.
- Options for Implementation and Development: Introduction of concepts for implementation and development for the project that draw on international best practice but are relevant and appropriate to the opportunities and constraints presented by the local context. These include housing and project finance and facilitation, delivery vehicles and methods, integration of development into larger municipal systems and ongoing viability of project (operations and maintenance).
- Concepts for Financial Modeling: Expenditures and income for the development and a framework for implementation.
- Sustainability Parameters and Metrics: These were developed to provide a quantitative tool for measuring and evaluating the project against achieving the GCK Four Foundations of Sustainability. More details on the parameters and metrics can be found in Section 6.8.1.

4.2 Design Competition (UADC Tender)

The feasibility study process included the development of an interim "Mid-Term Feasibility Study" (Sweco, 2019) that was used as a primary input in the development of an "Urban Design Handbook" (Sweco, 2019) and a Design Brief (ToR) and Sustainability Assessment for an international design competition, that formed part of the tender documents for the tender for consulting services of an Urban and Architectural Design Consultant (UADC).

From the tender for consulting services a preferred bidder was selected, based on a variety of criteria, which included the quality of submitted masterplan proposals for the 600ha Planning Area, 16ha Pilot Area, supporting design data and a sustainability assessment of the submitted design (based on the framework presented in the design brief). These design outputs have further been integrated into the feasibility study, as an input, to support the development of a Final Feasibility Study (Sweco, 2020/2021).

4.3 Comparative Affordable Housing Development Case Studies Analysis

A case study review for this report was undertaken to supplement the work done during the feasibility assessment process. This section can be considered an additional input beyond those FS inputs described in previous parts of this chapter.

4.3.1 Introduction

In the absence of a long list of affordable housing projects in Kigali, the projects reviewed as case studies were selected based on being comparators to GCK project. Certain aspects about the projects were sourced from available public information but a significant element of the information relied on Sweco JV sub-consultant Altair's experience of working in Kigali over the last number of years, insights from industry experts, information from non-public databases and regional experience.

Due to the commercial confidential nature of some of the data gathered, public presentation of certain detailed information was not possible. The case studies presented here contain the information that can be presented publicly.

Overall, the case studies review and identification of important lessons inferred from the assignment provide reasonable insights and provide a benchmark and guide to stakeholders in the evaluation of the GCK project feasibility and crucially in the design of the transaction structure.

4.3.2 Affordability

A key objective for the GCK project is that the housing units produced and sold in the affordable category should be attainable for target groups. In contrast to a commercial market-rate development that seeks to maximize sales prices, the GCK project has sought to provide housing products feasible for middle-income households. Affordability is a relative term and it is important clarify what affordable means within the context of Rwanda and the GCK project prior to an examination of comparative case studies. A unit's affordability has been estimated on the basis that housing costs, either rent or debt payments, should not exceed 35% of household income in any one year. The affordability target is based on the BRD Managed/World Bank Support Fund Loans, which require a deposit of 10% of a home purchase price with a loan for the remaining 90% at an interest rate of 11% per annum and a twenty-year annuity-based repayment profile. GoR classifies housing as affordable if it is attainable for households earning up to 1,2 million RWF per month.

Table 4: Rwanda World Bank Mortgage Scheme for affordable housing requirements, managed by BRD

Deposit:	10%
Interest Rate:	11 %
Annual Fees:	1% (estimate, determined by the individual bank providing the mortgage)
Max Housing Costs:	35% of monthly household income
Loan:	90%
Tenor:	20 years
Type:	Annuity
Ceiling Household Income:	RWF 700k per month

Development Bank of Rwanda (BRD) has a data base of over 60 000 pre-registered households for the mortgage scheme. Very few mortgages have been disbursed so far due to the lack of housing supply within the range and meeting the criteria laid out in the table above.

Figure 22: Case Studies Projects Location Map, with GCK Pilot Area for Reference

4.3.3 Rugarama Park Project

Figure 23: Rugarama Park Phase 1, Under Construction

Rugarama Park Project is a 1,700 units mixed-use affordable housing project initiated by Shelter Afrique and BRD. The promoters set up a joint vehicle structure to finance and develop the project. The site (land) was a contribution from City of Kigali, but the promoters paid for the resettlement compensation and site clearance costs which was significant. Initial negotiations to develop the project commenced in 2015 with formal start in 2017.

The implementation of the project has not gone smoothly and has been subject to delays partially resulting from complexity of the site assembly, changes in the financial fortunes of the promoters and turnover of key personnel responsible for the project.

Activity on the site is currently suspended, because the most recent partner Remote group (American owned firm) brought in to provide finance and development of the project has experienced financial difficulties. This was the second partner brought in by the promoters, the original partner being the developer Roko.

The site is located at Nyarugenge, Nyamirambo and the scheme typology consists of 1 bed, 2 bed and 3 beds. The bedroom sizes range from 39 sqm for the 1 bed, the 2 bed ranges from 55 sqm, 61 sqm, to 72 sqm and the 3 bed is 95 sqm.

The build cost per sqm is estimated to be about $250 sqm - $300 sqm. Considering the delays, the likelihood is that this estimated cost will increase but it is not certain by how much. The main building material deployed for the construction is Aerated Autoclave Concrete blocks (AAC). AAC is a building technology that could potentially help to reduce build costs prices in Rwanda. The plant formerly owned by Remote group is now owned by local company, Petrocom Co.

The main amenities provided are a public park and commercial centre. Roads infrastructure is provided by GoR. The development is planned to take place over 4 phases.

The sales prices start from 12m RWF for the smallest unit, 17m RWF for the 2 bed 55 sqm, 18m RWF for the 61 sqm, 23m RWF for the 72 sqm and 35m RWF for the 95 sqm unit. The developers have proposed options for purchase that includes subsidised mortgage through the WB scheme and a cash purchase option. The cash option provides for potential purchasers to pay up to 80% before completion of the units.

Although the project commenced in 2015, it has been subject to lengthy delays which seem to have increased the overall project costs and provides some key lessons for GCKC to take into account. A notable key risk appears to be the challenge of selection and retention of development partner able to fulfil their obligations.

Table 5: Rugurama Park Case Study Key Facts

Developer or consortium partners	Shelter Afrique and BRD (replacement being sought for Remote group)
Delivery method	Joint venture partnership
Unit numbers	1,700
Estimated Average cost per m^2	$250-$300 per m^2
Affordable Housing subsidies status	Granted
Project status	Under Construction (ON HOLD)
Project start date (formal)	2017
Estimated land costs	$25-$51 per m^2

4.3.4 See Far Housing Estate


Figure 24: Photos of the project under construction

The promoter of the See Far Housing Estate affordable housing scheme is a social enterprise whose main purpose in developing the scheme is to generate revenue to support Agahozo-Shalom Youth village (ASYV). The non-for-profit backers of the project based in the US, have ambitions to build 1500 homes over the coming years, with an initial 600 homes built in Kabeza over the next 3 years. The pilot project of 56 units located in Kicukiru district Kabeza will serve as a launching pad to achieve the larger scale ambition.

The unit typologies for the pilot project consists of studios, 2 beds, 3 bed and 4 beds apartments. The unit sizes are generous compared to typical affordable housing projects and range from 49 sqm for the studio, 78 sqm for the 2bed, 119 sqm and 158 sqm respectively for the 3 bed and 158 sqm/171 sqm for the 4 beds.

The build costs estimates are on the higher side of the spectrum and range from $450-$550 m^2 reflecting higher specification and general higher purchase values. The main building technology is clay bricks for the walling system. A central water system is proposed, and the road infrastructure is provided by GoR.

The pricing ranges from 18m RWF for the studio to 38m RWF for the 2 beds. The 2 different versions of the 3 bed prices are 57m RWF and 72m RWF, respectively. The 4 beds are 77m RWF and 82m RWF.

This project is unique in that it seems to be financed from impact investors such as Impact Assets, a non-for-profit foundation out of Bethesda, Maryland. The foundation was established in 2010 by Calvert Impact Capital in order to assume responsibility for the Giving Fund and transform it into something bigger. The foundation's aim is to increase the flow of capital into investments that deliver financial, social, and environmental returns. It specializes in impact investing, social finance, donor-advised funds, and environmental impact investing for philanthropists and individual investors. Donations (grants) from high worth investors that are primarily interested in the mission of the social enterprise supplements the funds raised from impact investors. The profit from the affordable housing project is a means to further the social purpose of the youth village.

The project is being delivered by a directly appointed local team and the project started in May 2020 and is expected to be completed in December 2021.

Table 6: SEE FAR Housing Case Study Key Facts

Developer or consortium partners	See Far Housing
Delivery method	Single developer
Unit numbers	Initial 56 units pilot
Estimated Average cost per m^2	$450 -$550
Affordable Housing subsidies status	Granted
Project status	On site
Project start date	May 2020
Estimated land costs	$20-$28 per m^2

4.3.5 Busanza Housing Estate - Phase 2

Figure 25: Entrance view of the estate and a side facade view of the project

This controversial project is a partnership between City of Kigali and a private consortium with a primary objective of resettling the Bannyahe slum dwellers in Nyarutarama (Kigali city's largest informal settlement straddling three large informal settlements of Kangondo Kangondo II and Kibiraro I) from prime located land to lower price location outside the city centre.

The project developer is Savannah Creek Development Company LTD (SCDC) fronted by local businessman Mr Dennis Karera. SCDC is a $56m joint venture special purpose vehicle owned by Karera's Gold Capital investment firm and the Finnish private equity firm Taleeri.

The phase 2 scheme to relocate the slum dwellers is located at Kicukiro-Kanombe and consists of 840 units. The housing typology is mainly 1 bed, 2 bed and 3 bed apartments. The unit sizes are small compared to some of the other affordable housing projects reviewed. The sizes range from 27 sqm for the 1bed, 47 sqm for the 2 bed apartments and 67 sqm for the 3 beds.

The build costs estimates range from $250- $300 sqm and the primary building technology is concrete framed structures with clay brick walls infill. Social infrastructure is not included however roads, power and sewage system is provided.

The purchase prices have been calculated to match the valuation of the land swap with the slum dwellers. The prices range from 18m RWF for the 1 bed, 23m RWF for the 2 bed and 34m RWF for the 3 beds. It is suggested by some commentators that this valuation may be somewhat inflated, especially considering project location and unit sizes.

As stated above this is a resettlement project that is controversial. The valuation of land, procedural irregularities, lack of consultation on the design and appropriateness of the unit's typology to meet the needs of households were some of the several issues of concern raised by the slum dwellers.

The quality of the design and completed homes of the phase 1 of the project leaves much to be desired.

Table 7: Busanza Phase 2 Case Study Key Facts

Developer or consortium partners	City of Kigali and Savannah Creek Development company (SCDC)
Delivery method	Single Housing Developer
Unit numbers	840
Estimated Average cost per m^2	\$250 - \$300 m^2
Affordable Housing subsidies status	Granted
Project status	Phase 1 completed and Phase 2 on site
Project start date	2019
Estimated land costs	\$14-\$33 per m^2

4.3.6 Bwiza Riverside Houses

Figure 26: Project Site

The Bwiza Riverside Houses affordable housing scheme is located at Nyarugenge-Karama. The project consists of 250 homes. The main developer is a firm called ADHI. The corporate group was established in Gabon in 2011.

The unit typologies include 2 bed, 3 bed and 4 bed Town houses. And the sizes range from 2bed 40 sqm, 2 bed 65 sqm, 3 bed 90 sqm and 4 bed 135 sqm.

The build cost estimates range from \$450 - \$550 sqm and the main building materials used are cold formed steel, cement fibre panels, politerm blu light weight concrete and self-locking galvanised light gauge steel sheet. The ADHI

sustainable construction method is a patented system that uses modular parts, pre-made in a factory, for "plug-and-play" construction.

The road infrastructure is provided by GoR and utilities include a central water system. A preschool, general store, accessible garden, and community centre is planned to be developed as part of the project.

The price ranges from 15m RWF for the 2 bed, 25m RWF for the 3 bed and 65m RWF for the 4 bed. Unlike other schemes this project consists mainly of town (row) houses.

Table 8: Bwiza Riverside Houses Case Study Key Facts

Developer or consortium partners	ADHI
Delivery method	Single Housing developer
Unit numbers	250
Estimated Average cost per m^2	$450 -$550
Affordable Housing subsidies status	Granted
Project status	On site
Project start date	2020
Estimated land costs	$2-$20 per m^2

4.3.7 Relevance of the Projects to Green City Kigali

It is worth noting at the outset that one of the observations during site visits is the lack of provision for social infrastructure in the reviewed schemes. In the absence of specific guidelines (beyond those as prescribed in the CoK MP and UPC) for social infrastructure for affordable housing projects, the projects seemed to have overlooked the provisions of such amenities. This was likely a financial decision, but does impact on a development's social sustainability, especially when they are located in more remote, city periphery areas.

Similarities

- Generally, for the large scale projects the concept of construction phasing is well established and a standard practice providing its attendant benefits.
- Projects indicate a trend toward higher density development in Kigali. All projects are between 90 – 120 DU/ha (GCK pilot projected at 108 DU/ha).
- All projects have secured or have applied for Infrastructure Subsidies as Affordable Housing Projects.
- Presented unit prices align generally with GCK prices and are in some cases more expensive.
- The main legal entity to implement the projects are privately owned companies who appears to work in partnership with landowners and/or a statutory authority such as City of Kigali, especially when it comes to land assembly.
- In a few instances two or more businesses have come together to form a joint venture to develop the projects like what is proposed with GCK delivery models.

Differences

- Projects tend to be located further from the city centre or with longer travel time to Kigali core areas, taking advantage of lower land prices but lead to additional transport costs for the purchasers which increases the total housing costs. While it may appear from an aerial map that GCK is about the same distance, when accounting for topography, quality road transport connections and ease of accessibility to the city centre, GCK is situated with better access to Kigali urban core areas such as Kimihurura.
- Projects reviewed provided cash payment options in addition to mortgage payment option. They generally tend to demand a higher upfront deposit on the home, often before the home is complete and which puts the purchaser at risk. The World Bank mortgage program will not disperse funds for uncompleted housing.
- Projects do not provide the same level of social infrastructure or community facilities as provided at GCK.
- Projects are not "Green" and use standard infrastructure systems such as open concrete drainage channels which may exacerbate existing environmental challenges such as flooding in Kigali.

4.3.8 Lessons Learnt from Case Studies and Past Projects Applicable to the risk mitigation strategy of the GCK project

The lessons from the case study review and feasibility assessment provide important insights relevant to GCK and to GCKC.

<u>Addressing project risks and complexity through transaction structure, institutional capacity and partner selection</u>

The importance of selecting a competent private developer partner and mitigating the risk of misinformation on a partner's financial capacity is highlighted in the case of Rugurama Park's, which is the most comparable of the projects reviewed for the GCK Pilot. It also demonstrates that allocation of development and finance responsibilities to one designated development partner does not mitigate against the risk of failure. On the contrary, it reinforces the need for a well-established and resourced GCKC to step in and take over the reins in the event the counterparty is unable to fulfil their contractual obligations. This also reinforces the need for GCKC to build strong and independent procurement, monitoring and project evaluation capacity directly and indirectly through the support of management consultants. Furthermore, this also has implications for the governance oversight, board effectiveness, roles and responsibilities between the executive team and the management consultants and other issues relating to institutional capacity building.

The review has demonstrated that the GCK project is, in ways, more complex and multi-faceted compared to the other affordable housing projects being considered or developed. The range of skills that would be needed as well as the in-depth experience required to reduce the risk of the problems that existing affordable housing projects have had with procurement, construction management and funding, should be noted.

To overcome these, it is recommended that supervisory roles are enhanced so that the management consultant appointed takes responsibility for the day-to-day executive function of the company to the point where construction of the first phase is commenced on site. This will enable the company's executive team to learn directly from the experienced management consultancy team and have templates for the future phases as well as provide a way to transfer roles. This expertise could be further enhanced by the appointment of at least two or more experienced non-executive directors that are independent of sponsoring agencies. The non-executive directors, in conjunction with the executive team, would provide continuity by following the completion of the work of the management consultants.

The delays at Rugarama illustrate the issue of developers not having sufficient equity or secured debt. Any selection process should ensure developers have transferred sufficient equity into RWF and have evidence of secured and unconditional debt. For GCKC, any Joint Venture agreement should include an agreement with the counter party has settled sufficient RWF with BRD. If a developer proposes reliance on instalment payments from purchasers, as a way

of financing the project, it should be treated as a major financial risk to the project and affordability of the housing. This should be avoided, if possible, given the serious implications.

Implications of delayed project start and disruptions

The case study review found that the slow roll-out of projects is the norm rather than the exception. The time between initiation of projects to start on site and actual completion is consistently longer than estimated. It suggests that stress testing exercises to assess the impact of delays on construction costs, financing costs, cashflows, and affordability need to be undertaken at inception and through-out the project cycle.

The risk and implication of construction delays leading to cost increases, loss of profit margin, pressures on price affordability and general reputational damage are very real.

Access to affordable housing finance

Access to lower cost of housing finance to stimulate effective demand for buyers and project finance for developers remains a big challenge. The World Bank mortgage programme, although known to most actors in the market, has not been realized in tangible ways to support buyers. Partly due to perceived bureaucracy from the commercial banks as well as the lack of affordable housing supply. This provides an opportunity for GCKC in terms of competitiveness of its product and the company can pursue collaboration with commercial banks to address issues that might affect off plans sales and marketing. Off plan sales is the norm with most developers.

Government infrastructure funds

Infrastructure cost contribution by Government is the norm for affordable housing. However, implementation and reimbursement to a developer where the developer is prefunding the physical infrastructure is slow. This is not anticipated to be an issue with the GCK pilot due to the KFW infrastructure grant subsidy envisioned as a direct payment to the GCKC, but it is worth noting.

Effect of transportation costs on total housing costs

Housing costs calculation should include transportation costs from locations further away where most jobs are situated. This is rarely done, and it is a positive for the GCK project that it is located closer to job markets compared to the projects reviewed. This advantage should make it more attractive for purchasers and potential counterparty partners.

Project phasing

The case studies review reinforces the importance of phasing the scheme to provide inbuilt flexibility to learn and apply lessons from earlier phases.

Building costs, technology and supply of materials

As outlined previously in the report, the cost of building affordable homes is expensive in Rwanda which leads to prices that are not affordable for low to middle income groups. The case studies demonstrate this continues to be a big challenge. While the WB mortgage programme goes some way to address the demand side of the problem, it is not sufficient both in terms of scale and interest reduction to handle most of the population's needs that require affordable housing.

The review also highlights the need for a building technology on the supply side that will drive down building costs. It also highlighted that the costs of infrastructure, roughly about 30% of project costs, is a significant cost driver that needs to consider the nature of the project and be monitored carefully on-site to prevent costs overrun.

One innovation that could be a game changer is Autoclaved Aerated Concrete (AAC) blocks. AAC is composed of a mixture of cement, lime, water, sand, and aluminium powder. The concrete blocks are lighter, insulates well and can be used on walls, flooring, roof, and lintels. The AAC factory, formerly owned by Remote Group, is now owned by Petrocom Co., with a production capacity 200,000 blocks per day.

The other major player in the market is the Ruliba Clay factory. Their Nyabarongo factory has been expanded, it now has two production lines with 200 tonnes of production per day, roughly over 102,000 bricks per day. They are proposing a new factory to respond to the increasing demand and cultural acceptance of clay bricks. The factory that will be located in Rugende, will produce 250 tonnes per day which translates to 156,000 bricks per day. They will be using peat and gas, which is more efficient and environmentally friendly.

Benefits of mixed-use and mixed-income projects

Mixed-use land and housing development has multiple benefits. Mixed-use land and housing projects require developers to deliver a minimum built area of affordable housing alongside market-rate housing and commercial uses. The Rugurama Park project and other schemes employ a mixed-price approach to maximize cross subsidies from higher value sales and mitigate risks associated with purely affordable housing projects.

Post-development management and maintenance

The affordable housing projects considered have not traditionally dealt well with post-construction asset management and social sustainability —these functions tend to be left to municipal authorities with limited capacity. We found that affordable housing projects were susceptible to poor operations and maintenance practices leading to potential asset deterioration. To address post-construction asset management risk GCKC will need to build internal capacity and resources to manage post-development responsibilities not adopted by statutory agencies such as CoK or utilities. Similarly, regional experience demonstrates that better post-construction social management practices reduce social risks in mixed-income housing projects.

5 PROCESS

5.1 Feasibility Study Development Process

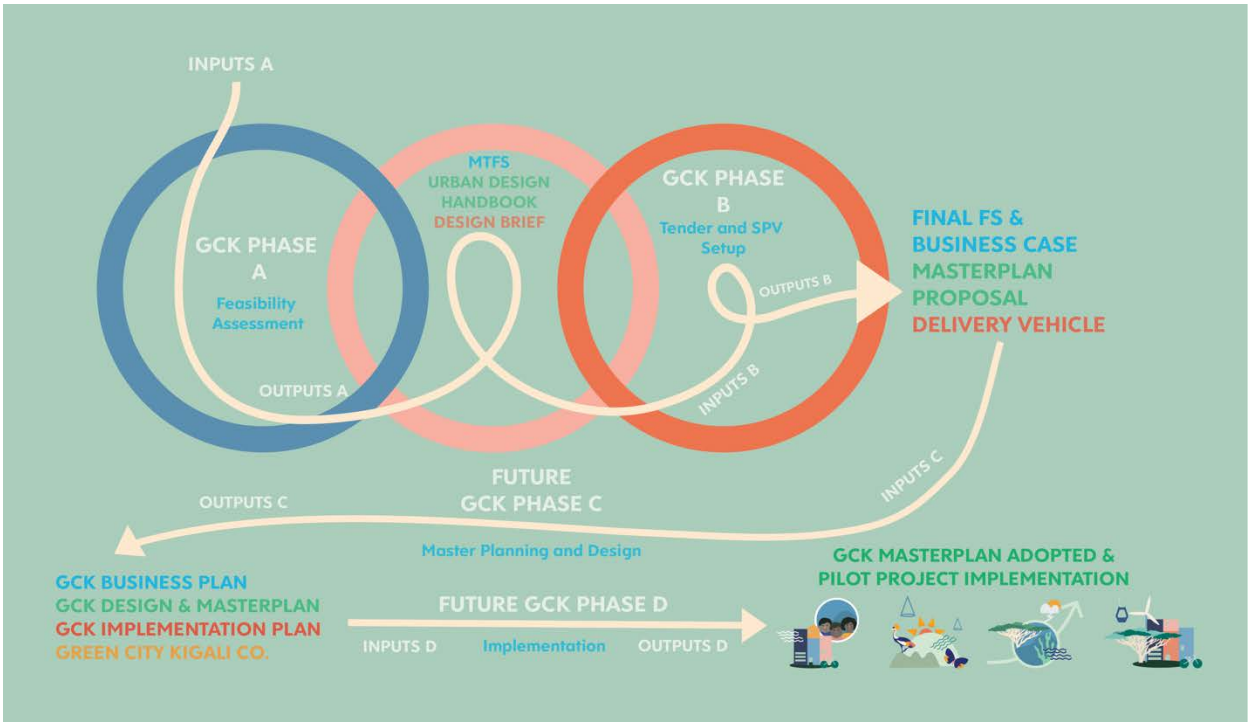

Figure 27: Adapted Feasibility Study development process – the iterative process applied as the feasibility study was progressed

The feasibility study began by and followed an iterative process of analytical and synthesis work using project input data (as outlined in chapter 4) to assess the strengths and weaknesses of the project site and location as well as the larger housing market and aligning with the objectives provided at the outset of the project to create a long-term vision (goal) for the Green City Kigali. From there a series of outcomes were identified as foundations for achievement of the project's vision (see four foundations). These outcomes required that process outputs be achieved and presented in the form of a feasibility study and project design report, that help arrive at in the presented development outputs for the 16ha pilot project (see table 9).

As noted in the previous section, and illustrated above, this required an integrative feasibility and master planning process by a series of sector specialists at the outset and later paired by the master planning outputs of a preferred bidder (UADC consultant). In parallel, and as a core part of the process, was a continuous cycle of community and stakeholder engagement and partnership development process. As part of devising a financially feasible and implementable pilot project this process included financial modeling, implementation planning and business planning support which included the development of an overarching delivery vehicle in the form of the Green City Kigali Company (GCKC).

6 PROCESS OUTPUTS (FEASIBILITY ASSESSMENT)

6.1 Introduction

Rwanda is a forward-looking country which seeks to increase the prosperity of its people while safeguarding its natural environment and strengthening communities socially and culturally. Rwanda's cities are predicted to grow in line with the country's growing economic prosperity. While cities occupy only around 3% of the planet's surface area, they account for around 70% of global carbon emissions[26]. It is recognized by leaders in the country therefore that a model for sustainable urban growth is required to manage the process of urbanization in line with its vision for green growth.

The ambition for Green City Kigali is therefore to become a transformative project which will help drive systemic and sustainable change that will have a significant impact on the pattern of urban development within Kigali and throughout the country. It will contribute to the delivery of the UN 2030 Sustainable Development Goals and the New Urban Agenda together with the country's climate change and affordable housing commitments

This chapter outlines the work of the various sector specialisms of the feasibility assessment and the work of the preferred UADC bidder in order to achieve the outcomes required to arrive at the GCK project's goal (vision). This report focuses more specifically on those process outputs particularly relevant for the realization of the GCK pilot project, but which also accounts for the existing situation at the planning area and the wider Kigali and Rwanda context.

6.2 The Development Outputs

As an outcome of the feasibility assessment outlined within this chapter and further in Chapter 7: Institutional and Implementation Arrangements, a series of development outputs have been established to guide the future design and subsequent construction of the pilot project. The following table, introduced at Chapter 1, but repeated here presents key development outputs for the pilot, with Table 10 providing a glance at how various outputs relate to GCK outcomes. The concluding Chapter of this report examines the feasibility of the outputs and their quantity further and following Chapter 6 and 7.

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Table 9: GCK Goals and Outcomes and Key GCK Pilot Development Outputs

GCK Goal
Residents of Kinyinya Hill should be able to enjoy the social and economic benefits of urbanization while minimizing ecological footprints
GCK Outcomes
Green City Kigali: A solutions-based pilot for green urbanization in Rwanda. an urban development model for increased resilience against the consequences of climate change and the ensured sustainable urban development of Rwanda through the development of a model community at Kinyinya Hill. via Four Foundations of Sustainability that serve as the project outcomes. (See Section 2.3). • An affordable and socially equitable development • Climate change adaptation and mitigation • Resource and land efficiency at the core of development • A culturally sensitive urban development
Key Development Outputs (GCK Pilot)
The feasibility study process, (as presented at Chapter 6 and 7) result in the following key outputs through the development of a 16ha model community (pilot project) which is based around the GCK livable city concept and which employs resource efficient and climate change mitigative building technology and infrastructure. Key outputs include: <u>Housing:</u> 1680 housing units in total, of which 1430 are affordable housing. Affordable unit sizes from circa 30m^2 to 80m^2 (Studio, 1 BD, 2 BD, 3BD) based within simple walkup multi-storey buildings of up to 5x floors (G+4), serving a population of circa. 7,728. Affordable units are designed be affordable to those earning incomes between 250k – 700k RWF/mo (See Section 7.3.1) Buildings developed using cost efficient and sustainable resources and employing environmental design features (see Section 6.5 and 6.7). All buildings achieve EDGE Advance certification (which applies to public buildings as well). A medium to high density development (approx. 108 DU/ha), while providing open spaces (public, semi-private and private) and maintaining a human scale through limiting building heights. <u>Physical infrastructure (refer to Section 6.8.10 for a more detailed summary):</u> Transport and mobility: A road network, developed using sustainable and low carbon materials and methods, which promotes the use of public and non-motorized transport modalities and draws upon the GCK transport vision (see Section 6.8.4)

Energy & ICT: Metered electrical connections supplied to all homes and businesses via the national grid (REG) and LPG cooking facilities made available (Chapter 6.8.7). All buildings are solar energy and water heating install ready, with key public buildings including install at outset (See Section 6.7.1).

Water supply: Metered water supply connections to all homes via the municipal WASAC network and supplemented by grey water sourced from rainwater harvesting (RWH), with RWH system also acting as retention and control point for sustainable urban drainage network. (See Section 6.8.5)

Sanitation: Simplified sewerage and treatment system serving all homes and businesses. Simplified sewerage with reduced embodied carbon compared to traditional systems and recommended semi-centralized system with lower energy requirements. (See Section 6.8.6)

Waste Management: Waste sorting space provided for each 60 HH and within 200m of HH to allow for sorting into organic, recyclable and residual waste. Employment of "waste ambassadors" to provide training to residents around waste separation. (See Section 6.8.8)

Climate resilient stormwater management: (See Section 6.3.3 and 6.8.9): The use of nature-based stormwater management systems for the local treatment, detention and infiltration of stormwater. Result is reduction of erosion and increase of groundwater recharge.

For a summary of roles and responsibilities regarding provision see Section 7.4

Public and Community Spaces: Pursuant to CoK Masterplan and Rwanda UPC requirements as regard community facilities, the following are proposed as part of the GCK Pilot Project in recognition of it as a neighborhood and forming part of the larger Ngaruyinka Village and Murama Cell: (see Section 6.5.4)

Commercial: Neighborhood Centre and Market Square (2,500 m^2)

Education: Primary and Nursery School (6,000m^2, including use of park and sports field for outside activities)

Socio-cultural: Community Hall (utilizing auditorium space of primary school with size to be determined in conjunction with UADC as part of overall school programming)

Socio-cultural: Religious, Youth and Social Space: 1,400m^2

Parks: Neighborhood Park and Sports Field (nearby to primary school, for cross use): 4,050m^2

Public Realm: Public plazas and squares using semi-porous materials for natural stormwater infiltration as part of nature-based system: 5,200m^2

Project Delivery and Implementation Arrangements:

Government owned special purpose vehicle in the form of a community benefit company (Green City Kigali Company) established and responsible for management of the project master planning, design and tender process, land transfer and development of the site with infrastructure, potential development of housing and commercial, and shared operations and maintenance (in conjunction with municipality and utilities – see Section 7.4) of infrastructure and public buildings/areas.

Enforcement and verification of project sustainability ambitions through use of contract covenants by GCKC (See Section 6.8.2)

GCKC enters into agreements with relevant utilities and municipal authorities as regards provision and operations of public infrastructure (See Section 7.4).

	GCKC potentially enters into agreement with private developer counterparties for transfer of land for development of commercial and residential buildings.

Table 10: GCK Outcomes and Outputs

GCK Outcomes	GCK Process and Development Outputs
Affordable and socially equitable development	o Mixed community/Dwellings for various income groups to invest in housing and in alignment with national affordable housing policy: • 150 dwelling units within reach of sub-RWF 250k-300k p/m income group • 550 dwelling units within reach of RWF 380k – 430k p/m income group • 470 dwelling units within reach of RWF 500k – 550k p/m income group • 260 dwelling units within reach of RWF 600k – 700k p/m income group o Affordability of sustainable development through construction costs per sqm (affordable housing) of less than 400 USD (preliminaries, site works and contingency inclusive, land exclusive).
Climate change adaptation and mitigation	o Adaptation to climate change through slowing down of stormwater runoff, and reduction of the urban heat island effect through provision of a permeable surface area ≥65% within the project area boundary. o Mitigation of climate change through atmospheric GHG emission reduction and adaptation to climate change through slowing down and evapotranspiration of stormwater, and reduction of the urban heat island effect via a Green plot ratio of 2. o Greater than existing Ecosystem Services profile within project area provides multiple benefits for climate mitigation and adaptation and as documented in the sustainability assessment performed by UADC. o Increased efficiency of energy and water consumption in construction and operation of budlings, through a >50% reduction in energy, water and embodied energy (materials) (EDGE Advance). o Increased efficiency of energy consumption in construction & operation of the transport system through a proposed construction methodology for ROWs and utilities infrastructure focusing on the use of low carbon materials, local sourcing of materials, efficiency in construction, lifespan of material and recyclability / reusability. Plans for pedestrians and cycling routes.
	o Greater than existing Ecosystem Services profile within project area provides multiple benefits as regards resource efficiency and as documented in the sustainability assessment performed.

Resource efficiency	o Land resource efficiency through the achievement of medium to high development densities of 100+ DU/ha while maintaining human scales. o Increased efficiency of energy consumption in construction & operation of the transport system through a proposed construction methodology for ROWs and utilities infrastructure focusing on the use of low carbon materials, local sourcing of materials, efficiency in construction, lifespan of material and recyclability / reusability. Plans for pedestrians and cycling routes. o Reduction of road land use allocation to circa. 16% o Increased efficiency of energy and water consumption in construction and operation of budlings, through a >50% reduction in energy, water and embodied energy (materials) (EDGE Advance). o SWM management systems in place to increase the circular use of material through the placement of household waste source separation points no more than 200m distance from homes.
Culturally sensitive urban development	o Enhanced community cohesion and preservation and cultivation of cultural traditions in the community, through the introduction of social and community infrastructure. o Implementation of a Green-Blue Network providing public space and space for stormwater infiltration. o Greater ecosystems services profile than existing provides for community cohesion, health and wellbeing. o Development at a human scale, with building height limitations and limiting plot coverage while achieving medium to high housing densities (100+ DU/ha).

6.3 Livable Communities

The provision of a GCK livable community places a strong focus on finding synergies between social, economic and environmental systems and celebrating them through spatial planning and urban design. In this way, the sustainable features of the community begin to define its physical character and identity in the city, as well as life within it. For example, strategic views and spaces are coordinated with the sustainable green and blue infrastructure and transport-oriented design (TOD) focal points to enhance the inhabitant's orientation, sense of place and to create a characteristic community that is appropriate within its context. Public open spaces and landmark buildings are located at local centers to promote community cohesion, safe streets and a dynamic and vibrant urban life. These centers should contain sustainable infrastructure such as recycling points and transit stops.

Further concepts contributing to the development of a livable city can be found within other relevant sections of this report. This section focuses on the urban planning scale, while further sections cover elements at the building and infrastructure scale.

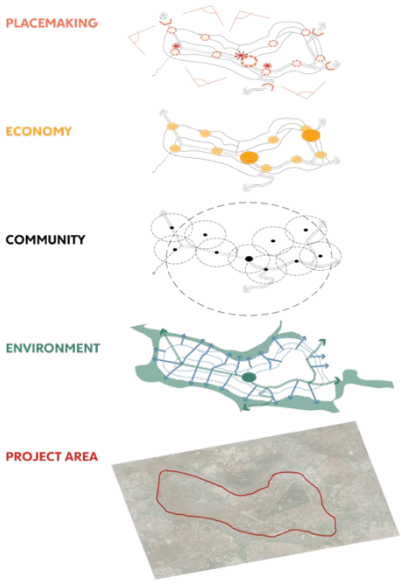


Figure 28: Spatial Synergies and Placemaking at the GCK Planning Area.

Figure 29: A model Liveable Community for the Planning Area as presented by the Design Competition Winner (UADC), src: confidential

Within the context of the site and the larger city of Kigali, certain characteristics of a livable city are necessary in order to provide for a sustainable community and that meets the objectives of the GCK project. These include:

6.3.1 Land Resource Efficiency Programming

Both the Planning and Pilot Areas are located nearby to the Kigali city center as well as national government institutions (Kimihurura Sector) in a city growing at over 4% a year. To achieve targets as regards housing affordability, and to comply with zoning requirements as set forth by the CoK Masterplan (R3), further density requirements as set forth by affordable housing policy and for larger policy aspirations, land must be used efficiently, and higher levels of density achieved.

Figure 30: While highly land efficient and with a similar topography, such a housing project like this in Hong Kong would not be appropriate considering the context in Kigali. (src: Baycrest)

Figure 31: However, land resource efficiency can be achieved while still maintaining human scale and with simple walk up buildings as proposed in this concept for the GCK Pilot Project core (src: Confidential)

6.3.2 Transport Oriented Development (TOD)

Transit oriented development (TOD) is characterized by high density, compact mixed-use development focused around public transit corridors, with strong walking and cycling (non-motorized transport) links to transit stops and reduced use of private cars. TOD supports livable, sustainable communities in many ways. In conventional cities, roads and footways occupy typically as high as 30% of the surface area. In GCK however, a key aim is to radically improve conditions for walking, cycling and greener mobility modes to mitigate against the increase in private car use. Consequently, the project targets a reduction in the road land-use allocation to circa. 16%.

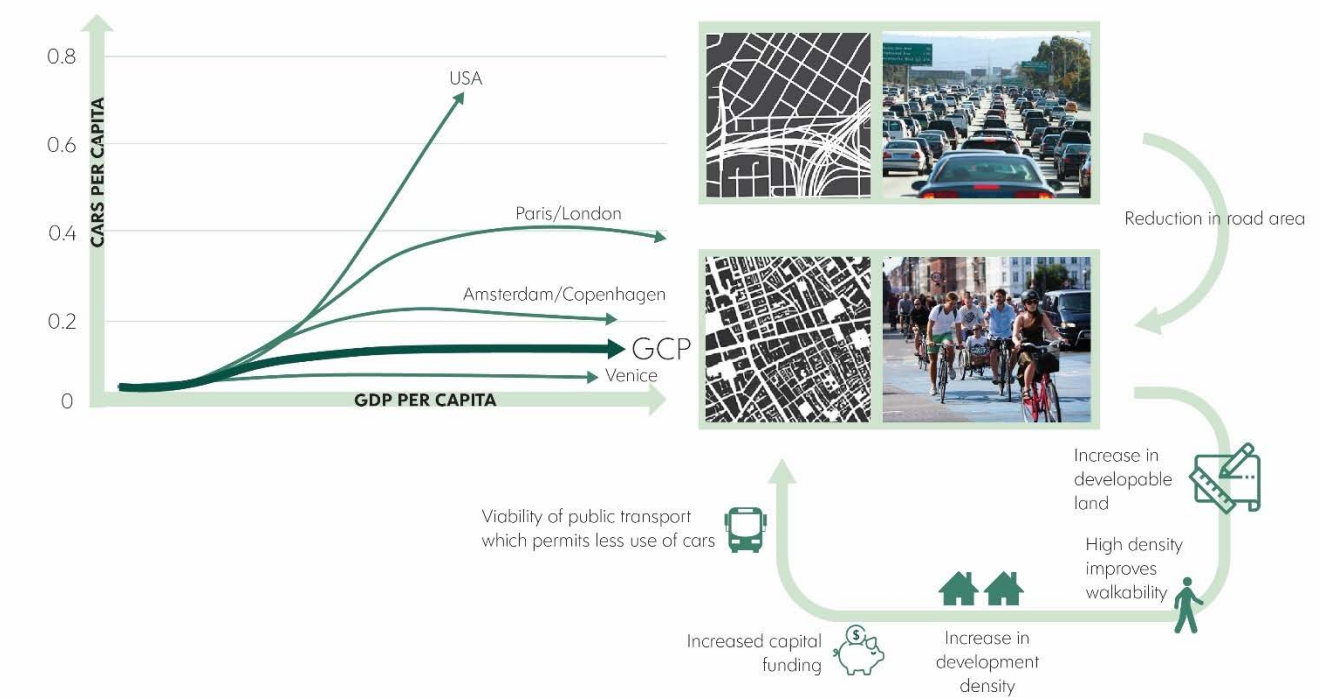


Figure 32: Sustainable transport strategy

By designing for modest levels of car use (roads and parking), land area is freed up to provide significantly more development. This enhanced development value and increased resident population helps to make better, greener community infrastructure including more viable, high frequency public transport. This in turn supports a strong local economy still further.

6.3.3 The Green-Blue Network

Using nature-based solutions (NBS) at the GCK, a green and blue area provides the backbone of a sustainable urban drainage system (SUDS), ensures permeability to mitigate stormwater runoff, urban heat island mitigation, safe walking and cycling routes, and to protect natural habitats and create public open recreation space. Synergies can be found to overlap these land uses where appropriate thereby maximizing developable area and increasing housing capacity elsewhere within the developable area (refer to Figure 10 for an illustration of how a green corridor might be implemented at the GCK pilot project).

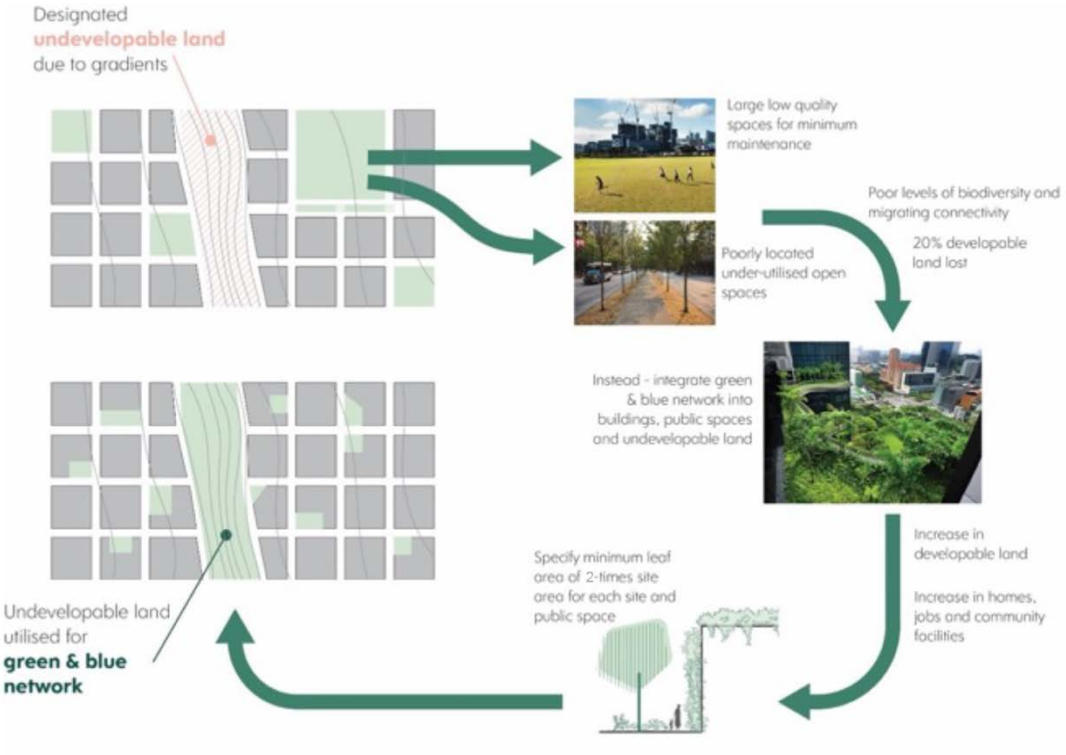


Figure 33: Green and blue network strategy

6.3.4 Social Infrastructure and Mixed-Use Development

A livable community requires that certain amenities are present to ensure quality of life and sustainability of the community. These include educational services, health, recreation, and physical health spaces as well as commerce, retail and entertainment services. These services, while also providing for an increased quality of life also provide potential sources of employment within the community (mixed use development) further increasing livability.

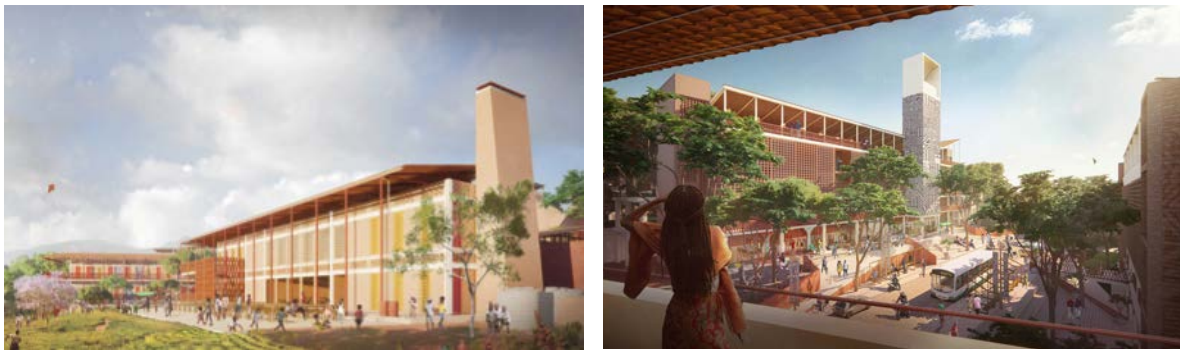


Figure 34: Proposed concept for a new primary school and central market square at the Pilot Area (source: Confidential)

The GCK liveable city concept provides for a community with sufficient social infrastructure that meets or exceeds that required by the CoK MP or equivalent statutory planning requirements and which adheres to relevant standards (ie. Ministry of Education's Child Friendly Schools Infrastructure Standards and Guidelines). At the GCK Pilot Project, for example, a primary school is provided for circa. 900 pupils. This is about as large as a primary school should be to allow for a sense of its own identity and to serve its local community (the Pilot and surrounding Ngaruyinka area).

6.4 Sustainable Spatial Planning

A key process output of the study is the presentation of spatial planning data to ensure the development of a project that provides for a livable and sustainable community (as presented in the preceding section) for its inhabitants but at the same time which aligns with planning regulations, national and international policy as well as the goals and outcomes for the project.

A review of the urban planning context at the Planning Area (micro), Kigali (meso) and Rwanda (macro) included secondary research, such as review of CoK MP and urbanization policies, as well as primary site-based evaluation, such as land use, notable sites and existing communities. The existing land use within the planning area is provided in Figure 18 at Section 3.2.7.

6.4.1 GCK Carrying Capacity (Planning Area)

The following figures were generated through a spatial planning analysis with the aim to identify the carrying capacity of the Project Area as a basis for the Feasibility Study and pursuant development within that area and further the pilot project.

Developable Areas

The Gross Residential Development Area (GRDA) is defined as those parts of the overall Planning Area that remain after discounting: i) the areas that are unsuitable for development ii) the areas that are allocated for non-residential clusters.

The table below summarizes all the areas that are discounted from the overall GCK study area to arrive at a Gross Residential Development Area (GRDA).

Table 10: Gross Residential Development Area calculation

Overall GCK study area	600 ha
Areas unsuitable for development	220 ha
Proposed employment cluster	10 ha
Urban center park(s)	7.5 ha
Gross Resi. Development Area (GRDA)	362.5 ha

A parallel analysis by the winning bidder (UADC) produced a GRDA of 356ha, a less than 2% difference, from the Sweco analysis and helping to confirm the overall GCK GRDA presented.

Net Residential Developable Areas

The Net Residential Development Area (NRDA) is defined by reductions from and additions to the Gross Residential Development Area (GRDA) to allow for public rights of way and other special conditions at the Planning Area. The table below summarizes the NRDA including customized calculations to account for densification of the informal settlements and key commercial areas.

Table 11: Final Net Residential Development

Gross Residential Development Area	362.5 ha
Less inefficiency factor for informal settlements	84 ha
Plus densification factor for Sub Urban Centre	30 ha

Subtotal GRDA	308.5 ha
Of which…	
Highways & footpaths	16%
Sustainable transport routes	1%
Green & blue network	13%
Net Residential Development Area	70%
Final Net Residential Development (NRDA)	216 ha

6.5 Mixed Use Development: Populations, Densities, Housing Types and Community Facilities

6.5.1 Zoning Requirements

The City of Kigali Masterplan (2020) indicates most of the undeveloped areas of the Planning Area as a mix of medium density residential areas, with mixed use (R2 and R3 – formerly R5 at interim plan, and C2-O). The pilot area is specified as R3, with minimum densities of 50-90 DU/ha. National affordable housing policy indicates a further 25% density requirement for affordable housing projects[27], increasing densities to between 63-113 DU/ha.

27 Official Gazette n°48 of 30/11/2015, Prime Ministers Instructions

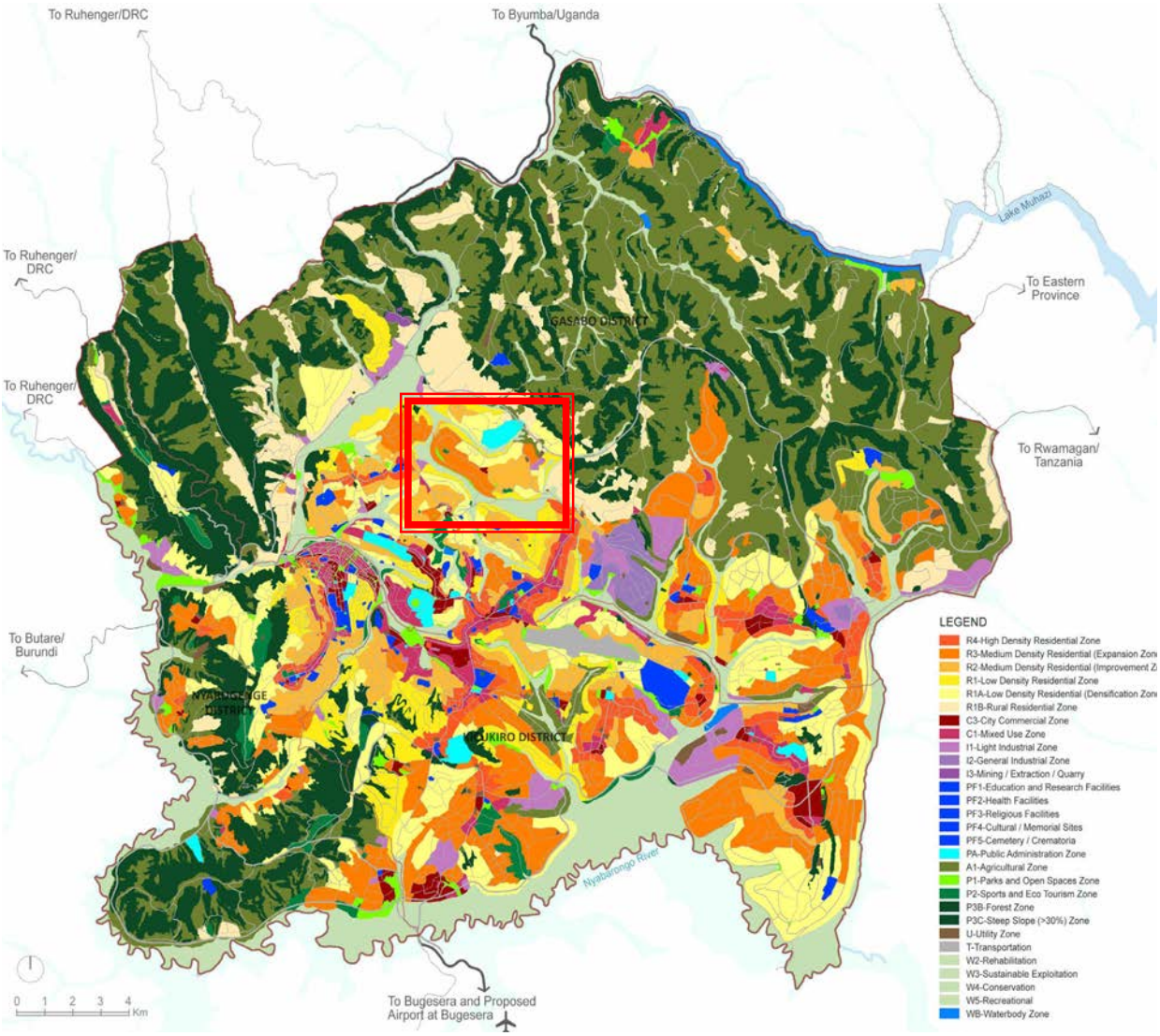


Figure 35: Zoning Plan CoK MP 2020 (GCK Planning Area in Focus) (src: City of Kigali)

6.5.2 600ha Planning Area

The table below shows a sample breakdown of housing types distributed across the 216 ha Net Residential Development Area (NRDA) of the Planning Area, followed by a resulting projected population.

Table 12: Populations, Densities and Housing Types

Typology		Parameters					Population	
Unit type	Building type	Typ. area (sqm)	Typ. FAR	Density category	Pers / Household*	Units/ha (gross)	% mix	Population
Basic standard	Apts	45	1.75	High	4.15	210	5	8 066
Basic standard	Houses	45	0.5	Low	4.15	78	5	5 969
Affordable 1BR	Apts	45	1.75	High	4.15	160	23.3	42 868
Affordable 2BR	Apts	60	1.4	Med	4.15	115	23.3	34 503

Affordable 3BR	Apts / rowhouses	80	1.2	Med	4.15	80	23.3	26 139
Market Houses (average market sale unit size used for density and FAR)	Single Family Homes	100 120 150	1	Low	4.15	50	10	12 609
Total Population (NDA)								130 154

**A pers/household average rate has been applied based on IPAR study over average from 2030 to 2050.*

When expandable micro-unit housing is considered to meet the affordability levels of lower income households who do have the potential to enter the housing market the following may apply:

Table 13: Populations, Densities and Housing Types: Affordability

Typology		Parameters				
Unit type	Building type	Typ. area (sqm)	Typ. FAR	Density category	Pers / Household*	Units/ha (gross)
Affordable 1BR	Apts	30	1.75	High	4.15	210
Affordable 2BR	Apts	45	1.75	High	4.15	160

In addition, there is an estimated existing and near future development population that must be included in the calculations to provide an accurate overview of the expected final population. The table below summarizes these factors:

Table 14: Planned future development population

Existing / planned housing area	No. Units	Household size [(2)]	Population
Cactus project	349	4.3	1 500
Dubai site west	110 (estimated)*	4.3	473
Central site	150 (estimated)*	4.3	645
Informal settlements	8400 (estimated)[#]	4.3	36 120
Total population within the NDA (see above)			130 154
Total population within the overall GCK Planning Area			168 892

* Formal development data is unavailable. Consequently, counts have been made using satellite imagery.

[#] Calculation based on total area of informal settlements by 50 dwellings per ha.

6.5.3 16ha Pilot Project

The table below shows the breakdown of housing types distributed across the greenfield 16ha area, and also as already presented at Table 10, followed by the projected population and overall density. R3 zoning requirement with C2-O overlay, and additional density requirements as prescribed by affordable housing projects, indicate a minimum density for the Pilot Project of between 63-113 DU/ha. The GCK Pilot aims to achieve a density of 108 DU/ha, which is a similar density to other planned affordable housing developments in Kigali (see Section 4.3).

Table 15: Populations, Densities and Housing Types

		Parameters					Population	
Unit type	Building type	Typ. area (sqm)	Typ. FAR	Density category	Total Units	Units/ha (gross)	% mix	Population*
Affordable 1BR Micro-unit	Apts	30	1.75	High	150	210	9	690
Affordable 1BR	Apts	45	1.75	Med	550	160	18	1 380
Affordable 2BR	Apts	60	1.4	Med	470	115	28	2 162
Affordable 3BR	Apts	80	1.2	Med	260	80	15	1 196
Market Sale 3BR	Rowhouse	100	1	Low	250	60	15	1 150
Total Population								7 728

*A persons/household average of 4.6 has been applied based on IPAR projection of HH size at 2024.

6.5.4 Community Facilities

The 2020 Kigali Masterplan provides guidelines for the provision of community facilities in residential areas. The Masterplan proposes a hierarchy of social infrastructure with population catchments as trigger points for the provision of certain services. They are:

National	3.8m people
District	1.2m people
Precinct	120 000 people
Neighborhood	20 000 people

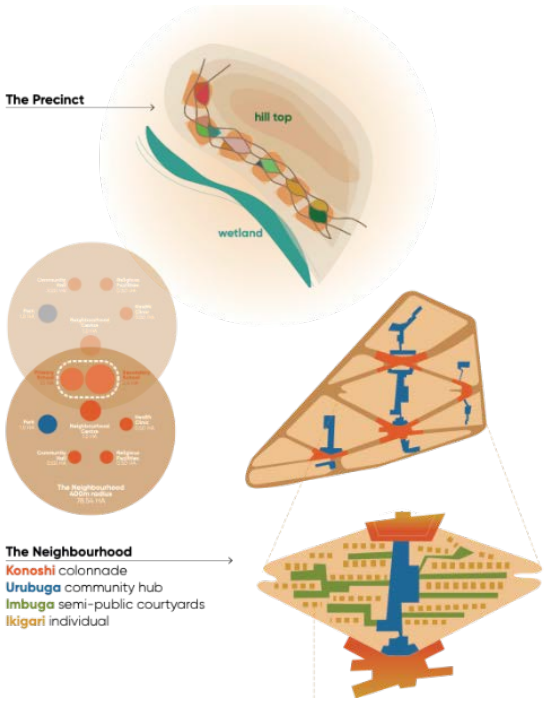


Figure 36: From the Precinct (GCK Planning Area) to the Neighbourhood (GCK Pilot Site) (src: Confidential)

The projected population of the Planning Area (600ha) therefore constitutes one Precinct and the Pilot Area (16ha) within a Neighborhood. The standards set for provision of community facilities are show below.

TYPE	PUBLIC FACILITIES	PORPOSED FOR KIGALI
COMMERCIAL	Neighborhood Centre	1 per neighborhood; 1.2 ha site.
	Town Centre	1 per precinct; 12.0 ha site.
	Regional Centre	1 per 0.5 million, 50 ha site.
EDUCATIONAL FACILITIES	Primary School	1 per neighborhood (15,000-20000 population). 1.5 ha site.
	Secondary School	1 per 20,000 - 25,000 population. 2.4 ha site.
	Primary + Secondary School (Combined)	2.8 ha site. (Based on existing school sites)
	Vocational / ICT Institute	1 per precinct. 5.0 ha site.
	Higher Education Institute	1 per 500,000 population. 6.0 ha site
SOCIO-CULTURAL FACILITIES	Community Hall*	1 per 5,000 population. 0.5 ha site.
	Regional Library	1 per 500,000 population. 0.5 ha site.
	Religious Facility	1 per neighborhood (15,000- 20000 population). 0.5 ha site.
	Cemeteries	1 per precinct 20 ha over 20 years
	Museums/ Cultural Centre etc.	1 per precinct. 1.5 ha site.
HEALTH FACILITES	Health Clinic *	1 per neighborhood (15,000-20000 population). 0.5 ha site.
	Polyclinic	1 per precinct. 5.0 ha site. Max travel time of 30 mins.
	Regional Hospital	1 per 500,000 population. 5.0 ha site
PARKS & OPEN SPACES	Neighborhood Park	1 per neighborhood (15,000-20000 population). 1.0 ha site
	Town Park	1 per precinct. 6.0 ha site
	Sports Field	1 per precinct. 1.5 ha site. (Near to schools or community centres or combine with parks.)
SPORTS & RECREATION	Sports Centre (with swimming pool and stadium)	1 for every 500,000 population. 6.0 ha site.
CIVIC FACILITIES	Fire Station	5 minutes response time. 0.5 ha site.
	Government/ Municipal Offices	1 Sector office per Sector. 1 District office per District.
*(as part of neighborhood centre)		

Table 16: Public facilities proposed for Kigali. Source: City of Kigali Masterplan 2020

Community Facilities at the GCK Pilot Project

Pursuant to CoK Masterplan and Rwanda UPC requirements as regard community facilities, the following are proposed as part of the GCK Pilot Project in recognition of it as a neighborhood and forming part of the larger Ngaruyinka Village and Murama Cell (sizings of which are presented at Table 9):

- Commercial: Neighborhood Centre and Market Square
- Education: Primary School
- Socio-cultural: Community Hall
- Socio-cultural: Religious, Youth and Social Facility
- Parks: Neighborhood Park and Sports Field (nearby to primary school)

Not Required:

- Health: Health Clinic – City of Kigali have indicated sufficient provision of primary health care facilities within Murama cell already and thus such a facility within the Pilot Area is not required.

Section 7.4 of this report elaborates further as regards implementation and operations transfer.

Figure 37: Simple Community Halls designed to service neighbourhoods of 200 - 300 homes at the GCK Pilot Project (src: Confidential)

Further details of the carrying capacity and approach to creating a livable community in GCK are contained in the Urban Design Handbook (Sweco, 2019) as well as the expanded Final Feasibility Study (Sweco, 2020).

6.6 Affordable and Sustainable Housing

Work undertaken regarding the housing sector comprises two primary sections; a study of the existing housing situation in Kigali and proposals for new housing for the Planning Area. The existing housing situation was broken down into two areas; (i) an analysis of existing policy and regulation as it regards affordable housing at the Project Site, and (ii) a study of the predominant housing typology found within Kigali. The proposal for new housing was prefaced by an examination of the parameters influencing the proposal of new housing forms. This was then followed by the proposal of relevant new housing typologies at the block, building and unit level.

For further information refer to the expanded Final Feasibility Study (Sweco, 2020) and the GCK Housing Sector Report (Sweco, 2019).

6.6.1 Existing situation for housing

Kigali faces a number of challenges and opportunities regarding housing provision:

- A rapidly urbanizing city, with around 80% living in informal settlements.
- Problems with housing supply and affordability means a failure to deliver housing for the majority.
- Development that must make use of the nation's existing natural resources for building over those imported from overseas.
- Current urban sprawl threatens the environment, food security and urban livability.
- Government drive toward sustainable development and urban excellence.
- Measures introduced to promote densification and land use efficiency of the city based around key growth poles - of which the Planning Area is one (ie. Pilot Area as R3, C2-O).
- A current indicated preference amongst the residents of Kigali for single-family homes which provide challenges for a drive toward greater land use efficiency.

6.6.2 Proposed housing typologies

Factors driving the need for a change from existing housing types include climate change, density, affordability, accessibility, safety and security, sustainability and community and which reflect the GCK Four Foundations of Sustainability (project outcomes).

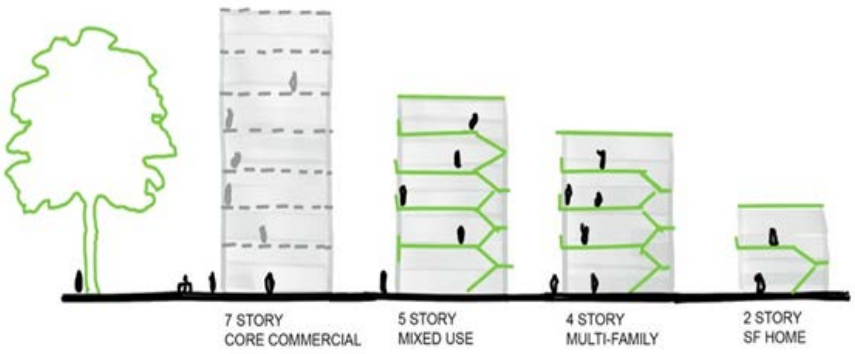


Figure 38: Human to building height scale and experience (Up to 5 stories provide human scale and prospect for those living above, thus the proposal to limit building heights at the GCK pilot to G+4, 5 stories)

Housing and site parameters that required examination prior to the determination of future housing typologies for GCK are; site planning criteria, area densities, building heights, building materials, cost, social and cultural factors (including a priority for privacy and defensibility aspects), and environmental design requirements. A detailed examination and integration of these factors resulted in the development of proposed typologies at the block, building and unit level which were presented within the Mid-Term Feasibility Study (Sweco, 2019) and further developed by the preferred bidder as part of the design competition.

6.6.3 Proposed housing typologies at the block level[28]

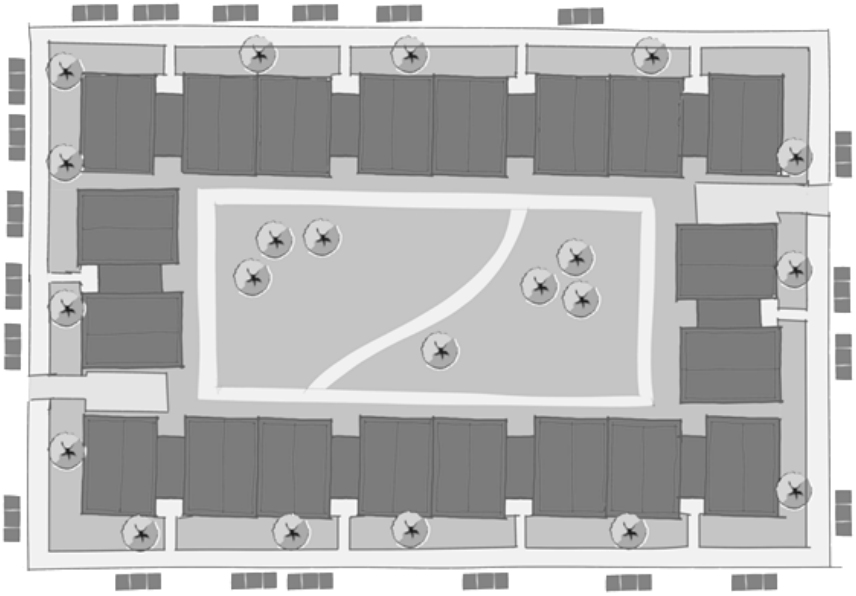


Figure 39: The Community Block concept as Presented in the Mid Term Feasibility Study (2019)

28 A block plan shows the siting of buildings as blocks laid out on maps of the surrounding area.

Figure 40: The community block further developed as a design concept (src: Confidential)

The following guidelines are considered:

Community Courtyard (Igikari)

The proposed block design focus on the need for shared private space in multi-family residential development. It is recommended that each block be based around a common community courtyard or semi-public space, allowing for shared services and promoting a sense of privacy for residents. Privacy has been repeatedly identified in research, community engagement and stakeholder interviews as a fundamental requirement in any successful future housing in Kigali. The idea of the shared courtyard is based on the Rwandan Ikigari, or central shared space found in a typical Rwandan residence.

Street Front

At major street fronts, a unified street edge could be considered with commercial activity activating the streetscape. At quiet residential streets, setbacks should be considered to provide for privacy for units facing the street edge.

Figure 41: The use of colonnades in Kigali streetscapes and presented in the GCK design concept (src. confidential)

6.6.4 Proposed housing typologies at building level

Rwanda is a culture used to living in single family homes, whether these are formal or informal. Multi-story multi-family residential living is a new concept in the country and will require an adjustment in attitude towards it. However, such a move to more land resource efficient building is necessary not as an abstract ambition but as a real need, and as prescribed by municipal zoning requirements and national policy (ie. GCK pilot as R3 and C2-O).

In addition, Kigali is a city where housing is expensive and financially out of reach of most residents. As compared to GNI per capita, Rwanda has the most expensive housing in Sub-Saharan Africa. These issues as well as the overall ambition of the GCK project to adhere to its Four Foundations of Sustainability help to develop these simple guidelines in the design of appropriate buildings:

- Affordability
- Privacy and security
- Environmental design considerations
- Resource efficiency (land, energy and materials)

The following Building Typologies are proposed for the GCK Planning Area and further the Pilot Area:

Table 17: Proposed Housing Typologies

Proposed Housing Typologies		
Number of Floors	Housing Type	Usage
4-Story (G+3)	Multifamily Residential (Pilot)	Residential
4-Story (G+3)	Mixed Use (Pilot)	Commercial and residential

5-Story (G+4)	Mixed Use (Pilot)	Commercial and residential
2-Story (G+1)	Single family residential (Pilot)	Row House residential
2-Story (G+1)	Single family residential	Duplex residential
2-Story (G+1)	Single family residential	Villa residential

Figure 42: From the building to the community - the layers of private, semi-private and public spaces with the sustainable building at its core (src: Confidential)

6.6.5 Proposed housing typologies at unit level

Unit designs are influenced by several factors which include:

i. Maximizing cost efficiency and space utilization.

ii. Upgradeability and adaptability of the units.

iii. Provision of good airflow and natural daylighting to reduce external energy use.

iv. Privacy and security.

v. The transition from single family home living to higher density multi-family habitation.

Efficient unit typologies based around a common structural grid and employing strong environmental design fundamentals, thereby reducing life cycle costs, can provide the basis for affordable and sustainable housing units at GCK.

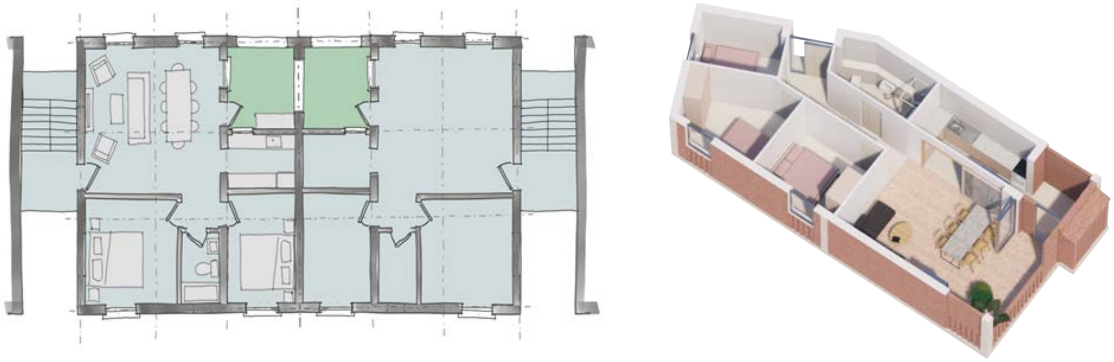


Figure 43: Efficient unit layouts for affordability (left); The efficient unit concept developed (right, src: confidential)

The following Unit Typologies are proposed (see Table 11 for a breakdown of unit typologies by number at Pilot):

Table 18: Proposed Unit Typologies

Proposed Unit Typologies		
	Type	Size
1	**Apartment Units:**	
1.1	1 BD expandable microunit (affordable housing) (Pilot)	30 m^2
1.2	2 BD expandable microunit (affordable housing) (Pilot)	45 m^2
1.3	1 BD unit (affordable housing) (Pilot)	45 m^2
1.4	2 BD unit (affordable housing) (Pilot)	60 m^2
1.5	3 BD unit (affordable housing) (Pilot)	80 m^2
2	**Single Family Housing Units:**	
2.1	2-Story (G+1) – Single family residential – Row House (Pilot)	100 m^2
2.2	2-Story (G+1) – Single family residential – Duplex	120 m^2
2.3	2-Story (G+1) – Single family residential – Villa	150 m^2

6.6.6 Holistic Approach to Construction and Energy Use

The proposed housing design strategy follows passive design principles informed by the climatic opportunities in Kigali and local procurement principles. Servicing strategies are informed by climatic resources and use of appropriate technology combined with progressive thinking around infrastructural opportunities created by optimizing density. The figure below indicates how some of the visible elements are integrated into the housing design.

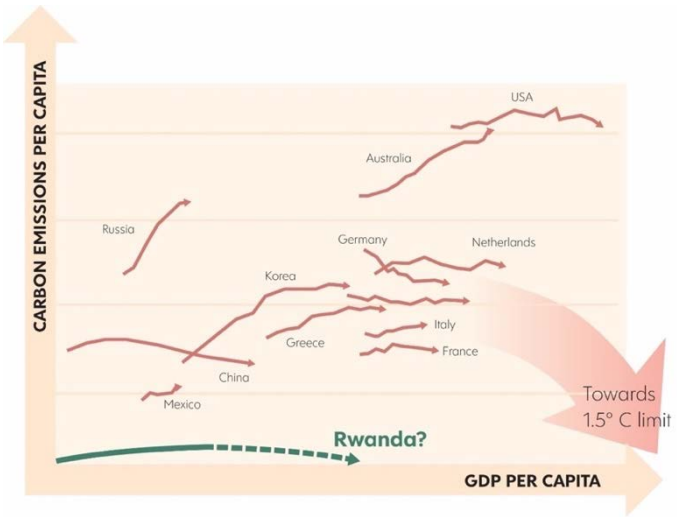
Figure 44:Sustainable solutions integrated at building and street level (src: confidential)

6.7 A Roadmap to Zero Carbon at the GCK Pilot, A Buildings Focus

Energy use in Kigali is expected to increase as prosperity increases. At the GCK this may not be a challenge in the short-term given Rwanda's centralized excess generating capacity. In the medium to longer term however, when coupled with the need to turn away from carbon emitting fuel sources, a means of detaching economic development from carbon emissions is needed. However, Rwanda ranks 182 out of 188 countries in per capita GHG emissions[29] and contributes less than 0.01% to global emissions[30], and thus the focus must be on maintaining a low level of resource usage that contribute to GHGe.

The GCK proposes a medium to long term roadmap and timeline to Zero Carbon using demand reduction coupled to onsite renewable electricity generation. In the short term it presents a pathway to reduced resource and energy usage of over 50%. Key to this is showing how modern lifestyles can be achieved using significantly less energy use than would be the business-as-usual case. Thus, the initial focus is on reduced energy demand by users at the outset, while ensuring that buildings are solar PV ready for installation at a point where demand requirements provide both an economic and environmental case for such investment. As current per capita usage is so low, and the grid currently provides a surplus, the current benefit to cost ratio does not support installation at the outset. However, the benefit to this low per capita usage is that it is easier to maintain at a lower level than reduce from a higher demand level.

Figure 46: Carbon emissions per capita versus GDP per capita



Resource modeling via the EDGE tool for buildings has shown how building energy use can be more than halved at the outset using largely passive design and simple measures. For future PV install, roof areas of buildings of up to 5 stories can potentially generate more than enough renewable energy to meet their overall energy needs

29 https://data.worldbank.org/indicator/EN.ATM.CO2E.PC?locations=RW&most_recent_value_desc=false based on 2016 data
30 https://ourworldindata.org/co2/country/rwanda

and thus achieve zero carbon, when coupled with electric based cooking methods. With many buildings at the GCK proposed to be of fewer stories, there is the potential for their roof installed solar panels to provide excess power and for this to be fed back into the municipal grid or for use by community infrastructure and for future electric transport needs.

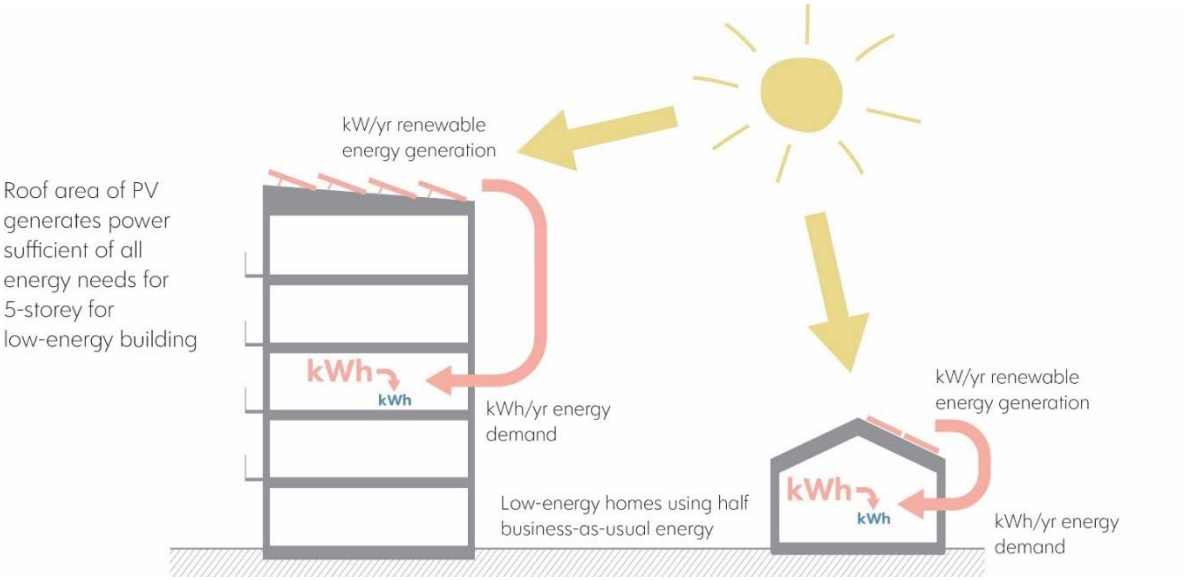


Figure 47: Zero carbon buildings

There is potential to reduce or eliminate needed capacity increases of a future local electrical grid, however, based on building level reduced demand. The GCK pilot, will focus on ensuring this reduced demand potential results in reduced peak demand and therefore deliver on the goal to mitigate the need for potential future capacity increases and resultant capital costs. As outlined in the Resource Modelling section ensuring the correct governance is in place is crucial - requiring effective land contracts, design and site implementation to deliver on this potential.

To assist in achieving the ambition for a net zero future for the GCK pilot all buildings are to be ready for future installation of PV panels and solar hot water heaters. Initially limited PV may be installed for internal building use where an economic case, paired with sustainability case can be made. Solar street lighting is intended from the outset.

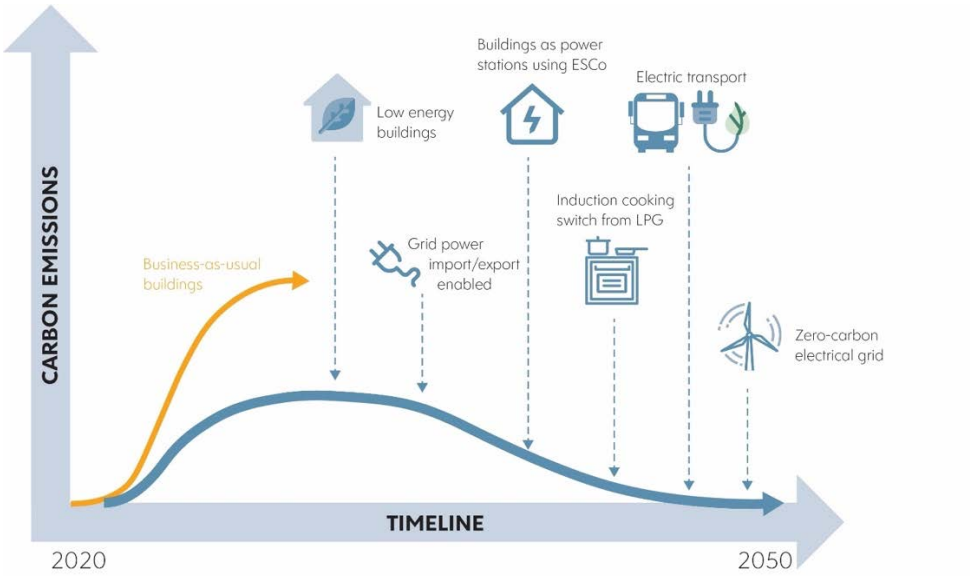


Figure 48: GCK Timeline to zero carbon

Initially LPG for cooking is anticipated as an alternative to the use of wood-based fuel. LPG whilst still a fossil fuel is considered an acceptable medium-term solution given the availability of domestic resources and the scaling up of extraction from Lake Kivu to facilitate a shift away from wood based domestic fuel. The longer-term aim is a transition to induction electric stove cooking powered from clean energy sources. Whilst appliances are currently prohibitively expensive for most Kigali households, this aim reflects the expectation that induction prices will fall significantly being a simple solid-state device amenable to manufacturing scale cost reductions.

6.7.1 Demonstrating Net Zero School at the Pilot Project (Nursery and Primary School)

The floor area size of the primary school and nursery planned on the 16ha pilot areas is for an estimated 6000m^2. This Is based on the anticipated 900 students and additional staff of 100 persons. In addition, there will be labs, school restaurant, auditorium and other areas available for the students and staff as well as general circulation areas. The design of the school Is a G+1 construction which provides a roof area of total 3,000 m^2. There Is an electricity demand and demand for cooking energy. It is assumed that there Is no demand for heating or cooling, considering the temperate climate. The solution suggested for electricity generation are solar panels on the roof with or without storage capacity depending on the opportunity to connect to the grid or not. For cooking energy, a biogas reactor is suggested using combination of organic wastes collected from the area and sewage sludge.

In designing the appliances and electric system in the school careful consideration should be given to take full advantage of reducing power demand and achieve high level of energy efficiency. Based on studies[31] in South Africa energy demand for a school could be put at 10-40 kWh/m^2 and where electricity demand will vary dependent on among other things whether the school is affluent or not (affluent have higher electricity demand). This range provide basis to assess a potential annual power demand in the net-zero school. With 6,000 m^2 floor area the electricity demand may reach up to 240 MWh/year. Direct normal solar irradiation is given to about 1,260 kWh/m^2/year in Kigali[32]

31 Samuels, J. A., S. S. Grobbelaar and M. J. Booysen (2020). "Light-years apart: Energy usage by schools across the South African affluence divide." Energy Research & Social Science 70: pp 101692.
32 Energydata.info. (2021). "Global Solar Atlas." from https://globalsolaratlas.info/.

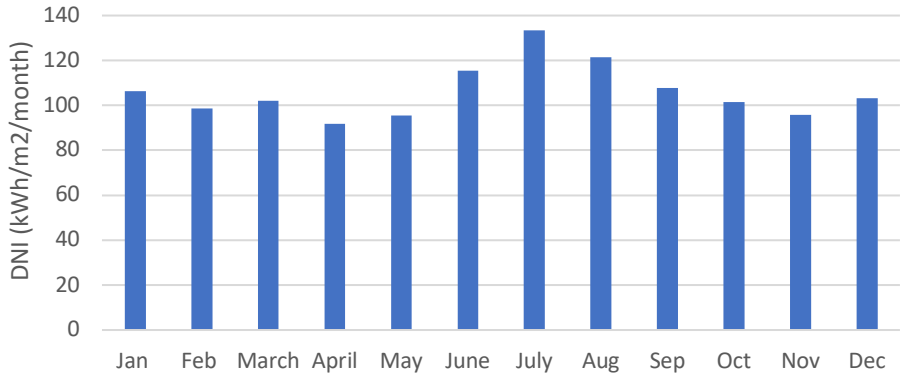


Figure 49: Direct normal irradiation in Kigali, average per month (kwh/m²/month)[33]

With a potential 3,000 m² roof area providing space for about 350 kW_p solar panels. The yearly electricity generated from these solar PV mounted on the roof would reach about 520 MWh/year which is more than the yearly electricity demand based on earlier assumptions. This shows that electricity demand in the school can be covered by electricity generated within the school premises. As an indicative budget frame, a solar PV system of 350 kW_p would be about 500,000-700,000 USD with a straight payback of 6-8 years considering an electricity tariff of 186 RWF/kWh (tariff of educational and health facilities).

Connecting the solar PV system to the grid with option to feed electricity on to the grid is presently complicated from an administrative point of view (lack of net metering arrangements in country). A PV system including storage could provide a solution to balance demand and electricity generation over the day. Storage should be designed considering the daily electricity demand and based on how independent the system is determined to be and in conjunction with the UADC, GCKC and CoK. It is suggested that the school is still on-grid to ensure that school operations have a redundancy in electricity supply in all scenarios.

Cooking energy can be provided via a co-digestion biogas unit and high-efficient biogas stoves in the school kitchen. The substrates to be used in the biogas digester are organic municipal waste collected as part of the source separation in the pilot area and organic substrates from the sewage treatment. The co-digestion anaerobic system would require pre-treatment of substrates to ensure safe operation, efficiency, and a productive use of digestate. Considering the combination of substrates, the biogas system including substrates storage, digester, digestate treatment etc should be found in connection with the wastewater treatment site. It is difficult to assess the exact gas demand at this point as further data on number of meals to be prepared, potential additional gas demands (labs, generator etc) would need to be developed as the school is further programmed during design[34]. Substrates will be sourced from the 16 ha pilot site and thus not restricted to the substrates produced at the school. Design solutions could include plug-flow or continuous systems. Biogas from the digester will be transported in a pipeline to the school. Considering alternative handling of the organic waste (dumping at the landfill) the biogas solution could provide a net negative GHG contribution (methane from landfill is a more potent greenhouse gas than carbon dioxide as results from burning the gas). The anaerobic solution will in addition to climate also contribute and showcase a circular approach to waste management and sewage treatment.

With a solar PV system on the roof of the school building, and a biogas system to provide gas for cooking the greenhouse gas emissions from the running of the school can be kept to a minimum. It is strongly suggested that the design of the systems are made in order to accommodate for students and others to study and monitor the systems and production from the solar panels and biogas digestions as well the use of the final digestates. Both solar PV, with or without storage, and co-digestion biogas generation are mature technical solutions and provide safe and secure

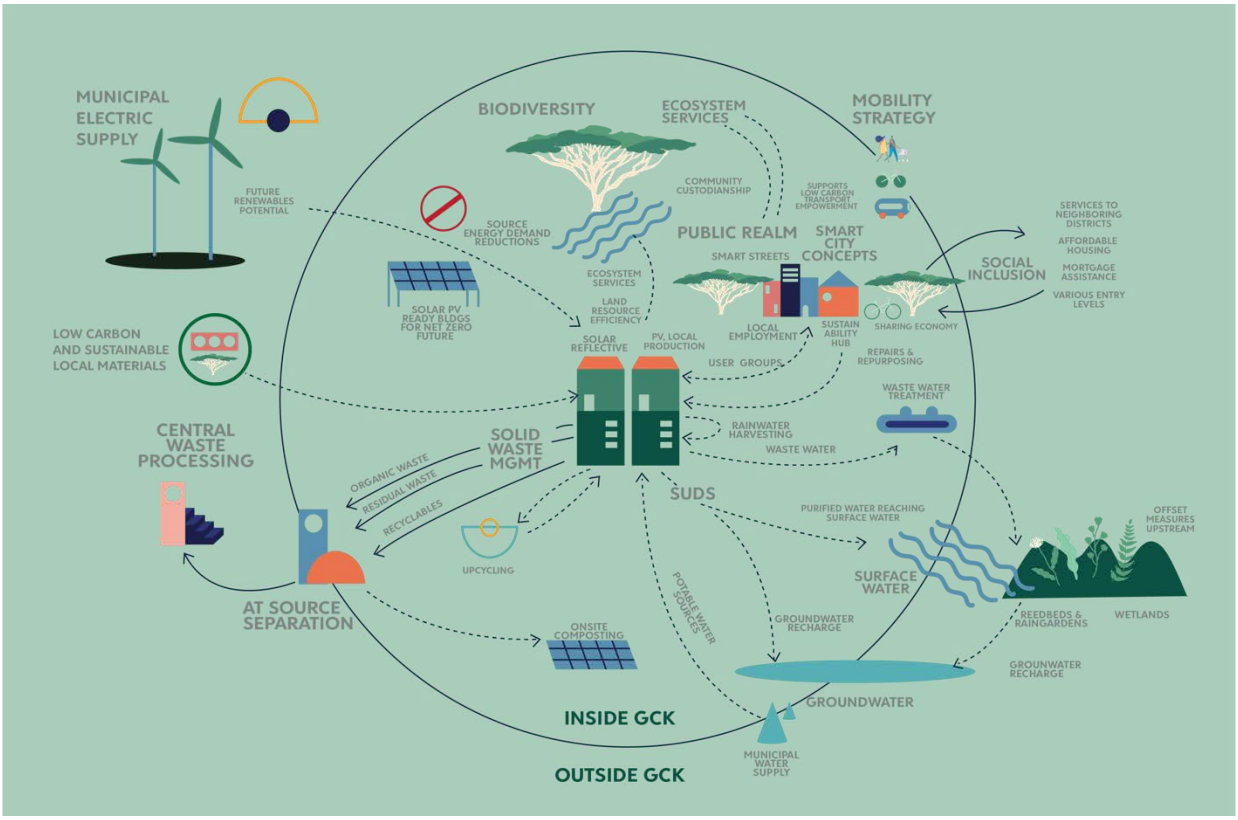
33 Energydata.info. (2021). "Global Solar Atlas." from https://globalsolaratlas.info/.

34 Much data found in the literature on energy demands in schools are quantified as demand of energy carriers, while the efficiency of appliances are not known. High efficiency stoves at schools and other public institutions are good initiatives to support and stimulate innovation and markets for these improved options. A biogas stove provides an example of efficient stove solution.

energy services. In the Rwandan context the suggested approach will provide a showcase of Net zero solution for a school that can also be replicated to other institutional buildings.

It is recommended that this demonstration project be further developed for potential implementation as part of the design phase of the project and in conjunction with the UADC, GCKC and CoK. Determination of specific systems such as battery backups and biogas demands can be established as the school programming is elaborated.

6.8 Resource efficient and climate change mitigative building technology and infrastructure



6.8.1 Sustainability Assessment Result

The building technology and infrastructure have been designed with the GCK Four Foundations as the focus (affordable and socially equitable development; climate change adaptation and mitigation; resource efficiency; and culturally sensitive urban development). The following parameters were selected to support these four foundations, and metric and benchmarks were provided for the design competition. The results from the design competition for the winning masterplan are shown in the column on the right. During the detailed design phase, there will be verification that designs continue to meet these parameters and mechanisms will need to be put in place to ensure compliance during project construction.

Table 19: Sustainability Parameters, Benchmarks and Results

Parameter	GCK Four Foundations	Impact	Metric & Benchmark	Result from Preferred Bidder, Design (UADC)
Green Plot Ratio	Climate Change	Mitigation of climate change through atmospheric GHG emission reduction. Adaptation to climate change through slowing down and evapotranspiration of stormwater runoff, and reduction of the urban heat island effect.	Green plot ratio (Total Leaf Area divided by Total Site Area)	1.999
Permeable surface area	Climate Change	Encourages natural percolation of stormwater, replenishment of groundwater sources and slowing down of runoff. Adaptation to climate change through slowing down of stormwater runoff, and reduction of the urban heat island effect.	≥65% Permeable surface land area within the project area boundary	65%
Ecological diversity & Ecosystem services appraisal	Climate Change, Resource Efficiency, Culturally Sensitive Urban Development	Multiple benefits for climate mitigation and adaptation. Increased efficiency of resource consumption in the community. Spaces for community cohesion, health, wellbeing and learning.	≥ existing Ecosystem Services profile	≥ existing Ecosystem Services profile as documented in the assessment performed
EDGE buildings	Resource Efficiency, Climate Change	Increased efficiency of energy and water consumption in construction & operation of buildings. (EDGE Advance)	EDGE building assessments for four building types 50% reduction in energy 50% reduction in water 50% reduction in embodied energy (materials)	>50% reduction in energy >50% reduction in water >50% reduction in embodied energy (materials)
Carbon impact of transport	Resource Efficiency, Climate Change	Increased efficiency of energy consumption in construction & operation of the transport system.	Carbon impact of transport assessment, assessed against a base-case	Proposed construction methodology for ROWs and utilities infrastructure focusing on the use of low carbon materials, local sourcing of materials, efficiency in construction, lifespan of material and recyclability / reusability. Plans for pedestrians and cycling routes.

Solid waste	Resource Efficiency	SWM systems in place to increase circular use of material	≤ 200 m Maximum distance from door to household waste source separation point	≤ 200 m
Communal spaces and cultural venues	Culturally Sensitive Urban Development	Enhanced community cohesion and preservation and cultivation of cultural traditions in the community.	Sqm and catchments organized community activity internal floor area and cultural floor area, assessed against a base-case	Education, 3,000 $m^{2,}$ with additional outdoor spaces. Football pitch, 19,227 m^2 (planned for plateau park at top of slope) Community Facilities, 1,390 m^2 Covered Market Square, 2,497 m^2
Mixed community	Affordable and Socially Equitable Development	Opportunities for a range of income groups to invest in housing in GCK *(updated against recent affordability models)*	% dwelling units within reach of sub-RWF 250k-300k p/m income group % dwelling units within reach of RWF 300k – 450k p/m income group % dwelling units within reach of RWF 500k – 600k p/m income group % dwelling units within reach of RWF 600k – 700k p/m income group	150 dwelling units within reach of sub-RWF 250k-300k p/m income group 550 dwelling units within reach of RWF 380k – 430k p/m income group 470 dwelling units within reach of RWF 500k – 550k p/m income group 260 dwelling units within reach of RWF 600k – 700k p/m income group
Affordable	Affordable and Socially Equitable Development	Affordability of sustainable development	Construction cost per sqm (affordable housing) ≤ USD 400 (presented as RWF 380k at assessment, Feb 2020, but changed to USD here to reduce FX volatility and to align with construction cost model)	≤ USD 400

The sections below provide more details about how the buildings and infrastructure at the pilot site will be developed to ensure social and environmental sustainability, in support of the above parameters.

6.8.2 Verification and Enforcement of Sustainability Ambitions

Governance

To ensure that sustainability goals are delivered within the completed pilot development following project design, a comprehensive set of Governance Rules should be required and implemented through embedding them into contract covenants. This is important as sustainable resource use is a comprehensive challenge which involves multiple stakeholders needing to cooperate who may not otherwise be motivated to safeguard these project targets and aspirations.

At each stage of the project, resource modelling should be undertaken to ensure that aforementioned targets are being maintained. The UADC will use the tool at milestone stages to demonstrate that their designs achieve stated targets, as presented in the previous section. This will be verified by the Employer's design supervision consultant. Subsequently, future developers should have in their contracts the requirement to demonstrate that their proposals maintain these targets, with real and enforceable penalties if they do not. Finally, the operators of the completed buildings should be contractually obliged to submit reports with verifiable evidence (eg. actual meter readings) to demonstrate delivery of the targets.

Without these Governance Rules, through contractual requirements, to deliver on resource targets they may become diluted, and benefits lost during the project implementation process.

This is particularly important if the cost benefits of reduced resource use are to be delivered. For example, the cost benefits of a more modest installed infrastructure capacity can only be achieved if the resource targeting Governance Rules can be relied upon to limit resource demands via contractual requirements through each stage of design and construction implementation.

The Green City Kigali Company (SPV) responsible to undertake the development and management of the future pilot will incorporate into its governance structure mechanisms in order to ensure that sustainability and affordability targets are achieved at the pilot and at future expansions.

A Framework for Healthy, Efficient and Resource Efficient Green Buildings

A key part of the infrastructure synthesis, during the feasibility stage, was the use of resource modelling for setting realistic GCK resource use targets. This was then followed by modelling during the design competition (as part of the tender process for GCK UADC). This modelling has used the IFC EDGE-buildings modelling tool to allow direct cost comparisons between different building infrastructure sustainability measures along with their economic payback. This has allowed early identification of and then continued focus on maximizing benefits for minimum investment. This was to establish cost-realistic targets for improvements in building energy use, for water use and materials embodied energy. Future designers, and subsequently project developers, will be expected to use this tool to demonstrate GCK will deliver on the targets set. Additional modelling analysis is expected during the master planning stage. For example, for defining the measures needed by the infrastructure and building plots to deliver on UHI mitigation and climate change readiness.

Figure 50: IFC EDGE, Excellence in Design for Greater Efficiencies

Sustainable Long-Term Maintenance and Management Arrangements at GCK Pilot

A key aspect for GCKC is the procurement and management of significant construction and development contracts and the options appropriate to these which have been described in section 7.2. Similarly, to ensure long term sustainability, arrangements for the long-term maintenance and management of the pilot project is crucial. Set out below are different options to address this.

a. Rwanda has a 'condominium law' which enables occupants of blocks or groups of houses to get together and take responsibility for the management of the land and buildings that are within the hereditament through establishement of Homeowners Associations (HOAs). One option is for GCKC to support building occupants in exercising their responsibilities in the early stages of establishing the community. It will require through freehold titles and leases, for GCKC to have the ability to intervene where this does not occur or where HOAs may fail in their larger obligations. This will also entitle the GCKC to recover its costs in doing this.

b. Through the freehold titles and leaseholds to ensure the usage of buildings so that affordable homes are only occupied as a main residence and that businesses maintain their occupation responsibilities under the planning code and again the ability to recover any costs.

c. Responsibility for setting up an elected body made up of city HOAs to supervise with GCKC and CoK on the maintenance of the pilot project overall with the electorate being those who hold the freehold titles and leasehold rights.

d. The promotion of the estate to the public including opportunities for employment and similar to the benefit of the businesses of the pilot project.

e. The benefit of the land value capture so those residents who have not purchased at market price (the affordable housing) must use their homes as a main residence. If it required that they rent it out or sell they require the consent of the GCKC as the overarching freehold owner and must pay a proportion of the uplift in value if selling, which will be available to the SPV to reinvest in the estate or similar elsewhere.

f. The SPV may also generate income from, for example, the letting of café and entertainment space in the parks (and in conjunction with CoK), parking charges, local bus licenses and similar. It must account for these monies to the residents' consultative committee and publish its accounts on a regular basis.

6.8.3 Construction Materials

Construction materials will include local options (such as stone, granite, clay bricks, earth bricks) as well as carefully selected imported materials, such as cement, reinforcement and steelwork. In addition, material newcomers to the market in Kigali such as AAC block and Strawtec may be considered.

For more information on suitable local and sustainable construction materials and as well as a background of the construction industry in Kigali please refer to the "Housing and Building Technology Report" (Sweco, 2019)

6.8.4 Transport and mobility

The GCK transport vision is to provide the community with affordable and safe transport options for their daily activities, that allows the Planning Area to develop as a lively mixed-use development with local opportunities for its residents, and that is environmentally sustainable and financially feasible.

Key transport principles include:

i. Build on the existing network and travel patterns.
ii. Prioritize transport options that are sustainable and affordable by residents and that facilitate the financial feasibility of the development.
iii. Prioritize direct access for walking for speed and convenience particularly to neighborhood centers.
iv. Balance directness and suitable gradients for cycling connectivity.
v. Public transport must have high reliability and frequency.
vi. There should be no through travel for private cars.
vii. The transport environment should be planned as a 'slow traffic environment' and designed for high safety and amenity.
viii. Minimize parking to maximize affordability and prioritize sustainable travel modes

ix. Stage implementation to prioritize sustainable and affordable transport options and facilitate the financial feasibility of the development

Two main future transport scenarios were analyzed in developing the proposed strategy and to also assess the project's financial feasibility: 1) A baseline scenario (BS) both drawing from the indicative road network proposed in the Kigali Master Plan and responding to the increasing affordability of private car use for some Kinyinya Hill residents. 2) A green enhancement scenario (GES) drawing on the Kigali City Master Plan, which heavily prioritizes walking and cycling, plans for a high-quality bus service, and employs several slow traffic measures paired with a low parking supply to complement transit-oriented development and improve affordability. This scenario caters for anticipated future transport needs but minimizes the provision and cost of road infrastructure. This scenario requires additional support from an overall policy level to strongly promote sustainable transport modes affordable for all.

Outside of the 600ha site boundary, the Green Enhancement Scenario adopts all proposals from 2013 & 2020 transport masterplans with one exception. Proposals include:

- the development of a high-quality public transport system with good coverage and direct, fast and frequent services
- the implementation of Kigali's proposed Bus Rapid Transit system in stages to 2050
- Development of networks for non-motorized transport as a priority
- new and upgraded main roads.

The single deviation is the shortened arterial bypass road in the valley to the south-east which reduces impact on the wetlands.

The green enhancement scenario best satisfies GCK policy and project objectives, but also the policy objectives for the masterplan for Kigali as a whole. The socioeconomic profile of the existing and target population is a critical factor that necessitates planning for a high degree of walking and cycling, paired with increasing access to local jobs and services. As the wealth of the resident population rises over time, high quality public transport services will be required to limit the demand for private car use and its space-inefficient and unaffordable road infrastructure requirements.

Important components of the spatial plan include:

i. A fine-meshed network of narrow streets on the hill to support transit-oriented development, and design for a slow traffic environment.

ii. Dedicated feeder bus lanes included on three of the hill's access roads to allow for frequent services linking to three points on Kigali's proposed bus rapid transit network (BRT).

iii. A set of design measures to severely limit through travel by private car from east to west.

iv. Streets designed to be a part of the slow water management and overall climate control (with less cars with heat producing motors and a high degree of canopy-shaded road space).

v. Comprehensive street lighting to improve safe access.

vi. Low parking supply (circa. 0,15 spaces per dwelling including street and public parking).

Maps and images of the proposed road network within the pilot site are shown below.

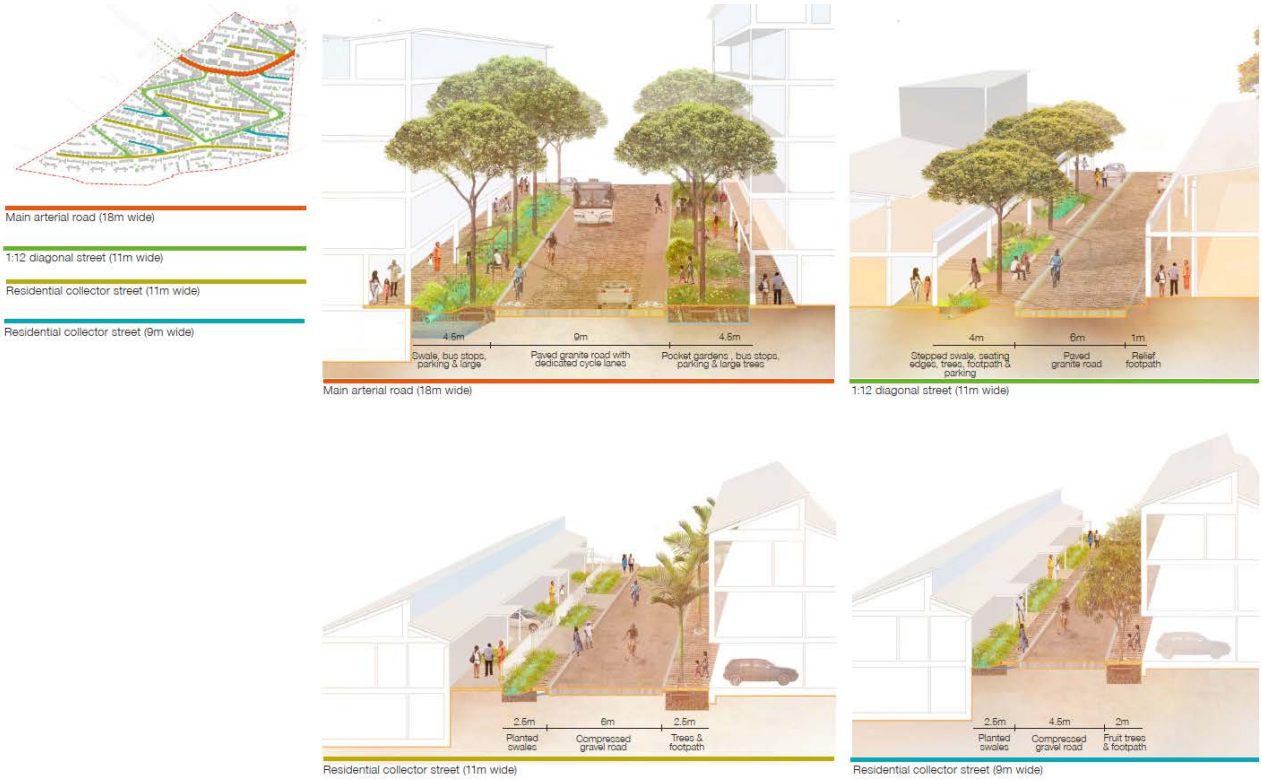


Figure 51 51: Roads and connecting spaces, as presented in the proposed design report (UADC), src: confidential

6.8.5 Water supply

Water supply for the pilot site will be provided through the central water supply system operated by the Water and Sanitation Corporation (WASAC), as well as through rainwater harvesting systems.

The estimated water demand for the pilot site is approximately 927 m^3/day (based on a population of 7,728 and WASAC's recommended planning guideline of 120 litres per capita per day to cover all uses). WASAC has several projects underway currently to increase the quantity of water available in this area of Kigali, and they expect to have sufficient water treatment and distribution capacity to meet this demand. Risks of intermittent supply, as is currently common in Kigali, will be mitigated through the construction of a water reservoir, to be located at the top of the pilot site where the land is flatter. The UADC / GCKC will be responsible for designing and constructing the distribution system within the pilot site and the connection to the distribution main located near the site. Assets will be handed over to WASAC upon completion, and WASAC will be responsible for long-term operation and maintenance, paid by user tariffs.

Rainwater harvesting systems will be constructed to supplement the central supply. These systems improve the community's resilience against climate change as they safeguard against future water shortages and provide benefits for the attenuation of surface water runoff during increasing storm events. Thus, they should be considered as integral parts of the larger pilot infrastructure system and not simply upgrades at the building level only. They also reduce carbon emissions compared to centrally supplied water as no treatment or pumping is required. Harvested rainwater will be used for general household purposes (not for cooking, drinking). The proposed rainwater harvesting systems are based on the recommendations in Rwanda Standard RS 187: Rainwater Harvest Systems. The Rwanda Standard provides recommendations on the design, installation, testing and maintenance of rainwater harvesting systems. These systems will be required to be included in the designs and construction.

Efficient water use is critical to minimize capital and operating costs of the drinking water supply, as well as reduce pressures on natural resources. Efficient water use minimizes the cost of water to residents and reduces quantities

discharged to wastewater systems. All new buildings will be required to use efficient taps, toilets and shower fixtures, based on the requirements from the Rwanda Green Building Standards (category "enhanced efficient plumbing fixtures").

WASAC's process as regards expansion of bulk infrastructure to site is to apply for funds to undertake such an extension via a standard process. To apply for funds, WASAC submit requests with supporting feasibility studies in October of each year to the Ministry of Finance (MINECOFIN). The Public Investment Committee from MINECOFIN reviews the requests in February of the following year, and then upon approval WASAC receives the funds to undertake the expansion. It should be noted that expansion of the bulk water supply is being considered as part of the GCF application. This application is due to be submitted no later than March 2022. Should GCF not accept to provide funding for the expansion, then it would be recommended that the standard application process be undertaken within the October 2022 window.

6.8.6 Sanitation

Affordable, effective sanitation systems are necessary to protect the environment and health of residents at the pilot site. At the pilot site, simplified sewerage and semi-centralised wastewater treatment are planned.

Sewage collection system: The Rwanda National Sanitation Policy (2016) recommends the construction of simplified, condominial or small-bore sewerage systems when using off-site collection and treatment. Simplified sewers are constructed using smaller diameter pipes that are laid at shallower depths compared to conventional sewers. These systems can be built and repaired with locally available materials and are approximately 50 to 80% less expensive compared to conventional gravity sewerage. They also have lower embodied carbon since less concrete is required. Greywater and blackwater should be discharged to the system to ensure adequate flushing of the system, and there will need to be an average water use of at least 60 L / person / day[35]. Stormwater flows will not be connected to the sewer system.

Wastewater treatment: Regarding the wastewater treatment, a range of different options have been analysed for the pilot site, with a focus on reliability, affordability, land requirement and simplicity. We summarise conclusions for several treatment processes below. Scores have been given from 1 to 5 (very poor, poor, fair, good, very good).

Table 20: Summary of wastewater treatment options considered for the pilot site.

System	Reliability	Affordability	Land Requirement	Simplicity	Conclusion
Activated sludge / Sequencing Batch Reactor (SBR)	Fair 3	Poor 2	Very good 5	Very poor 1	Total score: 11 Concerns about the complexity of the O&M
Aerated lagoon	Good 4	Fair 3	Poor 2	Fair 3	Total score: 12 We do not recommend an aerated lagoon due to the land required
Oxidation ditch	Good 4	Fair 3	Poor 2	Fair 3	Total score: 12 We do not recommend an oxidation ditch due to the land required
Trickling filter / Biofilter	**Good 4**	**Fair 3**	**Very good 5**	**Fair 3**	**Total score: 15 We recommend this as a treatment option.**

35 https://sswm.info/sanitation-systems/sanitation-technologies/simplified-and-condominial-sewers

Rotating biological contactor	Fair 3	Poor 2	Very good 5	Poor 2	Total score: 12 This could be considered as an option.
Waste stabilisation ponds	Very good 5	Good 4	Very poor 1	Very good 5	Total score: 15 We do not recommend this option due to the land required

As indicated above, unfortunately there is not enough land available for aerated lagoons, oxidation ditches or waste stabilization ponds for the pilot site. We therefore recommend a technology that requires less space. Of the remaining options, we are concerned about the performance of the activated sludge and sequencing batch reactors. These systems can be quite difficult to operate correctly, as shown in the evaluation results of a recent MINIFRA study, which assessed the performance of a number of activated sludge and SBR plants in Kigali. Of the plants assessed in the recent MINIFRA study, only one of the plants that were sampled met the discharge standards, and many plants were struggling with proper operation and maintenance. We also note that many of the activated sludge and SBR systems on the WASAC list are for smaller flows than what will be required for the pilot site.

A more robust, stable option would be to use a solution that includes a sludge tank or Imhoff tank including gas extraction and a trickling filter / submerged filter. This would be the most sustainable and reliable solution. It would fulfil Rwanda's requirements to use low energy requirements. There is a solution offered by a company licensed for wastewater in Rwanda (Star Construction / BioKube) that generally fits this description.

The plant will need to have the capacity to treat wastewater from the planned population (approximately 7,728 people). The estimated wastewater production is approximately 816 m^3/day (assuming an estimated water demand of 927 m^3/day times 0.8 wastewater production coefficient and 1.1 infiltration coefficient). The capital cost for the construction of semi-centralized system (BioKube) has been estimated by Star Construction to cost between 400,000 – 600,000 USD.

According to a report by the Ministry of Infrastructure titled "Consultancy Services for the Study on Appropriate Semi-Centralized Wastewater Treatment Technologies and Faecal Sludge Management in Rwanda" dated February 2019, the cost for operating and maintaining the surveyed semi-centralized wastewater treatment plants varied between 2,000 and 60,000 FRw per household per month, with an average of 13,000 FRw per household per month. Lower costs were associated with septic tank systems with a large number of users, and higher costs were associated with more modern treatment technologies (such as activated sludge or SBR systems). The study found that most occupants in real estates in Kigali indicated that they should not have to pay more than 5,000 FRw per month, and others thought the service should be free of charge. It is paramount to select the simplest technology possible to minimise the operation and maintenance costs due to the common gap between average costs and willingness to pay.

With regard to Sweco's recommended wastewater management system (BioKube), Star Construction has indicated that their system at Karama IDP village (80-140m^3/day) which serves approx. 1,250 persons has a maintenance of about 140,000 RWF/month. According to Star Construction this is based on the calculations of staff costs, electricity, replacement parts, and emptying. Therefore expected OPEX cost of about 875,000 RW/mo when adjusting for size at the pilot. This would translate to about 500 RWF/hh base costs. It is worth noting the system is still quite new (2 years old) and Sweco would advise, at this time, a more conservative OPEX cost estimate being used and based on the average at the referred to MININFRA study and accounting for administrative and overhead costs which are not included in Star Construction's estimates. A more realistic estimate would be at the lower end of the range and within the 5,000 RWF user ceiling preference indicated.

In the next stage of work, we recommend that the UADC selects a licensed firm / technology based on proven past performance on projects of a similar size and complexity in Rwanda, investment cost, operation and maintenance cost, simplicity and reliability. This choice should be shared with and agreed with WASAC.

We recommend considering a constructed wetland following the wastewater treatment plant to increase the effluent quality even further prior to discharge into the natural environment. This would help ensure that the water could be reused for other purposes, such as irrigation.

The following actions are required to support sustainability:

- Conduct information campaigns for residents regarding the system and operation and maintenance fees
- Establish and collect a fee that fully covers the operation and maintenance costs
- Conduct extensive training for the estate manager and engineer/technician(s) who will perform the operation and maintenance over the long-term. There should be a handover period of 6-12 months to ensure a strong understanding of the system.
- The WWTP operator will need to keep records of the system performance and effluent quality, and report this to WASAC. Regular monitoring of the system and effluent quality by WASAC is necessary.

The design must meet the criteria according to the Rwanda Standard Board 109:2017. These limits are values that are not to be exceeded during periodic measurement under normal conditions.

6.8.7 Energy and ICT

Electricity: Kinyinya falls within the scope of the Kigali City master plan and its anticipated grid expansion (CoK 2013, CoK 2019). The KCMP estimates that Kinyinya Hill will have increased power demand from the present 6.56 MVA to 32.93 MVA in 2050 (CoK 2019). Plans are developed correspondingly for the infrastructure. Current capacity at Kinyinya Hill is designed to meet current electricity demand which is low. There is a 15 kV medium voltage line passing near the transport station at the current neighbourhood centre at Kinyinya hill, and through the planned upgrade site at Ngaruyinka. A transformer supports the area with 400 V. The Birembo substation serving the hill is northeast of the site. In addition to a 110 kV transmission line at the substation it also includes a 10MW diesel generator.

Additional capacity as required by the future pilot site and other future development in the planning area is undertaken in conjunction with Rwanda Energy Group (REG) and the City of Kigali. Standard practice is for REG to undertake costs related to expanding electrical capacity via additional substations or other infrastructure, while the lead ins required will be the responsibility of the site developer. The electrical capacity to the pilot site at present is nominal and proper connection needs to be ensured based on the expected demand. The expected electrical demand will be determined as part of the overall detail design process. This information will then be used to motivate the necessary expansion of electrical supply to the site in conjunction with the City of Kigali and REG.

Cooking: At Kinyinya Hill, LPG or biogas (if this is available, see section 6.7.1) for its potential implementation at the new primary school and nursery) would be the preferred cooking fuels, in the short term. Induction stoves provide a lower energy demand cooking alternative but are at this time too expensive for mass adoption but are considered as a long term and low energy solution for cooking.

Energy efficiency and renewable sources: Citing the recently published Rwanda Green Building Minimum Compliance System (RHA 2019, annex 3) several actions linked to energy consumption reduction are available. The Rwanda Green Building Minimum Compliance System is not mandatory for residential developments but can be applied on a voluntary basis. However, developers are encouraged to adopt the system in order to meet sustainable development targets and will be expected at the development of the pilot site.

Solar water heating is an easy target for energy efficiency for domestic and commercial end-users that have a hot water demand. As per the Rwanda Green Building Minimum Compliance System (RHA 2019, annex 3) installation of

solar hot water systems is mandatory and applicable to all premises with hot water requirements of a capacity exceeding one hundred liters (100 L) per day. All buildings at the GCK pilot will be designed as to be solar water heater ready, for when the buyer is ready to upgrade their unit with hot water.

Buildings at the Pilot Area will also be Solar PV install ready. The installs are not likely to be present at the outset due to low household energy demands average in Kigali, high cost to buyers and the subsequent impacts on affordability as well as the overall central grid surplus in Rwanda. However, in the long term as the economy expands, incomes grow, and energy demands ultimately increase the option to invest in these arrays are an essential part of the project's net zero future aims. Thus, the buildings are designed and sized so that a rooftop array can serve the energy demands of an up to five story building (maximum building height at pilot) when the economic and environmental case make sense for the install.

The need for heating and air conditioning at the pilot is not anticipated, but passive cooling and heating methods will be employed. Good architectural design and appropriate application of building materials should be used to ensure a comfortable ambient environment.

Light should be provided via energy efficient solutions and should make use of daylight wherever possible. Any lamp fittings should be designed with low-energy solutions. This is mandatory in the Green Building approach (RHA 2019, annex 3).

Information and communications technology: Access to the internet and the services provided via mobile phones is considered a basic need for all Rwandans. The ambition is that by 2023/2024 universal access to internet is achieved (GoR 2019). Mobile phones are not only used to communicate with one another, but also to access services such as banking, money transfers, and information sharing. Often, basic feature phones are used (non-smart phones) and services are designed to accommodate for this hardware.

The standard way to access phone services and mobile internet is via the purchase of pre-pay credits (airtime). The service is easily accessible in Kigali and modern 4G networks for internet is readily available. If dedicated fixed line access is needed, there are opportunities for fiber connections. The cost is relatively high as compared to mobile solutions. Access to the internet is typically via smart phones but also via, albeit at a lower rate, laptop computer.

For the Pilot Area, it is anticipated that most households will access internet services via mobile solutions (3G, 4G and future 5G) in the short term. Television and radio are accessible via antenna. The Rwanda Building Code for urban areas mentions that access to ICT should be considered in designing the building (RHA 2019). The pilot will be designed as fiber ready to allow for a private provider to install and connect buildings when this is feasible both physically and economically. Site planning and building design by the UADC will account for this need, with private providers informed and made aware of the opportunity to build out systems along with site construction or at a later date. Liquid Telecom have recently completed an expansion of their fiber network to a nearby development at the Planning Area (John Dubai Estate), and thus expansion to the Pilot should be a fairly simple process.

6.8.8 Waste Management

The solid waste collection is organized by the City of Kigali and operationalized by the three city districts. The services are carried out by private operators bidding for three-year contracts in 35 sectors (collection areas). Households have weekly collection and businesses have collection as needed (daily collection). Households pay a fee for waste collection, which is collected at the cell level and paid on to the collection company directly. Households pay fees according to their Ubudehe classification.

The solutions planned for the pilot site aim to reduce waste and to improve solid waste collection and treatment to enable reuse, recycling and recovery of nutrients and energy at Kinyinya Hill. They have been planned in accordance with the Rwanda Urban Planning Code, which requires source sorting for single family homes as well as apartments.

Multi-family residential houses will have a waste sorting room/light structure with waste bins/containers for source separation in three fractions 1) Organic waste 2) Recyclables 3) Residual waste. Recommended bin size for multifamily houses: i) 120 l organic waste, ii) 240/660 l recyclables, iii) 240/660 l residual waste.

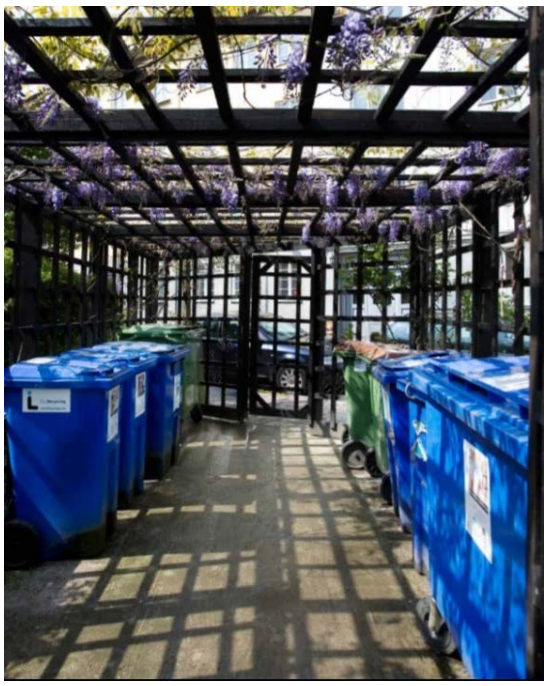


Figure 52: Simple structure to limit access to waste drop off to residents/potentially local businesses (image VA-Syd).

The number of households with access to a sorting room/space should be limited (60-80 households preferable). A cost calculation estimate has been done of 60 households share the same sorting room. The rooms should be located with easy access for both collection vehicles and users. The rooms should be large enough to allow for collection 1/week. Estimated waste generation per week for waste sorting room for 60 households is approximately 840 kg week. An estimated 7-8 bins for organic waste, 2-5 bins for recyclables 1-4 bins for residual waste are required.

Note that the estimates are based on unreliable waste composition data, and waste sorting rooms should allow for flexibility to add bins as needed. The rooms should be locked, to allow for access only by the households and waste collectors. The waste bins hold a value and should be clearly marked to deter theft. Restricted access is a measure to improve sorting practices from the households. Several studies have shown that waste sorting is improved when a limited number of users have access to the sorting room.

Single family houses will sort waste in at least two fractions 1) Organic waste 2) residual waste. The waste should be stored in containers/bin within the property and placed on curb side on collection day. Single family houses should also have collection once a week. The recycling fraction can be organized at a neighborhood collection point, or as a third fraction at the household level.

At Kinyinya hill the solid waste system will continue to support reduction of waste primarily by creating space for small scale artisan upcycling of materials that would otherwise become waste. The waste recycling rooms may also be used as centers for information on the importance of reducing waste and sorting waste to enable recycling and energy recovery.

A recommendation is to, at least initially, employ waste ambassadors who give instructions to residents about waste separation. It is also important to set a culture of keeping the waste sorting rooms clean and hygienic. Using waste ambassadors to implement new SWM systems or improving compliance with older systems has been successfully implemented in many countries.

Figure 53: Map showing approximate locations of community waste stations. Waste stations are to be within 200m of all residents. (Source: Confidential)

6.8.9 Nature Based Solutions / Climate Resilient Stormwater Management

Following from Section 6.2.3, Green Blue Network, the steep slopes at Kinyinya Hill mean that storm water often does not have enough time to infiltrate and replenish the groundwater resource, but instead creates high runoff speeds. This in turn leads to erosion, property damage and downstream flooding and siltation. The proposed pilot design will aim to slow down stormwater runoff and encourage natural percolation and replenishment of groundwater sources through the use of nature-based solutions.

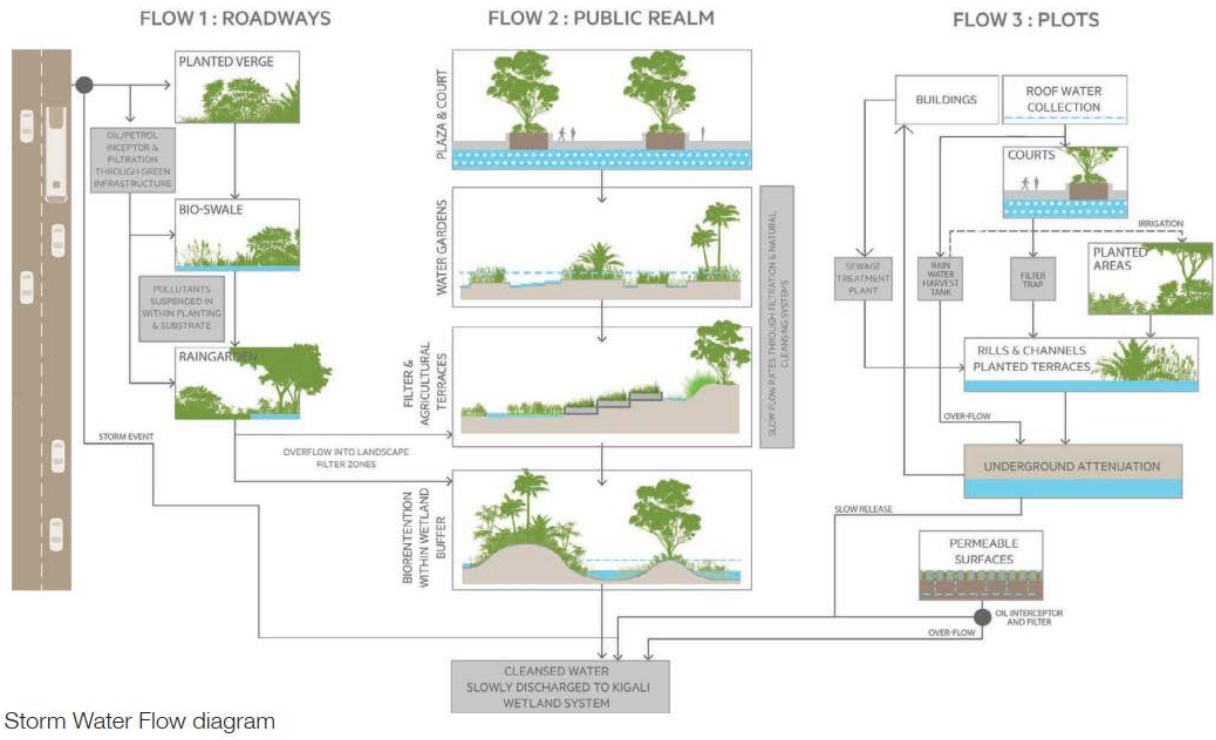


Figure 54: Diagram of stormwater management approaches (Source: Confidential)

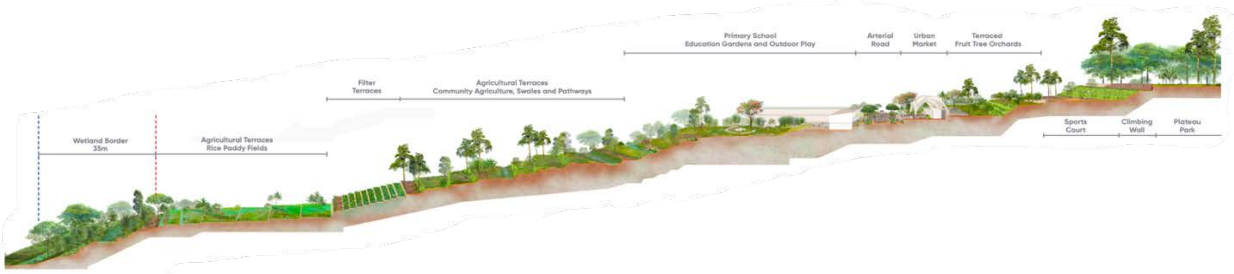


Figure 55: Green corridor from ridge to wetland (Source: Confidential)

6.8.10 Summary of Recommended Infrastructure and Materials

Summary of recommended infrastructure and associated social and environmental benefits compared to a business-as-usual scenario.

Table 21: Summary of social and environmental advantages of planned infrastructure, compared to business as usual

Sector	Social / Environmental Advantages of Planned Infrastructure
Construction Materials	Local materials and low-carbon options will be used to the extent possible. Efforts will also be made to reduce material waste during construction.
Transport & mobility	The road network is designed to support and encourage active mobility, such as walking and biking. Local, resilient and lower carbon materials will be used to reduce embodied carbon and provide for infiltration of stormwater. Recycled materials where possible.
Water supply	Central water connections at each household provide health and social benefits, particularly for women who often have responsibility for water collection. Rainwater harvesting provides resilience against water shortages due to climate

	change. It also helps reduce stormwater runoff and associated erosion and damage during heavy storms.
Sanitation	The proposed simplified sewerage and treatment system will protect human health and environment, especially compared to many unimproved sanitation systems common in Kigali. Simplified sewerage has reduced embodied carbon compared to traditional sewerage systems. The preferred semi-centralised treatment system has low energy requirements.
Energy & ICT	Using LPG for cooking is better for the environment and health compared to charcoal or wood. Efficient construction and appliances will reduce energy demand compared to business as usual. Solar energy and solar water heating systems will mitigate carbon emissions when installed.
Waste Management	Improved separation of waste at the source will support better resource recovery and reduce energy required compared to using virgin materials. Provides opportunity for community composting and upcycling.
Stormwater Management	Nature-based stormwater management approaches will be used to locally treat, detain, and infiltrate stormwater. This will reduce erosion and increase groundwater recharge. RWH systems at buildings are directly linked into this larger system.

6.9 Environmental and Social Safeguarding

Environmental and Social Studies and Assessments to Support Environmental and Social Safeguarding at the Planning Area

A high level ESIA for the overall 600ha Kinyinya Hill planning area, as well as an ESMF and SEF/SEP, has been undertaken. In addition, a Resettlement Policy Framework (RPF), has been completed which will guide the process for any future resettlement on the hill via a Resettlement Action Plan (RAP). A SESA may be undertaken during Phase C activities and in support of the GCF application. All environmental and social safeguard documentation has been development in line with national requirements as well as those of KFW's Sustainability Guidelines (2019), WB ESS1-ESS8 and ESS10, WB/IFC General EHS Guidelines, UN Basic Principles and Guidelines on Development Based Evictions and Displacement, ILO Core Labor Standards, as well as voluntary guidelines on governance of tenure of land, fisheries and forests.

For further information please refer to the specific documents and in particular the GCK E&S Master Document (ERM 2021), which provides guidance on the various frameworks, as well as the Non-Technical Summary (NTS) Report (ERM 2021). In addition, a more detailed overview of Environmental and Social Safeguarding can be found in the Final Feasibility Study (Sweco, 2020).

It is intended that as part of the Pilot Project an ESIA, ESMP, SEP and RAP will be undertaken focusing on the specific impacts of the pilot project and using the aforementioned framework documents as guiding documents in their development.

7 INSTITUTIONAL AND IMPLEMENTATION ARRANGEMENTS

7.1 An Overarching Delivery Vehicle – The Green City Kigali Company

7.1.1 Vision of GCKC as a Special Purpose Vehicle and Why It Was Established

The vision of the Green City Kigali company (GKCK) is to create a Community Benefit Company (CBC) that combines social purpose and commercial drive to create homes and neighbourhoods where residents of Kinyinya Hill could enjoy the social and economic benefits of urbanisation while minimising ecological footprints. CBC are known as such due their objective of community benefit over return to shareholders and are commonly used in Europe, Asia and The Americas. In many countries, such as Germany, they have their own legislation and regulatory environment.

The CBC structure was selected, following a stakeholder engagement process, to enable the company to reinvest profits generated into new and existing homes, creating successful communities, sustaining the green principles of the GCK project over the long term and providing services for residents of Kinyinya Hill.

The FS consultants reviewed how locally other affordable housing projects had been managed and issues that had arisen. In particular, the following key issues had been identified:

- A lack of developers which could raise sufficient capital to providing the working capital for schemes.
- That affordable developments had either not delivered or turned into market sales developments because of the difficulties of accessing mortgage finance or the skills in assisting potential purchasers to raise finance.
- Poor quality of construction and lack of skills training.
- Poor project management because of a lack of involvement of those with the right experience and training.
- Problems of financing stockpiles of materials.
- No provision for capturing capital value appreciation and the future management of the estates.
- Lack of green initiatives.
- Not providing the public and social amenities required by the urban planning code/regulatory framework.
- The lack of adequate and cost competition for contracts.

The above was not unique to Rwanda and not untypical of projects where one of the major drivers was government policy for affordable housing, which conflicted with developer's priorities of higher profit sales to cash purchasers. Experience has shown that provision of a dedicated vehicle of which the sole purpose was the development, construction and management of the project and against which the success of the SPV could be measured, was a more efficient method. Rwanda has some track record on this, having had similar vehicles developed, for example, of the new airport and forestry projects.

A number of presentations were made to stakeholders and it was agreed that a CBC was a suitable way forward for an SPV that could fit the requirements of being a private company but non-profit distributing and responsible to GoR. Through the appointment of directors (controlled by FONERWA as majority shareholder) could be an independent agency but still responsible to government. The board and the executive can be recruited from those with experience of responsibility for such projects and the costs have been anticipated within the financial feasibility. The company would also benefit from tax breaks (subject to GoR MINECOFIN final approval) that would provide enhancement to the feasibility of the project. Upon approval, the company has now been formed, directors appointed and a suite of necessary policies and procedures for the operation of the company has been approved by the board. The summary of the policies are set out below in section 7.1.2.

The company will be responsible for such items as; acquiring the land, applying for grant aid, procurement of the infrastructure and possibly housing, potential sale of the affordable homes and support to the purchasers, liaising with BRD and the World Bank on the affordable mortgages and construction finance, ensuring that residents manage the blocks responsibly, long term management and reinvestment in the City and ensuring that the original vision of the City is maintained. It may have a longer-term role in undertaking other similar projects within Kigali.

Draft documentation has been initialised for the appointment of external auditors, internal audit services, legal advisors and other requirements for a company undertaking this size of project. The costs of these are all included in the medium-term budget for the SPV.

7.1.2 GCKC Constitution, Policies and Procedures

GCKC requires a company constitution as well as a suite of policy and information documents to progress its business. These documents provide strategic direction and overview for the governance structure and the business planning process. The outputs of these will be important to partners such as funders, GoR and its constituent departments, shareholders, executive and other major agencies with which the company will interact.

The below provides a list of core documents developed for the GCKC, to provide for its forward operations:

- Constitution of the Company – The legal constitution of the Company with explanatory references to Rwandan Company Law where applicable.
- Board Terms of Reference – An overview of the responsibilities of the Board.
- Board Committees – Suggested Committee Structure, Membership, relationship to the executive structure and reporting to Board.
- Delegated authorities
- Governance Appraisal Procedures – Recommendations as to the appraisal procedures for individual Directors and Committee Members as well as the performance of the Board and Committees.
- Roles and Responsibilities of Directors
- Board Membership Policy – Suggestions as to numbers, skills, and organisation of the Board
- Chair and Non-Executive Director's Service Agreements – An example of a service agreement that could be used as a template for confirming appointments.
- Chair's Role and Responsibility – An overview description for the position.
- Appointment of Company Secretary – Requirement and responsibilities of the Company Secretary who need not be a Director but has legal responsibilities.
- Procedures Required for Board and Committee Operations
- Transparency and Whistle Blowing Policy – Procedure to protect staff or external partners from negative actions when reporting matters of concern other than when maliciously motivated.
- Board and Committee Members Expenses – To ensure all claims are properly recorded and the Company can demonstrate probity.
- Conflict of Interest Policy – To ensure probity is demonstrated where Board and Committee Members have conflicts of Interests
- Senior Executive Structure

- Executive Structure – Recommendations as to the Executive Structure, skills required, outline responsibilities and remuneration (to be completed) and relationship with Board and Committees. Further amendments may be required depending on the operating model adopted by the board
- Business Planning
- Outline of Business Plan
- PR and Media Strategy – GCKC will be in the public eye and important the company deals with enquiries, complaints, requests for information and similar in a responsive manner.

7.2 GCK Pilot Project Delivery

A development project such as GCK pilot can be implemented by the project owner in several different ways. In a market such as the one in Kigali where there are few financially strong developers on the market several concerns have been balanced in order to find the most robust implementation models, below follows a description of them as well as associated benefits and risks.

7.2.1 Proposed Delivery Models for the Implementation of the GCK Pilot Project

Two models for implementation for the GCK pilot project are considered:

- Public Delivery Model (PDM) whereby the GCKC is charged with the delivery of infrastructure (social and physical) as well as affordable housing. Considering the unique requirements around developing and selling market rate housing that segment of the housing would be delivered via a JV with a private developer.
- Public Private Partnership (PPP). GCKC would enter into a joint venture with a private developer for the delivery and sale of all buildings (housing, commercial and mixed-use) and GCKC would only be responsible for delivering infrastructure (social and physical) at the site.

Before considering details of specific implementation models, we outline the common risks associated with property development in the section below.

7.2.2 Common Risks

Physical development projects, whether for a new house, a multi-level office block, or infrastructure projects, are complex and unique–as are the risks that go with them. Property development projects are often carried out in several phases and involve uncertainty and risk. In the property development context, a risk is any factor, event or influence that threatens the successful completion of a project in terms of time, cost, or quality.

A development project is a multifaceted process governed by complicated contracts and involving complex relationships on several levels. The client is not only buying a product but also a service. At one level, the contractor performs an essential service by directing and coordinating the work of dozens or potentially hundreds of subcontractors, suppliers, craftspeople, and laborers. At the next level, someone—often the contractor or the architect—must coordinate the builder's services with architects, engineers, and consultants. In addition to the risks associated with construction, projects face financing and sales risks.

Finally, someone must control the entire process and coordinate the various coordinating bodies. At this level, the executive and the board of directors will require strong project management skills to ensure that risks are not further exacerbated.

Two factors should also be considered based on available information and experience – the likelihood of a particular risk-taking place and the impact or consequences of that. Development projects carry risks that are interrelated and interdependent. In the below, we outline common risks that apply to this project notwithstanding the implementation models chosen.

Construction Risks

Many construction risks often lead to either delay, additional costs, or deficiencies in the standards of the completed work compared to the specification. Common risks passed on by the client to the party responsible for the construction who could be a contractor, developer, or consortium include:

- changes in the geo technical conditions (more likely in developer partnership),
- poor mobilization
- lack of available labor
- inaccurate contract time estimates
- underpricing
- shortage or increase in costs of labor and materials.

The direct construction risk is normally mitigated by adequate client briefing, selection of the right business partners, governance oversight/monitoring and use of right contract/terms such as design, build and transfer contracts that seeks to hold the counter party to fixed cost in exchange for design control.

Organizational Risks

The Green City Kigali Company (GCKC) is a new company that is effectively a start-up and lacks operational resources at this stage to oversee a complex project. Although the Board consists of experienced directors there is a need for board members that are not representatives of shareholders or stakeholders but bring oversight experience of similarly complex projects and knowledge of construction law, project finance and project management.

The challenges and key tasks of the board and the executive on this project can be summarized as follows:

1. Understanding the types and phases of risk.

2. Assessing the risks of this project.

3. Matching risks with in-house capabilities and building a client team.

4. Defining a procurement strategy.

5. Picking the right kind of contract.

6. Choosing the counter party organization.

7. Monitoring construction.

8. Accepting handover or transfer of completed projects, as applicable.

As a result, risks resulting from lack of organizational capacity of GCKC would need to be addressed by a timely appointment of a reputable management consultancy firm. The contracted firm would support GCKC and help the board on an ongoing basis with the key challenges and tasks outlined above. The management consultancy would need to be supplemented by technical consultants that would supervise the counter parties and provide the client team, stakeholders, and the Board with monitoring reports on project status and progress. It is expected that over time GCKC would appoint its in-house team supported, initially, by the management consultants to take over the long-term operations of the company and its responsibilities.

Financial and Economic Risks

The primary financial and economic risks relate to the possibilities to absorb changes in either costs or receipts for the development. This could either be done by using the contingency funds to address unforeseen costs or costs

increase, or by increasing receipts by raising prices (if possible while still meeting affordability targets). As the affordable housing of GCK would be sold at below market rates the market rate housing and commercial units sales receipts are identified as the bigger risk since there is more competition to sell such products.

Counter Party Risks

The way the company chooses a counter party or delivery partner should match its project-risk level, risk appetite and contract type. Notwithstanding the counter party selected, the company should also be aware of counter party risks. Those risks include exposure to one single party contractors, the difficulties of unwinding contracts which could stem from contractual and legal disputes, change order negotiation, non-performance, or insolvency of contractor, sub-contractors, or counter party in general. The magnitude and extent of the issues to address would be different depending on the exposure to one or a multitude of parties.

Other common risks that might apply that is worth considering at this stage are force majeure factors and black swan events. Examples of these include political, economic instability, market conditions, social and health factors. The COVID 19 pandemic during the past year is an example of one such black swan event that was impossible to factor into a risk assessment. Force majeure factors are by nature challenging to plan for, but the company should be aware of the need for flexibility to address them as they occur. Also see section 4.3 for a description of lessons learned from case studies of other projects that have also been an input when formulating the strategy for GCKC.

Risk of Operation and Maintenance of Common Areas of Multifamily Houses Delivered Through Owners Association

Homeowner Associations (HOA) require resources to undertake their responsibilities effectively. An HOA where formally constituted are normally run by a board of directors or equivalent form. These are homeowners elected by other residents and it's the responsibility of the association to set rules and regulations for the building or neighborhood.

To function effectively the homeowners who live within the community must pay HOA fees to handle the upkeep of the common areas and the exterior of homes.

There is always the risk that homeowners do not pay their fees or regulations are not adhered to. For the HOA, it is crucial that everyone living in the community pay their fees. If the HOA is unable to collect enough money from residents, this can result in insufficient funds for maintaining the property. As a result, the community may not have enough funds to maintain the common areas or facilities, and the appearance and condition of the neighborhoods can be adversely affected as a result. This can have a negative impact on property values and the sustainability objectives of the pilot project.

7.2.3 Baseline Assumptions for the GCKC Pilot

Before examining specific implementation model risks and benefits, we made baseline assumptions as follows:

- The baseline financial model meets criteria for affordable housing project in Rwanda (quantity, affordability range and density).
- The project meets green ambitions as outlined in national policy, feasibility study, and UADC tender.
- The project meets all zoning regulations relevant to its site.
- All Homes are for sale.
- Assumes ability to utilize World Bank Mortgage support scheme.
- KFW infrastructure grant at 30m EUR (ca. 35m USD)
- 20% contingency on all costs, including consulting fees.

- Current site user's livelihood reassignment costs estimated.
- The project is to be developed along three phases, with each phase complete and stand-alone at every stage, with further sub-phases contained in each main phase.

Following this is provided an explanation of the two project delivery models being considered, including benefits and risks of each.

7.2.4 Public Delivery Model (PDM)

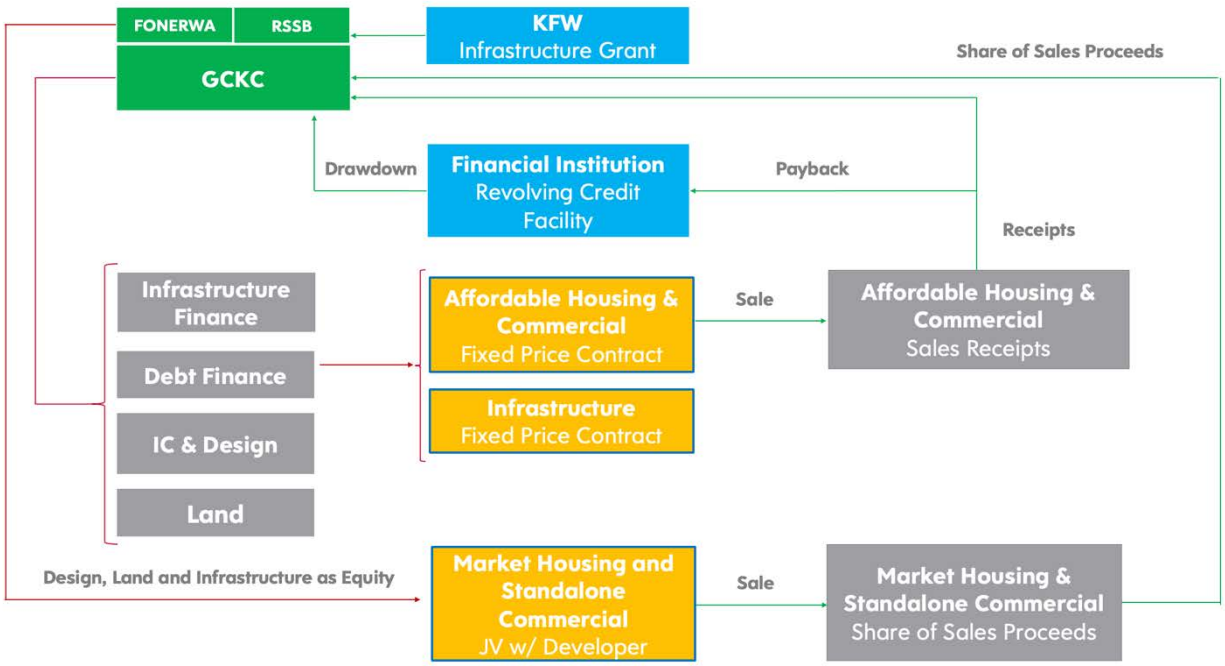


Figure 56: GCK Public Delivery Model

Responsibilities and Financial Obligations of GCKC Under a Public Delivery Model

These include:

- GCKC is ultimately responsible for the entire project but mitigates risks by entering into fixed-price build and transfer contracts with private sector contractor/s to build affordable housing, ground floor commercial (core/shell), and infrastructure the pilot.
- GCKC is responsible for the sales of affordable housing and ground floor commercial units (core and shell). However, the risks around affordable housing sales are considered low due to the below-market level sales price of affordable housing, market demand and low supply of housing products in this category. Like other projects in Rwanda, a waiting list of likely buyers will be created before project commencement.
- A private developer is responsible for building, selling, and financing the market rate housing and standalone commercial units with profit share for GCKC who provide land and infrastructure as equity contribution to JV.
- To deliver affordable housing and ground-level commercial GCKC will source and utilize a construction finance credit facility. This presents GCKC with a financial risk but maximum peak debt at any time would not be expected to exceed an estimated $3m.

- To reduce peak debt and finance costs, the project will be built in phases and sub-phases as is standard in housing development projects in Rwanda, with new development only following sale of completed units.

Benefits and Risks of Public Delivery Model

Benefits

- GCKC retains a higher share of the project surplus. The profit, where available, could in turn provide finance for things such as social or subsidized housing. Additionally, the recycling of profits into the project can be phased throughout the project.
- The control this delivery option provides to GCKC helps guarantee the primary objective of the project: to provide affordable housing toward the lower end of the income pyramid (225k/mo.+ entry points).
- Provides GCKC a higher level of control over the delivery of the project by limiting the risk of exposure to a single counterparty.
- Avoids the need to pay private developer profits on a product, in the case of affordable housing, which has an over-demand in the marketplace already.
- Availability of a construction finance facility for such a project has been confirmed by BRD.

Specific Risks

- It presents GCKC with a higher level of risk as it is solely responsible for delivery and sales of affordable housing and infrastructure.
- The most significant risk is that GCKC would be expected to raise and assume the burden of construction finance for the affordable housing and ground floor based commercial elements of the project.
- It requires a more significant in-house coordination expertise and capability to oversee, potentially multiple, contractual agreements.
- All the common risks outlined previously should also be considered as they apply to this model. In particular, the importance of developing institutional capacity to select and manage relationships with counterparties.

7.2.5 Public Private Partnership Delivery Model (PPP)

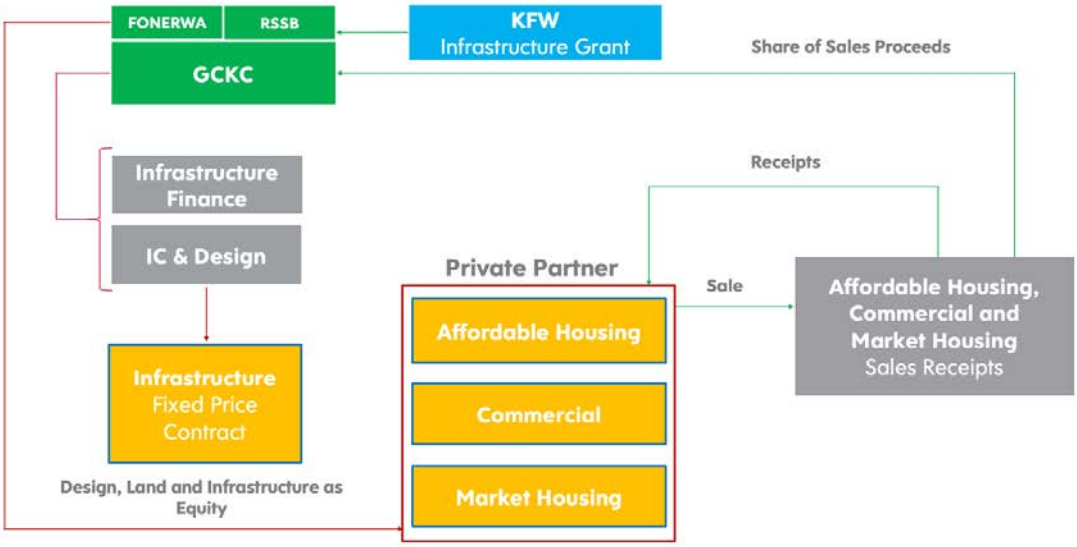


Figure 57: GCK PPP Delivery Model

Responsibilities of GCKC under the PPP Model

These include:

- GCKC is ultimately responsible for the project but outsources direct responsibility for the design (from a supplied conceptual level), build, finance (where relevant). It would involve transfer of the entire project, or significant parts thereof, to a private sector partner/(s) with whom it enters into a contract for delivery.
- The contract will include several delivery related payment milestones (where applicable), an agreed baseline model excluding contingencies which calculates the amount to be paid back to GCKC from the sales proceeds and a formula based on price indices to offset costs overruns or vice versa a form of overage payments to GCKC if the sales exceed the assumed baseline estimates.
- The infrastructure delivery could be contracted separately outside of the PPP agreement under this model.
- The Private sector partner will work to a brief and outline design to do all the construction work, sales, and financing for the price agreed.
- This model avoids the need for GCKC to utilize a construction finance credit facility and its associated risks but comes with higher costs to the project in the form of a developer profit margin/risk transfer cost.
- GCKC would be expected to source a private sector partner that will take on the responsibility of delivering this project with all the associated coordination responsibilities.
- GCKC makes interim payments to complete infrastructure on an agreed payment schedule only (performance-based contract) no matter the contractual arrangement.
- Like public option, the development will occur incrementally, but with lower ultimate levels of control of the overall program for GCKC.
- All the common responsibilities of being an intelligent client set out in the common risks paper also apply.

Benefits and Risks of PPP Delivery Model

Benefits:

- GCKC reduces finance and construction risks by outsourcing responsibility to a private consortium.
- Single point of accountability for the bulk of the construction and finance obligations.
- GCKC maintains a degree of profit share resulting from the provision of land and infrastructure or infrastructure finance.
- With agreed interim payment schedule, the performance contract provides control for GCKC over delivery of infrastructure and protection of grant throughout pilot project.
- Offers the opportunity to reduce the level of design services required by GCKC.
- Opportunity for contracting the delivery of infrastructure separately.

Specific Risks:

- Loss of profits to cover the margin demanded by the private consortium. This results in a loss of financial flexibility, where surplus profit could be used to improve housing affordability or paying for social housing. Overall, this also reduces the GCKC´s control of the delivery schedule.
- Transfer of profits to a private consortium on sales of affordable housing, which considering high market demand and infrastructure subsidies may be considered a lower risk investment. Thus, potentially creating a paradox whereby the investor benefits from higher profit margins on a lower risk investment.
- GCKC is ultimately the responsible authority. Any risks associated with bankruptcy or breach of contract of consortium remain, with only a certain level of risk transfer possible.
- Challenges around attracting the right partner to take on the multiple responsibilities may be accentuated in a smaller market environment such as Rwanda.
- In the event of non-performance, exposure to a single party may present difficulties in enforcing contractual terms.

7.2.6 Common Advantages and Disadvantages of the Two Models

A review of similar projects identifies the following success factors that should be considered when choosing implementation model:

- Both models depend on having bidders with the skills to manage and finance large-scale projects and have a good knowledge of local conditions and resources.
- Whatever the model, the employer (GCKC) will always need to oversee the delivery of the project, which requires a high level of technical and project management skills.
- The employer should not provide assets for the counterparty to charge as security for loans or pseudo equity. This forces the counterparty to raise funds on its own assets and reduce the employer's risk (GCKC).
- In these types of projects, there are effectively numerous clients. In the case of the GCK pilot project, it is likely to be up to 1,680 house purchasers and commercial owners. The skills to organize and phase these relationships are just as important as the construction skills. For example, on hand over, each completion will need verification of funds, connection and billing arrangements for utilities, defects sign-off, keys, equipment, and safety testing etc. Both skill sets need to be present within the consortium or GCKC, whether in-house or sub-contracted.
- These size and type of projects are nearly always completed in phases to better manage resources, materials, skills and finances. In the case of GCKC it is currently projected as three phases over four and a half to five years,

with smaller sub-phases within. Whichever model is used, the contractual arrangements need flexibility, usually at the end of each phase, to change the mix of units and buildings, density, funding arrangements and timing to reflect changing circumstances. The contracts need to ensure that the financial penalties on the employer for requiring such changes do not undermine the viability of the project.

- For these types of projects, a key risk is the availability of mortgage finance for the purchasers of affordable housing. The World Bank Support arrangements and the RMRC are the preferred options in this context.

In summary, these projects fail if the employer (GCKC) does not have the ranges of skills and expertise for all the critical aspects of the project and the party with delivery responsibility does not have the appropriate experience and resources. Projects fail if the counterparty or the employer, in the Public Delivery Model, do not have the financial and management resources to manage the project. Finally, projects of this type fail if the customer-facing responsibilities are not taken seriously.

The challenge facing the board of GCKC is whether counterparties with the right financial backing and skills for the full project are available and who would be interested in working on the project and understanding the local market. A successful negotiation could lead to a PPP-style project and allow time for GCKC to acquire people with the experience, technical and management skills in such projects to provide control and oversight.

If the conclusion is that suitable counterparties are unlikely to exist or be interested, then a model where the market-facing activities are outsourced through a JV or similar legal arrangements is preferable. GCKC would finance and take responsibility for constructing the infrastructure and affordable housing. This option may lower the risk and provide more flexibility and direct control for GCKC. Such an option would also mean negotiating a working capital facility as described above.

7.2.7 Recommendations

Ultimately it is the board of the GCKC that needs to decide on which delivery model to adopt for the GCK pilot. However, we note the following points:

- On paper, the PDM model stands out (quantitatively) as the superior model simply due to its higher profit margin, which can, and as already be noted, be invested back into the project.
- However, it will require a higher level of responsibility and day-to-day management by the company as would otherwise be required in a PPP model (though management of the counterparty would be an additional task in a PPP).
- Considering the financial models associated with each delivery model and the profit margins for each, a profit spread can be determined (difference between PDM and PPP).
- Following this, a series of risks can be modeled into the PDM model to determine what kind of stress the model can endure while remaining viable. The risk model can then be compared to the PPP (such a “worst case” event has been modeled into the updated financial viability model for the PDM model).
- A comparison can then be made as to which model is most appropriate for the project which includes all relevant stakeholders.

7.3 Financial viability overview

The financial viability of the GCK project has been a central component in determining the feasibility of the project. During phase A of the project, the different sector reports provided pre-design cost estimates to form the basis of the construction costs of both buildings and infrastructure. The price of land has been negotiated with the landowner RSSB, and the expected receipts from selling and or renting housing units have been examined in the housing market review sector report. The consultant team developed a spreadsheet-based Financial Viability Model to advise on the viability of different mixes and density of building, tenure and pricing options. The base assumptions data feed into an

output overview model which is rerun each time an additional item of information was communicated, an assumption changed or upon client requests for a change in inputs and/or output. The spreadsheet model is provided to stakeholders with access and with this report a summary of the output model is provided in annex.

As described in this report, the market conditions in Kigali are not conducive to delivering housing in the affordable segments to meet the demand. The reasons for this are many but include high land and construction costs, high capital costs and low formal household incomes. *It has been a key goal of the GCK project to balance cost structures, develop a robust financial model and ensure a reliable implementation vehicle that will deliver attractive affordable housing and quality green urban development.*

Throughout the feasibility stage, several workstreams have been ongoing to develop and test a unit mix structure, cost-efficient green and social infrastructure, and to identify ways for the target income groups to purchase/get access to the housing. The constraints/goals that the project's financial viability models seek to capture and optimize are;

- Cost-efficient design providing quality housing and sustainable infrastructure
- Affordability to income groups eligible for the World Bank Mortgage Scheme and according to Rwanda Government Standard
- Robust implementation - resistant to common implementation risks such as construction cost increase and delayed construction.
- Replicability – an implementation model that can be scaled

7.3.1 The Development Viability Model for the 15,8ha site

Since GCK project inception, the consultant team has iterated a series of financial models to monitor and explain the viability of the project and reflect the considered implementation models cost implications. The financial model has evolved in response to our increased contextual understanding and field experience and guided by our client's requirements. The model has gone through several iterations to reflect changes in design, tenure mix and affordability strategy. It also needs to link with a number of other models reflecting affordability, ownership initiatives and legal structure. Each version of the model has been subject to stress testing to identify the key variables and inform potential control mechanisms. A copy of the outputs from models under consideration, the Public Delivery Model (PDM) and the Public Private Partnership (PPP) model, is attached as an appendix to this report and a summary table is supplied here.

Table 22: Financial Model Summary Table for the two considered delivery models.

Project Profit	PDM	PPP
Revenue		
Infrastructure Grants	35,40	35,40
For Sale Affordable	25,33	25,33
Rent receipts prior to capitalisation	0,00	0,00
HtO balance available for Rent to Own	0,00	0,00
Market and Commercial Sale	32,96	32,96
- JV Developers Profit Share Affordable		-4,43
- JV Developers Profit Share Market and Commercial	-3,72	-5,77
Total Revenue	**89,98**	**83,49**
Costs		
Land cost	2,46	2,46
Housing construction - affordable incl. Green energy	21,11	21,11
Housing construction - market sale	11,25	11,25
Green energy for affordable	0,57	0,57
Social Construction	3,32	3,32
Commercial Construction	3,87	3,87
Other costs	19,53	19,53
Contingency	12,42	12,42
SPV set up costs		
Total Costs	**74,53**	**74,53**
(excluding Financing, Management Consultants & Supervision)		
Gross Profit	**15,45**	**8,97**
- Management Consultants (Implementation Monitoring)	-2,00	-2,00
- Construction Administration	-2,40	-0,93
- Site Supervision	-1,41	-1,41
- SPV Set Up and Running Costs	-2,00	-2,00
- Consultant Contingency	-1,56	-1,27
- Financing Costs	-0,54	
Profit	**5,54**	**1,36**
- Net loss Supp. Project	-1,84	-0,67
Total Profit	**3,70**	**0,69**

The model shows that both delivery models show financial viability under current assumptions, and with assumed contingencies of 20% on all costs. The next significant revision will most likely follow the release of the initial detailed cost estimate, pursuant to the completion of the detailed masterplan and schematic design package by the UADC. (expected 5 months from design works initiation). The UADC has already done an initial screening of the assumed costs for the project as it was part of the design competition to do a cost commentary. The commentary found the cost estimate within the design brief as achievable from the perspective of the winning UADC/bidder.

The underlying criteria for the viability model are that the expected receipts should at least cover all anticipated costs and that costs should include sufficient contingency to achieve operational success. With no costing based on a design available at this early stage, the models have assumed an overall 20% contingency to account for uncertainties.

A summary of the unit mix elements of the financial viability models can be found in the table below. Both models under consideration (PDM and PPP models), are assumed to have the same unit mix. However, due to the format of implementation the revenue items are somewhat different, resulting in different profit and loss statements . The basic model, no longer under consideration, had a different unit mix and includes rental units and fully subsidized housing. After deliberation with the project stakeholders, the basic model, was determined not feasible as it did not include the required contingency.

Table 23: Projected housing products for sale, selling prices and target income groups

Unit type	Building type	Typ. area (sqm)	Total Units	Selling price (mRWF)	Estimated Income group (Household Income/month)
Affordable 1BR Micro-unit	Apts	30	150	10,23	250-300k
Affordable 1BR	Apts	45	550	15,40	380-430k
Affordable 2BR	Apts	60	470	20,52	500-550k
Affordable 3BR	Apts	80	260	27,36	660-700k
Market Sale 3BR	Rowhouse	100	250	45.0	From 2500k
Total			**1 680**		

Estimates of Costs

The cost estimates for the two models are the same for the estimated cost of land, compensation, construction of buildings and infrastructure. The buildings are costed in the model by their different types; affordable housing, market rate housing, social construction (buildings for social purposes) and commercial units.

Housing construction is for costs within the curtilage of the construction site, excluding infrastructure. The costs of $329 psm for affordable units and $450 psm for market rate units (baseline cost is excluding preliminaries and site works), have been assessed by the consultant team through the development of housing typologies that have been costed with the help of a local quantity surveyor and validated by local experts. The design competition winners have also indicated that they believe the budget is feasible.

The land value assumed in the financial model was valued by RSSB. The relocation compensation has been estimated by the consultants E&S specialist. The baseline assumption is that cost of land for public realm and infrastructure will be carried by GoR and the land used for housing will be a cost in the financial model and ultimately carried by the housing and commercial space purchaser. The relocation compensation will be a cost to GCKC.

For infrastructure the costing exercise has been carried out using two methods, when possible suitable systems have been costed, but as the distribution and design of buildings, streets and other infrastructure is not yet known rules of thumb have also been used. This practice is widely used in early stages of planning development projects. Large industry actors such as Turner Townsend also publish yearly reviews of construction costs and rule of thumb cost averages, including a review of construction costs in Rwanda. This guide has been consulted to verify that the rule of thumb cost estimates computed are relevant also in the Rwandan setting.

Social Construction is a provision for a school, healthcare center, youth and social facilities, have been costed at $400 psm. The social buildings are to be handed over to the City of Kigali at nil capital cost, CoK will be responsible for cost associated with operations and management of the facilities. The cost estimates were constructed through a comparative process.

The direct infrastructure includes some elements that might be considered part of the Green Enhancements e.g. Blue/Green Network. SWECO experts have developed these costs considering typical pro-rata costs and other local schemes.

Municipal fees, taxes and other revenues are based on a standardized cost percentage and include several items sources such as planning fees and site insurance premiums.

With the difficulty to arrive at precise estimates at this stage of the process, prior to a cost able design, and with the construction risks involved a 20% contingency has been added to the estimated costs. We would like to highlight that a 20% contingency is high. Pre-design contingencies are often around 10% but a conservative approach has been adopted here in order to show a robust financial model that can withstand delays and other risks that might have an impact on the construction costs.

Table 24: Detailed breakdown of costs per item

Housing					
Unit type/ total units		m^2	total m^2	USD/ m^2	USD
Affordable 1BR Micro-unit	150	30	4 500	329	1 480 500
Affordable 1BR	550	45	24 750	329	8 142 750
Affordable 2BR	470	60	28 200	329	9 277 800
Affordable 3BR	260	80	20 800	329	6 843 200
Market Sale 3BR	250	100	22 095	450	9 942 750 (ex VAT)
					35 687 000
Social Construction					
Education			6 000	400	2 400 000
Healthcare			700	400	280 000
Retail/Commercial	shell only		19 822	170	3 369 740
Sports Area			4050	20	81 000
Community facilities, youth,meeting			1 400	400	560 000
Market Square			2 500	200	500 000
					7 190 740
Public realm			5 200	150	780 000
Road systems, (on and off-site)					2 080 000
Infrastructure	water sewage power inclusive of equipment		6,5%		3 570 000
Preliminaries - Mobilization			10%		5 690 000
Ground Work & Site Improvement			6,50%		3 810 000
Land cost					6 320 000
Municipal fees, licences, titles tax etc.			6%		3 600 000
Contingency			20%		12 420 000
Total Costs excluding Financing, Management Consultants & Supervision					74 529 000

Estimates of Receipts

Infrastructure and support grants from KFW and with FONERWA (totaling EUR 30m) are paid in Euros and then converted to dollars at an exchange rate of $1.18 per Euro. In total, the grants equal $35.40m with this exchange rate.

Affordable housing sales prices are currently set at construction costs plus 20%. After factoring in fees, the assumed value of land, compensation and contingencies the sale price will be significantly below cost and the corollary of market value.

The sale receipts of the market sale housing and commercial units reflect the research carried out and described in the mid-term and final feasibility studies. Effectively the profits on the market sale housing and the profits on the sale of the commercial properties will be subsidizing the sale prices of the affordable housing.

Fees, Consultants and Financing Costs

A series of specific support costs have been identified as important to the project's success. These include management consultants to support the work of GCKC, supervision of works, initial running costs of the GCKC, plus a 20% contingency on these costs to provide flexibility and risk mitigation. In addition, there are costs relating to the FS and UADC consultants for both design and management plus a 20% contingency. Also the contingency on the consultancy costs is high, but applied to have a conservative cost estimate also for these costs.

The project's total consultancy costs, including feasibility consultant, design competition and detailed design consultants are relatively high. There are several reasons for the relatively high soft cost, the project is carried out with international standards for E&S studies and resettlement. This goes beyond the requirements of the national regulations and is a requirement of the financier. The project goal to achieve innovation and thoroughly investigate a new urban development pattern in Kigali also drove some of the soft cost associated with the international design competition. In addition, these costs include the development of the 600ha masterplan and supporting feasibility study and the development of a GCF full funding application, with supporting design for the upgrade of an informal settlement. The many international teams that joined brought ideas on how to achieve the project goals. The covid-19 pandemic has also delayed he project with some associated impacts for consultant cost.

It is assumed that the infrastructure grant will be available as works proceed and that the housing and commercial construction will take place through sub-phases (as modelled in the cash flow analysis). In the Public Delivery Model, a housing developer finances the cost of constructing the housing sold at market rate, leaving GCKC with the short-term funding needed to build affordable housing. In the PPP-model, the contracted consortium provides all the funding leaving GCKC with little or no debt financing requirements.

BRD has confirmed interest in providing a revolving credit facility to finance the working capital requirements of the GCK project. After the initial stakeholder discussions, the path forward has been agreed. The project will share financial information about the project (which can be released after the approval of this report) and BRD can then confirm the terms of the facility. For the purpose of the financial viability model an assumed interest rate of the facility of 16% has been assumed.

Phasing and finance

The construction period for the pilot site is currently estimated at four and a half years, based around three phases (complete at every stage and each phase assumed 18 months). Each phase is assumed equal in terms of proportions of the unit mix and infrastructure items. Phasing of the development is crucial as it allows in market rate housing and commercial construction an opportunity to reflect changes in demand, material, and skills availability and cost as well as the performance of contractors, sales agents and other involved parties.

Phases with significant numbers of standalone buildings, including apartment blocks, will normally be divided into sub phases. In practical terms this allows better use of skills, reduced need to stockpile materials and especially phased hand over of completed homes to purchasers. The additional benefit is to reduce the cash flow requirements as

purchasers' contributions are released at hand over and construction for further sub phases can be held back until sufficient sales have been achieved on completed phases. This approach is particularly relevant to affordable housing as sales are often made prior or during construction due to demand exceeding supply for these homes. The phasing is reflected in the assumed cash flow analysis provided in the spreadsheet version of the financial viability model.

The Public Delivery Model (PDM)

Table 25: Public Delivery Model - Summary Financial Model

Receipts Summary ($m)	
Total Receipts PDM	89.98
Expenditure Summary ($m)	
Total Expenditure PDM	74,53
Projected Profit or Deficit ($m)	
Projected Gross Profit PDM	15,45
Less Management and Financing Costs	5,54
Less project support costs and contingency and net of contributions	-1,84
Projected Adjusted Total Profit PDM	**3,70**

The PDM assumes that GCKC realizes that developing homes for market sale to higher-income households requires increased resources, skills and experience that would be difficult for GCKC to acquire and efficiently utilize for a single project. The option is to work with an experienced developer most likely in the form of a Joint Venture (JV).

In a typical JV, GCKC would provide the land and the infrastructure to enable construction and the developer would provide construction, sales, marketing and project management. Each party would finance its responsibilities. In its simplest form, receipts and profits would be shared in proportion to the value of the inputs but this would be subject to negotiation.

Until the final planning is agreed (detailed design) it isn't easy to estimate the value of the land for the market sale housing or the infrastructure element. Both would need to be revised to consider the current national financing costs. Costs associated with funding project management and construction for the developer would be dependent on assumptions regarding pre-sales and the sub-phases. Developers might also have differing valuations of the market price of the homes. For this model, an underlying assumption is that a developer would require a typical profit margin of 17.5% (this estimate was obtained after speaking to several market stakeholders).

GCKC retains control of the land within the JV by only providing a 'building license' not transferring ownership.

The PPP Model (PPP)

Table 26: Summary Financial Model - PPP

Receipts Summary ($m)	
Total Receipts PPP	83,49

Expenditure Summary ($m)	
Total Expenditure PPP	74,53
Projected Profit or Deficit ($m)	
Projected Gross Profit PPP	8,97
Less Management and Financing Costs	1,36
Less project support costs and contingency and net of contributions	-0,67
Projected Adjusted Total Profit	**0,69**

In the PPP model, the whole housing project is handed over to a 'consortium' (which could be a single company but more likely one company bringing together a group of companies that provide different resources and skills). Here GCKC has a more supervisory role, although still needing the technical and management skills to ensure the completion and quality of the project and the appropriate sale of the affordable homes.

The nature of the contract is different from the Public Delivery Model in that instead of detailed specifications to a contractor. there is a framework design setting out the key requirements and controls. The consortium is then able to make a range of decisions regarding materials, timing, fittings and similar to keep costs under control and enhance sales. This is effectively the tradeoff for the consortium taking the risks of the project from GCKC. Any contract always carries some specific risks (e.g. political and wider economic risks) for which a developer would look to financial support from the employer.

Consistent with the PDM model above an assumption has been made of the 'consortium' wanting a developer's profit of 17.5% on all the activities they are responsible for which is related to additional costs. However, all financing costs are the responsibility of the 'consortium' and covered by the developer's profit.

7.3.2 Affordability

Refer to Section 4.3.2 - Affordability

7.3.3 Risk Assessment of the viability model

Each of the viability models are stress-tested to identify the critical financing constraints. On the receipts side of the model, the sales of the affordable housing units should hold little risk as long as there would be no significant changes in the construction costs. The affordable housing sales receipts are based on values significantly below the market, and demand is robust. A situation where a reduction in the housing market would reduce the receipts from affordable units is not likely and would have widespread ramifications for the rest of the Rwandan economy. It is assumed that the VAT rebate arrangements will be reflected in an agreement between the Rwandan government and GCKC before works proceed and should therefore be secured. The areas where there could potentially be a shortfall in receipts are from the sale of the market housing and the commercial property.

All the costs, excluding the cost of land and taxes, could be exposed to price inflation or additional costs. Given that these are all effectively construction-linked costs, they would be expected to move under a standard index unless specific other items were identified. According to Turner Townsend Construction Cost Review (2019) the cost increase in construction materials was 3% in both 2018 and 2019; estimates for 2020 are not available but are assumed to be the same. As supervision costs relate mainly to the construction costs, these would also increase at a similar rate.

<u>Sensitivities</u>

Delays in the implementation of the project could result in higher construction costs, both caused by general price inflation and increased costs incurred due to equipment and staff being longer at the construction site. In the excel version of the financial model we have shown how a change the square meter cost of construction effects the overall viability of the project. That analysis is not shared in this public document, but it shows that it will be important to keep construction costs low to meet the affordability targets. Since the delivery of affordable housing products are at the core of the GCK project we have provided an example of how cost inflation would affect affordability with the current cost estimate of $329 USD per square meter. The example shows how the impact of cost inflation coupled with associated earnings inflation would affect the affordability of one of the housing units.

Table 27: Example of how price inflation coupled with associated earnings inflation affects the affordability of the 45 sq meters one-bedroom unit

Year	3% price inflation (RWF)	2% earnings inflation (RWF)	5% price inflation (RWF)	3% earnings inflation (RWF)
1	14.84m	380k-430k	14.84m	380k-430k
2	15.28m	380k-430k	15.57m	380k-430k
3	15.72m	380k-430k	16.33m	400k-450k
4	16.19m	400k-450k	17.13m	400k-450k
5	16.67m	400k-450k	17.99m	420k-470k
6	17.16m	400k-450k	18.87m	420k-470k
7	17.67m	420k-470k	19.81m	440k-490k
8	18.19m	420k-470k	20.77m	440k-490k
9	19.28m	420k-470k	21.79m	510k-560k
10	19.84m	440k-490k	22.87m	530k-560k

Continued work with the financial viability model

As the GCK pilot project progresses it will be central to continue to stress test and monitor the financial viability model. As mentioned in this section the next expected major revision is expected when the first cost estimate of the detailed design is provided by the UADC team. It will also be important to continually follow construction costs and terms for access to mortgage assistance.

7.4 Infrastructure Service Provision

Roles and responsibilities for infrastructure service provision have been discussed and confirmed with service providers, focusing on ensuring that infrastructure will be sustainable in the long term. More details about stakeholder consultations held can be found in the Annex 2. The table below outlines the roles and responsibilities for providing and maintaining infrastructure at the pilot site.

Table 28: Summary of infrastructure roles and responsibilities

Infrastructure	Design and Construction Responsibilities	Maintenance Responsibilities
Public Roads	UADC will design the roads in the pilot site. GCKC will be responsible for construction. Design and construction will be coordinated with CoK and the Rwanda and Transport Development Agency. A circa. 1.5km extension of KG 31 Ave, connecting the pilot site with the surfaced road will require surfacing (a dirt road exists). The extension is based around a 12.7m wide collector road (excluding drainage and pedestrian walkways the road is 6.40m) with an easement provision to allow for future expansion to arterial road (see figure 49). During stakeholder engagement it has been indicated that this would be designed (detail), financed (GoR) and constructed by CoK. It is anticipated that financing for the road be applied for through the GCF (via MoE as AE and FONERWA as EE) as part of larger extension roads for the Kinyinya Hill to the future ring road and BRT, and within the GCF application. Land costs outside of the existing ROW as well as baseline co-financing would require GoR or other financing source. The details of which will be available within the GCF application. Note that the financial model includes a funding provision within the overall pilot development costs for the local road extension as a backup should GCF funding not be available.	Public roads will formally be handed over to the CoK for long-term maintenance.
Electrical Installation	REG will be responsible for designing and expanding the electrical capacity via additional substations or other infrastructure needed. UADC /GCKC will be responsible for lead-ins to the network.	REG/CoK will be responsible for maintaining the electrical system.
Water Supply	Central Water Supply System: UADC will design the water distribution within the pilot site and the connection to the nearby distribution main. GCKC will be responsible for constructing the water distribution system and the connection to the distribution main. All design and construction work must be coordinated with WASAC.	Central Water Supply System: Assets will be formally handed over to WASAC for maintenance, funded by user tariffs. Rainwater Harvesting Systems: Any central systems will be managed by GCKC; Individual systems will be governed by homeowners / associations.

	Rainwater Harvesting Systems: UADC will design the rainwater harvesting systems, and the GCKC will be responsible for construction.	
Sanitation	The UADC will design the simplified sewerage system and semi-centralized WWTP. The GCKC will be responsible for the construction.	The sewerage system and WWTP will be maintained and operated by the GCKC, funded by user fees in the near-term. In the long-term, responsibility may transition to WASAC (WASAC plans to manage WWTPs in the future).
Solid Waste	UADC will design the collection points. The GCKC will be responsible for construction. The design and construction must be coordinated with CoK and the collection company.	Collection company and CoK will be responsible for the maintenance of collection points.
Storm Water	UADC will be responsible for designing the stormwater management system. The GCKC will be responsible for constructing the stormwater management system. The design and construction must be coordinated with CoK.	CoK will be responsible for maintaining the stormwater management system.
Public Recreation Spaces	UADC will be responsible for designing public recreation space. The GCKC will be responsible for constructing public recreation spaces. Design and construction must be coordinated with CoK.	CoK will be responsible for maintaining the public recreation spaces.
Health Clinic	(not required)	(not required)
Public Schools	UADC will be responsible for design the public school at the pilot site. The GCKC will be responsible for constructing the public school.	The public school will be formally handed over to the CoK following construction. The CoK will be responsible for operating the school and maintaining the building and grounds.
Community Centre	UADC will be responsible for designing the community centre. GCKC will be responsible for construction.	GCKC and/or localized HOA for smaller quadrant facilities will be responsible for the maintenance (potentially via Umuganda)

7.4.1 Design Review, Approval, Construction and Transfer

On-going communication must continue between providers and the UADC and GCKC during the detailed design and construction phases. This will be achieved by scheduled design reviews, site visits, and workshops. Additional consultations, such as with community stakeholders, are of course required, especially for the completion of the ESIA, ESMP, and RAP. This process is summarized below.

Design Inception Phase:

- UADC organises a Kick-off Meeting and Stakeholder Validation Workshop (including PEA, CoK, Kinyinya Sector, WASAC, REG, RTDA and other stakeholders) with assistance and support by Sweco.
- UADC conducts detailed coordination with utility providers (especially REG)
- FONERWA finalises MoUs confirming responsibilities of CoK, WASAC and REG as described in the table above (if not yet done, with assistance from Sweco as needed). These MoU's should include, at minimum, the following:

    1. A background which includes:
        - The motivation behind the partnership between GCKC and the relevant authority.
        - Project background
        - The approved and updated preliminary design (in annex) following the inception/masterplan criteria alignment phase (stakeholder validated output to provide basis for future design) and to which the relevant authority had the opportunity to provide comment and input and which forms a basis for the MoU.
    2. Purpose:
        - The MoU should present the purpose for the partnership
        - Present the goals anticipated as a result
        - How noted goals will be accomplished and through what activities
        - Who is planned to undertake the activities/who will do what.
        - A timeline of the activities
    3. Reporting:
        - It is recommended that the GCKC as PEA provide responsibility in evaluating effectiveness and adherence to the agreement.
        - It should be agreed between both parties when evaluation will happen. It is recommended that at the outset evaluation timelines be agreed for the design period only, with tender and construction timelines agreed prior to relevant stage commencement, and that these be based around design milestone deliveries.
    4. Funding:
        - It should be indicated that the MoU does not in itself indicate a commitment of funds.
        - However, the arrangement of funding for provision of infrastructure and later adoption of relevant infrastructures for operations and maintenance should be clearly outlined and agreed between both parties. This forms an essential foundation of the MoU.
    5. Duration:
        - It is recommended that the duration of the MoU itself be at-will, but that it is based around project milestones as presented in the timeline (Part 2). However, an ultimate end date should be provided, coinciding, with the anticipated completion of construction activities and adoption of relevant infrastructures, with the opportunity for extension.

Schematic Design Delivery:

- UADC shares schematic designs with stakeholders – CoK, Kinyinya Sector, WASAC, REG, RTDA
- UADC holds workshops to discuss schematic designs and incorporate comments.
- UADC holds further consultation with individual providers to ensure compliance with requirements.
- Approval by the Project Executing Agency (PEA) with ongoing support of Sweco.

Detailed Design:

- UADC shares detailed designs with stakeholders – CoK, Kinyinya Sector, WASAC, REG, RTDA
- UADC organises workshops to discuss detailed designs and incorporate comments
- UADC completes permitting (using One Stop Centre for buildings; in discussion with responsible utilities for infrastructure)
- Approval by the PEA with ongoing support of Sweco.

Tender Documents:

- UADC shares relevant tender documents with stakeholders – CoK, Kinyinya Sector, WASAC, REG, RTDA
- UADC conducts construction phase coordination planning, where required.
- Approval by the PEA and with ongoing support by Sweco.

Construction:

- Coordination between GCKC and stakeholders during construction.
- Site visits, inspections and signoffs by CoK
- Handover of certain assets to the CoK and/or utilities once completed (roads, water distribution system, school, etc) and upon commissioning. Included in handover package to CoK/utilities would be complete as-built package, operations and maintenance manuals (as required) and operations tutorials/workshops (as required). These specifically can be determined during the design process as specific systems are decided.

7.5 Project Detailed Design

As outlined in Section 7.1 of this report, the chosen project delivery model for implementation of the pilot project (construction and operation) impacts the level of detailed design services required by the project UADC. The PPP method of delivery via a private developer in the form of a partnership with GCKC may require only the design of buildings (buildings is the term here to refer to housing, commercial and mixed-use buildings) to a schematic design or conceptual level. It is understood that from the schematic stage of buildings design, the private developer counterparty would then elaborate the designs into construction level information. However, the PDM delivery model would require elaborating all pilot components' designs to construction and tender level information (Construction Document and Tender Document Stage).

The terminology used for these levels of detail varies by region. Please refer to the below figure for a regional guide as an aide. The Terms of Reference (Part 2B) of the ITT used the US (AIA) terminology, but it is understood that different countries use different terms and the below is a helpful guide.

	Pre-Design		Design				Construction	Handover	In Use	End of Life
RIBA (UK)	0	1	2		3	4	5	6	7	
	Strategic Definition	Preparation and Brief	Concept Design	NOT USED	Developed Design	Technical Design	Construction	Handover & Close Out	In Use	NOT USED
ACE (Europe)	0	1	2.1	2.2	2.3	2.4	3		4	5
	Initiative	Initiation	Concept Design	Preliminary Design	Developed Design	Detailed Design	Construction	NOT USED	Building Use	End of Life
AIA (USA)			-		-	-	-			
	NOT USED	NOT USED	Schematic Design	NOT USED	Design Development	Construction Documents	Construction	NOT USED	NOT USED	NOT USED
APM (Global)	0	1	2		3	4	5	6	7	
	Strategy	Outcome Definition	Feasibility	NOT USED	Concept Design	Detailed Design	Delivery	Project Close	Benefits Realisation	NOT USED

Figure 58: Comparisons of International Plans of Design Work (src: RIBA)

It is essential for project implementation, regardless of delivery model chosen, that the UADC conducts design services to a minimum of a schematic design level. This would ensure that the concept building typologies developed align with the overall vision for the project regarding sustainability and affordability. And that the design is compatible with the overall pilot detail masterplan and coordinated appropriately with the developed concepts for infrastructure (social and physical). These would provide a template design onto which the private developer can create the building information while ensuring that they align with the project's guiding principles. In addition, as indicated in Section 6.7.2, Verification and Enforcement of Sustainability Ambitions, covenants must be included in the counterparty agreement that ensures that the project's overall sustainability ambitions shown in the GCK Sustainability Assessment Framework, are adhered to. The project cannot meet its sustainability objectives if the buildings do not meet the criteria set forth within the framework.

Design and Project Risks Mitigation

Should a PPP option for delivery be chosen, and the need for detailed design services for buildings by the UADC is deemed not necessary beyond schematic designs, Sweco recommends that a study on the capacity of local contractors and developers. The study's purpose would be to understand if potential contractors can develop the detailed designs of the buildings to a quality expected of an international project of this type and preserve its sustainable credentials. If this review finds deficiencies in the local market, a bespoke set of services within the scope set out at design development may be recommended. We further recommend, that the UADC be aware of the need for potential additional services beyond the Schematic Design stage may be necessary.

8 CONCLUSION AND NEXT STEPS

8.1 Conclusion

This Final Feasibility Study is aimed to provide stakeholders with a comprehensive yet concise overview of the proposed Green City Kigali project and with a particular focus on the future pilot project development. It has presented how it aims to achieve its goal as a sustainable development project through the project's four foundations (outcomes) of sustainability and further through a series of process outputs as presented in Table 10. This has resulted in a series of development outputs for the pilot project as described below, and as presented previously throughout the report, that reflect the various ambitions and requirements for the project. Following the presentation of the higher-level ambitions for the GCK project overall and the motivation behind each output, and further the presentation of its financial viability and implementation recommendations, this concluding section presents a brief analysis of the specific development outputs. Please see the below table outlining the specific GCK pilot development outputs, followed by an explanation as to the genesis and motivation behind key outputs.

Table 30: Pilot Development Outputs

GCK Pilot Development Outputs
URBAN PLANNING PRINCIPLES
• Work with nature in all its forms: The city's layout will work with the natural topography of the site, utilizing ecosystem services while protecting and enhancing its natural environment and biodiversity. • Be resilient and climate change ready: The pilot will adopt a range of strategies to mitigate climate change effects such as increased temperatures and water scarcity. These include nature-based solutions to mitigate stormwater run-off during heavy rains that will also contribute to shading and mitigating heat island effects. • A strong sense of community and ownership: The pilot will provide a hierarchy of communities from the dwelling level to the quadrant with a socially mixed development based around high-quality public spaces that encourage social interaction and provide opportunities for incremental growth and economic development. It will create social infrastructure beyond a typical private development in Kigali, such as schools and community facilities. • Well-connected and pedestrian-friendly: The pilot and the GCK in general will connect with the local transport network reducing the need for motorized vehicles. Compact, mixed-use planning where the higher densities are oriented toward public transport corridors will help create walkable neighborhoods which enhance the viability of regular and quality public transport. At the same time, pedestrians and cyclists will enjoy a network of shaded routes throughout the city. • Stand-alone at every stage: At each stage in its development (anticipated to be three phases, with further sub-phases) the GCK pilot will be stand-alone and not reliant on future phases to function. • Provide a catalyst for change in Kigali and beyond: The pilot will create a best-practice example by setting a new standard for the provision sustainable communities.

HOUSING

- 1,680 housing units in total. 1,430 are affordable housing (83%) to those <700k RWF/mo
- Affordable unit sizes from circa 30m^2 to 80m^2 (Micro, 1 BD, 2 BD, 3BD) based within simple walkup multi-storey buildings of up to 5x floors (G+4).
- Affordable units are designed be affordable to those earning incomes between 250k – 700k RWF/mo (circa. 250 – 700 USD/mo)
- Buildings developed using cost efficient and sustainable resources and employing environmental design features, meeting minimum internal dwelling area standards and where possible expanding beyond these.
- All buildings achieve EDGE Advance certification.
- Density of c. 108 DU/ha and taking advantage of land resource use efficiency, but with building heights, FAR and plot coverages in line with zoning regulations (R3 and C2-O).
- Estimated population of 7,728 based on an average HH size of 4.6.

PHYSICAL INFRASTRUCTURE

- Transport and Mobility: A road network, developed using sustainable and low carbon materials and methods, which promotes the use of public and non-motorized transport modalities and draws upon the GCK transport vision and further elaborated within future development of the design.
- Energy & ICT: Metered electrical connections supplied to all homes and businesses via the national grid (REG) and LPG cooking facilities made available. Buildings are solar energy and water heating install ready, with public buildings including install at outset.
- Water supply: Metered water supply connections to all homes via the municipal WASAC network and supplemented by grey water sourced from rainwater harvesting (RWH), with RWH system also acting as retention and control point for sustainable urban drainage network.
- Sanitation: Simplified sewerage and treatment system serving all homes and businesses. Simplified sewerage with reduced embodied carbon compared to traditional systems and recommended semi-centralized system with lower energy requirements.
- Waste Management: Waste sorting space provided for each 60 HH and within 200m of HH to allow for sorting into organic, recyclable and residual waste.
- Climate resilient stormwater management: The use of nature-based stormwater management systems for the local treatment, detention and infiltration of stormwater. Result is reduction of erosion and increase of groundwater recharge.
- Work with nature in all its forms: The city's layout will work with the natural topography of the site, utilizing ecosystem services while protecting and enhancing its natural environment and biodiversity. The blue green infrastructure will enhance transport system and livability quality by mitigating urban heat island effect.
- Roles and responsibilities as regards construction, operations and maintenance of systems agreed and pathway to handover presented.

PUBLIC AND COMMUNITY (SOCIAL) INFRASTRUCTURE

- Commercial: Neighborhood Centre and Market Square (2,500 m^2)
- Education: Primary and Nursery School (6,000m^2, including use of park and sports field for outside activities)
- Socio-cultural: Community Hall (utilizing auditorium space of primary school with size to be determined in conjunction with UADC)
- Socio-cultural: Religious, Youth and Social Space: 1,400m^2
- Parks: Neighborhood Park and Sports Field (nearby to primary school): 4,050m^2
- Public Realm: Public plazas and squares using semi-porous materials for natural stormwater infiltration: 5,200m^2

PROJECT DELIVERY AND IMPLEMENTATION ARRANGEMENTS

- Government owned Green City Kigali Company established and responsible for management of the project master planning, design and tender process, land transfer and development of the site with infrastructure, transfer of land for housing and commercial to developer counterparties, and maintenance (in conjunction with municipality and utilities) of infrastructure and public buildings/areas.
- Enforcement and verification of project sustainability ambitions through use of contract covenants by GCKC with counterparties.
- GCKC enters into agreements with relevant utilities and municipal authorities as regards provision, handover and operations of public infrastructure.
- GCKC enters into agreement with private developer counterparties for transfer of serviced land for development of commercial and residential buildings.
- The construction of the pilot will, where feasible, aim to build skills and capacity by utilizing, where possible, local labor and local materials; thereby maximizing the benefit to the local economy while minimizing environmental impact.

FINANCIAL MODEL AND VIABILITY

- Both considered implementation frameworks show financial viability under current assumptions. During the coming phases it will also be possible to work with a variation of the two models depending what model that can best deliver the desired results. The best implementation model can be evaluated at each sub-phase to allow flexibility.
- The GCK pilot will provide housing products that are in great demand on the housing market in Kigali. The units will be in a price range that households earning less than 700 000 RWF/m can afford. There is currently very little supply in that price range and given the long list of households pre-approved for mortgages, it is expected that the demand for the GCK units will be high. The sales receipts from affordable housing is considered to have low associated risk as long as construction costs remain stable.
- The cost estimate for construction costs will be further detailed and elaborated as the detailed design is developed. The current cost estimate has been thoroughly benchmarked and reviewed by both local and international experts.
- Sensitivity analysis has been carried out on several key parameters including USD/RWF exchange rate and cost inflation. The primary financial and economic risks relate to the possibilities to absorb changes in either costs or receipts for the development. This could either be done by using the contingency funds

to address unforeseen costs or costs increase, or by increasing receipts by raising prices (if possible while still meeting affordability targets).

8.1.1 The Development Outputs in the Context of GCK

Unit Sizes and Building Heights:

- In addition to factors presented in Proposed housing typologies at unit level, and further those for block and building level in determining unit sizes were economic factors related to household affordability and as presented at Section 7.2 and 4.3.2.
- The 3 bedroom unit (circa. 80m^2), under the considered model, would be considered the maximum size affordable to those within the 700,000 RWF World Bank mortgage assistance cap.
- Smaller units such as the 1 bed and 2 bed unit would provide affordability to lower levels of income (380k RWF/mo and above) while also providing for the Rwandan desire for space within the home and providing a minimum and comfortable internal dwelling area (MIDA)[36]. Thus, providing increased sales appeal and attractiveness to private developers.
- The 30m^2 micro-unit is designed to provide maximum affordability to those starting at 250k RWF per month, while also providing the opportunity for future expansion as income and needs expand to up to 45m^2. It is considered, pursuant to community and stakeholder engagement and marketplace research, the minimum viable unit size that is marketable within the Kigali context. It was introduced at the request of GoR stakeholders and project financiers during the mid-term review to determine ways to provide an even greater level of affordability than was originally envisioned during the feasibility process.
- During community and stakeholder engagements the various typologies, or similar, were presented to parties and while larger units were always the most desired, there was consistent feedback that users would be willing to sacrifice unit size for high quality units (leaking roofs were a constant complaint) that were affordable. A small outside space was always mentioned as important, thus informing Sweco's development of recommended typology character to include balconies or terraces.
- Building heights are determined in respect to zoning requirements within the pilot development area, while also respecting the need to keep construction and operations costs low through the provision of simple walk-up buildings in lieu of elevators, which are uncommon in residential buildings in Kigali. Lower building heights also retain an important human scale to a neighborhood (see Section 6.6.2).
- Another factor are statutory floor to area ratio (FAR) and plot coverage (PLC) requirements for the pilot site, which is limited to 1.4 FAR (C2-O mixed use zone) at collector road zones, and 1.2 elsewhere (R3). Sweco would recommend the pursuit of a planning variance upon approval of the development's schematic design to a 1.4 FAR throughout the development area, and further to 1.75 at C2-O in consideration of its status as an affordable housing project (requirement to align with PM Instructions re Affordable Housing).
- Statutory plot coverage limits are 60% but this is further constrained by the project's green ambitions as regards stormwater management systems and the requirement for an overall permeable area of 65% within the project boundary, and as presented in the GCK sustainability benchmarks (6.8.1). The UADC is aware of this requirement and will be required to maintain this. It is worth noting that when considering stormwater management, building green can come at a premium in its more expanded permeable space requirements vs. a conventional and BAU approach.
- The recommendation for row housing, in lieu of more detached typologies, for the market housing has been motivated by the recognition that this is a green city development and thus all units must adhere to certain

36 Housing Space Standards, GLA (2006)

standards as regards density and resource efficiency. In addition, is the fact that while being sold at market prices with higher levels of finish, the units are located within a development of mostly affordable housing and thus unit prices and further typology should be appropriate for its setting, while maximizing returns to its developer.

- Further the pilot development as located within zone R3, promotes a more intensive development through preferencing row housing and multi-family housing development over single-family housing.

Development Densities:

- Several factors have determined the proposed density for the pilot development. These are zoning requirements (R3/C2-O), RHA requirements as regards affordable housing developments, land use efficiency within a higher land cost area, and the project's overall green ambitions.
- The pilot site's zoning requires a minimum residential density of 50-90 DU/ha (dependent upon land use). Further affordable housing developments require a higher density by 25%, thus pushing this minimum to between 63-113 DU/ha. This is the most significant factor influencing development densities.
- Further, at 40 USD/m^2 (reduced to 36 USD/m^2), land costs for the pilot development, and as indicated previously, are higher than those for a typical affordable housing development in Kigali. This requires that land be utilized intelligently to achieve and maximize the project's affordability ambitions.
- Further, one of the principal foundations for the GCK is resource efficiency, including land. These broader ambitions are presented at 6.3.1.
- It should also be noted, that unlike other typical affordable housing developments within Kigali the GCK provides a higher standard of social infrastructure, such as a nursery, primary school, community spaces and recreational space(s). Therefore, at a glance development densities may appear similar to other projects, such as those case studies presented in chapter 4, the land use of these community facilities as well as the provision of commercial/mixed-use spaces drive housing densities higher within housing clusters.

Physical Infrastructure

- The rationale behind recommended infrastructure systems within this specific report, has been developed with the requirements of the 16ha pilot development as a focus. Thus, those arguments as laid out in Section 6.8 are relevant for the pilot specifically.
- It is worth re-iterating the issue of the ambition for a nature-based stormwater management system vs. its real-world costs as regards permeable space and the cost consequences of this in the context of an affordable housing development. If the design development and further construction is not closely monitored it would be easy to forsake this ambition for a more conventional approach. It is also worth noting that in a traditional BAU affordable housing development, and without direct subsidy, it would likely not be feasible for the developer to develop such a system due to larger land requirements.
- Roles and responsibilities for the transfer of assets and the long-term maintenance have been determined through stakeholder consultations, as laid out in Section 7.4.

Public and Community (Social) Infrastructure

- The GCK goal presents the vision for a socially and economically equitable community within the context of an environmentally sustainable development. The provision of quality social infrastructure, in addition to physical infrastructure systems, is a requirement to achieve this vision and in line with the project livable community ambitions.
- Further the CoK Masterplan and Rwanda Urban Planning Code, are prescriptive in their requirements as regards public and community facilities, the future pilot development being considered a neighborhood and as part of the larger Ngaruyinka village community.
- The school at 6,000m^2 has been determined based on an estimated student population of 900. Based on the consideration of 2.5m^2 per student per class, a further 2.5m^2 per student for the provision of auditorium (intended to double as a community meeting facility), dining hall, library, labs, administrative areas and nursery this totals to 4,500m^2 total NIA. A further 30% has been added for circulation, services and storage. However, this total area need not all be conditioned space, and the future detail design will allow the opportunity to investigate the use of covered and outdoor spaces where possible to reduce costs. It should be noted that UPC requires a 1.5ha site, so a variance will likely be required, though the recreational area will be dedicated for student use during school hours. The current design proposal anticipates a G+1 construction for the school.
- The ambition for the pilot as a vibrant mixed-use development, providing not just residential but space for commercial activities providing sources for potential employment for its inhabitants as well as services has been presented within the project brief and further reinforced by the site as a C2-O mixed use zone within the CoK MP. As such, and following a commercial demand study as well as community engagement that indicated the importance of such services (a major complaint about Vision City was its lack of on-site services at outset), the following are presented for the pilot development:
    - Market Square: 2,500 m^2
    - Commercial Space: located at the ground floor of G+4 buildings within the C2-O zones.
- It should be noted that the provision of commercial space at the ground floor of buildings allows for flexibility should there be a shortfall in anticipated demand for such space. This would allow for conversion of commercial space to housing or parking sale.
- Spaces such as the public realm and neighborhood park, provide important dual use functions. In addition to providing important public gathering and recreational space in accordance with the project livable community concept, the spaces provide permeable ground for stormwater infiltration and recharge. As previously noted, a permeable ground area of 65% is required as part of the project's sustainability benchmarks.

Project Implementation

- An overarching delivery vehicle in the form of the Green City Kigali Company has been established to serve as principal implementing entity for the 16ha pilot development.
- Working in conjunction with PEA, GCKC, the UADC, and client project manager on the master planning and detail design of the site, will be the GoR, City of Kigali, WASAC and REG. These municipal and utility entities will provide input, comment and knowledge into the design process with the understanding that they will ultimately takeover relevant infrastructures (and as presented at 7.3) and provide for their operations and maintenance. Revenues for this will come either through user tariffs or through external budgets. A step-by-

step process for milestone design review and input and handover, and as agreed in principle with the relevant entities, has been laid out.

- One major site service that will not be provided via the municipality or a utility is wastewater treatment. Section 6.8.6 provides information, and with this consideration in mind, regarding expected capital costs for the treatment system itself, projected operations and maintenance costs and typical user tariffs in Kigali for such service by household. It is projected by WASAC that in the future the utility may provide for the operation of such semi-centralized wastewater management systems, but not within the timeframe for the system coming online at the GCK pilot. Thus, it should be anticipated to be an ongoing responsibility of GCKC, likely through an agreement with a qualified company, unless a special arrangement can be found with WASAC, outside of the FS consultant's abilities.
- Further, one option presented (PPP model) is for the GCKC to work with a private developer(s) who will undertake the detail design and construction of housing and commercial space within the development. The benefits and downsides of such an approach is examined at Section 7.1. It is noted here to highlight the fact, that and as presented within the section, the importance that GCKC is adequately equipped with skilled staff to oversee a variety of different agreements and partnerships for its successful development.
- As for most development projects the time of construction is key, as it will determine how long the developer has to carry the cost of finance before revenues come into the project. As highlighted in the case studies delayed construction times was a major cause of increased costs. Sweco has included sensitivity analysis on cashflow due to delayed construction in the financial model and suggested a mitigation strategy of sub-phasing the project in order to secure revenue back to the project. However even with that in place it will be crucial that the GCKC has experienced staff who can manage the contract/(s) with the private developer/(s) to avoid construction delays and other potential interruptions.

Financial Viability

Section 7.3 provides a detailed examination of the project's viability within the context of the presented development outputs for the 16ha mixed use affordable housing pilot.

Concluding Remarks

The GCK is a complex and multi-dimensional project(s) with the core aim to combine two objectives, which have not historically been associated in projects. These are affordable housing combined with environmentally sustainable development, which includes the provision of green physical and community infrastructure. Alone these are lofty ambitions, especially within the context of a resource limited setting with low levels of income paired with very high rates of urbanization and housing costs. Combined they present a project that will need to be planned and developed carefully as it moves into its next stage(s) of development. The commencement of design will allow for provision of information such as more detailed costs, heretofore unavailable, which will provide crucial information to feed back into the project's viability model and business plan. Flexibility and care in approach and the employment of careful sub-phasing will be importantl going forward to ensure achievement of the project's worthy goals.

8.2 Next Steps

This Executive Summary report to the Final Feasibility Study comes at the end of Phase B. Phase C, as the pursuant stage of the Green City Kigali Project, includes the following tasks and which is further illustrated in a high level workplan below:

1. The development of a 600ha Green City Masterplan and pursuant adoption of the plan into the overall CoK Masterplan as a special planning area within Kigali.
2. The development of a Land Subdivision Plan, detail design and tender documents (where necessary) for the 15.8ha mixed-use affordable housing pilot project.
3. Development of the Green City Kigali Company with the support of a management consultant from a shell company to establish it as the implementing entity for the pilot project.
4. Continued development of a full funding Green Climate Fund application and its associated projects, and gckc includes an 18ha urban upgrade project adjacent to the future pilot.
5. Environmental and Social Safeguards Assessments and Plans in support of the aforementioned projects and which include ESIA, RAP, ESMP, SEP and GAP.
6. Continued update of the project financial viability model as the project's design progresses.
7. Preparation for implementation of the pilot and upgrade projects
8. Ongoing support to FONERWA as well as other GoR and Municipal entities.
9. Continuous cycles of stakeholder and community engagement.

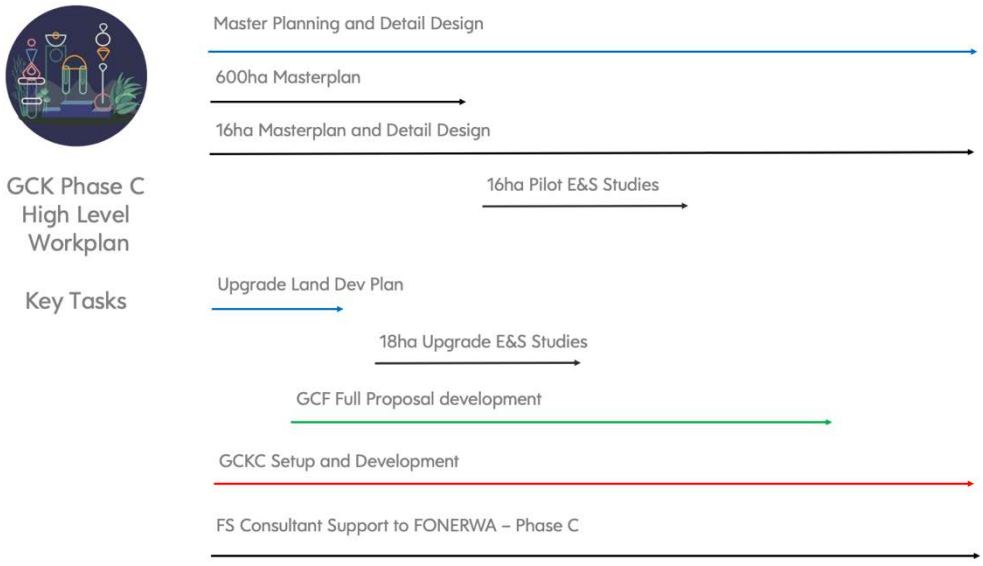


Figure 59: GCK Phase C High Level Workplan of Key Tasks

9 REFERENCES / APPENDICES

9.1 Annex 1: Bibliography

Please refer to the Final Feasibility Study (Sweco 2020) for the full bibliography

9.2 Annex 2: List of stakeholder and Community Engagements

For further information as regards site visits, panel discussions, user groups and interviews please refer to MTFS Part II, Sector Studies.

List of persons/institutions consulted as part of this FS ES document (March and April 2021)

In addition to the below list were conducted several interviews with those within the housing development industry. For the sake of confidentiality and to allow them to speak honestly and critically they are not listed below. The outcomes of these discussions form part of the information provided at Section 4.3 – Comparative Case Study Projects.

Name	Organisation	Position
Liliane Uwera	Rwanda Development Bank (BRD)	SPIU Coordinator
Jean Claude Ilibonye	Rwanda Development Bank (BRD)	Senior Manager/Credit Division
Nelson Mandera	Rwanda Development Bank (BRD)	RHFP Coordinator
Harouna Nshimiyimana	Rwanda Housing Authority (RHA)	Building Regulations Division Manager
Martha Yankurije	City of Kigali /MINEDUC	Education Officer / MNEDUC Attaché
Ruzindana Jean Claude	City of Kigali	Director of Social Development
Longin Uwiduhaye	EUCL/REG	Electric Supply / CoK Attachée
Jean Bosco Utegerejeyezu	City of Kigali	Public Lights
William Bihoyiki	EUCL/REG	Electric Supply
Mukangabire Patricie	City of Kigali	Director of Public Health & Environment Unit
Marie Therese Kangabire	City of Kigali	Public Health Officer
Solange Muhirwa	City of Kigali	Chief Urban Planner
Rukundo Benon	City of Kigali	Director One Stop Center
Sheila Uwase	City of Kigali	Acting Director of infrastructure
Etienne Rwagatore	City of Kigali	Public Transport
Anthony Kulamba	RURA	Public Transport
Virgile Mugisha	City of Kigali	City Engineer
John Mugabo	City of Kigali	Solid Waste Officer
Fidele Tuyisenge	City of Kigali	Water and Sanitation officer
Alice Muhorakeye	City of Kigali	Environmental officer
Vincent Mugwaneza	WASAC	Director of Rural water and sanitation services
Dominque Murekezi	WASAC	Manager of Water and Sanitation Infrastructure Planning

Community Engagement Kinyinya – Murama – Ngaruyinka

Name	Position /KINYARWANDA	Position /ENG
Nduwayezu Alfred	Sector Executif of Kinyinya	
Jean Marie Vianney Habiyambere	Umukuru W'umudugudu	Head of the Village
Nizeyimana Emmanuel	Umufashamyumvire	Counsellor
Uwamariza Esther	Umutwarasibo	Head of Isibo
Rukundo Alexandre	Umutwarasibo	Head of Isibo
Chaweli Randrada	Umufashamyunvire	Counsellor
Niyibizi Thacien	Umujyanama	Advisor
Nirere Marie-Rose	Umugoroba w'Ababyeyi	Conflict resolutions within Households
Munyaneza Jean Claude	Imibereho Myiza	Health Advisor
Kubwimana Laethitia	Umufashamyumvire	Counsellor
Rutaganira Jean-Leon	Ushinzw' Umutekano	In charge of Security

Name	Organisation	Position
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Asaba Emmanuel Katabarwa	City of Kigali	City Engineer
Patricie Mukangarambe	City of Kigali	Social Affairs & Good Governance
Frank Gisagara	Isuku Kinyinya Waste Management Company	Manager
Jean Claude Munyaneza	Ngaruyinka Village	Village Leader
Jean Marie-Vianney Habiyambere	Ngaruyinka Village	Village Leader
Jaqueline Nsabiyaremye	Ngaruyinka Village	Health Representative
Jean Leonard Rutaganira	Ngaruyinka Village	Community Information
Alphons Muramutsa	Ngaruyinka Village	Community Security
Clementine Nzanzamahoro	Ngaruyinka Village	Women Representative
Jean Claude Munyaneza	Ngaruyinka Village	Village Leader
Dominique Murekezi	Water and Sanitation Corporation (WASAC)	Manager of Water & Sanitation Infrastructure Planning
Ammos Shyaka Kazora	Water and Sanitation Corporation (WASAC)	Acting Head of Sewer Operations
Vincent de Paul Mugwaneza	Water and Sanitation Corporation (WASAC)	Director of Rural Water & Sanitation Services
Paulin Buregeya	COPED	CEO
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Fabrice Barisanga	Rwanda Transport Development Agency (RTDA)	Division Manager of Planning, Quality Assurance & Research
Emile Baganizi	RTDA	
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Urban Design Handbook

Name	Position	Organization
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KALISA Catherine	National Technical Advisor on Urbanisation in Rwanda	UN-Habitat
KASIRYE Dan	Resident Representative Rwanda	International Finance Corporation (IFC)
KYAZZE Eddie	Manager of the Urbanization and Human Settlements Division	MININFRA
MUGISHA Fred	Director of Urban Planning & Construction	City of Kigali
SORGO Hamidou	Senior Private Sector Specialist Rwanda	International Finance Corporation (IFC)
SPALIVIERO Mathias	Senior Human Settlements Officer	UN-Habitat - Regional Office for Africa,

Feasibility Sector Report II – Housing *(for lists of other consultations re sector studies refer to specific sector reports)*

Name	Position	Organization
MUHIRWA, Solange Marie	Building Construction Architect Officer	City of Kigali
MUVUZANKWAYA Samson	Acting Division Manager of Affordable Housing	Rwanda Housing Authority

NSHIMIYIMANA Harouna	Building Regulation, Inspection and Audits Division Manager	Rwanda Housing Authority
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ARRABOTHU Dheeraj	Officer	Global Green Growth Institute
DIEYE Fatou	Coordinator	Swiss Resource Centre and Consultancies for Development
GAHAMANYI Jean-Claude	General Manager	Greenrock Iwacu
HOLLAND Jim	AAC Plant General Manager	Remote Group
CHIRINDA Wellington	Marketing Director	New Forests Company Rwanda
MUPENDE Liliane	Urban Planner	Global Green Growth Institute
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Preliminary ESIA *(for other E&S Studies please reference specific study reports by SRA or ERM)*

Organization	Name
Rwanda Development Board (RDB)	Simeon Ntute
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Kigali City (KC)	Benon Rukundo
Rwanda Social Security Board (RSSB)	Louise Muteteri
Kinyinya Sector	Esther Ngaruyinka-Murama Rose Ngaruyinka-Murama

World Urban Forum 2020

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Bright NTARE	Chief Finance Officer	FONERWA
Sylvia KAWERA	Project Analysis Specialist	FONERWA
Emmanuel NKIRINKINDI	Executive Secretary and Registrar	Rwanda Institute of Architects (RIA)
Jean Marie Vianney KAMIYA	President	Rwanda Institute of Architects (RIA)
Eudes KAYUMBA	President, African Union Architects Association and Vice-President	Rwanda Institute of Architects (RIA)
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Catherine KALISA	Acting Program Manager	Rwanda UN Habitat
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Donald. R. Kabanda	CEO	Rwanda Electric Mobility (REM)
Emmanuel Hategeka	Ambassador	Rwanda to the UAE